Parker Point Desalination Plant

17 September 2021

Assessment of Marine Impacts

Report to Hamersley Iron Pty Limited

From

MScience Pty Ltd
Perth, Western Australia

Parker Point Desalination Plant

Assessment of Marine Impacts

Document Information

REPORT NO.	MSA286R02
DATE	September 17, 2021
CLIENT	Hamersley Iron Pty Ltd
USAGE	This report is provided for use as part of a broader assessment of the environmental impacts of the proposed Parker Point Desalination Plant.
KEYWORDS	Marine, impacts, desalination
CITATION	MScience 2021. Parker Point Desalination Plant. Assessment of Marine Impacts. Unpublished report MSA286R02 to Hamersley Iron Pty Ltd, Perth Western Australia, pp79

Version History

Version/Date	Issued as	Author	Approved
1/22.07.2021	For client review	IJP	JAS
2/17.09.2021	Client comments addressed	IJP	JAS

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List of Acronyms and Abbreviations

Acronym	Definition
ADWG	Australian Drinking Water Guidelines
AHD	Australian Height Datum
AMSA	Australian Marine Safety Authority
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
BC Act	Biodiversity and Conservation Act 2016
BCH	Benthic Communities and Habitats
CAMBA	China Australia Migratory Bird Agreement
CT	Contaminant Threshold
DAF	Dissolved Air Filtration
DBCA	Department of Biodiversity Conservation and Attractions
DPIRD	Department of Primary Industries and Regional Development
EILs	Ecological Investigation Levels
EPA	Environmental Protection Authority
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EQG	Environmental Quality Guideline
EQMP	Environmental Quality Management Framework
EQO	Environmental Quality Objective
ERD	Environmental Review Document
EV	Environmental Value
HAT	Highest Astronomical Tide
HILs	Health Investigation Levels
IMS	Introduced Marine Species
JAMBA	Japan Australia Migratory Bird Agreement
LAT	Lowest Astronomical Tide
LEP	Level of Ecological Protection
LTMMP	Long Term Dredging Monitoring and Management Plan
MARPOL	The International Convention for the Prevention of Pollution from Ships
MNES	Matters of National Environmental Significance
NAGD	National Assessment Guidelines for Dredging
NEPM	National Environment Protection (Assessment of Site Contamination) Measure 1999
NWQMS	National Water Quality Management Strategy
PTS	Permanent Threshold Shift
Rio Tinto	Rio Tinto Iron Ore
ROV	Remotely Operated Vehicle
SQGV	Sediment Quality Guideline Value
SST	Sea Surface Temperatures
SWQMS	State Water Quality Management Strategy
SWRO	Seawater Reverse Osmosis
The Proponent	Hamersley Iron Pty Limited
TSS	Total Suspended Sediment
TTS	Temporary Threshold Shift
UCL	Upper Confidence Limit
UF	Ultra-filtration
WA	Western Australia
WAMSI	Western Australian Marine Science Institute
WET	Whole of Effluent Toxicity

EXECUTIVE SUMMARY

Hamersley Iron Pty Limited (the Proponent) is undertaking an assessment of the environmental impacts of constructing and operating a seawater reverse osmosis (SWRO) desalination plant (the Project) at its Parker Point facility within its Dampier Operations in the Port of Dampier in Western Australia's Pilbara Region. An existing cooling water intake pond to the south of the Parker Point facility, which previously serviced the now decommissioned power station, has been identified as the location for the seawater intake. The brine generated as a wastewater during desalination will be discharged to the ocean via an outfall to be constructed under the Parker Point wharf. These locations were selected specifically to minimise the Project's impact on the marine environment. The Project will be developed in stages up to a maximum production capacity of 8 GL/a. Construction and operation activities of the seawater intake and brine outfall have the most relevance to this marine impact assessment.

This document presents an assessment of potential environmental impacts of the marine aspects of construction and operational activities of the proposed Project. Details provided in this assessment may be used to support an Environmental Review Document (ERD) to form part of a proposal referred to the Environmental Protection Authority (EPA) under Section 38 of Part IV of the Western Australian *Environmental Protection Act* 1986 and Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The conclusion of the assessment was that there should be no additional impacts of the Project beyond the existing footprint of port operations in this area, based on:

- Siting of the outfall towards the centre of the existing disturbance footprint of the Parker Point wharf, berth and swing basin infrastructure;
- Using existing infrastructure for the seawater intake;
- The type and concentration of residual chemical compounds anticipated to be within the wastewater discharge;
- The rapid dilution of the discharge water to less than 1:222 (worst case dilution scenario) to achieve the 99% species protection level (SPL) at the Moderate/High level of ecological protection (LEP) boundary within 500 m of the outfall (predicted from dispersion modelling) - based on criteria derived from other SWRO projects;
- The lack of benthic communities and habitats of conservation significance within 1.5 km of the outfall;
- The management measures proposed during construction and operation to limit any impacting processes within the receiving environment, such as reducing light emissions to as low as reasonably practicable.

Modelling provided by Advisian predicts that:

- The Moderate/High LEP boundary for temperature and suspended sediments should be achieved within 50 m of the outfall; and
- The Moderate/High LEP boundary for salinity should be achieved within 300 m of the outfall

The rapid dilution of discharge waters predicted was consistent with the protection of the small community of sparse benthos 120 m to the south of the outfall from any effects of lowered water quality.

Overall, this assessment has found that the Project is unlikely to cause significant environmental impacts to marine environmental quality, benthic communities and habitats or marine fauna.

1 INTRODUCTION

1.1 Background

Hamersley Iron Pty Limited (the Proponent), is undertaking an assessment of the environmental impacts of constructing and operating a seawater reverse osmosis (SWRO) desalination plant (the Project) at its Parker Point facility within its Dampier Operations within the Port of Dampier in Western Australia's (WA) Pilbara Region. Hamersley Iron Pty Limited is a wholly owned subsidiary of Rio Tinto Iron Ore (Rio Tinto), and the Project is being managed by Rio Tinto on behalf of the Proponent.

The Project will establish a reliable supply of water for the Proponent's Dampier Operations and a potable water supply to the township of Dampier, which are currently supplied from the Water Corporation managed West Pilbara Water Supply Scheme which draws upon the Bungaroo Coastal Water Supply Borefield in the Robe Valley.

The Proponent proposes to locate the plant's associated seawater intake and wastewater discharge pipes within existing port infrastructure (Figure 1-1). An existing cooling water intake pond to the south of the Parker Point facility, which previously serviced the now decommissioned power station, has been identified as the location for the seawater intake. It was selected specifically to minimise the Project's impact on the marine environment. The brine generated as a wastewater during desalination will be discharged to the ocean via an outfall to be constructed under the Parker Point wharf.

The Project is proposed to be developed in stages up to a maximum production capacity of 8 GL/a.

1.2 Purpose of Document

The purpose of this document is to present an assessment of the potential environmental impacts of the marine aspects of construction and operational activities of the proposed Project. Details provided in this assessment may be used to support an Environmental Review Document (ERD) to form part of a proposal referred to the Environmental Protection Authority (EPA) under Section 38 of Part IV of the Western Australian *Environmental Protection Act* 1986. As such, the impact assessment sections of this document are structured in accordance with the EPA document "Instructions: Environmental Review Document. Instructions on how to prepare an Environmental Review Document" (EPA 2020). Details in this document will also be used to support a referral under the Environment and Biodiversity Conversation Act 1999.

1.3 Environmental Impact Assessment Process

1.3.1 Western Australian Environmental Protection Act 1986

The *Environmental Protection Act 1986* (EP Act) is the primary legislative instrument for environmental assessment in Western Australia (WA). Under Part IV of the EP Act, the EPA is responsible for providing advice to the WA Minister for the Environment on proposals assessed under Part IV of the EP Act and considered by the EPA as likely to have significant impact on the environment.

1.3.2 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) an action requires approval from the Environment Minister if it will have, or is likely, to have a significant impact on a matter of national environmental significance. Matters of National Environmental Significance (MNES), as these relate to the marine aspects of this project, might include interactions with:

- Listed threatened species and communities; and
- Migratory species protected under international agreements.

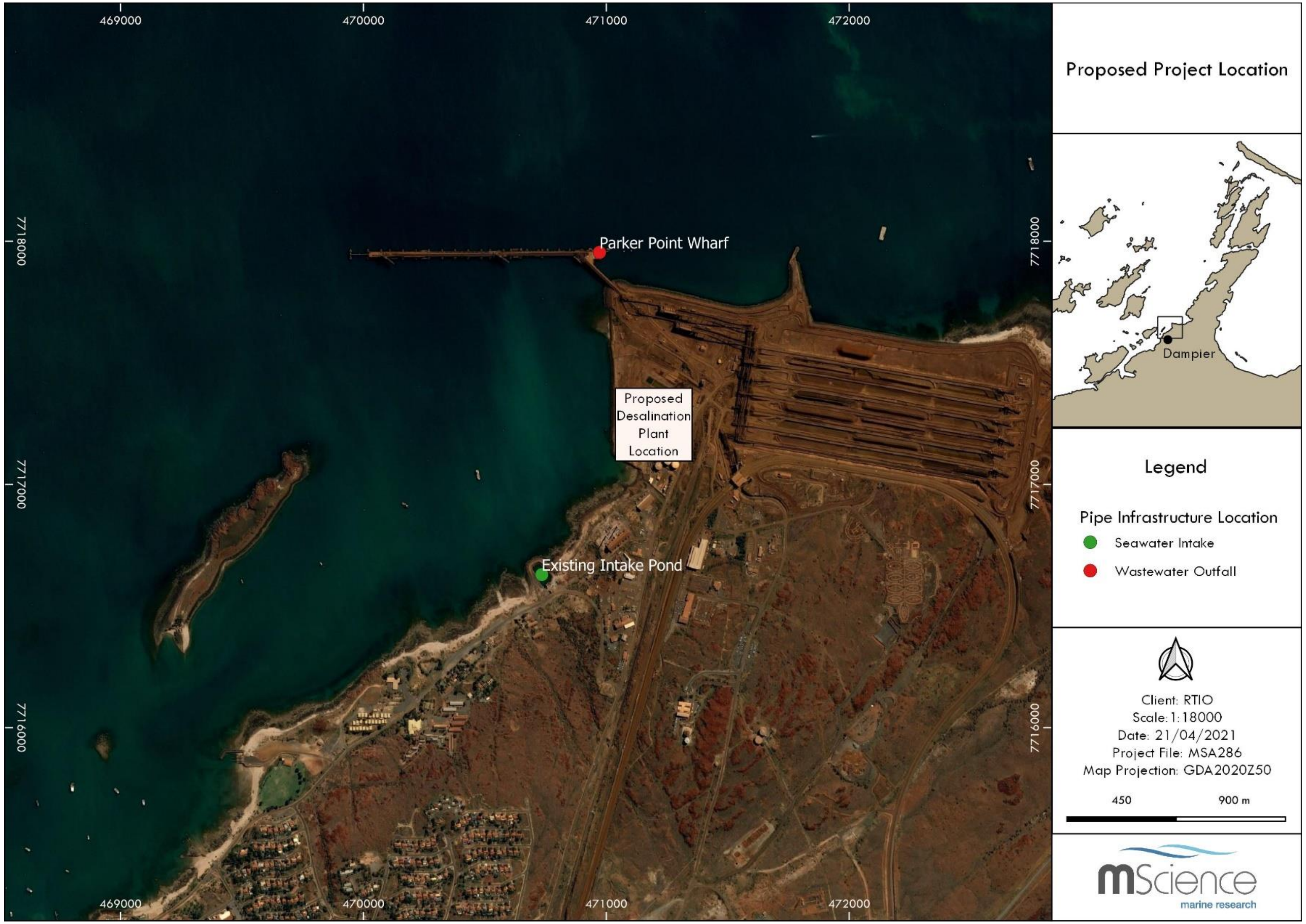


Figure 1-1. Project location

Listed threatened and migratory species identified from a search of the EPBC Protected Matters Database with the potential of occurring within and/or adjacent to the Project area are provided in Section 6 and **Appendix A**. A separate assessment has been undertaken which considers only MNES under significance guidelines relevant to the EPBC Act.

1.4 Project Description

The Project development envelope comprises of three key areas:

- Seawater intake site – located within an existing intake pond;
- Plant site – within an existing disturbed area; and
- Wastewater brine outfall – located along the Parker Point wharf.

The following Project description focuses on the construction and operation activities of the seawater intake and brine outfall, which have most relevance to this marine impact assessment.

1.4.1 Desalination Process Overview

The desalination process for the plant involves pre-treatment of seawater including removal of particulates using physical filtration and chemical treatment followed by two stages of reverse osmosis (RO) to remove dissolved salts.

The backwash wastewater from the pre-treatment and brine generated from the RO process will be discharged back to the ocean through a common outfall, while the permeate (product) water will undergo further treatment to achieve drinking water quality. Further treatment includes remineralisation, pH correction, chlorination and fluoridation.

1.4.2 Construction Activities

1.4.2.1 SEAWATER INTAKE

The initial construction activities at the intake area will involve remediation of the pond and culverts which link the pond to the ocean. A silt curtain will be setup on the ocean side of the culverts to minimise sediment dispersion beyond the pond during these works.

Firstly, the bar screens in front of the culverts (on the ocean side) will be replaced with new 150 mm aperture screens to prevent large debris and marine life entering the pond. Remotely operated vehicle (ROV) inspection revealed that the existing bar screens are partially buried so this will require a small volume of material to be excavated from in front of the culverts, including moving any fallen rocks. This work will be limited to the original excavation footprint of the seawater intake pond.

The inside of the culverts will then be cleaned to remove any biological and sediment build-up. It's expected that this work will be undertaken using underwater jetting or vacuuming, with dislodged material directed towards the pond.

Following this, the culverts will be completely blocked on the pond side using pipeline plugging methods. Once isolation from the ocean has been confirmed, sediment will be removed from the base of the pond to return it to the original cooling water pond levels. The original cooling water pond levels are known from the construction as-built drawing of the pond and the silt level bathymetric monitoring. Excavation below the level of previous disturbance and excavation of competent rock will be avoided as much as possible during construction of the pond. This work will be undertaken by a long reach excavator or other suitable equipment. A temporary causeway may be built out into the pond to provide equipment access to all areas of the pond.

A dedicated area will be established adjacent to the pond where the excavated material will be temporarily stockpiled. This area will be lined and bunded and will include a decant system to dewater the excavated material. Water runoff will be directed back to the pond and excavated material will be transported to an appropriate off-site landfill facility.

The temporary causeway will remain in place to provide drill rig access for the drill-based piling activities which are required to construct the seawater intake structure. Up to 6 piles will be installed with a maximum diameter of 1,050 mm and maximum wall thickness of 20 mm. Drilling methods are proposed, rather than driven/hammering methods, to minimise noise and vibration associated with the works to both the marine environment and to the community of Dampier. Piles will be driven into the upper reclaimed substrate until bedrock is reached, then a steel anchor rod will be drilled through the centre of the pile into bedrock. The space between the anchor rod and the pile will be filled with grout. After the piling work is complete, the causeway material will be removed using an excavator and set aside for reuse in the intake equipment pad.

The sequencing of the above activities is preliminary only and may change for operational reasons.

Vertical turbine pumps will be suspended from the intake structure, with the base of the pumps positioned above the seabed to limit entrainment of seabed material. A mesh screen will be installed around the pumps to avoid entrapment of debris and marine life within the intake pond. The screen will be supported from the steel piles and attached in place by divers.

Material will be imported to construct the intake equipment pad which will be sized for the maximum 8 GL/a capacity. The pad will be raised above the current surface level (approx. 2.5 m AHD) to a maximum height of 6.5 m AHD, above storm surge levels.

Total suspended sediment (TSS) concentration in the intake pond will be tested and any issues remedied (filtering in the event of high TSS) prior to the culverts being unplugged. Filtered water would be discharged back to the intake pond and removed sediment transported offsite.

1.4.2.2 WASTEWATER OUTFALL

The desalination plant's reject brine and backwash wastewater will be conveyed via a pipeline to the ocean outfall location along the Parker Point wharf. The ocean outfall will comprise a multi-outlet diffuser arrangement to aid initial mixing. The proposed design aims to minimise impacts on the marine environment, as no disturbance of the seabed is required and discharge is to deep water within an existing disturbed port area, providing for improved mixing rates of the discharge wastewater.

The pipeline will be buried overland from the plant to the start of the Parker Point wharf to minimise heat transfer from high ambient air temperatures, which is an important consideration for the receiving environment.

The section of pipeline installed along the wharf will be attached to the existing bracket that supports the diesel line. Installation will be via scaffolding around the bracket and undertaking work from the shore and/or off the wharf where feasible, however, it's likely that construction vessels will be required to support the construction activities. Anchoring of construction vessels will take place outside of existing Benthic Communities and Habitats (BCH) and within the previously disturbed wharf area.

The diffuser design is expected to comprise a single arrangement fixed to a single wharf pile submerged 7 m below the lowest astronomical tide (LAT). The diffusers will be sized to achieve an exit velocity of 3 - 6 m/s and contain 4 – 6 outlets of 100 – 150 mm in diameter. The diffuser pieces will either be lifted into place from off the wharf or from a construction barge and fixed to the wharf piles using divers.

1.4.2.3 COMMISSIONING

Commissioning will begin by initially flushing all components of the plant. Flush water will be remediated (e.g. removal of debris with screens, neutralisation of chorine with sodium bisulphite etc.) and quality tested prior to discharge. Water used for testing and commissioning will be sourced from either the ocean or the potable water network.

1.4.3 Operations

1.4.3.1 INTAKE CULVERTS

The existing culverts linking the pond to the ocean are over 50 years old. Replacement of the existing culverts during construction to meet the initial project requirements is not expected, however, this may be required during the operational phase of the Project should the culverts fail or become damaged preventing sufficient flow to the pond. Culvert replacement is expected to involve the following activities as a worst-case scenario:

- Removing the area of rock wall from above the existing culverts and stockpile for later reuse
- Removing the existing culvert(s) with an excavator including the concrete encasement surrounding the culvert(s) which may require a rock breaker (30 – 40 tonne rock breaker)
- Installing new culvert(s) including pouring underwater concrete to encase the culvert(s)
- Providing suitable backfill around the culvert(s)
- Rebuilding the rock wall above the culvert(s)

This work would be undertaken using land-based equipment. A silt screen would be placed around the culverts during these operations.

1.4.3.2 LAGOON DESILTING

During the operational life of the Project, there is the possibility that sediment may build up in the seawater intake pond and require desilting. This would involve:

- Blocking the culverts to isolate them from the ocean.
- Installing a silt curtain on the ocean side of the culverts.
- Establishing a lined and bunded area adjacent to the pond where the excavated material will be temporarily stockpiled with a decant system to dewater the excavated material.
- Directing water runoff back to the pond.
- Transporting excavated material offsite to an appropriate landfill facility.
- Unplugging the culverts once water has been tested to be of a suitable quality.

1.4.3.3 PRE-TREATMENT

Multiple screens are proposed as the first level of pre-treatment prior to RO for separation of coarse suspended solids and micro-organisms.

Sodium hypochlorite will be routinely dosed in the seawater being transferred to the plant to prevent biofouling of the intake pipeline. The dosing point will be located downstream of the pump discharge check valves to achieve a concentration of 1 to 5 mg/L.

The screens will be regularly backwashed into a backwash wastewater holding tank at the intake site, macerated and then pumped to the plant site. Any chlorine residual that is still present will be neutralised with sodium bisulphite. Sodium hypochlorite will also be intermittently dosed to the backwash wastewater tank to achieve a concentration of 10 to 50 mg/L to prevent biofouling of the backwash line.

Ultra-filtration (UF) is proposed as the final level of pre-treatment prior to RO for separation of finer suspended solids and micro-organisms. This technique uses membranes with pore size down to 0.01 micron and it is chemical free during operations. The UF membranes will be regularly cleaned in off-line mode, using chlorine, or sometimes with sodium hydroxide. If an acidic clean is required, citric acid (a weak organic acid) is preferred but sulphuric acid may be used if required.

Sodium bisulphite neutralises the chlorine, while sulphuric acid or citric acid neutralise the sodium hydroxide. Chlorine becomes chloride, sodium hydroxide becomes water, and sodium bisulphite and sulphuric acid become sulphate. Each of these are found naturally in seawater. Citric acid becomes citrate which can readily be biodegraded in the ocean.

The screen backwash TSS will be co-disposed with the UF backwash TSS to the common ocean outfall from the main backwash tank.

Water quality sampling conducted by the Proponent has indicated that a Dissolved Air Flotation (DAF) unit in the pre-treatment system is not necessary. Should there be an ongoing, unexpected change in influent seawater characteristics, or if a higher plant capacity is required, the plant will be staged in a way to be able to retrofit a DAF unit into the pre-treatment process. The DAF may operate in two modes: one with air only and another with coagulation and flocculation to enhance flotation and/or settling of particulates for more effective solids removal. The subsequent inclusion of a DAF unit will not impact the ocean outfall design with respect to solids discharge, as all DAF wastewater sludge will be disposed onshore to an approved waste facility. However, if the increase in influent TSS is sufficient to require the DAF with chemical dosing there may be residual coagulant and flocculant in the waste stream discharged to the ocean.

1.4.3.4 REVERSE OSMOSIS

RO technology is proposed as the method to desalinate seawater. It requires a high pressure (around 6,500 kPa) as it is primarily a pressure-driven rather than a chemical-driven process. The RO process will remove dissolved salts from the seawater in a two-stage process to achieve the required permeate quality that complies both with the Proponent's requirements (<80 mg/L chloride) and Australian Drinking Water Guideline (ADWG) values.

Two benign chemicals are proposed to be dosed continuously on line to the RO; sodium bisulphite and anti-scalant. Sodium bisulphite is dosed to prevent any residual level of chlorine reaching the RO membranes which have zero tolerance to chlorine. The reject brine will therefore not have chlorine in it. Sodium bisulphite itself has no beneficial use to the RO process, but once it has reacted with chlorine, it will revert to sodium sulphate which is already prevalent in the ocean, and as such it will be rejected by the RO membranes to the reject brine stream. Anti-scalant is proposed to be dosed at 2 to 5 mg/L to prevent scaling of calcium salts by attaching to any scaling particles. As such, anti-scalant deactivates itself prior to discharge to the reject brine stream.

Anti-scalant products are generally formulated with around 5% active material (the phosphonate). Therefore a 2 to 5 mg/L dosage "as product" equates to 0.18 - 0.45 mg/L active chemical. In its mode of action, the active level will deplete as the treated seawater progresses through the plant. The expectation is that by the time the reject stream exits the RO racks, the anti-scalant active material will be close to zero mg/L.

The RO membranes will be cleaned using clean-in-place compounds i.e. proprietary cleaners (containing surfactants) and a biocide, and chemicals such as citric acid and sodium hydroxide. Neutralised waste will be discharged to a dedicated wastewater tank and transported to a suitable disposal facility.

1.4.3.5 POST TREATMENT

The post-treatment system will produce water that meets drinking standards. Post-treatment will occur downstream of the RO into the permeate stream prior to the potable water storage tank. The calcite contactor will require occasional backwashing using water sourced from the potable water system. The waste solids from this process will be further treated in a high-rate thickener to densify the solids to a paste or spadeable cake; use of flocculant will enhance the dewatering of this sludge. The dewatered sludge will be discharged to a skip bin that will be removed to an on shore approved waste facility in consideration that there may be some residual flocculant material entrained within the sludge.

1.4.3.6 OUTFALL

The wastewater generated from desalination will consist of reject brine from the RO process as well as neutralised wastewater from pre-treatment backwash and cleaning processes containing a mixture of suspended solids from the influent seawater and a very low concentration of sodium bisulphite, antiscalant and neutralised chemicals. The final discharge is proposed to have the following characteristics:

- Flow Rate – up to 35 ML/day (at 8 GL/a)
- Temperature - <2^{o}C above ambient seawater
- Dissolved Oxygen – At saturation
- pH – same as seawater (~pH 8.0-8.3)
- Total Dissolved Solids – 1.8 times ambient up to 70,000 mg/L
- Total Suspended Solids – ~1.8 times the prevailing seawater, based on a seawater value of 10 mg/L the discharge will be ~17-18 mg/L

2 MARINE ENVIRONMENTAL SETTING

The following provides a general overview for the region. More detailed treatments of the receiving environment are provided in the impact assessment sections.

2.1 Physical Characteristics

2.1.1 Climate

Air temperatures along the Pilbara coast vary from mean maximum temperatures in the mid to high twenties during the cooler months (May to August) and low to mid thirties during the warmer months (September to April) (BOM 2020). Records show March to have the highest mean maximum temperature of 34.8^{o}C, with July the lowest mean maximum of 25.8^{o}C (BOM 2020). On average, over two hundred days per annum exceed 30^{o}C, five of which exceed 40^{o}C. January has the highest mean minimum temperature of 26.6^{o}C with July further recording the lowest mean minimum temperature of 17.3^{o}C.

Monthly and annual rainfall is highly variable with the majority of rain falling during the warmer months as a result of tropical low pressure systems. Mean annual rainfall for the Port of Dampier is 303.9 mm with highest mean rain falling in February 97.1 mm, and lowest mean rainfall in November 0.1 mm (BOM 2020).

2.1.2 Winds

Prevailing winds are west to south westerly during the warmer months (September to April) and easterly during the cooler months (May to August). During the warmer months wind strength tends to increase throughout the day and are strongest in the afternoons, whilst the opposite occurs in the cooler months (BOM 2020). The south westerly winds average between 15 and 20 knots and easterly winds typically between 20 and 25 knots.

Tropical cyclones generally occur between November and April in the Pilbara. Winds in excess of 250 km/hr, torrential rain, storm surges, large waves and substantial movement of coastal sediments can be experienced during cyclones.

2.1.3 Wave Climate

Typically, swell and waves approach the Pilbara coast from the north and north-west as a result of Southern Ocean swell refracted by the regional bathymetry and islands of the North West Shelf (Semeniuk 1996). The Port of Dampier is protected to the west and east by the islands of the Dampier Archipelago and south by mainland Australia. As a result, these islands reduce swell and wave height by up to 50% as they propagate down Mermaid Sound towards the inner Port region (Pearce et al. 2003).

Swells tend to be greatest in winter (June/July, typically 2 m in height) and smallest in summer (~1 m in height) (Pearce et al. 2003). Swells generated offshore during storms and cyclones can reach heights of more than 5 m, with a theoretical height of 20 m.

2.1.4 Tides

The tidal regime of the area is semi-diurnal with a slight diurnal inequality (difference in height between the two highs or two lows) (Pearce et al. 2003). The Port of Dampier experiences mean high water springs tides of 4.5 m and mean low water spring tides of 0.8 m approximately two days after the full and new moon; however, Highest Astronomical Tides (HAT) can be much higher (up to 5.1 m) (Pearce et al. 2003).

2.1.5 Currents

Water circulation and currents in the Dampier Archipelago are determined by a combination of large scale ocean circulation, tides, local winds (including tropical cyclones) and non-tidal long period waves (continental shelf waves and meteorological effects) (Pearce et al. 2003). Close to the coast, flows are mainly parallel to the shore with speeds ranging from about 5 cm/s (neap tides) to 25 cm/s (spring tides). The magnitude of currents in the Archipelago are firstly influenced by localised bathymetry and secondly by the location of islands (Pearce et al. 2003). Consequently, strong currents flow along the axis of Mermaid Sound and in the channels between the islands due to the narrow passages and the shallow bathymetry.

2.1.6 Water Quality

Waters of the North West Shelf are usually temperature-stratified, with sea surface temperatures (SST) attaining a mean temperature of 29.3°C in March, dropping to 24°C in August (Pearce et al. 2003). Nearshore, in the semi-enclosed waters of the Port of Dampier, temperature means vary from 21°C in July/August to 31°C in February (Stoddart and Anstee 2005).

Salinity remains relatively constant temporally, however it can vary spatially. Within the Dampier Archipelago, surface salinity increases from inshore (about 36.7 ppt) to further offshore (about 35.5 ppt). Mermaid Sound displays a 'winter hydrographic regime' whereby denser (cooler and more saline) water forms within the Archipelago, and wedges seaward beneath open North West Shelf waters. During summer, a 'summer hydrographic regime' is characterised by vertical stratification on the open continental shelf and elevated salinity in shallower coastal waters (Pearce et al. 2003). Heavy rainfall from cyclones may significantly reduce surface salinity at times (Stoddart and Anstee 2005).

The deeper, offshore, waters of the North West Shelf are characterised by a relatively clear water column. Conversely, nearshore waters of the North West Shelf and waters of the inner Dampier Archipelago experience naturally higher levels of turbidity as a result of shallow bathymetry, tropical cyclone events and local re-suspension of fine sediments caused by wind and tidal mixing (Stoddart and Anstee 2005). Studies have shown that local variation in exposure to wind and wave conditions may cause areas of the Dampier Archipelago to react differently from adjacent areas within a kilometre away (Stoddart and Anstee 2005).

Nutrient concentrations from the nearshore waters of the Dampier Archipelago, such as those within the Port of Dampier are considered oligotrophic. High spatial and seasonal variability are evident in nutrient and chlorophyll-a concentrations (Pearce et al. 2003). During the warmer months, blooms of nitrogen-fixing microbes such as *Trichodesmium* or mangrove mud-flat cyanobacteria are known to occur and may contribute significantly to the nutrient budget, however there have been no known deleterious water quality impacts caused by toxic algal blooms in the region (Heyward et al. 2000).

Coastal waters of the North West Shelf are generally very high quality, the concentration of metals are low by world standards. Localised elevations of some metals have been reported adjacent to the industrial centres and port operations of Dampier (MScience 2005; Wenziker et al. 2006).

2.1.7 Sediment Quality

Testing of sediments associated with dredging campaigns within the Port of Dampier, including Parker Point, has been undertaken on many occasions providing a thorough understanding of the physical and chemical characteristics of the marine sediments in the area. Sediments have very low levels of organic carbon (total organic carbon <1%) and the presence of hydrocarbons has been low in past investigations of sediment chemistry within the port (MScience 2016a). Historical surveys of the area have repeatedly identified high background concentrations of chromium and nickel which are considered to be naturally occurring (Stoddart et al. 2019). Other metals analysed for as part of the National Assessment Guidelines for Dredging (NAGD) are commonly below their relevant screening levels, as was the case for the most recent sediment sampling conducted within Parker Point (MScience 2020a). The particle size distribution of sediments vary from fines (silts and clays, <63 µm) which accumulate in the berths/swing basins of the port, sheltered embayment's along the Burrup Peninsula and some of the inner islands, to coarse sand in the outer Archipelago (DEC 2006; MScience 2020a).

2.2 Biological Characteristics

2.2.1 Marine Habitats

The subtidal substrates around Dampier generally consist of soft silt/sand sediments of terrestrial origin with occasional limestone rocky reef (Stoddart and Anstee 2005). The fringing and subtidal reef systems provide habitat for a range of species including diverse coral, fish and invertebrate communities mixed with macroalgae. The distribution of the five key benthic communities and habitats identified within the Dampier Archipelago is shown in Figure 2-1. The current setting of benthic communities and habitats around Parker Point have been detailed in Section 5.3 of this document.

The following sections detail the marine environments of the Dampier Archipelago as described in Semeniuk *et al*. (1982) and Wells and Walker (2003). The following information is based on those references, unless cited otherwise.

2.2.1.1 ROCKY SHORES

Rocky shores are the most conspicuous intertidal habitat within the Dampier Archipelago. The coastline is largely Precambrian igneous rock, but in some areas, there is an overlay of Pleistocene limestone. The fauna of the upper shores is sparse, dominated by littorinid snails and grapsid crabs. The intertidal region has a diverse fauna dominated by oysters and associated species such as limpets, chitons, crabs, and barnacles. The biota becomes increasingly diverse in the lower intertidal, with a variety of sessile and motile invertebrates and benthic algae. Corals reach into the lowest portions of the intertidal zone, and then dominate most subtidal rocks in areas of lower turbidity.

2.2.1.2 SANDY AND MUDDY SHORES

Sedimentary shorelines dominate in the bays and inlets of the Pilbara coastline. There are few sandy beaches in the area. The exception is Hearson's Cove on the eastern Burrup Peninsula and a few coarse sand beaches and sand flats in the outer areas of the Dampier Archipelago. The sedimentary upper intertidal areas are dominated by extensive mudflats, which generally have mangroves. Seaward of the mangroves, the mudflats extend into subtidal areas. The seabed is mostly mud and fine sand. In many areas both the intertidal and subtidal areas have a rich and diverse benthos; however, the biota is impoverished in the vicinity of port infrastructure where there is a very fine mud on the bottom. Both seagrasses and algae are also relatively sparse in the intertidal, increasing in the shallow subtidal, but still reduced in biomass compared to temperate regions.

2.2.1.3 MANGROVES

The geographical distribution of mangrove habitat is typically restricted to sheltered areas such as estuaries, tidal creeks and sheltered bays. Mangroves are recognised as being important habitats for feeding grounds and fish nurseries, as well as protecting coastal areas from erosion by stabilising sediments. The Pilbara region supports a small number of mangrove species: *Avicennia marina*, *Aegialitis annulata*, *Aegiceras corniculatum*, *Bruguiera exaristata*, *Ceriops tagal*, and *Rhizophora stylosa*. *Avicennia marina* is the most abundant and ubiquitous of those species, occurring along some shores of Dampier and surrounding islands.

2.2.1.4 CORAL REEFS

Coral reefs are widely distributed throughout the Dampier Archipelago. Those of the inner and mid zones of the Archipelago, particularly on the western side of the Burrup Peninsula within the Port of Dampier, are often limited to narrow bands adjacent to rocky shorelines. Although live coral cover can be reasonably high, the reefs themselves are generally only a veneer over rock rather than being of entirely biogenic origin.

More consistent and extensive areas of coral occur in the outer Archipelago, particularly at Hamersley Shoal, Legendre Island, the Malus Islands, Flying Foam Passage and the northern end of West Lewis Island. These reefs are up to several hundred metres wide and generally exhibit well-developed reef

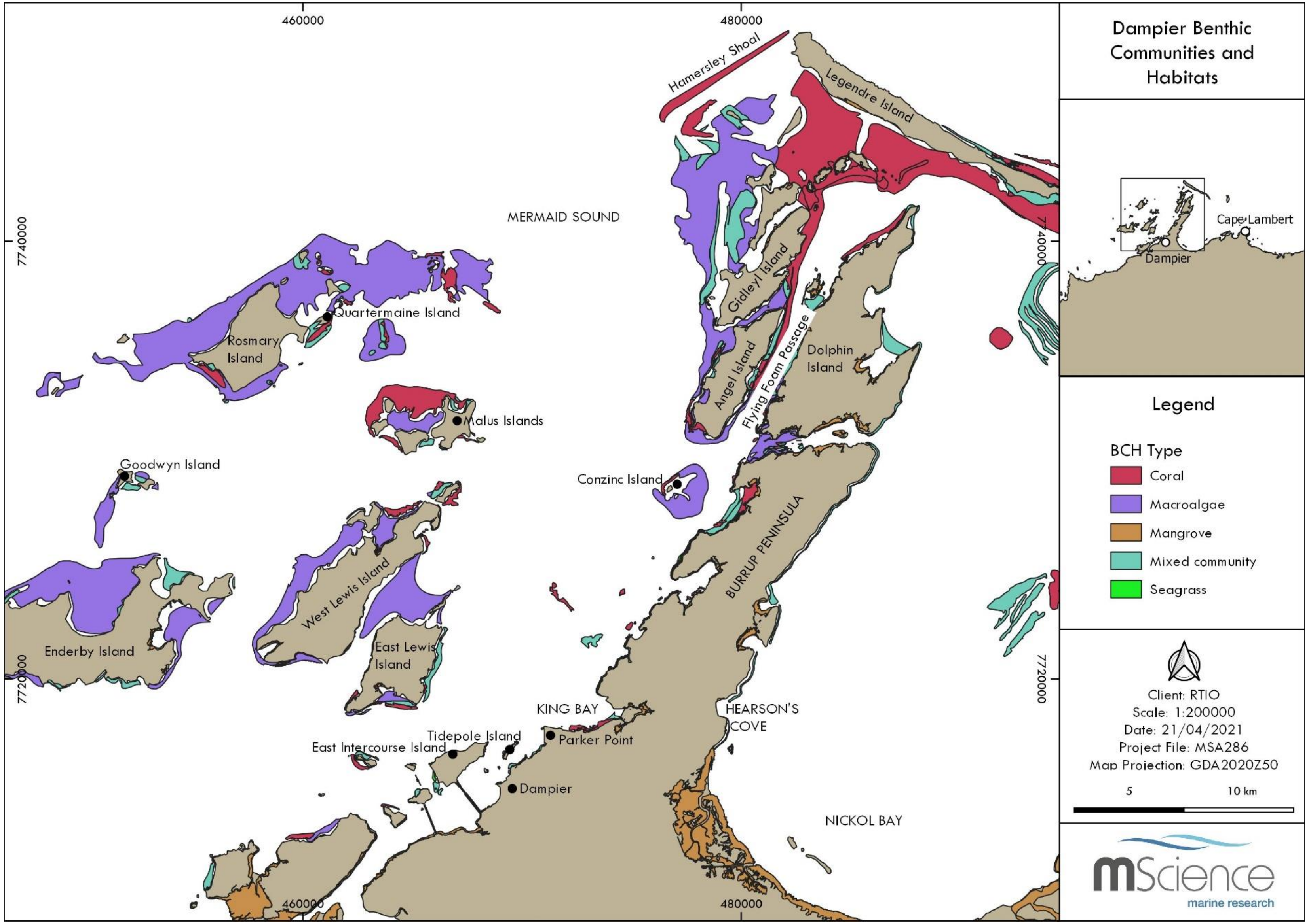


Figure 2-1. Dampier Archipelago marine habitats

flats, reef crests and reef slopes. The deeper reef slopes of Hamersley Shoal and Legendre Island are dominated by soft corals (MScience 2007a).

Coral reefs have also been recorded in the vicinity of King Bay. The majority of coral habitat identified within the Port of Dampier occurs in the immediate subtidal area; between approximately Spring Low Water and -4 m LAT (MScience 2005). The majority of corals in the Archipelago occur at depths between 0-10 m (Jones 2004a). A total of 120 scleractinian coral species from 43 genera have been recorded in the Dampier Archipelago (Blakeway and Radford 2005). Coral reef communities fringe the islands and coastline of Mermaid Sound.

2.2.1.5 TURF ALGAE, MACROALGAE AND SEAGRASS COMMUNITIES

Nine species of seagrasses occur in the Dampier Archipelago; *Cymodocea angustata*, *Enhalus acoroides*, *Halophila decipiens*, *Halophila minor*, *Halophila ovalis*, *Halophila spinulosa*, *Halodule uninervis*, *Syringodium isoetifolium*, *Thalassia hemprichii*. These seagrasses tend to have reduced biomass compared to the dense seagrass meadows found in southern Western Australia (Wells and Walker 2003). *Halophila sp.* have been observed in small patches at Tidepole Island and covering large expanses of seabed throughout the offshore islands of Dampier (IRC Environment 2003). A survey of port waters found only *Halophila sp* which occurred ephemerally in small patches, with the largest distribution being in Withnell Bay (Bertolino 2006).

Subtidal limestone pavements within the Pilbara region are colonised by varying abundances of large communities of macroalgae including brown algae species *Sargassum sp.*, *Dictyopteris sp.* and *Padina*, green algae species *Halimeda sp.* and *Caulerpa sp.* and red algal species of crustose corallines, non-corallines and algal turf (CALM 2005). Several of these species form thick canopies in summer which can compete with scleractinian corals (MScience 2010).

2.2.2 Marine Fauna

The area adjacent to Parker Point contains a wide variety of marine fauna of conservation significance within its various habitats, some of which are of international significance to conservation. A search of the EPBC Protected Matters Database (under the EPBC Act 1999) and Department of Biodiversity Conservation and Attractions (DBCA) Threatened, and Priority Fauna List (under the *Biodiversity and Conservation Act 2016*, BC Act) identified a number of threatened, migratory/specially protected, priority, and other protected marine faunal species with the potential of occurring within and/or adjacent (within 20 km) to the Project area. These are listed in Section 6.3 and described in the following sections.

2.2.2.1 SEABIRDS

The islands of the Dampier Archipelago provide breeding/nesting habitat for 16 species of seabirds which includes migratory species protected by international agreements, the China Australia Migratory Bird Agreement (CAMBA) and Japan Australia Migratory Bird Agreement (JAMBA) (CALM 2005). A number of listed threatened and/or migratory seabirds have been identified as potentially occurring within and/or adjacent to the Project area; Southern Giant-Petrel (*Macronectes giganteus*), Australian Fairy Tern (*Sternula nereis nereis*), Common Noddy (*Anous stolidus*), Fork-tailed Swift (*Apus pacificus*), Wedge-tailed Shearwater (*Ardenna pacifica*), Streaked Shearwater (*Calonectris leucomeias*), Lesser Frigatebird (*Fregata ariel*), Caspian Tern (*Hydroprogne caspia*), Bridled Tern (*Onychoprion anaethetus*) and Roseate Tern (*Sterna dougallii*). The Streaked Shearwater is a non-breeding visitor to Australian waters. The Southern Giant-Petrel, Common Noddy and Lesser Frigatebird breed in Australia but have not been recorded as breeding in the Dampier Archipelago. The Dampier Archipelago has been recognised as a Biologically Important Area for the Roseate Tern, Australian Fairy Tern and Wedge-Tailed Shearwater (Parks Australia 2021). The Wedge-Tailed Shearwater has been recorded breeding on twelve islands in the Dampier Archipelago, the closest to Parker Point being Conzinc Island (~12 km from Parker Point), the Malus Islands (~14 km away), and

Quartermain Island (at Elphick Nob, 21 km) (CALM 1990; Johnstone et al. 2013). Quartermain Island is the closest island (21 km) to Parker Point that the Australian Fairy Tern has been recorded to breed on (CALM 1990). Similarly, Roseate Terns have been recorded breeding 22 km from Parker Point, on Goodwyn Island, and are rarely recorded foraging in shallow sheltered inshore waters (Higgins and Davies 1996).

2.2.2.2 MARINE MAMMALS

Threatened, priority and/or migratory marine mammal species identified as potentially occurring within the Project area include the humpback whale (*Megaptera novaeangliae*), blue whale (*Balaenoptera musculus*), killer whale (*Orcinus orca*), Bryde's whale (*Balaenoptera edeni*), the spotted bottle nose dolphin (*Tursiops aduncus*), the Indo-Pacific hump backed dolphin (*Sousa chinensis*) and dugong (*Dugong dugon*).

Humpback whales migrate annually from feeding grounds in the Antarctic to breeding grounds in Camden Sound in the Kimberley region of Western Australia. The north bound migration peaks adjacent to the Dampier area between approximately the last week of July and the first week of August. The peak of the south bound migration occurs during the last week in August and the first week of September. Jenner et al. (2001) suggested that the majority of migrating whales are found in waters deeper than 50 m; however, some individuals come closer to shore, particularly during the southern migration.

The Dampier region is not an aggregation or calving area for this species, although there is some suggestion that Nickol Bay (between Dampier and Karratha, outside the Port of Dampier) may constitute some form of milling area during the southern migration (Jenner and Jenner 2009; Jenner and Jenner 2011). More recent surveys indicate that Nickol Bay is used as a single day staging post, mainly by pods with calves using the areas close to shore during the southern migration (BMT Oceanica 2017).

Humpback whales, blue whales and the other species of whales listed are unlikely to frequent the nearshore waters off Dampier around Parker Point tending to remain in deep water (>30 m).

Prince (2001) undertook aerial surveys of marine mammals and other large fauna of the Pilbara coast and concluded that Pilbara coastal waters support small populations of dolphins, the majority of which appear to be bottlenose. Dolphins do have the potential to occur in the Project area, but due to their intelligent and mobile nature, they are not generally considered at threat from vessel operations. Dugongs (*Dugong dugon*) are common in the Dampier Archipelago; however their distribution have been directed towards seagrass beds (CALM 2005; Wells and Walker 2003), which are not present around Parker Point.

2.2.2.3 MARINE REPTILES

Five threatened and/or migratory turtle species have been identified as potentially occurring within and/or adjacent to the Project area; Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Flatback (*Natator depressus*), Loggerhead (*Caretta caretta*) and Leatherback Turtle (*Dermochelys coriacea*). Of these, four species (green, hawksbill, flatback and loggerhead) are known to nest on the islands of the Dampier Archipelago (Biota 2009; Prince 1993). Subsequently, the Dampier Archipelago (including Rosemary island) has been identified by the May 2017 Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) as critical nesting habitat for green, hawksbill and flatback turtles.

Fossette et al (2021) conducted aerial surveys to assess the distribution and abundance of nesting turtles in the Pilbara, including the Dampier Archipelago. During the period of the survey, evidence of nesting activity was concentrated around Enderby Island, West Lewis Island, the Malus Islands, Rosemary Island, Gidley Island, Angel Island and Legendre Island. The nearest inter-nesting area to the Project area recorded for green and flatback turtles is on the northern side of West Lewis Island (~10-12 km distant) (AIMS 2020; Fossette et al. 2021). Rosemary Island, to the north of West Lewis Island, has been previously identified as a critical nesting and inter-nesting habitat for hawksbill turtles (Limpus 2009a).

Marine turtles mainly frequent the seagrass beds, in shallow bays, and coral reefs of remote areas to the north of the Dampier Archipelago (CALM 2005), but they are known to occur within the coral communities of Angel and Conzinc Island (MScience, unpublished). Seagrass beds have not been recorded within the vicinity of the proposed Project area and studies have shown the habitat of the inner Dampier Archipelago does not appear to be a key endpoint for foraging behaviour of the green or hawksbill turtles (Pendoley 2005).

The critically endangered Short-nosed sea snake (*Aipysurus apraefrontalis*) and Leaf-scaled sea snake (*Aipysurus foliosquama*) were identified as potentially occurring within and/or adjacent to the Project area in a search of the EPBC Protected Matters database and check of the DBCA Threatened, and Priority Fauna List. Until recently breeding populations of these two species were only known from Ashmore and Hibernia Reefs in the Timor Sea, but they have since been found during field surveys in the coastal waters of the Exmouth Gulf (Udyawer et al. 2016). A recent study has identified the Pilbara coast as a suitable habitat for the Short-nosed and Leaf-scaled sea snake, however the key locations for their preferred habitat included Ashmore Reef, Exmouth Gulf and the Montebello Islands, not the Dampier Archipelago (Udyawer et al. 2020). An additional fifteen sea snake species, listed as other protected matters under the EPBC Act, were also identified as potentially occurring within the Project area. These include the; Horned sea snake (*Acalyptophis peronii*), Dubois' sea snake (*Aipysurus duboisii*), Spine-tailed sea snake (*Aipysurus eydouxii*), Olive sea snake (*Aipysurus laevis),* Brown-lined sea snake (*Aipysurus tenuis*), Stokes sea snake (*Astrotia stokesii),* Spectacled sea snake *(Disteira kingii),* Olive-headed sea snake (*Disteira major*), North-western Mangrove sea snake *(Ephalophis greyi),* Black ringed sea snake *(Hydrelans darwiniensis),* Fine-spined sea snake (*Hydrophis czeblukovi*), Elegant sea snake (*Hydrophis elegans*), Spotted sea snake (*Hydrophis ornatus*) and Yellow-bellied sea snake (*Pelamis platurus*). Little is known of the size of sea snake populations, distribution or status within Australia. Sea snakes inhabit a variety of environments, but commonly prefer sandy substrates with seagrass beds. Although, the black ringed sea snake is found in mangroves and mudflats, while the olive and short nosed sea snake, inhabit coral reefs (Guinea et al. 2004).

2.2.2.4 SHARKS, RAYS AND FISH

Listed threatened shark species with the potential to occur in the Project area include the grey nurse shark (*Carcharias taurus*), white shark (*Carcharodon carcharias*) and whale shark (*Rhincodon typus*). The EPBC Act and DBCA database search also identified two threatened sawfish species: the green sawfish (*Pristis zijsron*) and dwarf sawfish (*P. clavate*) and the migratory narrow sawfish.

Grey nurse sharks have a broad inshore distribution and tend to be found in groups at specific aggregation sites around inshore rocky reefs or islands (Otway et al. 2003). The grey nurse shark has been recorded along the North West Shelf, but their distribution in Western Australia is largely confined to the south-west coastal waters (Commonwealth of Australia 2014) and there are no known aggregation sites in Western Australia (Chidlow et al. 2005).

White sharks have a global marine distribution in temperate to tropical latitudes. In Western Australia they are most commonly found in continental shelf waters and around oceanic islands in the southwest of the state (McAuley et al. 2017). White sharks tagged in southern Australia have shown most movements of the species were confined to shelf waters generally in areas less than 100 m, but sometimes into waters of less than 5 m (Bruce et al. 2006).

The whale shark is cosmopolitan in distribution, occurring in all tropical and warm temperate seas apart from the Mediterranean, and inhabits pelagic habitats (Colman 1997). In Western Australia, large numbers of whale sharks aggregate off Ningaloo Reef for several weeks between March and June every year. When sharks depart the Ningaloo Reef they travel northeast along the continental shelf before moving offshore into the northeastern Indian Ocean (Wilson et al. 2006).

The known distribution of sawfish species in north-western Australia has been based on targeted sampling or discovery/donation of sawfish rostrum (Morgan et al. 2011). The closest targeted sawfish surveys to the Project area have occurred at Onslow (Morgan et al. 2015; Morgan et al. 2017). Nursery sites for newborn sawfish pups are generally found in shallow, nearshore habitats often in close proximity to river mouths (Morgan et al. 2011). The Project area is not located close to a river mouth. Of the three species of sawfish identified as having the potential of occurring in the Project area only the green sawfish has been confirmed through sightings or evidence of rostra in the Karratha area (Morgan et al. 2019; Morgan et al. 2011). Green Sawfish generally have a very small home range, occupy very shallow waters and are likely to avoid areas of high vessel traffic, such as Parker Point (Morgan et al. 2017).

Twenty-six fish species from the family *Sygnathidae*, listed as other protected matters under the EPBC Act, have been identified as potentially occurring within the Project area. Annual fish surveys undertaken over a ten year period at the artificial reef constructed in a near-shore area to the east of the Parker Point service wharf identified 111 reef fish species, dominated in abundance by *Acanthurus grammoptilus*, *Caesio teres* and *Neopomacentrus filamentosus* (MScience 2017), no fish from the family *Sygnathidae* were recorded.

In general, the fish fauna of the outer islands of the Dampier Archipelago are dominated by coral reef fishes, while mangrove and silty bottom dwellers comprise the majority of the fish assemblages in the inner areas of the Archipelago, close to shore, such as Parker Point.

Hutchins (2004) studied the shallow-water fish fauna of the Archipelago (to a depth of 30 m) and found it comprised a total of 650 species and featured a prominent component of coral reef species (465) and to a lesser extent mangrove species (116), soft bottom inhabitants (106 species) and a relatively low number of pelagic species (67). Larger species that attract divers and recreational and commercial fishers include coral trout (Plectropomus spp.), tusk fish (Cheorodon spp.), rock cod, large potato cods (Epinephelus tukula) and manta rays (Manta birostris).

2.2.3 Introduced Marine Species

Eight introduced marine species (IMS) (including seven crustaceans and one ascidian) have been recorded in the literature from the Dampier Archipelago and Mermaid Sound (Jones 2004; Wells et al. 2009). Of the eight species, three crustacea are well known, widley-distributed foulers in Australian waters. No studies or anecdotal data are available showing evidence that introduced crustaceans in the Dampier area have caused any ecological consequences, such as adverse impacts on native species. The now widespread and highly invasive *Didemnum perlucidum* is listed as occurring in the Port of Dampier according to the National Introduced Marine Pest Information System (Commonwealth of Australia 2021).

3 IMPACT ASSESSMENT FRAMEWORK

3.1 Key Environmental Factors and Objectives

This assessment of impacts has been developed using the EPA *Statement of Environmental Principles, Factors and Objectives*, April 2020. The EPA has 14 environmental factors across five themes, Sea, Land, Water, Air and People. This assessment addresses the Key Environmental Factors for Sea which have the potential to be impacted by the Project (Table 3-1). Each environmental factor has an associated environmental objective which have been developed to ensure the objects and principals of the EP Act are achieved.

Table 3-1. Key environmental factors and objectives of the Project

Environmental Factor	Objective	Relevance to the Project
Benthic Communities and Habitats	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.	Sensitive benthic communities could potentially respond to changes in water quality associated with construction or operational activities.
Marine Environmental Quality	To maintain the quality of water, sediment and biota so that environmental values are protected.	The Project has the potential to modify water and sediment quality during construction and operational phases of the Project through vessel activities associated with pipeline installation and discharge of brine effluent.
Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.	There is potential for marine faunal behaviour, migratory and foraging activities to be modified during construction/operation activities. Small mobile fauna, or larvae, may also become entrained in the seawater intake during operations

Based on the Project's development envelope being located within the already well-developed highly modified areas of an operating port and the proposed wastewater outfall does not require modification to the seafloor, the Environmental Factor for Sea 'Coastal Processes' is not considered to have a potential to be impacted by the Project and is not considered further in this assessment.

3.2 Risk Assessment of Potential Impacts

The assessment of impacts from the Project's activities on the key environmental factors (identified in Section 3.1) in the following sections includes an assessment of the level of residual risk, after the Proponent's standard mitigation measures (not discussed in this document) for construction and operational activities have been put in place, may have on each key environmental factor. The risk assessment was undertaken using a systematic approach, based on international best practice standards (AS/NZS ISO 31000:2018: Risk Management – Guidelines), of assigning a consequence and probability to potential negative outcomes on the key environmental factors of the various impacting processes of the Projects activities. Impacts may occur through both direct (primary) and indirect (secondary) pathways (cause-effect).

Risk ratings were assigned to each impacting activity using the risk matrix in Table 3-2.

Table 3-2. Risk Matrix

		1-Minor	2-Medium	3-Serious	4-Major	5-Catastrophic
	Consequence	Localised harm to the environment that is confined to the operating footprint, affects no sensitive receptors and can be rectified or reversed within a day	Localised harm to the environment that is confined to the operating footprint, affects no sensitive receptors and can be rectified or reversed within a day	Harm to a regionally significant sensitive receptor that can be rectified or reversed within weeks to months of work effort or natural recovery	Harm to a nationally significant sensitive receptor that can be rectified or reversed within months to years of work effort or natural recovery	Widespread harm to a globally significant sensitive receptor that can be rectified or reversed within years to decades of work effort or natural recovery
Likelihood	**A-Almost certain** Recurring event during the lifetime of an operation / project. Occurs more than twice per year	Moderate	High	Critical	Critical	Critical
	B-Likely Event that may occur frequently during the lifetime of an operation / project. Typically occurs once or twice per year	Moderate	High	High	Critical	Critical
	C-Possible Event that may occur during the lifetime of an operation / project. Typically occurs in 1-10 years	Low	Moderate	High	Critical	Critical
	D-Unlikely Event that is unlikely to occur during the lifetime of an operation / project. Typically occurs in 10-100 years	Low	Low	Moderate	High	Critical
	E-Rare Event that is very unlikely to occur during the lifetime of an operation / project. Greater than 100-year event	Low	Low	Moderate	High	High

4 MARINE ENVIRONMENTAL QUALITY IMPACT ASSESSMENT

4.1 EPA Objective

To maintain the quality of water, sediment and biota so that environmental values are protected.

4.2 Policy and Guidance

The following EPA policies and guidance have been considered in evaluating potential impacts on Marine Environmental Quality:

- Environmental Factor Guideline – Marine Environmental Quality
- Technical Guidance – Protecting the Quality of Western Australia's Marine Environment (WAEPA 2016a)
- Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and Environmental Quality Objectives (Department of Environment 2006)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)

4.3 Marine Environmental Quality Values and Objectives

Western Australia pursues a sustainability strategy at State level through the Environmental Quality Management Framework (EQMF). The State's EQMF was developed to be consistent with the State Water Quality Management Strategy (SWQMS) and National Water Quality Management Strategy (NWQMS).

The key management elements of the EQMF include the establishment of Environmental Values (EVs) and Environmental Quality Objectives (EQOs)'. This is a hierarchical framework in which EVs are established for significant water resources and for each EV broad EQOs are established.

The Pilbara Coastal Water Consultation Outcomes (Department of Environment 2006) specifies EVs, and associated EQOs, for the Pilbara Region. The EVs and EQOs that are considered relevant to the Project are presented in Table 4-1, however the potential for impacts (Section 4.5) and assessment of impacts (Section 4.6) presented in this document relate only to the ecological value 'Ecosystem Health'.

Table 4-1. Environmental values and environmental quality objectives related to the Project

Environmental Values	Environmental Quality Objectives
Ecosystem Health (ecological value)	Maintain ecosystem integrity: This means maintaining the structure (e.g. the variety and quantity of life forms) and functions (e.g. the food chains and nutrient cycles) of marine ecosystems.
Recreation and Aesthetics (social use value)	Water quality is safe for recreational activities in the water (e.g. swimming). Water quality is safe for recreational activities on the water (e.g. boating). Aesthetic values of the marine environment are protected.

Environmental Values	Environmental Quality Objectives
Culture and Spiritual (social use value)	Cultural and spiritual values of the marine environment are protected.
Fishing and Aquaculture (social use value)	Seafood (caught or grown) is of a quality safe for eating. Water quality is suitable for aquaculture purposes.
Industrial Water Supply (social use value)	Water quality is suitable for industrial supply purposes.

4.4 Receiving Environment

4.4.1 Levels of Ecological Protection

The Pilbara Coastal Water Consultation Outcomes (Department of Environment 2006) spatially defines the Levels of Ecological Protection (LEP) for Mermaid Sound (Figure 4-1). The ecological protection areas are set at one of four levels as described in Table 4-2.

Table 4-2. Levels of ecological protection and corresponding environmental quality conditions

Level of Ecological Protection	Environmental Quality Condition (limit of acceptable change)	
	Contaminant concentration indicators	Biological indicators
Maximum	No contaminants – pristine	No detectable change from natural variation
High	Very low levels of contaminants	No detectable change from natural variation
Moderate	Elevated levels of contaminants	Moderate changes from natural variation
Low	High levels of contaminants	Large changes from natural variation

Areas around wastewater outfalls, ports and harbours are generally assigned a moderate or low level of ecological protection to ensure that ecosystem integrity is maintained whilst still allowing multiple uses. In relation to the proposed Project area within Mermaid Sound (Figure 4-2):

- the Parker Point Port Operations has been designated a Moderate LEP.
- The marine area adjacent to the existing seawater intake pond has been designated a High LEP, with the exception of a thin band of coastline (200 m at its widest point) directly north of the existing seawater intake pond which has been designated a Moderate LEP.

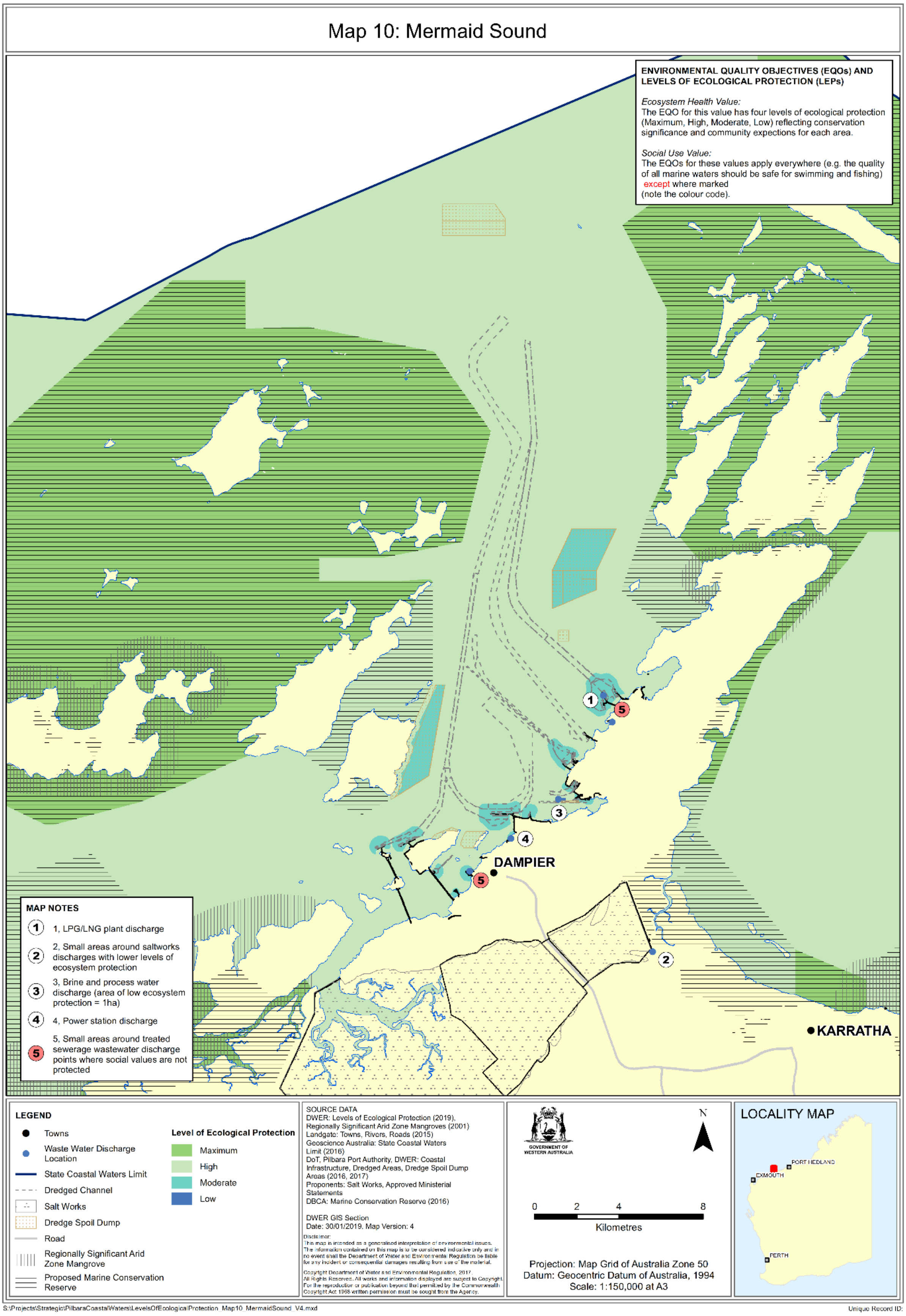


Figure 4-1. Ecological protection areas for Mermaid Sound (after DEC 2006)

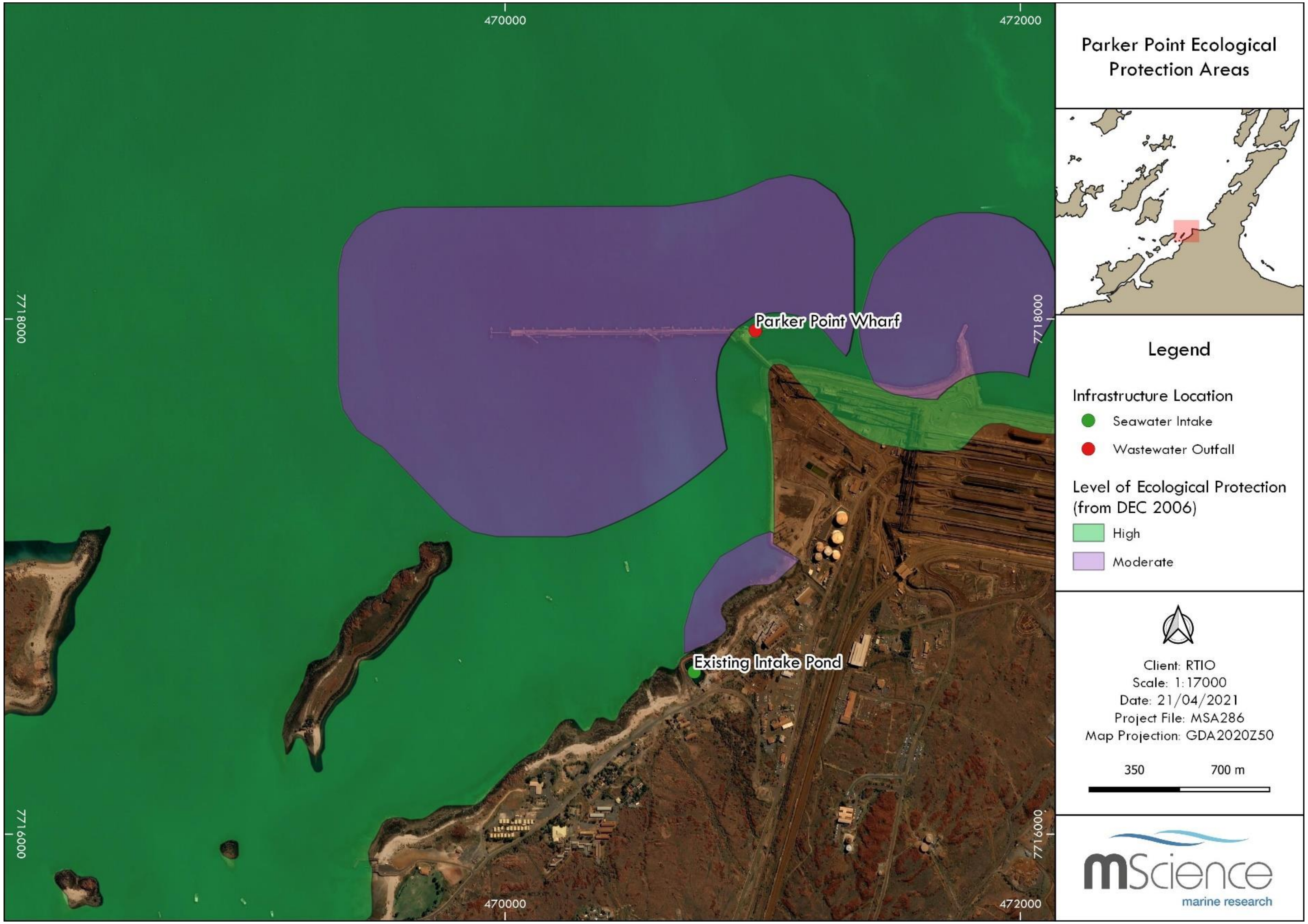


Figure 4-2. Parker Point levels of ecological protection

4.4.2 Sediment Quality

Sediment quality was assessed most recently around Parker Point in 2020 (MScience 2020a) as part of commitments stipulated by the Proponent's Long Term Dredging Monitoring and Management Plan (LTMMP)(MScience 2016b).

Investigation showed that the 95% upper confidence limit (UCL) of metal and metalloid concentrations in Parker Point were below the ANZG (2018) screening guideline levels for all metals. Nickel concentrations were shown to exceed the listed numerical screening level, however after normalisation for grain size, nickel concentrations met the screening assessment value derived from comparison with the 80th percentile of the background. High nickel concentrations in sediments from the Pilbara is a well-documented feature (DEC 2006; Stoddart et al. 2019). Normalisation of nickel concentrations for grain size in Pilbara sediments has been confirmed to be indicative of reduced bioavailability of these metals – both through dilute acid extraction and elutriation of sediment metals (Stoddart et al. 2019). Assay for a suite of organic compounds (total petroleum hydrocarbons, polycyclic aromatic hydrocarbons and organotins) showed that none of these compounds were detected in any sample.

Sediments around Parker Point would be classified as uncontaminated under ANZG (2018).

4.4.3 Water Quality

Mermaid Sound (including the Port of Dampier) has been comprehensively studied over the past 20 years, which has provided a good understanding of the existing water quality of the area. As a precursor to the assessment of the marine environmental impacts of the Project's construction and operation, a review was undertaken to identify the relevant marine environmental data sets that exist for the Dampier area (including Parker Point) and what gaps in the data exist that might constrain an impact assessment for the Project (MScience 2020b). That analysis identified that there was sufficient broad-scale data over many years to characterise physical water quality of the area and that this data was relevant to that around Parker Point. However, there was a need for specific detailed physical water quality data at Parker Pont within the modelled extent of the brine discharge.

A campaign was conducted to identify whether significant vertical stratification of water quality parameters exists within the Project area in Summer or Winter (MScience 2021a), and whether long-term water quality data collected from a single near-seabed site was representative of water quality throughout the Project area. The study undertook sampling over two days in Winter 2020 and one day in Summer 2021 for differing tidal states.

Sampling sites in the area were categorised as Inner (shallow sites within the area south of the Parker Point wharf outside of channels, berths and swing basins) and Outer (deeper sites around the wharf and to the north and west of the wharf).

Mean values of physical water quality data, averaged over sites and depths, collected during the sampling period have been provided in Table 4-3.

For the parameters of temperature, dissolved oxygen, salinity and pH, there was little indication of spatial variation during Winter or in near-seabed samples during Summer. Values from surface samples in Summer were somewhat more variable, although there were no strong spatial patterns. One pattern observed (on the single day of Summer sampling) was that dissolved oxygen saturation levels were below 100% in both surface and bottom samples for sites close to the shoreline. Repeated sampling over several days would be required to confirm whether this result indicates a consistent pattern.

Table 4-3. Parker Point mean values of water quality data

Zone	Season	Temperature (°C)	Salinity (g/L)	Dissolved Oxygen (%)	pH	Turbidity (NTU)
Outer	Summer	32.2	37.2	103.9	8.2	1.1
	Winter	21.6	36.8	100.7	8.1	1.1
Inner	Summer	32.3	37.3	100.6	8.1	1.4
	Winter	21.6	36.9	101.4	8.1	1.3
Summer (both zones)		32.25	37.25	102.25	8.15	1.25
Winter (both zones)		21.6	36.85	101.05	8.1	1.2

Temperature data was analysed most intensively as an indicator of vertical stratification. In both Summer and Winter sampling, water temperatures rose throughout the day in response to solar heating. In Summer, surface temperatures rose faster than bottom temperatures providing evidence of incomplete mixing.

Other parameters showed similar evidence of vertical stratification from the Summer sampling, although the measurement of those parameters relies on temperature compensation and these may not be independent of temperature stratification. The lack of stratification in Winter may be due in part to the Winter sampling occurring during a period of greater tidal energy than Summer sampling.

Based on the limited sampling period, the conclusions of the study were:

- There is little spatial variation for most water quality parameters;
- There is some small degree of vertical stratification in deeper waters during Summer;

A data set from a fixed benthic instrument recording every 30 minutes was collected by Advisian between 2019 and 2021. This data was collected to provide a cross-seasonal assessment of relevant water quality parameters (salinity, temperature, pH, dissolved oxygen, turbidity and PAR) from a near-seabed site within the Project area to assist in the development of Environmental Quality Criteria (EQC) for the Low/Moderate and Moderate/High LEP boundaries for input into a dispersal model for the proposed brine effluent discharge. Results of the full data set are subject to a separate report by Advisian. Table 4-6 defines the EQC values for water near the seabed derived for temperature and salinity from the fixed benthic instrument data.

Table 4-4. Proposed EQC water quality thresholds

LEP (Season)	Percentile of Data	EQC Temperature (°C)	EQC Salinity (PSU)
Low/Mod boundary (Summer)	95th percentile of summer data	31.95	37.08
Low/Mod boundary (Winter)	95th percentile of winter data	27.28	36.20
Mod/High boundary (Summer)	80th percentile of summer data	30.46	36.86
Mod/High boundary (Winter)	80th percentile of winter data	25.58	36.07

4.5 Potential Impacts

The possible cause-effect pathways leading to potential impacts on Marine Environmental Quality associated with the construction activities and operation of the Project are detailed in Table 4-5. Consequential secondary impact effects on BCH and/or Marine Fauna are detailed in Section 5.4 and 6.4, respectfully.

Table 4-5. Potential impacts to marine environmental quality

Activity	Cause	Effect	Impact	Impact Type
Construction Activities				
Construction of outfall pipeline	Construction/support vessel operations	Hydrocarbon spill/waste discharge	The use of construction and other support vessels creates the potential for there to be a release of toxicants to the water column from an unplanned hydrocarbon spill or waste discharge.	Direct
Refurbishment of the seawater intake pond	Underwater excavation activities and jet cleaning of the culverts	Sediment resuspension	Temporary local areas of elevated TSS generated from excavation and underwater jetting activities within and adjacent to the seawater intake pond may lead to increased turbidity and reduced light penetration through the water column.	Direct
		Release of toxicants	The mobilisation of sediments potentially containing contaminants may introduce toxicants to the water column	Direct
Plant Commissioning	Short term flushing of pipe infrastructure	Release of toxicants and debris	The mobilisation and discharge of construction residues and cleaning agents may introduce toxicants to the water column around the wastewater outfall.	Direct
Operations				
Wastewater discharge	Discharge of brine effluent	Increased marine salinity	Elevated salinity levels due to discharge of the brine effluent may persist at the seabed and lead to stratification of the water column.	Direct
		Stratification of the water column	Reduced mixing due to stratification may reduce dissolved oxygen levels at the seabed.	Direct
		Elevated water temperature	The discharge of brine effluent at higher than ambient temperatures may elevate water temperatures.	Direct

Activity	Cause	Effect	Impact	Impact Type
		Elevated suspended sediments	Total Suspended Solids (TSS) within the wastewater discharge has been estimated to be ~1.8 times the prevailing seawater. Elevated TSS may lead to increased turbidity and reduced light penetration through the water column.	Direct
	Discharge of residual RO treatment process chemicals	Released of toxicants	Chemicals used in the RO treatment process may introduce toxicants to the water column.	Direct
Replacement of the seawater intake pond culverts	Removal of existing culverts via excavation. Install of new culverts and rebuilding of rock wall	Sediment resuspension	Temporary local areas of elevated TSS generated from excavation activities may lead to increased turbidity and reduced light penetration through the water column.	Direct

4.6 Assessment of Impacts

4.6.1 Construction

4.6.1.1 HYDROCARBON SPILL (WATER AND SEDIMENT TOXICITY)

It is anticipated that construction work for the Project will be conducted from the shore and/or off the jetty where feasible. However, there may be times when a construction barge and dive support vessel (two additional vessels) will be required to support the construction activities. The risk of an unplanned waste discharge or hydrocarbon spill from a Project vessel is considered low when taking into consideration the Proponent's existing port operating procedures to prevent hydrocarbon and other spills into the marine environment. In addition, all vessels within port limits must manage wastes in accordance with Port of Dampier requirements appropriate to the class of vessel (including Australian Marine Safety Authority [AMSA] and International Convention for the Prevention of Pollution from Ships [MARPOL] legislative requirements) – on the basis that a waste discharge and/or hydrocarbon spill is unlikely to enter the marine environment, the risk to Marine Environmental Quality is considered low.

4.6.1.2 REFURBISHMENT OF SEAWATER INTAKE POND (SEDIMENT RESUSPENSION / TOXICITY)

Sediment resuspension effects from excavation and underwater jetting to refurbish the exiting seawater intake pond culverts will be localised within the silt curtain used to minimise sediment dispersion during these works. The relatively small area of excavation (18 m^3) and the short duration of sediment uplift events in a naturally turbid environment are unlikely to significantly impact Marine Environmental Quality in the Project area. During excavation of the intake pond to return it to original depths, the culverts will be completely blocked on the pond side eliminating the potential for sediment dispersion beyond the pond during these works.

A study to assess the sediment quality within the decommissioned Power Station pond was undertaken to provide a preliminary view of its suitability for land disposal. In the absence of a full site history assessment, the objective of the study was to screen for a comprehensive suite of the metals, hydrocarbons, nutrients, pesticides and herbicides recommended in the *National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended in 2013* (NEPM 2013) and Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) (2018).

When analysed for particle sizing, approximately 70-80% of the sediments in samples taken at the edge of the Pond reported to the coarse sand and gravel fractions (500 – 10000 µm). Sediment from sites A20-02 and A20-03, located towards the ocean side of the pond, reported a higher fraction of fines with the clay and silt fraction (sediments <62 µm), comprising 45 – 50% of the sample. Sediments from the middle of the Power Station pond were shown to be sorted into either a mix of fine to medium sand (62 – 500 µm) and fines (<62 – 500 µm) or fine to coarse sand (62 – 2000 µm) and gravel (2000 - 10000 µm).

Concentrations of metals were relatively low: the investigation into metal and metalloid concentrations in sediments showed that 95% UCL concentrations of all sediment metals were below the available ANZG screening guideline levels. Whilst the NEPM recommends the ecological investigation levels (EILs) and health investigation levels (HILs) should not be applied directly to assess the contamination of marine sediments, the mean, median and 95% UCL concentrations of all metals were below the EILs and HILs for commercial and industrial land use prescribed by the NEPM. In accordance with the DWER waste classification guidelines for quantitative assessment of a large quantity (>5,000 m^3) of waste for disposal to landfill (using a minimum number of 12 samples), assessment of 95% UCL concentrations of sediment metals against the landfill waste contaminant threshold (CT) levels (DWER 2019) indicated sediments within the Pond would be suitable for disposal in a Class III landfill facility.

Results of assays for most of the suite of organic compounds (Total Petroleum Hydrocarbons, Benzene, Toluene, Ethylbenzene, Xylene, Naphthalene, Organochlorine/Organophosphorus pesticides and phenoxyacetic acid herbicides) were below levels of detection in every sample. Polyaromatic Hydrocarbons, when tested against an ultra-trace screen, were detected in sediments collected from the middle of the Pond, but concentrations were below the default sediment quality guideline values (SQGVs) described in the ANZG.

The nutrient concentrations reported were generally low and similar to other studies of marine sediments in the Port of Dampier (MScience 2007; Worley Parsons 2009).

Secondary impacts of sediment resuspension and toxicity on BCH are discussed in Section 5.5.

4.6.1.3 PLANT COMMISSIONING (WATER AND SEDIMENT TOXICITY)

Plant commissioning requires flushing and testing of the plant infrastructure. Risks to Marine Environmental Quality are considered negligible due to the following:

- Flush water will be remediated (e.g. removal of debris with screens, neutralisation of chorine with sodium bisulphite etc.); and
- Flush water must pass quality testing prior to discharge.

4.6.2 Operations

4.6.2.1 WASTEWATER DISCHARGE

The potential effects of wastewater from the RO plant on water quality include changes in salinity, temperature and dissolved oxygen, as well as introducing toxic contaminants, such as metals, anti-scalants, coagulants and cleaning chemicals (Petersen et al. 2018).

While wastewater for the proposed plant is not yet available, whole effluent toxicity (WET) testing of desalination wastewater has been undertaken on a number of occasions for other Australian desalination projects. BMT (2021) conducted a review of desalination discharge environmental management triggers for operating desalination plants across Australia to determine suitable dilution thresholds for the current project. Dilutions were required to achieve the 90% species protection level (SPL) at the boundary of the low/moderate LEP and 99% SPL at the moderate/high LEP boundary. Table 4-6 presents the proposed average and worst-case dilutions, informed by the BMT review, required for typical desalination wastewater to meet the required SPLs at the boundary of each of the designated LEPs.

Table 4-6. Dilutions to meet SPLs of the designated LEPs

Boundary	SPL	Scenario	Dilution
Low/Moderate LEP boundary	90%	Worst Case	1:59
Moderate/High LEP boundary	99%	Average	1:65
Moderate/High LEP boundary	99%	Worst Case	1:222

There is the potential for metals to be introduced into SWRO desalination plant wastewater where pipelines constructed of metals corrode over time (Larche et al. 2013). The Proponent proposes to use a combination of mild-steel cement lined (MSCL), glass reinforced polyester (GRP) and/or high-density polyethylene (HDPE) pipeline material, therefore the mobilisation of metals into the wastewater is considered unlikely and the impacts of metals toxicity has not been assessed further.

The chemicals proposed to be used during operations of the SWRO desalination plant that are likely to enter the wastewater discharge will either be neutralised or small in volume and low in active chemical concentration. Chlorine is proposed to be used to clean the RO membranes, sometimes with sodium hydroxide. If an acidic clean is required, citric acid (a weak organic acid) is preferred. Chlorine, sodium hydroxide and citric acid will be neutralised before being released. Chlorine will be neutralised by sodium bisulphite to chloride, whilst sulphuric acid (or citric acid) will neutralise the sodium hydroxide. The sodium bisulphite and sulphuric acid will become sodium sulphate as a result of the neutralisation process. Each of these compounds are found naturally in seawater. Citric acid becomes citrate which can readily be biodegraded in the ocean. Anti-scalant, dosed into the feed water at 2 to 5 mg/L of product (5% active material) equates to 0.18 - 0.45 mg/L of active chemical. The active level will deplete as the treated seawater progresses through the plant resulting in close to zero mg/L of the anti-scalant active material within the wastewater. The flow of anti-scalant will be monitored by flow meters that are cross referenced with anti-scalant delivery pump telemetry data to achieve the desired dosing rate. The RO membranes will be cleaned by proprietary cleaners (containing surfactants) and a biocide, in addition to the commodity chemicals (citric acid and sodium hydroxide). The chemical waste from the proprietary cleaners will be discharged to a dedicated wastewater tank for disposal to a suitable land facility. Falkenberg and Styan (2015) reviewed the WET testing results on simulated effluents of brine only and combined (brine and chemicals) wastewater for Australian desalination plants in Cape Riche, Victoria and Barrow Island. In all three cases, there was no evidence of any combined waste streams being more toxic than the brine only component. Given the type and concentration of residual chemical compounds anticipated to be within the wastewater discharge and the results of WET testing for existing Australian desalination plants (BMT 2021; Falkenberg and Styan 2015), it is unlikely that the chemical composition of the discharge will significantly impact Marine Environmental Quality in the Project area.

Advisian (2021) undertook three dimensional modelling for the dispersal, dilution and trajectory of the brine discharge plume using the dilution scenarios proposed by the BMT (2021) study. The relevant software packages and modelling methods are described in Advisian (2021). Modelling suggested that not all components of the plume behave in the same way, and the following discussion treats these separately.

<u>Temperature</u>

The temperature of the wastewater discharge is anticipated to be < 2^{0}C above ambient, the outfall pipeline will be buried overland from the plant to the start of the Parker Point wharf to minimise heat transfer from higher ambient air temperatures.

The temperature of the wastewater at the point of discharge was modelled under two scenarios:

- Scenario 1: 2^{0}C above ambient:
  - Summer – wastewater 31.64^{0}C at the point of discharge
  - Winter - wastewater 25.18^{0}C at the point of discharge
- Scenario 2: 5^{0}C above ambient:
  - Summer - wastewater 34.64^{0}C at the point of discharge
  - Winter - wastewater 28.18^{0}C at the point of discharge

Temperature models did not predict any exceedance of the EQC values (Table 4-4) for the designated LEPs (Advisian 2021). As such, the temperature of the wastewater discharge is considered unlikely to significantly impact Marine Environmental Quality in the Project area and has not been assessed further.

<u>Salinity</u>

The Advisian (2021) model assumed salinity at the point of discharge to be ~65 PSU. Figure 4-3 and Figure 4-4 detail:

- The trajectory and dispersal of the brine discharge plume before it achieves the proposed salinity EQC to meet the Moderate/High LEP boundary in Summer (EQC of 36.88 PSU) and Winter (ECQ of 36.07 PSU) conditions, respectively; and
- The modelled salinity dilution contours based on the dilutions proposed by the BMT (2021) WET testing study, calculated as the 95th percentile for salinity concentrations around the proposed wastewater outfall location for Summer and Winter conditions, respectively.

Table 4-7 summarises the distances from the outfall within which the proposed EQC value for salinity is achieved for the designated Mod/High LEP boundary.

Table 4-7. Distance from outfall proposed salinity Mod/High LEP EQC value achieved

Boundary	EQC Salinity (PSU)	Distance (m)*
Moderate/High LEP boundary (Summer)	36.86	300
Moderate/High LEP boundary (Winter)	36.07	210

*at the furthest point of dispersal

Table 4-8 summarises the distances from the outfall within which the brine discharge plume achieves the dilutions proposed by the BMT (2021) WET testing study.

Table 4-8. Distance from outfall proposed brine plume dilutions achieved

Boundary	Dilution	Scenario	Distance	
			Summer	Winter
Low/Moderate LEP Boundary	1:59	Worst Case	10	35
Moderate/High LEP Boundary	1:65	Average	20	45
Moderate/High LEP Boundary	1:222	Worst Case	375	500

Modelling the vertical profile of the brine plume indicates that after the initial dilution phase (jetting of the brine through diffuser ports at 45° to the seabed), the brine sinks to the seafloor before dispersing along shallow to deep water gradients (Figure 4-5). A very high rate of initial dilution is achieved through the diffusers resulting in salinity concentrations within the modelled brine plume being within 1 PSU of background concentration between 20 - 40 m of the outfall (Figure 4-5). As such, the salinity of the wastewater discharge is considered unlikely to significantly impact Marine Environmental Quality in the Project area outside that buffer.

The retention of brine at the seabed may lead to persistent stratification and reduced dissolved oxygen in the deepest parts of the receiving environment. However, given the rapid dilution of salinity predicted above, such effects are likely to be localised and minor. In addition, Parker Point and the area around the proposed discharge outfall are regularly subjected to propeller wash from ship and tug movements. The effect of vessel movements on the brine plume could not be modelled accurately, however it is likely that these movements would increase mixing of the water column around the outfall and reduce the potential for significant stratification.

Figure 4-3. Summer salinity modelling output

Figure 4-4. Winter salinity modelling output

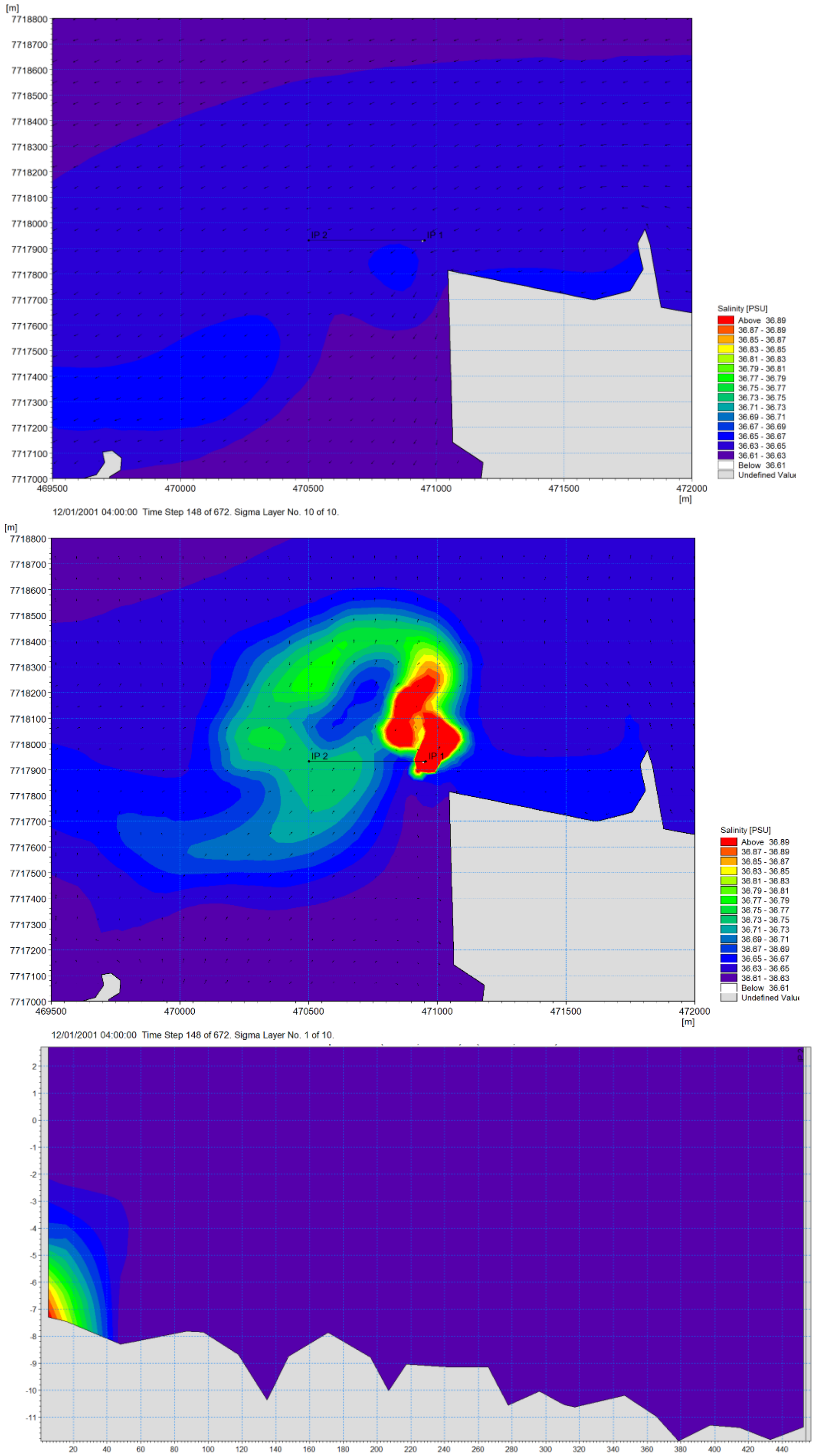


Figure 4-5. Modelled summer salinity dispersal

(top: plan view of surface dispersal, mid: plan view of bottom dispersal, bottom: profile view of dispersal)

Suspended Solids

In addition to the reject brine and very low concentration of sodium bisulphite, anti-scalant and neutralised chemicals, the wastewater generated from desalination will contain suspended solids derived from the influent seawater. Total Suspended Solids (TSS) within the wastewater has been estimated to be ~1.8 times that of the incoming seawater. Based on an assumed seawater value of 10 mg/L (conservative high value) the discharge at the outfall would be ~17- 18 mg/L. The modelled dilution contours calculated as the 95th percentile for the assumed TSS concentrations around the proposed wastewater outfall location for Summer and Winter conditions are shown in Figure 4-6 and Figure 4-7, respectively.

The model results indicate that TSS concentrations will reduce to 0.18 mg/L above background i.e. 10.18 mg/L, within 40 m and 50 m of the outfall for Summer and Winter conditions, respectively. As such, the TSS of the wastewater discharge is considered unlikely to significantly impact Marine Environmental Quality in the Project area.

The model considered that suspended sediments would be very fine in size and may contain a significant organic fraction. The outcome of those assumptions is that suspended sediment impacts will be concentrated in surface waters (Figure 4-8). While TSS elevation is predicted to be low, TSS will be further dispersed at the surface by wind and vessel movements, which have not been included in the model.

Secondary impacts of the wastewater discharge on BCH are discussed in Section 5.5.

4.6.2.2 REPLACEMENT OF SEAWATER INTAKE CULVERTS (SEDIMENT RESUSPENSION)

Sediment resuspension effects from excavation to replace the seawater intake pond culverts will be localised to within the silt curtain used to minimise sediment dispersion during these works. The relatively small amounts of sediment uplifted and the short duration of such events in a naturally turbid environment are unlikely to significantly impact Marine Environmental Quality in the Project area.

Secondary impacts of sediment resuspension on BCH have been discussed in Section 5.5.

Figure 4-6. Summer TSS dilution contours

Figure 4-7. Winter TSS dilution contours

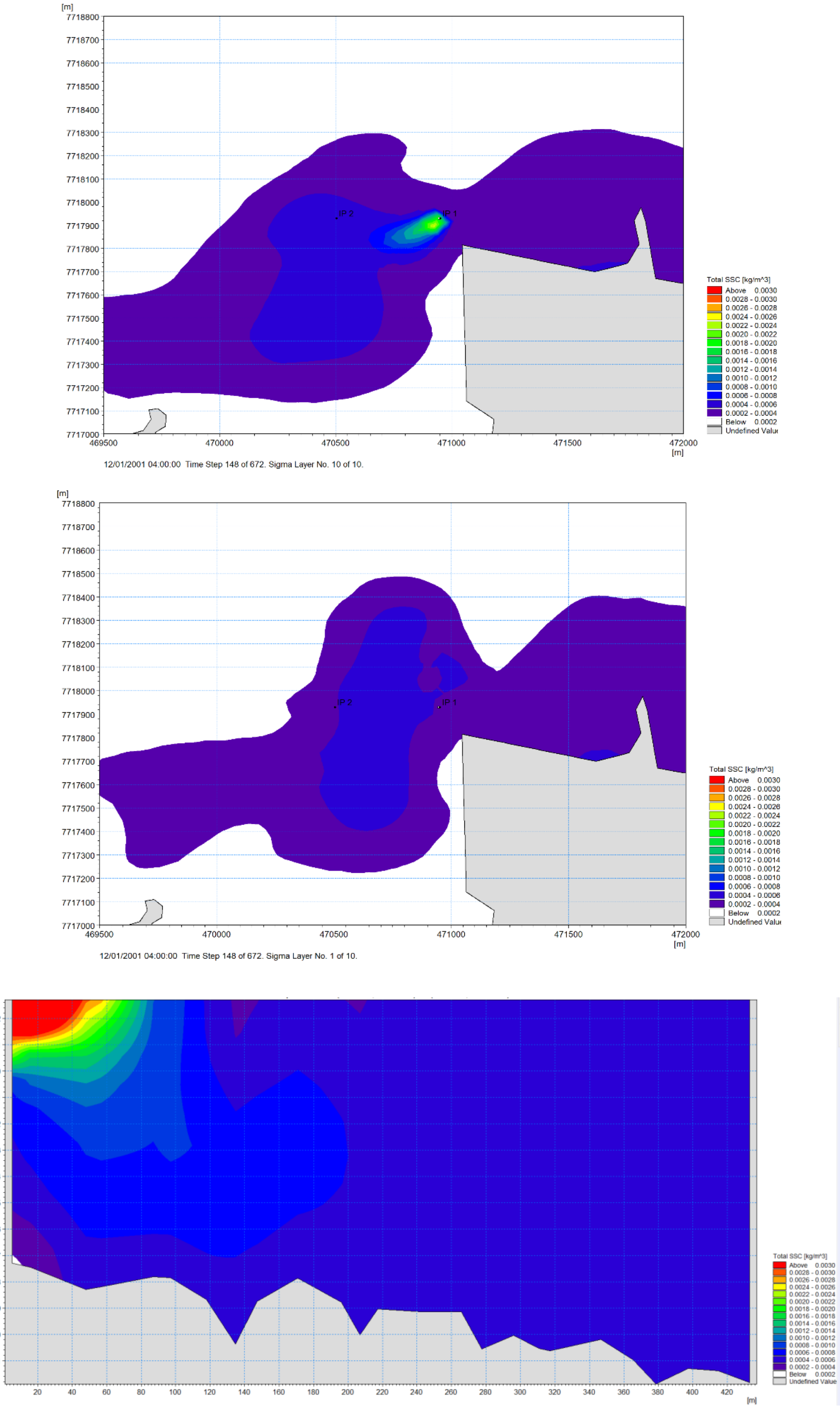


Figure 4-8. Modelled summer TSS dispersal

(top: plan view of surface dispersal, mid: plan view of bottom dispersal, bottom: profile view of dispersal)

5 BENTHIC COMMUNITIES AND HABITATS IMPACT ASSESSMENT

5.1 EPA Objective

To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.

5.2 Policy and Guidance

The following EPA policies and guidance have been considered in evaluation of potential impacts on Benthic Communities and Habitats:

- Environmental Factor Guideline – Benthic Communities and Habitats
- Technical Guidance – Protection of Benthic Communities and Habitats (WAEPA 2016b)

5.3 Receiving Environment

The composition of Benthic Communities and Habitats (BCH) within the Dampier Archipelago has been well documented by a variety of studies over the last 20 years. A habitat map (Figure 2-1) detailing the synthesis of the most recent information on the distribution of BCH has been produced (MScience 2018), however, the Pilbara marine environment is subject to frequent perturbations (Evans et al. 2020). The current status of mapped BCH around Parker Point was assessed in August 2020 (MScience 2020c) and January 2021 (MScience 2021b) by drop camera survey. While this represents the current status, it may not represent a stable long-term status.

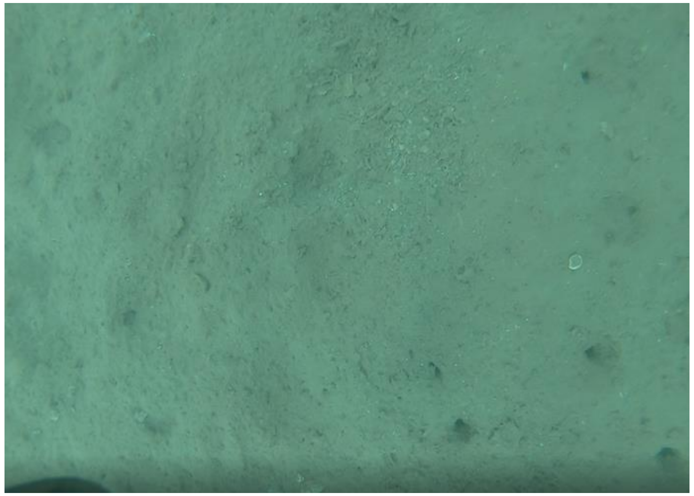
Five key BCH have been identified in the Dampier Archipelago (see Section 2.2.1), these include coral, macroalgal beds, mixed communities (including hard corals, macroalgae, soft coral and sponges), seagrass beds and mangroves.

Physical habitats identified during the recent surveys of the Parker Point area included bioturbated silt, fine to coarse grained sand, natural hard substrate and artificial hard substrate (rockwalls). The natural hard substrate supported corals, sponges, turf algae, and macroalgae. The 'coral' habitat was defined as where coral cover exceeds 10% - cover below 10% fell into the 'mixed community' classification. The nearest coral communities were those of approximately 25% cover at Tidepole Island (located ~1.5 km southwest of the proposed discharge outfall) and 70% at the fringing reef southwest of the seawater intake pond (located ~2 km southwest of the proposed discharge outfall). The most common coral groups found around Tidepole Island include *Pavona* species and *faviids*. The hard substrate of constructed surfaces around the outfall area was sparsely inhabited, with coral cover generally less than 3%.

A small patch of mixed community is located on a shallow rock outcrop ~120 m south of the proposed discharge outfall. The one-hectare rock outcrop supports occasional small (<30 cm width) corals (predominantly *Turbinaria spp*) with sparse sponges and zoanthids. The percentage of live coral cover is estimated at 3 – 5%. The mixed community habitat type found in this small area is considered to be widespread across the turbid nearshore environments of the Pilbara region, and characteristic of disturbed areas with high turbidity, and as such does not represent habitat of conservation significance.

The distribution of BCH within the Project area is shown in Figure 5-1 and detailed in full in MScience (2021b). The classification of mapped BCH together with representative images is provided in Table 5-1. Areas outside of the mapped BCH in Figure 5-1 consisted of disturbed, bioturbated, uncolonised and unconsolidated silt and fine sand i.e. bare substrate categories. The seabed surrounding Parker Point and the proposed discharge outfall falls within port infrastructure which has been dredged on multiple occasions or is regularly subjected to propeller wash from ship and tug movements.

Table 5-1. Habitat classification description

BCH Classification	Substrate Type	Biota Present	Representative Image
Bare	Silts to medium grained sand	No macro epibenthos. Bioturbation in sediment suggests presence of infauna	
	Hard substrate (artificial)	No macro epibenthos.	

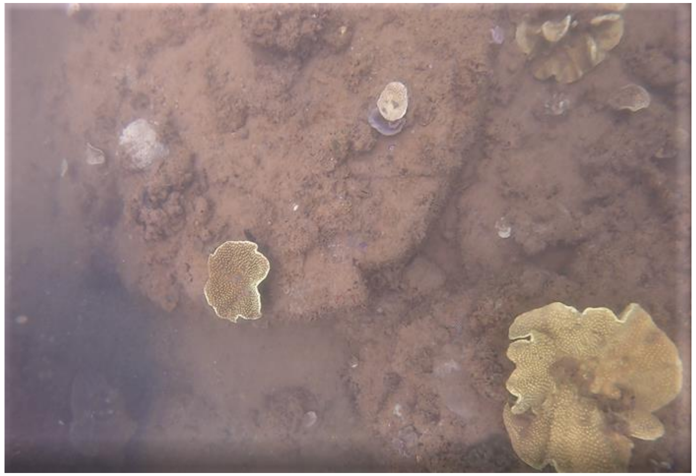
BCH Classification	Substrate Type	Biota Present	Representative Image
Mixed Community	Hard substrate (natural and artificial), sometimes overlaid by a veneer of medium to coarse grained sand.	Turf algae and macroalgae, occasional corals and sponges. Live coral cover between 3 and 10 %	
Coral	Hard substrate and well-developed coral reef	Turf algae and macroalgae, large coral colonies and sponges. Live coral cover greater than 10%.	

Figure 5-1. Distribution of Parker Point benthic communities and habitats

5.4 Potential Impacts

The possible cause-effect pathways leading to potential impacts to BCH associated with construction and operation of the Project are detailed in Table 5-2. The proposed Project design minimises direct loss of BCH as no construction work or direct disturbance is required on the seabed.

Table 5-2. Potential impacts to BCH

Activity	Cause	Effect	Impact	Impact Type
Construction Activities				
Construction of outfall pipeline	Anchoring of construction/dive support vessels	Physical damage	Physical damage or direct loss of BCH within the direct footprint of the anchor and attached chain.	Direct
	Construction/support vessel operations	Hydrocarbon spill/waste discharge	The potential release of toxicants to the water column from an unplanned hydrocarbon spill or waste discharge may induce toxic stress on BCH near the site of the spill/discharge.	Indirect
Refurbishment of the seawater intake pond	Underwater excavation activities and jet cleaning of the culverts	Sediment resuspension	Temporary local areas of elevated TSS generated from excavation and underwater jetting activities within and adjacent to the seawater intake pond may lead to a reduction in light availability and potential smothering of nearby BCH.	Indirect
		Release of toxicants	The mobilisation of sediments potentially containing contaminants may introduce toxicants to the water column and may induce toxic stress on nearby BCH.	Indirect
Plant Commissioning	Short term flushing of pipe infrastructure	Release of toxicants and debris	The mobilisation and discharge of construction residues and cleaning agents may introduce toxicants to the water column around the wastewater outfall which may subsequently impact BCH through stressor effects.	Indirect
Operations				
Wastewater discharge	Discharge of brine effluent	Increased marine salinity	Elevated salinity levels due to the brine effluent may persist at the seabed and induce osmotic stress in sensitive BCH.	Indirect

Activity	Cause	Effect	Impact	Impact Type
		Stratification of the water column	Reduced mixing due to stratification may reduce dissolved oxygen levels at the seabed and impact BCH.	Indirect
		Elevated water temperature	The discharge of brine effluent at higher than ambient temperatures may elevate water temperatures and induce temperature stress on nearby sensitive BCH.	Indirect
		Elevated suspended sediments	Total Suspended Solids (TSS) within the wastewater discharge has been estimated to be ~1.8 times the prevailing seawater. Elevated TSS may lead to may lead to a reduction in light availability and potential smothering of nearby BCH.	Indirect
	Discharge of residual RO treatment process chemicals	Released of toxicants	Chemicals used in the RO treatment process may introduce toxicants to the water column which may subsequently impact BCH.	Indirect
Replacement of the seawater intake pond culverts	Removal of existing culverts via excavation and install of new culverts and rebuilding of rock wall	Sediment resuspension	Temporary local areas of elevated TSS generated from excavation and removal of the culverts may lead to a reduction in light availability and potential smothering of nearby BCH.	Indirect

5.5 Assessment of Impacts

5.5.1 Construction

5.5.1.1 VESSEL ANCHORING (PHYSICAL DAMAGE)

It is anticipated only a barge (and potentially a dive support vessel) will be required during construction and work will take place adjacent to the Parker Point wharf in areas which have previously been dredged or in areas regularly subjected to propeller wash from ship and tug movements. Habitat mapping shows that these areas do not support BCH (Figure 5-1) and as such the risk of physical damage to BCH from project vessels anchoring is considered negligible.

Vessels will not be required to support remediation works at the exiting seawater intake pond, all works will be completed from land.

5.5.1.2 VESSEL WASTE DISCHARGE/HYDROCARBON SPILL (TOXICITY EFFECTS)

It is anticipated that construction work for the Project will be conducted from the shore and/or off the jetty where feasible. However, there may be times when a construction barge and dive support vessel (two additional vessels) will be required to support the construction activities. The risk of an unplanned waste discharge or hydrocarbon spill from a Project vessel is considered low when taking into consideration the Proponent's existing port operating procedures to prevent hydrocarbon and other spills into the marine environment. In addition, all vessels within port limits must manage wastes in accordance with Port of Dampier requirements appropriate to the class of vessel (including AMSA] and MARPOL legislative requirements) – on the basis that a waste discharge and/or hydrocarbon spill is unlikely to enter the marine environment, the risk to BCH is considered low.

5.5.1.3 REFURBISHMENT OF SEAWATER INTAKE POND (SEDIMENT RESUSPENSION/ TOXICITY)

Sediment resuspension effects from excavation and underwater jetting to refurbish the exiting seawater intake pond culverts will be confined to the original excavation footprint, with dislodged material directed towards the pond. During excavation of the intake pond to return it to original depths, the culverts will be completely blocked on the pond side eliminating the potential for sediment dispersion beyond the pond during these works. Furthermore, a silt curtain will be setup on the ocean side of the culverts to minimise sediment dispersion beyond the pond during these works. Some elevation of suspended sediments may occur in surrounding areas, however, the relatively small area of excavation (18 m^3) and the short duration of sediment uplift events are unlikely to produce intensity-duration-frequency combinations of light reduction or sediment smothering at levels sufficient to cause mortality of benthos outside of the excavation footprint (WAMSI 2019). The nearshore BCH located adjacent to the seawater intake are naturally accustomed to frequent, brief, natural turbidity and sedimentation events (e.g. from cyclones).

As discussed in Section 4.6.1.2, concentrations of contaminants of potential concern from sediments collected from the intake pond were below the default SQGVs described in the ANZG, therefore the risk of toxicity effects to BCH from mobilisation of intake pond sediments is considered negligible.

5.5.1.4 PLANT COMMISSIONING (TOXICITY EFFECTS)

Risk to BCH from flushing of the plant infrastructure during commissioning is considered negligible due to the following:

- Flush water will be remediated (e.g. removal of debris with screens, neutralisation of chorine with sodium bisulphite etc.); and
- Flush water must pass quality testing prior to discharge.

5.5.2 Operations

5.5.2.1 WASTEWATER DISCHARGE (TOXICITY EFFECTS)

The toxicity of desalination wastewater brine on BCH is largely due to osmotic stress, hypersalinity can damage or be lethal to marine flora and fauna, particularly seagrasses, by interfering with osmotic processes (Clark et al. 2018). The other effects of brine on water quality (changes in temperature and dissolved oxygen, addition of toxic contaminants etc) can also induce stress on certain BCH (Petersen et al. 2018).

The modelled dispersal and trajectory of the wastewater discharge was used to assess the risks to BCH within the Project area. In the absence of seagrass beds around Parker Point, the assessment focussed on corals as the most conservation significant BCH in the area. As discussed in Section 4, the change in ambient temperature, dissolved oxygen and TSS associated with the wastewater discharge is expected to be minimal and well within the tolerance limits of local corals and the 80th percentile of ambient waters. Similarly, modelling confirmed that under average dilution conditions the brine discharge plume would achieve a 99% SPL (Moderate/High LEP boundary) within a maximum of 45 m of the discharge point. The closest mapped BCH in the Project area is ~120 m from the outfall (see Figure 5-1). Under worst case dilution conditions during Winter, the small patch of mixed community located ~120 m south of the discharge outfall may encounter salinities 1 PSU above background (~36 PSU) (Figure 5-2). Worldwide corals are reported to survive salinities from 25 to 50 ppt (RPS 2009), with a number of species documented to survive where ambient salinities are in excess of 40 ppt, such as in the Arabian Gulf (Table 5-3). It is uncertain whether survival of corals exposed to elevated salinities in the Arabian Gulf is long term adaptation or resilience, however while low salinity is well known as damaging to corals (Berkelmans et al. 2012; Scott et al. 2013), salinity increases of several PSU have been shown to cause little impact to corals, and in some cases can increase thermotolerance (Gegner et al. 2017; Kuanui et al. 2015)

Algal species such as *Sargassum spp.* have been found to have quite broad salinity ranges. The literature indicates that although growth and survival is probably optimised at natural salinity, the majority of algal species will tolerate moderate increases in salinity (RPS 2009). As such, the salinity of the wastewater discharge is considered unlikely to significantly impact the BCH ~120 m south of the outfall.

5.5.2.2 REPLACEMENT OF SEAWATER INTAKE (SEDIMENT RESUSPENSION)

Should the seawater intake pond culverts fail or become damaged during operations, they may require replacement. Excavation activities required to replace the culverts will result in similar sediment resuspension effects to the refurbishment activities discussed in Section 0. Sediment resuspension will be localised and a silt curtain will be setup on the ocean side of the culverts to minimise sediment dispersion beyond the pond during these works. WAMSI (2019) documented intensity-duration-frequency combinations of light reduction and sediment smothering found to result in mortality of benthos. Due to the short-term nature of the replacement works, the combinations of light reduction that would result in mortality are unlikely to be reached outside of the excavation footprint.

Table 5-3. Upper salinity tolerances of coral species (modified from RPS 2009)

Coral Family	Coral Species	Upper Salinity Limit (ppt)	Location
Acroporidae	*Acropora sp.*	48	Arabian Gulf
Acroporidae	*Acropora sp.*	51 - 52	Christmas Island
Dendrophyllidae	*Turbinaria sp*	42 - 45	Arabian Gulf
Faviidae	*Cyphastrea micropthalma*	50	Arabian Gulf
Faviidae	*Cyphastrea seralia*	46	Arabian Gulf
Faviidae	*Favia favus*	42 – 45	Arabian Gulf
Faviidae	*Favia pallida*	44 – 45	Arabian Gulf
Faviidae	*Favia speciosa*	48	Arabian Gulf
Faviidae	*Favites chinensis*	48	Arabian Gulf
Faviidae	*Favites pentagona*	44 – 45	Arabian Gulf
Faviidae	*Leptastrea purpurea*	48	Arabian Gulf
Faviidae	*Platygyra daedalea*	48	Arabian Gulf
Faviidae	*Platygyra lamellina*	42 – 45	Arabian Gulf
Faviidae	*Platygyra sinensis*	44 - 45	Arabian Gulf
Faviidae	*Plesiastrea sp.*	42 – 45	Arabian Gulf
Pocilloporidae	*Stylophora pistillata*	42 – 45	Arabian Gulf
Poritidae	*Porites compressa*	46	Arabian Gulf
Poritidae	*Porites nodifera*	50	Arabian Gulf
Siderastreidae	*Coscinarea monile*	44 - 45	Arabian Gulf
Siderastreidae	*Psammocora sp*	42 – 45	Arabian Gulf
Siderastreidae	*Siderastrea savingyana*	50	Arabian Gulf

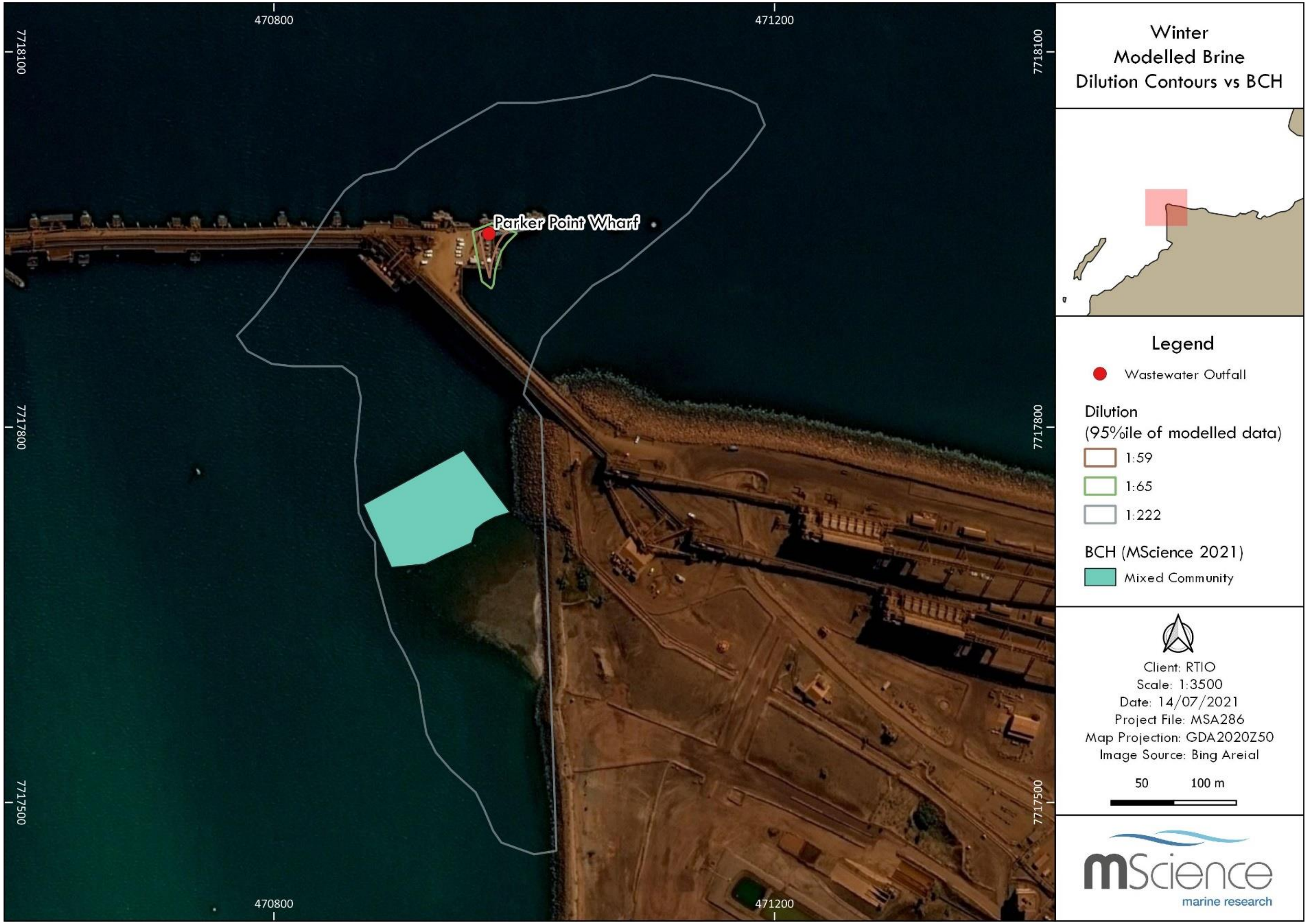


Figure 5-2. Winter salinity dilution contours and benthic communities

6 MARINE FAUNA IMPACT ASSESSMENT

6.1 EPA Objective

To protect marine fauna so that biological diversity and ecological integrity are maintained.

6.2 Policy and Guidance

The following EPA policies and guidance have been considered in evaluation of potential impacts on Marine Fauna:

- Environmental Factor Guideline – Marine Fauna (WAEPA 2016c)
- Environmental Assessment Guideline for Protecting Marine Turtles From Light Impacts (EAG5) (EPA 2010)
- National Light Pollution Guidelines for Wildlife (including marine turtles, seabirds and migratory shorebirds (Commonwealth of Australia 2020)

6.3 Receiving Environment

A search of the EPBC Protected Matters Database and check of the DBCA Threatened, and Priority Fauna List was conducted for the proposed Project area within Parker Point (with a 20 km buffer). The search identified protected species that may potentially occur within and/or within the vicinity of the Project area. These include marine reptiles, mammals and seabirds that potentially occur in or migrate through the area. The terrestrial species identified by the search have not been included in this assessment. Results of the EPBC and DBCA search has been summarised in Table 6-1

In addition to the listed threatened, migratory/specially protected and priority marine faunal species, the data base search identified 46 other matters protected by the EPBC act which are found in the marine environment. These included six marine mammal species (five dolphins and one whale), 15 species of sea snake and 26 fish species from the family *Sygnathidae*. Due to the shallow nature and busy port environment of the Project area, only a few of those marine species listed are relevant to the Project area.

Table 6-1 provides an indication of the preferred habitat for each listed species and likelihood of being present in the Project area. Potential impacts to marine fauna are detailed in Section 6.4.

Table 6-1. Conservation significant marine fauna, preferred habitat and likelihood of occurring in area

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
Marine Birds					
Southern Giant-Petrel *Macronectes giganteus*	Endangered Migratory	Species or species habitat may occur within area	Protected under International agreement Migratory	The Southern Giant-Petrel is a marine bird that occurs in Antarctic to subtropical waters. In summer it mainly occurs over Antarctic waters (DAWE 2021)	May fly over the area but unlikely to land
Australian Fairy Tern *Sternula nereis nereis*	Vulnerable	Breeding known to occur within area	Vulnerable	The Fairy Tern (Australian) nests on sheltered sandy beaches, spits and banks above the high tide line and below vegetation (DAWE 2021). The species is known to breed on several islands in the Dampier Archipelago, the closest to the Project area being ~21 km away at Elphick Nob on Quartermaine Island (CALM 1990)	May be found occasionally on shoreline feeding – no breeding likely
Common Noddy *Anous stolidus*	Migratory	Species or species habitat may occur within area	Protected under International agreement Migratory	In Australia, the Common Noddy occurs mainly in the ocean off the Queensland coast. During the breeding season, the Common Noddy usually nests on or near islands, on rocky islets and	Unlikely - Not known to breed in the area. Pelagic when not breeding

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				stacks with precipitous cliffs, or on shoals or cays of coral or sand. When not at the nest, individuals will remain close to the nest, foraging in the surrounding waters. Birds may nest in bushes, saltbush, or other low vegetation. During the non-breeding period, the species occurs in groups throughout the pelagic zone (DAWE 2021)	
Fork-tailed Swift *Apus pacificus*	Migratory	Species or species habitat likely to occur within area	Protected under International agreement Migratory	The Fork-tailed Swift is almost exclusively aerial and is not known to breed in Australia. They are seen in inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. *Apus pacificus subsp. pacificus* is the only subspecies to migrate to Australia (DAWE 2021)	May fly over the area but unlikely to land

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
Wedge-tailed Shearwater *Ardenna pacifica*	Migratory	Breeding known to occur within area	Migratory	The Wedge-tailed Shearwater is a pelagic, marine bird known from tropical and subtropical waters. The species breeds throughout its known range, mainly on vegetated islands, atolls and cays. In the north west of Australia the Wedge-tailed Shearwater breeds in October/November. The species is known to breed on several islands in the Dampier Archipelago, the closest to the Project area being ~12 km away at Conzinc Island (CALM 1990).The Islands of the Dampier Archipelago have been identified as a BIA for the species (DAWE 2021).	May be found occasionally feeding in the area – no breeding
Streaked Shearwater *Calonectris leucomelas*	Migratory	Species or species habitat may occur within area	-	The Streaked Shearwater breeds on islands off Japan, Korea and China. The species is an uncommon visitor to Pilbara seas between March and May (Johnstone et al. 2013)	Rare visits possible, no feeding or breeding likely
Lesser Frigatebird	Migratory	Species or species habitat known to occur within area	Protected under International agreement	The Lessor Frigatebird is known to occur in the Dampier Archipelago, however no	May be found occasionally

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
Fregata ariel			Migratory	breeding has been recorded (Johnstone et al. 2013)	feeding – no breeding
Caspian Tern *Hydroprogne caspia*	Migratory	Breeding known to occur within area	Migratory	The Caspian Tern is mostly found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred (DAWE 2021). Their distribution is widespread in coastal regions of Western Australia (Higgins and Davies 1996) and they are known to breed on numerous islands in the Dampier Archipelago, the closest to the Project area being ~12 km away at Conzinc Island (CALM 1990).	May be found occasionally feeding in the area – no breeding
Bridled Tern *Onychoprion anaethetus*	Migratory	Breeding known to occur within area	Migratory	Bridled Terns occupy tropical and subtropical seas, breeding on islands, including vegetated coral cays, rocky continental islands and rock stacks (DAWE 2021). In Western Australia, breeding is widespread and is known to occur on numerous islands in the north of the Dampier Archipelago, with	Rare visits possible, no feeding or breeding likely

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				foraging taking place well offshore (Johnstone et al. 2013)	
Roseate Tern *Sterna dougallii*	Migratory	Breeding likely to occur within area	Protected under International agreement Migratory	The Roseate Tern occurs in coastal and marine areas in subtropical and tropical seas. The species inhabits rocky and sandy beaches, coral reefs, sand cays and offshore islands. Birds rarely occur in inshore waters or near the mainland. The Roseate Tern is usually associated with coral reefs, where foraging may occur along the seaward margin, within reef lagoons, or over the reef itself. The species may also forage around islands on the continental shelf, either in lagoons or offshore. They are rarely recorded foraging in shallow sheltered inshore waters (DAWE 2021).	Rare visits possible – no breeding
Marine Mammals					
Blue Whale *Balaenoptera musculus*	Endangered Migratory	Species or species habitat likely to occur within area	Endangered	Blue whales, and the pygmy subspecies (*B. m. brevicauda*) are known to aggregate and feed along the southern	Unlikely - may be found in offshore waters but unlikely to

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				continental shelf in the Perth Canyon during Summer (Rennie et al. 2009), and migrate west and north along the Australian coast until they reach West Timor and Indonesia (Moller et al. 2020) The species is likely to occur in the waters offshore from the Project area.	frequent shallow nearshore waters in the vicinity of the proposed Project outfall infrastructure.
Humpback Whale *Megaptera novaeangliae*	Vulnerable Migratory	Species or species habitat known to occur within area	Special conservation interest	The coastal area off Dampier is a known migratory path for Humpback Whales moving between their southern feeding grounds and northern breeding grounds. The north bound migration peaks adjacent to the Dampier area between approximately the last week of July and the first week of August. The peak of the south bound migration occurs during the last week in August and the first week of September. The Dampier region is not an aggregation or calving area for this species, although surveys	Unlikely - may be found in offshore waters but unlikely to frequent shallow nearshore waters in the vicinity of the proposed Project outfall infrastructure.

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				indicate that Nickol Bay is used as a single day staging post, mainly by pods with calves using the areas close to shore during the southern migration (BMT Oceanica 2017).	
Bryde's Whale *Balaenoptera edeni*	Migratory	Species or species habitat may occur within area	-	Bryde's Whales are found year-round in waters between 40° S and 40° N, primarily in temperatures exceeding 16.3 °C. The coastal from of Bryde's Whale appears to be limited to the 200 m depth isobar, moving along the coast in response to availability of suitable prey. The offshore form is found in deeper water (500 m to 1000 m) (DAWE 2021). Bryde's whales have been recorded off-shore of Nickol Bay during summer months, most likely feeding (Jenner and Jenner 2009)	Unlikely - may be found in offshore waters but unlikely to frequent shallow nearshore waters in the vicinity of the proposed Project outfall infrastructure
Killer Whale *Orcinus orca*	Migratory	Species or species habitat may occur within area	-	Killer Whales are cosmopolitan in distribution. The species distribution and occurrence in Australia strongly reflect locations of prey aggregation,	Unlikely - may be found in offshore waters but unlikely to frequent

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				particularly breeding and feeding grounds (Morrice 2004), such as those of the humpback whale (Pitman et al. 2015).	shallow nearshore waters in the vicinity of the proposed Project
Indo-Pacific Humpback Dolphin *Sousa chinensis*	Migratory	Species or species habitat known to occur within area	Priority 4: Rare, Near Threatened and other species in need of monitoring	Indo-Pacific Humpback Dolphins are found in tropical, shallow coastal waters and tend to occur in enclosed bays with mangrove forests and seagrass beds, but are also found in open coastal waters around islands and coastal cliffs in association with rock or coral reefs (SEWPaC 2012). In the north-west of Australia, the species has been recorded between Coral Bay and Roebuck Bay (Allen et al. 2012).	May be found in the area but visits will be brief due to port activity, no breeding likely
Spotted Bottlenose Dolphin *Tursiops aduncus*	Migratory	Species or species habitat likely to occur within area	-	The Spotted Bottlenose Dolphin tends to occur in deep, open coastal waters (up to 200 m deep), including coastal areas around oceanic islands (SEWPaC 2012), however the species has been recorded around the islands of	Rare visits possible, no breeding likely

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				the Dampier Archipelago (Allen et al. 2012).	
Dugong *Dugong dugon*	Migratory	Species or species habitat known to occur within area	Other specially protected fauna	Dugongs occur in coastal and island waters from Shark Bay in Western Australia across the northern coastline to Moreton Bay in Queensland. Dugongs are seagrass community specialists and the range of the dugong is broadly coincident with the distribution of seagrasses in the tropical and sub-tropical waters in their Australian range (DAWE 2021)	Rare visits possible, but due to lack of food source and port activity no feeding or breeding likely
Marine Reptiles					
Loggerhead Turtle *Caretta caretta*	Endangered Migratory	Breeding known to occur within area	Endangered	Loggerhead turtles' nest on open, sandy beaches. Western Australia supports one genetic stock of loggerhead turtles with nesting encompassing the Gascoyne (Dirk Hartog Island) to Pilbara (Varanus Island) Regions (Limpus 2002). Foraging occurs in areas of seagrass beds and coral/rocky reefs	Rare visits possible, but due to lack of food source and port activity no feeding or breeding likely

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
Green Turtle *Chelonia mydas*	Vulnerable Migratory	Breeding known to occur within area	Vulnerable	Western Australia supports one genetic stock of green turtles nesting from the Gascoyne (Ningaloo Coast) to the Kimberley (Lacepede Islands) Regions (Limpus 2002). The Dampier Archipelago is a key nesting and interesting area for the species (DAWE 2021). Green Turtles spend their first five to ten years drifting on ocean currents. Once Green Turtles reach 30 to 40 cm curved carapace length, they settle in shallow benthic foraging habitats such as tropical tidal and sub-tidal coral and rocky reef habitat or inshore seagrass beds (Limpus 2008).	Brief visits possible, but due to lack of food source and port activity no feeding or breeding likely
Leatherback Turtle *Dermochelys coriacea*	Endangered Migratory	Breeding likely to occur within area	Vulnerable	There has been no confirmed breeding of leatherback turtles in Western Australia (Limpus 2009b). Foraging leatherback turtles from foreign rockeries e.g. Indonesia, pass through Western Australian waters.	Rare visits possible, but due to lack of food source and port activity no feeding or breeding likely

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
Hawksbill Turtle *Eretmochelys imbricata*	Vulnerable Migratory	Breeding known to occur within area	Vulnerable	Hawksbill Turtles are found in tropical, subtropical and temperate waters in all the oceans of the world (DAWE 2021). Major nesting of Hawksbill Turtles in Australia occurs at Varanus Island and Rosemary Island in Western Australia (Pendoley 2005). Hawksbill Turtles spend their first five to ten years drifting on ocean currents, Once Hawksbill Turtles reach 30 to 40 cm curved carapace length, they settle and forage in tropical tidal and sub-tidal coral and rocky reef habitat (Limpus 2009a).	Brief visits possible, but due to lack of food source and port activity no feeding or breeding likely
Flatback Turtle *Natator depressus*	Vulnerable Migratory	Breeding known to occur within area	Vulnerable	The Flatback Turtle is found only in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya (DAWE 2021). Nesting is confined to Australia and four genetic stocks are recognised (Limpus 2007). Adults inhabit soft bottom habitat over the continental shelf, Post-hatchling and juvenile Flatback	Brief visits possible, but due to lack of food source and port activity no feeding or breeding likely

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				Turtles do not have the wide dispersal phase in the oceanic environment like other sea turtles (DAWE 2021)	
Short-nosed Sea Snake *Aipysurus apraefrontalis*	Critically Endangered	Species or species habitat likely to occur within area	Critically Endangered	The Short-nosed Sea snake is endemic to Western Australia, and has been recorded from Exmouth Gulf, Western Australia to the reefs of the Sahul Shelf, in the eastern Indian Ocean (DAWE 2021). Most specimens have been collected from Ashmore and Hibernia Reefs (Guinea and Whiting 2005). The species prefers the reef flats or shallow waters along the outer reef edge in water depths to 10 m.	Unlikely – species not previously been recorded from the area
Leaf-scaled Sea Snake *Aipysurus foliosquama*	Critically Endangered	Species or species habitat known to occur within area	Critically Endangered	Until recently breeding populations of the Leaf-scaled sea snake were only known from Ashmore and Hibernia Reefs in the Timor Sea, but the species has since been found during field surveys in the coastal waters of the Exmouth Gulf (Udyawer et al. 2020). The Leaf-scaled Sea snake occurs in	Unlikely – species not previously been recorded from the area

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				shallow water (less than 10 m in depth), in the protected parts of the reef flat, adjacent to living coral and on coral substrates (DAWE 2021).	
Sharks and Rays					
Grey Nurse Shark (west coast population) *Carcharias taurus*	Vulnerable	Species or species habitat likely to occur within area	Vulnerable	Grey nurse sharks have a broad inshore distribution and tend to be found in groups at specific aggregation sites around inshore rocky reefs or islands (Otway et al. 2003). Their distribution in Western Australia is largely confined to the south-west coastal waters (Commonwealth of Australia 2014) and there are no known aggregation sites in Western Australia (Chidlow et al. 2005)	Unlikely
White Shark *Carcharodon carcharias*	Vulnerable Migratory	Species or species habitat may occur within area	Vulnerable	White sharks have a global marine distribution in temperate to tropical latitudes. In Western Australia they are most commonly found in continental shelf waters and around oceanic islands, and are present all year-round in the southwest of	Unlikely to frequent nearshore waters

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				the state (McAuley et al. 2017).	
Oceanic Whitetip Shark *Carcharhinus longimanus*	Migratory	Species or species habitat may occur within area	-	Oceanic Whitetip Sharks are found in pelagic waters throughout the topics and subtropics. Within Australian waters, it is found in from Cape Leeuwin (Western Australia) through parts of the Northern Territory, down the east coast of Queensland and New South Wales to Sydney (Last and Stevens 2009)	Unlikely – Pelagic species, unlikely to frequent nearshore waters
Whale Shark *Rhincodon typus*	Vulnerable Migratory	Species or species habitat may occur within area	Other specially protected fauna	The whale shark is cosmopolitan in distribution, occurring in all tropical and warm temperate seas apart from the Mediterranean, and inhabits pelagic habitats (Colman 1997). In Western Australia, large numbers of whale sharks aggregate off Ningaloo Reef for several weeks between March and June every year. When sharks depart the Ningaloo Reef they travel northeast along the continental shelf before moving offshore into the	Unlikely to frequent nearshore waters

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				northeastern Indian Ocean (Wilson et al. 2006).	
Dwarf Sawfish *Pristis clavata*	Vulnerable Migratory	Species or species habitat known to occur within area	Priority 1: Poorly known species	The Dwarf Sawfish usually inhabits shallow (2–3 m) coastal waters and estuarine habitats, often influenced by large tides. Estuarine habitats are used as nursery areas by Dwarf Sawfish, with immature juveniles remaining in these areas up until three years of age (DAWE 2021). The majority of capture locations and donated rostra in Western Australia have been between King Sound and Cape Keraudren (Morgan et al. 2011)	Unlikely – species has not previously been recorded from the area.
Green Sawfish *Pristis zijsron*	Vulnerable	Species or species habitat known to occur within area	Vulnerable	Green sawfish are currently distributed from about the Whitsundays in Queensland across northern Australian waters to Shark Bay in Western Australia and inhabit inshore shallow marine waters. The green sawfish has been recorded in estuaries, river mouths, embankments and	Brief visits possible, no breeding likely

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
				along sandy and muddy beaches (DAWE 2021). The green sawfish has been confirmed through sightings or evidence of rostra in the Karratha area (Morgan et al. 2019; Morgan et al. 2011). Green Sawfish generally have a very small home range, occupy very shallow waters and are likely to avoid areas of high vessel traffic, such as Parker Point (Morgan et al. 2017).	
Narrow Sawfish *Anoxypristis cuspidata*	Migratory	Species or species habitat likely to occur within area	-	In Australia, the Narrow Sawfish is found across northern Australia from the Pilbara Coast Western Australia) to Broad Sound (Queensland). It is a bentho-pelagic species that inhabits coastal and estuarine habitats. It occurs to depths of at least 40 m (Last and Stevens 2009). Adults mainly occur offshore while juveniles and pupping females require inshore and estuarine habitats.	Unlikely – species has not previously been recorded from the area.

Species	EPBC Act 1999		Biodiversity Conservation Act 2016 Status	Preferred Habitat	Likelihood of Occurring in Project Area
	Status	Type of Presence			
Reef Manta Ray *Manta alfredi*	Migratory	Species or species habitat known to occur within area	-	The Reef Manta Ray is commonly sighted on the continental shelf, around tropical and subtropical coral and rocky reefs, islands and along coastlines, preferentially occupying shallow depths < 20 m (Armstrong et al. 2020). Reef Manta Rays are capable of long-distance dispersal when habitat is continuous but also display a high degree of site fidelity.	Brief visits possible, no breeding likely
Giant Manta Ray *Manta birostris*	Migratory	Species or species habitat likely to occur within area	-	The Giant Manta Ray has a circumglobal distribution and is considered an oceanic species found predominantly in cooler, temperate to subtropical waters (Last and Stevens 2009).	Unlikely – Pelagic species, Project area not preferred habitat.

6.4 Potential Impacts

The potential impacts to Marine Fauna, including possible cause-effect pathway and risk rating, associated with the construction activities and operation of the Project are detailed in Table 6-2.

Table 6-2. Potential impacts to marine fauna

Activity	Cause	Effect	Impact	Impact Type
Construction Activities				
Construction of outfall pipeline	Marine fauna collision with construction vessels	Injury/mortality to marine fauna	The use of construction and other support vessels increases the potential for marine fauna interactions and collisions.	Direct
	Construction/support vessel operations	Hydrocarbon or other waste spill	The potential release of toxicants to the water column from an unplanned waste discharge or hydrocarbon spill may impact marine fauna near the site of the discharge/spill.	Indirect
	Introduction of IMS from construction vessels	Loss of local biodiversity	The potential introduction and establishment of IMS via the construction or support vessels may lead to ecological impacts to marine fauna.	Indirect
Construction of seawater intake structure	Noise associated with rotary drilling	Disruption to marine fauna behaviour, migratory and foraging activities	Noise propagation from rotary drilling during construction of the seawater intake structure within the intake pond may exhibit negative behavioural responses, interfere with biologically important sounds and/or cause stress, hearing impairment and/or injury to marine fauna.	Direct
Construction operations at night	Artificial lighting	Disruption to light sensitive marine fauna	Additional light emissions from spot lighting used during construction activities may cause behavioural changes to marine fauna (transiting, resting, mating, nesting, foraging etc)	Direct
Plant Commissioning	Short term flushing of pipe infrastructure	Release of toxicants and debris	The mobilisation and discharge of construction residues and cleaning agents during plant commissioning may introduce toxicants to the water column around the wastewater outfall and adversely impact marine fauna	Indirect

Activity	Cause	Effect	Impact	Impact Type
Operations				
Outdoor directional lighting	Artificial lighting	Disruption to light sensitive marine fauna	Light spill from outdoor directional lighting on the desalination plant facility may contribute to a net increase in light emissions within the Proponent's Parker Point operations, causing behavioural changes to marine fauna (transiting, resting, mating, nesting, foraging etc)	Direct
Seawater Intake	Intake of feed water	Entrainment or impingement of zooplankton/larvae and fauna	Potential injury/mortality to marine fauna from entrainment or impingement at the seawater intake leading to community changes.	Direct
Wastewater discharge	Discharge of brine effluent	Decrease water quality (changes in stratification, salinity and/or temperature)	Changes to water quality may lead to stressor effects on marine fauna. Discharge of the brine effluent may lead to stratification of the water column resulting in reduced mixing and oxygen drawdown. Elevated salinity may result in osmotic stress. Elevated temperature may exceed tolerance limits of some marine fauna.	Indirect
	Discharge of residual RO treatment process chemicals	Release of toxicants	Release of toxicants which may contaminate the water column or affect its physio-chemical properties may adversely impact marine fauna near the diffuser.	Indirect

6.5 Assessment of Impacts

6.5.1 Construction

6.5.1.1 VESSEL DISTURBANCE (COLLISION)

It is anticipated that construction work for the Project will be conducted from the shore and/or off the jetty where feasible, however, there may be times when a construction barge and dive support vessel (two additional vessels) will be required to support the construction activities. The number of vessel movements will be few, barge vessels move too slowly to present a collision risk and the dive vessel will mobilise from nearby to the wharf. On that basis, incremental risk of vessel strike is minimal.

Satellite tracking of hawksbill and green turtles nesting at Rosemary Island (AIMS 2020; DPaW 2021) indicates that Parker Point is not actively used for inter-nesting or foraging activities and so construction activities are unlikely to impact these critical life stages. Marine turtles, dolphins and sea snakes may occasionally transit the construction area, but will not remain in the Project area for long periods of time due to the limited food source available and the background levels of activity. Construction and support vessels will be stationary during construction activities and slow-moving within the port during transit to site, therefore it is very unlikely that vessel strikes will occur. The fish and bird species that frequent the harbour area will be habituated to the port activities, so will not be significantly impacted. Slow moving marine fauna (cetaceans) are unlikely to frequent the nearshore waters off Dampier tending to remain in deep water (>30 m) and are therefore unlikely to be at risk of vessel strike from construction activities.

6.5.1.2 VESSEL WASTE DISCHARGE/HYDROCARBON SPILL (TOXICITY)

It is anticipated that construction work for the Project will be conducted from the shore and/or off the jetty where feasible. However, there may be times when a construction barge and dive support vessel (two additional vessels) will be required to support the construction activities. The risk of an unplanned waste discharge or hydrocarbon spill from a Project vessel is considered low when taking into consideration the Proponent's existing port operating procedures to prevent hydrocarbon and other spills into the marine environment. In addition, all vessels within port limits must manage wastes in accordance with Port of Dampier requirements appropriate to the class of vessel (including AMSA] and MARPOL legislative requirements) – on the basis that a waste discharge and/or hydrocarbon spill is unlikely to enter the marine environment, the risk to marine fauna is considered low.

6.5.1.3 INTRODUCED MARINE SPECIES FROM VESSELS

There are two main vectors for IMS to enter the marine environment from vessels, these include ballast water and hull fouling. IMS have the potential to impact local biodiversity by:

- Altering ecosystem processes;
- Changing community structure and food webs;
- Displacing native species through competition; and
- Degrading habitats.

The use of construction and support vessels may potentially introduce non-native marine species, transported via ballast water and on vessel hulls, leading to impacts on local biodiversity. However, the risk is considered low given the Proponent has operating procedures in place for local works which require any vessel arriving from outside of the Dampier or Cape Lambert area to complete a marine pest risk procedure which complies with the Western Australian Government's Biofouling Biosecurity Policy of 2017 (DoF 2017). This includes the Proponent's IMS risk assessment which was developed to align with the WA Department of Primary Industries and Regional Development (DPIRD) Vessel-Check (DHI 2021). Dampier is also included in the State Wide Array Surveillance Program for introduced marine species coordinated by the Pilbara Ports Authority, with two arrays being put out each year.

6.5.1.4 ROTARY DRILLING (UNDERWATER NOISE)

Underwater noise has the potential to impact marine fauna in a number of ways, the potential effects of noise can be broadly categorised as:

- Behavioural response (displacement, attraction or avoidance);
- Masking or interfering with biologically important sounds (e.g. communication and echolocation);
- Stress
- Hearing impairment (temporary or permanent); and
- Hearing damage.

The hearing capabilities and thresholds to impulsive and non-impulsive noise exposure of various marine fauna including marine mammals, reptiles and fishes has been reviewed and well documented by ERM (2018) and Southall et al (2019). Southall et al (2019) outline frequency-dependent weighting functions and numeric thresholds for the onset of temporary threshold shift (TTS) and permanent threshold shift (PTS) as a result of steady-state (non-impulsive) noise (as is likely to occur during rotary drilling) for different groups of marine mammals (Table 6-3). Only impulsive noise exposure thresholds have been reported for turtles, Popper et al (2014) recommends the use of subjective criteria for TTS (Table 6-3). The problems of assessing the impacts of noise upon fish are well known (Hawkins and Popper 2017), however impulsive noise exposure thresholds have previously been reported by Popper et al (2014) (Table 6-3).

Table 6-3. Marine fauna noise thresholds

Marine Fauna Group	Noise Exposure	Behaviour	TTS Threshold	PTS Threshold
		Risk**	SEL*	SEL*
Cetacean - Low Frequency	Non-impulsive	-	179	199
Cetacean – High Frequency		-	178	198
Cetacean – Very High Frequency		-	153	173
Sirenian (dugong)		-	186	206
Turtles	Impulsive	(N) High (I) Moderate (F) Low	(N) High (I) Low (F) Low	-
Fishes – no swim bladder		(N) High (I) Moderate (F) Low	186	-
Fishes – swim bladder involved in hearing		(N) High (I) Moderate (F) Low	186	-

*Sound Exposure Level thresholds are in dB re 1 μPa^2

**Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I) and far (F).

The factors which cause a behavioural response from marine mammals are complex (ERM 2018), therefore a specific threshold is not provided. Similarly, it is recommended that potential for hearing effects, masking and behavioural disturbance to turtles be assessed qualitatively based on relative risk to the animal at varying distances from the noise source, however a level of 175 dB re 1 μPa^2 is expected to be the received sound level at which marine turtles would actively avoid an impulsive noise source (ERM 2018). There is little information about the effects of underwater noise on sea snakes, however, they are likely to be similar to other reptiles i.e. turtles. Sea snakes are not sedentary, and like turtles, can swim away from a sound source.

Sound exposure criteria for fishes without a swim bladder are proposed to be the most appropriate for sharks (ERM 2018).

A previous investigation into underwater noise associated with small scale drilling operations (20 cm diameter drill-bit) has indicated that sound levels recorded during hard rock drilling peaked at 107 dB re 1 μPa^2 at 7.5 m from the noise source, decreasing to 95 dB re 1 μPa^2 up to 179 m from the source of the sound (Willis et al. 2010). A geotechnical drilling noise study (120kW, 83 mm diameter drill-bit, 1500 rpm, 16-17 m drill depth) recorded sound levels between 142 and 145 dB re 1 μPa^2 across a frequency range of 30 – 2000 Hz at 1 m from the drilling source (Erbe and McPherson 2017).

Impacts to marine fauna from construction drilling will be negligible, given that:

- Cetaceans are unlikely to frequent the nearshore waters around Parker Point, although dolphins may be occasional visitors;
- Marine reptiles will not remain in the Project area for long periods of time;
- Sound levels recorded during previous similarly small-scale rotary drilling activities did not produce sound levels above recommended marine fauna threshold values directly adjacent to the drill; and
- Drilling will be brief and only be conducted within the enclosed seawater intake pond, which is likely to minimise the noise propagation into the open ocean.

6.5.1.5 CONSTRUCTION LIGHTING (ARTIFICIAL LIGHT)

All construction activities are proposed to be conducted during daylight hours only with no lighting required, however, there may be the need for some night works. Parker Point is an active operational port area and as such, is subject to existing levels of elevated artificial light. If night works are required, construction areas will be lit for short periods and to the minimum extent required to provide safe working conditions. Only areas where works are being carried out, or which are critical to safe movements around the site will be lit. As such, lighting used during construction is not expected to significantly change artificial light levels within the area – on this basis and considering the assessment of artificial light impacts on marine fauna during operations provided in Section 6.5.2.1, the risk to marine fauna from artificial lighting during construction activities is considered low.

6.5.2 Operations

6.5.2.1 OUTDOOR DIRECTIONAL LIGHTING (ARTIFICAL LIGHTING)

Outdoor directional lighting will be used during operations of the desalination facility. Parker Point is an active operational port area and as such, is subject to existing levels of elevated artificial light, however there is little information on what levels of light might be biologically important for the Dampier Archipelago. The Proponent proposes to complete detailed light modelling to quantify the facility's light emissions and inform a lighting design that minimises light emissions to as low as reasonably practicable. In the absence of modelling and light designs, the potential for the desalination plant to contribute to a net increase in the light environment of the Proponent's Parker Point operations is unclear. However, a precautionary approach should consider what the effects of such a net increase might be.

Marine turtles nesting on beaches in Western Australia are known to be at risk from the effects of light pollution from urban and industrial development, because artificial light can disrupt critical behaviours (Commonwealth of Australia 2017; Pendoley 2005). The National Light Pollution Guidelines for Wildlife (2020) provides a comprehensive review on the effects of artificial light on nesting marine turtles and hatchlings emerging from nests. Nesting females use visual cues to select nesting beaches and artificial light on or near beaches has been shown to disrupt this behaviour. Hatchlings orientate towards the brighter oceanic horizon and away from the elevated darkened silhouettes of dunes and/or vegetation behind the beach. Artificial light up to 18 km away has been shown to disorientate hatchlings when they are trying to find the sea. The known distribution of the marine turtles (green, hawksbill and flatback) with the potential of occurring adjacent to Parker Point has been described in Section 2.2.2.3 and Table 6-1. The nearest recorded turtle nesting location to the Project area is on the north facing beaches of West Lewis Island (Fossette et al. 2021), ~10-12 km away. It is unlikely that direct artificial light from the proposed desalination facility would reach these nesting beaches due to the light sources being shielded by West Lewis Island and East Lewis Island.

The intensity, wavelength and position of artificial lighting have been identified as important aspects to manage to reduce the impacts of artificial light on hatchlings (Commonwealth of Australia 2020). Long wavelength (yellow-orange), low intensity light located outside of the horizontal/vertical range of vision for the hatchlings have been considered the least disruptive. The Proponent proposes to use amber outdoor directional lighting (long wavelength) and will complete light modelling during detailed design to optimise the positioning and intensity of lights so that light emissions during operations are reduced to as low as reasonably practicable.

Similarly, artificial light can disorientate seabirds causing collision, entrapment, stranding, grounding and interference with navigation. The degree of disruption varies by species, however all species active at night are vulnerable (Commonwealth of Australia 2020). The National Light Pollution Guidelines for Wildlife (2020) identify that fledglings are more affected by artificial light than adults due to the synchronised mass exodus of fledglings from their nesting sites. Artificial light up to 15 km away has been shown to effect fledgling seabirds. Conzinc Island supports the closest known breeding site to Parker Point for a listed seabird species, the Wedge-Tailed Shearwater (CALM 1990). Long wavelength, low intensity light has been identified as least disruptive in the case of the shearwater species (Commonwealth of Australia 2020). Conzinc Island is ~12 km from Parker Point, at this distance and considering the long wavelength directional lighting proposed for use around the desalination plant facility it is unlikely that artificial lighting from the Project will impact fledglings leaving their nests.

Given:

- the Proponent's intention to complete light modelling to inform the Projects light design and minimise light emissions to as low as reasonably practicable;
- the existing light environment in this operational port area; and
- The distance and position of marine turtle and seabird breeding sites relative to the proposed project location.

impacts to the key light sensitive marine fauna from Project operations are expected to be low.

6.5.2.2 SEAWATER INTAKE (INPINGEMENT/ENTRAINMENT)

Impingement and entrainment of marine organisms associated with seawater that is drawn to the intake structure through screens of various apertures has the potential to occur. Impingement refers to adult marine organisms such as fish which are large enough to be retained by the intake screens. Entrainment is associated with smaller organisms including larva and juveniles of different marine species that pass through the intake screens and are transported with feedwater into the desalination facility.

Design of the culverts (which link the ocean to the intake pond), and the intake structure will minimise any potential impacts of impingement and entrainment. An aperture of 150 mm will be used in the screens covering the culverts and the estimated velocity of feedwater through the culverts is low (0.1 – 0.3 m/s). Based on this, impingement of marine fauna larger than 150 mm and adult marine organisms <150 mm is considered unlikely as they can actively swim against the passive water intake. Hawksbill and green turtle hatchlings remain passive in the water for a number of years following initial dispersal and may not be able to swim against the passive water intake, however they are unlikely to be impacted based on the distant location of the culverts in relation to known turtle nesting beaches in the Dampier Archipelago (Fossette et al. 2021) and satellite tracking of hawksbill and green turtles (AIMS 2020; DPaW 2021) indicating that Parker Point is not actively used for inter-nesting or foraging activities.

Marine larvae move passively through the water column and are typically of a size that can pass through the intake screens and would be at risk of entrainment. However, the waters adjacent to the intake culverts are not known to support any spawning aggregations of fish and the risk of any loss of coral larvae due to entrainment causing a decline in the following year's coral recruits growing on substrate is considered negligible - based on the very low abundance of corals nearby and the tendency of coral larvae to congregate at the water surface.

6.5.2.3 WASTEWATER DISCHARGE (COMMISIONING AND OPERATIONS)

Changes to water quality due to discharge of brine effluent during operations or pipe flushing during commissioning are detailed in Section 4.6.

Reduced water quality conditions may lead to stress effects on marine fauna if exposure to these conditions is maintained for an extended period. However, as discussed in Section 4.6 the change to ambient water temperature, dissolved oxygen, TSS and toxicity from discharge of the wastewater is considered minimal and under average dilution conditions the Moderate/High LEP boundary will be achieved within 45 m of the Parker Point wharf (discharge point), which is an area of high vessel traffic that mobile marine fauna are likely to avoid.

7 REFERENCES

Advisian (2021) Dampier and Cape LambertDesalination Project - Early Studies, Dilution Modelling Study - Parker Point. Report: 301012-00015-CS-REP-0010_Rev B, Unplublished Report to Rio Tinto Iron Ore, Perth, W.A.

AIMS (2020) North West Shoals to Shore Research Program. Hawksbill and green turtle distribution and important areas. In: eatlas.org.au. https://eatlas.org.au/nwa/nws2s-megafauna#green_nesting. Accessed 31 Aug 2021

Allen SJ, Cagnazzi DD, Hodgson AJ, et al (2012) Tropical inshore dolphins of north-western Australia: Unkown populations in a rapdily chaming region. Pac Conserv Biol 18:56–63.

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. www.waterquality.gov.au/anz-guidelines.

Armstrong AJ, Armstrong AO, McGregor F, et al (2020) Satellite Tagging and Photographic Identification Reveal Connectivity Between Two UNESCO World Heritage Areas for Reef Manta Rays.

Berkelmans R, Jones AM, Schaffelke B (2012) Salinity thresholds of Acropora spp. on the Great Barrier Reef. Coral Reefs 31:1103–1110.

Biota (2009) Turtle Monitoring at Bells Beach and Selected Rookeries of the Dampier Archipelago: 2008/09 Season. Report Prepared for Rio Tinto Iron Ore., Perth WA

BMT (2021) A review of desalination discharge triggers. Technical Note to Hamersley Iron, Perth WA

BMT Oceanica (2017) Cape Lambert Port B Development - Ecosystem Research and Monitoring Program 6: Humpback Whale Aerial Surveys 2012-2016 Review. Prepared for Rio Tinto (on behalf of Robe River Mining Co. Pty Ltd)

BOM (2020) Climate statistics for Australian locations: Dampier Port. http://www.bom.gov.au/climate/averages/tables/cw_004097_All.shtml.

Bruce BD, Stevens JD, Malcolm H (2006) Movemenrs and swimming behaviour of white sharks (Carcharodon carcharias) in Australian waters. Mar Biol 150:161–172.

CALM (1990) Dampier Archipelago Nature reserves Management Plan 1990 - 2000. Management Plan No.18. Department of Conservation and Land Management, Perth, WA

CALM (2005) Indicative Management Plan for the Proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area 2005. Western Australian Department of Conservation and Land Management

Chidlow J, Gaughan D, McAuley R (2005) Identification of Western Australian Grey Nurse Shark aggregation sites. Department of Fisheries, Government of Western Australia

Clark GF, Knott NA, Miller BM, et al (2018) First large-scale ecological impact study of desalination outfall reveals trade-offs in effects of hypersalinity and hydrodynamics. Water Res 145:757–768.

Colman JG (1997) A review of the biology and ecology if the whale shark. J Fish Biol 51:1219–1234.

Commonwealth of Australia (2014) Recovery Plan for the Grey Nurse Shark (Carcharias taurus). Department of Environment, Canberra ACT

Commonwealth of Australia (2017) Recovery Plan for Marine Turtles in Australia.

Commonwealth of Australia (2020) National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds.

Commonwealth of Australia (2021) The National System for the Prevention and Management of Marine Pest Incursions. https://nimpis.marinepests.gov.au/mapping.

DAWE (2021) Department of Agriculture, Water and the Environment. Species Profile and Threats Database. In: Species Profile Threats Database. http://www.environment.gov.au/sprat. Accessed 3 Sep 2021

DEC (2006) Background Quality of the Marine Sediments of the Pilbara Coast. Report: MTR1 2006, Department of Environment and Conservation, Perth, WA

Department of Environment (2006) Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives. Report: MR1 2006, Department of Environment, Perth, WA

DHI (2021) DHI Water and Environment Pty Ltd Vessel-Check. In: Vessel-Check. https://www.vessel-check.com/auth/home-page. Accessed 16 Feb 2021

DoF (2017) Department of Fisheries Biofouling Biosecurity Policy.

DPaW (2021) Satellite Tracking Rosemary Island Hawksbill Turtles. In: Seaturtle.org. http://www.seaturtle.org/tracking/index.shtml?project_id=1136. Accessed 10 Jun 2021

DWER (2019) Landfill Waste Classification and Waste Definitions 1996 (as amended 2019).

EPA (2010) Environmental Assessment Guidelines 5: Environmental Assessment Guideline for Protecting Marine Turtles from Light Impacts. Western Australian Environmental Protection Authority, Perth, WA

EPA (2020) Instructions: Environmental Review Document. Instructions on how to prepare an Environmental Review Document. Environmental Protection Authority, Western Australia

Erbe C, McPherson C (2017) Underwater noise from geotechnical drilling and standard penetration testing.

ERM (2018) Potential Impact of Pile-Driving Noise at Cape Lambert. A Review of the Literature and International Regulations, 2018 Addendum. Report to Rio Tinto Services Limited, Perth WA

Evans R, Wilson S, Fisher R, et al (2020) Early recovery dynamics of turbid coral reefs after recurring bleaching events.

Falkenberg LJ, Styan CA (2015) The use of simulated whole effluents in toxicity assessments: A review of case studies from reverse osmosis desalination plants. Desalination 368:3–9.

Fossette S, Loewenthal G, Peel LR, et al (2021) Using Aerial Photogrammetry to Assess Stock-Wide Marine Turtle Nesting Distribution, Abundance and Cumulative Exposure to Industrial Activity.

Gegner HM, Ziegler M, Radecker N, et al (2017) High salinity conveys thermotolerance in the coral model Aiptasia. Biol Open 6:1943–1948.

Guinea ML, Limpus CJ, Whiting SD (2004) Marine Snakes. In: National Oceans Office. Description of Key Species Groups in the Northern Planning Area. National Oceans Office, Hobart, Tasmania, pp 137–145

Guinea ML, Whiting SD (2005) Insights into the distribution and abundance of seasnakes at Ashmore Reef. pp 199–206

Hawkins AD, Popper AN (2017) A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. J Mar Sci 74:635–651.

Heyward AJ, Revill AT, Sherwood CR (2000) Review of Research and Data Relevant to Marine Environmental Management of Australia's North West Shelf. Report to the Western Australian Department of Environmental Protection by the Australian Institute of Marine Science (AIMS) and CSIRO Marine Research

Higgins PJ, Davies SJJF (1996) Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons. Oxford University Press, Melbourne, Melbourne, VIC

Hutchins JB (ed) (2004) Fishes of the Dampier Archipelago, Western Australia. Records of the Western Australian Museum Supplement No. 66, Perth, WA

Jenner C, Jenner M (2009) A description of Humpback whale and other mega fauna distribution and abundance in the Western Pilbara using aerial surveys - 2009/2010. Prepared for API Pty Ltd by the Centre for Whale Research, Fremantle, Western Australia

Jenner C, Jenner M (2011) A description of humpback whale behaviour patterns in Nickol Bay, Western Australia, using vessel based surveys. Prepared for API Pty Ltd by the Centre for Whale Research, Fremantle, Western Australia

Jenner KCS, Jenner MNM, McCabe KA (2001) Geographical and temporal movements of humpback whales in Western Australian waters. APPEA J 749–765.

Johnstone RE, Burbidge AH, Darnell JC (2013) Birds of the Pilbara region, including seas and offshore islands, Western Australia: distribution, status and historical changes. Rec West Aust Mus 78:343–441.

Jones DS (2004) Barnacles (Cirripedia: Thoracica) of the Dampier Archipelago, Western Australia. In: Jones DS (ed) Marine Biodiversity of the Dampier Archipelago, Western Australia 1998-2002. Western Australian Museum, Perth, WA, pp 121–157

Kuanui P, Chavanich S, Viyakarn V, et al (2015) Effects of Temperature and Salinity on Survival Rate of Cultured Corals and Photosynthetic Efficiency of Zooxanthellae in Coral Tissue. Ocean Sci J 50:263–268.

Larche N, Dezerville P, Le Flour D (2013) Corrosion and corrosion managememt investigations in seawater reverse osmosis desalination plants. Desalination Water Treat 51:1744–1761.

Last PR, Stevens JD (2009) Sharks and Rays of Australia, Second Edition. CSIRO Publishing, Collingwood, Australia

Limpus CJ (2002) Western Australian Marine Turtle Review. Queensland Environmental Protection Agency, Brisbane, QLD

Limpus CJ (2007) A Biological Review of Australian Marine Turtles – 5. Flatback Turtle, Natator depressus (Garman). Queensland Environmental Protection Agency

Limpus CJ (2008) A Biological Review of Australian Marine Turtles – 2. Green Turtle, Chelonia mydas (Linnaeus). Queensland Environmental Protection Agency

Limpus CJ (2009a) A Biological Review of Australian Marine Turtles – 3. Hawksbill Turtle, Eretmochelys imbricatta (Linnaeus). Queensland Environmental Protection Agency

Limpus CJ (2009b) A Biological Review of Australian Marine Turtles – 6. Leatherback Turtle, Dermochelys coriacea (Vandelli). Queensland Environmental Protection Agency

McAuley RB, Bruce BD, Keay IS, et al (2017) Broad-scale coastal movements of white sharks off Western Australia described by passive acoustic telemetry data. Mar Freshw Res 68:1518–1531.

Moller LM, Attard CRM, Bilgmann K, et al (2020) Movements and behaviour of blue whales satellite tagged in an Australian upwelling system.

Morgan D, Wueringer B, McDavitt M (2019) Technical Memo in relation to the presence of sawfish species and the construction of a marina in Port Hedland. Report to Department of Transport, Murdoch University, Sharks and Rays Australia

Morgan DL, Allen MG, Ebner BC, et al (2015) Discovery of a pupping site and nursery for critically endangered green sawfish Pristis zijsron. J Fish Biol 86:1658–1663.

Morgan DL, Ebner BC, Allen MG, et al (2017) Habitat use and site fidelity of neonate and juvenile green sawfish Pristis zijsron in a nursery area in Western Australia. Endanger Species Res 34:235–249.

Morgan DL, Whitty JM, Phillips NM, et al (2011) North-western Australia as a hotspot for endangered elasmobranchs with particular reference to sawfishes and the Northern River Shark. J R Soc West Aust 94:345–358.

Morrice MG (2004) Killer whales (Orcinus orca) in Australian territorial waters. Report for the Whale & Dolphin Conservation Society, Deakin University, School of Ecology and Environment

MScience (2005) Dampier Marine Monitoring Program: Initial Monitoring Survey. Report: MSA32R1, Unpublished Report to Hamersley Iron Pty Ltd by MScience Pty Ltd, Perth, WA

MScience (2007) Dampier Port Authority: DCW Capital Dredging: Sediment Quality Report - March 2007. Report: MSA78R5, Unpublished Report to Dampier Port Authority by MScience Pty Ltd, Perth, WA

MScience (2016a) Long Term Dredging Sea Dumping Permit Port of Dampier. Sampling and Analysis Plan (SAP). Prepared for Plibara Iron Pty Ltd, Perth, W.A.

MScience (2016b) Long Term Dredging Sea Dumping Permit Port of Dampier: Long Term Monitoring and Management Plan. Report Prepared for Pilbara Iron Pty Ltd., Perth, W.A.

MScience (2017) Parker Point Artificial Reef : Status Report at June 2017. Report: MSA118.9-1, Unpublished Report to Pilbara Iron Pty Limited by MScience Pty Ltd

MScience (2018) Marine Habitat Mapping. Dampier and Cape Lambert 2017. Report for Rio Tinto Iron Ore, Perth WA

MScience (2020a) Long Term Dredging Sea Dumping Permit Port of Dampier. Sampling and Analysis Plan Implementation Report. Report: MSA299R01, Report Prepared for Rio Tinto Iron Ore., Perth, W.A.

MScience (2020b) Proposed Dampier and Cape Lambert Desalination Plants Gap Analysis: Review of Available Data. Report: MSA286M01, Memorandum to Rio Tinto, Perth WA

MScience (2020c) Parker Point Benthic Community and Habitat Survey - August 2020. Report: MSA286M02, Memorandum to Rio Tinto, Perth WA

MScience (2021a) Parker Point Physical Water Quality. Report: MSA286M04, Memorandum to Rio Tinto, Perth WA

MScience (2021b) Parker Point Benthic Community and Habitat Survey - January 2021. Report: MSA286M03, Memorandum to Rio Tinto, Perth WA

NEPM (2013) National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013.

Otway NM, Burke NS, Morrison NS, Parker PC (2003) Monitoring and Identification of NSW Critical Habitat Sites for conservation of Grey Nurse Sharks. Report: 47, NSW Fisheries Office of Conservation, Port Stephens, New South Wales, Australia

Parks Australia (2021) Dampier Marine Park Biologically Important Areas. In: Aust. Mar. Parks Sci. Atlas. https://atlas.parksaustralia.gov.au/amps/natural-values/biologically-important-areas?rsid=27184&featureId=AMP_NW_DAM.

Pearce AF, Buchan S, Chiffings T, et al (2003) A review of the oceanography of the Dampier Archipelago. In: Wells FE, Walker DI, Jones DS (eds) Proceedings of the Twelfth International Marine Biological Workshop: The Marine Flora and Fauna of Dampier, Western Australia. Vol.1. Western Australian Museum, pp 13–50

Pendoley K (2005) Sea turtles and the environmental management of industrial activities in North West Western Australia. Murdoch University

Petersen KL, Frank H, Paytan A, Bar-Zeev E (2018) Impact of seawater desalination on coastal environments. In: Sustainable Desalination Handbook: Process Design and Implementation Strategies, 1st Edition. Elsevier Inc,

Pitman RL, Totterdell JA, Fearnbach H, et al (2015) Whale killers: Prevalence and ecological implications of killer whale predation on humpback whale calves off Western Australia. Mar Mammal Sci 31:629–657.

Popper AN, Hawkins AD, Fay RR, et al (2014) Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

Prince RIT (1993) Western Australian marine turtle conservation project: an outline of scope and an invitation to participate. Mar Turt Newsl 60:8–14.

Prince RIT, Lawler IR, Marsh HD (2001) The Distribution and Abundance of Dugongs and Other Megavertebrates in Western Australian Coastal Waters Extending Seaward to the 20 metre Isobath

Between North West Cape and the DeGrey River Mouth, Western Australia. Report for Environment Australia

Rennie S, Hanson CE, McCauley RD, et al (2009) Physical properties and processes in the Perth Canyon, Western Australia: Links to water column production and seasonal pygmy blue whale abundance. J Mar Syst 77:21–44.

RPS (2009) Effects of a Desalination Plant Discharge on the Marine Environment of Barrow Island. Report: N09504, Unpublished Report to Chevron Australia, Subiaco, Western Australia

Scott A, Harrison PL, Brooks LO (2013) Reduced salinity decreases the fertilization success and larval survival of two scleractinian coral species. Mar Environ Res 1–5.

Semeniuk V (1996) Coastal forms and quaternary processes along the arid Pilbara coast of northwestern Australia. Palaeogeogr Palaeoclimatol Palaeoecol 123:49–84. doi: 10.1016/0031-0182(96)00103-4

Semeniuk V, Chalmer PN, Le Provost I (1982) The marine environments of the Dampier Archipelago. J R Soc West Aust 65:97–114.

SEWPaC (2012) Species Group Report Card - cetaceans: Supporting the marine bioregional plan for the north marine region. Canberra ACT

Southall BL, Finneran JL, Reichmuth C, et al (2019) Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquat Mamm 45:125–232.

Stoddart JA, Anstee S (2005) Water quality, plume modelling and tracking before and during dredging in Mermaid Sound, Dampier, Western Australia. In: Stoddart JA, Stoddart SE (eds) Corals of the Dampier Harbour: Their Survival and Reproduction During the Dredging Programs of 2004. MScience Pty Ltd, Perth Western Australia, pp 9–30

Stoddart JA, Welsh JQ, Stoddart C (2019) Concentrations of some metals in the nearshore marine sediments of Western Australia's Pilbara Region.

Udyawer V, D'Anastasi B, McAuley R, Heupel M (2016) Exploring the status of Western Australia's sea snakes. National Environmental Science Program Marine Biodiversity Hub

Udyawer V, Somaweera R, Nitschke C, et al (2020) Prioritising search effort to locate previously unknown populations of endangered marine reptiles.

WAEPA (2016a) Technical Guidance - Protecting the Quality of Western Australia's Marine Environment. Western Australian Environmental Protection Authority, Perth WA

WAEPA (2016b) Technical Guidance: Protection of Benthic Communities and Habitats. Western Australian Environmental Protection Authority, Perth Western Australia

WAEPA (2016c) Environmental Factor Guideline: Marine Fauna. Western Australian Environmental Protection Authority, Perth Western Australia

WAMSI (2019) Dredging Science Node - Final Synthesis Report. Western Australian Marine Science Institute, Perth Western Australia

Wells FE, McDonald JI, Huisman JM (2009) Introduced Marine Species in Western Australia. Department of Fisheries, Perth, WA

Wells FE, Walker DI (2003) Introduction to the marine environment of Dampier, Western Australia. In: Wells FE, Walker DI, Jones DS (eds) The Marine Flora and Fauna or Dampier, Western Australia. Western Australian Museum, Perth, WA, pp 1–12

Wenziker K, McAlpine K, Apte S, Masini R (2006) Background Quality for Coastal Marine Waters of the North West Shelf, Western Australia. Report: North West Shelf Joint Environmental Management Study Technical Report 18

Willis MR, Broudic M, Bhurosah M, Masters I (2010) Noise Associated with Small Scale Drilling Operations. Bilbao,

Wilson SG, Polovina JJ, Stewart BS, Meekan MG (2006) Movemements of whale sharks (Rhincodon typus) tagged at Ningaloo Reef, Western Australia. Mar Biol 148:1157–1166.

Worley Parsons (2009) Dampier Marine Services Facility: Preliminary Site Investigation Sampling and Analysis Plan Implementation Report. Perth Western Australia

8 APPENDIX A – EPBC PROTECTED MATTERS SEARCH RESULTS

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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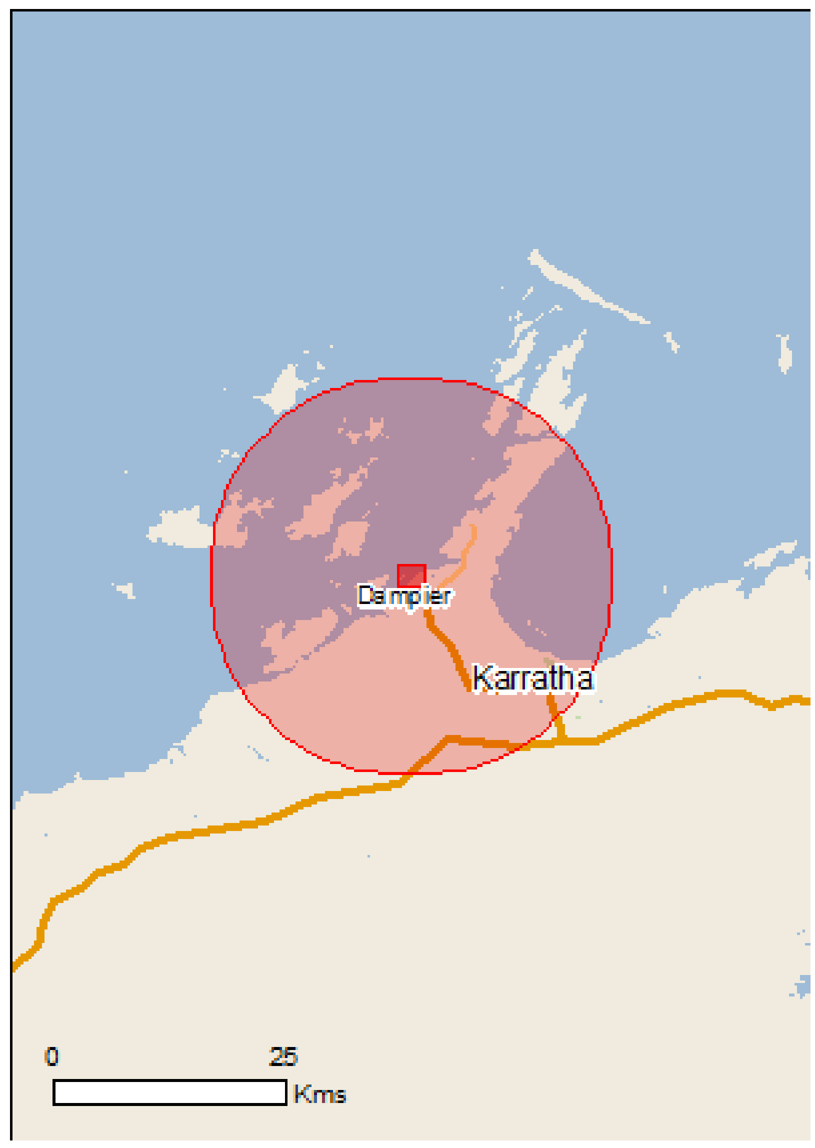

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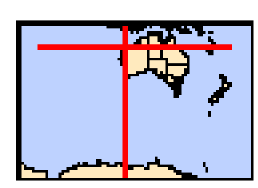

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	29
Listed Migratory Species:	60

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	2
Commonwealth Heritage Places:	None
Listed Marine Species:	100
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	6
Regional Forest Agreements:	None
Invasive Species:	17
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

National Heritage Properties		[Resource Information]
Name	State	Status
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		

Name	Threatened	Type of Presence
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land - Defence - KARRATHA TRAINING DEPOT

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding likely to occur within area
Stiltia isabella Australian Pratincole [818]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area
Fish		
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse		Species or species

Name	Threatened	Type of Presence
[66234]		habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		

Name	Status	Type of Presence
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Murujuga	WA
Unnamed WA36907	WA
Unnamed WA36909	WA
Unnamed WA36910	WA
Unnamed WA36915	WA
Unnamed WA38287	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Ramphotyphlops braminus		
Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat known to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-20.63574 116.70405,-20.63574 116.72972,-20.65485 116.72972,-20.65485 116.70405,-20.63574 116.70405

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111