Kimberley Technology Solutions Pty Ltd

Cockatoo Island Multi-User Supply Base

Referral - Supporting Document

June 2017

Executive summary

Kimberley Technology Solutions Pty Ltd is referring the Cockatoo Island Multi-User Supply Base (the Proposal) to the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986*. This supporting document has been prepared to provide additional information to supplement the s38 Referral, and to assist the EPA to decide whether to assess the Proposal.

The Proposal would establish a hi-tech / subsea focused supply base as part of a multi-user supply chain cluster. Developments would comprise an upgraded airfield, a wharf and an aftermarket subsea workshop as well as other related support infrastructure.

Six Key Environmental Factors were identified for the Proposal and an assessment of significance was undertaken for each factor:

- **Benthic communities and habitat**

  The Project will result in the direct loss of 0.54 ha of hard coral and algae, of which 0.3 ha is very sparse hard coral. Species are represented in adjacent bays and in higher densities and coverage. Some colonisation by marine species will occur on the new sheet piling. As this bay has very little primary producer habitat compared to the adjacent bays, there is unlikely to be a significant impact to local biological diversity and ecological integrity.

- **Coastal processes**

  The new wharf will run parallel to the shoreline and will not significantly affect or interrupt longshore current movements or existing coastal processes.

  Any residual impacts on sedimentation, geomorphology, current speeds and patterns will be localised and restricted to the vicinity of the wharf.

- **Marine environmental quality**

  The Proposal does not involve dredging or any planned discharge, and is not expected to interrupt longshore current movements or existing coastal processes.

  Impacts will be largely confined to the construction phase and limited to the immediate area of construction that is largely dominated by unvegetated sandy environs. Further, due to the large tidal regime and seasonally high rainfall, fluxes in total suspended solids and turbidity are common.

  There is not expected to be any significant risk to maintaining environmental values of the water, sediment and biota through the construction or operational phases.

- **Marine habitat and fauna**

  Given the proposed mitigation measures, lack of known critical marine fauna habitat in the impacted bay and comparably less benthic communities and habitats than adjacent bays, the Proposal activities are not expected to result in any significant losses of marine fauna. There is the potential for some fauna losses to occur during the reclamation process, but progressive reclamation will allow marine fauna to relocate.

  During reclamation and piling, there is likely to be behavioural avoidance of the area but not direct physical trauma. Any impacts to behaviour will be limited to transient individuals near to the activity, as the area is not significant for cetaceans or turtles. Migrating species that pass through the area will be able to navigate around any point source disturbance.

With adherence to the management controls proposed, potential impacts are considered acceptable.

- **Terrestrial vegetation**

  The impacts to terrestrial vegetation are based on the loss of 34.23 ha of native vegetation. No Threatened species or communities have been recorded, or are likely to occur on Cockatoo Island and clearing will remove less than 10% of the remaining area of Eucalyptus woodland present across the Island. Some plants of the Priority 1 species, *Triodia* sp. Hidden Island will potentially be cleared, but a significant number of plants of this species occur in areas that are outside the Proposal area.

  Drainage will be designed to minimise the risk of impact to downslope vegetation during construction and operations. Revegetation using cleared topsoil and vegetative material will replace some of the vegetation initially removed.

- **Terrestrial fauna**

  The Proposal will result the loss of 34.23 ha of habitat for fauna, including foraging habitat suitable for some conservation significant species. Some of the habitat will be re-generated through topsoil and vegetation replacement following construction.

  Some direct loss of reptile and SRE fauna will occur because of vegetation clearing and ground disturbance but this is unlikely to affect conservation significant species as most are nocturnal and arboreal and can move away from the disturbance area.

  The availability of other suitable habitat on Cockatoo Island and on adjacent islands and the mainland is likely to ensure the survival and continued presence of the conservation significant species recorded.

  Potential operational impacts are unlikely to significantly affect fauna presence or diversity.

Actual and potential impacts to terrestrial and marine flora and fauna and their habitats are not considered to be significant, due to the amount of existing disturbed habitat and to other, existing factors such as the availability of significant areas of adjacent habitat of similar, or better, quality.

The development and implementation of Construction and Operations Environmental Management Plans will assist in minimising impacts.

Table of contents

Table index

Figure index

Appendices

Appendix A – Technical Study - Marine Flora and Fauna

Appendix B – Technical Study - Terrestrial Flora and Fauna

Abbreviations and Acronyms

Abbreviation	Definition
AHD	Australian Height Datum
CD	Chart datum (approx. 0 mLAT)
DotEE	Department of Environment and Energy
DPaW	Department of Parks and Wildlife
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EP Act	*Environment Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FAT	Facility Acceptance Testing
ha	Hectare
HPU	Hydraulic Power System
IBRA	Interim Biogeographic Region of Western Australia
IWOCS	Intervention Workshop Control System
km	Kilometre
KTS	Kimberley Technology Solutions Pty Ltd
kV	Kilovolt
L	Litre
LAT	Lowest Astronomical Tide
LCT	Large Carrier Tank
LCTV	Large Crew Transfer Vessel
LGA	Local Government Area
m	Metre
m^3	Cubic metre
m/s	Metres per second
MARPOL	International Convention for the Prevention of Pollution from Ships
MCP	Master Control Panel
mg/L	Milligrams per litre
mg/kg	Milligrams per kilogram
ML	Million litres
PEC	Priority Ecological Community
PSV	Platform Supply Vessel
t	Tonne
TEC	Threatened Ecological Community
SMPEP	Shipboard Marine Pollution Emergency Plan
SOPEP	Shipboard Oil Pollution Emergency Plan

1. Introduction

1.1 Purpose of this Document

Kimberley Technology Solutions Pty Ltd (KTS) is referring the Cockatoo Island Multi-User Supply Base (the Proposal) to the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act). This supporting document has been prepared to provide additional information to supplement the s38 Referral, and to assist the EPA to decide whether to assess the Proposal.

1.2 Overview of the Proposal

KTS proposes to construct and operate the Proposal from Cockatoo Island.

The Proposal would establish a hi-tech / subsea focused supply base as part of a multi-user supply chain cluster. Developments would comprise an upgraded airfield, a wharf and an aftermarket subsea workshop as well as other related support infrastructure.

The cluster incorporates the towns of Broome and Derby and is based on the Norwegian model, which focuses specific industries within an area but not necessarily in one location.

The Proposal would support the exploration, development and operation of oil and gas projects in the Browse Basin. It will also increase opportunities for other strategic industries such as Defence and Tourism in north-western Australia and significantly reduce the operating costs of the mine on Cockatoo Island.

The Proposal represents an opportunity to use the Norwegian model as a test case in Western Australia which, when established, will draw business from existing locations in Asia and interstate. It can be used by the State Government as a catalyst for bringing real economic development to the Kimberley region.

1.3 The Proponent

The Proponent for the Proposal is Kimberley Technology Solutions Pty Ltd, a joint venture between NorSea Group, Brunel Australia and Advantec Group and advised by Global Air and Energy (Singapore). Contact details for the Proponent are:

Mr Jeremy Bower
Kimberley Technology Solutions Pty Ltd
Level 2, 101 St Georges Terrace, Perth WA 6000
Ph: 08 9429 5600
ACN: 615 631 386

1.4 Location of the Proposal

Cockatoo Island is located approximately 7 km off the Western Australian coast within the Buccaneer Archipelago, approximately 130 km north of Derby (Figure 1-1). The Island is located within Yampi Sound, between Irvine and Koolan Islands.

The Island has historically been mined for iron ore, with mining operations on the Island commencing in 1951. Mining operations on the Island are currently in care and maintenance. Existing infrastructure and disturbances on the Island include an airstrip, processing plant, open pit mine (involving mining of high grade ore from a deposit below sea level), a permanent seawall, wharf with ship loading facilities and historic township.

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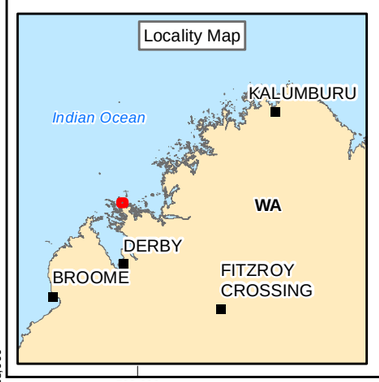

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 51

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Kimberley Technology Solutions Pty Ltd
Cockatoo Island Multi-User Supply Base

Job Number	61-35178
Revision	0
Date	14 Jun 2017

Location Map

Figure 1-1

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Data source: Calibre: Aerial photography - 201703; GA: Geoscience Australia Topo 250k Series III - 2006. Created by: mmikkonen

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2. The Proposal

2.1 Proposal Justification

The Proposal will:

- Increase safety advantage during the petroleum life cycle
- Promote economic activity in the locations which make up the cluster with Cockatoo Island
- Make best use of existing assets without substantial government funded capital upgrades, allowing for a staged development approach
- Transfer technology and knowledge from proven international locations to enhance Australian local content
- Support mining operations on Cockatoo Island by reducing logistics costs
- Assist nearby mining operations through shared services and an expansion of service providers within the key Kimberley towns
- Centralise selected hi-tech services for Browse Basin oil and gas operators currently having to rely on subsea support from further afield (Asian ports and Darwin)
- Link into the supply chain corridor between Perth and Singapore.

2.2 On-shore Developments

Onshore developments will primarily consist of an expanded and upgraded airstrip for fixed wing aircraft and helicopters, airfield support facilities, an accommodation village and site roads.

2.2.1 Airfield, laydown and roads

Airfield

The airfield footprint will be approximately 30 ha, comprising a 1,950 m long by 30 m wide paved airstrip, 90 m wide clearway and a taxiway of 400 m by 100 m (Figure 2-1). The airstrip will provide a take -off distance of 1800 m.

The design follows the alignment of the existing airstrip which reduces the disturbance footprint, makes use of existing mined waste material, uses locally mined rock and will make use of a locally based mining fleet and support system to reduce mobilisation/demobilisation.

Drainage from the airfield will be directed to table drains for infiltration.

Terminal and hangars

An aviation terminal will be constructed adjacent to the runway (Figure 2-1). The proposed structure will be approximately 40 m x 20 m.

The helipad will be designed to accommodate a 3-bay hangar (Figure 2-2).

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Laydown 1

Helicopter stand

Hangar

Terminal

Laydown 2

Laydown 3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 51

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LEGEND

- Proposed Airstrip
- Proposed Laydown Area
- Proposed Eastern Wharf
- Proposed Road

Kimberley Technology Solutions Pty Ltd
Cockatoo Island Multi-User Supply Base

Job Number	61-35178
Revision	0
Date	12 Jun 2017

Layout of Proposal Elements

Figure 2-1

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Data source: Cardno: Clearing elements - 20170606; Calibre: Aerial photography - 201703. Created by: mmikkonen

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Figure 2-2 Three bay hangar with bi-fold door

Fuel storage

There are no plans to install underground/permanent Jet A1 or Avgas refuelling tanks as all aircraft refuelling will be undertaken in Derby.

Some Jet A1 refueling for helicopters will be undertaken. All fuel will be stored above-ground in self-bunded fuel tanks (pods) within a fenced off area adjacent to the helipad (Figure 2-3). Fuel will be transported by barge in articulated trailer tanks that will be decanted and returned to the mainland for filling. The total capacity of the stored fuel will not exceed 100,000 L of Jet A1 (five pods). Filling of helicopters will be done by a dedicated fuel delivery vehicle that will draw fuel from the pods.

Diesel for generators and mobile plant will be stored in a dedicated bunded area. Diesel will arrive by barge in drums and will be transferred to the storage area for distribution when required.

Fuel storage areas will have appropriate spill response equipment.

Figure 2-3 Above-ground self-bunded Jet A1 tank 22,000 L

Utilities

The proposed location of the apron and terminal are close to the existing Island bores. This supply will service the ablution facilities and will be filtered to provide potable water.

Sewage will be treated in a contained septic tank system.

Power will be provided to the terminal by a dedicated 150 kV diesel genset with backup. In the event that the airfield's clients request the provision of runway lighting, this will be provided by a 500 kV genset with backup. These will be switched off when the terminal is not in use.

Laydown and roads

Some land adjacent to the airfield and the wharf (Figure 2-1) will be used for:

- Laydown (overflow from the wharf) of pipe, umbilical reels, containers of spares and parts, drilling equipment and bulk materials
- Construction support
- Offices
- Workshop and warehousing.

Construction support will comprise a demountable site office and less than 20 accommodation units. These will be relocated or dismantled when not required. It is intended to make use of the permanent accommodation on the existing Crown Lease for staff and occasional visitors.

Additional offices, warehouses and workshops will be developed in the future if demand exceeds available space at the wharf.

A road will link the airfield to the wharf (Figure 2-1). This makes use of an existing haul road to the mining tenement. A short extension, not shown on the figure, will be required to connect this haul road to the wharf.

Accommodation may be required should there be space constraints on the existing Crown Lease. This will be the subject of a separate application.

2.2.2 Construction

Construction will disturb up to approximately 53 ha of land (Figure 2-4).

Clearing for the airfield and laydown areas will be undertaken by bulldozer. Cleared vegetation will be respread on areas being rehabilitated including those associated with the mine.

The geology of the area to be levelled indicates that bands of hard rock are present. Provision has been made for up to 80% drill and blast. Loose rock will be moved by truck to areas requiring fill.

The airfield will be bituminised and a temporary bitumen plant will be mobilised. Aggregate will be sourced from the borrow pits on the mining lease and will be crushed and screened on-site.

Construction materials for buildings will be barged to the Island, offloaded and erected on-site.

Extending the existing haul road to the wharf will require some limited blasting. Material will be used in reclamation for the wharf.

Putrescible wastes will be disposed at the existing licenced landfill on the Island. There is also an existing metal dump for disposal of metal waste. Waste hydrocarbons will be removed from the Island for reprocessing. Wastes that cannot be disposed onsite will be transferred to the mainland by barge for disposal.

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Laydown 1

Laydown 2

Airstrip clearing

Roads

Laydown 3

Wharf

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 51

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LEGEND

Disturbance Area

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Job Number	61-35178
Revision	2
Date	12 Jun 2017

Disturbance Areas

Figure 2-4

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Data source: GHD: Disturbance areas - 20170606; Calibre: Aerial photography - 201703. Created by: mmikkonen

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2.2.3 Operations

With a single client, air traffic will consist of two Regional Jets and eight to ten helicopter cycles (take-off and landing) per week. Fixed wing aircraft will only operate during daylight hours with helicopters operating both day and night.

Waste materials during operations will be disposed in a similar manner to construction wastes.

2.1 Marine Developments

The bay to the east of the existing ship loader has a suitable profile for development of a wharf. The bay comprises a sandy beach at low tide with a drop off to between -10 mCD and - 20 mCD.

2.1.1 Wharf and subsea workshop

Wharf

The topography of the seabed together with the tides experienced at Cockatoo Island favour the development of an anchored sheet pile retaining wall inside the drop off and a floating outer quayside caisson attached to the shore by a linkspan (Figure 2-5). This design allows for access at all stages of the tide, reduces the footprint on the seabed and reduces cost of construction.

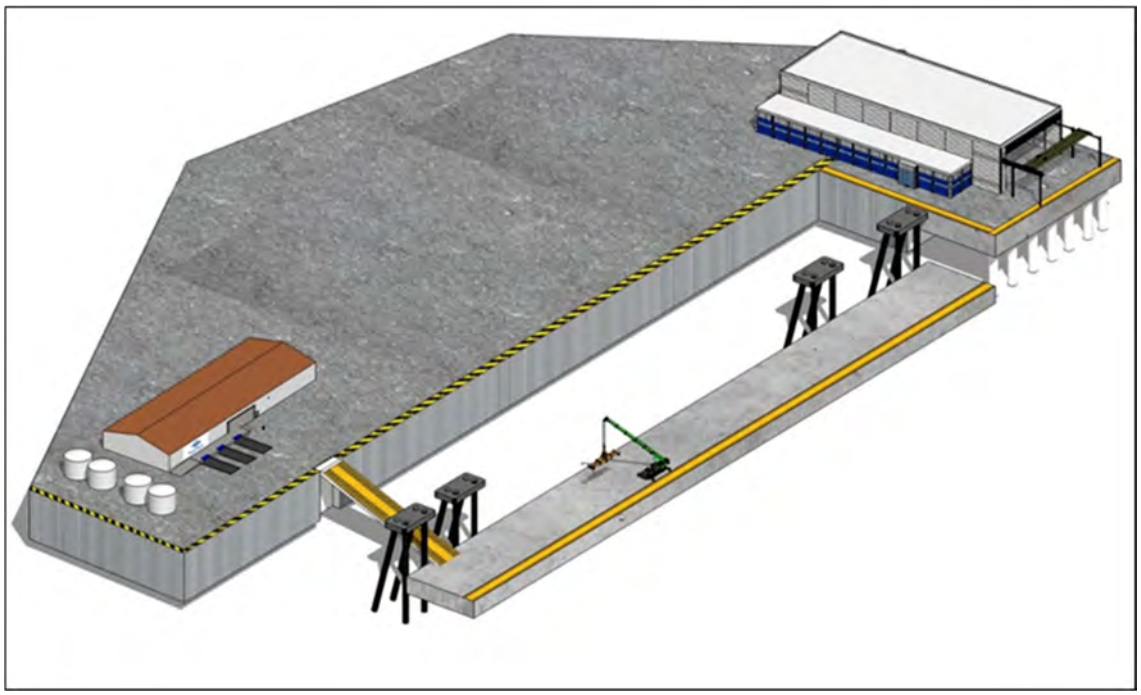

Figure 2-5 Schematic of proposed wharf

The eastern end of the wharf will accommodate a fixed section to access the deeper water close to shore and is the preferred location for the subsea workshop.

The access road to the wharf is shown in Figure 2-1.

The proposed facilities on the wharf are:

- Tanks – 1 ML of marine gas oil in self-bunded tanks and 0.5 ML of potable and/or drilling water. Final location will be subject to detailed design
- Warehouse – 100 m x 40 m. Steel and colour bond construction. Cyclone rated
- Diesel and hydraulic fluids in drums within bunded and covered areas

- Laydown areas – demarcated on the wharf for pipe, umbilical reels, containers of spares and parts, drilling equipment and bulk materials
- Lighting to allow for night works
- Mobile Cranes – 250 t
- 2 x 500 kV generators, 1 operating and one on standby
- Contained grey and blackwater treatment plant
- Future LNG bunkering
- 30 m x 20 m Large Crew Transfer Vessel (LCTV) passenger terminal.

Subsea workshop

The workshop will provide subsea aftermarket support such as:

- Receiving subsea components (trees)
- Systems Integration Testing (SIT)
- Factory Acceptance Testing (FAT)
- Control System servicing and testing and repair
- Storage of control modules such as Intervention Workover Control Systems (IWOCS), Master Control Panels (MCP) and Hydraulic Power Systems (HPU)
- Storage of tools and parts.

The workshop will be 96 m x 50 m, of steel and colour bond construction, and cyclone rated (Figure 2-6).

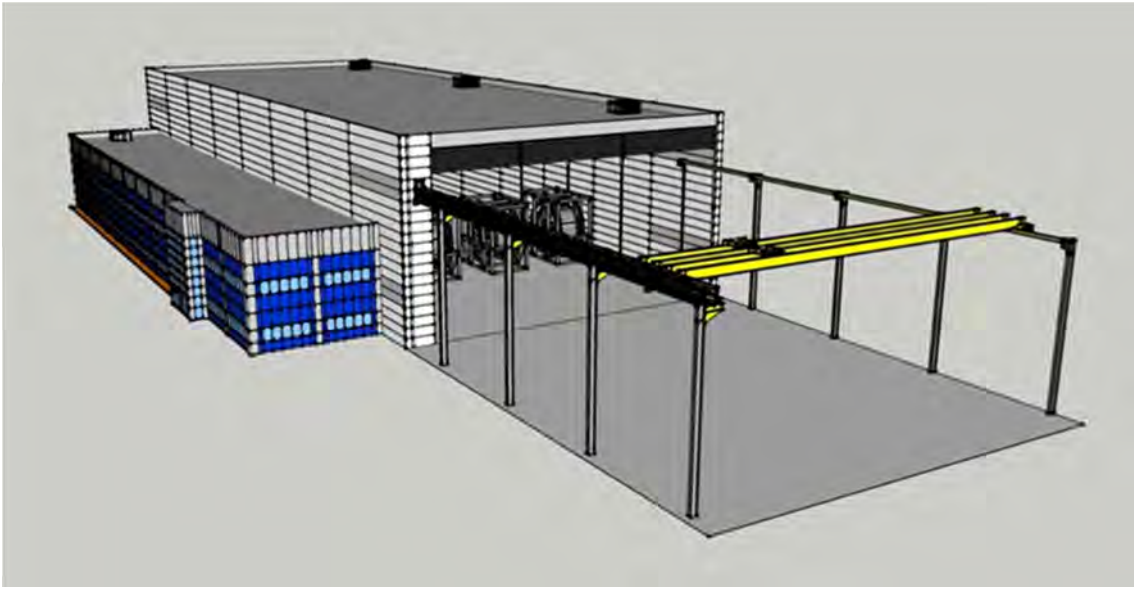

Figure 2-6 Schematic of proposed subsea workshop

The workshop will be integrated with a gantry crane that can access the quayside. The workshop portion will contain a test pit that can be flooded and discharged. The test pit will service equipment designed to operate on the seabed so there is minimal risk of water contamination within the pit and the discharge water. The test pit is isolated from the surrounding seawater.

Power will be supplied by 2 x 500 kV gensets, one active and one on standby.

Sewage will be collected in tanks and transferred to the septic tank system at the airstrip for disposal.

2.1.2 Construction

Whilst geotechnical drilling has not been undertaken at the proposed site, the geology of the adjacent bay is well described. The geology suggests that the piles will encounter the Quarry Schist and will not penetrate any coralline sediments.

The depth of bedrock below the seabed is estimated at 5 m – 15 m. The sheet piling will be anchored into the bedrock by drilling a toe in the rock to a depth of 1 m to stabilise the foot and the pilings will be stabilised with tiebacks to anchors.

The quayside caissons will be anchored by a series of concrete and steel pilings that will be anchored into the bedrock.

The caisson and subsea area pilings will require rock drilling and cementing.

The wharf area behind the sheet pile will be around 6.2 ha and will require around 75,600 m^3 of fill to raise the level of the platform to 2 m above high tide. Fill will be sourced from benign mine waste, compacted and sealed with a concrete, layblock or asphalt hardstand. Waste rock will be delivered using the mine's current vehicle fleet and progressively tipped into the reclamation area, starting from the shoreline.

No dredging will be required.

Putrescible wastes will be disposed at the existing licenced landfill on the Island. There is also an existing metal dump for disposal of metal waste. Waste hydrocarbons will be removed from the Island for reprocessing. Wastes that cannot be disposed onsite will be transferred to the mainland by barge for disposal.

2.1.3 Operations

Activity at the wharf will be dependent on drilling and construction campaigns and traffic will vary as a result. The wharf will typically handle two LCTV port calls per day, two subsea vessel calls per month averaging five days, four to five Platform Supply Vessel (PSV) calls per week, two Large Carrier Tank (LCT) calls per week and one to two other industry calls per month (defence and tourism).

Operations will occur 24/7 as required.

Waste materials during operations will be disposed in a similar manner to construction wastes.

2.2 Staging

The preceding discussion identifies the ultimate development for the Proposal.

However, to take into account activities associated with Prelude and Ichthys hook-up, commissioning and production stages, as well as construction and production for Browse, there is flexibility to progressively develop the Proposal.

Staging could include:

- Initially bitumising the existing airstrip and upgrading the existing terminal building with the addition of another transportable unit to allow for new seating
- Progressive development of the airstrip to 1600 m, 1800 m and ultimately 1950 m
- Construction of the new terminal based on passenger demand
- Construction of the helipad based on demand.

3. Stakeholder Consultation

KTS has completed an extensive stakeholder engagement program outlining the Proposal to the following government departments and stakeholder groups:

- Department of State Development
- Department of Mines and Petroleum
- Department of Lands
- Department of Premier and Cabinet
- Department of Transport
- Kimberley Ports Authority
- Shire of Derby/West Kimberley
- Office of the Environmental Protection Authority
- Dambimangari Aboriginal Corporation (Dambimangari)
- Djarindjin Aboriginal Corporation
- Lombadina Aboriginal Corporation
- Ardyloon/One Arm Point Aboriginal Corporation
- Pelican Resources Limited
- Pluton Resources Limited.

There is engagement and ongoing dialogue with Pelican Resources Limited, Pluton Resources Limited (mining lease holders on Cockatoo Island) and the Traditional Owners and Native Title holders of Cockatoo Island, the Dambimangari.

KTS will undertake ethnographic and anthropologic heritage studies with the cooperation of the Islands Traditional Owners. KTS and Dambimangari have agreed to a Heritage Protocol for activates undertaken on the Island and are negotiating a Land Access Agreement.

Department of Parks and Wildlife

Following the completion of the 2016 baseline biological survey (GHD 2017), GHD arranged a teleconference with staff from Department of Parks and Wildlife (DPaW) West Kimberley District to discuss the Proposal and expectations in relation to survey effort and guidance on assessment of impacts to conservation significant flora and fauna species. In particular, GHD sought advice on the implications of the extensive 2016 bushfire on Cockatoo Island on further targeted surveys of the *Triodia* sp. Hidden Island, as well as survey effort to date targeting bats (including the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed Ghost Bat).

Participants in the teleconference included:

- Bruce Greatwich (DPaW – West Kimberley District)
- Karen Bettick (DPaW – West Kimberley District)
- Glen Gaikhorst (Principal Zoologist, GHD)
- Jordan Tindiglia (Senior Environmental Scientist, GHD)
- Jeremy Bower (on behalf of KTS).

During the teleconference, the following key points were discussed:

- GHD explained that *Triodia* sp. Hidden Island had previously been collected from one location in the central part of the Island during the 2014 wet season survey (GHD 2014). The plant was located adjacent to a track, north of the airpstrip in an area that had historically been used as a material dump (believed to be back in the 1950s). GHD revisited the location during the 2016 field survey, however, the site had been burnt and the *Triodia* could not be re-located. Staff from DPaW advised that further assessment should be based on the existing/baseline habitats present, not just the post-fire habitats i.e. although the vegetation has been burnt, the habitat is still present on the Island. DPaW also advised that the fire should be considered as a limitation to the December 2016 survey. There was agreement between GHD and DPaW that further targeted survey work would be undertaken to determine the extent of the species' distribution elsewhere on the Island.
- GHD outlined the previous survey effort undertaken for Threatened and Priority bat species, the species recorded and the habitats available for bats on the Island. Previous surveys have identified the presence of three species on the Island, including the Ghost Bat, Northern Leaf-nosed Bat and Little North-western Mastiff Bat. There was a general discussion of the foraging/hunting and breeding habitat for each of these species and Glen explained there is one cave potentially suitable to support the roosting (of Ghost Bat and Northern Leaf-nosed Bat) in close proximity to the disturbance footprint. It is unknown how this cave is affected by the tidal movements (i.e. partially or completely fills with water) and/or is utilised by any bat species. DPaW advised that as the cave is outside the proposed disturbance footprint, the main concern would be noise and vibration impacts associated with blasting activities during construction. DPaW indicated that no further survey effort would be needed to assess the suitability of the cave as bat roosting habitat. DPaW also raised the issue of increased aircraft flights at night and the associated increased risk of striking bats. Jeremy advised that there are no anticipated scheduled night flights, except in the case of an emergency.
- The northern sub-species of the Masked Owl was also discussed, including the previous record of the species on the Island and the impact of the 2016 fire on the value of the woodland habitat for breeding. Glen described the lack of trees with hollows that may provide breeding and roosting opportunities for the species and how little impact is likely on the species. DPaW indicated that the habitat should be assessed as if it was pre-fire, and potential impacts evaluated accordingly.

The outcomes of this discussion indicated that no further survey effort would be required for the Ghost Bat and northern sub-species of the Masked Owl, however a targeted flora survey should be undertaken to determine the distribution of *Triodia* sp. Hidden Island. This has been completed and the results are presented in GHD (2017) and discussed in this report.

4. Environmental Principles and Factors

4.1 Principles

Section 4A of the EP Act establishes the object and principles of the Act. In accordance with the EPA's Statement of Environmental Principles, Factors and Objectives (EPA 2016), this section describes how each of the five principles of the EP Act has been applied to the Proposal.

Principle	Consideration of Principle in the Proposal
The precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decision should be guided by: a. careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and b. an assessment of the risk-weighted consequences of various options.	Baseline and targeted flora and fauna surveys have been undertaken for the entire area potentially impacted by the Proposal. Information collected builds on information from earlier surveys. No significant impacts are likely from construction and operation of the Proposal. The Proposal will have a relatively small disturbance footprint with a significant proportion of the development occurring on previously disturbed areas.
The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	No significant impact to the existing environment is predicted to occur.
The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	The Proposal will not threaten biological diversity or ecological integrity.
Principles relating to the improved valuation, pricing and incentive mechanisms a. Environmental factors should be included in the valuation of assets and services. b. The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement. c. The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes. d. Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.	The Proposal is not expected to generate any significant pollution or waste. Justification for the Proposal includes incentives to reduce environmental footprints and costs including: • Promote economic activity in the locations which make up the cluster with Cockatoo Island • Make best use of existing assets without substantial government funded capital upgrades • Assist nearby mining operations through shared services and an expansion of service providers within the key Kimberley towns • Centralise selected hi-tech services for Browse Basin oil and gas operators currently having to rely on subsea support from Asian ports and Darwin.
The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Construction and operation of the facility will not result in the generation of significant waste streams. Putrescible wastes will be disposed at the existing licenced landfill on the Island. There is also an existing metal dump for disposal of metal waste. Waste hydrocarbons will be removed from the Island for reprocessing. Wastes that cannot be disposed onsite will be transferred to the mainland by barge for disposal. Cut and fill volumes for the airstrip essentially balance. Any excess material, and some waste rock from existing mine dumps, will be used as fill for the wharf.

4.2 Identification of Key Environmental Factors

Environmental factors are those parts of the environment that may be impacted by an aspect of a proposal. The EPA has 14 environmental factors, organised into five themes: Sea, Land, Water, Air and People.

The environmental factors are provided in Table 4-1 together with the EPA's objective for each factor. The relevance of each factor to the proposed Cockatoo Island Multi-User Supply Base is discussed to identify which of the factors are Key Environmental Factors requiring further consideration.

Table 4-1 Identification of Key Environmental Factors

Factor	Objective	Relevance to Proposal	Key Environmental Factor?
Sea			
Benthic Communities and Habitat	To protect benthic communities and habitat so that biological diversity and ecological integrity are maintained.	Wharf construction will impact benthic habitats.	Yes
Coastal Processes	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.	Wharf construction has potential to modify coastal processes.	Yes
Marine Environmental Quality	To maintain the quality of water, sediment and biota so that environmental values are protected.	Wharf construction has potential to cause sedimentation. Wharf operations will involve handling and storage of hydrocarbons.	Yes
Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.	Wharf construction and operations have potential to generate noise and result in vessel strikes.	Yes
Land			
Flora and Vegetation	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.	Construction will result in vegetation clearing.	Yes
Landforms	To maintain the variety and integrity of distinctive physical landforms so that environmental values are protected.	Distinctive landforms are not present. Construction will result in cut and fill to extend the airstrip.	No
Subterranean Fauna	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.	Construction and operations will not result in any direct impact to subterranean fauna habitat. No new groundwater extraction. Indirect impacts (e.g. fuel spillage) managed through containment.	No
Terrestrial Environmental Quality	To maintain the quality of land and soils so that environmental values are protected.	No significant impact to environmental values expected.	No
Terrestrial Fauna	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	Construction will result in habitat clearing.	Yes

Water			
Hydrological Processes	To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.	No impact to any environmentally significant water dependent ecosystem. No new groundwater extraction. No permanent watercourses occur on the Island.	No
Inland Waters Environmental Quality	To maintain the quality of groundwater and surface water so that environmental values are protected.	No inland waters occur on the Island.	No
Air			
Air Quality	To maintain air quality and minimise emissions so that environmental values are protected.	No significant emissions are expected.	No
People			
Social Surroundings	To protect social surroundings from significant harm.	No social surroundings will be impacted.	No
Human Health	To protect human health from significant harm.	No human health impacts expected.	No

4.3 Key Environmental Factor - Benthic Communities and Habitat

4.3.1 EPA Objective

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

4.3.2 Policy and Guidance

- Environmental Factor Guideline – Benthic Communities and Habitats (EPA 2016k)
- Technical Guidance – Protection of Benthic Communities and Habitats (EPA 2016l).

4.3.3 Receiving Environment

Baseline studies relevant to the Proposal are provided in Table 4-2.

Table 4-2 Baseline studies – benthic communities and habitat

Consultant	Survey Name
GHD (2017a)	Cockatoo Island Multi-User Supply Base Technical Study - Marine Flora and Fauna
MScience (2011)	Cockatoo Island Marine Closure Knowledge Base and Completion Criteria
MScience (2013)	Cockatoo Island Barge Wharf Benthic Habitat Survey

The Cockatoo Island climate is a dry sub-tropical environment, in an area of low wave energy with a large tidal range of 10 m (MScience 2013). The large tidal range, steep cliffs and beach profile, and high ultraviolet radiation are the dominant factors that drive habitat distributions.

GHD (2017a) undertook a marine survey utilising digital drop camera video system to assess benthic habitats within the bay proposed for the wharf facility (Bay 1) along with the two adjacent bays to the south-east (Bay 2 and Bay 3, also known as Copper Bay) (Figure 4-1). The quality of habitat and occurrence of benthic communities to the north-west of Bay 1 has been compromised through mining-related operations (MScience 2011, 2013) and as such these areas were not surveyed.

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Bay 1

Bay 2

Bay 3

Cockatoo Island

Paper Size A3

0 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 51

N

LEGEND

Substrate Type

- Coral rubble
- Pebbles
- Rocky
- Sand
- Silt
- Proposed Eastern Wharf

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Cockatoo Island Multi-User Supply Base

Job Number	61-35178
Revision	0
Date	12 Jun 2017

Substrate Type

Figure 4-1

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Data source: GHD: Substrate Type Assessment - 20161206, Eastern wharf footprint - 20170606; Calibre: Aerial photography - 201703. Created by: krawlinson, mmikkonen

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Marine Substrate

The dominant substrate across the three bays was sand with fewer sites comprised of silt, gravel/pebbles, coral rubble and rocks (Table 4-3). All three bays had similar substrate patterns with rocky habitats around the shoreline and sandy bottoms in the centre, although Bay 2 had a considerable greater proportion of rocky substrate (21%) than the other two bays (1-8%). A breakdown of the seabed substrate and its spatial distribution is shown in Figure 4-1.

Table 4-3 Substrate percentages within each of the three bays

Bay	Silt	Sand	Gravel/Pebbles	Coral Rubble	Rocky
Bay 1 (proposed wharf site)	0%	91%	1%	0%	8%
Bay 2	0%	71%	5%	3%	21%
Bay 3 (Copper Bay)	<1%	98%	0%	<1%	1%

Marine Habitats

Overview

All three bays had similar physical attributes with gently sloping sandy beaches from the shore to approximately 0 mCD (approx. 0 mLAT). Because of the large tidal range, much of this sandy area is likely to be exposed or very shallow at low spring tides. These areas were very sparsely colonised by hard coral and macroalgae. Rocky environments were common in deeper waters around the headlands and were colonised only by turfing algae. As the depth increases, sandy habitats are more densely colonised by macroalgae and hard coral until approximately -5 mCD. Thereafter, the slope profile steeply descends to -20 mCD where generally only rippled sand was present with sparse hydroids and soft coral.

Bay 1 - Proposal Area

The survey area for Bay 1 was approximately 7.55 ha. Shallow (below 0 mCD) sandy habitats extended from the shoreline for approximately 120 m and steeply descended thereafter to -20 mCD. Of the 110 survey sites in this Bay, 67% were comprised of bare substrate (Table 4-4).

Table 4-4 Marine habitat types within Bay 1

Marine habitat types	Observations %	Marine habitat	Observations %
Bare	**67**	**Soft Coral**	**6**
Macroalgae	**21**		
Dense	0	Dense	0
Moderate	4	Moderate	0
Sparse	65	Sparse	89
Very Sparse	30	Very Sparse	0
Hard Coral	**15**	**Hydroids**	**8**
Dense	13	Dense	0
Moderate	13	Moderate	11
Sparse	19	Sparse	89
Very Sparse	56	Very Sparse	0

Note: Multiple marine habitat types were observed at some sites and therefore the cumulative percentages are >100%.

Macroalgae was observed at 21% of all sites with the majority comprised of very sparse to sparse coverage, and limited to shallower than -15 mCD (Figure 4-2). Macroalgae included *Caulerpa* spp. and *Chlorodesmis* spp.

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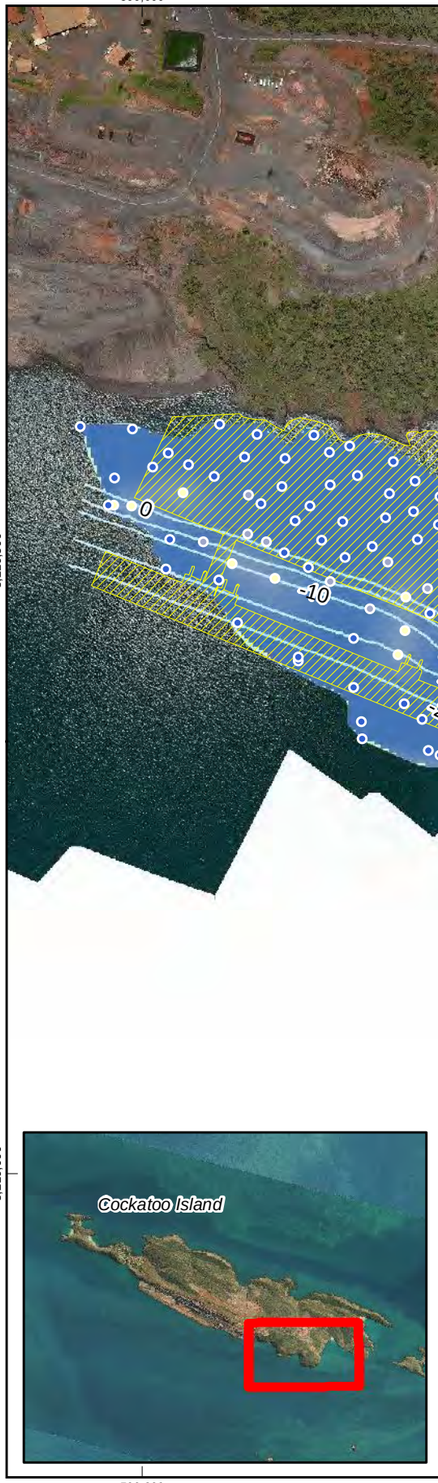

Paper Size A3

0 40 80 120 160 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 51

N

LEGEND

BCH Sampling Points
BCH Cover (%)
- 0
- 0 - 5
- 5 - 25
- 25 - 50
- 50 - 100

Bathymetry Contours (m LAT)
Proposed Eastern Wharf

BCH Cover Interpolated
%
High : 100
Low : 0

GHD SLIP

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Cockatoo Island Multi-User Supply Base

Job Number	61-35178
Revision	0
Date	12 Jun 2017

Benthic Communities and Habitats Figure 4-2

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Data source: GHD: Benthic Habitat Sampling Points - 20161112, Eastern wharf footprint - 20170606; Surrich Hydrographics: Bathymetry Data - 20161202; Calibre: Aerial photography - 201703. Created by:mmikkonen

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Hard coral occurred at 15% of sites primarily at the south-eastern edge of the bay (Figure 4-3). Hard coral coverage was moderate to dense. Several sites outside of this area had very sparse hard coral cover. Most sites with hard corals were shallower than -5 m to -10 mCD. Corals included foliose forms of *Turbinaria*, massive and sub-massive forms of *Porites*, branching *Acropora* and other corals from the families Acroporidae, Faviidae and Pocilloporidae.

Soft coral and hydroids were observed at less than 10% of sites (Table 4-4).

Video stills of sites at key areas throughout Bay 1 are shown in Figure 4-4.

Adjacent Bays

The survey area for Bay 2 was approximately 3.47 ha. Shallow sandy habitats extended from the shoreline to approximately 360 m with a band of hard coral prior to the steep drop-off. Of the 235 sites in Bay 2, 47% had bare substrate (Table 4-5).

Hard corals occurred at 43% of Bay 2 sites with the majority restricted to approximately a 50 m band width across the bay (Figure 4-3). Around 80% of coral sites had moderate to dense coverage. Corals included foliose forms of *Turbinaria*, massive and sub-massive forms of *Porites*, *Fungia*, branching *Acropora* and other corals from the families Acroporidae, Faviidae and Pocilloporidae.

Macroalgae were observed at 30% of Bay 2 sites. The majority of these sites had sparse coverage. Macroalgae included *Caulerpa* spp and *Chlorodesmis* spp.

Soft corals were observed at 1% of the Bay 2 sites.

Table 4-5 Marine habitat types within Bay 2

Marine habitat types	Observations %	Marine habitat	Observations %
Bare	**47**	**Soft Coral**	**1**
Macroalgae	**30**		
Dense	3	Dense	0
Moderate	11	Moderate	0
Sparse	66	Sparse	50
Very Sparse	20	Very Sparse	50
Hard Coral	**43**	**Hydroids**	**0**
Dense	46	Dense	0
Moderate	32	Moderate	0
Sparse	14	Sparse	0
Very Sparse	9	Very Sparse	0

Note: Multiple marine habitat types were observed at some sites and therefore the total cumulative percentages are >100%.

The survey area for Bay 3 was approximately 19.64 ha. Shallow sandy habitats extend from the shoreline for approximately 400 m, and transition into a deeper band of hard coral before steeply descending the drop-off. Of the 378 sites in Bay 3, 38% had bare substrate (Table 4-6).

Hard corals were observed at 49% of Bay 3 sites with the majority of corals restricted to approximately a 50 m wide band across the bay (Figure 4-3). Approximately 60% of all coral observations were moderate to dense coverage. Corals included foliose forms of *Turbinaria*, massive and sub-massive forms of *Porites*, *Fungia*, branching *Acropora* and other corals from the families Acroporidae, Faviidae and Pocilloporidae.

Macroalgae were observed at 36% of Bay 3 sites. The majority of these sites had sparse coverage. Macroalgae included *Caulerpa* spp and *Chlorodesmis* spp.

Soft corals and hydroids were observed at less than 2% the bay's sites.

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0 -5 -10 -15 -20 -5

Paper Size A3

0 40 80 120 160 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 51

N

LEGEND

Benthic Habitat Sampling Points
Hard Coral Cover (%)
- 0
- 0 - 5
- 5 - 25
- 25 - 50
- 50 - 100

Bathymetry Contours (m LAT)
Proposed Eastern Wharf

Coral Cover Interpolated
%
High : 100
Low : 0

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Cockatoo Island Multi-User Supply Base

Job Number	61-35178
Revision	0
Date	12 Jun 2017

Hard Coral Coverage

Figure 4-3

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Data source: GHD: Benthic Habitat Sampling Points - 20161112, Eastern wharf footprint - 20170606; Surrich Hydrographics: Bathymetry Data - 20161202; Calibre: Aerial photography - 201703. Created by:mmikkonen

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Paper Size A3

0 25 50 75 100 125

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 51

N

LEGEND

Substrate Type

- Coral rubble
- Pebbles
- Rocky
- Sand
- Silt
- Proposed Eastern Wharf

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Cockatoo Island Multi-User Supply Base

Job Number	61-35178
Revision	0
Date	12 Jun 2017

Marine Habitat and Substrate Observations in Bay 1

Figure 4-4

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Data source: GHD: Benthic Habitat Sampling Points - 20161112, Eastern wharf footprint - 20170606; Calibre: Aerial photography - 201703. Created by:mmikkonen

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Table 4-6 Marine habitat types within Bay 3 (Copper Bay)

Marine habitat type	Observations %	Marine habitat	Observations %
Bare	**38**	**Soft Coral**	**1**
Macroalgae	**36**		
Dense	1	Dense	0
Moderate	22	Moderate	0
Sparse	47	Sparse	25
Very Sparse	31	Very Sparse	75
Hard Coral	**49**	**Hydroids**	**<1**
Dense	41	Dense	0
Moderate	22	Moderate	0
Sparse	21	Sparse	100
Very Sparse	15	Very Sparse	0

Note: Multiple marine habitat types were observed at some sites and therefore the total cumulative percentages are >100%.

Comparison of Bays

The survey identified that the estimated percentage of bare substrate in Bay 1 (67%) is substantially higher than in Bay 2 (47%) and Bay 3 (38%), likely due to Bay 1 having been impacted by nearby mining-related activities to the northwest.

Soft coral and hydroids are relatively minor contributors to the benthic community assemblage, although they represent a greater proportion of Bay 1 than the other two bays.

The estimated hard coral area in Bay 1 of 0.2 ha is approximately 3% of this bay's surveyed area. The total estimated hard coral area of the three bays is 4.92 ha. Bay 1 therefore represents 4% of the total hard coral area across the three bays.

The estimated macroalgal area in Bay 1 of 0.19 ha is approximately 3% of this bay's surveyed area. This is a similar proportion to Bay 2 (5%) and Bay 3 (6%). The estimated macroalgae area in Bay 1 comprises 13% of the total macroalgae area across the three bays. Hence, a relatively small proportion (13%) of the total macroalgae area across the three bays will be at risk of impact by construction and operation activities of the proposed wharf facility.

Pile Survey

An opportunistic survey was undertaken to assess the marine environment near to and on the piles of the ship loader. At the seafloor, sparse soft corals, macroalgae and hydroids were noted. Deeper sections of the piles were colonised by hydroids and macroalgae, and shallower (and likely intertidal) portions were heavily encrusted by bivalves.

4.3.4 Potential Impacts

Construction Phase Impacts

Direct Loss of Benthic Communities and Habitat

Construction of the wharf will result in the direct loss of approximately 6.18 ha of benthic habitat comprising:

- 5.64 ha of bare rock, sand or pebbles
- 0.54 ha of area with hard coral and algae.

This will include a loss of all sessile invertebrates and any motile fauna that do not move out of the area.

The reclaimed area of the bay will be largely sealed by sheet piling prior to the area being filled with waste rock, and it is unlikely that material will disperse and smother any areas outside of the bay.

A barge with piling capabilities will be required for the proposed works, which will need to be anchored to complete the works. Repeated anchoring will physically disturb benthic communities and habitats.

Reduction in Marine Environmental Quality

A temporary reduction in water quality during construction may occur during drilling of the piles, inserting and anchoring of the sheet piles and placement of fill material. A reduction in water quality may occur through re-suspension of fine material that could smother benthic habitats, reducing the light climate reaching photosynthetic organisms.

During construction, a number of solid and liquid wastes will be generated on both land and any vessels, including sewage, bilge waters, cooling waters, deck drainage, food wastes, lubricating oils, hydraulic oils, and excess concrete and asphalt. If released into the marine environment, hazardous and non-hazardous wastes and discharges could affect benthic communities and habitats through localised toxic effects and reduction in water quality.

Introduction of Invasive Marine Species

Vessels and marine equipment will be required during construction. Invasive marine species can be carried by the vessel in ballast tanks, biofouling on the hull and internal systems, and in sediments collected around marine equipment. A successful translocation of an invasive marine species could out-compete the existing benthic communities.

Post-Construction and Operational Phase Impacts

Loss of Benthic Communities and Habitat

The floating pontoon and any moored vessels at the pontoon will reduce light reaching the seabed beneath. Any photosynthetic benthic communities such as hard coral or algae may be effected by the reduced light climate.

No anchoring during operations is anticipated, as vessels will moor alongside the pontoon.

Gain of Benthic Communities and Habitat

Based on observations of flora and fauna living on or around the existing ship loader piles, it is anticipated that a similar community assemblage will colonise the proposed wharf infrastructure. Further, colonisation of the wharf structure by hard corals may occur, particularly along the eastern portion of Bay 1 where some hard corals currently occur. As the majority of the subtidal environment is dominated by unconsolidated sediments, it is likely that these hard structures will be colonised quickly due to its limited availability in the wider area.

Reduction in Marine Environmental Quality

A number of solid and liquid wastes will be generated during operations on the wharf and visiting vessels, and hazardous materials will be stored on the wharf. These include marine gas oil, sewage, bilge waters, cooling waters, deck drainage, food wastes, lubricating oils, hydraulic oils and cleaning fluids. If released into the marine environment, hazardous and non-hazardous wastes and discharges could affect benthic communities and habitats through localised toxic effects and reduction in water quality.

4.3.5 Assessment of Impacts

The planned activities are unlikely to have a significant impact on benthic communities and habitats due to a number of factors, including:

- The expected very small loss of benthic primary producing habitat within the bay of 0.54 ha of hard coral and algae
- Adjacent bays have considerately benthic habitat of conservation value
- No dredging is required
- Fill material will be benign mine waste with little fine sediment content and no known contaminants
- The floating pontoon and any operational vessels will be in deep waters and will not shade areas with benthic photosynthesisers such as hard coral or algae
- Any accidental spillages or releases of wastes or discharges will quickly disperse due to the large tidal range of the area
- Additional habitats will become available for colonisation by marine flora and fauna.

4.3.6 Mitigation

Potential construction impacts will be reduced through the following measures:

- Development of a Construction Environmental Management Plan to minimise risks to the surrounding environment and to provide monitoring during construction
- Construction vessels will where possible limit their anchoring to areas that will be directly impacted in the reclamation process
- Use of local construction vessels to reduce the likelihood of translocating marine pests from high risk geographical areas
- Construction vessels will follow relevant Australian and international regulations, including MARPOL Marine Orders and Sewage Prevention Pollution Certificate, which include all hazardous materials being stored with secondary containment, with continuous bunding or drip trays around machinery or equipment with the potential to leak hazardous materials
- Construction vessels will have current MARPOL-compliant Shipboard Oil Pollution Emergency Plan (SOPEP) and Shipboard Marine Pollution Emergency Plan (SMPEP – for noxious liquids)
- Construction vessel equipment and machinery will be maintained on a Planned Maintenance System to avoid any unplanned discharges to the marine environment
- There will be no discharge of untreated or macerated sewage or food wastes from vessels
- Where possible, non-toxic chemicals will be used
- All wastes will be stored on-board and transferred to the mainland for disposal at a licensed facility as per the vessels Waste Management Plan
- Waste containers (bins etc.) provided for waste containment will be clearly marked and suitably covered to prevent material being blown overboard.

Potential operational impacts will be reduced through the following measures:

- Development of an Operations Environmental Management Plan to define techniques to minimise risks to the surrounding environment
- Operational vessels will not anchor
- Waste containers on the wharf (bins etc.) will be clearly marked and suitably covered to prevent material being blown into the marine environment. Wastes will be appropriately disposed of on the Island or transferred to the mainland for disposal at a licenced facility
- Hazardous materials stored on the wharf (e.g. marine gas oil, diesel, hydraulic fluids etc.) will be stored in self bunded tanks or in drums within bunded and covered areas
- Sewage will be transferred to the airfield septic tank system
- Putrescible wastes will be disposed to the current licenced landfill
- Waste hydrocarbons will be removed from the Island for reprocessing. Wastes that cannot be disposed onsite will be transferred to the mainland by barge for disposal.

4.3.7 Predicted Outcomes

The Project will result in the direct loss of 0.54 ha of hard coral and algae, of which 0.3 ha is largely very sparse hard coral. Species are represented in adjacent bays and in higher densities and coverage. Some colonisation by marine species will occur on the new sheet piling. As this bay has very little primary producer habitat compared to the adjacent bays, there is unlikely to be a significant impact to local biological diversity and ecological integrity.

4.4 Key Environmental Factor - Coastal Processes

4.4.1 EPA Objective

To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.

4.4.2 Policy and Guidance

- Environmental Factor Guideline – Coastal Processes (EPA 2016j).

4.4.3 Receiving Environment

Baseline studies relevant to the Proposal are provided in Table 4-7.

Table 4-7 Baseline studies – coastal processes

Consultant	Study Name
M P Rogers and Associates PL (2011)	Cockatoo Island Seawall Decommissioning and Closure Plan
MScience (2011)	Cockatoo Island Marine Closure Knowledge Base and Completion Criteria

Tidal variations at Cockatoo Island are semi-diurnal and macrotidal, meaning two high and two low tides are typically experienced within a 24-hour period and that the difference between low and high tides are in excess of 4 m. Tidal planes are detailed in Table 4-8 for different vertical datums (MRA 2011).

The large variation in tidal levels, particularly during spring conditions, result in relatively high ambient current speeds around Cockatoo Island. Purcell (2002) indicated that tidal currents around 5 m/s can occur in the Buccaneer Archipelago.

Table 4-8 Local tidal planes

Tidal Plane	m CID[1]	m CD[2]	m AHD
Highest Astronomical Tide	+10.1	+10.9	+6.2
Mean High Water Spring	+9.1	+9.9	+5.2
Mean High Water Neap	+6.0	+6.8	+2.1
Mean Sea Level	+4.7	+5.5	+0.8
Mean Low Water Neap	+3.3	+4.1	-0.6
Mean Low Water Spring	+0.2	+1.0	-3.7
Lowest Astronomical Tide (LAT)	-0.8	0.0	-4.7

1. CID (Cockatoo Island Datum) is approximately 0.8m above CD (Chart Datum) and 3.9m below AHD (Australian Height Datum)
2. CD is approximately LAT

The ambient wave climate of Yampi Sound and the Buccaneer Archipelago is very mild due to the protection from southerly and south westerly swells by the Dampier Peninsula (MScience 2011). The southern side of Cockatoo Island is further protected from wave energy due to short wave fetch and protection offered by other offshore Islands. The largest waves are experienced during cyclonic events, which are frequent in this region, and are capable of creating damaging wave conditions (MScience 2011).

The wharf will be located in Bay 1 on the southern side of Cockatoo Island (Figure 4-1). The geomorphology of the bay is defined by steeply sloped rocky outcrops and characterised by intertidal and subtidal platforms typically between -2.0 mCD and 0 mCD (Figure 4-5). The seaward slope of the platform is steep and bed levels in the adjacent Yampi Sound reach -30 mCD to -40 mCD.

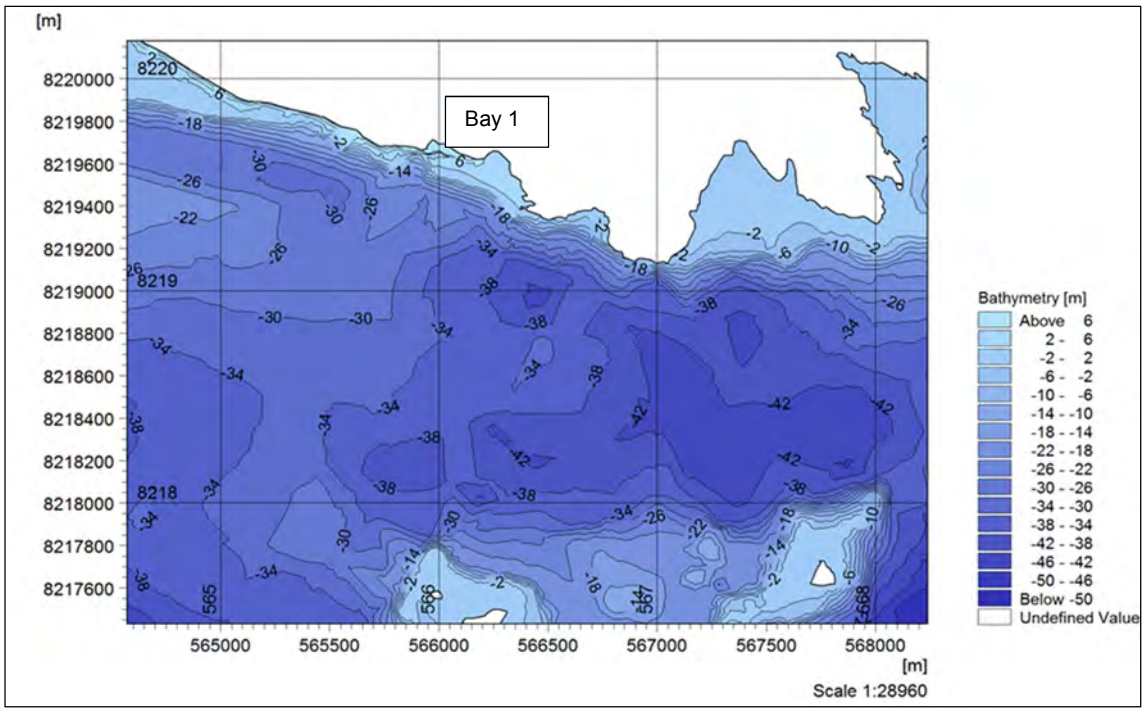

Figure 4-5 Indicative bathymetry based on interpolation of data from C-MAP (Jeppesen Charts). Levels referenced to Chart Datum

A small sandy beach occurs at the apex of Bay 1 (Figure 4-6). This was further supported by substrate assessment that indicates that Bay 1 has mainly a thin sandy substrate overlying a rock base (Figure 4-1).

Figure 4-6 Bay 1 site photograph

Sediment transport processes around Cockatoo Island are expected to be primarily driven by tidal currents due to the high tidal ranges and low ambient wave energy.

Evidence of current patterns in geomorphological features at Cockatoo Island is limited due to the lack of sediment and sedimentary landforms. The main sedimentary feature is the shallow subtidal and intertidal beach at the head of the bay as described above, which has formed from a combination of lithogenic and biogenic sediment sources.

4.4.4 Potential Impacts

The wharf has the potential to locally alter current speeds and patterns that may impact:

- Patterns of erosion and accretion
- Benthic communities and habitats.

4.4.5 Assessment of Impacts

The wharf will be constructed as an earth-filled sheet-pile retained hardstand. The wharf will be located adjacent to existing areas of steep rock within the bay and will run almost parallel to the shoreline. No dredging will be required.

Location of the wharf adjacent to existing areas of steep rock will result in a minimal impact on local current speeds and patterns, as the sheet-pile hardstand will have a similar vertical profile to existing geological formations.

The wharf will not create tidally restricted bodies of water that are separated from Yampi Sound and consequently there will be no impact on coastal hydrodynamics as tidal current characteristics will not significantly change.

The wharf will be sited across the existing beach areas and this may affect sediment supply from the beach to the subtidal platform. Given the small size of the beach, sediment movement is unlikely to be significant.

The installation of sheet-piles is likely to have only localised impacts and may result in some erosion of sand and silts around the pile.

4.4.6 Mitigation

The design and location of the wharf removes the need for any additional mitigation.

4.4.7 Predicted Outcomes

The wharf will run parallel to the shoreline and will not significantly affect or interrupt longshore current movements or existing coastal processes.

Any residual impacts on sedimentation, geomorphology, current speeds and patterns will be localised and restricted to the vicinity of the wharf.

4.5 Key Environmental Factor - Marine Environmental Quality

4.5.1 EPA Objective

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

4.5.2 Policy and Guidance

- Environmental Factor Guideline – Marine Environmental Quality (EPA 2016h)
- Technical Guidance – Protecting the quality of Western Australia's marine environment (EPA 2016i).

4.5.3 Receiving Environment

Baseline studies relevant to the Proposal are provided in Table 4-9.

Table 4-9 Baseline studies – marine environmental quality

Consultant	Study Name
Ecologia (2003)	Cockatoo Island Marine Monitoring Reports
MScience (2010)	Cockatoo Island Marine Monitoring - Monitoring Survey Reports

Marine environmental surveys have historically focussed on physical parameters of marine sediments and water in relation to the seawall activities. A summary of the available marine environmental quality information taken from 'baseline' sites and not related to historical impacts associated with seawall activities include (MScience 2010):

Seawater

- Total suspended solids ranging between 1 and 7 mg/L
- Secchi depths ranging between 2.3 and 6.6 m.

Marine Sediments

- Total iron content ranging between 1.46 to 7.13 mg/kg.

No known marine water quality investigations have been undertaken in the area of the proposed wharf, and sediment contaminant levels have not been investigated. However, the absence of historical use of this area suggests that marine sediments are likely to be high quality with low or absent contamination levels. Similarly, due to a lack of anthropogenic inputs and large tidal regime, water quality is expected to be high with low or absent contamination levels. Turbidity and total suspended solids are known to be variable and influenced by large tides and seasonally high rainfall.

The dominant benthic habitat in the area of the wharf is unvegetated sandy substrate (67%).

4.5.4 Potential Impacts

Construction Phase Impacts

Reduction in Marine Environmental Quality

A temporary reduction in water quality during construction may occur during drilling of the piles, inserting and anchoring of the sheet piles and placement of fill material. A reduction in water quality may occur through re-suspension of fine material that could smother benthic habitats, reducing the light climate reaching photosynthetic organisms.

During construction, a number of solid and liquid wastes will be generated on both land and any vessels, including sewage, bilge waters, cooling waters, deck drainage, food wastes, lubricating oils, hydraulic oils, and excess concrete and asphalt. If released into the marine environment, hazardous and non-hazardous wastes and discharges could affect benthic communities and habitats through localised toxic effects and reduction in water quality.

Post-Construction and Operational Phase Impacts

Reduction in Marine Environmental Quality

A number of solid and liquid wastes will be generated during operations on the wharf and visiting vessels, and hazardous materials will be stored on the wharf. These include marine gas oil, sewage, bilge waters, cooling waters, deck drainage, food wastes, lubricating oils, hydraulic oils and cleaning fluids. If released into the marine environment, hazardous and non-hazardous wastes and discharges could affect benthic communities and habitats through localised toxic effects and reduction in water quality.

4.5.5 Assessment of Impacts

The planned activities are unlikely to have a significant impact on marine environmental quality due to a number of factors, including:

- No dredging is required
- Fill material will be largely benign mine waste with little fine sediment content and no known contaminants
- Fluxes in total suspended solids are common in the wider area and are related to large tidal movements and seasonally high rainfall
- Any accidental spillages or releases of wastes or discharges will quickly disperse due to the large tidal range of the area.

4.5.6 Mitigation

Potential construction impacts will be reduced through the following measures:

- Development of a Construction Environmental Management Plan to minimise risks to the surrounding environment and to provide monitoring during construction
- Construction vessels will follow relevant Australian and international regulations, including MARPOL Marine Orders and Sewage Prevention Pollution Certificate, which include all hazardous materials being stored with secondary containment, with continuous bunding or drip trays around machinery or equipment with the potential to leak hazardous materials
- Construction vessels will have current MARPOL-compliant Shipboard Oil Pollution Emergency Plan (SOPEP) and Shipboard Marine Pollution Emergency Plan (SMPEP – for noxious liquids)
- Construction vessel equipment and machinery will be maintained on a Planned Maintenance System to avoid any unplanned discharges to the marine environment
- There will be no discharge of untreated or macerated sewage or food wastes from vessels
- Where possible, non-toxic chemicals will be used
- All wastes will be stored on-board and transferred to the mainland for disposal at a licensed facility as per the vessels Waste Management Plan
- Waste containers (bins etc.) provided for waste containment will be clearly marked and suitably covered to prevent material being blown overboard.

Potential operational impacts will be reduced through the following measures:

- Development of an Operations Environmental Management Plan to define techniques to minimise risks to the surrounding environment
- Waste containers on the wharf (bins etc.) will be clearly marked and suitably covered to prevent material being blown into the marine environment. Wastes will be appropriately disposed of on the Island or transferred to the mainland for disposal at a licenced facility
- Hazardous materials stored on the wharf (e.g. marine gas oil, diesel, hydraulic fluids etc.) will be stored in self bunded tanks or in drums within bunded and covered areas
- Sewage will be transferred to the airfield septic tank system
- Putrescible wastes will be disposed to the current licenced landfill
- Waste hydrocarbons will be removed from the Island for reprocessing. Wastes that cannot be disposed onsite will be transferred to the mainland by barge for disposal.

4.5.7 Predicted Outcomes

The Proposal does not involve dredging or any planned discharge and is not expected to interrupt longshore current movements or existing coastal processes.

Impacts will be largely confined to the construction phase and limited to the immediate area of construction that is largely dominated by unvegetated sandy environs. Further, due to the large tidal regime and seasonally high rainfall, fluxes in total suspended solids and turbidity are common.

There is not expected to be any significant risk to maintaining environmental values of the water, sediment and biota through the construction or operational phases.

4.6 Key Environmental Factor - Marine Fauna

4.6.1 EPA Objective

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

4.6.2 Policy and Guidance

- Environmental Factor Guideline – Marine Fauna (EPA 2016g).

4.6.3 Receiving Environment

Baseline studies relevant to the Proposal are provided in Table 4-10.

Table 4-10 Baseline studies – marine fauna

Consultant	Study Name
GHD (2017a) – Appendix A	Cockatoo Island Multi-User Supply Base. Technical Study - Marine Flora and Fauna

Marine Mammals

Nine species of protected or listed marine mammals may potentially occur within the Proposal area of which one species, the Humpback Whale, is listed as Threatened under the EPBC Act (Table 4-11).

Table 4-11 Conservation significant marine mammals

Common name	Scientific name	EPBC listing			DPaW	Presence
		Listed threatened	Listed migratory	Other matters	Schedule / Ranking	
Whales						
Humpback Whale	*Megaptera novaeangliae*	VU	✓	✓	CD (D1)	B
Bryde's Whale	*Balaenoptera edeni*		✓	✓		M
Dolphins						
Common Dolphin, Short-beaked Common Dolphin	*Delphinus delphis*			✓		M
Irrawaddy Dolphin, Australian Snubfin Dolphin	*Orcaella brevirostris*		✓	✓	P4	M
Indo-Pacific Humpback Dolphin	*Sousa chinensis*		✓	✓		B
Spotted Dolphin, Pantropical Spotted Dolphin	*Stenella attenuata*			✓		M
Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	*Tursiops aduncus*		✓	✓		L
Bottlenose Dolphin	*Tursiops truncates s. str.*			✓		M
Sirrenians						
Dugong	*Dugong dugon*		✓	✓		L

Note: 'B': Breeding known to occur within area.
'L': Species or species habitat likely to occur within area.
'M': Species or species habitat may occur within area.

'CD': Conservation dependant.
'VU': Vulnerable.
'SP': Specially protected.
P1-P4: Priority 1 – 4.

Humpback Whale

Humpback Whales occur throughout Australian waters with their distribution influenced by their migratory pathways and aggregation areas for resting, breeding and calving. Humpbacks arrive in the coastal waters of the Kimberley after summer to breed and calve before returning to the Antarctic after the winter season has passed. Humpback Whales are likely be in deeper waters of the Proposal area.

Bryde's Whale

Byrde's Whale is the second smallest of the baleen whales. They inhabit tropical and warm temperate waters and generally travel alone or in pairs. This species appears to be limited to the 200 m depth contour, moving along the coast in response to the availability of suitable prey, while the offshore form is found in deeper waters (500 to 1,000 m) (Best 1977). Because of its small population, lack of sightings and preference for deeper water, it is unlikely to be encountered in the Proposal area.

Dolphins

Six species of dolphin listed under the EPBC Act were identified as potentially occurring in the Proposal area with three listed as Migratory and all as 'other matters'.

Common Dolphins are recorded in all Australian waters and are not thought to be migratory. They are associated with high topographical relief of the ocean floor, drop-offs and upwelling areas, however, there are no known key areas for this species in Australia.

Redescription and genetic research has resulted in the Irrawaddy Dolphin being renamed the Australian Snubfin Dolphin. This dolphin is primarily found in nearshore habitats, but has been recorded up to 23 km offshore. Beagle Bay and Pender Bay are important areas for the Australian Snubfin Dolphin (DotEE 2016).

The Indo-Pacific Humpback Dolphin is primarily found in nearshore habitats, such as those associated with the Buccaneer Archipelago (DotEE 2016). Indo-Pacific Humpback Dolphins typically occur in open waters around coasts and Islands, generally in less than 20 m water depth (Parra *et al.* 2002).

Little is known about the distribution of the Spotted Dolphin in the Kimberley region, although they have been recorded at the shelf edge and shelf slope area of the Browse Basin in large, high energy, mixed schools in association with tuna, seabirds and other pelagic cetaceans. Small groups of *Stenella* species have also been observed resting in nearshore areas of coast on the lee side of bays (DSEWPaC 2012a).

The Bottlenose Dolphin is a cosmopolitan species found in all Australian waters in coastal, estuarine and pelagic settings. Bottlenose Dolphins have been observed during surveys by Jenner and Jenner (2009) between Cape Leveque (north of Broome) and Scott Reef in June, July, October and November 2008. The Spotted Bottlenose Dolphin is widely distributed in Indo-Pacific coastal waters, however there is limited information on the distribution and population of the Arafura/Timor sea population.

Due to shallow water preferences, the Irrawaddy/Australian Snubfin Dolphin, Indo-Pacific Humpback Dolphin and the Bottlenose Dolphins are likely to be present all year round near the Proposal area. Due to its depth preferences, the Spotted Dolphin is unlikely to occur.

Dugong

North-western Australia is thought to have one of the largest populations of Dugongs in the world and are largely sighted feeding in wide and shallow seagrass beds but also in estuarine streams (DSEWPaC 2012b). Regional sightings pooled from 1996 to 2008 show some sightings around Cockatoo and Irvine Islands but notably less than that around the Dampier Peninsular, Derby and Walcott Inlet (Holley and Prince 2011). Due to the Dugongs presence being largely correlated with seagrass beds, it is unlikely to be found within the Proposal area but is likely to be found in the wider coastal area.

Fish

Thirty-three species of protected or listed fish may occur near the Proposal area, of which five species are listed as Threatened (Table 4-12).

Whale Shark

Whale Sharks have a broad distribution in tropical and warm temperate seas, and feed on phytoplankton, macroalgae, zooplankton, krill and small nektonic life, such as small squid or vertebrates. Whale Sharks undertake a well-known annual migration between March and June to aggregate in Ningaloo Marine Park and believed to be linked to localised seasonal peaks of coral spawning that occurs around March/April each year (Woodside 2011). Following this period, observers have recorded Whale Sharks migrating northwest to the Indian Ocean, or directly north to Sumatra and Java, or northeast passing within the region of Scott Reef and the Browse Basin and travelling along the 200 m contour (Woodside 2011). Due to the preference for deeper waters, the Whale Shark is unlikely to be found in the Proposal area.

Table 4-12 Conservation significant fish

Common Name	Scientific Name	EPBC Listing			DPaW	Presence
		Listed Threatened	Listed migratory	Other matters	Schedule /Ranking	
Whale Shark	*Rhincodon typus*	VU	✓		SP	M
Great White Shark	*Carcharodon carcharias*	VU	✓		VU	M
Green Sawfish	*Pristis zijsron*	VU	✓		VU	K
Largetoothed Sawfish	*Pristis pristis*	VU	✓		P1	K
Dwarf Sawfish	*Pristis clavata*	VU	✓		P3	K
Reef Manta Ray	*Manta alfredi*		✓			K
Giant Manta Ray	*Manta birostris*		✓			M
Killer Whale, Orca	*Orcinus orca*		✓			M
Northern River Shark, New Guinea River Shark	*Glyphis garricki*	EN			P1	M
25 other species of pipefish and sea dragon				✓		M

Note: 'K': Species or species habitat known to occur within area.
'M': Species or species habitat may occur within area.

CD': Conservation dependant.
'VU': Vulnerable.
'SP': Specially protected.
P1-P4: Priority 1 – 4.

Great White Shark

In Australian waters, Great White Sharks are widely but not evenly distributed, and sightings are considered uncommon to rare compared to most other large sharks (CITES 2004). Great White Sharks can be found in areas close to inshore around rocky reefs, surf beaches and shallow coastal bays, and in outer continental shelf and slope areas (Pogonoski *et al*. 2002). It is unlikely that they would be present in the Proposal area.

Largetooth Sawfish

This species has been recorded in riverine and marine environments across northern Australia and is known to have occurred within most of the subtropical areas between Cape Keraudren in Western Australia and Princess Charlotte Bay in Queensland. It is known to occur up to 100 km offshore. The generally accepted model of movement and migration of Largetooth Sawfish in Australian waters is that young are born at the mouths of rivers and in estuaries and then migrate up river where they spend the first several years of life (Thorburn *et al.* 2004). As they reach maturity, they move out of the rivers and into the marine environment. Given this species known distribution, it is possible that they can occur in the Project area.

Green Sawfish

The DotE (2015) reports that Green Sawfish are distributed from the Whitsundays to Shark Bay. Individuals have been recorded from inshore coastal environments and estuaries to offshore deep waters (Stevens *et al*. 2005). Given this species known distribution, it is possible that they could occur in the Proposal area.

Dwarf Sawfish

The distribution of Dwarf Sawfish is considered to be restricted to northern Australia, ranging from northern Queensland to the Pilbara coastline. Sawfish generally inhabit shallow coastal waters and estuaries, which are utilised as nurseries for juveniles. Surveys have found most captures of Dwarf Sawfish occur over soft sediment environments (DotE 2015). Given the known distribution of this species, it is possible that they could occur in the Proposal area.

Manta Rays

Manta Rays commonly occur throughout the majority of Australian coastlines. The Reef and Giant Manta Ray may be found in the Proposal area.

Killer Whales

Killer Whales are thought to be the most cosmopolitan of all cetaceans in Australasian waters and have been sighted along the Kimberley coast (Kimberley Society 2010). Although not common, the Killer Whale may occur in the Proposal area.

Northern River Shark

The DotE (2015) reports that the Northern River Shark utilise rivers, tidal sections of large tropical estuarine systems and macrotidal embayment's, as well as inshore and offshore marine habitats. Given this species known distribution, it is possible that they could occur in the Proposal area.

Seahorses, Seadragons and Pipefish

Twenty-five species of Syngnathids have been identified that could potentially occur within the Proposal area. Although uncommon, these species are expected to occur in shallow coastal areas. However as preferable habitats (seagrass) are likely to be sparse in the area, the occurrence of Syngnathids in the Proposal area is unlikely.

Marine Reptiles

Sixteen species of protected or listed marine reptiles potentially occur within the Proposal area, of which five species are listed as Threatened (Table 4-13). Conservation significant marine reptiles are described below.

Loggerhead Turtle

Loggerhead Turtles are globally distributed, occurring within coral, rocky reef, seagrass and muddy bay habitats throughout eastern, northern and western Australia (DotEE 2016a). Nesting is concentrated in southern Queensland and from Shark Bay to the North West Cape (Ningaloo) in WA, although foraging areas are more widely distributed. There has also been one reported nesting at Ashmore Reef (Guinea 1995). Given the absence of important areas for feeding and nesting, it is unlikely that Loggerhead Turtles will be present in the Proposal area.

Table 4-13 Conservation significant marine reptiles

Common Name	Scientific Name	EPBC Listing			DPaW	Presence
		Listed Threatened	Listed Migratory	Other matters	Schedule/ Ranking	
Turtles						
Loggerhead Turtle	*Caretta caretta*	✓	✓	✓	EN (D3)	K
Green Turtle	*Chelonia mydas*	✓	✓	✓	VU (D3)	C
Leatherback Turtle	*Dermochelys coriacea*	✓	✓	✓	VU (D3)	L
Flatback Turtle	*Natator depressus*	✓	✓	✓	VU (D3)	C
Hawksbill Turtle	*Eretmochelys imbricata*	✓	✓	✓	VU (D3)	L
Crocodiles						
Saltwater Crocodile	*Crocodylus porosus*		✓	✓	SP (D3)	L
Freshwater Crocodile	*Crocodylus johnstoni*			✓	SP (S3)	M
Seasnakes						
9 species of seasnake				✓		M

Note: Presence identified by EPBC Protected Matter Search Tool (PMST)

'C': Congregation or aggregation known to occur within area.

'K': Species or species habitat known to occur within area.

'L': Species or species habitat likely to occur within area.

'M': Species or species habitat may occur within area.

'EN': Endangered.

'VU': Vulnerable.

'SP': Specially protected.

Green Turtle

Green Turtles are the most widespread and abundant turtle species in Western Australia waters, nesting from the Ningaloo coast to the Kimberley Islands (Prince 1994). There are two known migration pathways for Green Turtles from Scott Reef and Browse Island to the Australian mainland coast – either travelling north-east to the Bonaparte Archipelago and then following the coast to the Northern Territory; or travelling south to Cape Leveque and along the coast to the Pilbara (Guinea 2010). Satellite tracking has shown that Green Turtles nesting on Browse Island and Sandy Island (Scott Reef) feed between 200 km and 1000 km from their nesting beaches (Pendoley 2005). In surveys by RPS (2010) from 2009-2010 in the Dampier Peninsula and Lacepede Islands, the majority of Green Turtles migrated north-east along the Kimberley coast in the post-nesting migration period (from approximately April). Given the known migration route and use of shallow benthic habitats for foraging, it is likely that Green Turtles could occur in the Proposal area.

Leatherback Turtle

Leatherback Turtles are pelagic feeders, found in tropical, subtropical and temperate waters throughout the world. This species regularly forages over Australian continental shelf waters and has been reported in south-western WA waters (DotEE 2016a). There are no major nesting areas recorded in Australia, although there are scattered records in the NT, Queensland and NSW (DotEE 2016a). Given the absence of important areas for feeding and nesting, it is highly unlikely that Leatherback Turtles occur in the Proposal area.

Flatback Turtle

The Flatback Turtle is one of the two turtle species without a global distribution, found only in tropical waters of northern Australia, Papua New Guinea and Irian Jaya, with nesting confined to Australia (Limpus 2007). The Kimberley region is an important nesting area, with significant nesting occurring on the Lacepede Islands. Studies of Flatback Turtles during the 2009-2010 nesting season on the Lacepede Islands tracked several individuals via satellite tags during the inter-nesting and post-nesting periods (RPS 2010). Individuals were found to remain within 50 km of the Islands during the inter-nesting period. During post-nesting migration, turtles stayed in shallow depths, travelling from 17 km to up to 1,005 km, mainly staying within WA waters, such as Adele Island, Lacepede Island and the Maret Islands (north-east of Derby). Migration pathways of Flatback Turtles nesting in rookeries further south, such as Port Hedland, generally pass the Dampier Peninsula to probable foraging grounds in the Kimberley region (RPS 2010). Given the known migration route and use of shallow benthic habitats for foraging, it is likely that Flatback Turtles could occur in the Proposal area.

Hawksbill Turtle

The species has a global distribution throughout tropical, sub-tropical and temperate waters, with nesting largely concentrated on sub-tropical beaches (Marquex 1990). Adults tend to forage in tropical tidal and sub-tidal coral and rock reef habitats where they primarily feed on sponges and algae (DotEE 2017). Key nesting and inter-nesting areas include the Dampier Archipelago, Barrow Island, Lowendal and Thevenard Islands, with areas of Ashmore Reef, Cartier Island and Sandy Island. Given this turtle's regional presence and use of reefs for foraging, it is likely that the Hawksbill Turtle could occur in the Proposal area.Crocodiles

Saltwater and Freshwater Crocodiles are known to inhabit marine, coastal and riverine habitats from Port Hedland to Townsville (Department of Conservation and Land Management 2004). Anecdotal observations from Cockatoo Island confirm that Saltwater Crocodiles occur infrequently near the Proposal area. Due to the lack of freshwater habitats, the Freshwater Crocodile is unlikely to occur in the Proposal area.

4.6.4 Potential Impacts

Construction Phase Impacts

Direct Loss of Benthic Communities, Habitat and Waters

Construction of the wharf will result in the direct loss of approximately 6.18 ha of benthic habitat comprising:

- 5.64 ha of bare rock, sand or pebbles
- 0.54 ha of area with hard coral and algae.

This area also includes the sub-tidal and intertidal waters above the benthic communities.

These habitats may support marine fauna that use the habitats as food sources, refugia, spawning and nursery grounds.

A barge with piling capabilities will be required for the proposed works, which will need to be anchored to complete the works. Repeated anchoring will physically disturb benthic communities and habitats.

Reduction in Marine Environmental Quality

A temporary reduction in water quality during construction may occur during drilling of the piles, inserting and anchoring of the sheet piles and placement of fill material. A reduction in water quality may occur through re-suspension of fine material that could smother benthic habitats, reducing the light climate reaching photosynthetic organisms.

During construction, a number of solid and liquid wastes will be generated on both land and any vessels, including sewage, bilge waters, cooling waters, deck drainage, food wastes, lubricating oils, hydraulic oils, and excess concrete and asphalt. If released into the marine environment, hazardous and non-hazardous wastes and discharges could affect benthic communities and habitats through localised toxic effects and reduction in water quality.

Introduction of Invasive Marine Species

Vessels and marine equipment will be required during construction. Invasive marine species can be carried by the vessel in ballast tanks, biofouling on the hull and internal systems, and in sediments collected around marine equipment. A successful translocation of an invasive marine species could out-compete the existing benthic communities.

Marine Fauna Interaction

The physical presence and movement of construction vessels and reclamation of the bay has the potential to impact marine fauna. Impacts may range from behavioural (e.g. changes in surfacing patterns, swimming speed, duration underwater) to injury (e.g. propeller lacerations) or mortality (e.g. vessel strike, crushed by rocks).

Noise Emissions

During construction, underwater noise will be generated by vessel operations including propellers/thrusters and associated machinery/engines, piling, securing the sheet piles and the reclamation process.

Underwater noise has the potential to adversely affect marine fauna and in extreme cases cause physiological harm. Underwater noise may impact marine fauna by:

- Causing behavioural changes including displacement from biologically important habitat areas (such as feeding, resting, breeding, calving and nursery sites)
- Masking or interference with other biologically important sounds such as communication or echolocation systems used by certain cetaceans for navigation and location of prey
- Causing physical injury to hearing and other internal organs
- Indirectly impacting predator or prey species.

Post-Construction and Operational Phase Impacts

Changes to Benthic Communities, Habitat and Waters

Post-construction, the benthic communities and habitats will be altered locally.

The floating pontoon and moored vessels at the pontoon will reduce light reaching the seabed beneath. Any photosynthetic benthic communities such as hard coral or algae may be effected by the reduced light climate, which may affect marine fauna that previously utilised this area. Conversely, shaded structures also attract some marine fauna species as an area of refuge.

Based on observations of flora and fauna living on or around the existing ship loader piles, it is anticipated that a similar community assemblage will colonise the proposed wharf infrastructure.

This would eventually provide alternative food sources, habitat and refugia for some marine fauna species.

Reduction in Marine Environmental Quality

A number of solid and liquid wastes will be generated during operations on the wharf and visiting vessels, and hazardous materials will be stored on the wharf. These include marine gas oil, sewage, bilge waters, cooling waters, deck drainage, food wastes, lubricating oils, hydraulic oils and cleaning fluids. If released into the marine environment, hazardous and non-hazardous wastes and discharges could affect marine fauna through direct toxicity, ingestion or entanglement.

Light Emissions

Operations could occur 24 hours a day and navigational and safety lighting will be required that may affect marine fauna behaviour.

Continuous lighting in the same location for an extended period may result in alterations to normal marine fauna behaviour, as summarised below for each fauna group:

Fish and Zooplankton

- Attraction of some fish and zooplankton species to light, which may alter local predator-prey interactions (Milicich *et al*. 1992).

Marine Turtles

- Disorientation of turtle hatchlings (Environment Protection Authority 2010)
- Disorientation of nesting turtles (Environment Protection Authority 2010).

Seabirds

- Attraction of some seabirds to illuminated structures or the attracted food sources (Marquennie *et al*. 2008).

Marine Fauna Interaction

During normal operations, there could be up to seven vessel movements to and from the Island per week. Vessel movements have the potential to cause behavioural effects (e.g. changes in surfacing patterns, swimming speed, duration underwater) to injury (e.g. propeller lacerations) or mortality (e.g. vessel strike) to marine fauna.

Noise Emissions

During operations, underwater noise will be generated by the vessel operations and workshop activities. Underwater noise may impact marine fauna by:

- Causing behavioural changes including displacement from biologically important habitat areas (such as feeding, resting, breeding, calving and nursery sites)
- Masking or interference with other biologically important sounds such as communication or echolocation systems used by certain cetaceans for navigation and location of prey
- Causing physical injury to hearing and other internal organs
- Indirectly impacting predator or prey species.

4.6.5 Assessment of Impacts

The planned activities are unlikely to have a significant impact on marine fauna due to a number of factors, including:

- Previous activities within Cockatoo Islands marine environment involved wharf construction, ship movements and ship loading with no reported marine fauna strikes
- The loss of the marine habitats will be partially offset with new colonisable areas and refugia created by the sheet piling and floating pontoon
- Adjacent bays have considerately more benthic habitats available for marine fauna usage
- There are no known turtle nesting beaches on the Island
- There is no known critical habitat for any conservation significant marine fauna within the bay
- Filling of the bay will be staged from the shore and progressively move out to deeper waters. This approach should provide audible and vibratory disturbance that will force motile marine fauna out of the area
- No dredging is required
- Construction vessels will largely be stationary once in the bay
- Fill material will be largely benign mine waste with little fine sediment content and no known contaminants
- Any accidental spillages or releases of wastes or discharges will quickly disperse due to the large tidal range of the area
- Fluxes in total suspended solids are common in the wider area and are related to large tidal movements and seasonal high rainfalls.

4.6.6 Mitigation

Construction impacts will to be reduced through the following measures:

- Development of a Construction Environmental Management Plan to minimise risks to the surrounding environment and to provide monitoring during construction
- Use of local construction vessels to reduce the likelihood of translocating marine pests from high risk geographical areas
- Construction vessels will follow relevant Australian and international regulations, including MARPOL Marine Orders and Sewage Prevention Pollution Certificate, which include all hazardous materials being stored with secondary containment, with continuous bunding or drip trays around machinery or equipment with the potential to leak hazardous materials
- Construction vessels will have current MARPOL-compliant Shipboard Oil Pollution Emergency Plan (SOPEP) and Shipboard Marine Pollution Emergency Plan (SMPEP – for noxious liquids)
- Construction vessel equipment and machinery will be maintained on a Planned Maintenance System to avoid any unplanned discharges to the marine environment
- There will be no discharge of untreated or macerated sewage or food wastes from vessels
- All wastes will be stored on-board and transferred to the mainland for disposal at a licensed facility as per the vessels Waste Management Plan

- Waste containers (bins etc.) provided for waste containment will be clearly marked and suitably covered to prevent material being blown overboard.
- Marine fauna identification posters and Marine Fauna Sighting Datasheets will be made available on-board construction vessels
- Trained crew will maintain vigilant observation for marine cetaceans or turtles during construction
- Works will be timed to limit impacts to whales, dolphins, rays, turtles etc (i.e. outside of main migration timing)
- In accordance with Part 8 of the EPBC Regulations (Vessels), all vessels must travel at less than 6 knots and minimise noise within the caution zone of a cetacean (150 m radius for dolphins, 300 m for whales) known to be in the area
- In accordance with EPBC Act Policy Statement 2.1 Part A (DEWHA 2008), during piling activities:
    - Precaution zones will be implemented (Observation (3+ km), Low Power (1 km) and Shut down (500 m))
    - Pre-start up visual observation of precaution zones (>30 minutes before soft start)
    - Piling will not commence if cetaceans or turtles are within low power or shut-down zone
    - Trained crew will maintain vigilant observation for marine cetaceans and turtles within precaution zones and vessel planned path throughout piling activities
    - Piling will cease if cetacean or turtle enters shut-down zone
    - Relevant crewmembers are briefed on EPBC Act Policy Statement requirements, soft start, start-up delay, operations and stop work procedures, nighttime and low visibility procedures.

Potential operational impacts will be reduced through the following measures:

- Development of an Operations Environmental Management Plan to define techniques to minimise risks to the surrounding environment
- Waste containers on the wharf (bins etc.) will be clearly marked and suitably covered to prevent material being blown into the marine environment. Wastes will be appropriately disposed of on the Island or transferred to the mainland for disposal at a licenced facility
- Hazardous materials stored on the wharf (e.g. marine gas oil, diesel, hydraulic fluids etc.) will be stored in self-bunded tanks or in drums within bunded and covered areas
- Vessel or wharf spot lights not required for safety purposes will be turned off or directed inboard or towards land at night
- Non-safety lights to be shielded and pointed inboard/at the deck/landward where possible
- Construction vessels will follow relevant Australian and international regulations, including MARPOL Marine Orders and Sewage Prevention Pollution Certificate, which include all hazardous materials being stored with secondary containment, with continuous bunding or drip trays around machinery or equipment with the potential to leak hazardous materials
- In accordance with Part 8 of the EPBC Regulations (Vessels), all vessels must travel at less than 6 knots and minimise noise within the caution zone of a cetacean (150 m radius for dolphins, 300 m for whales) known to be in the area

- In accordance with EPBC Act Policy Statement 2.1 Part A (DEWHA 2008), during piling activities:
    - Precaution zones will be implemented (Observation (3+ km), Low Power (1 km) and Shut down (500 m))
    - Pre-start up visual observation of precaution zones (>30 minutes before soft start)
    - Piling will not commence if cetaceans or turtles are within low power or shut-down zone
    - Trained crew will maintain vigilant observation for marine cetaceans and turtles within precaution zones and vessel planned path throughout piling activities
    - Piling will cease if cetacean or turtle enters shut-down zone
    - Relevant crewmembers are briefed on EPBC Act Policy Statement requirements, soft start, start-up delay, operations and stop work procedures, nighttime and low visibility procedures.

4.6.7 Predicted Outcomes

Given the proposed mitigation measures, lack of known critical marine fauna habitat in the bay and comparably less benthic communities and habitats than adjacent bays, the activities are not expected to result in any significant losses of marine fauna. There will be some losses during the reclamation process, but progressive reclamation will allow marine fauna to relocate.

During reclamation and piling, there is likely to be behavioural avoidance of the area but not direct physical trauma. Any impacts to behaviour will be limited to transient individuals near to the activity, as the area is not significant for cetaceans or turtles. Migrating species that may pass through the area will be able to navigate around any point source disturbance.

With adherence to the management controls proposed during the activities potential impacts are considered acceptable.

4.7 Key Environmental Factor - Flora and Vegetation

4.7.1 EPA Objective

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

4.7.2 Policy and Guidance

- Environmental Factor Guideline – Flora and Vegetation (EPA 2016a)
- Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016b).

4.7.3 Receiving Environment

Baseline studies relevant to the Proposal are provided in Table 4-14.

Table 4-14 Baseline studies – flora and vegetation

Consultant	Survey Name
Astron Environmental Services (2012)	Cockatoo Island Weed Survey
ENV Australia (2008)	Cockatoo Island Declare Rare and Priority Flora Species Search
GHD (2014)	Cockatoo Island Flora, Fauna and SRE Surveys
GHD (2017) – Appendix B	Cockatoo Island Multi-User Supply Base. Technical Study - Terrestrial Flora and Fauna
Outback Ecology Services (2009)	Cockatoo Island Rehabilitation Planning

Vegetation Types

A survey area surrounding the Proposal was assessed for vegetation and flora over a number of visits to the Island.

The survey area supports three vegetation associations (GHD 2017) as well as highly disturbed/cleared areas (Figure 4-7). Vegetation is dominated by Eucalyptus open woodland, which occurs across 151.46 ha of the survey area, on hillslopes, cliffs, valleys and gullies. Other vegetation associations present include 1.35 ha of *Dioscorea* Vineland (DtV) and *Eucalyptus* open woodland mosaic (EmW), and 2.17 ha of Mixed *Acacia* shrubland (AS) (Table 4-15).

Vegetation throughout the western part of the survey area was impacted by fire in May 2016, which has altered the vegetation structure. However, this is likely a temporal change with extensive natural regeneration observed in December 2016 and May 2017 (GHD 2017).

Significant Vegetation

None of the vegetation associations on the Island are considered to be Threatened Ecological Communities (TECs) or State listed Priority Ecological Communities (PECs).

Two vegetation associations known to occur on Cockatoo Island outside of the survey area, mangroves and vineland (equivalent to rainforest patches), are considered to be 'other significant vegetation' (EPA 2016b). No mangrove vegetation occurs within the survey area. A very small area of true vineland (*Dioscorea* Vineland) occurs outside of the survey area on the northern side of the Island at No. 3 North Bay.

The Proposal area supports several small patches that have species distinctive of rainforest patches, but do not form discrete communities. These areas were mapped as '*Dioscorea* Vineland (DtV) and *Eucalyptus* open woodland (EmW) mosaic', and are likely to represent other significant vegetation as they have a restricted distribution, represent local endemism in restricted habitats and act as a refuge.

563,750 565,000 566,250 567,500

8,221,250 8,220,000 8,218,750

Triodia sp. Hidden Island (T. Handasyde TH 6109)

Chlorophytum laxum

Flemingia parviflora

Paper Size A3

0 125 250 375 500 625

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 51

N

LEGEND

Conservation Significant Flora

- *Triodia* sp. Hidden Island P1 (GHD 2014)
- Range Extension (GHD 2014)
- *Triodia* sp. Hidden Island P1 (GHD 2017)

- Survey Area
- Disturbance Area
- *Triodia* sp. Hidden Island cluster (GHD 2017)

Vegetation Types

- Mosaic *Eucalyptus* open woodland (EmW) and *Dioscorea* Vineland (DtV)
- *Eucalyptus* open woodland (EmW)
- Mixed *Acacia* shrubland (AS)
- Highly disturbed/cleared

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Cockatoo Island Multi-User Supply Base

Job Number 61-35178
Revision 0
Date 14 Jun 2017

Vegetation Associations and Conservation Significant Flora Locations Figure 4-7

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Data source: GHD: Survey Area - 20170214, Conservation Significant Flora, Triodia clusters - 20170609, Vegetation Types - 20170214, Disturbance areas - 20170606; Calibre: Aerial photography - 201703. Created by: mmikkonen

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Table 4-15 Vegetation associations within the survey area

Vegetation code	Vegetation association description	Landform and extent	Photograph
Eucalyptus open woodland (EmW)	*Eucalyptus miniata, Corymbia cadophora, Brachychiton diversifolius* open low woodland over *Calytrix exstipulata, Grevillea agrifolia* subsp. *agrifolia*, *Buchanania obovata* tall sparse shrubland over *Calytrix exstipulata, Bridelia tomentosa, Acacia stigmatophylla* sparse shrubland over *Dodonaea hispidula, Hibbertia oblongata, Acacia hippuroides* low shrubland over *Triodia bynoei* and *T. pungens* hummock grassland over *Sorghum plumosum, Heteropogon contortus, Eriachne avenacea*, *Cymbopogon* sp. sparse tussock grassland over *Trachymene didiscoides* isolated herbs over *Cassytha candida, Gossypium costulatum* and often **Passiflora foetida* open vineland.	Hillslope, cliffs, valleys and gullies 151.46 ha	
Dioscorea Vineland (DtV) and *Eucalyptus* open woodland (EmW) mosaic	*Canarium australianum* subsp. *australianum, Sersalisia sericea* woodland with *Eucalyptus miniata*, *Corymbia cadophora* isolated trees over *Pavetta kimberleyana, Grevillea agrifolia* subsp. *agrifolia* mid- to tall open shrubland with *Dioscorea transversa, Ampelocissus acetosa, Tinospora smilacina, Flagellaria indica* vineland over open herbland of *Tacca leontopetaloides*.	Limited to very small areas in valleys 2.17 ha	
Mixed *Acacia* shrubland (AS)	*Acacia colei var. colei, Acacia tumida* var. *tumida* tall shrubland.	Dam, embankment and hillslope 1.35 ha	

Vegetation Condition

Large sections of Cockatoo Island have been subject to major disturbances in the past, which include the development of mining areas, an airstrip, accommodation village and associated infrastructure area. Approximately 150 ha (28%) of the Island is mapped as being Disturbed or Highly Disturbed (GHD 2014). Despite these localised areas of major disturbance, the remaining areas of the Island support remnant vegetation, of which the majority is in excellent condition (GHD 2014).

Areas of *Eucalyptus* open woodland in the eastern and western parts of the survey area are in Very Good condition (Figure 4-8). Vegetation structure in these areas is intact, and disturbances include repeated fires, the presence of relatively non-aggressive weeds and occasional vehicle tracks.

Several areas adjacent to the existing airstrip and/or mine were rated as Good to Good-Poor (Figure 4-8). These areas show more obvious impacts to vegetation structure, and disturbances included partial clearing and the presence of more aggressive weeds. Areas associated with the tailings dam are in Degraded condition and have been previously cleared and comprise natural regrowth mostly limited to several *Acacia* species (GHD 2017).

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8,221,250

8,220,000

Paper Size A3

0 125 250 375 500 625

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 51

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LEGEND

Vegetation Condition

- 2. Excellent
- 2-3
- 3. Very Good
- 3-4
- 4. Good
- 4-5
- 5. Poor
- 5-6
- 6. Degraded
- 6-7
- 7. Completely Degraded
- Survey Area
- Disturbance

GHD

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Vegetation Condition

Figure 4-8

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Data source: GHD: Survey Area - 20170214, Vegetation Condition - 20170214, Disturbance areas - 20170606; Calibre: Aerial photography - 201703. Created by: mmikkonen

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Flora Diversity

Flora diversity recorded on Cockatoo Island is comparable to numbers recorded on nearby Irvine Island and Koolan Island (GHD 2014).

Conservation Significant Flora

No flora taxa currently listed under the EPBC Act or *Wildlife Conservation Act 1986* (WC Act) have been recorded from Cockatoo Island.

One species of Priority flora, *Triodia* sp. Hidden Island (T. Handasyde TH 6109) – Priority 1, has previously been recorded from the survey area.

Triodia sp. Hidden Island is known from seven collections on Hidden Island, located approximately 22 km south-west of Cockatoo Island (in 2009 and 2010), where it is found in rocky locations. Collection of this species on Cockatoo Island by GHD (2014) represented the first record outside of Hidden Island. The specimen recorded by GHD (2014) was collected from one location in the central part of the Island, to the north of the existing airstrip. This plant was located adjacent to an access track within an area that had historically been used as a material dump.

Further attempts in 2016 to identify *Triodia* sp. Hidden Island at the previously known location were unsuccessful due to an extensive bushfire that had burnt through the area in May 2016 (GHD 2017). A follow up survey in May 2017 identified the occurrence of *Triodia* sp. Hidden Island at a number of locations on the Island. Over 1,300 plants were recorded. All occurrences were outside of the area that will be impacted by the development, but its presence cannot be discounted in the Proposal area due to the temporary impacts of the 2016 fire.

Other Significant Flora

Two species recorded from Cockatoo Island represent range extensions and as such are likely to be considered 'significant flora' as defined by the EPA (2016a) (Table 4-16). One of these species, *Flemingia parviflora*, has been recorded from the survey area but outside of the disturbance footprint.

Table 4-16 Species recorded as range extensions and their current known range

Species	Known locations (WA Herbarium 1998– and DPaW 2007–)
Flemingia parviflora	11 locations including the Mitchell Plateau, Beverley Springs Station and near King Edward River, with the nearest record approximately 200 km north-east of Cockatoo Island
Chlorophytum laxum	Recorded within the Mitchell IBRA subregion; with the nearest record approximately 200 km east of Cockatoo Island

Introduced and Invasive Species

No Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) or Weeds of National Significance (WoNS) have been recorded from within areas of native vegetation on Cockatoo Island. One WoNS, *Lantana montevidensis* occurs within the townsite as a cultivated plant however this species does not appear to have established outside of maintained areas (GHD 2014).

A total of 33 introduced (weed) species have been recorded from Cockatoo Island, of which 16 are naturalised and occur within the vegetated areas of the Island. Most of these taxa are widespread throughout the Kimberley region (GHD 2014).

GHD (2017) recorded six introduced species within the Proposal area. Weed species were generally recorded in disturbed areas with the exception of Stinking Passion Flower (**Passiflora foetida*) and **Melinis repens* which are more widespread.

4.7.4 Potential Impacts

The Proposal will result in the direct loss of native vegetation and flora including:

- Up to 34.23 ha of *Eucalyptus* open woodland, 0 ha of *Dioscorea* Vineland and *Eucalyptus* open woodland mosaic, and 0 ha of Mixed Acacia shrubland (Table 4-17)
- Up to 34.18 ha of vegetation in Good to Very Good condition (Table 4-18)
- Loss of one known location of the Priority 1 flora species – *Triodia* sp. Hidden Island
- Loss of up to 34.23 ha of other significant vegetation (EPA 2016b): *Eucalyptus* open woodland (EmW).

The Proposal could also result in the following indirect impacts to vegetation and flora:

- Possible introduction and/or spread of weeds to adjacent vegetation
- Changes in local hydrology due to alteration of surface water flows
- Increased dust on leaf surfaces during construction activities.

Table 4-17 Clearing of local vegetation associations

Element	Maximum area of disturbance (ha)				
	Cleared area / existing disturbance	*Eucalyptus* open woodland	Mixed *Acacia* shrubland	Eucalyptus open woodland and *Dioscorea* Vineland	Total
Airfield, apron and support services	15.85	20.61	0	0	**36.46**
Laydown areas	1.72	13.45	0	0	**15.17**
Roads	0.86	0.17	0	0	**1.03**
Total	**18.43**	**34.23**	**0**	**0**	**52.66**

Table 4-18 Vegetation condition

Element	Maximum area of disturbance (ha)					
	Very Good (3)	Good (4)	Poor (5)	Degraded (6)	Completely Degraded (7)	Total
Airfield, apron and support services	13.57	6.99	0.05	0	15.85	**36.46**
Laydown areas	10.92	2.53	0	0	1.72	**15.17**
Roads	0.17	0	0	0	0.86	**1.03**
Total	**24.66**	**9.52**	**0.05**	**0**	**18.43**	**52.66**

4.7.5 Assessment of Impacts

Extent of Vegetation Types

One of the vegetation types identified within the Proposal area is broadly consistent with the pre-European vegetation association (Beard 1977):

- Grasslands, curly spinifex, low tree savanna; bloodwood (*Eucalyptus dichromophloia* [*Corymbia dichromophloia*]) and woolybutt [*Eucalyptus miniata*] over curly spinifex on Islands (association 8001).

The extent of the Beard vegetation association 8001 has been determined by the state-wide vegetation remaining extent calculations maintained by the DPaW (current as of June 2015 – Government of Western Australia (GoWA) 2015). As shown in Table 4-19, the extent of vegetation association 8001 is greater than 85% of the pre-European extent remaining at all scales (e.g. State, IBRA bioregion, IBRA subregion and local government authority (LGA)). There is less than 0.015% of the current extent of this vegetation association within the Proposal area at the Bioregion level.

Table 4-19 Vegetation association 8001 extent (Beard 1977, GoWA 2015)

Scale	Pre-European Extent (ha)	Current Extent (ha)	Remaining (%)
State: WA	237,440.25	203,756.79	85.81
Bioregion: Northern Kimberley	219,927.66	200,503.71	91.17
Sub-region: Mitchell	219,927.66	200,503.71	91.17
LGA: Shire of Derby-West Kimberley	233,722.26	201,062.33	86.03

Regional and Local Significance

The regional and local significance of the vegetation types was assessed by incorporating and adapting relevant characteristics as outlined in EPA (2016b). Characteristics included:

- Degree of degradation/clearing within Northern Kimberley IBRA Bioregion, Mitchell IBRA Subregion and Shire of Derby-West Kimberley LGA
- Size of remnant and condition/intactness of vegetation
- Heterogeneity or complexity of vegetation
- Rarity of vegetation
- Presence of other significant vegetation
- Representation of ecological refuge or linkage
- Presence of Threatened, Priority or other significant flora taxa.

The vegetation types within the disturbance area are:

- Not considered to be regionally or locally significant
- Only a small portion is considered to be 'other significant vegetation', and the remainder of the vegetation is generally not considered to be rare, an ecological refuge or part of a local or regional ecological linkage
- The vegetation types are considered to be well represented on and outside of Cockatoo Island – with only 0.015% of Beard vegetation association 8001 and 10% of the *Eucalyptus* open woodland on the Island (based on mapping in GHD 2014) proposed to be cleared.

Priority Flora Species

The records of *Triodia* sp. Hidden Island on Cockatoo Island represent the first records outside of Hidden Island. The GHD 2017 targeted survey for *Triodia* sp. Hidden Island recorded over 1,300 plants of the species, none of which will be directly or indirectly impacted. There is potential for more plants to be present within the burnt area, and within some un-accessed areas at the eastern end of the Island, but the majority of these areas will remain unaffected by the Proposal. The locations of the plants recorded are provided in Figure 4-7).

Summary of Impacts

The direct and indirect impacts to flora and vegetation associated with the Proposal are unlikely to be significant. This is because:

- Less than 0.015% of the Beard vegetation type 8001 and less than 10% of the *Eucalyptus* open woodland on Cockatoo Island will be directly impacted
- No vegetation types recorded as 'other significant vegetation' will be directly impacted
- At least 1,300 additional plants of *Triodia* sp. Hidden Island have been recorded outside the Proposal area
- *Solanum vanstittartense* has not been recorded within the disturbance area
- *Flemingia parviflora* has been recorded within 50 m of the disturbance area but unlikely to be indirectly impacted
- No impact to *Chlorophytum laxum*.

4.7.6 Mitigation

Impacts will be minimised through the following measures:

- Development of a Construction Environmental Management Plan to define techniques to minimise risks to the surrounding environment and provide monitoring during construction. Included will be procedures to ensure that earthmoving equipment is free of weeds prior to use
- Minimising clearing of terrestrial vegetation by locating a substantial proportion of the Proposal in previously disturbed areas (i.e. around the existing airstrip and mine)
- Provision of drainage design for the proposal that considers and reduces the potential impacts of runoff during operations. This will include installation of table drains adjacent to the airfield to capture and infiltrate surface water runoff
- Drainage treatments provided during construction to minimise and /or direct runoff from cleared areas in order to minimise downslope erosion and siltation
- Topsoil and vegetation to be respread over disturbed areas not required following construction to re-establish original vegetation.

4.7.7 Predicted Outcomes

The outcomes of the Proposal will:

- Disturb 34.23 ha (permanent and temporary) of native vegetation
- Not detrimentally impact adjacent native vegetation following construction
- Not significantly impact any flora of conservation significance
- Allow as much impacted area as possible to re-establish natural vegetation through assisted regeneration
- Provide a positive net revegetation by using available topsoil and vegetation on previously cleared disturbance areas.

4.8 Key Environmental Factor - Terrestrial Fauna

4.8.1 EPA Objective

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

4.8.2 Policy and Guidance

- Environmental Factor Guideline – Terrestrial Fauna (EPA 2016f)
- Technical Guidance – Terrestrial fauna surveys (EPA 2016e)
- Technical Guidance – Sampling methods for terrestrial vertebrate fauna (EPA 2016c)
- Technical Guidance – Sampling of short range endemic invertebrate fauna (EPA 2016d).

4.8.3 Receiving Environment

Baseline studies relevant to the Proposal area are provided in Table 4-20.

Table 4-20 Baseline studies – terrestrial fauna

Consultant	Survey Name
Aprasia Wildlife (2009)	Fauna Assessment of Cockatoo Island (Desktop Review)
GHD (2014)	Cockatoo Island Flora, Fauna and SRE Surveys
GHD (2017)	Cockatoo Island Multi-User Supply Base. Technical Study - Terrestrial Flora and Fauna
Warham (1957)	Cockatoo Island Birds

Vertebrate Fauna Habitats

A survey area surrounding the Proposal was assessed for fauna over a number of visits.

Fauna habitat within the survey area is dominated by woodland (with rocky ridgelines and exposed rocky areas) and regrowth shrubland (Figure 4-9). Much of the woodland habitat was burnt in May 2016 and provides little cover for fauna species in its current condition. The rocky nature of the area does provide some refugia however, this would be limited to use by rock dwelling species. Due to the heat of the fire, many of the large trees on the Island have been burnt and large hollows have been lost. Small areas of vineland and woodland mosaic habitat were recorded in valleys, however these patches were considered to be too small to support any fauna specific to this habitat type.

There are no permanent waterbodies within the survey area, however seasonal pooling occurs around small rocky areas and the historic tailings dam. Minor drainage lines occur within gullies bisecting the survey area that transport surface water runoff following seasonal rainfall events.

Large portions of Cockatoo Island (approximately 150 ha) have been cleared or highly disturbed through mining, the air strip, roads and other infrastructure. Approximately 18.43 ha (35%) within the proposed disturbance area is Degraded to Completely Degraded (Table 4-18).

Vertebrate Fauna Assemblages

Previous fauna surveys on Cockatoo Island have recorded 177 species on and near the Island, including five mammals, 13 reptiles, 157 birds and two amphibian species.

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8,221,250

8,220,000

Hipposideros stenotis

Macroderma gigas

Hipposideros stenotis

Mormopterus loriae cobourgiana

563,750 565,000 566,250 567,500

Paper Size A3

0 125 250 375 500 625

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 51

N

LEGEND

- Bat Detectors
- Large Tree with Hollow

Conservation Significant Fauna

- P1
- P2
- V

- Survey
- Disturbance

Fauna Habitats

- Regrowth Shrubland
- Woodland
- Highly disturbed/cleared

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Revision	0
Date	12 Jun 2017

Fauna Habitats and Conservation Significant Fauna Locations

Figure 4-9

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Data source: GHD: Survey Area - 20170214, Conservation Significant Fauna, Bat Detector, Large Tree with Hallow- 20170214, Fauna Habitats - 20170214, Disturbance Areas - 20170606; Calibre: Aerial photography - 201703. Created by: mmikkonen

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Conservation Significant Vertebrate Fauna

Five conservation significant terrestrial fauna species have been recorded from Cockatoo Island. Details of these species and their State and Commonwealth conservation status are included in Table 4-21.

The habitat in its current form would support few conservation significant species however, opportunistic use for foraging may occur.

Migratory Species

Three species listed as Migratory under the EPBC Act and/or under Schedule 5 of the WC Act were recorded from the survey area during the surveys. These included:

- Eastern Osprey (*Pandion cristatus*)
- Lesser Frigatebird (*Fregata ariel*)
- Common Sandpiper (*Tinga hypoleucos*).

These species were observed flying over the survey area, are considered highly mobile and would opportunistically utilise the survey area for foraging.

Introduced Fauna

Three introduced species have historically been recorded from Cockatoo Island, including the domestic cat, goat and Asian House Gecko. Domestic cats and goats were previously known to occur on the Island however anecdotal evidence suggests that they have not been seen on the Island since the 1980s. The Asian House Gecko (*Hemidactylus frenatus*) continues to occur on the Island and is predominantly found around the townsite.

Short Range Endemic Invertebrates

Baseline surveys on Cockatoo Island identified 22 invertebrate species from 12 families and five classes (Table 4-22).

Taxonomic assessment indicates that none of the recorded species represented confirmed SRE species, however three likely and 15 potential SRE species have been recorded. The remaining four species are known to have a widespread distribution and therefore have no SRE status.

The bushfire event that occurred across much of the northern part of Cockatoo Island in early 2016 has temporarily reduced the value of the SRE habitat within the Proposal area. However, a site visit in May 2017 showed dense regrowth of understorey species in most of the burnt areas.

Table 4-21 Conservation significant fauna known to occur on Cockatoo Island

Species	WC Act Ranking	EPBC Ranking	Occurrence within the Proposal area
Masked Owl (northern sub-species) (*Tyto novaehollandiae kimberli*)	Priority 1	Vulnerable	Previously recorded in woodland habitat on the eastern side of Cockatoo Island. In its current form the woodland habitat within the survey area may provide some foraging habitat. Nine trees with large hollows that may be used by this species have been recorded from the survey area, however there was no evidence of existing or historical use (GHD 2017).
Ghost Bat (*Macroderma gigas*)	Vulnerable	Vulnerable	Ghost bats have previously been recorded on Cockatoo Island on one occasion via echolocation. This species is known to occur on nearby Koolan Island and other Islands throughout the Buccaneer Archipelago. The occurrence of the species on Cockatoo Island indicates that there is likely to be a significant refuge for the species in close proximity to both Koolan and Cockatoo Islands. No Ghost Bat roosts or maternity caves have been recorded from the survey area. One potentially suitable cave is present in the rocky coastal cliffs approximately 600 m from the north-west boundary of the survey area. It is unknown if this cave is affected by the tidal movements (i.e. partially or completely fills with water) and/or is utilised by any bat species.
Little North-western Mastiff Bat (*Mormopterus loriae cobourgiana*)	Priority 1		Within its distribution, the Little North-western Mastiff Bat is restricted to localised habitats, typically occupying mangrove stands. The extent of mangrove areas on Cockatoo Island is minimal and there are no mangroves within the survey area. It is likely that this species roosts in mangroves on nearby Islands or on the mainland, however may utilise the survey area for opportunistic foraging.
Northern Leaf-nosed Bat (*Hipposideros stenotus*)	Priority 2		The Northern Leaf-nosed Bat has been recorded on Cockatoo Island along with nearby Koolan Island, Irvine Island and Bathurst Island. This species occurs within a variety of habitats and typically roosts in shallow cracks, caves, boulder piles and disused mines. No small caves and limited rocky crevices suitable for breeding for this species have been recorded from the survey area however, it is likely to utilise the survey area for foraging.
Water Rat (*Hydromys chrysogaster*)	Priority 4		The Water Rat has been recorded from Cockatoo Island, Irvine Island, Margaret Island and other Kimberley Islands to the north. This species typically occurs in permanent fresh or brackish water but can also be found in marine environments, mangroves and sheltered beaches. It is likely that the population of Water Rats on Cockatoo Island utilise the coastal areas, including the coastal margins of the survey area.

Table 4-22 Invertebrate species recorded within the survey area

Species	SRE Status
Gastropoda: Camaenidae: *Kimboraga* cf. *yampiensis*	Potential SRE
Gastropoda: Camaenidae: *Torresitrachia* aff. *bathurstensis*	Potential SRE
Gastropoda: Helicarionidae: *Westracystis lissus*	Widespread
Crustacea: Isopoda: Armadillidae: *Buddelundia* '82'	Likely SRE
Crustacea: Isopoda: Philosciidae: *Philosciidae* 'cockatoo Island'	Likely SRE
Crustacea: Isopoda: Philosciidae sp. indet.	Likely SRE
Chilopoda: Geophilida: Chilenophilidae	Potential SRE
Chilopoda: Geophilida: Mecistocephalidae	Potential SRE
Chilopoda: Scolopendrida: Cryptopidae: *Cryptops* sp.	Potential SRE
Chilopoda: Scolopendrida: Scolopendridae: *Rhysida polyacantha*	Widespread
Chilopoda: Scolopendrida: Scolopendridae: *Scolopendra laeta*	Widespread
Chilopoda: Scolopendrida: Scolopendridae: Scolopendridae genus indet. sp.	Potential SRE
Chilopoda: Scutigerida: Scutigeridae: genus indet. sp.	Potential SRE
Chilopoda: Scutigerida: Scutigeridae: *Parascutigera*? sp.	Potential SRE
Chilopoda: Scutigerida: Scutigeridae: *Thereuopoda* sp.	Potential SRE
Diplopoda: Polydesmida: Paradoxosomatidae: genus indet. (juvenile) and sp. indet. (juvenile)	Potential SRE
Arachnida: Pseudoscorpiones: Olpiidae: *Xenolpium* sp.	Potential SRE
Arachnida: Scorpiones: Buthidae: *Lychas bituberculatus* Pocock, 1891	Widespread
Possibly juvenile Arachnida: Araneae: Barychelidae: *Synothele* sp. juv.	Potential SRE
Arachnida: Araneae: Ctenzidiae: *Conothele* sp. female	Potential SRE
Arachnida: Acari: Trombidioidea: *Trombidioidea*	Potential SRE
Arachnida: Opiliones: Assamiidae: *Dampetrus*?	Potential SRE

4.8.4 Potential Impacts

Construction Phase Impacts

Direct Clearing and Loss of Habitat

Construction of the Proposal will result in clearing of 34.23 ha of native vegetation and associated fauna habitat, including the following habitat for conservation significant fauna:

- 34.23 ha of the potential foraging and low value breeding habitat for the Masked Owl (northern sub-species)
- 34.23 ha of potential foraging/hunting habitat for bat species – Ghost Bat, Little North-western Mastiff Bat and Northern Leaf-nosed Bat
- Up to 1 ha of potential coastal habitat for the Water Rat.

GHD (2014) reported that the woodland fauna foraging habitat occurs over 65% of the Island, totalling 340 ha. Over 90% of this vegetation type will remain following clearing.

Potential impacts associated with vegetation clearing include:

- Loss of up to 10% of potential foraging habitat on the Island for some conservation significant fauna
- Loss of up to 10% of habitat for likely or potential SRE species
- Death or displacement of fauna species – clearing and construction works may result in the injury or death of fauna
- Fragmentation of habitat – vegetation clearing may reduce the overall connectivity of the habitat available to fauna on the Island, however this impact will be limited to the local area (north to south in the centre of the Island).

Noise, Vibration, Light and Dust

During the construction phase, there will be a temporary increase in secondary impacts such as noise, vibration, light and dust. Increased noise, vibration and dust will temporarily result in fauna avoiding the area, however is unlikely to have a permanent impact on fauna species on the Island.

Operational Phase Impacts

Vehicle Strike

Operation of the Supply Base will result in an increase to vehicle movements on the Island. Previous mining activities involved frequent vehicle movements throughout the Island. Operational activities associated with the Supply Base may increase the risk of fauna strike, however it will not introduce any new impacts.

Noise and Vibration

During peak times there will be up to seven flights servicing the Island per week. Noise and vibration associated with helicopter and aircraft movements have the potential to result in short-term disturbance to fauna on a local scale. An airstrip has been operational on the Island for several decades servicing the mine. Operational activities associated with aircraft servicing the Supply Base will result in an incremental increase in potential noise impacts to fauna, however it will not introduce any new impacts.

Routine scheduled flights will operate during daylight hours, although aircraft movements may occur at night during emergencies, such as medical evacuations.

4.8.5 Assessment of Impacts

The direct and indirect impacts associated with the Proposal are unlikely to have a significant impact on terrestrial fauna given:

- The relatively limited extent of foraging habitat loss
- The presence of extensive habitat for bat and large bird species on adjacent Islands and the mainland.

4.8.6 Mitigation

Impacts will be minimised through the following mitigation measures:

- Development of a Construction Environmental Management Plan to define techniques to minimise risks to the surrounding environment and provide monitoring during construction
- Fauna management measures will be implemented during clearing of native vegetation, including a qualified fauna handler being on site to identify and relocate fauna
- Staging the clearing of native vegetation associated with the different aspects of the Proposal
- Rehabilitation of areas associated with the Proposal that are not required for operational purposes.

4.8.7 Predicted Outcomes

The Proposal will result the loss of up to around 34.23 ha of habitat for fauna, including foraging habitat suitable for some conservation significant species. Some of the habitat will be re-generated through topsoil and vegetation replacement following construction.

Some direct loss of reptile and SRE fauna will occur because of vegetation clearing and ground disturbance but this is unlikely to affect conservation significant species as most are nocturnal and arboreal and can move away from the disturbance area.

The availability of other suitable habitat on Cockatoo Island and on adjacent islands and the mainland is likely to ensure the survival and continued presence of the conservation significant species recorded.

Potential operational impacts are unlikely to significantly affect fauna presence or diversity.

5. Conclusions

Actual and potential impacts to terrestrial and marine flora and fauna and their habitats are not considered to be significant, due to the amount of existing disturbed habitat and to other, existing factors such as the availability of significant areas of adjacent habitat of similar, or better, quality. The development and implementation of Construction and Operations Environmental Management Plans will assist in minimising impacts.

5.1 Benthic communities and habitat

The Project will result in the direct loss of 0.54 ha of hard coral and algae, of which 0.3 ha is largely very sparse hard coral. Species are represented in adjacent bays and in higher densities and coverage. Some colonisation by marine species will occur on the new sheet piling. As this bay has very little primary producer habitat compared to the adjacent bays, there is unlikely to be a significant impact to local biological diversity and ecological integrity.

5.2 Coastal processes

The new wharf will run parallel to the shoreline and will not significantly affect or interrupt longshore current movements or existing coastal processes.

Any residual impacts on sedimentation, geomorphology, current speeds and patterns will be localised and restricted to the vicinity of the wharf.

5.3 Marine environmental quality

The Proposal does not involve dredging or any planned discharge, and is not expected to interrupt longshore current movements or existing coastal processes.

Impacts will be largely confined to the construction phase and limited to the immediate area of construction that is largely dominated by unvegetated sandy environs. Further, due to the large tidal regime and seasonally high rainfall, fluxes in total suspended solids and turbidity are common.

There is not expected to be any significant risk to maintaining environmental values of the water, sediment and biota through the construction or operational phases.

5.4 Marine habitat and fauna

Given the proposed mitigation measures, lack of known critical marine fauna habitat in the impacted bay and comparably less benthic communities and habitats than adjacent bays, the Proposal activities are not expected to result in any significant losses of marine fauna. There is the potential for some fauna losses to occur during the reclamation process, but progressive reclamation will allow marine fauna to relocate.

During reclamation and piling, there is likely to be behavioural avoidance of the area but not direct physical trauma. Any impacts to behaviour will be limited to transient individuals near to the activity, as the area is not significant for cetaceans or turtles. Migrating species that may pass through the area will be able to navigate around any point source disturbance.

With adherence to the management controls proposed during the activities, potential impacts are considered acceptable.

5.5 Terrestrial vegetation

The impacts to terrestrial vegetation are based on the loss of 34.23 ha of native vegetation. No Threatened species or communities have been recorded, or are likely to occur on Cockatoo Island and clearing will remove less than 10% of the remaining area of Eucalyptus woodland present across the Island. Some plants of the Priority 1 species, *Triodia* sp. Hidden Island will potentially be cleared, but a significant number of plants of this species occur in areas that are outside the Proposal area.

Drainage will be designed to minimise the risk of impact to downslope vegetation during construction and operations. Revegetation using cleared topsoil and vegetative material will replace some of the vegetation initially removed.

5.6 Terrestrial fauna

The Proposal will result the loss of 34.23 ha of habitat for fauna, including foraging habitat suitable for some conservation significant species. Some of the habitat will be re-generated through topsoil and vegetation replacement following construction.

Some direct loss of reptile and SRE fauna will occur because of vegetation clearing and ground disturbance but this is unlikely to affect conservation significant species as most are nocturnal and arboreal and can move away from the disturbance area.

The availability of other suitable habitat on Cockatoo Island and on adjacent islands and the mainland is likely to ensure the survival and continued presence of the conservation significant species recorded.

Potential operational impacts are unlikely to significantly affect fauna presence or diversity.

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Appendices

Appendix A – Technical Study - Marine Flora and Fauna

Appended separately

Appendix B – Technical Study - Terrestrial Flora and Fauna

Appended separately

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