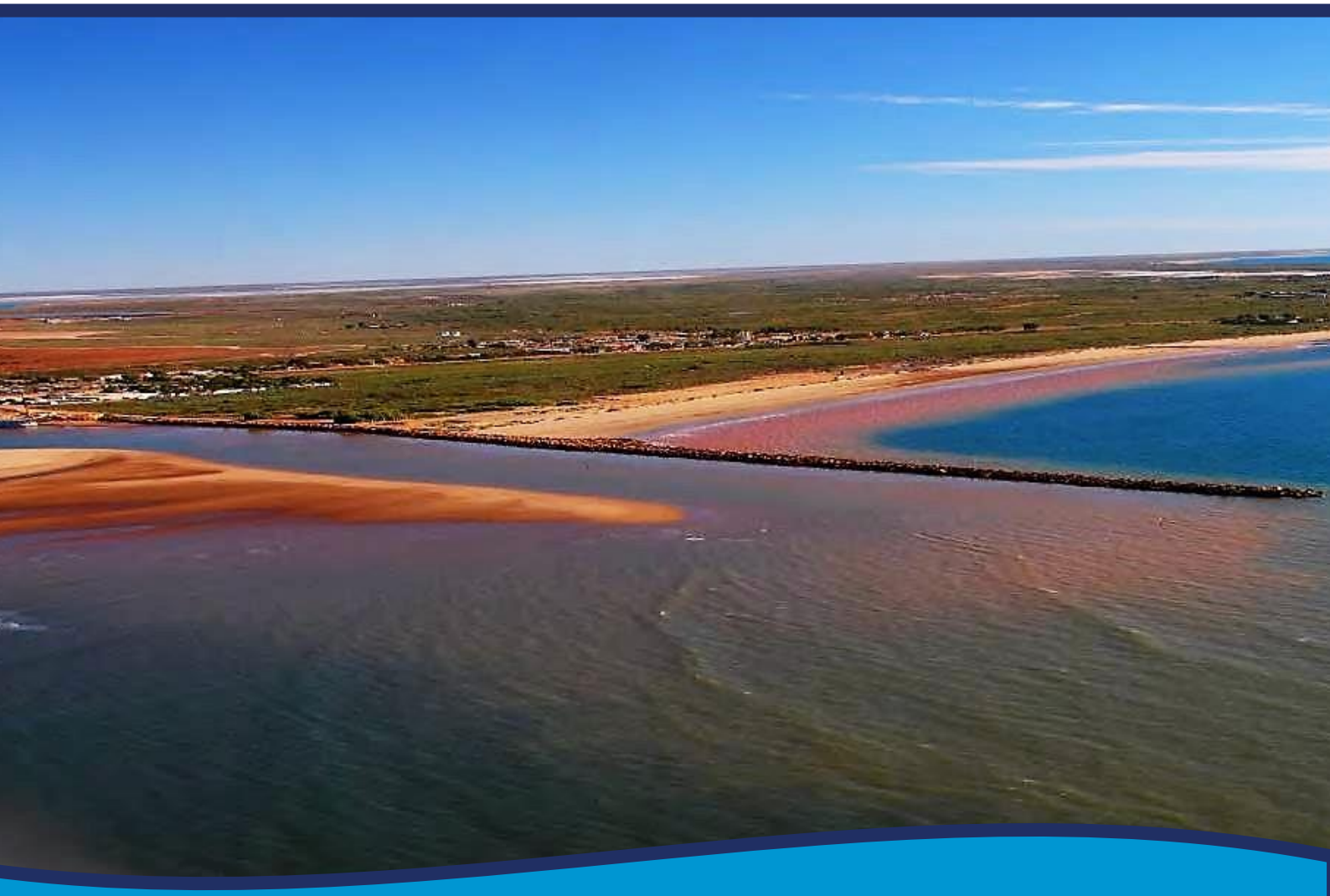
Onslow Marine Support Base
Stage 2: Capital Dredging

Environmental Review Document



PROPONENT:

Onslow Marine Support Base Pty Ltd

STATUS:

Rev 2

REPORT NUMBER:

1702027

ISSUE DATE:

3rd November 2017

Important Note

This report has been prepared for the sole use of the **Onslow Marine Support Base Pty Ltd** (herein, 'the Proponent'), for a specific purpose specified in Section 1 of this report (herein 'the purpose'). This report is strictly limited for use by the Proponent, to the purpose and may not be used for any other purposes.

Third parties, excluding regulatory agencies assessing an application in relation to the purpose, may not rely on this report. O2 Marine waives all liability to any third-party loss, damage, liability or claim arising out of or incidental to a third party publishing, using or relying on the facts, content, opinions or subject matter contained in this report.

O2 Marine waives all responsibility for loss or damage where the accuracy and effectiveness of information provided by the Proponent or other third parties was inaccurate or not up to date and was relied upon, wholly or in part in reporting.

WA Marine Pty Ltd t/as O2 Marine
ACN 168 014 819
Originating Office – Dunsborough
Suite 5 5/18 Griffin Drive, Dunsborough WA 6281
PO Box 1370 Dunsborough WA 6281
T 1300 739 449| F 61 7 3339 7222 | info@o2marine.com.au

Version Register

Version	Status	Author	Reviewer	Change from Previous Version	Authorised for Release	
					Signature	Date
Rev 0	Final	T. Hurley C Lane	R.Hanley	N/A	On File	06/08/2017
Rev 1	Final	T. Hurley C Lane	R.Hanley	Minor reference corrections	On File	17/08/2017
Rev 2	Final	T. Hurley C Lane	R.Hanley	Updated impact assessment	On File	03/11/2017

Transmission Register

Controlled copies of this document are issued to the persons/companies listed below. Any copy of this report held by persons not listed in this register is deemed uncontrolled. Updated versions of this report if issued will be released to all parties listed below via the email address listed.

Name	Email Address
Andrew Natta	andrew.natta@omsb.com.au
Gordon Motherwell	Gordon.motherwell@epa.gov.wa.au

Executive Summary

Onslow Marine Support Base Pty Ltd (the Proponent) is proposing to modify and extend the Beadon Creek harbour approach channel (HAC), Turning Basin and Berth Pocket as part of Stage 2 of the Onslow Marine Support Base (OMSB) Proposal. The proposed capital dredging will enable offshore supply vessels to access the newly-constructed OMSB land-backed wharf facility (Stage 1) within the Department of Transport (DoT) managed Beadon Creek Maritime Facility. Dredge material will be disposed of onshore to a Dredge Material Management Area (DMMA) to be constructed within freehold land, located adjacent to the Onslow airport and owned by the Shire of Ashburton (SoA).

This Environmental Review Document has been prepared to provide supplementary information for referral of the Proposal to the Environmental Protection Authority (EPA) in accordance Section 38 (Part IV) of the *Environmental Protection Act 1986* (EP Act).

The Proposal was considered to pose a moderate risk to five of the EPA's environmental factors. The actual and potential impacts of the Proposal on each of these factors was investigated and the significance of the impacts was evaluated. A summary of the predicted outcomes for each environmental factor is provided below.

Benthic Communities and Habitat

Proposed dredging activities in Beadon Creek (Turning Basin and Berth Pocket) and Beadon Bay (HAC) will result in the following predicted environmental protection outcomes with respect to benthic communities and habitat (BCH):

- Direct irreversible loss within LAU 1G of:
  - 21 ha (0.2%) of seagrass/macroalgae/filter feeder BCH;
- Potential indirect irreversible loss within LAU 1G of:
  - 35 ha (0.3%) seagrass & macroalgae from seagrass/macroalgae/filter feeder BCH;
- Potential recoverable impact within LAU 1G of:
  - 31 ha (0.3%) to 260 ha (2.5%) of seagrass & macroalgae from seagrass/macroalgae/filter feeder BCH;
  - 4 ha (0.3%) to 19 ha (1.5%) of macroalgae from macroalgae/filter feeder BCH;
- Potential recoverable impact within LAU 1C of:
  - 0 ha (0%) to 25 ha (0.4%) of seagrass & macroalgae from seagrass/macroalgae/filter feeder BCH;
  - 0 ha (0%) to 10 ha (0.3%) of macroalgae from macroalgae/filter feeder BCH; and
- No impact to coral BCH from dredging generated SSC and sedimentation

Proposed onshore disposal activities at the proposed DMMA will result in the following predicted environmental protection outcomes with respect to benthic communities and habitat:

- Permanent loss of BCH within LAU 0A of:
  - 2.4 ha (0.2%) of algal mat from construction of the DMMA;
  - 0.8 ha (<0.1%) of bioturbated mudflat/samphire to widen the Turning Basin;
- Potential recoverable impact of 1.3 ha (0.2%) of mangrove, 0.4 ha (<0.1%) of samphire/bioturbated mudflat and 8.5 ha (0.8%) of algal mat within LAU 0A from tail water discharge from the DMMA; and
- No loss of subtidal BCH due to offshore disposal.

The combined impact of the Proposal activities and the consequent predicted environmental protection outcomes are not considered to pose significant residual risks to the protection of BCH and therefore

biological diversity and ecological integrity can be maintained. In respect of the proposed design and management of the Proposal, the Proponent considers that the EPA's objective for BCH has been met.

Coastal Processes

The proposal will result in the following predicted environmental protection outcomes with respect to coastal processes:

- A reduction in current speeds of approximately 50% through the entrance channel and central Beadon Creek, including along the eastern side of the training wall;
- A slight increase in current speeds will occur within the section of Beadon Creek immediately upstream of the dredge footprint due to the increased efficiency of the dredged entrance channel to convey ebb tide peak flows;
- The Beadon Creek tidal prism will remain largely unchanged with total inflow and outflow volumes estimated to increase by only 1%;
- Negligible change to the estuary tidal plane is predicted post-construction;
- A reduction in the capacity of the entrance to 'naturally bypass' the net eastward bound littoral drift as the deepened channel becomes a sediment trap for this material, resulting in a requirement for regular maintenance dredging to maintain navigable depths and disposal of the material on the eastern shoreline to restore the natural sand bypassing processes;
- A predicted annual sedimentation infill, and subsequent requirement for maintenance dredging to maintain navigable depths in the HAC, Turning Basin and Berth Pocket, of between 18,000 m^3 to 28,000 m^3;
- Post-dredging estimates indicate the historical rate of sedimentation (~1,700 m^3) could increase by approximately 30% (~2,300 m^3) upstream of the dredge footprint, although this is likely to stabilise within the historical range as the bathymetry adjusts to the new hydrodynamic regime over the longer term; and
- Sedimentation volumes deposited within the development footprint from an extreme cyclone event could range from 5,000m^3 to 10,000m^3.

Based on these predicted environmental protection outcomes, and in consideration of the proposed monitoring and management strategies, the Proposal activities are not expected to pose any significant residual risks to maintaining the geophysical processes that shape coastal morphology and therefore the environmental values of the coast can be protected. In relation to the proposal, the Proponent considers that the EPA's objective for coastal processes has been met.

Marine Environmental Quality

The proposal will result in the following predicted environmental protection outcomes with respect to marine environmental quality:

- A temporary decline in marine water quality in the immediate vicinity of dredging operations due to increased turbidity and SSC, release of mobilisation of contaminants is not expected;
- A potential slight decline in marine water quality in the High Ecological Protection Area in the east arm of Beadon Creek during dewatering operations; and
- No residual impact on marine environmental quality as a result of the Proposal activities.

Based on these outcomes, and in consideration of the proposed monitoring and management strategies, the Proposal activities are not expected to pose any significant residual risks to maintaining the quality of water, sediment and biota and therefore the environmental values can be protected. In relation to the proposal, the Proponent considers that the EPA's objective for marine environmental quality has been met.

Marine Fauna

The predicted environmental protection outcomes of the Proposal on marine fauna include:

- No harm of individuals and/or declines in the population of the range of conservation significant marine fauna species;
- No reductions in populations of species of local and regional importance;
- Impacts to species or groups of species that fulfil critical ecological functions within the system;
- No loss or impact to critical marine fauna habitat, including nesting beaches, nursery areas, specific foraging or breeding areas;
- No reduction in the biodiversity of marine fauna in the area; and
- No introduction and/or spread of invasive marine species or diseases.

The combined impact of the Proposal activities and the consequent outcomes are not considered to pose any significant residual risks to the protection of marine fauna and therefore biological diversity and ecological integrity can be maintained. In respect of the proposed design and management of the Proposal, the Proponent considers that the EPA's objective for marine fauna has been met.

Flora and Vegetation

The predicted environmental protection outcomes of the Proposal include:

- Direct removal of 15.8 ha of native vegetation;
- No detrimental impacts to adjacent native vegetation following construction; and
- No direct impacts to any flora of conservation significance.

The combined impact of the Proposal activities and the consequent predicted environmental protection outcomes are not considered to pose any significant residual risks to the protection of flora and vegetation and therefore biological diversity and ecological integrity can be maintained. In respect of the proposed design and management of the Proposal, the Proponent considers that the EPA's objective for flora and vegetation has been met.

Holistic Impact Assessment

Overall actual and potential impacts of the Proposal on the environment are considered not to represent a significant environmental risk on the basis that:

- The EP Act principles and relevant EPA guidance documents have been considered in investigating and evaluating potential impacts of the Proposal on the EPA's environmental factors;
- A comprehensive set of monitoring and management measures have been developed to further mitigate and avoid potential impacts of the Proposal on the EPA's environmental factors;
- The proponent has committed to open and transparent reporting of environmental performance throughout the Proposal construction phase; and
- Evaluation of impacts against all relevant environmental factors, including other environmental factors determined that the EPA's objectives would be met.

Acronyms and Abbreviations

Acronyms/Abbreviation	Description
ALA	Atlas of Living Australia
AH Act	*Aboriginal Heritage Act 1972*
ANSIA	Ashburton North Strategic Industrial Area
ARRP Act	*Agriculture and Related Resources Protection Act 1976*
ASS	*Acid Sulfate Soils*
ASSMP	*Acid Sulfate Soils Management Plan*
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BCH	Benthic Communities and Habitats
BIA	Biologically Important Area
BPPH	Benthic Primary Producer Habitat
CSD	Cutter-suction dredge
DBCA	Department of Biodiversity, Conservation and Attractions
DMMA	Dredge Material Management Area
DoEE	Department of the Environment and Energy
DPIRD	Department of Primary Industries and Regional Development
DoT	Department of Transport
DSD	Department of State Development
DSDMP	Dredging and Spoil Disposal Management Plan
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environment Regulation
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPO	Environmental Protection Outcome
EQMF	Environmental Quality Management Framework
EQO	Environmental Quality Objective
EQP	Environmental Quality Plan
ERMP	Environmental Review and Management Program
EV	Environmental Value
EVNT	Endangered, Vulnerable and Near Threatened
Ha	hectares
HAC	Harbour Approach Channel
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for Conservation of Nature and Natural Resources
LAU	Loss Assessment Unit
LIA	Light Industrial Area

Acronyms/Abbreviation	Description
LNG	Liquified Natural Gas
MH Act	*Marine and Harbours Act 1981*
MNES	Matters of National Environmental Significance
MOF	Materials Offloading Facility
MT	Management Target
MVG	Major Vegetation Groups
MVS	Major Vegetation Sub-groups
NVIS	National Vegetation Information System
OCCI	Onslow Chamber of Commerce and Industry
OMSB	Onslow Marine Support Base
OPMF	Onslow Prawn Managed Fishery
OZCAM	Online Zoological Collections of Australian Museums
PECs	Priority Ecological Communities
PD Act	*Planning and Development Act 2005*
PMST	Protected Matters Search Tool
PPA	Pilbara Ports Authority
RiWI Act	*Rights in Water and Irrigation Act 1914*
SoA	Shire of Ashburton
SP Act	*Shipping and Pilotage Act 1967*
SSC	Suspended Sediment Concentrations
TACC	Technical Advisory and Consultative Committee
TECs	Threatened ecological communities
TC	Tropical Cyclone
WAFIC	Western Australian Fishing Industrial Council
WAMSI	Western Australian Marine Science Institution
WC Act	*Wildlife Conservation Act 1950*
WONS	Weeds of National Significance
ZoHI	Zone of High Impact
ZoI	Zone of Influence
ZoMI	Zone of Moderate Impact

Table of Contents

Figures

Tables

Appendices

1. Introduction

1.1. Purpose and Scope

This Environmental Review Document (ERD) presents an Environmental Review of a Proposal to undertake a capital dredging and spoil disposal project in Onslow, WA. The purpose of this ERD is to provide supplementary information for referral of the Proposal to the Environmental Protection Authority (EPA) in accordance with Section 38 (Part IV) of the *Environmental Protection Act 1986* (EP Act).

In accordance with the requirements of the EPA's '*Instructions and Template: Environmental Review Document*', the scope of the document includes:

- A description of the Proposal, including key characteristics of the Proposal which have the potential to cause an impact on the environment (**Section 2**);
- A summary of stakeholder consultation undertaken in support of the Proposal (**Section 3**);
- An assessment of the potential significant environmental impacts of the Proposal for each of the EPA's Key Environmental Factors (**Section 4**);
- An assessment of potential minor environmental impacts of the Proposal on other relevant Environmental Factors (**Section 5**);
- Identification of any offsets Proposed for the Proposal (**Section 6**); and
- A holistic impact assessment summarising the potential impacts of the Proposal (**Section 7**).

1.2. Proposal Summary

The Proponent (OMSB Pty Ltd) is proposing to modify and extend the Beadon Creek harbour approach channel (HAC), Turning Basin and Berth Pocket as part of Stage 2 of the Onslow Marine Support Base (OMSB) Proposal (herein the Proposal). The proposed capital dredging will enable offshore supply vessels to access the newly-constructed OMSB land-backed wharf facility (Stage 1) within the Department of Transport (DoT) managed, Beadon Creek Maritime Facility. Dredge material will be disposed of onshore to a Dredge Material Management Area (DMMA) to be constructed within freehold land, located adjacent to the Onslow airport and owned by the Shire of Ashburton (SoA). A detailed description of the Proposal, including the key Proposal characteristics is provided in **Section 2**.

1.2.1. Proposal Title

The formal title of the Proposal is the **'Onslow Marine Support Base Stage 2: Capital Dredging'**, referred to as the Proposal, and includes all dredging and spoil disposal activities.

1.3. Proponent

The Proponent for the Proposal is Onslow Marine Support Base Pty Ltd. Proponent details are provided in Table 1.

Table 1 Proponent details

Company Name:	Onslow Marine Support Base Pty Ltd
Australian Business Number (ABN):	59 167 963 715
Address:	Level 3, Suite 24, 25 Walters Drive, Osborne Park WA 6017
Key Contact (Role):	Andrew Natta (OMSB Director)
Key Contact Details:	Phone: +61 488 888 960 Email: andrew.natta@omsb.com.au

1.4. Environmental Impact Assessment Process

1.4.1. Environmental Protection Act 1986 (EP Act) (Part IV)

The Proposal is being referred to the Government of Western Australia Environmental Protection Authority (EPA) in accordance with Part IV (Section 38) of the *Environmental Protection Act 1986* (EP Act).

Environmental Factors

In March 2017, an Environmental Identification workshop (ENVID) was undertaken as an early evaluation and screening tool to determine the aspects or activities of the Proposal which could pose a significant risk of compromising the Environmental Objectives for each of the EPA's environmental factors. A summary of the ENVID workshop is presented in **Appendix A**.

The ENVID identified that the Proposal had the potential to pose a moderate risk of impacting the following environmental factors:

- Benthic Communities and Habitat;
- Coastal Processes;
- Marine Environmental Quality;
- Marine Fauna; and
- Flora and Vegetation.

Potential impacts upon the above environmental factors were thoroughly investigated and are described within **Section 4** of this ERD.

Potential impacts on several other EPA environmental factors were also evaluated in the ENVID workshop and it was determined that these impacts were not significant. These factors were therefore considered to be 'Other Environmental Factors'. Potential impacts on the following additional environmental factors are therefore summarised within **Section 5** of this ERD:

- Terrestrial Environmental Quality;
- Terrestrial Fauna;
- Hydrological Processes;
- Air Quality; and
- Social Surroundings.

1.4.2. Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

Based on the outcomes of environmental investigations and following advice provided by key stakeholders, the Proponent does not consider that the Proposal involves an action that is likely to have a significant impact upon Commonwealth Matters of National Environmental Significance (MNES) or other protected matters. Furthermore, the Proposal does not involve an action that is considered likely to have a significant impact on any Commonwealth-owned land or waters. Therefore, the Proposal is not expected to require assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and referral to the Commonwealth Department of the Environment and Energy (DoEE) is not proposed.

The potential for impacts upon MNES are considered and discussed further as they relate to the relevant environmental factors (**Section 4** and **Section 5**).

1.5. Other Approvals and Regulation

The key legislation that applies to this Environmental Review Document includes, but is not limited to:

- *Environmental Protection Act 1986* (EP Act) (General provisions);
- *Planning and Development Act 2005* (PD Act);
- *Rights in Water and Irrigation Act 1914* (RiWI Act);
- *Wildlife Conservation Act 1950* (WC Act);
- *Aboriginal Heritage Act 1972* (AH Act);
- *Shipping and Pilotage Act 1967* (SP Act); and
- *Marine and Harbours Act 1981* (MH Act).

The key decision-making authorities (DMAs) and the other relevant approvals for the Proposal are identified in **Table 2**.

Table 2 Other approvals and regulation

Proposal activities	Land tenure/access	Type of approval	Legislation regulating the activity	Responsible Agency	Timeframe
Dredging	'Seabed' is located within the Port of Onslow limits.	Seabed Lease with DoT, expected to include reference to compliance with: • Management and mitigation of risks to DoT infrastructure (i.e. Beadon Creek Training Wall); • Dredging and dewatering management described within a Dredging and Spoil Disposal Management Plan (DSDMP); and • Maintenance dredging requirements described within the DoT Maintenance Dredging Environmental Quality Management Framework. (Refer Section 1.5.1 below)	SP Act MH Act	DoT	Q4 - 2017
Vessel Operations	'Waters' are located within the Port of Onslow limits.	Waterway Licence with DoT, expected to include reference to compliance with: • Vessel operations described within the OMSB Information Handbook for harbour users; • DoT Oil Spill Contingency Requirements; and • Marine safety requirements.	SP Act MH Act	DoT	Q4 - 2017
Clearing of Native Vegetation	Lot 9001 on Deposited Plan 405414, which is owned under freehold title by the Shire of Ashburton. Land zoned as 'Public Purposes – Airport' (Town Planning Scheme No.7).	Native Vegetation Clearing Permit	EP Act (Part V)	DEWR	Pending outcome of S38 Referral under Part IV of the EP Act

Proposal activities	Land tenure/access	Type of approval	Legislation regulating the activity	Responsible Agency	Timeframe

Construction of DMMA and Pipeline Route Option A & B	Lot 9001 on Deposited Plan 405414, which is owned under freehold title by the Shire of Ashburton.
	Land zoned as 'Public Purposes – Airport' (Town Planning Scheme No.7).
		Landuse Agreement (Lease) with SoA, expected to include reference to compliance with:
		• Management of dredge spoil disposal described within the DSDMP, including:
		  ○ Dust management;
		  ○ Dewatering management; and
		  ○ Stormwater and site drainage management.
		SoA have acknowledged the suitability of the preferred site in a letter dated 31st July 2017 (Appendix G)
			PD Act	SoA	Q3 - 2017

		Section 18 consent to use land for a purpose which may impact an Aboriginal Heritage Site.	AH Act (Section 18)	DPLH	If required pending results of Aboriginal Heritage Survey.
Dredging Turning Basin	'Seabed' and 'Waters' are located within the Port of Onslow limits	Permit to Interfere with Bed and Banks (if Required)	RiWI Act (Section 11/17/21A)	DoW	Pending outcome of S38 Referral under Part IV of the EP Act
Dewatering - DMMA	Lot 9001 on Deposited Plan 405414, which is owned under freehold title by the Shire of Ashburton.				
Pipeline Route Option B	Waters that are located within the Port of Onslow limits; and Land zoned as 'Public Purposes – Airport' (Town Planning Scheme No.7).				

1.5.1. Maintenance Dredging

The Proposal is expected to generate a requirement for annual maintenance dredging of approximately 18,000 to 28,000 m^3 (Baird 2017). However, given that all maintenance dredging will occur within the DoT-managed Port of Onslow waters, maintenance dredging is proposed be undertaken and managed in accordance with the Seabed Lease that is currently being negotiated with the DoT (Refer to **Table 2**). It is therefore, further proposed that the environmental impact assessment and subsequent environmental management of maintenance dredging activities is to be undertaken in accordance with the existing DoT Maintenance Dredging Environmental Quality Management Framework.

2. The Proposal

2.1. Background

The Beadon Creek Maritime Facility was developed in 1964 and is managed by the DoT. The facility is used as a harbour for both recreational and commercial activities, although it has recently transformed from a small facility supporting local and charter fishing activities to a significant facility supporting the myriad of industrial and commercial activities associated with the growing offshore oil and gas industry in the region. The Beadon Creek Maritime Facility covers an area of 15.29 ha and includes ~260 m wharf face, 10 berths on mooring piles, public service wharf, dual public boat ramp, vessel diesel fuelling facilities, public car park and fish cleaning facilities (**Figure 1**).

In 2012, DoT proposed to upgrade the current facilities in Beadon Creek via the capital dredging of 65,000 m^3 of material to create a Berth Pocket to -2.6 m Chart Datum (CD) and Turning Basin to a design depth of -1.6m CD, immediately west of the existing channel (BMT Oceanica 2015). These proposed works were referred to the Environmental Protection Authority (EPA) in August 2013 and determined to be '*Not Assessed - Public Advice Given*' in April 2014 (EPA 2014).

These approved upgrade works were then undertaken by DoT in conjunction with OMSB Pty Ltd, as part of the Stage 1 of the OMSB Project. The approved OMSB Stage 1 project included construction of a 2.58 ha land-backed wharf within the existing Beadon Creek Maritime Facility and capital dredging to facilitate the development of a marine support facility (**Figure 1**). OMSB Stage 1 is now nearing completion and OMSB Pty Ltd (the Proponent) proposes to improve vessel access to the facilities as part of Stage 2 of the OMSB Project (this Proposal).

Figure 1 Existing Beadon Creek Maritime Facility (shaded blue), including existing OMSB land-backed wharf facility (OMSB Project Stage 1) footprint (shaded red) (Source: BMT Oceanica 2015)

2.2. Justification

Extensive recent growth of the resources sector in the Pilbara region, particularly the oil and gas industry, has led to increased commercial use of the Beadon Creek Maritime Facility and demand for maritime support services and industries. The Beadon Creek Maritime Facility is also regionally important for providing cyclone refuge for vessels along the Pilbara coast. The DoT recognised the requirement to upgrade and improve the facilities at Beadon Creek to cater for the increasing demand and, in mid-2010, the DoT issued an expression of interest (EOI) for the development of harbour based facilities within the Beadon Creek Maritime Facility. An area of approximately 10 ha was identified for Stage 1 development and applications were to include wharf facilities offering general supply base capability.

Also In 2014, the DoT commissioned the preparation of a Land Use Framework to ensure that future development of the Beadon Creek Maritime Facility is undertaken in line with design principles that would ensure that the Harbour is managed appropriately to meet the needs of the community and future resource projects (GHD 2014).

In 2016, OMSB Pty Ltd (the Proponent) was granted a lease to develop the waterways and landside wharf facilities at Beadon Creek. Since award of the lease, the DoT have been working closely with the Proponent to progress leasehold development within the Beadon Creek Maritime Facility. The OMSB land-backed wharf was constructed during 2016/17 and has been designed in accordance with the Land Use Framework (LUF) developed for the Beadon Creek Maritime Facility to meet the visions, principles and goals of both the SoA and the DoT to provide both social and economic opportunities for Onslow.

The OMSB facility is expected to provide a range of benefits to the community through establishing the impetus for a broad range of businesses to service the resources sector and create sustainable employment for the region. However, these benefits cannot be fully realised without widening and deepening the HAC to improve vessel access to the existing OMSB land-backed wharf facility.

2.2.1. Alternatives Considered

The purpose of the Proposal is to improve the ability of the OMSB to provide crucial marine support services to industry in the Pilbara. To provide these services effectively, the HAC must be widened and deepened to accommodate the larger vessels and increased vessel traffic to the OMSB.

Proposal Location

No alternative locations for the Proposal have been considered as it is reliant on the existing infrastructure of the OMSB land-backed wharf facility.

Channel Design Optimisation

Channel width for the HAC has been predominantly designed to comply with *Pianc Report No. 121-2014_Harbour Approach Channels Design Guidelines* (PIANC 2014), for the proposed vessels based on inner and outer channel widths for one and two-way traffic scenarios (WGA 2017).

Channel Navigation Markers

The Proponent has proposed the installation of floating (i.e. moored) channel navigation markers. Piled channel markers were considered as an alternative, although floating channel markers were considered adequate and posed a reduced risk of environmental harm (i.e. underwater noise impacts) during installation.

Dredge Return Water Pipeline Route

Two options were considered for the dredge return water pipeline route:

- Pipeline Route Option A – 450 mm diameter pipeline installed within a 50 m wide pipeline route corridor. Pipeline confined to existing tracks and road reserve. Clearing of 0.2 ha of native vegetation is expected within the pipeline corridor.
- Pipeline Route Option B – 450 mm diameter pipeline installed within a 50 m wide pipeline route corridor. Pipeline confined to Beadon Creek and intertidal flats adjacent to Beadon Creek. Clearing of <0.1 ha of native vegetation is expected within the pipeline corridor. Potential direct loss of 0.1 ha of BCH within the pipeline corridor.

Both options have been assessed in the Ecological Site Investigation (O2 Marine 2017). Preference for Option A was selected based on avoidance of disturbance and removal of intertidal BCH such as mangroves, mudflats and algal mat. Selection of this preference is in accordance with Guideline 4 for reducing the impacts of developments on mangrove habitat and ecological function of the mangroves to the minimum practicable level (EPA, 2001).

Dredge Spoil Disposal Options

A proposed offshore spoil disposal location, located ~700 m east of the proposed channel was initially considered. However, given the quality of the dredge material for use as clean fill, an opportunity to use the dredge material for future development of industrial land in Onslow was identified. Onshore disposal was also considered to present a more environmentally acceptable option as potential impacts on the EPA's factors, 'Benthic Communities and Habitat' and 'Marine Environmental Quality' were minimised.

Various locations for onshore spoil disposal were considered, however, the proposed spoil disposal location represents the area requiring the least vegetation clearing, minimal direct impacts to intertidal Benthic Communities and Habitat (i.e. Cyanobacterial algal mat communities) and minimal risk of disturbance of aboriginal heritage sites.

Both the SoA and the Department of State Development have expressed the need for fill in the proposed spoil location. In addition to the above benefits, the proposed disposal site is significantly larger than the predicted spoil volumes and will therefore provide additional area for management berms and disposal water monitoring/control.

2.3. Proposal Description

The Proposal includes the following activities:

- Capital dredging to modify and extend the existing HAC, Turning Basin and Berth Pocket within the Proposal Area;
- The development and use of a ~44 ha DMMA, located onshore;
- The release of excess dredge return water from the DMMA to the intertidal flats between the DMMA and the western tributary of Beadon Creek; and
- An increase in vessel traffic to/from the existing OMSB land-backed wharf facility.

Capital dredging proposed includes a Turning Basin and HAC to a target depth of - 6.0 m CD and a Berth Pocket to -8.0 mCD. The total volume of dredging is anticipated to be ~946,450 cubic metres and it is expected that dredging will be undertaken using a medium-sized cutter suction dredge (CSD) over a period of approximately eight (8) months. The proposed capital dredging will enable offshore supply vessels to access the newly-constructed OMSB land-backed wharf infrastructure within the Beadon Creek Maritime Facility.

Dredge material is proposed to be disposed of onshore within freehold land owned by the SoA adjacent to the Onslow airport. During dredging, the DMMA will be dewatered to the intertidal flats between the disposal site and the western tributary of Beadon Creek. In accordance with the strategic objectives of the SoA to meet the region's demand for affordable serviced industrial land, the material is proposed for future reuse to develop and extend the Light Industrial Area in Onslow.

2.3.1. Key Proposal Characteristics

Consistent with the requirements outlined within the EPA's '*Instructions on how to define the key characteristics of a Proposal*' (EPA 2016a), a summary of the Proposal is provided in **Table 3** and the key Proposal characteristics, which have the potential to impact on the environment are provided in **Table 4**.

Table 3 Summary of the Proposal

Proposal Title	Onslow Marine Support Base Stage 2: Capital Dredging
Proponent Name	OMSB Pty Ltd
Short Description	Capital dredging of 946,450 m^3 of uncontaminated sediment to extend the Beadon Creek Harbour Approach Channel, Turning Basin and Berth Pocket to enable offshore supply vessels to access the existing OMSB land-backed wharf infrastructure located within the Beadon Creek Maritime Facility. The dredging activities will require the development and use of a 44 ha Dredge Material Management Area (DMMA), located onshore, adjacent to the Onslow Airport; and the release of dredge spoil return water to the intertidal flats between the DMMA and the western tributary of Beadon Creek.

Table 4 Location and proposed extent of physical and operational elements

Element	Location	Proposed Extent
Physical Elements		
Approach Channel	Figure 2	Harbour approach channel (HAC) dredge area of 32 ha, with a target depth of -6.0 m CD, width of 55 metres (m) and length of 2 km. Direct removal of 21 ha of nearshore subtidal benthic communities and habitat (BCH) from within the HAC dredge area.
Turning Basin	Figure 2	Turning basin dredge area of 2 ha, with a target depth of -6.0 m CD and a diameter of 143 m.
Berth Pocket	Figure 2	Berth pocket dredge area of 3 ha, with a target depth of -8.0 m CD.
Dredge Material Management Area (DMMA)	Figure 2	Onshore spoil disposal area of 44 ha. Clearing of no more than 15.5 ha of native vegetation within the onshore spoil disposal area.
Channel Navigation Markers	Unspecified.	Floating (i.e. moored) channel navigation markers (approximately 15) will be installed within the development areas as required. No removal of BCH is required.
Dredge Material Disposal Pipeline	Figure 2	450 mm diameter pipeline installed within a 50 m wide pipeline route corridor. Pipeline confined to existing tracks and road reserve. Clearing of up to 0.3 ha of native vegetation is expected within the pipeline corridor.
Operational Elements		
Capital Dredging – Approach Channel	Figure 2	Capital dredging of 773,500 m^3 of marine sediment from within the harbour approach channel dredge area to target depth of -6.0 m CD.

Element	Location	Proposed Extent
Capital Dredging – Turning Basin	Figure 2	Capital dredging of 71,800 m^3 of marine sediment from within the Turning Basin dredge area to target depth of -6.0 m CD.
Capital Dredging – Berth Pocket	Figure 2	Capital dredging of 101,150 m^3 of marine sediment from within the Berth Pocket dredge area to target depth of -8.0 m CD.
Dredge Material Disposal Pipeline	Figure 2	Temporary installation of 450 mm diameter onshore pipeline and booster stations within the pipeline corridor to transport dredge material from floating pipeline to DMMA.
Onshore Spoil Disposal to DMMA	Figure 2	Disposal of approximately 946,450 m^3 of clean, uncontaminated marine sediment to the DMMA.
Onshore Spoil Disposal Dewatering	Figure 2	Controlled discharge of approximately 21 megalitres (ML) per day of dredge spoil return water to the adjacent intertidal catchment of Beadon Creek.
Channel Navigation Markers	Unspecified	Floating (i.e. moored) channel navigation markers will be installed within the development areas as required.
Vessel Operations	Figure 2	Increase in vessel traffic up to approximately 700 vessels per annum to/from the existing OMSB land-backed wharf within the Beadon Creek Maritime Facility, via the HAC, Turning Basin and Berth Pocket.

The construction and operational elements of the Proposal are discussed in more detail in **Section 2.3.2** and **Section 2.3.3**, respectively. Other activities that may be considered as associated with the OMSB Project (i.e. including Stage 1), but are not being referred as part of this Proposal are identified in **Section 2.3.4**.

Figure 2 OMSB Stage 2 Proposal Area, including proposed capital dredging area and spoil disposal location

2.3.2. Proposal Construction Elements

Scope of Construction Work

The scope and sequencing of the construction elements of the Proposal includes:

1. Mobilisation and installation of a dedicated CSD;
2. Mobilisation and Installation of all pipeline (floating and land based) including required booster stations to discharge all of the dredged materials in the DMMA;
3. Preparation of the DMMA;
4. Dredging of the Berth Pocket and discharging of dredged materials to the DMMA;
5. Dredging of the Turning Basin and discharging of dredged materials to the DMMA;
6. Dredging of the HAC and discharging of dredged materials to the DMMA;
7. Dredged materials handling at the DMMA as required;
8. Dredge return water discharge from the DMMA to the adjacent Beadon Creek intertidal area as required;
9. Pre- and post-dredge hydrographic Survey(s); and
10. Demobilisation and site clearance upon completion of the works.

Preliminary Construction Schedule

Under the current proposed schedule, dredging construction activities are planned to commence in Quarter 4, 2017 once all required internal and external approvals are granted. Dredging and onshore spoil disposal is proposed to occur 24 hours per day, 7 days per week for approximately eight months.

Site Facility

The area which is intended for use for site facilities and lay-down is located south of the Beadon Creek Road and west of the current DoT facilities, pending confirmation from the SoA.

The Lay-Down area will need to provide sufficient storage space to store site containers with spare parts, pipeline(s), booster station(s), etc. A basic site office with relevant amenities will be set-up. This site office will contain all the requirements under the contract as well as the superintendent's office (if required). A base station for survey will also be installed here to ensure the accuracy of works.

No clearing of native vegetation is required for use of, or access to this location.

Pipeline Installation (Floating)

The floating pipeline will run from the rear of the dredge to the shore connection. Floating booster station(s) will be added to the line when the pumping distance for the dredge becomes too long. The floating pipeline will be supported by flotation devices in order to maintain sufficient buoyancy and visibility at all times. Further information is provided in the DRAFT Dredging and Spoil Disposal Management Plan (DRAFT DSDMP) (**Appendix E**).

Pipeline Installation (Land)

The shore pipeline will have a fixed route from the shore connection towards the start of the DMMA. For pipeline route option A, there are a couple of road crossings (over and under-passes) identified, including the major crossing with Beadon Creek Road and the Discovery Park Crossing.

During discharge operations, additional lengths of pipeline will be added as the site progresses in size. On-Shore booster station(s) will have to be placed at strategic locations. Further information is provided in the DRAFT DSDMP (**Appendix E**).

For pipeline route option A, the pipeline will primarily be confined to existing tracks, roadside reserve and cleared areas. However, potential clearing of <0.2 ha native vegetation is expected (Refer to **Section 4.6**).

For pipeline route option B, the pipeline will primarily be confined to the intertidal flats adjacent to the western tributary of Beadon Creek. However, potential clearing of <0.1 ha native vegetation and potential direct impact on 0.1 ha BCH is expected. (Refer to **Section 4.2**).

Medium-sized Cutter Suction Dredge

A medium-sized CSD (**Figure 3**) is proposed to be used for the Proposal with the following indicative specifications:

- Production Rate: 3,000m^3/hr;
- Maximum dredging depth: 8-12m;
- Installed power: ~1000kw; and
- Discharge pipeline diameter: 450mm.

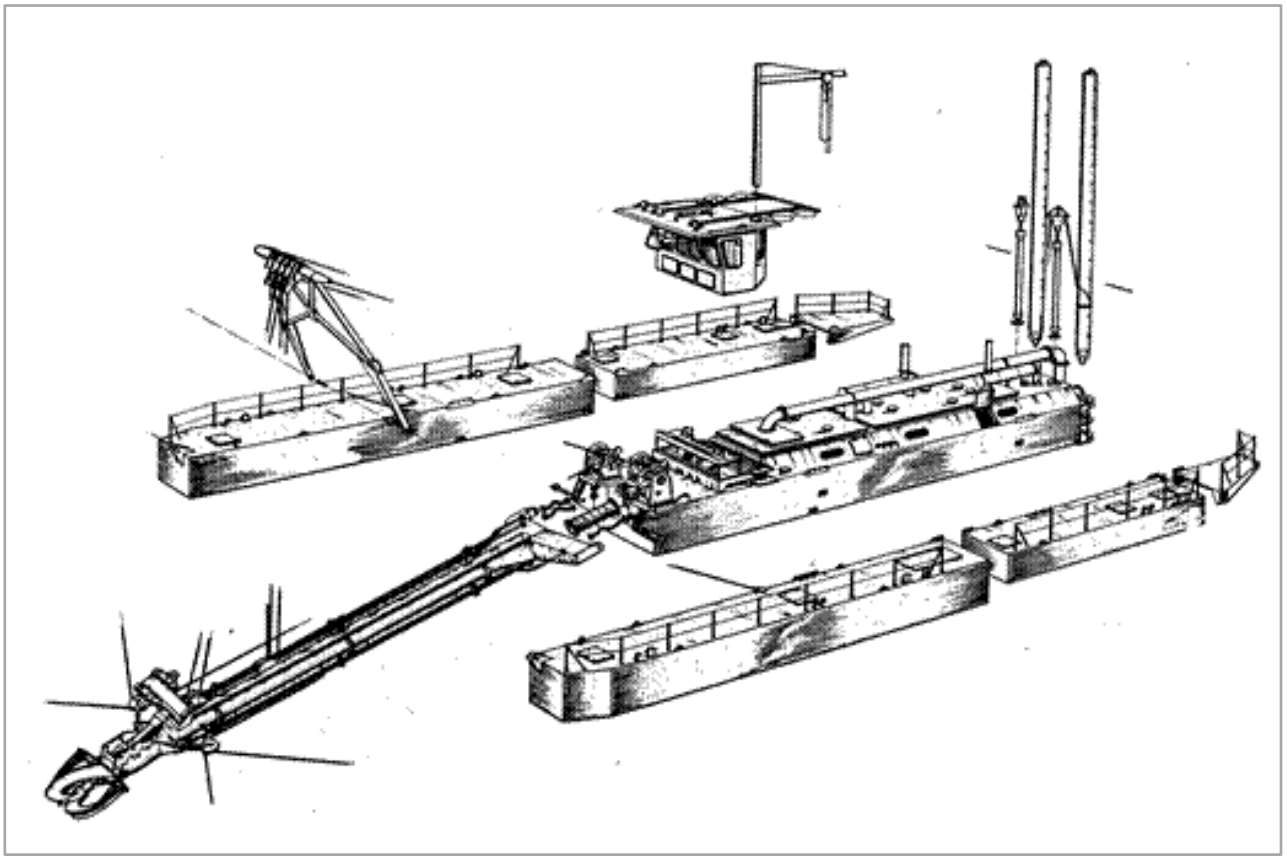


Figure 3 Typical Cutter Suction Dredge

In general, a CSD is a stationary dredge and consists of a U-shaped pontoon, which is held in position by a fixed spud and two anchors. The soil is loosened by rotating a cutting head (the "cutter").

During the dredging activities, the CSD swings around the main spud with the help of its side winches. The operation of the cutter section consists of cutting the seabed with the cutter head and pumping the mixture of water and materials by means of the centrifugal pump into the suction mouth. After loosening and suction, the soil is pumped to the allocated discharge location through a floating and/or submersed pipeline which is connected to the rear end of the CSD.

To enable the dredged materials to be transported hydraulically over a length of approximately 6-7 km and to generate a constant flow of material in the pipeline, several[1] booster stations will be installed at various onshore locations. The total length of the pipeline, the diameter of the pipeline, the constitution of the material transported – friction losses – and the capacity of the CSD determine the capacity and locations of the required booster stations.

Onshore Dredge Spoil Disposal

The dredged material will be transported through a series of pipelines and booster stations, ultimately to the DMMA. The dredged materials will be pumped in a controlled and sequenced manner into the respective sections of the DMMA. Filling will progress from the point of discharge (i.e. the outlet of the dredging discharge pipe). Controlling and managing the filling process will be achieved by monitoring and spreading the fill material using earthmoving equipment such as bulldozers and hydraulic excavators in combination with weir boxes. Further details regarding proposed dredge material management is provided in the DRAFT DSDMP (**Appendix E**).

Navigational Markers

Up to 15 floating (i.e. moored) navigational markers are proposed to be installed as required to mark the location of the HAC and Turning Basin. Where possible, navigational aids will be selected to match the style of existing Beadon Creek navigational aids. No piling is required for installation of the moorings. The mooring footprint will be <5 m^2, therefore no impacts to BCH have been predicted as a result of this activity.

2.3.3. Proposal Operational Elements

Widening and deepening of the HAC will enable the OMSB land-backed wharf facility to receive approximately 700 vessels per annum. The OMSB facility and HAC has been designed to service the following vessel classes:

- Anchor Handling;
- Barge/Cargo;
- Diving;
- Heavy Load;
- Landing Craft Tank;
- Offshore Supply;
- Research/Survey; and
- Tug.

The commercial operation and industry use of the OMSB including the HAC, waterway access arrangements, priority allocation, arrival/approval processes and facility user charges are managed by the DoT appointed Port of Onslow Port Captain and coordinated through the OMSB Information Handbook (OMSB Pty Ltd 2016).

2.3.4. Exclusions

The scope of the Proposal that is subject to assessment under Part IV of the EP Act excludes:

- Construction of the OMSB land-backed wharf facility (Refer below);
- All operations of the existing OMSB land-backed wharf facility (Refer below), including:
    - Facility lighting;
    - Vessel berthing and mooring;
    - Vessel loading/unloading; and

[1] Required number of booster stations will be defined by appointed contractor.

- Vessel refuelling.
- Provision of a sullage or waste reception facility for vessels utilising the OMSB;
- Future land development, utilising the dredge material that is to be disposed of at the DMMA as clean fill;
- Future Maintenance dredging (Refer below); and
- Vessel operations within the Port of Onslow Waters, but outside of the HAC.

Construction of OMSB Land-backed Wharf Facility

Construction of the OMSB Land-backed wharf facility (Stage 1) was referred to the EPA in August 2013 and determined to be *'Not Assessed - Public Advice Given*' in April 2014 (EPA 2014). All construction elements of the land-backed wharf facility are therefore excluded from this referral.

Operation of OMSB Land-backed Wharf Facility

Operational management requirements of the OMSB Land-backed wharf facility (Stage 1) are described within an existing Lease agreement between the Proponent and the DoT. All operational elements of the OMSB land-backed wharf facility are therefore excluded from this referral.

Future Maintenance Dredging

Sediment transport modelling of the proposed HAC design, indicates that the Proposal is expected to generate a requirement for annual maintenance dredging of approximately 18,000 to 28,000 m^3 (Baird 2017). Further details regarding the specific maintenance dredging requirements are provided in regards to the environmental factor 'Coastal Processes' in **Section 4.3**.

Maintenance dredging is proposed to occur annually, or as required to maintain safe navigable channel depths. The maintenance dredge material is proposed to be disposed of along the eastern shoreline to maintain the existing longshore sediment transport processes and prevent erosion of the eastern shore.

The Proponent has made provision, both financially and operationally, to undertake maintenance dredging of the OMSB, including Berth Pockets, Turning Basin and HAC as required to maintain safe navigable depths. This provision is proposed to be a requirement of the Seabed Lease agreement that is currently being negotiated between DoT and the Proponent. Given that all maintenance dredging will occur within the DoT-managed Port of Onslow waters, maintenance dredging is proposed be undertaken and managed in accordance with the Seabed Lease agreement with the DoT. Environmental impact assessment and subsequent environmental management of maintenance dredging activities is therefore proposed to be undertaken in accordance with the existing DoT Maintenance Dredging Environmental Quality Management Framework (EQMF).

Although not being referred as a specific activity of this Proposal, the future maintenance dredging requirements are identified and discussed in consideration of the environmental factors 'Benthic Communities and Habitat' and 'Coastal Processes' in **Section 4.2** and **4.3**, respectively.

2.4. Local and Regional Context

2.4.1. Locality

The Proposal is situated within and adjacent to the town of Onslow, located in the SoA, in the Pilbara region of WA (**Figure 4**). The area around Onslow is the traditional home to the Thalanyji People.

The township of Onslow was originally founded in 1883 and gazetted in 1885, as a port at the mouth of the Ashburton River, which was developed as a commercial marine industry with basic shipping activities to

support inland wool-growing and gold mining, which continued to be major industries for 80 years. Cattle farming has since replaced sheep running as the predominant inland agricultural enterprise.

In the early settlement days, Onslow became a home port for pearling luggers, which operated in the nearby Exmouth Gulf. Due to repeated cyclone damage and the flooding/silting of the Ashburton River, the townsite was moved in 1925 to its current location, 18 km northeast of Old Onslow, to take advantage of the deeper waters of Beadon Creek. Since then, the port function has developed to support growth in the fishing and resource sectors and more recently the exploitation of offshore oil and gas reserves.

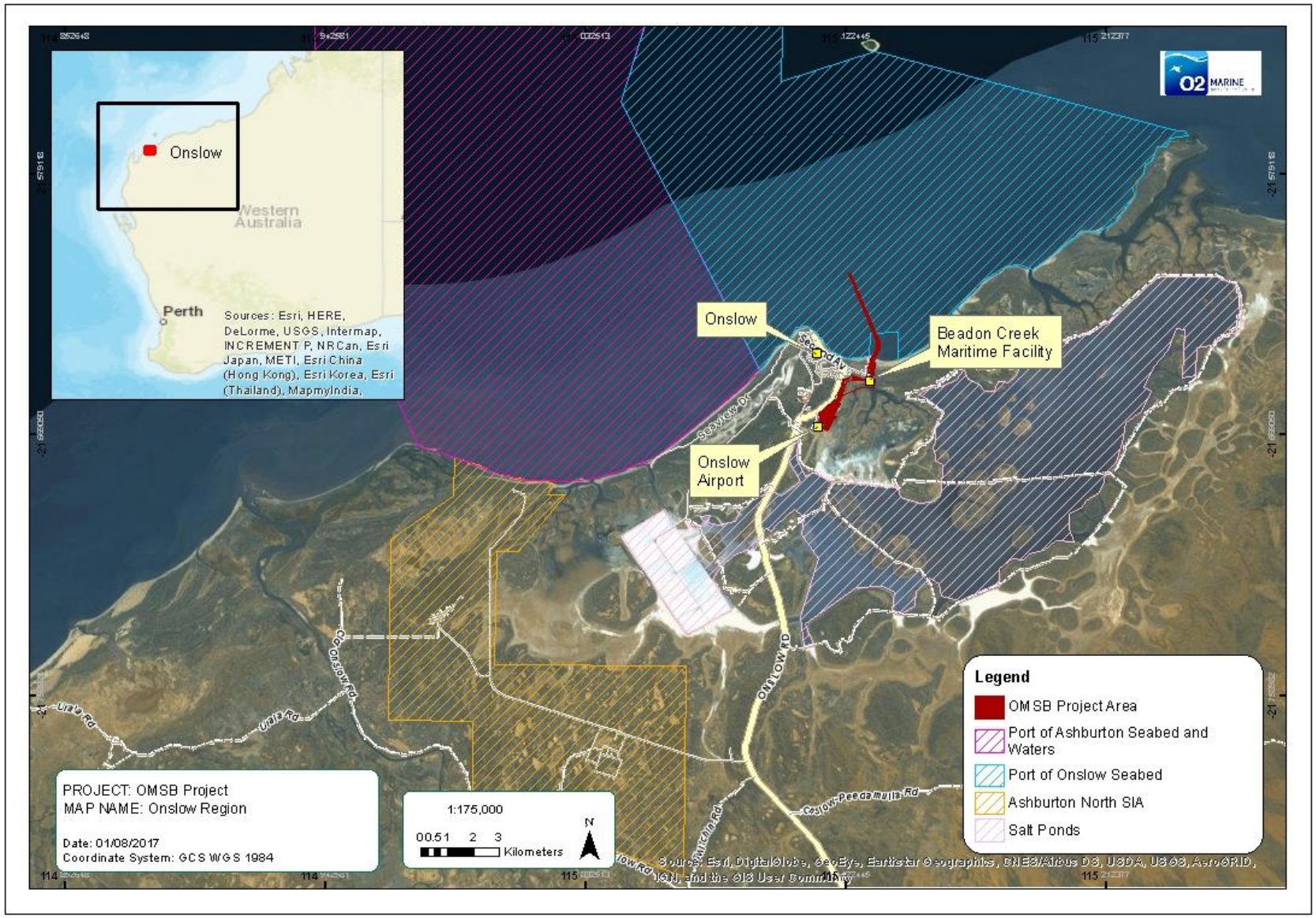


Figure 4 Proposal location local and regional context

2.4.2. Other Regional Developments

The township of Onslow is ideally located to service offshore locations including the Mackerel Islands, Barrow Island (Gorgon LNG Plant), Exmouth Gulf, and the Carnarvon Basin (oil and gas reserves) as well as in-land mines including Rio Tinto's Mesa A site and Pannawonica. However, the broader Proposal Area is largely undeveloped, except for:

- The Onslow Salt solar salt field, encompassing a large area of salt flats surrounding the Beadon Creek tidal embayment to Coolgra Point;
- The Roller oilfield in shallow coastal waters to the west of Onslow;
- The Liquified Natural Gas (LNG) plants, Wheatstone (Chevron) and Macedon (BHP) located approximately 12 km southwest of Onslow, within the Ashburton North Strategic Industrial Area (ANSIA);
- The Port of Ashburton: a multiuser port providing support for the Macedon and Wheatstone Projects LNG developments and other planned industrial activities in the area;
- Offshore loadout facilities for the Onslow Salt Facility located to the west of Onslow in the Port of Onslow. The Port of Ashburton and the Port of Onslow share a common port boundary; and
- The Onslow airport is owned and operated by the SoA and is located approximately three kilometres south of the Onslow town site. The airport underwent significant upgrades in 2015 to cater for the construction of the Macedon and Wheatstone Projects.

2.4.3. Environmental Assets

Other than protected or conservation significant species which may occur in the Proposal Area, there are no State or Commonwealth listed environmental assets located near the Proposal.

3. Stakeholder Consultation

3.1. Key Stakeholders

OMSB has been working with the key Proposal stakeholders to advance the Proposal for the past three years. Key stakeholders include:

- Beadon Creek Maritime Facility Users, including:
  - Bhagwan Marine;
  - Chevron Australia;
  - Eco Tours and Mackerel Island Group;
  - Total AMS;
  - Onslow Salt;
- Department of Biodiversity Conservation and Attractions (DBCA);
- Department of Primary Industries and Regional Development (DPIRD);
- Department of Transport (DoT);
- Department of State Development (DSD);
- Department of Water and Environment Regulation (DWER);
- Discovery Parks;
- Onslow Chamber of Commerce and Industry (OCCI);
- Pilbara Ports Authority (PPA);
- Shire of Ashburton (SoA);
- Thalanyji people as Traditional Owners (i.e. represented by Mr Brian Hayes); and
- Western Australian Fisheries Industry Council (WAFIC) (i.e. representing local commercial fishing licence holders).

3.2. Stakeholder Consultation

Engagement with key stakeholders involved a combination of face to face meetings, exchange of emails and provision of a comprehensive stakeholder memorandum which included an overview of the Proposal and summary of the potential environmental impacts and proposed management and mitigation.

In addition to face to face meetings, feedback was also provided via email, letter or completion of an O2 Marine stakeholder feedback form, which was included as an attachment to the stakeholder memorandum. All stakeholder feedback forms and emails are included in **Appendix F**. A letter of acknowledgement from the Shire of Ashburton is included in **Appendix G**. Comments compiled by WAFIC on behalf of the commercial fishing sector are provided in **Appendix H**.

The outcomes of stakeholder consultation that relate to assessment of the Proposal in accordance with Part IV of the EP Act are summarised in **Table 5**. Other unrelated comments that were raised by key stakeholders are being addressed by the Proponent directly with those stakeholders.

Table 5 Stakeholder consultation outcomes summary

Stakeholder	Date	Issues/Topics Raised[2]	Proponent Response/Outcome
DBCA	15/06/2017 Stakeholder Memo	Consider potential impacts on conservation significant marine species and migratory birds.	Potential impacts on conservation significant marine fauna species are discussed in Section 4.5 and Appendix B. Potential impacts on migratory birds are discussed in Section 5; Table 16 and Appendix B.
		Include monitoring, reporting and management commitments to minimise and avoid potential impacts to conservation significant marine species.	Specific management and mitigation objectives, actions and reporting to avoid impacts to conservation significant species are described in the DRAFT DSDMP (Appendix E).
DPIRD	15/06/2017 Stakeholder Memo Sawfish Impacts Report	Consider potential impacts on commercial fishers.	Consultation with commercial fishers undertaken by WAFIC (Appendix G). Potential impacts on commercially significant fish species are discussed in Section 4.5.
		Consider potential impacts on Sawfish. Note – Based on assessment of the information supplied, DPIRD do not consider the proposal would have significant potential impacts on Sawfish species.	Potential impacts on sawfish species are discussed in Section 4.5 and Appendix B.
		Consider and address biosecurity risks during dredging and future vessel operations.	Potential impacts on biosecurity are discussed in relation the EPA's factor 'Marine Fauna', which is discussed in Section 4.5 and Appendix B. Proposed activities for management of biosecurity risks are described in Section 4.5.6 and in the DRAFT DSDMP (Appendix E).
DSD	15/06/2017	Consider dust management strategies for the DMMA, particularly following completion of dewatering activities.	Potential dust-related impacts on the EPA's factor 'Air Quality' are discussed in Section 5; Table 16. Dust management strategies are further described in the DRAFT DSDMP (Appendix E).
DoT	15/06/2017 Stakeholder Memo Shoreline Impacts Report (Baird 2017)	Consider potential impacts to coastal processes including: • Altered hydrodynamics; • Altered sediment transport; • Sedimentation (i.e. volumes/location); • Cyclone influence on developed case; • Threat to existing infrastructure (i.e. training wall); and	Potential impacts on EPA's factor 'Coastal Processes' are discussed in Section 4.3 and Appendix C. It is noted that potential impacts of the Proposal on existing DoT coastal infrastructure are being investigated further in consultation with DoT.

[2] Key issues/topics raised by key stakeholders have been paraphrased for inclusion in Table 5. Complete records of stakeholder comments are included in Appendix F.

Stakeholder	Date	Issues/Topics Raised[2]	Proponent Response/Outcome
	Sediment Quality Assessment (O2 Marine 2017b)	• Shoreline erosion.	
		Provide a copy of the Environmental risk assessment undertaken for the Proposal with the Referral.	ENVID workshop summary is provided in Appendix A.
		Consider impacts on key stakeholders, including other Beadon Creek Maritime Facility users.	Feedback from key stakeholders that is relevant to assessment of the Proposal in accordance with Part IV of the EP Act is presented in this Table. Any other matters/concerns raised by key stakeholders are being addressed directly with those stakeholders.
		Consider potential future maintenance dredging requirements.	Maintenance dredging requirements are identified and discussed in relation to the EPA's factor 'Coastal Processes' in Section 4.3 and Appendix C. Process for regulation and implementation of future maintenance dredging requirements is described in Section 1.5.1.
		Consider ongoing management and monitoring requirements for the operational aspects of the Proposal.	Operational mitigation measures are described where relevant for each of the EPA's environmental factors identified in Section 4 and Section 5. Maintenance and monitoring requirements in relation to coastal processes and OMSB infrastructure, including the dredged areas are expected to be described in the Seabed Lease that is currently being negotiated with DoT.
		Consider potential impacts from dredge plumes.	Potential impacts from dredge plumes are discussed in relation the EPA's factor 'BCH' in Section 4.2 and Appendix B and 'Marine Environmental Quality' in Section 4.4.
		Sediment quality assessment is limited to the upper layers of the dredge material.	The O2 Marine (2017) sediment quality investigation report is provided in Appendix D. This report documents the sediment sampling that was undertaken to assess the sediment quality of the proposed dredge spoil to determine the suitability of the material for onshore disposal. The sampling was undertaken in accordance with relevant guidelines (i.e. DER 2014, NAGD 2009, NEPM 2013 & DER 2015) and as such is considered sufficient to characterise the quality of the sediment and the suitability of the material for onshore disposal. In regards to the depth of sampling, it is noted that the preliminary site investigation presented in O2 Marine (2017) identified that sources of anthropogenic contamination would be limited to surface sediments of the proposed capital dredge material. Therefore in accordance with DER (2014) and NAGD (2009), the number and depth of sample locations were focussed on the volume of surface sediments which *could* be contaminated, but does not include

Stakeholder	Date	Issues/Topics Raised[2]	Proponent Response/Outcome
			the volume of underlying natural geological materials which are, except for the surface 1 m of sediment, expected to be uncontaminated.
		Consider volume of fines within dredge material and the process for management of fines in the DMMA to minimise potential sedimentation impacts from tail water discharge to Beadon Creek.	Classification of the physical characteristics of the proposed dredge material is provided in the DRAFT DSDMP (Appendix E) based on sampling undertaken by CHM2HILL (2014), O2 Marine (2017) and GALT (2017). The geotechnical investigation undertaken by GALT included a review of the previous sampling and a classification of the fines content that could reasonably be expected to be encountered during the dredging. This information was used to inform the development of a Dredge Material Management Strategy, which is included in the DRAFT DSDMP. The design and proposed operation of the DMMA is considered appropriate to ensure that sufficient residence time is achieved to allow for fines to settle out prior to discharge of dredge tail water. This process is described in the DRAFT DSDMP (Appendix E).
		Confirm scope of sediment quality investigation report is to assess sediment quality and does not extend to assessment of the suitability of the dredge material for future reuse.	The scope of the O2 Marine (2017) sediment quality investigation is to determine the quality of dredge material and the suitability of the material for onshore disposal and does not extend to assessment of the material for potential reuse.
		Consider the sediment quality of the disposal site.	Potential impacts associated with terrestrial environmental quality are discussed in Section 5; Table 16. Although it is noted that the disposal site is primarily located on limestone rock that will not be disturbed.
DWER	13/11/2015 Initial Pre-referral Meeting	Include piling works as a key characteristic of the Proposal.	Piling is no longer required as a part of the Proposal and so has not been included as a key characteristic of the Proposal.
		Include coastal processes as a factor.	Potential impacts on the EPA's factor 'Coastal Processes' are discussed in Section 4.4.
		Confirm that erosion will not be an issue on the eastern bank of the creek.	Potential impacts on the eastern bank of Beadon Creek are discussed in Section 4.4.
		Consider potential impacts on sawfish and consult with DoF (now DPIRD) regarding these impacts.	Potential impacts on Sawfish are discussed in Section 4.5. Outcomes of consultation with DoF (now DPIRD) are presented in this Table.
		Consult with DoF (Now DPIRD) regarding commercial fishers operating in the area.	Consultation with commercial fishers undertaken by WAFIC (Appendix G). Potential impacts on commercially significant fish species are discussed in Section 4.5.
		Clarify that this Proposal does not include sullage or a waste reception facility for vessels.	The Proposal does not include sullage or a waste reception facility for vessels. Proposal exclusions are identified Section 2.3.4.

Stakeholder	Date	Issues/Topics Raised[2]	Proponent Response/Outcome
		Consider cumulative impacts on BCH.	Potential cumulative impacts on BCH are discussed in Section 4.2.
		Consider Acid sulphate soils (ASS) when characterising the dredge material.	Potential impacts associated with ASS of the dredge material are discussed in Section 4.4.
		Consider the dredging timeline in terms of effects on environmental receptors and key stakeholders.	Commitments in relation to dredging schedule are dependent on timeline for approvals.
		Reference maintenance dredging requirements and how this may be handled through a common user group for the facility.	Maintenance dredging requirements are identified and discussed in relation to the EPA's factor 'Coastal Processes' in Section 4.3. Process for regulation and implementation of future maintenance dredging requirements is described in Section 1.5.1.
	27/06/2017 2nd Pre-referral Meeting	Identify decision-making authorities and any additional approvals.	DMAs and additional approvals are identified in Section 1.5; Table 2.
		Consider providing a management plan with the referral supporting documents.	DRAFT DSDMP is provided in Appendix E.
		Consider WAMSI findings in evaluating impacts to seagrass.	Potential impacts to Seagrass are discussed in Section 4.2 and Appendix B.
		Consider potential impacts on industrial water supply (i.e. Onslow Salt requirements)	Potential impacts on industrial water supply are discussed in relation to the EPA's factor 'Marine Environmental Quality' in Section 4.4. Specific management commitments to maintain water quality to meet Onslow Salt's industrial water supply criteria are described in the DRAFT DSDMP (Appendix E).
		Describe the Level of Ecological Protection that will be achieved downstream from the tail water discharge.	Potential impacts on water quality in Beadon Creek are discussed in relation to the EPA's factor 'Marine Environmental Quality' in Section 4.4. Potential impacts are discussed in the context of the existing Environmental Quality Plan for Beadon Creek.
		Consider mechanisms to promote open, transparent reporting of environmental performance on the Proposal.	Proponent has proposed an open and transparent method of reporting environmental performance on the Proposal to key stakeholders through engagement with the Port of Ashburton Technical Advisory and Consultative Committee (TACC) for dredging. Proposed approach is outlined in Section 3.3.1.
Eco Tours and Mackerel Island Group	15/06/2017 Stakeholder Memo	Consider potential impacts on Direction Island, including noise, turbidity, visual amenity.	No impacts are predicted on Direction Island.
		Consider potential impacts (i.e. delays) on vessels transferring guests to/from Direction Island.	A description of the proposed vessels and likely vessel frequency is provided in Section 2.3.3.

Stakeholder	Date	Issues/Topics Raised[2]	Proponent Response/Outcome
			Potential impacts on the EPA's factor 'Social Surroundings' are discussed in Section 5; Table 16.
Onslow Salt	15/06/2017 Stakeholder Memo	Consider impacts on turbidity and sedimentation in the upstream areas of Beadon Creek, including in the vicinity of Onslow Salt's seawater intake in Beadon Creek.	Potential turbidity impacts on the EPA's factor 'Marine Environmental Quality' are discussed in Section 4.4. Potential sedimentation impacts on the EPA's factor 'Coastal Processes' are discussed in Section 4.4. Specific management commitments to maintain water quality to meet Onslow Salt's industrial water supply criteria are described in the DRAFT DSDMP (Appendix E).
		Consider impacts to Mangroves in Beadon Creek. Onslow Salt is required to monitor mangroves in the vicinity of the Proposal Area.	Potential impacts on BCH, including mangroves are discussed in Section 4.4.
PPA	15/06/2017 Stakeholder Memo	Identify maintenance dredging requirements and consider impact on coastal processes.	Maintenance dredging requirements are identified and discussed in Section 4.4. Potential impacts on the EPA's factor 'Coastal Processes' are discussed in Section 4.4. Environmental management of future maintenance dredging is proposed to be managed in accordance with the DoT's existing EQMF for maintenance dredging.
		Consider potential impacts upon migratory bird species which may be attracted to the DMMA.	Potential impacts on the EPA's factor 'Marine Fauna' including migratory are discussed in Section 4.5 and Appendix B. Specific management commitments to mitigate potential impacts on migratory birds are described in the DRAFT DSDMP (Appendix E).
		Consider and address biosecurity risks associated with future vessel operations.	Potential impacts on biosecurity are discussed in relation the EPA's factor 'Marine Fauna', which is discussed in Section 4.5 and Appendix B. Proposed activities for management of biosecurity risks during future vessel operations are described in Section 4.5.6.
		Consider the Commonwealth Marine Bioregional Plan for the North West and the Marine Turtles Draft Recovery Plan.	These Plans were considered in discussing potential impacts and proposed management in relation the EPA's factor 'Marine Fauna', which is discussed in Section 4.5 and Appendix B.
SoA	15/06/2017 Stakeholder Memo & Letter of Acknowledgement	Provide evidence of the quality of the dredge material to be disposed on Shire-owned land.	Quality of the sediment to be disposed at the DMMA is discussed in Section 4.4 and Appendix D. Classification of the physical characteristics of the proposed dredge material is provided in the DRAFT DSDMP (Appendix E) based on sampling undertaken by

Stakeholder	Date	Issues/Topics Raised[2]	Proponent Response/Outcome
	(Dated: 31st July 2017)		CHM2HILL (2014), O2 Marine (2017) and GALT (2017). This information will be provided to inform the development application to be submitted to the SoA.
		Consider impacts on surface water hydrology and site drainage.	Potential surface water impacts on the EPA's factor 'Hydrological Processes' are discussed briefly in Section 5; Table 16. A Site Drainage Assessment is proposed to support SoA Development Application.
		Consider flora and fauna impacts regarding clearing of the disposal site.	Potential impacts on terrestrial flora are summarised in Section 4.6 and discussed in detail in Appendix B. Additional detailed conservation significant botanical surveys completed October 2017, with summary report provided in Appendix B. Potential impacts on terrestrial fauna are summarised in Section 5; Table 16 and discussed in detail in Appendix B.
		Consider potential impacts on the groundwater table at the disposal site.	The disposal site is predominantly located on limestone rock and interactions with the groundwater at the disposal site are not proposed. In general, the disposal discharge water will hold lower salinity (37-50 ppt) than the groundwater (200 ppt) and accordingly any change to the groundwater because of unplanned interaction (i.e. leachate) is not likely to be deleterious.
		Consider potential impacts relating to changes in salinity levels in Beadon Creek	Potential changes to salinity levels in Beadon Creek are discussed in Section 4.4.
		Include proposed dust management measures for the disposal site.	Potential dust-related impacts on the EPA's factor 'Air Quality' are discussed in Section 5; Table 16. Dust management strategies during construction are described in the DRAFT DSDMP (Appendix E). A Post-Construction Dust Management Plan is proposed to support SoA Development Application.
WAFIC	29/06/2017 Stakeholder Memo	Concern expressed from the Marine Aquarium Fish sector re turbidity etcetera impacting holding areas.	Increased turbidity within Beadon Creek and in the immediate vicinity of the proposed HAC dredging area is expected. The extent of the Zones of influence and impact are presented and discussed in Section 4.2 and Appendix B.
		Concern expressed from the Marine Aquarium Fish sector re impact of dredging on their ability to collect fish.	Dredging is proposed to occur in areas where suitable habitat for marine aquarium fish is marginal (i.e. Dredge impacts are not expected on coral reefs or islands in clearer waters further offshore). Zones of high and moderate impact from dredging are discussed in relation to potential impacts on BCH in Section 4.2 and Appendix B.

Stakeholder	Date	Issues/Topics Raised[2]	Proponent Response/Outcome
		Request from the Aquarium Specimen Collectors Association of Western Australia that the start and approximate finish dates of the outer 4 month dredging program be confirmed well in advance of this activity so licence holders can endeavour to work around the dredging schedule.	The Proponent is committed to ongoing consultation with WAFIC and the commercial fishing licence holders. As soon as the dredging schedule has been confirmed these stakeholders will be notified.
		Request from the Aquarium Specimen Collectors Association of Western Australia that O2 Marine provide a minimum 2 months' notice of the commencement of the outer / ocean-side dredging.	Where possible, the Proponent will provide two months' notice to commercial fishing licence holders prior to the commencement of dredging the HAC.
		Requests from other fishery licence holders to be advised of the project commencement and completion dates.	
		Multiple fishers have identified the end of October / early November through to late April as the best window of opportunity for the outer / ocean-side dredging component of this project.	The proposed dredging schedule is dependent on numerous factors and as such the Proponent is unable to commit to specific timing for the proposed works. However, the Proponent will consider the WAFIC request and accommodate this request where possible.
		To minimise the potential impact of the Proposal on the commercial fishing Sector WAFIC requests that Dredging of the HAC occur between Late October 2017 and April 2018.	

3.3. Ongoing Stakeholder Consultation

The Proponent has committed to further ongoing consultation with all key stakeholders as the project progresses. One of the primary mechanisms for undertaking this consultation is through OMSB membership on the Port of Ashburton Technical Advisory and Consultative Committee (TACC). Further information regarding proposed consultation through TACC is described below.

3.3.1. Dredging Technical Advisory and Consultative Committee (TACC)

A TACC was established by PPA for the Port of Ashburton in early 2017 to support the implementation of effective, transparent and timely engagement with stakeholders who may have an interest or be affected by dredging programs within the PPA-managed Port of Ashburton (Located adjacent to the Proposal Area).

The TACC meets approximately twice per annum (i.e. April and October) or more frequently as required, such as during dredging campaigns. The TACC typically includes representation from:

- Chevron Australia;
- DoEE;
- DBCA;
- DPIRD;
- DoT;
- DSD;
- DWER;
- OCCI;
- OMSB;
- Onslow Salt;
- PPA; and
- Thalanyji people as Traditional Owners (represented by Buurabalayji Thalanyji Aboriginal Corporation).

In addition to the above stakeholders, the Chair may invite specialist consultants to attend meetings and provide input to the TACC on specific issues. Advice may also be sought from specialist consultants through the Chair outside TACC meetings.

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

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

Although not identified as a decision-making authority for the Proposal, the PPA invited the Proponent to participate as a Member of the TACC during the dredging phase of the Proposal. The primary aim of

engagement through the TACC regarding the OMSB Stage 2 Proposal is to enable open and transparent reporting of environmental performance against the management commitments made within the DRAFT DSDMP. It is also envisaged that the TACC will offer independent advice to the Proponent regarding effective implementation of the environmental management commitments made within the DRAFT DSDMP.

Given the TACC is already established in the region, and includes representation from most key stakeholders of the Proposal, this opportunity is considered to provide significant confidence to key stakeholders (including DWER), that the Proponent is committed to achieving a high standard of environmental management and performance during implementation of the project.

Specific timing and format for reporting commitments to the TACC are described within the DRAFT DSDMP (**Appendix E**). General information regarding the role and scope of TACC is provided in the TACC Terms of Reference, which is also included in the DRAFT DSDMP (**Appendix E**).

4. Environmental Principles and Factors

4.1. Principles

A summary of how the EP Act principles have been considered in relation to the Proposal is presented in **Table 6**.

Table 6 EP Act Principles

Principle	Consideration
1. 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 application of this precautionary principle, decisions 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.*	An ENVID workshop was undertaken to identify and consider all environmental risks of the Proposal. This enabled the Project Team (including DoT) to identify key risks, information gaps, monitoring and management requirements and to consider any appropriate alternatives to those aspects of the Proposal that posed the most significant environmental risks. The ENVID outcomes are presented in Appendix A.
2. The principle of intergenerational equity *The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.*	The Proponent considers that the Proposal is unlikely to result in any significant environmental impacts that would pose a threat to the health, diversity and productivity of the environment. The Proposal also provides hundreds of local jobs in the Town of Onslow, resulting in enhancement of the local economy and a more sustainable future for the Town.
3. The principle of the conservation of biological diversity and ecological integrity *Conservation of biological diversity and ecological integrity should be a fundamental consideration.*	The potential impacts of the Proposal activities on the conservation of biological diversity and ecological integrity has been considered and discussed in relation to the following environmental factors: • Benthic Communities and Habitat (Section 4.2); • Marine Fauna (Section 4.5); • Flora and Vegetation (Section 4.6); and • Terrestrial Fauna (Section 5; Table 16).
4. Principles relating to improved valuation, pricing and incentive mechanisms *i. Environmental factors should be included in the valuation of assets and services.* *ii. The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement.* *iii. 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 waste.* *Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.*	Environmental factors were considered in the Proposal design, in particular in consideration of the disposal options, i.e. offshore, vs. onshore and in consideration of onshore location. Specifically, the final disposal location is located further away from the dredging than other sites that were considered, but the requirement for native vegetation clearing was considerably higher. Although pumping dredge material to the proposed location will cost more than some alternative options, it is considered to be the most environmentally acceptable location. The Proposal is not expected to generate any significant pollution or waste. Principles related to improved valuation, pricing and incentive mechanisms are not considered to be relevant to this Proposal. However, it is also noted that the Proposal is situated strategically to provide critical infrastructure and services to the oil and gas sector, to develop the local economy and to provide much-needed local jobs in Onslow. These positive economic outcomes can be achieved in a manner that does not result in any significant residual impacts on the environment.

5. 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.*	Proposed mitigation, monitoring and management strategies to minimise waste generation and discharge to the environment are described within the DRAFT DSDMP (Appendix E). Onshore dredge spoil disposal enables potential future use of the material for development of industrial land in Onslow.

4.2. Benthic Communities and Habitat

4.2.1. Policy and Guidance

The following EPA policies and guidance have been considered in evaluating potential impacts on this factor:

- EPA (2016b). *Environmental Factor Guideline: Benthic Communities and Habitats,* EPA, Western Australia;
- EPA (2016c). *Technical Guidance – Protection of Benthic Communities and Habitats,* EPA, Western Australia; and
- EPA (2016d). *Technical Guidance – Environmental Impact Assessment of Marine Dredging Proposals,* EPA, Western Australia.

4.2.2. EPA Objective

The EPA's objective for the factor 'Benthic Communities and Habitats' (BCH) is:

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

4.2.3. Receiving Environment

Studies of benthic communities and habitat that are relevant to the Proposal are identified in **Table 7**.

Table 7 Receiving Environment Studies – Benthic Communities and Habitat

Author (Date)	Study
O2 Marine (2017a)	Onslow Marine Support Base Stage 2 – Ecological Site Investigation (Appendix B; Section 2)
Paling (1990)	Onslow Salt ERMP Volume 2 Technical Appendix C Report on the Biological Environments near Onslow, Western Australia
URS (2010a)	Wheatstone Project Draft EIS/ERMP Technical Appendices N12 Survey of Subtidal Habitats off Onslow, WA.
URS (2010b)	Wheatstone Project Draft EIS/ERMP Technical Appendices N11 Survey of Intertidal Habitats of Onslow, WA
Chevron (2017)	Wheatstone Project First Post-Development State of the Marine Environment Report
Wahab (In Press)	Comparisons of benthic filter feeder communities before and after a large-scale capital dredging program. Marine Pollution Bulletin.

Characteristics, Distribution and Condition of Benthic Habitat and Communities

In recent decades, a boom in large-scale regional resource development projects has resulted in a significant amount of site-specific biological survey work being carried out in the region. A detailed review of these existing studies is provided in O2 Marine (2017a). A ground-truth survey of intertidal and subtidal BCH was also undertaken in March 2017 to provide an overview of the current range and distribution of BCH potentially impacted from the Proposal activities (O2 Marine 2017a).

Subtidal Habitats

The complex topography of the nearshore seafloor in the Onslow region provides habitat for a variety of sessile benthic biota including coral, seagrass, macroalgae and filter feeder communities. The seabed is predominantly comprised of soft sediment substrate supporting a low cover of BCH. There is a gradation of silty sands from inshore to the 10 m isobath to sandy gravels seaward of the 10 m isobath. The silty sand habitat was found to support a lower density of sessile invertebrates than the gravels offshore (URS, 2010a). Description of subtidal BCH is focussed on nearshore environments as previous benthic diving surveys in Beadon Creek determined the creek and surroundings were entirely sand habitat (BMT Oceanica 2014).

Coral BCH typically occurs on biogenic reefs and rocks fringing islands with the ecosystem unit between 10-20 m depth. These reefs have been recorded to support a diverse community with a moderate to high percent coral cover. Closer to shore, the shoals and exposed pavements have a low coral cover (i.e. <10%). However, Ward Reef, Roller Shoal and Glennie Patches have been recorded to support a moderate to high coral cover (URS 2010c).

Mapping undertaken for the Wheatstone Project previously identified low cover seagrass habitat occurs between Beadon Creek and Coolgra Point, composed of occasional filter feeder and macroalgae with sparse to moderate bioturbation of the substrate. The low total biotic cover of *Halophila* seagrass with filter feeder and macroalgae habitat was identified in patches within transects from Beadon Creek to Third Creek (URS 2010a). Paling (1990) recorded similar BCH for the Onslow Salt ERMP dredge channel from East of Ward Reef beyond 750 m offshore. The abundance and diversity of seagrasses was typically greater within transects from Third Creek to Coolgra Point (URS 2010a). Review of baseline subtidal BCH maps for nearshore areas (<10 m) in Chevron (2017) determined that BCH is much more widespread than initially identified in the map, although at lower cover of dominant mapped habitat, which are more broadly comprised of mixed communities varying in cover between 0% to 10% (Chevron 2017).

Ground-truth surveys describe this nearshore subtidal BCH as predominantly bare silty sand substrate with broken shells/rubble and a sporadic low cover of biota. The biota consists of a mosaic of intermixed filter feeders, turf algae, macroalgae and occasional patches of *Halophila* seagrass. Total cover of sessile biota is typically low (<3%), although small patches of higher cover are found on patchy low-profile rocky outcrops adjacent to the creeks. This mosaic of intermixed low cover seagrass/macroalgae/filter feeders is widespread throughout the area, with low cover of filter feeders (e.g. sponges, octocorals, hydroids, ascidians), turf algae and macroalgae (Phaeophyceae: *Sporochnus*, *Hormophysa, Sargassum* & *Dictyota*; Rhodophyceae: *Asparagopsis*; Chlorophyceae: *Caulerpa*, *Halimeda*) recorded in all nearshore areas and *Halophila* seagrass recorded from Beadon Point to Coolgra Point (O2 Marine 2017a). The overall estimate of total cover of biota for these locations was ultimately reduced due to the patchy nature of these habitats reflecting heterogeneity in the substrate types.

The change in percent cover estimates of BCH were monitored annually from baseline in 2011 to December 2015 for the Wheatstone Project within mapped areas of macroalgae, seagrass, and filter feeder habitat. In general, complex temporal/spatial changes in seagrass cover were observed particularly in nearshore areas. The mean percent cover of seagrass and macroalgae declined across the Onslow region whilst a positive change was recorded for filter feeders during the same period. Negative changes recorded could not be attributed to dredging activities as the patterns of cover were not correlated with distance from the dredging (i.e. variable patterns recorded among sites directly adjacent to dredging and at reference sites), indicating natural variable influences on the cover and distribution of non-coral habitats in the area. More frequent sampling (3-6 months) undertaken at some seagrass cells showed cover estimates vary markedly and not always consistently between spatially distributed habitats within short-term intervals, with the highest variability recorded among nearshore sites from Beadon Creek to Coolgra Point (Chevron 2017).

Wahab *et al.* (2017) recorded that the Onslow region supports a relatively high diversity of filter feeder communities which potentially constitutes species adapted to living in highly turbid habitats. These surveys captured 59 species of sponge from 25 families and 34 octocoral species from 10 families, with filter and suspension feeders such as sponges, ascidians, gorgonians and hydrozoans dominant in the nearshore area. Monitoring of benthic community composition with a focus on sponges near the channel before and after the Wheatstone Project dredging program found a pronounced decline in the abundance of macroalgae and hydrozoan, although the remainder of taxa displayed relatively minor increases and decreases in abundance making it difficult to attribute an effect to a three-year dredging program (Wahab *et al.* 2017).

The distribution of subtidal BCH in the Onslow region has been mapped and is presented in **Figure 5**. The classifications of BCH shown in the legend of the map are described in **Table 8**. The approach to mapping subtidal BCH adopts numerous assumptions recommended within technical guidance provided by the EPA and recent documents published by the dredging node of the Western Australian Marine Science Institution. Historical information and the results of the recent field assessment demonstrate there is considerable spatial and temporal variability of various BCH across the Proposal Area. Therefore, due to the broad distribution of these habitats, the complex mosaic of BCH associations, and knowledge that habitat boundaries may extend beyond those areas mapped historically means the maps should not be taken as an accurate representation of boundaries for BCH.

Table 8 Description of the BCH groups presented in Figure 5 within the proposed nearshore Loss Assessment Unit Boundaries (LAU 1) for the Proposal

Grouping	BCH Types	Description
Coral Habitat	Coral reef	Coral assemblages previously recorded with >10% cover[1]
Low Cover (<5%) MA/FF	Macroalgae, Filter feeders	Low biomass patchy cover occurring in predominantly very turbid silty sand substrates in nearshore areas influenced by periodic discharges from the Ashburton River
Moderate Cover (5-10%) MA/FF	Macroalgae, Filter feeders	Broad areas of low biomass patchy cover with infrequent areas of higher density although moderate functional value
Moderate Cover (5-10%) S/MA/FF	Seagrass, Macroalgae, Filter feeders	Broad areas of low biomass patchy cover of mixed habitat with infrequent areas of higher density although moderate functional value
High Cover (>10%) S/MA/FF	Seagrass, Macroalgae, Filter feeders	Broad areas of moderate biomass patchy cover of mixed habitat with occasional areas of higher density and moderate functional value

[1] Mapping of coral habitat was limited to within the 10 m isobath based on the predicted impacts of the Proposal not extending beyond the nearshore area. Coral habitat beyond the 10 m isobath has been previously mapped for the Wheatstone Project

Intertidal Habitats

The intertidal habitats occurring within the Proposal Area are sandy beaches, sand bars and shoals at the mouth of tidal creeks, rocky shores, lagoon flats, mangroves and a large tidal mud flat unit which contains the habitats of bioturbated mud flats with samphire communities, algal mats and supratidal salt flats. The distribution of the various intertidal BCH and adjacent supratidal areas has been mapped for the western margin and the mouth of the Beadon Creek tidal embayment where Proposal activities are proposed to occur (**Figure 6**).

The tidal embayment of the DMMA adjacent to the western tributary of Beadon Creek is broad and flat with narrow mangrove fringed creeks backed by extensive mudflats. The distribution of habitat types within the tidal embayment is a landward progression from tidal creek, mangroves, samphire and bioturbated high tidal mud flat, algal mat covered high tidal flat, salt flat to hinterland margin.

The dominant mangrove in Beadon Creek is *Avicennia marina* with small pockets of *Rhizophora stylosa* lining as a discontinuous band and occasional trees of *Ceriops australis* present at the landward mangal edge (Paling 1990, URS 2010b). There are two habitat types on the high tidal mud flats:

- Bioturbated mud flats, devoid of macro-vegetation but heavily worked over by burrowing crabs
- Samphire flats, dominated by halophytic shrubs but with some crab burrows

Boundaries between these mud flat types are not always discrete and are not easily mapped. Typically, an area of bioturbated mud flat occurs immediately behind (landward of) the mangrove zone, while samphire flats extend landward of the bioturbated mud flat to the hinterland margin. Broad areas of algal mats are found landward of the high tidal mud flat habitats adjacent to the DMMA. The algal mats are generally in sheet form 5 mm thick and could be easily rolled and peeled back from the mud flat surface. Supratidal salt flats are located above the algal mat habitats which are predominantly devoid of marine invertebrates and vegetation (O2 Marine 2017a).

The DMMA is located immediately north of the Onslow Airport and west of the airport runway extending north to an existing stormwater open runoff drain (**Figure 6**). The site contains bare salt flats bounded to the west by an undulating terrestrial dune system and overlies a small area of algal mat in the north-east corner immediately adjacent to the airport runway. The salt flat portion of the DMMA area overlies part of an exposed limestone pavement possibly a previous coastline. The majority of algal mat within the DMMA overlies limestone pavement at the border of the salt flats, with a small area of algal mat on upper mudflats bounded to the east by the runway (O2 Marine 2017a).

Long sandy beaches of the Onslow coast are only interrupted by short, sloping intertidal limestone ramps (e.g. Beadon Point, Coolgra Point) and sand bars and shoals at the mouths of tidal creeks (described as lagoon flats in **Figure 6**). Sandy beaches in the area have been recorded to be remarkably consistent in profile, sediment characteristics and fauna, with medium to coarse-grained calcareous and shelly sands supporting limited fauna such as the occasional ghost crab burrows. The sand bars and shoals at the mouths of tidal creeks are also generally restricted in fauna (URS 2010b), except for the tidal lagoon inside the mouth of Beadon Creek where the Turning Basin is proposed. This tidal lagoon is comprised of bioturbated sand with abundant fiddler crab burrows and small pockets of mangrove seedlings/saplings (**Figure 6**) (O2 Marine 2017a). The wide rock platform at Beadon Point hosts a moderately well-developed rocky shore fauna and flora whereas at Coolgra Point the narrow transition between rocky shore and mangrove produces a diverse, mixed assemblage of mangrove a rocky shore species (URS 2010b).

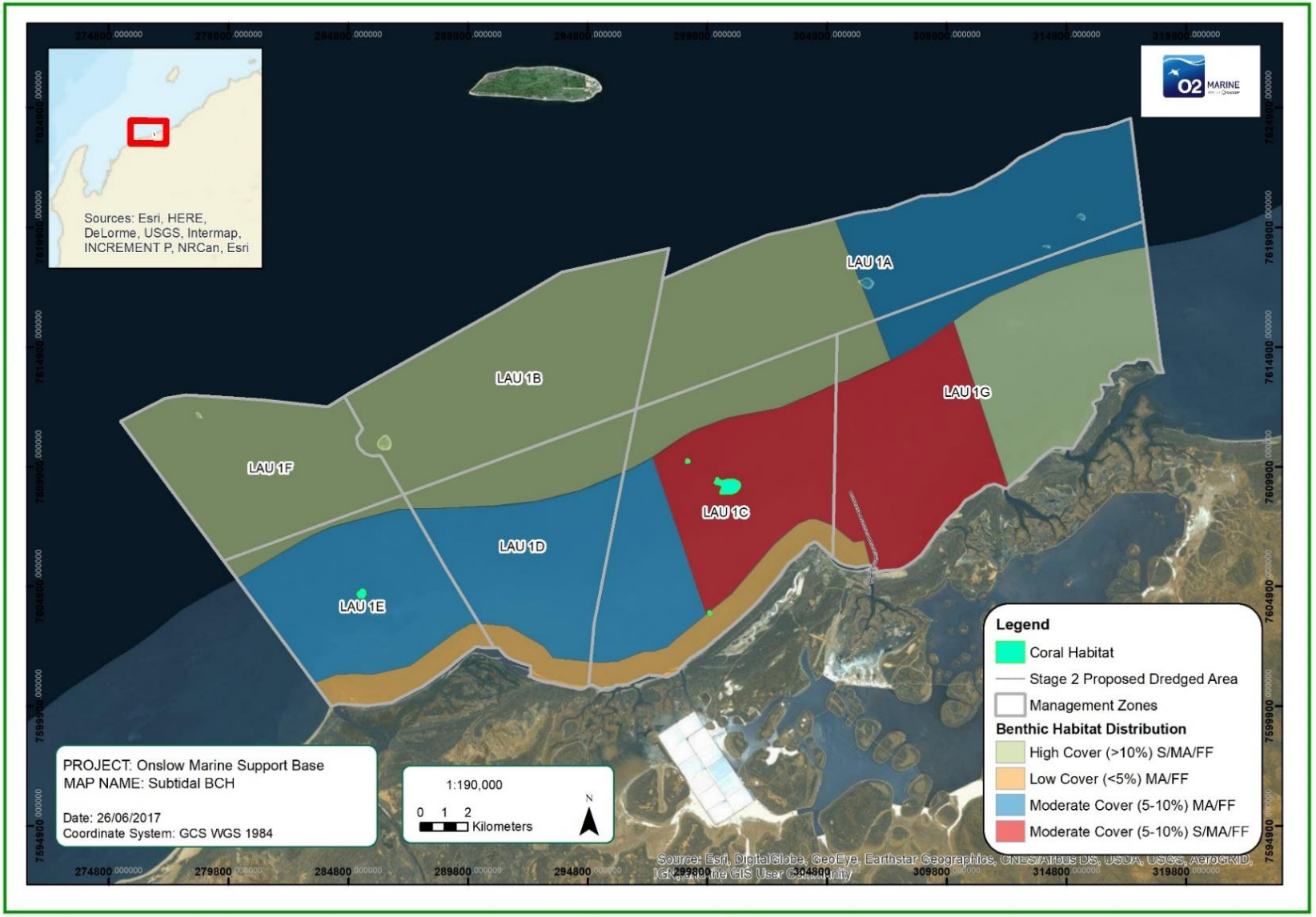


Figure 5 Subtidal BCH within the proposed nearshore Loss Assessment Unit Boundaries for the Proposal

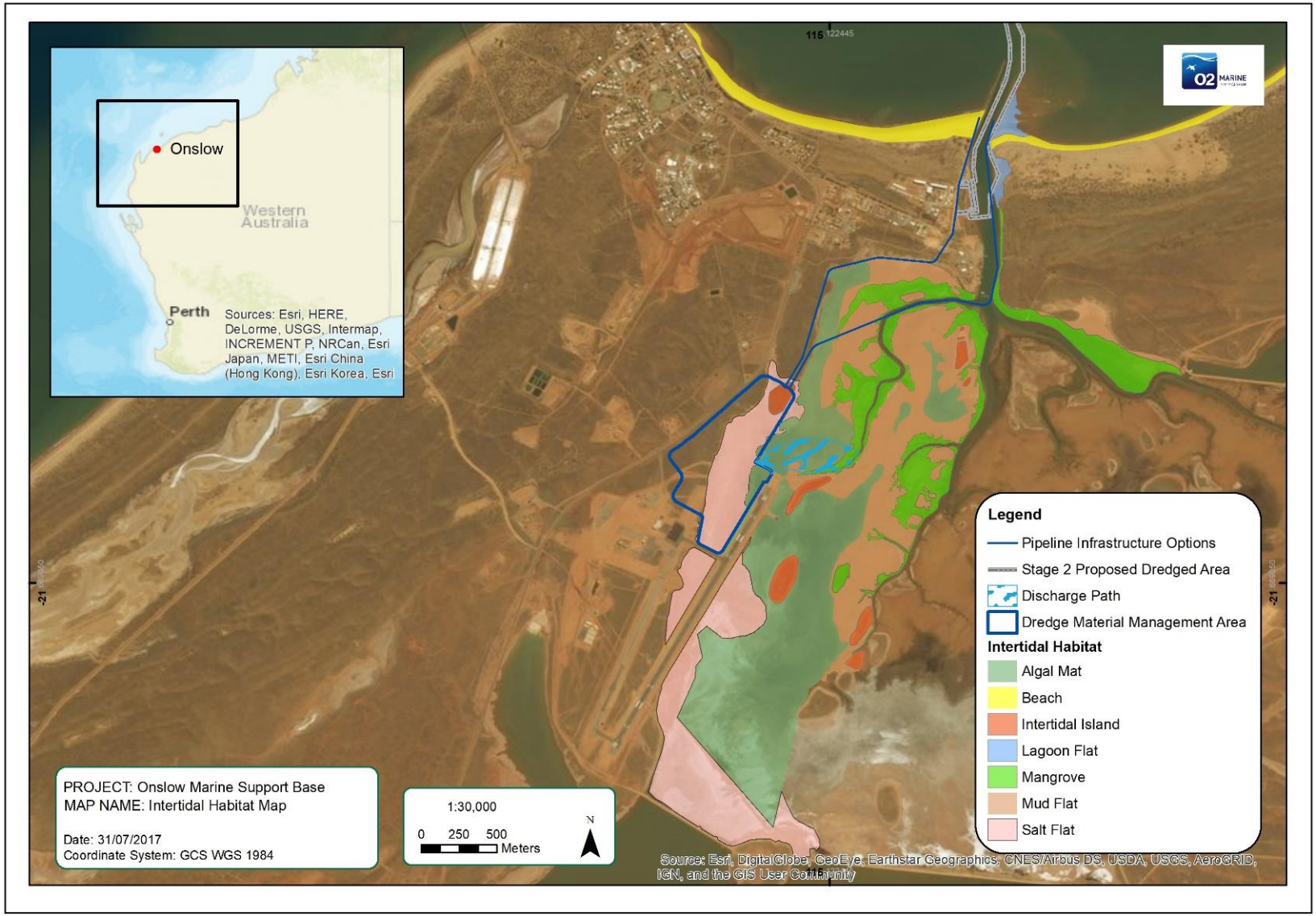


Figure 6 Intertidal BCH relevant to the Proposal activities within the proposed Beadon Creek tidal embayment

4.2.4. Potential Impacts

Construction Phase Impacts

During the construction phase of the Proposal, the following activities and resulting impacts have the potential to adversely affect BCH near the Proposal:

1. Dredging activities in Beadon Creek (Turning Basin and Berth Pocket) and Beadon Bay (HAC) have the potential to cause:
    a. Direct removal (permanent loss) of subtidal BCH within the proposed HAC;
    b. Direct removal (permanent loss) of intertidal BCH within the proposed HAC;
    c. Indirect potential impacts (irreversible loss and recoverable impacts) on subtidal BCH from increased turbidity, reduced light, sedimentation;
    d. Indirect potential impacts (irreversible loss and recoverable impacts) on intertidal BCH from sedimentation; and
    e. Indirect potential impacts (irreversible loss and recoverable impacts) from changing the hydrodynamics and flushing of Beadon Creek due to modification of the bathymetry at the mouth of the creek.
2. Onshore disposal activities at the proposed DMMA have the potential to cause:
    a. Direct removal (permanent loss) of intertidal BCH within the proposed DMMA;
    b. Indirect potential impacts (recoverable impacts) on intertidal BCH through tail water discharge from the DMMA to the Western tributary of Beadon Creek; and
    c. Indirect potential impacts (irreversible loss and recoverable impacts) on intertidal BCH through fine suspended sediments in tail water discharge from the DMMA.

Post-construction / Operational Phase Impacts

There will be an ongoing requirement for maintenance dredging of the Turning Basin, Berth Pocket and HAC during the lifetime of the Proposal from infill of sediment. Maintenance dredging which will be managed in accordance with the DoT Maintenance Dredging EQMF and impacts will be assessed on a case by case basis. However, maintenance dredging is considered for contextual information on the ongoing risks to BCH from the proposal.

4.2.5. Assessment of Impacts

A detailed assessment of the potential impacts on BCH from the proposal is provided in O2 Marine (2017a). The key findings of these assessments are summarised below.

Construction Phase Impacts

<u>Direct removal (irreversible loss) of subtidal BCH within the proposed HAC (1a)</u>

Dredging of the HAC within nearshore waters of Onslow will result in the permanent loss of 21 ha (0.2%) of BCH mapped as seagrass/macroalgae/filter feeder within LAU 1G. The LAU 1G is comprised almost entirely of BCH mapped as moderate cover (5-10%) seagrass/macroalgae/filter feeder except for small areas of macroalgae/filter feeder' habitat in the north-east and south-west corners of the LAU. The predicted loss of 21 ha represents only 0.2% of seagrass/macroalgae/filter feeder BCH in LAU 1G located within Port of Onslow seabed. This habitat locally and regionally widespread within the Pilbara.

<u>Direct removal (irreversible loss) of intertidal BCH within the proposed HAC (1b)</u>

Dredging to widen the existing Turning Basin will result in the direct removal of 0.8 ha of tidal lagoon habitat from the east side of Beadon Creek. The tidal lagoon community is comparable to communities found within bioturbated mud flat/ samphire BCH and is comprised of abundant fauna of burrowing ocypodid fiddler crabs

(i.e. species of *Uca*). No mangroves occur on the tidal lagoon within the proposed area to be dredged. Bioturbated mud flat/ samphire habitat is well represented both locally and regionally and the loss of 0.8 ha represents the *irreversible loss* of <0.1% of BCH within LAU 0A. Direct removal of this small area of bioturbated mud flat/ samphire does not change the cumulative percent of historical loss of this BCH type within LAU 0A (i.e. cumulative historical loss remains at 3.5% of the original area).

A further 1.4 ha of coarse sand will be removed from the sand spit in front of the mouth of Beadon Creek, although this dynamically shifting habitat was found to support limited invertebrate populations.

Indirect potential impacts (irreversible loss and recoverable impacts) on subtidal BCH through increased turbidity, reduced light, sedimentation (1c)

In accordance with guidance provided in EPA (2016d), a dredge plume impact assessment was undertaken to develop predictions of the Zone of High Impact (ZoHI), Zone of Moderate Impact (ZoMI) and Zone of Influence (ZoI) for BCH in the nearshore Proposal Area (O2 Marine 2017a). Separate zones of impact were created based on Suspended Sediment Concentrations (SSC) and sedimentation tolerance limits for coral and seagrass. The SSC dredge plume ZoHI represents the predicted area of *irreversible loss* and the ZoMI represents the predicted *recoverable impacts* of BCH. The impact zones for sedimentation are more localised and occur within the extent of area predicted in SSC dredge model outputs.

The predicted environmental impacts of the proposed OMSB dredging project were further refined based on the review of recent literature from the WAMSI Dredging Science Node and supplemented by advice provided from the Department of Water and Environmental Regulation (formally EPA). The modifications to the approach included:

- Seagrass model outputs of the combined seasonal scenarios depicted were separated into seasonal plots in summer, winter and transitional to represent commensurate impacts for a 13-week duration of the dredging program;
- The ZoHI for seagrass SSC plots was modified to extend 50 m from the boundaries of the harbour approach channel. The modelled ZoHI is small and reasonably high levels of migration over that range is expected (i.e. 2-5 km) and recovery to pre-dredging levels is anticipated within five years;
- The ZoHI for seagrass sedimentation plots was modified to extend 50 m from the boundaries of the harbour approach channel. Sedimentation thresholds developed for the Wheatstone Project are now considered overly conservative and review of more recent information and research indicates impacts on seagrass from sedimentation generated during the dredging program are unlikely;
- The SSC and sedimentation generated from the proposed small dredging program in the outer channel are unlikely to impact filter feeder communities within the nearshore area of Onslow which are resilient to the levels of dredging related pressures (SSC and sedimentation) predicted for the OMSB Project. Dredging effects on filter feeders are not expected to result in a measurable impact; and
- The temporal and spatial variability of seagrass and macroalgae within the Project area is highly dynamic. Historical monitoring exhibits continual low cover (<10%) with seasonal and annual fluctuations. Recoverable impacts to seagrass and macroalgae can only be estimated for that proportion of available habitat that is supporting seagrass and macroalgae at the time of dredging. Therefore, the spatial area of predicted seagrass and macroalgae has been conservatively estimated to cover 20% of the ZoMI if dredging occurs during the summer/transitional season or 10% if dredging occurs during winter.

The predicted *recoverable impacts* and *irreversible loss* of nearshore BCH from dredging the proposed HAC for the proposal are presented in **Table 9**. No areas mapped as coral habitat occur within the ZoHI or ZoMI for "best-case" or "worst-case" model outputs and therefore potential impacts to coral habitat are not predicted. The "best case" and "worst case" ZoHI and ZoMI for SSC are predominantly located over BCH mapped as 'Moderate cover (5-10%) seagrass/macroalgae/filter feeders' between Sunset Beach (i.e. Onslow back beach) and Third Creek which occur in LAU 1 G, and overlap into LAU 1C. These plumes also cover a small nearshore area mapped as 'Low cover (<5%) macroalgae/filter feeder' BCH.

The estimated *irreversible loss* of subtidal BCH within the ZoHI is 56 ha (0.6%) of seagrass/macroalgae/filter feeder BCH that is the same for either 'best case' or 'worst case' and for both SSC and sedimentation model outputs. The 56 ha composes direct impacts from the construction of the approach channel of 21 ha and indirect impacts of 35 ha from the effects of dredged generated sediments in the near field. Indirect impacts are predicted to occur only on seagrass and macroalgae components of BCH within this area. Filter feeders are not predicted to be impacted by low light attenuation, high SSC and sediment smothering generated during the proposed dredging activities. Consequently, the only predicted impacts to filter feeder BCH will be the permanent loss of filter feeder habitat in the footprint of the approach channel.

Separate model outputs were developed to predict the ZoMI recoverable impacts from dredging activities extending for approximately 13 weeks in the outer channel and undertaken during winter, summer or transitional seasons. The largest areas of impacts are predicted to occur when dredging during the summer season and the lowest impacts are predicted when dredging during winter. Dredging during the transitional seasons both reveal a level of predicted impacts that lie between those predicted for summer and winter. Therefore, the predicted scale (areas) of recoverable impacts are dependent on the season when dredging is undertaken.

In the absence of historical information on BCH prior to commercial trawling, it has been assumed there has been no historical loss of BCH within LAU 1G, so cumulative loss of BCH is limited to the irreversible loss occurring from the proposal. This predicted irreversible loss of BCH is likely to be within the range of error inherent in mapping BCH.

Table 9 Predicted *recoverable impacts* and *irreversible loss* of BCH from the proposal and cumulative loss

LAU	BCH	Recoverable Impacts		Irreversible Loss[1]
		Best Case	Worst Case	
Summer				
LAU 1G	Seagrass, Macroalgae, Filter Feeder[2]	212 ha (2.1%)	260 ha (2.5%)	56 ha (0.6%)
	Macroalgae, Filter Feeder[2]	4 ha (0.3%)	7 ha (0.5%)	-
LAU 1C	Seagrass, Macroalgae, Filter Feeder[2]	-	0.4 ha (<0.1%)	-
	Macroalgae, Filter Feeder[2]	-	-	-
Winter				
LAU 1G	Seagrass, Macroalgae, Filter Feeder[2]	31 ha (0.3%)	35 ha (0.3%)	56 ha (0.6%)
	Macroalgae, Filter Feeder[2]	17 ha (1.3%)	17 ha (1.3%)	-
LAU 1C	Seagrass, Macroalgae, Filter Feeder[2]	16 ha (0.3%)	25 ha (0.4%)	-
	Macroalgae, Filter Feeder[2]	5 ha (0.1%)	10 ha (0.3%)	-
Transitional				
LAU 1G	Seagrass, Macroalgae, Filter Feeder[2]	120 ha (1.2%)	153 ha (1.5%)	56 ha (0.6%)
	Macroalgae, Filter Feeder[2]	11 ha (0.8%)	19 ha (1.5%)	-
LAU 1C	Seagrass, Macroalgae, Filter Feeder[2]	2 ha (<0.1%)	4 ha (<0.1%)	-
	Macroalgae, Filter Feeder[2]	-	-	-

[1] Area of irreversible loss includes 21 ha of direct impact for the construction of the approach channel and 35 ha surrounding the approach channel to apply a precautionary approach for the potential indirect irreversible impacts on seagrass and macroalgae BCH caused by high levels of SSCs and sedimentation from dredge generated sediments within the near field. However, the reversibility of indirect impacts may recover to a state resembling that prior to being impacted within a timeframe of five years or less.

[2] Filter feeders within Seagrass/Macroalgae/Filter Feeder mixed BCH are unlikely to be impacted from the indirect effects from high levels of SSCs and sedimentation from dredge-generated sediments, resulting only in a predicted irreversible loss of 21 ha of direct impacts for filter feeder.

Indirect potential impacts (irreversible loss and recoverable impacts) on intertidal BCH from sedimentation (1d)

Dredging of the Turning Basin, Berth Pocket and HAC has the potential to result in elevated sedimentation in intertidal BCH. Mangrove, bioturbated mudflats/ samphire and algal mat BCH are relatively tolerant to the impacts of sedimentation. Historical dredging within Beadon Creek and other areas of the Pilbara coast with mangrove fringed tidal creek systems (e.g. Port Hedland) has not resulted in significant indirect impacts to intertidal BCH from dredging related sedimentation. Therefore, indirect potential impacts on intertidal BCH within Beadon Creek from smothering of dredging generated sediments for the Proposal is unlikely.

Indirect potential impacts (irreversible loss and recoverable impacts) from changing the hydrodynamics and flushing of Beadon Creek due to modification of the bathymetry at the mouth of the creek (1e)

Modelling simulations of the changes to the hydrodynamics within Beadon Creek post dredging undertaken for the Proposal predict there will only be a minor (<1%) increase to the overall tidal prism and negligible changes to existing water levels and velocities (Baird 2017). Therefore, the proposal for a wider, deeper entrance channel configuration is unlikely to result in irreversible loss or recoverable impacts of intertidal BCH within the Beadon Creek tidal embayment. Further description of the predicted changes to the hydrodynamics and sediment transport from the proposal is described in **Section 4.3.5**.

Direct removal (permanent loss) of intertidal BCH within the proposed DMMA (2a)

The location of the proposed DMMA overlies approximately 23 ha of bare supratidal salt flats and 2.4 ha of algal mat BCH. The salt flats are devoid of marine plants and invertebrates. Direct smothering of 2.4 ha (0.2%) of algal mat which has already been modified by the Onslow Airport runway is unlikely to cause a significant reduction in local and regional primary productivity and nutrient cycling.

The predicted irreversible loss of 2.4 ha was added to the historical loss of 195 ha of algal mat to result in a cumulative loss of 197.4 ha (19.7%). This additional loss of BCH is likely to be within the range of error inherent in mapping BCH.

Indirect potential impacts (recoverable impacts) on intertidal BCH through tail water discharge from the DMMA (2b)

Discharge of supernatant water from the DMMA is expected to pool as it free-flows over the intertidal zone back towards the creek, which may cause a temporary community shift in intertidal BCH due to perpetual inundation and subsequent changes to the salinity gradient. The specifics of the potential impact are not well understood and may have possible temporary beneficial consequences. However, any impacts on intertidal BCH from dewatering are expected to recover once the salinity gradient is re-established following completion of dewatering activities. A precautionary approach has been applied to predict the recoverable impact of 1.3 ha (0.2%) of mangrove, 0.4 ha (<0.1%) of samphire/bioturbated mudflat and 8.5 ha (0.8%) of algal mat within the predicted flow-path.

Indirect potential impacts (irreversible loss and recoverable impacts) on intertidal BCH through fine suspended sediments in tail water discharge from the DMMA (2c)

Fine sediments released during dewatering activities has the potential to result in indirect smothering by fine sediments on intertidal BCH. Settlement of fine suspended sediments within the DMMA can be managed through appropriate design and construction management techniques. An area of 44 ha is proposed for the DMMA, which allows sufficient area for the design of a dredge disposal strategy to ensure that dredged materials are disposed of within the designated DMMA and not released into return waters. Monitoring of SSC (via turbidity) can be conducted at the weir box and the discharge from the pond can be controlled to ensure that management targets for the protection of intertidal BCH will be achieved.

Post-construction / Operational Phase Impacts

Regular small maintenance dredging events will be required to be undertaken by the Proponent (see **Section 4.3.4**) to maintain navigable depths within the Turning Basin, Berth Pocket and HAC. Sediment infill is predominantly expected to occur at the end of the training wall or within the deeper Berth Pocket. These activities would typically involve small dredge plant operating over short durations. Dredge material will be used to replenish the beach on the east side of the mouth to restore natural bypassing and is not planned to be disposed offshore.

Similar regular maintenance dredging has been undertaken at these locations over recent years by the DoT (O2 Marine 2017b) for the Beadon Creek Maritime Facility. These dredging projects have not resulted in cumulative impacts to BCH. Maintenance dredging will be managed in accordance with the DoT Maintenance Dredging EQMF and impacts will be assessed on a case by case basis.

4.2.6. Mitigation

The DRAFT DSDMP developed for the Proposal (**Appendix E**), includes project specific Management Targets (MTs) to mitigate the potential impacts on BCH and subsequently ensure that the EPA's objective for BCH is met and the predicted Environmental Protection Outcomes (EPOs) are achieved. The project specific MTs for BCH include:

1. Dredging operations do not occur outside the defined dredge footprint.

2. Recovery of subtidal BCH within the ZoMI worst-case scenario within 3 years following disturbance.
3. No detectable impact on subtidal BCH within the Zone of Influence (ZoI) best-case scenario.
4. Manage water quality to achieve a High Level of Ecological Protection at the DMMA Tail water discharge.

For each of the above project specific MTs, a comprehensive set of management actions and environmental performance measures have been established and are described in the DRAFT[3] DSDMP (**Appendix E**).

4.2.7. Predicted Environmental Protection Outcomes

The predicted EPOs of the Proposal include:

Dredging activities in Beadon Creek (Turning Basin and Berth Pocket) and Beadon Bay (HAC)

The interpretation of predicted outcomes below should consider the precautionary approach implemented for the environmental impact assessment and additional considerations described in 1c.

- Direct irreversible loss within LAU 1G of:
  - 21 ha (0.2%) of seagrass/macroalgae/filter feeder BCH;
- Potential indirect irreversible loss[4] within LAU 1G of:
  - 35 ha (0.3%) seagrass & macroalgae from seagrass/macroalgae/filter feeder BCH;
- Potential recoverable impact within LAU 1G of:
  - 31 ha (0.3%) to 260 ha (2.5%) of seagrass & macroalgae from seagrass/macroalgae/filter feeder BCH;
  - 4 ha (0.3%) to 19 ha (1.5%) of macroalgae from macroalgae/filter feeder BCH;
- Potential recoverable impact within LAU 1C of:
  - 0 ha (0%) to 25 ha (0.4%) of seagrass & macroalgae from seagrass/macroalgae/filter feeder BCH;
  - 0 ha (0%) to 10 ha (0.3%) of macroalgae from macroalgae/filter feeder BCH; and
- No impact to coral BCH from dredging generated SSC and sedimentation

Onshore disposal activities at the proposed DMMA

- Permanent loss of BCH within LAU 0A of:
  - 2.4 ha (0.2%) of algal mat from construction of the DMMA;
  - 0.8 ha (<0.1%) of bioturbated mudflat/samphire to widen the Turning Basin;
- Potential recoverable impact of 1.3 ha (0.2%) of mangrove, 0.4 ha (<0.1%) of samphire/bioturbated mudflat and 8.5 ha (0.8%) of algal mat within LAU 0A from tail water discharge from the DMMA; and
- No loss of subtidal BCH due to offshore disposal.

The combined impact of the Proposal activities and the consequent outcomes are not considered to pose significant residual risks to the protection of BCH and therefore biological diversity and ecological integrity can be maintained. In respect of the proposed design and management of the Proposal, the Proponent considers that the EPA's objective for BCH has been met.

[3] The DSDMP presented in Appendix E, has been prepared in DRAFT and is proposed to be reviewed and updated following outcome of EPA assessment. Any revisions or amendments are proposed to be undertaken in consultation with the Port of Ashburton TACC (Refer to Section 3.3.1) and the relevant DMAs (i.e. DoT and SoA).

[4] Irreversible loss estimates include 21 ha of direct removal permanent loss

4.3. Coastal Processes

4.3.1. EPA Objective

The EPA's objective for the factor 'Coastal Processes' is:

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

4.3.2. Policy and Guidance

The following EPA policies and guidance have been considered in evaluating potential impacts on this factor:

- EPA (2016e). *Environmental Factor Guideline: Coastal Processes,* EPA, Western Australia.

4.3.3. Receiving Environment

Studies of coastal processes that are relevant to the Proposal are identified in **Table 10**.

Table 10 Receiving Environment Studies – Coastal Processes

Author (Date)	Study
Baird Australia (2017)	Onslow Marine Support Base - Shoreline Impacts Assessment (Appendix C)

Oceanographic Conditions

Onslow is situated on the northwest coast of Australia in the Pilbara region. The location experiences a tropical climate with two distinct seasons – a dry season between the months April to October and wet season between the months November to March. The dry season is typically categorised by light winds from the south, southeast and east. In the wet season or monsoon, the winds are typically stronger with a strong sea-breeze effect in operation and wind directions around the southwest, west and northwest directions (DoT 2017).

Ambient wave conditions at the Onslow shore are relatively minor, with a total wave height lower than 1m and generally less than 0.5m throughout the year. The location is well protected from swell originating in the Southern and Indian Oceans due to the orientation of the coast and the shallow continental shelf, with swell wave height generally less than 0.25m in the period range 8-20 seconds. An active sea breeze cycle is present in summer with onshore winds driving local seas in the afternoon at periods 3-8 seconds (DoT 2017).

The Pilbara is an active tropical cyclone region and Onslow has been subjected to a significant number of Tropical Cyclones (TC) in its history. The cyclone season typically lasts from November through April, and the impact from cyclones can result in extreme water levels, waves and damaging winds. The most damaging cyclone in recent history was TC Vance which impacted Onslow on 22 March 1999 as a Category 5 system creating an estimated storm surge of 4 m (BOM 2017).

Onslow experiences semi-diurnal tides with a spring tide range of 1.9m.

Beadon Creek and Entrance Channel Dynamics

The tidal exchange and flows through Beadon Creek are controlled by the general tide regime, local bathymetry, the training wall at the entrance and the characteristics influencing the upstream tidal flats (Baird 2017).

The Onslow breakwater / training wall is a low-rise rubble mound structure that is designed to be overtopped under extreme cyclone events and high tide levels. The structure was built in 1968 in conjunction with a dredged channel to maintain a navigation channel to the maritime facility within Beadon Creek (DoT 2017).

Sediment littoral transport is eastward under the prevailing longshore wave direction with net accretion rates along the shoreline west of the training wall estimated at 5,000 to 10,000 m^3 annually (Damara 2010). Continual accumulation of sediment on the western side of the training wall has occurred since its construction in 1968. The entrance channel is maintained to a depth of -1.6 mCD largely by the natural tidal flows, with the eastern bank of the creek and the ebb tide shoal to the east of the entrance fed by the natural bypass capacity of the channel (Baird 2017).

The upstream area of Beadon Creek was significantly modified resulting from the construction of the Onslow Salt levee banks in 1997, which served to greatly reduce the sediment transport impacts associated with large flooding events. Historically sedimentation resulting from large scale catchment flooding during extreme rainfall events and breakout of the Ashburton River has impacted Beadon Creek, and this source of sediment supply has now been largely restricted. As part of its operation, Onslow Salt operate three seawater pumps from a tidal branch on the eastern side of the upstream Beadon Creek, extracting 12 m3/s when the water level in the creek is above 0.8 mCD (Onslow Salt 2017). This extraction regime results in a difference between inflow and outflow volumes through Beadon Creek, with inflow exceeding outflow by approximately 35% during mean spring tides (HGM 1998).

The Beadon Creek entrance has generally maintained a stable cross section under the natural tidal regime, with this 'quasi-equilibrium' explained as evidence of a dynamically stable inlet system (HGM 1998). The inlet stability principle is governed by the dynamics of the upstream area, tide regime and available sediment supply, and for the Beadon Creek entrance, a stable cross-sectional area of 220-250m^2 was estimated, as measured below mean sea level (HGM 1998). This estimation of a stable cross-sectional area is supported by analysis of the present bathymetry through the channel. This concept has important implications for the planned deepening and widening of the channel through the entrance for the Proposal, which will increase the cross-sectional area of the entrance beyond this dynamically stable level (Baird 2017).

Historic maintenance dredging has occurred in Beadon Creek on an ad-hoc basis since construction of the entrance channel in 1964. A summary of the historic maintenance dredging is presented in Baird (2017) (**Appendix C**).

4.3.4. Potential Impacts

Construction Phase Impacts

Development of the proposed HAC, Berth Pocket and Turning Basin has potential to adversely affect coastal processes near the Proposal. The following potential impacts are identified:

1. Impact on the hydrodynamics of Beadon Creek, including:
    a. Changes to the tidal prism;
    b. Changes to current velocity at various Locations;
    c. Changes to tidal inundation characteristics.
2. Impact on sediment transport, including:
    a. Longshore sediment transport; and
    b. Sedimentation.

Post-construction / Operational Phase Impacts

3. Maintenance Dredging

4.3.5. Assessment of Impacts

Beadon Creek Hydrodynamics

Baird (2017) developed a hydrodynamic model of the Onslow coastal region to support investigations into changes to the coastal processes associated with the planned capital dredging. The model was validated against available measured water level records from a tide gauge location inside of Beadon Creek and an Acoustic Wave and Current (AWAC) instrument northwest of the training wall. The model showed good agreement to the measured data for water level, current velocity and direction in both locations. Key findings of the modelled changes to the hydrodynamics and sediment transport within Beadon Creek resulting from the Proposal are discussed briefly below. Further details are provided in Baird (2017) included in **Appendix C**.

Changes to the Tidal Prism (1a)

Total discharge volume through the channel entrance was examined for the developed case to investigate changes to the tidal prism against the existing condition. For a four-week period of modelled tides, the total inflow to the Beadon Creek system was estimated at 101GL and the total outflow volume 75GL. The difference in the inflow and outflow volume is due to the extraction of seawater from the Beadon creek system for the Onslow Salt pond operations, which have been included in the hydrodynamic model description. Under the developed scenario, the Beadon Creek tidal prism remains largely unchanged with total inflow and outflow volumes estimated to increase by only 1% based on the one month of modelled tides. There was an increase in the discharge rate at the channel entrance during ebb tides for the developed case, as the deeper wider channel allows more conveyance of the ebb tide flows (Baird 2017).

A cross section taken at the entrance of the channel illustrates that the proposed dredged area will increase from the present volume of approximately 220-250 m^2 (below MSL) to over 600 m^2 post-dredging. Model comparisons for the developed case against the existing case indicate that whilst discharge rates increase through the Beadon Creek entrance in the ebb tide cycle, the larger cross section of the developed case results in an overall reduction in the velocity magnitude of currents through the channel entrance. Based on historical assessments of the entrance, the present 220-250 m^2 area has been estimated to be representative of a 'stable' inlet dimension with respect to the tidal prism upstream. The increase in the cross section under the developed scenario will therefore likely result in increasing the sedimentation rate for the navigation channel as the entrance system tries to move towards a new dynamic equilibrium (Baird 2017).

Changes to Current Velocity at Various Locations (1b)

The change to current velocities post construction through the spring-neap phase was examined using the hydrodynamic model at key areas of interest in Beadon Creek. Current speeds are predicted to reduce within the areas proposed to be dredged through the entrance channel, central Beadon Creek and along the eastern side of the training wall post construction. The current magnitude is predicted to slightly increase in the channel upstream of the dredge footprint post construction, most likely due to the increased efficiency of the dredged entrance channel to convey ebb tide peak flows (Baird 2017).

Changes to Tidal Inundation Characteristics (1c)

Submergence curves were compared between the existing and post-construction scenarios at various locations upstream of the proposed footprint. The model outputs predict that there will be negligible change to the estuary tide plane post-construction.

Sediment Transport

Baird (2017) applied the Delft3D and LITDRIFT modelling suite to investigate potential sediment transport and morphology impacts resulting from proposed modifications to the creek for the HAC, Turning Basin and

Berth Pocket. Modelling was supported by analysis of historical aerial imagery of Beadon Creek provided from the DoT which dates back to the 1960's. This analysis enabled assessment of the historical rate of shoreline movement. The morphological changes in the coastal system associated with the proposed modification of the seabed and entrance channel dynamics were completed based on a representative year of simulations derived from dry season and monsoon conditions, and for two cyclone events (Baird 2017). Key findings are discussed briefly below. Further details are provided in Baird (2017) included in **Appendix C**.

Longshore Sediment Transport (2a)

The existing form of the Beadon Creek entrance channel has the capacity to 'naturally bypass' a proportion of the net eastward bound littoral drift. This is directed by the action of spring tide current velocities on the ebb and flood tide which redistribute sediment that falls into the existing channel around and onto the eastern shoal, assisted by wave action. The ability for the system to 'naturally bypass' will be significantly reduced under the developed case as the deepened channel becomes a trap for the eastward littoral drift. The deeper channel and associated reduced tidal velocities will not have the same capacity to move the sediment from the seabed (Baird 2017).

It is estimated that eastward littoral drift volume that bypasses the breakwater is in the range of 5,000m^3 – 15,000m^3 annually and could be deposited in the dredged navigation channel on the lee side of the breakwater. Maintenance dredging and bypassing of the material would be required to maintain navigable depth and to restore supply of sand to both the eastern shoal and eastern shoreline (Baird 2017).

Sedimentation (2b)

Model outcomes predict the annual total sedimentation for the navigable areas of the Proposal footprint (HAC, Turning Basin and Berth Pocket) is predicted to be in the range of 18,000 m^3 to 28,000 m^3/year. Post-dredging estimates indicate the historical rate of sedimentation (~1,700 m^3) could increase by approximately 30% (~2,300 m^3) upstream of the dredge footprint, although this is likely to stabilise within the historical range as the bathymetry adjusts to the new hydrodynamic regime over the longer term. The potential sedimentation impacts for the proposed development footprint from a severe tropical cyclone event was assessed based on modelling of TC Olwyn (2015) and TC Vance (1999). This analysis predicts that sedimentation volumes in the development footprint from an extreme cyclone event could range from 5,000 m^3 to 10,000 m^3.

In general, there is only minor annual sedimentation volumes predicted for the proposed Berth Pocket, Turning Basin and HAC, with highest sedimentation expected to occur within the proposed navigation channel both offshore and on the lee side of the training wall as eastward littoral drift of sediment is trapped in the deeper navigation channel. Maintenance dredging of the sediment that is directed into the navigation channel will be required to maintain navigable depths in the HAC, with some form of bypassing required that can restore the natural eastward supply of sand to the eastern shoal and eastern shoreline as described above (Baird 2017).

4.3.6. Mitigation

Construction Phase

Although potential impacts on coastal processes would most likely occur following completion of the proposed construction activities, management action is required during the construction phase to ensure that any potential future impacts are not greater in magnitude than those predicted. Therefore, the DRAFT DSDMP developed for the Proposal (**Appendix E**) includes a project specific MTs to mitigate the potential future impacts on coastal processes and subsequently ensure that ensure that the EPA's objective for coastal processes is met and the predicted EPOs are achieved. The project specific MTs for coastal processes include:

1. Dredging operations do not occur outside the defined dredge footprint.

A comprehensive set of management actions and environmental performance measures have been established to achieve the predicted EPOs and these are described in the DRAFT DSDMP (**Appendix E**).

Post-construction / Operational Phase

Maintenance Dredging (3)

Maintenance of the dredged areas is a requirement of the waterway lease that is currently being negotiated with DoT. It is proposed that a Maintenance and Monitoring Plan will be prepared to ensure that DoT are satisfied with planned arrangements for the ongoing maintenance of dredged areas as well as other aspects of maintaining the facilities. This plan will include methods to monitor and identify requirements for future maintenance dredging. Future maintenance dredging is proposed to be undertaken in accordance with the existing DoT Maintenance Dredging EQMF.

4.3.7. Predicted Environmental Protection Outcome

The proposal will result in the following EPOs with respect to coastal processes:

- A reduction in current speeds of approximately 50% through the entrance channel and central Beadon Creek, including along the eastern side of the training wall;
- A slight increase in current speeds will occur within the section of Beadon Creek immediately upstream of the dredge footprint due to the increased efficiency of the dredged entrance channel to convey ebb tide peak flows;
- The Beadon Creek tidal prism will remain largely unchanged with total inflow and outflow volumes estimated to increase by only 1%;
- Negligible change to the estuary tidal plane is predicted post-construction;
- A reduction in the capacity of the entrance to 'naturally bypass' the net eastward bound littoral drift as the deepened channel becomes a sediment trap for this material, resulting in a requirement for regular maintenance dredging to maintain navigable depths and disposal of the material on the eastern shoreline to restore the natural sand bypassing processes;
- A predicted annual sedimentation infill, and subsequent requirement for maintenance dredging to maintain navigable depths in the HAC, Turning Basin and Berth Pocket, of between 18,000 m^3 to 28,000 m^3;
- Post-dredging estimates indicate the historical rate of sedimentation (~1,700 m^3) could increase by approximately 30% (~2,300 m^3) upstream of the dredge footprint, although this is likely to stabilise within the historical range as the bathymetry adjusts to the new hydrodynamic regime over the longer term; and
- Sedimentation volumes deposited within the development footprint from an extreme cyclone event could range from 5,000m^3 to 10,000m^3.

Based on these outcomes, and in consideration of the proposed monitoring and management strategies, the Proposal activities are not expected to pose any significant residual risks to maintaining the geophysical processes that shape coastal morphology and therefore the environmental values of the coast can be protected. In relation to the Proposal, the Proponent considers that the EPA's objective for coastal processes has been met.

4.4. Marine Environmental Quality

4.4.1. EPA Objective

The EPA's objective for the factor 'Marine Environmental Quality' is:

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

4.4.2. Policy and Guidance

The following EPA policies and guidance have been considered in evaluating potential impacts on this factor:

- EPA (2016f). *Environmental Factor Guideline: Marine Environmental Quality,* EPA, Western Australia;
- EPA (2016g). *Technical Guidance – Protecting the Quality of Western Australia's Marine Environment, EPA*, Western Australia; and
- EPA (2016d). *Technical Guidance – Environmental Impact Assessment of Marine Dredging Proposals,* EPA, Western Australia.

4.4.3. Receiving Environment

Studies of marine environmental quality that are relevant to the Proposal are identified in **Table 11**.

Table 11 Receiving Environment Studies – Marine Environmental Quality

Author (Date)	Study
BMT Oceanica (2014)	BMT Oceanica (2014). Beadon Creek Maritime Facility Capital Dredging Environmental Impact Assessment. Prepared for the Department of Transport, 365_01_004/1_Rev6
Chevron (2010)	Wheatstone Project Draft Environmental Impact Statement/ Environmental Review and Management Programme, Technical Appendix Q5 Sediment Quality Assessment Wheatstone Dredging Program, Western Australia.
O2 Marine (2017b)	Onslow Marine Support Base Stage 2 – Sediment Quality Investigation (Appendix D)
MScience (2013)	Wheatstone LNG Development: Water Quality Around the Proposed Nearshore Outfall. Unpublished Report to Chevron Australia by MScience Pty Ltd, MSA188R1, Perth, WA
MScience (2009)	Wheatstone LNG Development: Baseline Water Quality Assessment Report November 2009. Unpublished Report to URS Corporation by MScience Pty Ltd, MSA134R3, Perth, WA

Environmental Quality

In accordance with guidance provided in EPA (2016g), the following key factors were considered in identifying the Environmental Values (EVs) and associated environmental quality objectives (EQOs) that are applicable to the Proposal Area:

- The existing EQMF described for Onslow in the *Pilbara Coastal Water Quality Consultation Outcomes* (DoE, 2006);
- The ecological values of the marine waters, including the presence of BCH (Refer to **Section 4.2.2**) and marine fauna (Refer to **Section 4.5.3**) that utilise the area;
- Existing operations of the Beadon Creek Maritime Facility, including the OMSB Land-back Wharf facility;
- Recreational and commercial use of the marine waters by the local community, industry and tourism operators (Refer to **Section 3.2**);
- The use of the marine waters to support commercial fishing operations (Refer to **Section 3.2**);
- The cultural values of the marine waters, specifically including the importance of the mythological water serpent *Warnamankura* (Refer to **Section 5; Table 16**); and

- Onslow Salt's requirement for industrial water supply in the upper eastern tributary of Beadon Creek.

In consideration of the above key factors, the EVs and associated EQOs defined in EPA (2016g), that are considered relevant to the Proposal Area are identified in **Table 12**.

Table 12 Environmental Values and Environmental Quality Objectives

Environmental Values	Environmental Quality Objectives
Ecosystem Health	EQO1: Maintenance of ecosystem integrity. EQO1 can be split into four sub-objectives, being Maximum, High, Moderate and Low Levels of Ecological Protection (LEPs). However, the following sub-objectives are applicable to the Proposal Area (Figure 7): • Moderate LEP: Beadon Creek, adjacent to the Beadon Creek Maritime Facility; and • High LEP: Beadon Bay and the upper tributaries of Beadon Creek.
Recreation & Aesthetics	EQO2: Water quality is safe for primary contact recreation (e.g. swimming and diving). EQO3: Water quality is safe for secondary contact recreation (e.g. fishing and boating). EQO4: Aesthetic values of the marine environment are protected.
Fishing and Aquaculture	EQO5: Seafood (caught) is of a quality safe for human consumption.
Cultural & Spiritual	EQO6: Cultural and spiritual values of the marine environment are protected.
Industrial Water Supply	EQO7: Water quality is suitable for industrial use.

The existing Environmental Quality Plan (EQP) for Onslow (including Beadon Creek) (DoE, 2006), which identifies the spatial areas designated with a 'Moderate' or 'High' Level of Ecological Protection (LEP) is presented in **Figure 7**.

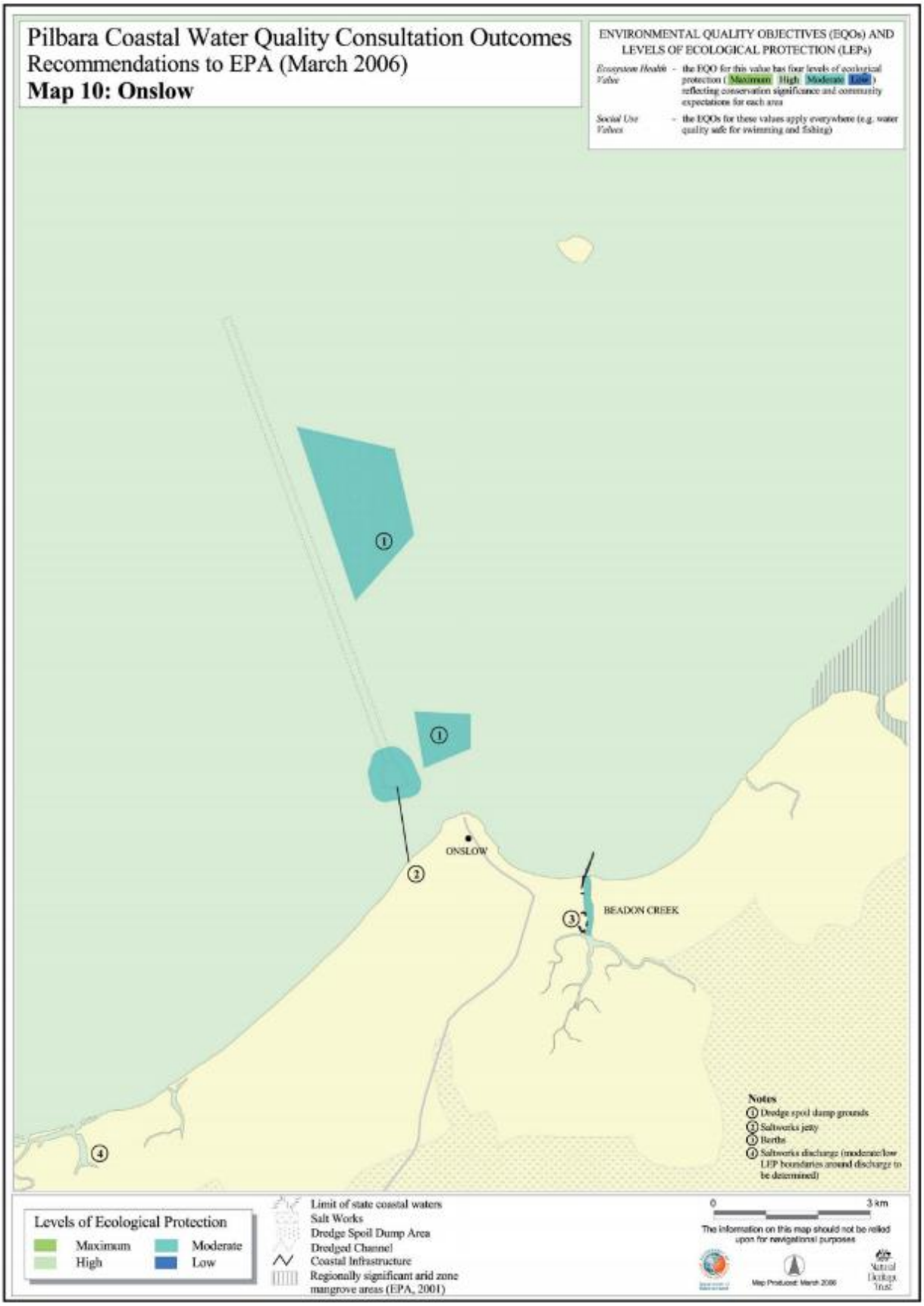


Figure 7 Environmental Quality Plan for Onslow (Including Beadon Creek) (DoE, 2006)

Marine Sediment Quality

O2 Marine (2017b) undertook a Sediment Quality Assessment to determine the quality of the material to be dredged and disposed of onshore within the proposed DMMA (**Appendix D**). The assessment included both preliminary and detailed site investigations in accordance with the DER (2014) guidelines for the *Assessment and Management of Contaminated Sites*.

Preliminary Site Investigation

The preliminary site investigation reviewed historical sediment investigations and sources of contaminants and identified that, except for tributyltin (TBT), there are no known contaminants of potential concern within the capital dredge areas. Therefore, all areas were classified as being as *"probably clean"*. An area adjacent to the proposed community boating precinct and the southern boundary of the OMSB wharf was identified with elevated TBT during sampling undertaken in 2012 for Stage 1 capital dredging (BMT Oceanica 2014). The surface 1.5 m to 3.5 m depth of contaminated sediment material from the Berth Pocket has been removed during Stage 1 capital dredging and sampling previously identified the underlying natural geological materials are clean. Historical sampling has also identified potential acid sulphide soils (PASS) within creek sediments during investigations in 2009 and 2012. However, all testing predicted that the natural alkalinity of the sediments would neutralise the acidity generated from oxidising the material during onshore disposal.

Outcomes of the preliminary site investigation provided a basis for determining the scope of the detailed site investigation, including defining the contaminants of potential concern (CoPC) and identifying the number, depth and location of required sampling (O2 Marine 2017b).

Detailed Site Investigation

A detailed site investigation was undertaken by O2 Marine in March 2017. A total of 49 surface and subsurface samples were collected from 26 sediment sampling locations during the field survey. Sediment samples were collected through a combination of vibracoring, sediment grabs and a test pit was dug for sediments at one (1) intertidal site during low tide. Observations and a screening test for PASS was undertaken prior to sediments being homogenised and packed into laboratory containers. Collected sediment samples were sent to a NATA-accredited laboratory for testing of:

- Physical Sediment Characteristics: Particle size analysis (PSA), total organic carbon (TOC), moisture content;
- Inorganic Compounds: Metals and Metalloids (Al, Ag, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Sb, V and Zn);
- Organic Compounds: Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl benzene and Xylene (BTEX), Poly Aromatic Hydrocarbons (PAH) and Tributyltin (TBT);
- Nutrients (TN, TKN, NH_4, NO_2+NO_3, TP, FRP); and
- Acid sulfate soils (SCr).

The following key findings were made during the detailed site investigation (O2 Marine 2107b):

1. Sediments within the upper layers of the capital dredge areas were found to be typically comprised of sandy/ shelly material which is low in moisture and TOC. These properties are considered beneficial for engineering grade fill and/or reclamation projects, indicating the bulk of the material is expected to be suitable for proposed future reuse plans to expand and develop the Light Industrial Area in Onslow for the Shire of Ashburton. However, the full volume of the dredge material was not sampled and further sampling of the final material would be required to prior to reuse;

2. Geochemical laboratory testing for total metals (Al, Ag, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Sb, V & Zn), organic compounds (TPH, BTEX, PAHs & TBT) and nutrients (TN, TKN, NH4, NO2+NO3, TP, FRP), and subsequent comparison against relevant screening levels for both onshore and ocean disposal, indicate that dredging, loading (pumping) and onshore disposal of the sediments to be dredged is

unlikely to result in adverse effects to marine living resources, terrestrial living resources and human health; and

3. Potential acid sulfate soils (PASS) were detected within the dredge footprint and DER (2015) recommends an acid sulfate soil management plan should be prepared. However, results show that the natural acid neutralising capacity of the sediments provide sufficient buffering for acid-generating processes, indicating the risk of acid sulfate soils is low and the material is not likely to require treatment strategies (i.e. lime dosing neutralisation of ASS) for disposal of the material to land.

Marine Water Quality

Beadon Creek

Baseline water quality information in Beadon Creek is limited. Particularly given that previous maintenance (DoT) and capital dredging (OMSB Stage 1) campaigns have not been required to describe or monitor baseline water quality conditions within Beadon Creek prior to, or during dredging. The only exception being targeted TBT monitoring undertaken during OMSB Stage 1 capital dredging, which was an EPA requirement whilst dredging an area of TBT-contaminated sediment.

Although baseline water quality information for Beadon Creek was limited at the time of this referral submission, during stakeholder consultation Onslow Salt agreed to make available their routine water quality monitoring data to the Proponent to assist in developing an appropriate water quality monitoring program (WQMP), which is a requirement of the DRAFT DSDMP (**Appendix E**).

Onslow Nearshore Region

To support preparation of environmental approval documents for Chevron's Wheatstone Project, MScience (2013) undertook a comprehensive study to characterise the baseline water quality conditions of the nearshore areas (0.5-1km) of the Onslow region, in which the OMSB Stage 2 Proposal is located. The key findings of the MScience (2013) study are summarised in Chevron (2016) and included:

- Toxicants:
    - For the waters around Onslow, the background 95th percentile of concentrations of Cd, Cr, Mg, Mo, Ni, V and Hg were below the ANZECC & ARMCANZ (2000) guideline values for 99% or 90% species protection levels;
    - Concentrations of As, Cu, Pb and Se in the waters around Onslow, were below the reporting limit and/or the ANZECC & ARMCANZ (2000) guideline values for 99% or 90% species protection levels. However, the reporting limit for these elements was occasionally above the guideline or low reliability guideline value;
    - The 95th percentile concentration of zinc exceeded the guideline value for 99% species protection (High LEP) in the waters around Onslow, but not 90% species protection (Moderate LEP);
    - Oil and grease was rarely detectable and median concentration was always below 5 mg/L (MScience 2013); and
    - Overall, the MScience (2013) results indicate that the water quality guidelines for 99% and 90% species protection for all elements, except possibly Zn, are suitable for application to the waters around Onslow.
- Nutrients:
    - For nitrogen-based water quality parameters (total nitrogen, nitrates + nitrites), background median concentrations were above the recommended guidelines specified in ANZECC & ARMCANZ (2000). The results of MScience (2013) therefore indicate that the water quality

guidelines recommended in ANZECC & ARMCANZ (2000) for nutrients are not suitable for application to the nearshore waters around Onslow;
    - The median concentrations for both total phosphorus and FRP were below the ANZECC & ARMCANZ (2000) default guideline values although individual samples of total phosphorus did, at times exceed the guideline value (MScience 2013); and
    - Based on the outcomes of this study, Chevron (2016) adopted locally-relevant triggers for nitrogen and phosphorus compounds, that were calculated in accordance with ANZECC and ARMCANZ (2000).
- Other Physical and Chemical Parameters:
    - MScience (2013) found that turbidity, temperature and salinity were highly variable and can change sharply over short periods of time.
- Biological Parameters:
    - Total coliforms measured were well below guideline values for recreational water use (MScience 2013).

An earlier Wheatstone study also undertaken by MScience (2009), provides a comprehensive characterisation of baseline turbidity, total suspended solids (TSS) and light attenuation for the nearshore and offshore marine waters of the Onslow region. The study considers a combination of MODIS imagery, *in-situ* instrument measurements and targeted field surveys to define the seasonal variation for each of these parameters. Key findings for the nearshore waters of Onslow, based on interpretation and validation of the MODIS imagery included (MScience 2009):

- Median turbidity ranged from 1.1 NTU in Winter to 2.4 NTU in Summer, with 80th percentile values of 2.9 NTU and 5.6 NTU respectively;
- Median total suspended solids (TSS) ranged from 2.8 mg/L in Winter to 4.6 mg/L in Summer, with 80th percentile values of 5.2 mg/L and 8.1 mg/L respectively; and
- Median light attenuation ranged from 0.11 E, m-1 in Winter to 0.18 E, m-1 in Summer, with 80th percentile values of 0.20 E, m-1 and 0.31 E, m-1 respectively.

It is noted that whilst the above values presented in MScience (2009) are representative of the nearshore region of Onslow, they include deeper waters i.e. >10m depth and extend out to 8km from the coastline. Therefore, it is likely that the median values presented above are lower than what would be expected in the shallower coastal waters of the Proposal Area.

4.4.4. Potential Impacts

Construction Phase Impacts

During the construction phase of the Proposal, the following activities and resulting impacts have the potential to adversely affect marine environmental quality near the Proposal:

1. Dredging activities in Beadon Creek (Turning Basin and Berth Pocket) and Beadon Bay (HAC) have the potential to:
    a. Increase turbidity, suspended sediment concentrations and deposition rates;
    b. Alter the physical characteristics of adjacent sediments;
    c. Mobilise contaminants contained within the sediments; and
    d. Reduce water clarity and light over quite large areas.

2. Tail water discharge from the DMMA to the Western tributary of Beadon Creek has the potential to:
    a. Result in localised increases in turbidity, suspended sediment concentrations and deposition rates within the Western tributary of Beadon Creek;
    b. Release contaminants to the environment;

c. Result in localised changes to the physical and/or chemical characteristics of the receiving waters;
d. Enrich receiving water and sediment with nutrients.

3. There is potential for a hydrocarbon release into the marine environment from a vessel spill and or bunkering operations during construction.

Post-construction / Operational Phase Impacts

The following post-construction or operational phase impacts have the potential to adversely impact on marine environmental quality within the Proposal Area:

4. Vessel spill or collision may result in hydrocarbon release into the marine environment.

4.4.5. Assessment of Impacts

Construction Phase Impacts

Dredging: Increase Turbidity, Suspended Sediment Concentration and Deposition Rates (1a)

Dredging operations are expected to result in localised increases to turbidity, SSC and deposition rates. This potential impact on EQO1 for the EV '*Ecosystem Health*', is discussed and assessed in the context of the extent, duration and severity of the potential impact on BCH and marine fauna in **Section 4.2.5** in **Section 4.5.5**, respectively.

Increases in turbidity also have the potential to temporarily compromise EQO7 for protection of the EV '*Industrial water supply*' at the Onslow Salt seawater intake which requires turbidity <10 NTU to be maintained in the upper reaches of the eastern tributary of Beadon Creek. Modelling of dredge plume extent within Beadon Creek was not previously undertaken or required for historic maintenance (DoT) and capital (OMSB Stage 1) dredging campaigns in Beadon Creek (same locations as the Proposal). Therefore, little information exists to accurately quantify the risk of this potential impact on Onslow Salt's industrial water supply requirements. However, it is noted that the dredge plume extent recorded during OMSB Stage 1 did not indicate plume migration towards the Onslow Salt seawater intake. Furthermore, the successful completion of OMSB Stage 1 capital dredging and other previous maintenance dredging campaigns in Beadon Creek, without a reported deterioration of industrial water supply quality, provides a strong indication that this potential impact represents a relatively low risk that can be effectively managed. Proposed monitoring and management strategies are provided in **Section 4.4.6**.

Dredging: Alteration of the Physical Characteristics of Adjacent Sediments (1b)

Alteration of in-situ sediments nearby from deposition of dredge sediments is a common impact that has been previously observed during other Pilbara dredging programs (Chevron 2017; MScience 2013). State of the Marine Environment (SOME) reporting for Chevron's Wheatstone Project documented an observed decrease in fines content with increasing distance from the dredged channel. Specifically, gradient sampling from the channel reported an increase in the concentration of fines within 750 m of the channel between baseline and post-development surveys (Chevron 2017). Whilst smaller changes in the percentage of fines were observed between 750-1500 m from the channel (Chevron 2017).

As discussed in **Section 4.2.5**, a much smaller dredge is proposed for this Proposal than was used for Wheatstone, therefore production rates of only a quarter (i.e. best case) and a third (i.e. worst case) of that achieved during Wheatstone have been used to derive the ZoI, ZoMI and ZoHI. Based on the same logic, it is expected that changes to the physical characteristics of sediment (i.e. increase in fines concentration) are likely to be observed out to approximately 375 – 500 m of the HAC footprint. The extent of changes to the physical characteristics of the sediment in the areas adjacent to the HAC are restricted to being within the

ZoHI for sediment deposition presented in O2 Marine (2017a) (**Appendix B**). Therefore, these changes are not considered to represent a significant additional impact.

Changes to the physical characteristics of the sediments in Beadon Creek are not expected as the currents in Beadon Creek are sufficient to transport any fine material mobilised during dredging into Beadon Bay (Baird 2017). The fine material disturbed during dredging in Beadon Creek is therefore likely to be deposited on the shallow sand delta located on the eastern side of the HAC, i.e. where fine material from Beadon Creek is currently deposited (Baird 2017).

Dredging: Mobilisation of Contaminants in Sediments (1c)

The Sediment Quality Assessment undertaken by O2 Marine (2017b) found that the concentration of CoPC (i.e. total metals, organic compounds and nutrients) in the material to be dredged were below the relevant screening levels for both onshore and ocean disposal. These results indicate that dredging or disturbance of the sediments is unlikely to result in adverse effects on marine environmental quality. Therefore, in consideration of potential impacts associated with mobilisation of contaminants, EQO1 for the EV '*Ecosystem Health*' is unlikely to be affected in either the Moderate or High LEP areas shown in **Figure 7**.

Dredging: Reduce Water Clarity and Light (1d)

Reduction in water clarity and light as a result of increased SSC, poses a risk to BCH and marine fauna. This potential impact on EQO1 for the EV '*Ecosystem Health*', is discussed and assessed in the context of the extent, duration and severity of the potential impact on BCH and marine fauna in **Section 4.2.5** in **Section 4.5.5**, respectively.

Tail Water Discharge: Increase Turbidity, Suspended Sediment Concentration and Deposition Rates (2a)

Increases to turbidity, SSC and deposition rates within the upper reaches of the western tributary of Beadon Creek, resulting from tail water discharge operations are possible. However, the DMMA includes adequate area to ensure sufficient residence time for settling of fines prior to controlled (i.e. weir box) and monitored (i.e. turbidity) discharge of tail water back to the intertidal area of Beadon Creek. Moreover, the final design of the DMMA will be optimised to ensure that fines are settled prior to discharge. Further details regarding proposed monitoring and management to mitigate this risk are provided in **Section 4.4.6**.

Although uncontrolled tail water discharge poses a moderate risk of increasing turbidity, SSC and deposition in Beadon Creek, the proposed monitoring and management strategies to mitigate this risk are considered sufficient to reduce the likelihood of the risk, such that the resulting potential impacts will not be significant.

Tail Water Discharge: Release Contaminants to the Environment (2b)

The Sediment Quality Assessment undertaken by O2 Marine (2017b) found that the concentrations of CoPC (i.e. total metals, organic compounds and nutrients) in the material to be dredged and disposed of onshore were below the relevant screening levels for both onshore and ocean disposal. These results indicate that onshore disposal and subsequent dewatering of this material is unlikely to result in adverse effects on marine environmental quality. Therefore, EQO1 for the EV '*Ecosystem Health'* is unlikely to be affected by release of contaminants to the environment in the western tributary of Beadon Creek which is designated as a High LEP area (**Figure 7**). However, despite the low risk of potential contaminant release through tail water discharge, additional monitoring of dissolved metals and TBT at the tail water discharge is proposed to occur during the first month of dredging. Further details regarding the proposed monitoring and management to mitigate this risk is provided in **Section 4.4.6**.

Based on the outcome of sediment quality assessment and in consideration of the monitoring and management proposed, the risk of contaminant release to the marine environment through tail water discharge is considered to be very low.

Tail Water Discharge: Changes to the Physical and/or Chemical Characteristics of the Receiving Waters (2c)

Tail water quality has the potential to be slightly outside of the natural pH, temperature and salinity range of the receiving environment waters within Beadon Creek. Therefore, it is possible that there may be some localised (within 100-300m) changes in these water quality characteristics within the western tributary of Beadon Creek as the tail waters are mixed. This may result in temporary impact on EQO1 for the EV '*Ecosystem Health*' in the upper western tributary of Beadon Creek which is designated as a High LEP area (**Figure 7**). Differences between the pH, temperature and salinity of the tail water and receiving environment waters are expected to be minimal and the extent, duration and severity of this impact is proposed to be managed through implementation of the water quality monitoring program, together with reactive control of the tail water discharge as required. Further details regarding proposed monitoring and management to mitigate this risk are provided in **Section 4.4.6**.

Any deleterious effects to the physical and/or chemical characteristics of the receiving environment water quality as a result of tail water discharge are expected to be temporary and confined to a relatively localised area within the upper western tributary of Beadon Creek. Furthermore, the proposed monitoring and management strategies to mitigate this risk are considered sufficient to reduce the likelihood of the risk, such that the resulting potential impacts will be insignificant.

Tail Water Discharge: Enrichment of Receiving Water and Sediment with Nutrients (2d)

The Sediment Quality Assessment undertaken by O2 Marine (2017b) found that the concentration of nutrients in the material to be dredged and disposed of onshore were below the relevant screening levels for both onshore and ocean disposal. These results indicate that onshore disposal and subsequent dewatering of this material is unlikely to result in adverse effects on marine environmental quality as a result of nutrient enrichment.

There is a slight potential for elevated nutrients to enter the receiving environment water column during dewatering of the dredge material in the event that extended periods of inundation of dehydrated algal mats in the intertidal zone promotes productivity and increases the export of biologically available nitrogen (O2 Marine 2017a). Organic nitrogen, nitrates and ammonium are all lost from the mats and typically enter a relatively complex cycle of export to marine waters, uptake by primary producers (mangroves and samphires) and geochemical mineralisation and immobilisation in intertidal sediments. Export is principally organic nitrogen and estimates for the Pilbara coast indicate export values of 68 kg of N/ha/yr (Paling & McComb 1994). Due to flooding of the intertidal areas it is plausible that this process may be modified resulting in reduced recycling of nitrogen in the intertidal zone and slightly higher concentrations entering the estuarine environment. However, it is also possible that the mats will be grazed directly by invertebrates which are usually restricted to lower salinity environments and the production and nutrient cycling from within the predicted sheet-flow path will be reduced.

Vessel Operations: Potential Hydrocarbon Spill (3)

There is potential for a hydrocarbon release into the marine environment from a vessel spill and or bunkering operations during dredging. However, this risk is inherent in all dredging operations and can be effectively managed through application of standard operating procedures. Nevertheless, the DRAFT DSDMP (**Appendix E**) includes proposed monitoring and management strategies to mitigate this risk.

Post-construction / Operational Phase Impacts

Vessel Operations: Potential Hydrocarbon Spill (4)

Increased vessel traffic within Beadon Creek and the HAC, increases the risk of vessel collision and associated accidental hydrocarbon spill. Although hydrocarbon spills are possible, the risk of significant hydrocarbon spill is considered to be very low, but is inherent in all operational port facilities. Standard operational management practices regulated by the DoT are considered adequate to effectively mitigate this risk. Further details regarding how these standard operating practices have been adopted is provided in **Section 4.4.6**.

4.4.6. Mitigation

Construction Phase Impacts

The DRAFT DSDMP developed for the Proposal (**Appendix E**), includes project specific MTs to mitigate the potential construction phase impacts on marine environmental quality and subsequently ensure that the EPA's objective for marine environmental quality is met and the predicted EPOs are achieved. The project specific MTs for marine environmental quality include:

1. Maintain water quality to achieve:
    - A High level Level of Ecological Protection at the tail water discharge (Weir box) and within the western tributary of Beadon Creek during tail water discharge; and
    - A High Level of Ecological Protection in the remaining upper tributaries of Beadon Creek.
2. Manage vessel bunkering, chemical storage and spill response to ensure no adverse impacts to the marine environment.
3. Maintain water quality to meet industrial water supply criteria for Onslow Salt's seawater intake.

For each of the above project specific MTs, a comprehensive set of management actions and environmental performance measures have been established and are described in the DRAFT DSDMP (**Appendix E)**.

It is further considered that achieving the above project specific MTs will subsequently result in achieving the EQOs for the other EVs identified in **Table 12**, but not specifically addressed above (i.e. Recreation & Aesthetics', 'Fishing' and 'Cultural and spiritual').

Post-construction / Operational Phase Impacts

The requirements for management of vessel operations to/from the OMSB are regulated by the Beadon Creek Maritime Facility Manager (DoT). In accordance with DoT waterway lease requirements, the Proponent has developed an Information Handbook to advise facility users of the operational requirements of the facility. The DRAFT OMSB Information Handbook is currently being reviewed by the DoT.

In general, the Proponent considers that the potential for operational phase impacts of the Proposal on marine environmental quality represents a very low risk. It is further noted, that the existing EQP does not require amendment to accommodate any of the operational aspects of the Proposal.

4.4.7. Predicted Environmental Protection Outcome

The proposal will result in the following predicted EPOs with respect to marine environmental quality:

- A temporary decline in marine water quality in the immediate vicinity of dredging operations due to increased turbidity and SSC, release of mobilisation of contaminants is not expected;
- A potential slight decline in marine water quality in the High Ecological Protection Area in the east arm of Beadon Creek during dewatering operations; and
- No residual impact on marine environmental quality as a result of the Proposal activities.

Based on these EPOs, and in consideration of the proposed monitoring and management strategies, the Proposal activities are not expected to pose any significant residual risks to maintaining the quality of water, sediment and biota and therefore the environmental values can be protected. In relation to the proposal, the Proponent considers that the EPA's objective for marine environmental quality has been met.

4.5. Marine Fauna

4.5.1. EPA Objective

The EPA's objective for the factor 'Marine Fauna' is:

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

4.5.2. Policy and Guidance

The following EPA policies and guidance have been considered in evaluating potential impacts on this factor:

- EPA (2016h). *Environmental Factor Guideline: Marine Fauna,* EPA, Western Australia.

4.5.3. Receiving Environment

Studies of marine fauna that are relevant to the Proposal are identified in **Table 13**.

Table 13 Receiving Environment Studies – Marine Fauna

Author (Date)	Study
O2 Marine (2017a)	Onslow Marine Support Base Stage 2 – Ecological Site Investigation (Appendix B; Chapter 3)
CWR (2010)	A Description of Mega Fauna Distribution and Abundance in the SW Pilbara Using Aerial and Acoustic Surveys –Final Report 2010
Pendoley (2010)	Marine Turtle Beach Survey: Onslow Mainland Area and Nearby Islands 25 January – 6 February 2009
RPS (2010a)	Marine Turtles Technical Report
RPS (2010b)	Marine Mammals Technical Report
RPS (2010c)	Dugong Aerial Survey Report
URS (2010b)	Intertidal Habitats of the Onslow Coastline
URS (2010e)	Biota of subtidal habitats in the Pilbara Mangroves, with particular reference to the Ashburton Delta and Hooley Creek
URS (2010f)	Survey of Fish in Hooley Creek and North-eastern Lagoon of the Ashburton Delta
Kangas *et al.* (2006)	Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia
Bamford *et al.* 2009	Survey for Migratory Birds in the Wheatstone LNG Project Area, November 2008 and April 2009. Wheatstone Project Draft EIS/ERMP Appendix K1.
Huisman (2008)	Marine Introductions into Western Australian Waters. Records of the Western Australian Museum 24: 323-366.

Threatened and Migratory Species

Database searches for threatened and migratory marine fauna were obtained from the DoEE Protected Matters Search Tool, the Department of Biodiversity, Conservation and Attractions (DBAC, formerly Department of Parks and Wildlife) Threatened (Declared Rare) and Priority Fauna database and the Threatened and Priority Fauna List, Naturemap and the Atlas of Living Australia. These results were then assessed for the potential to occur in the proposal area. Results of the searches and the desktop review are presented in O2 Marine (2017a).

The assessment identified four mammals, seven reptiles, five elasmobranchs and nine birds listed as threatened under the EPBC Act, WC Act or the International Union for Conservation of Nature (IUCN), were described as having a "moderate or higher potential to occur".

Marine Mammals

Listed threatened marine mammals from the search include the humpback whale (*Megaptera novaeangliae*), dugong (*Dugong dugon*), Australian snubfin dolphin (*Orcaella heinsohni*) and Australian humpback dolphin (*Sousa sahulensis*). All threatened species are also listed as migratory. A further three whale species and six dolphin species are listed as migratory and/or marine under the EPBC Act (O2 Marine 2017a).

Humpback whales migrate annually from Antarctic feeding grounds to the Kimberley coast for calving during the winter. The humpback whales predominantly occur further offshore. The southern migration is the period when they are closest to shore at an average of 36 km although have been recorded in waters less than 10 m deep during the latter part of the migration (September to November). Other whales recorded in the region are believed to only transit through oceanic waters well offshore from the shallow waters of the Proposal Area (CWR, 2010; RPS 2010b).

It is considered that at least some dugongs are resident in the area year-round but with seasonal variation in density. Dugongs have been predominantly sighted in water depths less than 10 m during aerial surveys as predominantly occurring in the South-west and North-east portion of the Onslow region (i.e. towards Exmouth Gulf and east of the Mangrove Islands, respectively), and less dense clusters were observed near areas of known seagrass habitat at Coolgra Point (although seldom within the proposal area) (CWR, 2010; RPS, 2010c).

The Australian humpback dolphin and Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) are likely to be the most abundant dolphin species in the proposal area inside the 20 m isobath. The Australian snubfin dolphin has also previously been recorded in the region but is presumed to be an occasional visitor from the Kimberley region. These dolphin species occur throughout the region likely to be present in shallow and nearshore waters of the Onslow region at any time. Other species of dolphin most likely occur further offshore from the proposal depths (CWR, 2010; RPS 2010b).

Reptiles

Listed threatened reptiles from the search include five turtle species, the short-nosed sea snake (*Aipysurus apraefrontalis*) and the salt-water crocodile (*Crocodylus porosus*). Only the short-nosed sea snake is not also listed as migratory. A further 13 sea snake species are listed marine under the EPBC Act (O2 Marine 2017a).

Green (*Chelonia mydas*) and flatback turtles (*Natator depressus*) are known to occur in the Onslow region during all sensitive life-history phases (mating, nesting and inter-nesting) and may be present all year round. Loggerhead (*Caretta caretta*) and hawksbill turtles (*Eremochelys imbicata*) are less abundant and their distribution in the Onslow region is unclear. Leatherback (*Dermochelys coriacea*) and olive ridley turtles (*Lepidochelys olivacea*) have not been previously recorded in the Onslow region, nor are they known to nest in the Pilbara. Flatback, green turtles and hawksbill turtles typically nest on offshore islands in the area except for 'low level' flatback turtle nesting on the mainland, with most marine turtle nesting at the Ashburton River delta beach and 1 or 2 isolated nests have been recorded at Onslow's Sunset Beach (known as "back beach") and between Beadon Point and Coolgra Point. The level of flatback turtle nesting along mainland beaches is not regionally or even locally significant and none of the mainland beaches surveyed are considered to support locally or regionally significant breeding colonies (Pendoley 2010). The most abundant turtles in the area are typically green turtles observed around the islands (CWR 2010, RPS 2010a). These turtles are likely to be residents at their foraging grounds in seagrass and algal habitats, with boat-based surveys finding highest densities (82.7%) were observed at shallow offshore reefs (RPS 2010a).

Five species of sea snake were captured in the trawl net from three surveys of Exmouth Gulf and Onslow between March and November 2004. This includes the threatened short-nosed sea snake (*Aipysurus apraefrontalis*) (1), and listed marine species dubois' sea snake (*Aipysurus duboisii*) (12), olive sea snake (*Aipysurus laevis*) (2), olive-headed sea snake (*Disteira major*) (1) and stoke's sea snake (*Disteira stokesii*) (1).

All sea snakes were caught either in the southern or central part of Exmouth Gulf but not near Onslow (Kangas *et al.* 2006).

There have been isolated records of the salt-water crocodile in the Ashburton River presumed to be an occasional visitor from the Kimberley region (URS 2010e).

Elasmobranch

Listed threatened elasmobranchs from the search include two sawfish species, the whale shark (*Rhincodon typus*), white shark (*Carcharodon carcharias*) and whitespotted guitarfish (*Rhynchobatus australiae*). Of these species, the whitespotted guitarfish is the only species not listed as migratory. One sawfish species and two species of Manta Ray are also listed as Migratory under the EPBC Act (O2 Marine 2017a).

Three species of sawfish are known from the Onslow area, including the green sawfish (*Pristis zijsron*), the freshwater sawfish (*Pristis pristis*) and the narrow sawfish (*Anoxypristis cuspidata*). In addition, the western extent of the dwarf sawfish's (*Pristis clavata*) range has not been fully resolved, and this species may therefore also occur in the Onslow region. Green sawfish were captured in the creeks and rivers to the west of Beadon Creek (i.e. Four-Mile Creek, Hooley Creek, Ashburton Delta & Ashburton River). The mouth of the Ashburton River is suggested to be an important pupping ground for green sawfish and after approximately 3 to 6 months old they are suggested to move into adjacent creeks before moving offshore to mature at a length of about 3 m (Morgan *et al.* 2012). Freshwater species were also recorded in the upper sections of the Ashburton River. These species are born in the estuary and migrate to and remain in freshwaters for about 5 years before leaving the river to attain maturity (O2 Marine 2017a).

The potential impacts to sawfish from the proposal was raised as an item to address during a pre-referral meeting held with the EPA. O2 Marine sought independent technical advice and consultation from Dr Dave Morgan from the Centre of Fish and Fisheries Research and Dr Rory McCauley, Elasmobranch Research Scientist from the Department of Fisheries. The findings from this assessment is presented as a separate appendix in O2 Marine (2017a).

The whale shark was spotted during aerial surveys of the region approximately 30-50 km offshore of Onslow (CWR 2010). White sharks have been spotted feeding on whale carcasses in the region although the distribution is typically further south. Five white-spotted shovelnose rays were captured in the trawl net from three surveys of Exmouth Gulf and Onslow between March and November 2004 (Kangas *et al.* 2006).

Manta rays have been frequently sighted sparsely distributed in depths further offshore of 50-150 m (CWR 2010).

Birds

Listed threatened birds from the search include eight international migratory shorebirds species and the Peregrine Falcon (*Falco peregrinus*). A further 21 species of international migratory shorebirds and 24 species of seabirds are listed as marine and/or migratory under the EPBC Act (O2 Marine 2017a).

Two targeted field surveys of waterbirds from Ashburton River to Coolgra Point in November 2008 and March 2009 recorded 58 waterbird species occurring in the region (Bamford *et al.*, 2009). A total of 39 species migratory shorebird species were suggested could occur in the region, and 26 of these species were recorded during the survey. The remaining species were suggested as likely to occur as vagrants.

In November 2008, the number of individual waterbirds recorded were low (789) throughout the survey area, with a high proportion (73%) of waterbirds occurring at Onslow Town Beach on the west facing beach towards Beadon Point. It was suggested this area of Town Beach was favoured by waterbirds due to the low tidal flats being composed of fine silts and muds containing higher invertebrate abundance when compared

to coarser sand fractions along the coastline east of town beach. The reef flat at Beadon Point also provides suitable habitat for water bird species to forage and roost during low tides. (Bamford *et al*. 2009).

Much greater numbers of individual waterbirds were recorded in March 2009 (3,663) and the species present and their distributions were very different from those observed in November 2008. High numbers of waterbirds were observed near coastal claypans and flats and inland marshes which were now inundated with water following wet season rains, whereas low numbers of waterbirds were observed near the coast. The area with the greatest concentration of waterbirds occurred on the tidal flats between the ANSIA and Onslow Salt evaporation ponds, with 2,000 migratory waterbirds observed during an aerial survey. The abundance of waterbirds recorded in Beadon Creek during the survey was low (Bamford *et al.* 2009).

Fish

The search found 29 listed marine species from the order Sygnathiformes which includes the family Sygnathidae (seahorses, pipefishes, pipehorses and seadragons) and the genus *Solenostomus* (ghost pipefishes) (O2 Marine 2017a). Four species of seahorse were captured in the trawl net from three surveys of Exmouth Gulf and Onslow between March and November 2004 with diverse preferences for suitable BCH ranging from soft bottom debris, algal rubble reefs, seagrass beds and coral reefs (Kangas *et al.* 2006).

Subtidal Marine Fauna Community

The nearshore area of the Onslow region contains a low to moderate abundance of fish and invertebrates, with species richness typically ranging from low close nearshore to high further offshore. Marine species within the nearshore area are predominantly tropical and are short lived with high productivity, resulting in life-history traits of high fecundity and high productivity and high input into reproduction during their relatively short life spans. Most species are locally and regionally widespread with dominant species comprising a high proportion (i.e. ~80-90%) of marine fauna present. Dominant fishes and invertebrates typically recorded are those known to inhabit muddy/sediment (trawling grounds) habitats which include ponyfish, goatfish, flathead or crabs and prawns, and the mantis shrimp. However, some dominant fish also suit reef and weed habitat (Kangas *et al.* 2006).

Intertidal Marine Fauna Community

An assemblage of fishes and invertebrates is commonly associated with mangrove ecosystems, with some dependant on mangrove ecosystems. Conspicuous among these are fishes known as mud-skippers, certain gastropod molluscs of the families Neritidae, Littorinidae, Potamididae and Ellobiidae, some barnacles, sesarmid and ocypodid crabs and several species of mud lobster and ghost shrimps. All species belong to taxa that are widespread in the Indo-Pacific region or are endemic to shores of the NW Shelf but have biogeographic affinities with that region. Many of the fish in mangrove creeks are occasional and sporadic visitors to the system that enter opportunistically during high tides and include groups such as sharks, longtoms, trevallies, queenfish, mackerel, pike and flatheads (URS 2010b, URS 2010e, URS 2010f).

Marine fauna in the algal mat zone are rare, although insects and insect larvae are sometimes seen under the algal mats. The salt flats are predominantly devoid of marine invertebrates (URS 2010b).

Commercial Fisheries

Commercial fisheries possibly occurring in the proposal area include (O2 Marine 2017a):

- Onslow Prawn Trawl Managed Fishery (OPMF);
- Sea Cucumber (Beche de Mer) Fishery;
- Marine Aquarium Fish Managed Fishery;
- Pearl Oyster Managed Fishery (Zone 1);
- Pilbara Line Fishery;

- Pilbara Developmental Crab Fishery; and
- Specimen Shell Managed Fishery.

Invasive Marine Species

No introduced marine species listed as species of concern on the National Introduced Marine Pests Coordination Group have been recorded in the Onslow region (Huisman *et al.* 2008). One introduced species, the barnacle *Megabalanus tintinnabulum* has been recorded in Onslow (Huisman *et al.* 2008). This species is not considered a pest, and has been recorded at several other WA ports.

4.5.4. Potential Impacts

The following activities and resulting impacts have the potential to adversely affect marine fauna near the Proposal:

1. Dredging activities that change the characteristics of the marine and coastal environment:
    a. Direct removal (permanent loss) of subtidal BCH within the proposed HAC;
    b. Direct removal (permanent loss) of intertidal BCH within the proposed HAC;
    c. Indirect potential impacts (irreversible loss and recoverable impacts) on subtidal BCH from increased turbidity, reduced light, sedimentation;
    d. Indirect potential impacts (irreversible loss and recoverable impacts) on intertidal BCH from sedimentation; and
    e. Indirect potential impacts (irreversible loss and recoverable impacts) from changing the hydrodynamics and flushing of Beadon Creek due to modification of the bathymetry at the mouth of the creek.
2. Onshore disposal activities at the proposed DMMA have the potential to cause:
    a. Direct removal (permanent loss) of intertidal BCH within the proposed DMMA;
    b. Direct removal (irreversible loss) of intertidal BCH within the proposed pipeline route to the DMMA;
    c. Indirect potential impacts (recoverable impacts) on intertidal BCH through tail water discharge from the DMMA to the Western tributary of Beadon Creek; and
    d. Indirect potential impacts (irreversible loss and recoverable impacts) on intertidal BCH through fine suspended sediments in tail water discharge from the DMMA.
3. Accidental spills and uncontrolled discard of wastes have the potential to cause:
    a. Toxicity and direct oiling causing fatalities and/or impact on critical habitat; and
    b. Entanglement or ingestion of debris.
4. General activities which have the potential to cause:
    a. Underwater noise emissions from dredging and vessel movements;
    b. Human presence at critical marine fauna habitat;
    c. Interaction with vessels during construction and operations;
    d. Inappropriate lighting on vessels that can alter turtle behaviour;
    e. Entrainment of marine fauna during dredging; and
    f. Introduction of invasive marine species.

4.5.5. Assessment of Impacts

A detailed assessment of the potential impacts on marine fauna from the proposal is provided in O2 Marine (2017a). The key findings of these assessments are summarised below.

Modification of Critical Habitat

DSWEPaC (2012) classifies habitat modification as a “Concern” for dugong, turtles and sawfish and “Potential Concern” for birds, dolphins, sea snakes and finfish.

Direct removal (permanent loss) of subtidal BCH within the proposed HAC (1a)

Dredging of the HAC within nearshore waters of Onslow will result in the permanent loss of 21 ha (0.2%) of BCH mapped as seagrass/macroalgae/filter feeder within LAU 1G. The LAU 1G is comprised almost entirely of BCH mapped as seagrass/macroalgae/filter feeder except for small areas of macroalgae/filter feeder'. This habitat is locally and regionally widespread and loss of this small area is unlikely to result in significant declines in the populations, range and diversity of marine fauna. The desktop review indicates the HAC does not occur within critical marine fauna habitat (see 1c).

Direct removal (permanent loss) of intertidal BCH within the proposed HAC (1b)

Dredging to widen the existing Turning Basin will result in the direct removal of 0.8 ha of tidal lagoon habitat on the east side of Beadon Creek. The tidal lagoon is comprised of abundant fauna of burrowing ocypodid fiddler crabs (i.e. species of *Uca*) which are typical invertebrates commonly associated with mangrove ecosystems within broad expanses of bioturbated mud flats of the region. The primary coastal dune system is wider on the east bank of Beadon Creek and the lagoon forms a protected near-horizontal lower intertidal sandy beach comprised of finer sediments than sandy beaches along the coastline, which creates suitable for colonisation by the crabs.

The biodiversity in this zone is low despite a high density of crabs. Previous surveys have found the ocypodid crabs *Uca flammula* and *U. elegans* are very common and widespread along the muddy banks of the creeks, and three other species of *Uca* (*U. dampieri*, *U. capricornis* and *U. mjobergi*) were also common but patchy in their distributions (URS 2010b). These crabs play an important role for nutrient recycling in mangrove systems as key secondary producers. However, only small areas of *A. marina* seedlings/saplings have colonised the landward edges of the lagoon flat and review of historical aerial imagery from 1949 indicates mangrove trees have never established in the lagoon. Therefore, nutrient sources are likely derived from mangrove systems further upstream in Beadon Creek, and colonisation of this area by fiddler crabs is considered opportunistic rather than performing a critical role for a mangrove system. This habitat is locally and regionally widespread and loss of this small area is unlikely to result in significant declines in the population, range and diversity of marine fauna.

Dr Morgan from the Centre for Fish & Fisheries Research, Murdoch University provided advice on the behaviour of juvenile green sawfish species that inhabit the Ashburton River and tidal creek systems to the west of Beadon Creek. The Ashburton River is a known pupping site for green sawfish where pups spend at least their first few months of life, before utilising other coastal mangrove-lined tidal creeks. Neonates and juvenile sawfish spend almost all their time within shallow waters (<1 m depth) at the mouth of creeks and utilise these habitats until up to 3 m in total length before moving offshore into deeper waters. Dr Morgan recommended to undertake an assessment of the existing and proposed shallow water habitats at the mouth of Beadon Creek. The subsequent assessment determined critical shallow water habitats near the mouth of the creek have already been significantly modified from historical dredging of Beadon Creek and the proposed slope of the channel will not significantly change the continuity or area of suitable habitat on the east bank. These findings suggest that the modified entrance at Beadon Creek is not currently ideal critical habitat for green juvenile sawfish and there is more potential for significant populations of this species in the adjacent creeks and rivers to the east and west of Beadon Creek. The details of this assessment are provided in O2 Marine (2017a).

Indirect potential impacts (irreversible loss and recoverable impacts) on subtidal BCH from increased turbidity, reduced light, sedimentation (1c)

The predicted areas of potential impact on seagrass/macroalgae/filter feeder and macroalgae/filter feeder BCH are presented in **Section 4.2.4**. Predicted 'worst case' irreversible loss is 4.5% seagrass/macroalgae/filter feeder and 7.3% macroalgae/filter feeder BCH within LAU 1G, and an addition of 0.3% seagrass/macroalgae/filter feeder BCH to historical loss within LAU 1C. Potential impacts include broader

areas of predicted recoverable impacts for each of these habitats. Evaluation of the potential indirect impacts to subtidal BCH and subsequent effects on marine fauna should consider the precautionary approach applied to the assessment described in **Section 4.2.4**.

Seagrasses and algae BCH provide important feeding habitats for species of conservation significance, such as dugongs and turtles, so removal can have substantial effects on survival, distribution and feeding habits (Gales *et al.*, 2004). Vegetated coastal habitats are also known to be important for supporting fisheries production and biodiversity (e.g. Loneragan *et al.* 2013). These vegetated habitats are hypothesised to provide an enhanced food supply, increased survival due to the provision of refuges from predation, and reduced wave action and water flow that stabilises sediments for fish and invertebrates (e.g. Manson *et al.*, 2005). For example, tiger prawn stocks are associated with sheltered coastal waters and seagrass habitat, which forms the main juvenile habitat for these species (Loneragan *et al.* 2013). In turn, these areas rich in productivity and biodiversity, provide important hunting grounds for secondary order predators such as coastal dolphins, sharks and sawfish.

Dugong satellite tracking studies, aerial surveys and turtle surveys of the region identify these species typically occur in highest densities east (i.e. Mangrove Islands), west (i.e. towards Exmouth Gulf) or further offshore (i.e. surrounding islands in clearer waters) from the proposal area, with very few records within the predicted impacted area. Coolgra Point represents the closest area with potential to be considered important foraging habitat for dugongs, while green or flatback turtles are typically found foraging and nesting on reefs around the offshore islands or small numbers may occur in shallow waters near Ashburton delta on the mainland during nesting periods for flatback turtles in December/January. Surveys of BCH in the region support findings that the proposal area is comprised of relatively poor quality (i.e. low cover and dynamic) vegetated habitats for foraging compared to areas where dugongs and turtles typically congregate. Therefore, the proposal area is unlikely to represent critical habitat for the marine fauna.

The Ashburton Nursery and Coolgra Point Nursery areas for the OPMF occur to the east and west of Beadon Creek. This is the only area within the Onslow coastal region which is not designated as a nursery for the OPMF. Predicted zones of impact for SSC only slightly overlap the boundaries of the nursery areas, although turbidity at threshold concentrations developed for photosynthetic organisms on the outer boundary of the predicted plumes are unlikely to cause impact on juvenile tiger prawns which bury themselves within the sediments. Predicted impacts for sedimentation do not extend to these juvenile habitats. The proposal is therefore unlikely to cause impact to nursery areas for the OPMF.

Information on the spatial and temporal variability of faunal assemblages in nearshore Onslow prior to the commencement of commercial trawling is not available. However, Kangas *et al.*, (2006) suggests that it is likely that the faunal assemblages, biodiversity and habitats in the trawled areas of Onslow have changed significantly since trawling began. Trawling activities decrease the complexity of the habitat and biodiversity of the fauna which creates suitable colonisation habitat for opportunistic species which may benefit from the disturbance, including those that may be important for commercial fishing. The dominant fish and invertebrate species within the nearshore areas of Onslow, such as the lizardfish, leatherjacket and goatfish or commercial prawn species and portunid crabs, have been described to prefer the disturbed, low-relief, soft sediment habitats modified by trawling (Kangas *et al.*, 2006). In addition, many of the most abundant fish and invertebrate species in the area have R type life history traits with high fecundity and high productivity with high input into reproduction during their relatively short life spans. Therefore, the present habitat and associated fauna within the proposal area is likely to have been modified into communities which have adapted to frequent anthropogenic (i.e. trawling) and natural (i.e. cyclones) disturbances (Kangas *et al.* (2006). The fauna are also likely to be relatively tolerant to the effects of suspended sediments and sedimentation due to the natural turbid conditions of the nearshore environment and species present are typically widespread both locally and regionally. These findings implicate that the indirect impact of dredging activities is unlikely to significantly impact commercial fisheries and is unlikely to result in significant declines in the population, range and diversity of marine fauna.

Indirect potential impacts (irreversible loss and recoverable impacts) on intertidal BCH from sedimentation (1d)

Dredging of the Turning Basin, Berth Pocket and HAC has the potential to result in elevated sedimentation on intertidal BCH. Mangrove habitats are also known to provide feeding opportunities for green turtles especially when large numbers of propagules of *Avicennia marina* are present (Limpus & :Limpus, 2000). **Section 4.2.5** identifies that indirect potential impacts on intertidal BCH within Beadon Creek from smothering of dredging generated sediments for the Proposal is unlikely. Therefore, subsequent impacts which have the potential to result in significant declines in the population, range and diversity of marine fauna associated with the mangrove intertidal ecosystems from indirect dredging generated sediments in Beadon Creek are also considered unlikely.

The Ashburton River represents an important habitat for Banana Prawns. Postlarvae settle in the upper reaches of the estuaries and the success of juvenile populations emigrating from these estuaries correlates positively with rainfall during the wet season (Vance *et al.* 1998). The catchment area of Beadon Creek has been significantly reduced through the development of 8,000 ha of salt ponds for Onslow Salt. The Beadon Creek system has already been significantly modified and is unlikely to represent critical habitat for banana prawn stocks in comparison to areas east and west of Beadon Creek such as the Ashburton River.

Indirect potential impacts (irreversible loss and recoverable impacts) from changing the hydrodynamics and flushing of Beadon Creek due to modification of the bathymetry at the mouth of the creek (1e)

Section 4.2.5 describes that the proposal for a wider, deeper entrance channel configuration is unlikely to result in irreversible loss or recoverable impacts of intertidal BCH within the Beadon Creek tidal embayment due to alteration of hydrodynamics and flushing of Beadon Creek. The predicted changes to the tidal prism, current velocities, tidal inundation and coastal processes from proposed post-dredge modifications to the depth and width of the Turning Basin, Berth Pocket and HAC described in **Section 4.3.5**. Modelling predicts negligible changes to the hydrodynamics within Beadon Creek which are unlikely to result in significant declines in the population, range and diversity of marine fauna. Sediment transport modelling of coastal processes predicts a deeper and wider channel will restrict natural bypassing around the training wall and result in infill of the channel in this area. Maintenance dredging directed into the navigation channel will be required to maintain navigable depth in this area, with the material to be disposed of on the eastern shoreline to restore the natural eastward supply of sand. These changes are considered unlikely to cause a reduction in connectivity and environmental or lifecycle cues between estuary and marine waters.

Direct removal (permanent loss) of intertidal BCH within the proposed DMMA (2a)

The location of the proposed DMMA overlies approximately 23 ha of bare supratidal salt flats and 2.4 ha of algal mat BCH. Marine fauna in the algal mat and salt flat habitats are rare. Potential impacts to marine fauna from construction of the DMMA in the proposed location are low.

Direct removal (irreversible loss) of intertidal BCH within the proposed pipeline route to the DMMA (2b)

Two options are provided for the dredge discharge pipe route, with Option A predominantly crossing terrestrial land and Option B navigating up Beadon Creek and crossing the mudflats before connecting to the DMMA. **Section 4.2.5** describes that temporary placement of the pipeline across the intertidal zone for Option B during construction activities is estimated to be minimal at 0.1 ha (<0.1%) within LAU 0A. The predicted loss of habitat is unlikely to result in significant changes to the abundance and species diversity of the intertidal fish and invertebrate communities of the Onslow region.

Potential impacts to mangrove dedicated fauna will be reduced through closer inspection and selection of preference for unvegetated banks along the Beadon Creek western tributary for the crossing of the Option B pipeline. In the event any fringing mangrove trees are to be removed, an inspection for bird and bat species

(including the Priority 1 listed Little Northern Freetail-bat *Mormopterus loriae cobourgensis*) will be undertaken prior to removal.

Indirect potential impacts (recoverable impacts) on intertidal BCH through tail water discharge from the DMMA to the Western tributary of Beadon Creek (2c)

The discharge of return water which is less saline than the receiving environment during the dredging operation could possibly lead to modification of the salinity gradient and subsequent physical, chemical and biological functions maintaining the zonation of intertidal BCH within the area affected. The discharge is predicted to create a sheet flow of water from the DMMA to the tributary covering an area of 10.2 ha of intertidal BCH. Areas of mangroves and low-lying mudflats of the upper intertidal zone which are typically only tidally inundated during high tidal periods are expected to be permanently flooded for the duration of dewatering. This is likely to result in a temporary shift in the fish and invertebrate communities commonly associated with the mangrove and mudflat ecosystems.

There is a slight potential for elevated nutrients to enter the water column during dewatering of the dredge material in the event inundation of dehydrated algal mats promotes productivity and increases the export of biologically available nitrogen. DSWEPaC (2012) classifies nutrient pollution as a "Potenial Concern" for coastal dolphins.

Organic nitrogen, nitrates and ammonium are all lost from the mats and typically enter a relatively complex cycle of export to marine waters, uptake by primary producers (mangroves and samphire) and geochemical mineralisation and immobilisation in intertidal sediments. Due to flooding of the mudflats, invertebrate inhabitants may exit the discharge flow-path area resulting in reduced recycling of nitrogen and secondary production, and slightly higher concentrations entering the estuarine environment. However, it is also possible that the mats will be grazed directly by invertebrates which are usually restricted to lower salinity environments and the production and nutrient cycling from within the predicted sheet-flow path will be reduced.

The intertidal surveys undertaken for the Wheatstone Project revealed no intertidal species abundant within the study area as being rare elsewhere or in need of special protection. The biodiversity significance expressed in terms of local endemicity was low. All species observed during this study belonged to taxa that are widespread in the Indo-Pacific region or are endemic to the shores of the north-west Shelf but have biogeographic affinities with that region (URS 2010b). The potential impact of the flooding of the intertidal zone during dewatering is expected to be limited to invertebrate taxa of the intertidal area within the predicted discharge flow-path, which predominantly comprises surface-dwelling and burrowing invertebrates. The potential change in nutrient concentration in the water column is highly unlikely to cause any impacts on marine fauna (i.e. from algal blooms) due to the very slight increase in nutrients and the temporary nature of the activities. Once dewatering activities cease the intertidal zonation of the salinity gradients and associated marine fauna distribution will return to that which is naturally regulated by the relationship between tidal elevation and frequency of tidal inundation.

Indirect potential impacts (irreversible loss and recoverable impacts) on intertidal BCH through fine suspended sediments in tail water discharge from the DMMA (2d)

Section 4.2.5 describes that the dewatering activities can be managed to prevent the potential impacts of suspended sediments released in return waters from impacting the intertidal BCH. Therefore, subsequent potential impacts on marine fauna within the intertidal zone are unlikely through the monitoring and management of the fines concentrations in the water prior to discharge. Refer to the DRAFT DSDMP (**Appendix E**) which details the proposed monitoring and management strategies to mitigate this risk.

Toxicity and direct oiling causing fatalities and/or impact on critical habitat (3a)

Birds, dolphins, sea snakes, sharks and rays and finfish have been classified as "Potential Concern" for their vulnerability to chemical spills (DSWEPaC 2012). The main substance of concern is diesel and small amounts of lubricating oil and grease for maintenance of the dredge or vessel equipment which may be accidentally spilled during regular vessel activities (i.e. accidental discharge, collision, deck drain and refuelling).

A DRAFT DSDMP has been prepared which provides the details to minimise the risk of a spill occurring during the construction phase of the proposal. The OMSB Information Handbook (OMSB 2017) provides the details for the requirement of the logistics company which will operate the facility to prepare and implement an Oil Spill Contingency Plan.

Hazardous substances must be appropriately stored such that they do not pose a threat to the health and safety of personnel and the environment. Spill kits for accidental spillage of hydrocarbons will be kept onboard vessels and on the wharf and personnel will be trained in oil spill response. Contractors will work to the required refuelling management plans and Oil Spill Contingency Plans reviewed and approved by DoT, and in accordance with the refuelling policy for DoT maritime facilities. In the event of accidental spillage, the Contractor will cease work immediately and ensure contamination is cleaned up prior to recommencing. A comprehensive environmental incident report will then be completed and provided to the DoT.

Entanglement or ingestion of debris (3b)

DSWEPaC (2012) classifies marine pollution as a "Concern" for turtles and "Potential Concern" for coastal dolphins, dugongs and sawfish. A DRAFT DSDMP has been prepared which provides the details for waste management during the construction phase of the proposal. The logistics company which will operate the facility is to prepare a waste management plan. Wastes will be segregated and secured to avoid the potential for wind-blown wastes entering the marine environment or terrestrial areas of Beadon Creek. Contractors will work to the required waste management plans reviewed and approved by DoT, and in accordance with the waste management policy for DoT maritime facilities. This requirement is expected to be further defined in Waterway Lease agreement currently being negotiated with DoT.

Underwater noise emissions from dredging and vessel movements (4a)

DSWEPaC (2012) classifies underwater noise as "Potential Concern" for humpback whales, dolphins and turtles. Dredging during construction and vessel movements during operations are the primary underwater noise generating activities which pose a risk to marine fauna. The potential effects of pile driving underwater noise risks on marine fauna for the proposal have effectively been eliminated through the decision to use anchored navigation markers for the harbour entrance channel.

The sensitive auditory ranges of marine fauna species compared with the predicted noise broadband frequencies from dredging and vessel movements indicate that the frequencies are at the lower end of hearing sensitivity for dolphins and sirenians, and within the hearing range for baleen whales, turtles, sharks, bony fish and prawns. Temporary loss of normal hearing capabilities might occur if individuals are in the immediate vicinity of a dredge and are exposed for a long time. Most effects are short, perhaps medium-term behavioural reactions to avoid the area of dredging operations and potential masking of low-frequency calls in humpback whales.

It is considered unlikely that significant masking of low-frequency calls in humpback whales will occur due to the paucity of humpback whales likely to occur within the 10 m bathymetry isobath. The nature of the sounds from dredging activities and supply vessel movements suggests that potential impacts to marine fauna will primarily be general avoidance of the area. Information gathered on the distribution of marine fauna indicates that, except for perhaps sawfish, the proposed approach channel to be dredged does not represent critical habitat for marine fauna. This is particularly relevant due to the proposal area already being utilised

as a working harbour. In the unlikely event marine fauna are disturbed by the underwater noise generated from dredging or vessel movements and cause them to leave the area, representative habitat is widespread and suitable habitat can be found in alternative areas outside of an operational harbour.

The sawfish risk assessment O2 Marine (2017a) recommends the following mitigations to be implemented during dredging activities:

- A soft start-up procedure for each new or re-start operation;
- Use small to moderate sized dredge plant;
- The dredge is to meet industry standards for noise; and
- Regular maintenance of the dredge for efficient running machinery in accordance with manufacturers specifications.

The DoT regulates 5 knot vessel speed limits within the Beadon Creek Maritime Facility. The OMSB Information Handbook outlines the approach speed within the proposed channel are set to not more than 5 knots for supply vessels using the OMSB facility, but may be less depending on the type, size and manoeuvrability characteristics of the vessel. Underwater noise from supply vessel movements whilst travelling at 5 knots are generally expected to be less than or equal to the lower range of noise levels generated from dredging. Vessel movements are predicted to occur for short periods approximately twice daily during the operational phase of the proposal. Although this may result in localised, transient disturbance to some individuals, it is likely that impacts will be minimal, with individuals/populations potentially habituated to noise from vessel activities within the already operational harbour.

Human presence at critical marine fauna habitat (4b)

DSWEPaC (2012) classifies human presence as a “Concern” for turtles and “Potential Concern” for birds and coastal dolphins.

The proposal occurs adjacent to the existing Port of Onslow waters and the Beadon Creek Maritime Facility. This harbour facility already represents an area of intensive human use, which has developed from a small facility supporting local and charter fishing activities to what is now a significant facility supporting the myriad of industrial and commercial activities in Onslow. The human presence within Beadon Creek from the Proposal construction and operational activities is not anticipated to represent significant additional potential risks to marine fauna. The proposed dredging activity will mean a more constant presence of vessels in the area than the current movement of vessels in and out of the harbour but the proposed operational activities anticipate an increase of approximately two vessel movements daily which will not add significantly to the already busy harbour activities. Potential impacts to marine fauna from vessels and associated human presence would primarily be general avoidance of the area.

Marine turtles and seabirds are particularly sensitive while on shore for nesting or roosting and can be easily disturbed by movement and light, modification or destruction of breeding habitat, displacement of breeders, nest desertion, destruction or predation of eggs and exposure of young. The proposed activities will not disturb beaches and dune systems which provide critical nesting areas for both turtles and birds. Turtle nesting predominantly occurs on offshore islands and near the Ashburton delta beach on the mainland. Only two records of turtle nests have previously been recorded between Beadon Creek and Coolgra Point. High number of birds roosting, nesting and foraging have been recorded on Town Beach near Beadon Point. The abundance of shorebirds recorded at the mouth of Beadon Creek during the same survey was significantly lower (Bamford 2009). The pipeline route Option A is the only beach crossing activity planned. This shoreline crossing occurs on the modified area at Town Beach adjacent to the training wall to the west of the mouth of Beadon Creek. The proposed pipeline route Option B crosses the intertidal area on the extensive tidal mudflats in the western tributary of Beadon Creek adjacent to the proposed DMMA. Neither of these areas represent existing critical habitat for turtles or birds.

The DMMA and the flooded tidal area may attract feeding and roosting migratory shorebirds. The level of shore bird aggregation at the DMMA may need to be monitored if impacts to birds are likely and deterrents could be implemented to minimise impacts to birds aggregating near construction works. Further complications arise due to proximity of the DMMA to the Onslow Airport. Higher numbers of migratory shorebirds have been recorded in the area during the wet season. However, there is already a significant expanse of similarly created artificial habitat (8,000 ha) as part of the Onslow Salt field ponds surrounding the Beadon Creek catchment.

Interaction with vessels during construction and operations (4c)

DSWEPaC (2012) classifies vessel strike as a "Potential Concern" for humpback whales, dugongs and turtles.

Vessel speeds can be managed to afford greater protection of individual animals from a broad range of sensitive marine fauna to the potential impacts from vessel strikes. Laist, (2001) found significant increase in the risk of vessel collision between marine megafauna and vessels at speeds above 10 knots and more severe and lethal injuries were found to be caused by vessels travelling at speeds above 14 knots.

The likelihood of a vessel strike during dredge and construction from proposed vessel movements is considered low due to the small scale (i.e. spatial movements) of the operation and dredge plant (i.e. slow-moving and small support vessels). Similarly, the risk of vessel strike on marine fauna during the operational stage is considered unlikely due to limited movements (i.e. two vessel movements per day) and speed restrictions of less than 5 knots for the approach channel and within the Beadon Creek Maritime Facility described in the OMSB Information Handbook (OMSB, 2017) and DoT (2017). The consequence of vessel strike on marine fauna may result in injury or mortality, although potential impacts from proposal activities are unlikely to result in significant declines in the local or regional populations of species and their distribution, or reductions in the diversity of species.

Inappropriate lighting on vessels that can alter turtle behaviour (4d)

Turtles have been classified as "Concern" in relation to the vulnerability of these animals to artificial lighting (DSWEPaC 2012).

For marine turtle and seabird species, light pollution along, or adjacent to, nesting beaches or rookeries may cause alterations to critical nocturnal behaviours, particularly the selection of nesting sites and the passage of emerging turtle hatchlings from the beach to the sea. The Proposal occurs within the Beadon Creek Maritime Facility and artificial light is already present.

The impact of artificial light emissions from the vessels (dredge, support vessels) based on the potential light spill and glow reaching significant turtle habitats and/or nesting beaches and rookeries is expected to be negligible. The Wheatstone Project established a distance of 1.5 km from turtle nesting beaches as the area within which light emissions would need to be managed (Chevron, 2016). The known nearest turtle nesting beach to the proposed activities occurs on Direction Island, approximately 10 km north of the nearest point of the Proposal Area at the end of the approach channel. Two nests have been previously recorded between Beadon Point and Coolgra Point although this low level of nesting would not be regarded as a turtle nesting beach (RPS, 2010a).

Entrainment of marine fauna during dredging (4e)

DSWEPaC (2012) classifies entrainment as a "Potential Concern" for turtles.

Entrainment describes the unintentional removal of organisms by the suction field created by hydraulic dredgers. Entrainment rates depend on numerous factors, including depth, dredger type, speed, and strength of suction field. The Proposal is planning to use a small to moderate CSD. The risk of entrainment for the Proposal is not predicted to result in declines in the abundance and dispersion of conservation

significant species or the species diversity of marine fauna. However, implementation of mitigation protection methods will further reduce the risk of harm to individual animals. Proposed mitigation protection measures for entrainment include a dredging soft start-up procedure and trained observers onboard to mitigate interaction and detect injury and mortality events.

Introduction of invasive marine species (4f)

Marine pests can be introduced through ballast water exchange or via biofouling. Dredgers and supply vessels are among the vessels considered high-risk for the introduction of species.

There is a low risk of marine pests becoming established and affecting the biodiversity values and/or ecological integrity of the local environment when appropriate mitigation measures are adopted. Mitigation measures consistent with the National System for the Prevention and Management of Marine Pest Incursions, the Australian Ballast Water Management Requirements, the National biofouling management guidelines for commercial vessels reduce the risk that Proposal activities will result in the introduction of marine pests in port and inshore environments. The DRAFT DSDMP and the DRAFT OMSB Information Handbook will include management measures to mitigate the risk of invasive marine species.

4.5.6. Mitigation

Construction Phase Impacts

The DRAFT DSDMP developed for the Proposal (**Appendix E**), includes project specific MTs to mitigate the potential construction phase impacts on marine fauna and subsequently ensure that the EPA's objective for marine fauna is met and the predicted EPOs are achieved. The project specific MTs for marine fauna include:

1. No reported incidences of marine fauna injury or death as a result of turbidity impacts;
2. No reported incidences of marine fauna injury or death as a result of dredge operations;
3. No reported incidences of marine fauna injury or death as a result of vessel strike; and
4. Minimise the risk of IMP translocation to protect biological diversity and integrity.

For each of the above project specific MTs, a comprehensive set of management actions and environmental performance measures have been established and are described in the DRAFT DSDMP (**Appendix E)**.

Post-construction / Operational Phase Impacts

The requirements for management of vessel operations to/from the OMSB are regulated by the Beadon Creek Maritime Facility Manager (DoT). In accordance with DoT waterway lease requirements, the Proponent has developed an Information Handbook to advise facility users of the operational requirements of the facility. The DRAFT OMSB Information Handbook is currently being reviewed by the DoT.

The DRAFT OMSB Information Handbook will be updated to include the following management measures to mitigate potential operational phase impacts on marine fauna:

- Biosecurity
    - All vessels should comply with Commonwealth Department of Agriculture and Water Resources – Biosecurity Requirements as well as all State legislation relating to management of introduced marine organisms; and
    - Any vessels visiting the Port of Onslow from international or interstate waters are required to complete the WA Department of Primary Industries and Regional Development 'Vessel Check' risk assessment (https://vesselcheck.fish.wa.gov.au).
- Vessel Strike
    - Maximum vessel speed within all operational areas of the OMSB facility is five knots;

- All incidents of marine fauna vessel strike that occur within the operational areas of the OMSB facility are required to be reported to the harbour master.

4.5.7. Predicted Environmental Protection Outcome

The predicted EPOs of the Proposal on marine fauna include:

- No harm of individuals and/or declines in the population of the range of species protected under state legislation;
- No reductions in populations of species of local and regional importance;
- No impacts to species or groups of species that fulfil critical ecological functions within the system;
- No loss or impact to critical marine fauna habitat, including nesting beaches, nursery areas, specific foraging or breeding areas and fish spawning aggregation areas;
- No reduction in the biodiversity of marine fauna in the area; and
- No introduction and/or spread of invasive marine species or diseases.

The combined impact of the Proposal activities and the consequent outcomes are not considered to pose any significant residual risks to the protection of marine fauna and therefore biological diversity and ecological integrity can be maintained. In respect of the proposed design and management of the Proposal, the Proponent considers that the EPA's objective for marine fauna has been met.

4.6. Flora and Vegetation

4.6.1. EPA Objective

The EPA's objective for the factor 'Flora and Vegetation' is:

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

4.6.2. Policy and Guidance

The following EPA policies and guidance have been considered in evaluating potential impacts on this factor:

- EPA (2016i). *Environmental Factor Guideline: Flora and Vegetation,* EPA, Western Australia; and
- EPA (2016j). *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment,* EPA, Western Australia.

4.6.3. Receiving Environment

Studies of flora and vegetation that are relevant to the Proposal are identified in **Table 14**.

Table 14 Receiving Environment Studies – Flora and Vegetation

Author (Date)	Study
O2 Marine (2017a)	Onslow Marine Support Base Stage 2 – Ecological Site Investigation (Appendix B)
ENV Australia (ENV) (2012)	Onslow Light Industrial Area Flora, Vegetation and Fauna Assessment. Prepared for Shire of Ashburton 11/097. ENV Australia Pty Ltd.
ENV (2011)	Onslow Townsite Strategy Flora, Vegetation and Fauna Assessment. Perth, Western Australia: ENV Australia Pty Ltd.
Biota (2013)	Desktop review of the proposed Onslow Micro-Siting Survey Area. Prepared for Chevron Australia.
Earth Stewardship (2017)	Onslow Marine Support Base Stage 2 – Pipeline and DMMA Botanical Surveys

Vegetation Types

Extensive flora and vegetation survey work completed in the Onslow area was reviewed in a detailed desktop assessment of the Proposal Area and a field ground-truth survey was undertaken. This allowed vegetation units to be extrapolated and mapped within this section of the Proposal Area with reasonable confidence. The distribution of vegetation associations has been mapped from the shoreline along the proposed terrestrial pipeline route Option A to the onshore disposal site near the airport approximately 3 km south of Onslow. An alternative pipeline route (Option B) has been proposed which tracks Beadon Creek and the western arm tributary crossing the intertidal flats overlying only a small portion of terrestrial vegetation.

Seven (7) vegetation associations have been described and mapped (

Figure 8) for the Proposal Area, based on the results of previous Level 2 Flora, Vegetation and Fauna Assessments (ENV 2011, 2012; Biota 2013) and results from the O2 Marine (2017a) site assessment. These include:

1. ID3 - Inland dunes: Scattered *Acacia* and *Hakea* shrubland over hummock grassland (*Troidia*) and Tussock grassland (*Cenchrus ciliaris*).
2. CD1 - Coastal dunes: Scattered *Acacia* shrubland over low open shrubland of *Crotalaria* and *Tephrosia* over Tussock grassland (*Cenchrus ciliaris*).
3. ID4 - Inland dunes: Shrubland of *Acacia* and *Rhagodia* over open Tussock Grassland (*Cenchrus ciliaris*).

4. ID5 - Inland dunes: Open shrubland of *Acacia* and *Hakea* shrubland over Hummock grassland (*Triodia*) and Tussock grassland (*Cenchrus ciliaris*).
5. T1 - Tidal/Creek bare mudflat scattered low samphire shrubs (*Tecticornia* spp.).
6. C3 - Claypan low samphire shrubland (*Tecticornia* spp.).
7. B1 - Beach dunes sparse vegetation *Spinifex* and *Ipomoea.*

HML describes human modified land and includes cleared, degraded and privately-owned areas and although presented in the map, are not considered to be a habitat association.

In addition, Earth Stewardship (2017) describes six vegetation types from the Pipeline and DMMA study area:

1. Coastal Dunes
2. Samphire Shrublands – Flats
3. Samphire Shrublands – Beach
4. Coastal Plains
5. Tidal Mudflats
6. Cleared/Degraded areas

Significant Vegetation

The vegetation types identified as occurring near the Proposal Area are considered widespread both locally and regionally across the Pilbara. None of these vegetation associations are listed as either:

- Threatened Ecological Communities (TECs) under the EPBC Act;
- Environmentally Sensitive Areas under the EP Act; Or
- Priority Ecological Communities (PECs) by DBCA.

Vegetation Condition

Vegetation condition across the Proposal Area was assessed in O2 Marine (2017a) and is discussed in detail in **Appendix B**. The condition of vegetation across the majority of the Proposal Area was generally described as 'very good to good', with 'degraded' areas disturbed by the presence of introduced species, tracks, previous clearing and dumped rubbish (O2 Marine 2017a). The distribution of the condition of habitats as described in O2 Marine (2017a) is shown in **Figure 9**.

Flora Diversity

Desktop review of regional flora and vegetation studies undertaken around the Onslow Region (including the Wheatstone Project Area) have recorded a total of 422 species of native vascular plants belonging to 58 families (O2 Marine 2017a). Sixty-six (66) flora taxa from 23 families were recorded within the Pipeline and DMMA study area (Earth Stewardship, 2017).

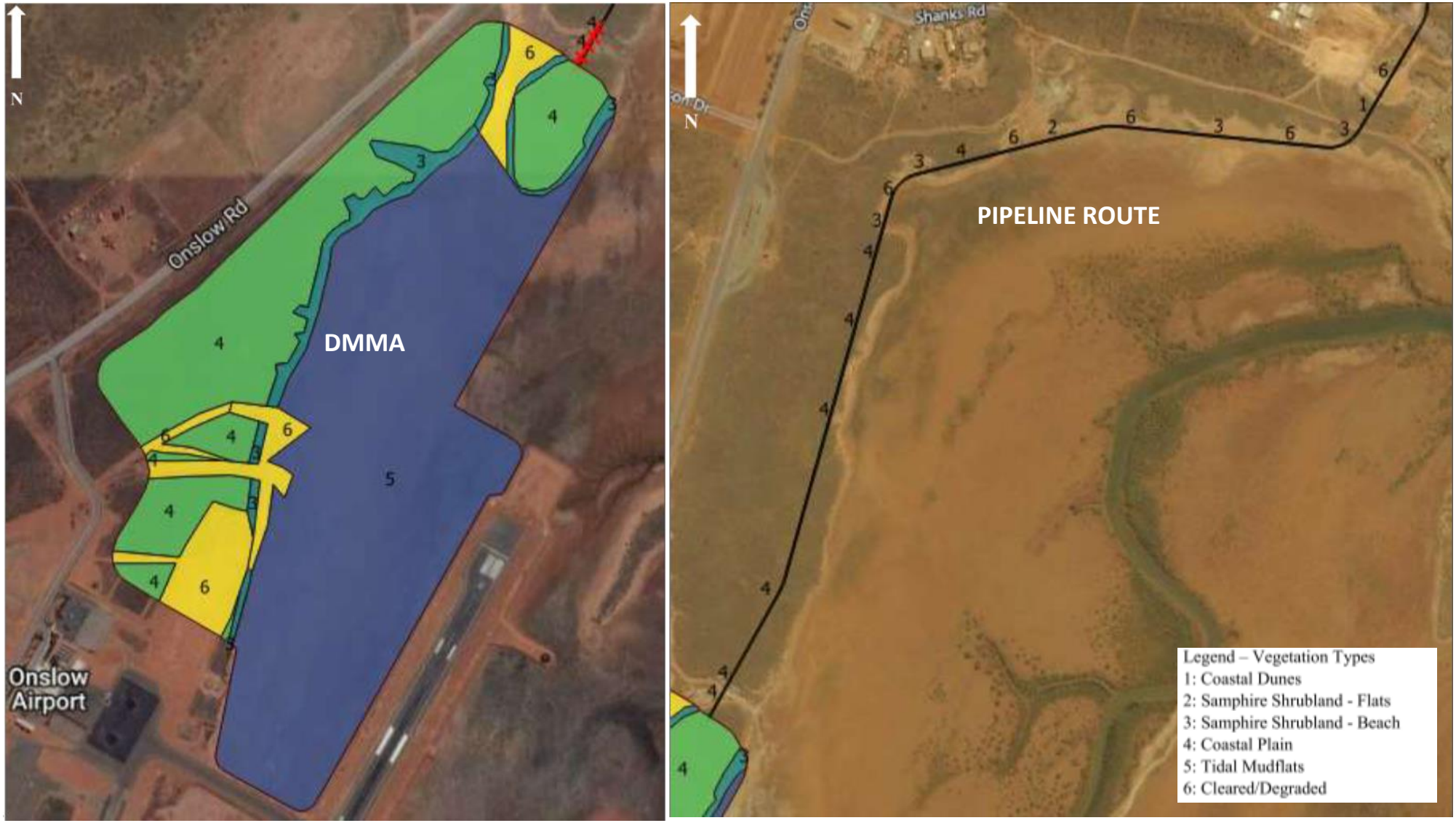


Figure 8 Terrestrial vegetation associations relative to the Proposed development envelopes (Adapted from Earth Stewardship 2017)

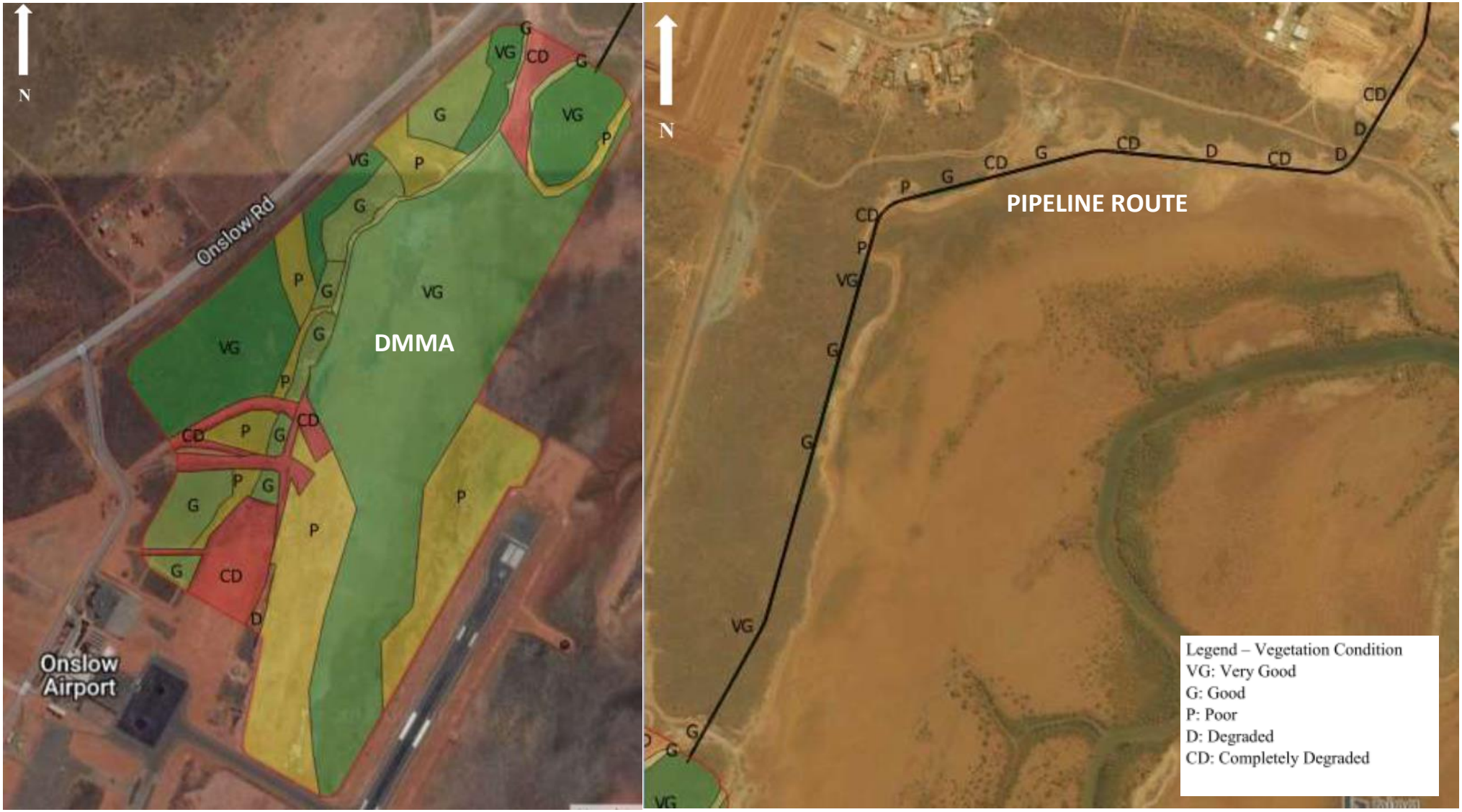


Figure 9 Vegetation condition (Adapted from Earth Stewardship 2017)

Conservation Significant Flora

No species listed under the EPBC Act (Cth), gazetted as Declared Rare Flora under the WC Act (WA), or listed as Priority Flora by DBCA, have been recorded within the Proposal Area during previous surveys (O2 Marine 2017a). Earth Stewardship (2017) recorded the Priority 3 flora taxon *Stackhousia clementii* within the Samphire Shrubland – Beach vegetation type, approximately 50 m east of the pipeline alignment close to the dredge material discharge point.

A search of government databases for species of conservation significance identified six (6) flora species. While some of these species are known to occur in the region, a likelihood of occurrence assessment (**Appendix B**) identified that suitable habitat for most of these species is unlikely to be present within the Proposal Area (O2 Marine 2017a). *Eremophila forrestii* subsp. v*iridis* (P3) and *Triumfetta echinata* (P3) were the only two flora species that were considered to be moderately likely to occur within or immediately adjacent to the Proposal Area. Earth Stewardship (2017) noted that the Priority 1 flora taxon *Abutilon sp.* Pritzelianum is considered possible to occur in the study area. This taxon was not recorded during the field surveys.

Introduced or Invasive Species

Desktop review identified six (6) introduced species that have been previously recorded within or adjacent to the Proposal Area. This included:

- Kapok (**Aerva javanica*);
- Buffel Grass (**Cenchrus ciliaris*);
- Athel Tree (**Tamarix aphylla*);
- Verano Stylo (**Stylosanthes hamata*);
- Mesquite (**Prosopis glandulosa*); and
- Caltrop (**Tribulus terrestris*).

Two (2) of these species, Mesquite and Athel Tree are listed as Declared Plants under theBiosecurity and Agriculture Management Act 2007 (BAM Act), and also as Weeds of National Significance (WONS) by the Australian Government (Thorp, 1988). However, these species were not observed within the Proposal Area (O2 Marine 2017a). Earth Stewardship (2017) notes that one Athel Tree is located immediately adjacent to the DMMA on the Onslow Airport Access Road.

Three (3) of these introduced species (Kapok, Buffel, Caltrop) were commonly found during previous surveys (ENV 2011; ENV 2012) and are expected to be encountered during any works undertaken in the Proposal Area. In addition, Verano Stylo was found in proximity to the border of the proposed pipeline route Option A and disposal site. Earth Stewardship (2017) recorded four species during the field surveys: Kapok, Buffel Grass, Athel Pine, and Speedy Weed (**Flaveria trinervia*).

4.6.4. Potential Impacts

The Proposal will require clearing of up to 15.5 ha within the proposed DMMA, and 0.3 ha along the pipeline route.

The Proposal (including the Pipeline Route) will result in a total direct loss of up to 15.8 ha of native vegetation and flora, including (**Table 15**):

- Samphire Shrublands – Beach: 2.1 ha;
- Coastal Plains: 13.4 ha;
- Tidal Mudflat: 24.5 ha; and
- Cleared/Degraded: 4.0 ha.

The narrow corridor of the Pipeline route precludes areal extent of vegetation types being calculated. However, the Pipeline route intersects:

- Coastal Dune;
- Samphire Shrubland – Beach;
- Samphire Shrubland – Flats;
- Coastal Plains; and
- Cleared/Degraded vegetation

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

- Possible introduction and/or spread of weeds to adjacent vegetation during construction activities; and
- Increased dust on leaf surfaces during construction activities.

Table 15 Estimated area of each vegetation association required to be cleared for pipeline route options and the disposal site (Earth Stewardship 2017)

Vegetation Type	Pipeline	DMMA	Total
1 – Coastal Dune	<0.01 ha	-	<0.01 ha
2 – Samphire Shrubland – Flat	<0.01 ha	-	<0.01 ha
3 – Samphire Shrubland – Beach	0.06 ha	2.09 ha	2.15 ha
4 – Coastal Plain	0.15 ha	13.41 ha	13.56 ha
5 – Tidal Mudflats*	-	24.50 ha	24.50 ha
6 – Cleared/Degraded*	0.06 ha	4.00 ha	4.00 ha
Total area per vegetation type	**0.28 ha**	**44.00**	**44.3 ha**
Total area requiring clearing	**<0.3 ha**	**15.5 ha**	**~15.8 ha**

* Vegetation types are unvegetated and have not been considered clearing area calculations.

4.6.5. Assessment of Impacts

Native Vegetation Clearing

The proposed clearing of native vegetation is not considered to represent a significant impact of flora and vegetation on the basis that:

- Vegetation associations to be cleared are well represented in the region and are not considered to be regionally or locally significant;
- No Threatened of Priority ecological communities occur within the Proposed clearing area; and

Indirect Impacts

Potential indirect impacts to adjacent flora and vegetation as a result of spread of weeds and/or dust generated from construction activities is considered to represent a low risk of causing environmental harm. However, through implementation of appropriate management strategies this risk is considered to be further reduced, such that the potential impacts are insignificant. Further details regarding proposed monitoring and management strategies to mitigate this risk are provided in the DRAFT DSDMP (**Appendix E**).

4.6.6. Mitigation

The DRAFT DSDMP developed for the Proposal (**Appendix E**), includes a project specific MTs to mitigate the potential construction phase impacts on flora and vegetation and subsequently ensure that the EPA's

objective for flora and vegetation is met and the predicted EPOs are achieved. The project specific MTs for flora and vegetation include:

1. No unauthorised vegetation clearing.
2. No impact on conservation significant flora species.
3. Minimise the potential for translocation of weeds.

A comprehensive set of management actions and environmental performance measures have been established to achieve the above MTs and these are described in the DRAFT DSDMP (**Appendix E)**.

4.6.7. Predicted Environmental Protection Outcome

The predicted EPOs of the Proposal include:

- Direct removal of a maximum of up to 15.8 ha of native vegetation;
- No detrimental impacts to adjacent native vegetation following construction; and
- No significant impacts to any flora of conservation significance.

The combined impact of the Proposal activities and the consequent EPOs are not considered to pose any significant residual risks to the protection of flora and vegetation and therefore biological diversity and ecological integrity can be maintained. In respect of the proposed design and management of the Proposal, the Proponent considers that the EPA's objective for flora and vegetation has been met.

5. Other Environmental Factors and Matters

As described in **Section 4**, an ENVID workshop was undertaken to identify those environmental factors which are considered to be most at risk as a result of the Proposal activities. In addition, other environmental factors were also identified during the ENVID, but due to the low risk of environmental impact, and in consideration of the mitigation measures that the Proponent propose to implement to manage any impacts, these factors are not expected to be required for assessment by the EPA. These other environmental factors are presented in **Table 16** and included:

- Terrestrial Environmental Quality;
- Terrestrial Fauna;
- Hydrological Processes;
- Air Quality; and
- Social Surroundings.

Table 16 Other environmental factors and potential impacts of the Proposal

Environmental Factor	EPA Objective	Receiving Environment	Potential Impacts	Mitigation	Assessment of Impacts[1] & Predicted Outcome
THEME: LAND					
Terrestrial Environmental Quality	To maintain the quality of land and soils so that environmental values are protected.	Sediments Marine sediments (i.e. Dredge material) from within the Berth Pocket/Turning Basin, inner channel and outer channel are typically comprised of sandy/ shelly material which is low in moisture and Total organic carbon (O2 Marine 2017b). All dredge material is classified as clean uncontaminated sediment suitable for onshore disposal. Terrestrial Soils Beach sand and historic spoil disposal material, over beach sand where Pipeline Option A meets the coast. Red/brown loamy sand on dune systems. A large proportion of the disposal site is exposed flat limestone rock. No evidence of historical contamination of the disposal site has previously been recorded.	Disposal of contaminated sediments.	Refer to DRAFT DSDMP (Appendix E)	**Meets EPA Objective** Results from the sediment sampling undertaken for the Proposal indicate that sandy, clean, uncontaminated sediments occur in the proposed capital dredge area. Therefore, onshore disposal of these sediments is unlikely to result in adverse effects to human health and terrestrial living resources (O2 Marine 2017b).

Environmental Factor	EPA Objective	Receiving Environment	Potential Impacts	Mitigation	Assessment of Impacts[1] & Predicted Outcome
		Sediments Consistent with the results from previous testing of ASS within Beadon Creek and at nearby coastal locations for other dredging programs, field testing indicate PASS occur within the dredge footprint, indicating an ASSMP is required. However, testing indicates treatment of PASS is not required as the acidity would be effectively buffered by the natural alkaline component of the sediment.	Disposal of ASS	Refer to DRAFT DSDMP (Appendix E)	**Meets EPA Objective** Sediment sampling results indicate that an ASSMP should be prepared and submitted to DER for this Proposal based on the presence of PASS within sediments to be dredged. However, the natural acid neutralising capacity of the sediments was found to provide sufficient buffering for any acid-generating processes and the material is unlikely to need treatment strategies for onshore disposal (i.e. lime dosing neutralisation of ASS) (O2 Marine 2017b).
		Terrestrial Soils ASS risk mapping previously provided by the WAPC now accessed via the Landgate SLIP website indicates that the terrestrial dunes are located in a 'low' ASS risk area.	Disturbance of existing Acid Sulfate Soils at the proposed DMMA.	Refer to DRAFT DSDMP (Appendix E)	**Meets EPA Objective** The majority of the DMMA lies on flat limestone rock so disturbance of ASS is unlikely. The upper intertidal zone bordering the DMMA poses potential ASS risk and soil disturbance in this area (if required) should be undertaken in accordance with the ASSMP.
Terrestrial Fauna	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	A comprehensive review of the terrestrial fauna habitat within the Proposal development footprint is provided in the Ecological Site Investigation Report (O2 Marine 2017a) (Appendix B). Four (4) fauna habitats are described: • Shrubland of *Acacia* species over Hummock grassland • Mangrove communities • Samphire claypan • Beach & Dunes All habitats are well represented in adjacent areas	Removal/smothering of terrestrial fauna habitat.	Refer to DRAFT DSDMP (Appendix E)	**Meets EPA Objective** Vegetation to be removed does not represent critical habitat for any conservation significant species. All vegetation clearing will be undertaken in accordance with vegetation clearing permit requirements (where required) and a pre-clearance survey will be undertaken by a fauna spotter/catcher prior to constructions works commencing.
		A comprehensive review of the conservation significant terrestrial fauna which may occur with the Proposal development footprint is provided in	Disturbance of conservation significant terrestrial fauna.	Refer to DRAFT DSDMP (Appendix E)	**Meets EPA Objective** All vegetation clearing will be undertaken in accordance with vegetation clearing permit requirements and a pre-clearance survey will be

Environmental Factor	EPA Objective	Receiving Environment	Potential Impacts	Mitigation	Assessment of Impacts[1] & Predicted Outcome
		the Ecological Site Investigation Report (O2 Marine 2017a) (Appendix B). O2 Marine (2017a) presents the results of a likelihood of occurrence assessment for all conservation significant species identified in database searches (i.e. EPBC Protected Matters Search, DPAW Search, Naturemap, ALA). The threatened terrestrial species considered 'moderately' likely to occur within or immediately adjacent to the Proposal Area includes one (1) reptile, the Keeled Slider (*Lerista planiventralis* subsp. *maryani*), and three (3) mammals: Northern Quoll (*Dasyurus hallucatus*), Lakeland Downs Short-tailed Mouse, (*Leggadina lakedownensis*) and the Little Northern Freetail-bat (*Mormopterus loriae cobourgensis*).			undertaken by a fauna spotter/catcher prior to constructions works commencement. Disturbance to conservation significant fauna is considered unlikely.
THEME: WATER					
Hydrological Processes	To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.	The proposed disposal is located near the Onslow Airport which drains into the West arm tributary of Beadon Creek. The catchment of Beadon Creek has already been significantly modified by the Onslow Salt Ponds. During times of heavy rains and large tidal cycles, the tidal flats can be subjected to inundation. The Western tributaries of Beadon Creek are the outlets of tidal surges that frequently inundate the intertidal flats (ATA, 2000). The proposed DMMA partly intersects a natural drain connecting Onslow road to the salt flats/mudflats. The drain has two entry points, the western arm which directs water towards the airport and runway, and the eastern arm which	Altered surface water runoff patterns.	Refer to DRAFT DSDMP (Appendix E) Consider Site Drainage Assessment to support SoA Development Application	**Meets EPA Objective** Surface water discharge will be undertaken in accordance with a DoW 'Permit to interfere with the bed and banks of a watercourse', which is to be obtained for the Proposal. The western arm of the natural drain will be infilled by the DMMA. Therefore, stormwater runoff from the road will need to be diverted through the eastern arm of the natural drain. This will result in more direct stormwater flows to the intertidal area and redirect stormwater flows away from the airport and runway.

Environmental Factor	EPA Objective	Receiving Environment	Potential Impacts	Mitigation	Assessment of Impacts[1] & Predicted Outcome
		directs runoff to the east. These arms are split by a small vegetated island.			
THEME: AIR					
Air Quality	To maintain air quality and minimise emissions so that environmental values are protected.	The dredge spoil disposal site is located ~3km to the southwest of the Onslow town and ~500m to the north of the airport. The surrounding land use has been designated as industrial.	Dust generation from stockpiles.	Refer to DRAFT DSDMP (Appendix E) Post-construction Dust Management Plan is proposed to support SoA Development Application	**Meets EPA Objective** Dust from spoil disposal areas poses a risk following completion of dredging once dewatering activities are completed and the disposal area is allowed to dry out. Therefore, dust suppression will be undertaken as required in accordance with a Dust Management Plan to be developed in consultation with the SoA.
THEME: PEOPLE					
Social Surroundings	To protect social surroundings from significant harm.	Three ethnographic and archaeological surveys have been undertaken within or immediately adjacent to the study area. <u>Beadon Creek</u> No ethnographic or archaeological aboriginal heritage sites or artefacts were reported in the land portion of the Department of Transport's project area. However, certain cultural protocols are requested prior to dredging commencing in order to ensure that proper respect is shown to the *Warnamankura* (mythological water serpent). <u>DMMA</u> A search on the aboriginal sites register identified two previously registered sites and an additional site was identified during the survey in the immediate vicinity of the Onslow airport. Site 6617 is outside the Proposal Area, although Archaeological Site Onslow Airport 01 and existing site DIA 6620 (Jinta 2) are recommended to be avoided entirely during all future works. The previous survey that was undertaken for the airport development and which identified the Site	Disturbance of a significant aboriginal heritage site.	Consider Aboriginal Heritage Survey of any areas of the DMMA and pipeline route not previously surveyed. Refer to DRAFT DSDMP (Appendix E)	**Meets EPA Objective** If applicable, all construction activities will be undertaken in accordance with requirements of Section 18 approval.

Environmental Factor	EPA Objective	Receiving Environment	Potential Impacts	Mitigation	Assessment of Impacts[1] & Predicted Outcome
		Onlsow Airport 01, also included a small proportion of the proposed DMMA, however the entire area has not been previously surveyed.			

[1] Potential environmental impacts have been determined in consideration of relevant EPA policy and guidance documents for each environmental factor.

6. Offsets

There were no significant residual impacts of the Proposal identified in this Environmental Review Document and therefore no offsets are proposed.

7. Holistic Impact Assessment

Overall actual and potential impacts of the Proposal on the environment are not considered to represent a significant environmental risk on the basis that:

- The EP Act principles and relevant EPA guidance documents have been considered in investigating and evaluating potential impacts of the Proposal on the EPA's environmental factors;
- A comprehensive set of monitoring and management measures have been developed to further mitigate potential impacts of the Proposal on the EPA's environmental factors;
- The proponent has committed to open and transparent reporting of environmental performance throughout the Proposal construction phase;
- Evaluation of impacts against all relevant environmental factors, including other environmental factors determined that the EPA's objectives were considered to be met. Specifically, for the key environmental factors the following outcomes were predicted:
    - **Benthic Communities and Habitats** - the combined impact of the Proposal activities and the consequent EPOs are not considered to pose significant residual risks to the protection of BCH and therefore biological diversity and ecological integrity can be maintained.
    - **Coastal Processes** - the combined impact of the Proposal activities and the consequent EPOs are not expected to pose any significant residual risks to maintaining the geophysical processes that shape coastal morphology and therefore the environmental values of the coast can be protected;
    - **Marine Environmental Quality** - the combined impact of the Proposal activities and the consequent EPOs are not expected to pose any significant residual risks to maintaining the quality of water, sediment and biota and therefore the environmental values are protected;
    - **Marine Fauna** - the combined impact of the Proposal activities and the consequent EPOs are not considered to pose any significant residual risks to the protection of marine fauna and therefore biological diversity and ecological integrity can be maintained; and
    - **Flora and Vegetation** - the combined impact of the Proposal activities and the consequent EPOs are not considered to pose any significant residual risks to the protection of flora and vegetation and therefore biological diversity and ecological integrity can be maintained.

8. References

ATA Environmental (2000) *Onslow Aerodrome Environmental Assessment and Management Plan*, Perth, WA.

Baird (2017) *Onslow Marine Support Base (Stage 2): Shoreline Impacts Assessment.* Report prepared by Baird Australia Pty Ltd on behalf of OMSB Pty Ltd. July 2017 Rev0

Bamford, M. J. (2009). *Survey for Migratory Birds in the Wheatstone LNG Project Area, November 2008 and April 2009. Wheatstone Project Draft EIS/ERMP Appendix K1.*

Biota. (2013). *Desktop review of the proposed Onslow Micro-Siting Survey Area.* Prepared for Chevron Australia

BMT JFA (2013) Beadon Creek (Onslow) Maintenance Dredging – Closeout Report 2012 Session. Prepared for Department of Transport by BMT JFA Consultants Pty Ltd, Report No R-300.03-12.1-1, Perth, Western Australia, May 2013

BMT Oceanica (2014) *Beadon Creek Maritime Facility Capital Dredging Environmental Impact Assessment*. Prepared for the Department of Transport, 365_01_004/1_Rev6

BMT Oceanica (2015) *Technical Memorandum: Pre-referral meeting for proposed Onslow Marine Support Base.* Memorandum issued to the Office of the Environmental Protection Authority on 12th November 2015.

BOM 2017b, Severe Tropical Cyclone Vance, http://www.bom.gov.au/cyclone/history/vance.shtml

Chevron (2010) *Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project*: Volume 1 (Chapters 1 to 6).

Chevron (2013). *Wheatstone Project: State of the Marine Environment Surveys Baseline Report*. WS0-0000-HES-RPT-CVX-000-00155-000

Chevron (2016a). *Wheatstone Project: Construction Onshore Facilities Waste Water Discharge Plan*. WS0-0000-HES-PLN-CVX-000-00096-000

Chevron. (2016b). *Wheatstone Conservation Significant Marine Fauna Interaction Management Plan. WS0-0000-HES-PLNP-CVX-000-00037-000.*

Chevron (2017). *Wheatstone Project: First Post-development State of the Marine Environment Report*. WS0-0000-HES-RPT-CVX-000-00253-000

CWR. (2010). *A Description of Mega Fauna Distribution and Abundance in the SW Pilbara Using Aerial and Acoustic Surveys –Final Report 2010.* Wheatstone Project Final Technical Appendices FD. Centre for Whale Research.

Damara WA Pty Ltd (2010). Coastal Geomorphology of the Ashburton River Delta and Adjacent Areas. Report 82-01-01 May 2010

DoT (2017a). "*Onslow Beadon Creek Breakwater Literature and Data Review*."

DoT (2017b). *Onslow Maritime Facility (Fact Sheet). Department of Transport.*

DER (2014) *Assessment and management of contaminated sites: Contaminated sites guidelines. December 2014.* Governement of Western Australia, Department of Environment Regulation. Pp134

Ellison, J.C. (1998). *Impacts of sediment burial on mangroves*. Marine Pollution Bulletin 37: 13-18

ENV (2012). *Onslow Light Industrial Area Flora, Vegetation and Fauna Assessment*. Report prepared for the Shire of Ashburton. 11/097

ENV (2012). *Onslow Townsite Strategy Flora, Vegetation and Fauna Assessment. Perth, Western Australia: ENV Australia Pty Ltd.* Report prepared for the Shire of Ashburton. 11/097

EPA (2014) *Beadon Creek Capital Dredging and Construction of Land-Backed Wharf. Not Assessed* – Public Advice Given. 28 April 2014.

EPA (2016a) *Instructions on how to define the key characteristics of a Proposal.* EPA, Western Australia

EPA (2016b). *Environmental Factor Guideline: Benthic Communities and Habitats*, EPA, Western Australia

EPA (2016c). *Technical Guidance – Protection of Benthic Communities and Habitats*, EPA, Western Australia

EPA (2016d). *Technical Guidance – Environmental Impact Assessment of Marine Dredging Proposals*, EPA, Western Australia

EPA (2016e). *Environmental Factor Guideline: Coastal Processes,* EPA, Western Australia

EPA (2016f). *Environmental Factor Guideline: Marine Environmental Quality,* EPA, Western Australia

EPA (2016g). *Technical Guidance – Protecting the Quality of Western Australia's Marine Environment, EPA*, Western Australia

EPA (2016h). *Environmental Factor Guideline: Marine Fauna,* EPA, Western Australia

EPA (2016i). *Environmental Factor Guideline: Flora and Vegetation,* EPA, Western Australia

EPA (2016j). *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment,* EPA, Western Australia

Gales, N. M. (2004). *Change in abundance of Dugongs in Shark Bay,* Ningaloo & Exmouth Gulf, Western Australia; evidence for large-scale migration. Wildlife Research 31: 283-290

Halpern Glick Maunsell (1998). *Investigation Report on Harbour Basin and Entrance Channel at Beadon Creek, Onslow (*DoT Reference No: CT 158/96/PI/011)

Keighery, B.J. (1994) *Bushland Plant Survey. A Guide to Plant Community Survey for the Community.* Wildflower Society of WA (Inc.), Western Australia.

Kangas, M.I., Morrison, S. Unsworth, P. Lai, E. Wright I. and Thomson A. (2006). *Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia. Final FRDC Report – Project 2002/038. Fisheries Research Report No.* 160, 2006

Laist, D. K. (2001). *Collisions between ships and whales.* Marine Mammal Science, 17: 35–75.

Loneragan NR, Kangas M, Haywood MDE, Kenyon RA, Caputi N, Sporer E (2013) *Impacts of cyclones and aquatic macrophytes on recruitment and landings of tiger prawns Penaeus esculentus in Exmouth Gulf, Western Australia.* Estuarine, Coastal and Shelf Science 127:46-58

Manson, F. L. (2005). *An evaluation for linkages in between mangroves and fisheries: A Synthesis of the Literature and Identification fo Research Directions.* Oceanography and Marine Biology 43: 485-515.

Morgan, D. (2017). *Onslow Marine Support Base Project: Potential Impacts to Sawfish*. Centre for Fish & Fisheries Research, Murdoch University.

MScience (2009). Wheatstone LNG Development: Baseline Water Quality Assessment Report November 2009. MSA134R3. Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project - Appendix Q7.

MScience 2013. Seagrass, Filter Feeder and Macroalgal Habitat Survey: Baseline Surveys - September and December 2012 [WS0-0000-HES-RPT-MSP-000-00006-000]

O2 Marine (2017a) *Onslow Marine Support Base (Stage 2): Ecological Site Investigation*. Report prepared on behalf of OMSB Pty Ltd. June 2017

O2 Marine (2017b) *Onslow Marine Support Base: Stage 2 Capital Dredging Sediment Quality Assessment*. Report prepared on behalf of OMSB Pty Ltd. June 2017

Oceanica (2012c). *Beadon Creek Acid Sulfate Soil Analysis Data Report*. Prepared for Department of Transport by Oceanica Consulting Pty Ltd, Report No 365_01_001/1, Perth, Western Australia, April 2012

Oceanica, JFA (2010) *Beadon Creek Maintenance Dredging – Revised Environmental Impact Assessment*. Prepared for Department of Transport by Oceanica Consulting Pty Ltd and JFA Consultants Pty Ltd, Report No 365_002/1, Perth, Western Australia, March 2010

Onslow Salt 2017, email from R.Baker to T.Hurley 25th July 2017

Pendoley, E. (2010). *Marine Turtle Beach Survey: Onslow Mainland Area and Nearby Islands 25 January – 6 February. Wheatstone Project Draft EIS/ERMP Appendix O8*.

Pearce A., Buchan, S., Chiffings, T., d'Adamo, N., Fandry, C., Searns, P., Mills, D., Phillips, R., & Simpson, C. (2003). *A review of the oceanography of the Dampier Archipelago, Western Australia*. In: (Eds) Wells, F., Walker, D. & Jones, D. 2003. The Marine Flora and Fauna of Dampier, Western Ausrtalia. Western Australian Museum, Perth, 13-50.

Paling, E.I. (1990). *Report on the Biological Environments near Onslow, Western Australia*. Onslow Solar Saltfield ERMP, Volume 2 Technical Appendices. Report produced by Gulf Holdings, Perth Western Australia

PIANC (2014) *Harbour Approach Channels Design Guidelines.* Pianc Report No. 121-2014

Seashore Engineering (2017). *Onslow Maritime Facility Beadon Creek Training Wall: Investigation and Design of Maintenance Options*. Report SE030-01-Rev0

Semeniuk (1993). *The mangrove system of Western Australia 1993*: Presidential Address. Journal of the Royal Society of Western Ausralia 76: 99-122.

Sheppard, D.P., Beeston, G.R., and Hopkins, A.J.M (2001*). Native Vegetation in Western Australia*. Technical Report 249. Department of Agriculture Western Australia, South Perth

Thorp, J. (1988). *Weeds of National Significance. Standing Committee on Conservation. Out of Session Paper.*

URS (2010a). *Wheatstone Project Survey of Subtidal Habitats Off Onslow, WA*. Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project - Appendix N12

URS. (2010b). *Wheatstone Project Draft EIS/ERMP Technical Appendices N11 Survey of Intertidal Habitats off Onslow, WA .*

URS (2010c). *Wheatstone Project Nearshore Acid Sulfate Soils Investigation (Turning Basin & Dredge Channel)*. Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project - Appendix Q4

Vance, D. H. (1998). *Seasonal and annual abundance of postlarval and juvenile prawns Penaeus merguiensis and environmental variation in two estuaries in tropical north-eastern Australia, a six-year study.* Marine Ecology Progress Series 163: 21-36.

Wahab, M. F., Fromont, J., Gomez, O., Fisher, R. and Jones, R. (2017). *Comparisons of benthic filter feeder communities before and after a large-scale capital dredging program.* Marine Pollution Bulletin. 122 (1-2): 176-193

Wells, F.E., McDonald, J.I., & Huisman, J.M. (2009). *Introduced Marine Species in Western Australia*. Western Australian Department of Fisheries, Occasional Publications 57:1-97

Appendix A Environmental Identification (ENVID) Summary

Appendix B OMSB Stage 2: Ecological Site Investigation

Appendix C OMSB Stage 2: Shoreline Impacts Study

Appendix D OMSB Stage 2: Sediment Quality Investigation

Appendix E Dredging and Spoil Disposal Management Plan

Appendix F Stakeholder Consultation Outcomes

Appendix G Shire of Ashburton Letter of Confirmation – Industrial Land Reclamation Site

Appendix H OMSB Stage 2: Commercial Fishing Sector - Stakeholder Consultation