BAA-201 0004

Santos

Darwin Pipeline Duplication (DPD) Project – EPBC Referral Supporting Information

PROJECT / FACILITY	Darwin Pipeline Duplication (DPD) Project
REVIEW INTERVAL (MONTHS)	No Review Required
SAFETY CRITICAL DOCUMENT	NO

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1			

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Acronyms and Abbreviations

Acronym	Definition
°C	Degrees Celsius
AIMS	Australian Institute of Marine Science
AIS	Automatic Identification System
ALA	Atlas of Living Australia
ALARP	As Low As Reasonably Practicable
AMSA	Australian Maritime Safety Authority
ANPM	Autoridade Nacional do Petróleo e Minerais
AOD	area of occupancy
AS	Australian Standard
ASS	Acid Sulphate Soil
AUV	Autonomous Underwater Vehicles
BHD	Backhoe dredger
BIAs	Biologically Important Areas
CEMP	Construction Environment Management Plan
CSD	Cutter Suction Dredges
dB	Decibel
dB re 1 µPa	decibels relative to one micropascal; the unit used to measure the intensity of an underwater sound
DAWE	Department of Agriculture, Water and Environment
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DENR	Department of Environment and Natural Resources
DEPWS	Department of Environment, Parks and Water Security
DLNG Facility	Darwin Liquefied Natural Gas Facility
DoEE	Department of Environment
DPD	Darwin Pipeline Duplication
DP	Dynamically positioned
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Cth)
e.g.	for example
EIS	Environmental Impact Statement
EN	Endangered

EP	Environment Plan
EP Act	*Environment Protection Act 2019* (Northern Territory)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FCGT	Flood, clean, gauge, testing
FPV	Fallpipe vessel
GA	Geoscience Australia
GEP	Gas Export Pipeline
GHG	Greenhouse Gas
h	hour
Ha	Hectare
HAT	Highest Astronomical Tide
HF	High Frequency
HFO	Heavy Fuel Oil
Hz	Hertz
IFO	Intermediate Fuel Oil
IMO	International Maritime Organization
IMR	Inspection, maintenance and repair
IMS	invasive marine species
ILT	In-line tee
IUCN	International Union for Conservation of Nature
km	Kilometre
KP	Kilometre Point
LAT	Lowest Astronomical Tide
LBL	Long base line
LNG	Liquefied Natural Gas
m	Metre
m^2	square metre
m^3	cubic metre
M	Migratory species
Mg/L	Milligrams per litre
mm	Millimetre
Mm^3	Cubic megametre

m/s	Metres per second
MARPOL	International Convention for the Prevention of Pollution from Ships
MBES	Multi-beam echosounder
MDO	Marine Diesel Oil
MEG	Monoethylene glycol
MNES	Matters of National Environmental Significance
MTPA	Million tonnes per annum
MSL	Mean Sea Level
NA	Not applicable
NEMP	Nearshore Environmental Monitoring Program
NOEC	No observed effect concentration
NSW	New South Wales
NT	Northern Territory
NT EPA	NT Environment Protection Authority
OEMP	Operations Environmental Management Plan
OFOV FME	Orientation field of view full moon equivalents
PASS	Potential Acid Sulphate Soil
PC	Protection concentration; e.g. PC99 is 99% protection concentration, PC95 is 95% protection concentration etc.
pig	pipeline inspection gauge
PLET	Pipeline End Termination
PMST	Protected Matters Search Tool
POB	persons on board
ppb	parts per billion
ppm	parts per million
PNEC	Predicted No-Effect Concentration
PTS	Permanent Threshold Shift
PWCNT	Power and Water Corporation Northern Territory
ROVs	Remotely Operated Vehicles
SBP	Sub-bottom profiler
SDV	Side dumped vessel
SEL	Sound exposure level
SEL_{24h}	24-hour sound exposure level

SOPEP	Ship Oil Pollution Emergency Plan
SPL	Sound Pressure Level
SSS	Side scan sonar
TBD	To be decided
t	tonne
TPWC Act	*Territory Parks and Wildlife Conservation Act 1976* (Northern Territory)
TRH	Total Recoverable Hydrocarbons
TSHD	Trailing suction hopper dredger
TSDMMP	Trenching and Spoil Disposal Management and Monitoring Plan
TTS	Temporary Threshold Shift
USA	United States of America
USBL	Ultra-short base line
VU	Vulnerable
WA	Western Australia
WDL	Waste Discharge Licence
WHO	World Health Organization

Contents

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1 Document Purpose

This document provides supporting information to the EPBC Act Referral Form for the Darwin Pipeline Duplication (DPD) Project (the 'Project'). The purpose of this document is to provide:

- a comprehensive description of the proposed activities;
- an environmental impact assessment of the proposed project activities to Matters of National Environmental Significance (MNES);
- additional information on MNES as referenced in Section 4 of the EPBC Act Referral Form; and
- mitigation measures to ensure the action will be taken in a 'particular manner' to avoid or reduce any impact such that the impacts will not be significant.

In addition, this document considers relevant species recovery plans, threat abatement plans and management plan to inform the impact assessment and mitigation measures. Where possible, Santos has attempted to minimise information 'overlap'; hence, where relevant this EPBC Act supporting information document refers to the NT EPA Referral.

2 Project description

2.1 Overview

Santos is proposing the action (herein referred to as 'the Darwin Pipeline Duplication (DPD) Project' or 'the Project') which involves the installation, pre-commissioning, operation and decommissioning of a new gas export pipeline and associated infrastructure located in Commonwealth waters and Northern Territory (NT) waters and land. The development of the Project will enable gas from offshore reservoirs to be transported to the existing DLNG facility. The Project pipeline will run predominately parallel to, and hence is effectively a 'duplication' of, a portion of the existing Bayu-Undan to Darwin pipeline. This section provides a description of the key characteristics of the Project, as summarised in **Table 2-1**.

Table 2-1 Key characteristics of the Project

Component	Description
Key Infrastructure	
Pipeline	+ The pipeline will be ~123 km in length (~100 km in NT waters and ~23 km in Commonwealth waters). + A proposed diameter transition from 26 inch to 34 inch ~61 km from the DLNG facility. Seabed disturbance will be within a 50 m disturbance corridor along the Project pipeline, with additional disturbance closer to shore due to vessel anchoring. + The pipeline will extend to the proposed pipeline beach valve location at the DLNG facility. The connection into the process plant is not included as part of the scope of this referral.
Associated infrastructure/hardware	+ One Pipeline End Termination (PLET) in Commonwealth waters (including PLET foundation with scour protection and protection structure). + Spool in Commonwealth waters (including mattresses with scour protection). + In-line tee (ILT) in NT waters (including protection structure). + Subsea support structures (scour protection mattresses, power and telecommunication cable crossing, span rectification structures).
Key Activities	
Surveys	Onshore and offshore
Pre-lay works	+ Pre-lay trenching + Spoil disposal + Pre-lay span rectification and foundation installation + Cable crossings + Onshore construction
Installation and pre-commissioning	Installation: + Pipelay activities + In-line tee installation + PLET installation (for DPD pipeline) + Spool installation + Shore pull

Component	Description
	+ Trench back-fill with locally sourced rock + Post-lay span rectification + Installation of temporary subsea positioning systems + Demobilisation at shore crossing Pre-commissioning: + flood, clean, gauge and pressure testing (FCGT) + Dewatering + Preconditioning + Nitrogen packing + Flushing and hydrostatic spool leak testing
Operations	+ Transport of hydrocarbons + Inspection, maintenance and repair activities (IMR)
Vessel, other equipment and helicopter operations	Vessels, helicopters and equipment entering the Project area including: + Pipelay vessels + Supply vessels incl. pipe supply vessels + Crew change vessels + Marine survey vessels + Construction vessels + Anchor handling vessels + Rock installation vessels + Trenching and spoil disposal vessels + Environmental monitoring vessels + IMR vessels + ROVs/AUVs + Helicopters + Vehicles, mobile plant and other onshore equipment Nominally 34 vessels may be used, with an expected maximum of 19 vessels within the project area at any one time.
Construction Elements	
Duration	Construction to commence as early as Q3 2023. Construction activities will span a nominal cumulative period of 15 months in the field.
Operations Elements	
Pipeline product	Natural gas
Operation life	First gas in first half of 2025 with operation ~25 years

Component	Description
Decommissioning Elements	
Proposed decommissioning	At end of Project life (>2050)

2.2 Project pipeline

The Project pipeline will run parallel to the existing Bayu-Undan to Darwin pipeline through Darwin Harbour and will come ashore at the DLNG facility (**Figure 2-1**). Alternatives for pipeline routing were evaluated, giving consideration to the following criteria:

- Proximity to the pre-disturbed Bayu-Undan to Darwin pipeline and shore crossing;
- Avoiding areas of environmental (including heritage) values and sensitivities;
- Avoiding any seabed hazards;
- Minimising long term integrity risks and/ or intervention requirements;
- Minimising the number of pipeline crossings, e.g., existing pipelines or communication cables;
- Minimising encroachment on the Darwin Harbour shipping channel; and
- Minimising risk to other assets during construction.

2.3 Project area

For the purpose of the assessment of the proposed action, the Project area has been defined as 3,000m radius around the PLET, a 2,000m buffer either side of the pipeline route with a reduced buffer in some sections to meet licence requirements and a 6.25km^2 spoil disposal area with a 100m buffer. The Project area includes the extent of all planned activities as described in **Section 2**, and encompasses activities of seabed preparation, trenching and spoil disposal, installation of the Project pipeline and associated infrastructure, onshore activities at the DLNG facility and support vessel movements in the immediate vicinity of the pipelay vessel (accounting for anchor handling activities, operational activities and decommissioning activities).

The Project area has been sub-divided into four key 'areas' relevant to this referral; being:

- Commonwealth waters;
- Offshore NT waters (i.e. NT waters outside Darwin Harbour). Note that this includes the proposed location for spoil disposal;
- Darwin Harbour (i.e. waters within the Darwin Harbour Management Area); and
- Shore crossing location (including the short onshore section of the Project pipeline).

The Project area is shown **Figure 2-1.**

DPD Project infrastructure (DPD pipeline, PLET and spool) in Commonwealth waters is shown in **Figure 2-2**

2.4 Project schedule and key activities

Santos and partners undertook a final investment decision for the DPD Project in Q3 2022. Santos is targeting to have all DPD regulatory approvals in place by Q3 2023 to ensure construction activities do not delay Barossa first gas in the first half of 2025. A nominal DPD Project construction window and sequence is shown in **Figure 2-3** representing a start of construction activities at the beginning of the nominal construction window. The construction activities will span a nominal cumulative period of 15-months in the field. The actual construction sequence and schedule will be subject to the timely receipt of all regulatory approvals and drivers such as vessel availability, operational issues, and weather.

Santos' regulatory approvals and stakeholder consultation consider construction activities at any time between Q3 2023 to the end of 2025.

Table 2-2 lists all the Project activities as described in this section, along with the locations they are proposed (as defined in **Section 2.3**).

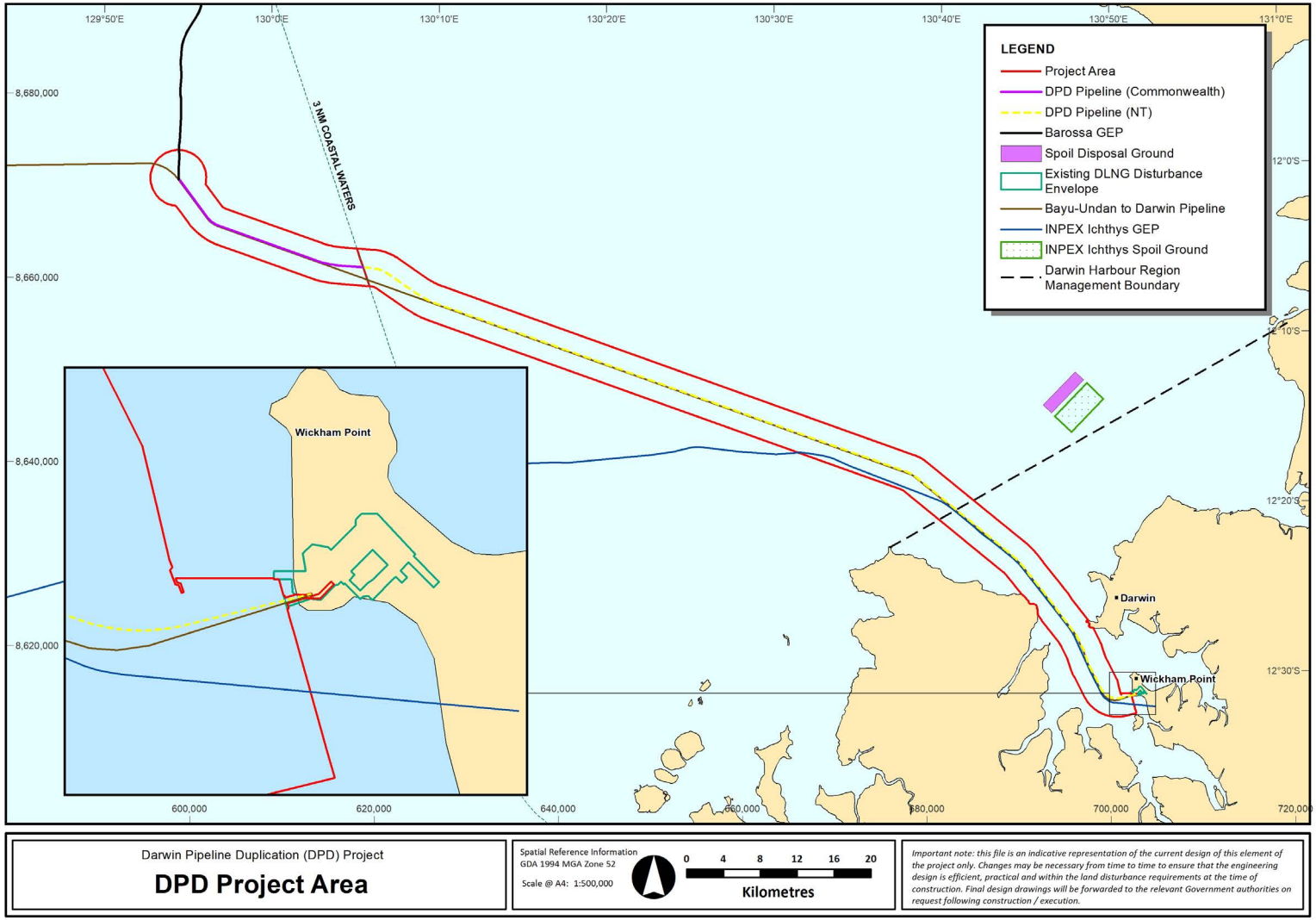


Figure 2-1: DPD Project area

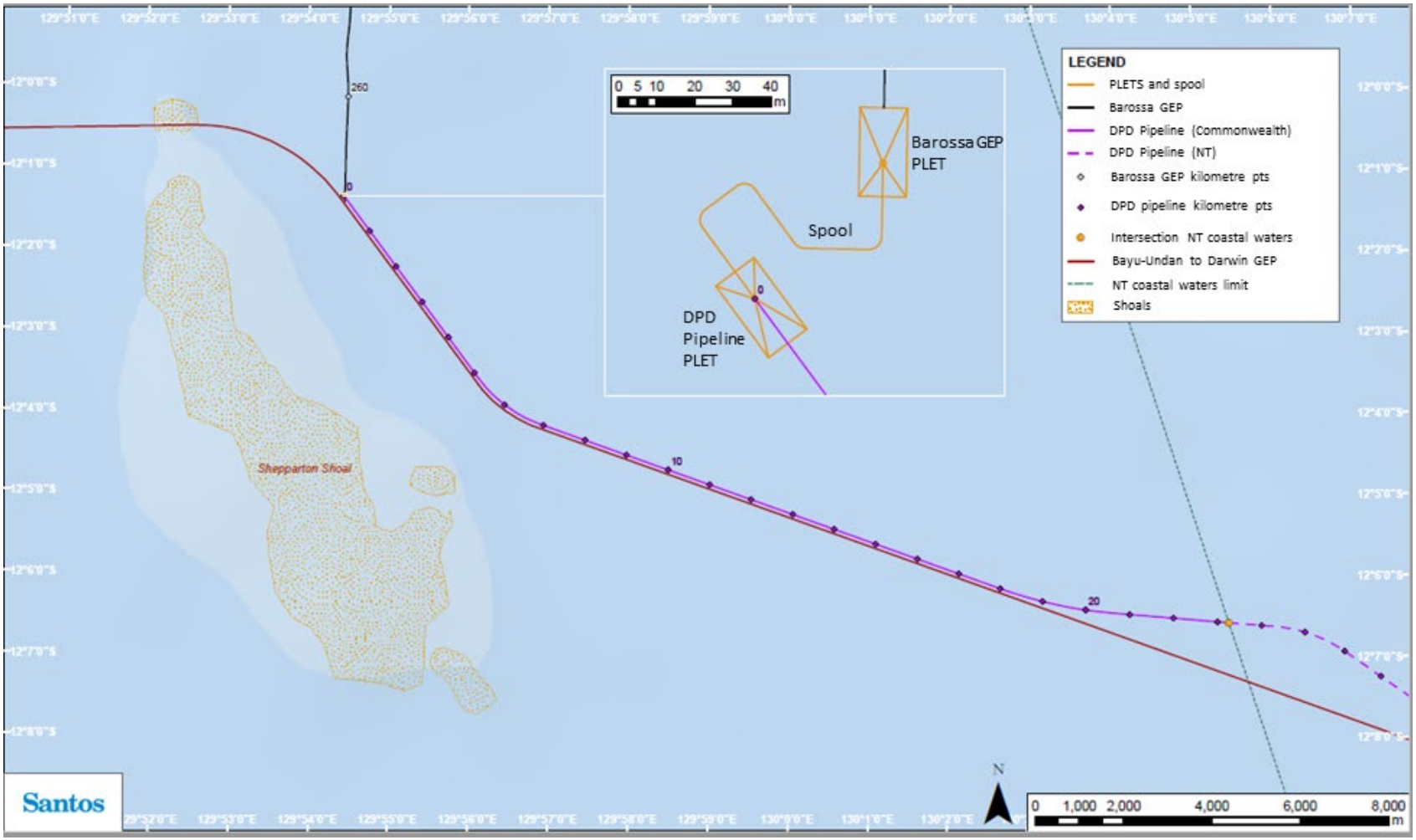


Figure 2-2: Commonwealth waters infrastructure

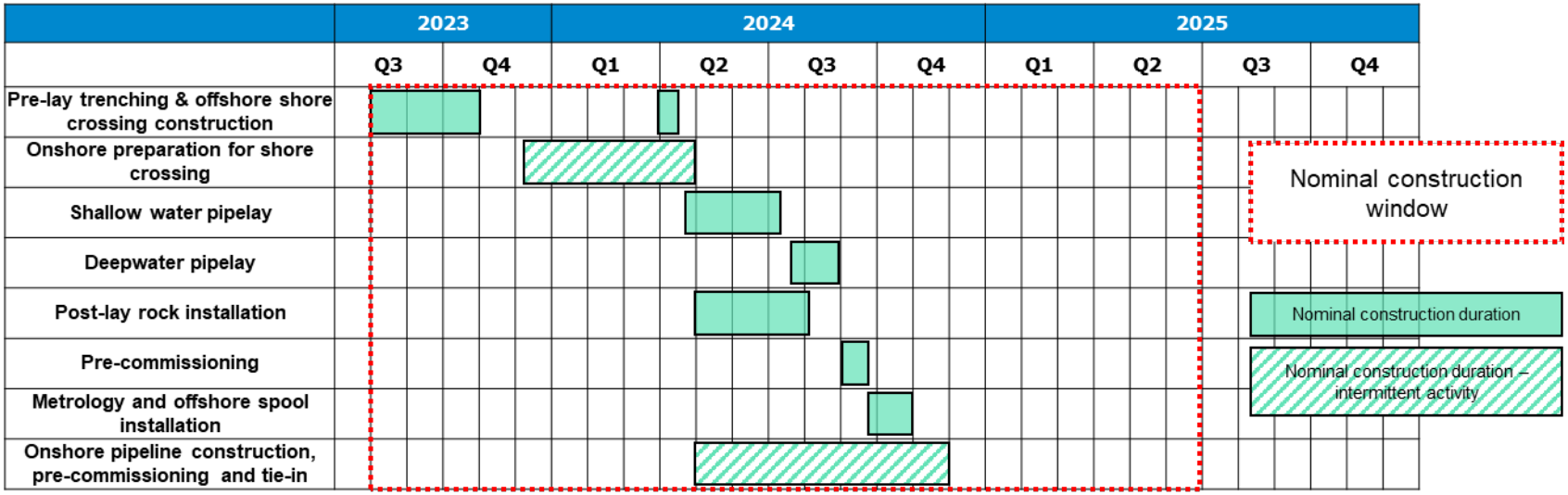


Figure 2-3: Nominal construction sequence and durations

Table 2-2 Location of the different activities associated with the Project

Activity	Commonwealth waters	Offshore NT waters (includes spoil disposal ground)	Darwin Harbour	Onshore / shore crossing
Surveys				
Offshore surveying	Y	Y	Y	
Onshore surveying				Y
Pre-lay work				
Pre-lay trenching		Y	Y	Y
Spoil disposal		Y		
Pre-lay span rectification	Y	Y	Y	
Cable crossing			Y	
Onshore and shore crossing construction				Y
Pipeline installation and pre-commissioning				
Pipelay activities	Y	Y	Y	
ILT installation		Y		
PLET installation	Y			
Spool installation	Y			
Pipeline shore pull				Y
Trench back-fill		Y	Y	Y
Post-lay span rectification		Y	Y	

Activity	Commonwealth waters	Offshore NT waters (includes spoil disposal ground)	Darwin Harbour	Onshore / shore crossing
Pre-commissioning activities	Y	Unplanned	Unplanned	Y
Pipelay contingencies	Y	Y	Y	Y
Demobilisation at shore crossing				Y
Commissioning and operations				
Transport of hydrocarbons	Y	Y	Y	Y
Inspection, maintenance and repair	Y	Y	Y	Y
Decommissioning				
Pipeline	Y	Y	Y	Y
Subsea infrastructure	Y	Y	Y	
Onshore				Y
As-left / post surveys	Y	Y	Y	Y
Support operations				
Vessel	Y	Y	Y	
Helicopter	Y	Y	Y	
Remotely Operated Vehicles (ROV)/ Autonomous Underwater Vehicle (AUV)	Y	Y	Y	
Onshore plant and equipment				Y

2.4.1 Surveys

2.4.1.1 Offshore surveys

Site surveys that will be undertaken at various stages throughout the construction and operation phases of the Project include:

- Pre-lay surveys;
- Surveys during and following pipeline trenching and installation;
- Surveys during FCGT (contingency inspections during pressure testing);
- Routine inspection surveys during operations; and
- Post decommissioning surveys.

Low impact pre-construction surveys required to gather information for Project planning and approvals are specifically excluded from the scope of this referral. These surveys include, but are not limited to, environment, heritage, geotechnical, geophysical and unexploded ordinance (UXO) surveys.

A pre-lay survey will be undertaken prior to commencement of pipeline installation and surveys will continue throughout the construction phase, to monitor the activity and evaluate progress of the installation. The pre-lay survey will include bathymetric and geophysical evaluations of the seabed to identify debris and other hazards along the proposed route prior to laying the Project pipeline, noting the initial site investigation did not identify any debris that would require removal prior to installation in offshore areas (RPS 2022a; **Appendix B**).

As laid and cathodic protection surveys will be progressively undertaken throughout the installation phase and also during subsequent operations, i.e., inspection, maintenance and repair activities. The data from these surveys will be used to determine the Project pipeline position once laid, inform free-span rectification requirements, identify deviations from straightness, etc. Surveys will use the same techniques as outlined above, as well as visual inspection using Remotely Operated Vehicles (ROVs) and cathodic protection equipment such as passive field gradient sensing equipment.

During operations, surveys will be undertaken as a part of ongoing inspection and maintenance. As-left surveys may also be conducted as part of future decommissioning activities.

Surveys will be undertaken either from dedicated survey vessels, or other support or installation vessels. ROVs or autonomous underwater vehicles (AUV) may be used during surveys, using visual or geophysical techniques (such as MBES).

Methods that will be used to undertake the offshore surveys include:

- Geophysical surveys

Geophysical marine survey methods for identifying debris, seabed features, buried assets (i.e. fibre optic cable) and obstructions are non-intrusive, and the equipment does not disturb the seabed. Survey methods will primarily include multibeam echosounder (MBES). MBES uses sound pulses to establish the seabed profile. Most modern MBES systems work by transmitting a broad acoustic pulse from a hull or pole mounted transducer. A sub-bottom profiler (SBP) also uses acoustics, although the acoustic pulse is transmitted from a towed surface or deep-sea source and collected by a receival array that is towed below the water surface.

Side scan sonar (SSS) identifies any sea floor debris and seabed profiles. SSS involves towing a set of transducers mounted on either side of a 'tow fish' approximately 10-20 m above the seabed, producing pulses at high frequencies.

+ Underwater acoustic positioning

Installation of the Project pipeline requires accurate positioning on the seabed and therefore long base line (LBL) and/or ultra-short baseline (USBL) acoustic positioning may be required. USBL and LBL utilise transponders. Typically, for a USBL array, transponders are installed attached to subsea equipment and recovered once the equipment is correctly positioned on the seabed. For LBL, transponders are typically fixed to seabed frames which are deployed and then fully recovered once subsea equipment is correctly positioned.

LBL arrays could be required at the in-line tee and PLET location. The footprint on the seabed of a typical LBL transponder frame is less than 5 m² per frame. It is estimated that 6 per structure (inline tee and PLET) may be used, with a total area for each structure of up to ~50m^2. LBL and USBL systems work by emitting short pulses of medium to high frequency sound. Transmissions are not continuous but consist of short 'chirps' with a duration that ranges from 3 to 40 milliseconds.

USBL and LBL will be installed at the site of the in-line tee before installation of foundations (up to 1 month prior). The array will then be set up to guide foundation installation. Units will be retrieved after installation of the in-line tee.

2.4.1.2 Onshore surveys

Onshore geophysical and geotechnical surveys will be undertaken prior to construction at the DLNG facility shore crossing location. These survey activities may include:

+ Geophysical, including refraction and multi-channel analysis of surface waves; and
+ Geotechnical, including digging of test pits with an excavator; PiezoCone penetration test testing and core sampling (i.e. to test for acid sulphate soils). These could extend down to the anticipated depth of the trench (i.e. 5 m).

Following decommissioning, surveys will be undertaken of the ground level (as-left survey).

2.4.2 Pre-lay works

For deep-water sections of the Project pipeline, including all of the pipeline route in Commonwealth waters, the pipeline will be laid directly on the seabed. Some seabed intervention will be required as part of pre-lay and post-lay span rectification.

In shallower waters, the Project pipeline will require stabilisation in some areas due to exposure to waves, currents and tidal movement, and where required impact protection from third-party activities (i.e. anchors). As such, in some areas the Project pipeline will be installed in a trench to protect it from such instabilities and activities.

2.4.2.1 Pipeline pre-lay trenching

While the carbon steel construction and concrete coating provides some protection to the Project pipeline from external impacts, in shallower waters other techniques are proposed for protection. A key technique will be to trench the Project pipeline, and following pipelay, backfill the trench using rock. The expected volume of rock placement material is estimated to be 300,000t, with a maximum volume of no more than 500,000t in the event of over dump or contingency scenarios.

Trenching will be required in areas within Darwin Harbour (i.e. nearshore) and at the shore crossing location.

Trenching

Pre-lay trenching involves the excavation of a trench in some areas along the pipeline route within an indicative corridor of 50m width. A Trailer Suction Hopper Dredge (TSHD), Cutter Suction Dredge (CSD) and Backhoe Dredge (BHD) have been proposed for the pre-lay trenching works. Material will be excavated and disposed of at the spoil disposal ground, as shown in **Figure 2-1**.

Closer to shore, it is expected that a BHD will be used. The BHD will be supported in shallow waters on spuds and will empty spoil onto split hopper barges. These barges are self-propelled or towed to the spoil disposal ground, where barges 'split' and spoil is released.

Locations of proposed trenching along the pipeline are shown in **Figure 2-4.**

Trenching from onshore

Excavators may be used from onshore to dig the trench through the shore crossing at the DLNG facility. To support this, some temporary shoreline modifications may be required, including the construction of a cofferdam using sheet piling to help retain trench walls and / or a temporary causeway so the excavators can operate further from the current shoreline. The temporary casuseway would be built with imported rock and fill and pushed out with the tide.

Experience from the original Bayu-Undan to Darwin pipeline shore crossing works identified that the intertidal zone had potential to contain Acid Sulphate Soils (ASS). Some of the material excavated during the crossing construction was shown to be ASS, which if left exposed to the air would have required treatment with lime. However, the ASS material recovered at the shore crossing was placed below the waterline so no treatment was ultimately required.

If ASS or Potential Acid Sulphate Soils (PASS) are identified during trenching activities, the main approach to manage these will be to keep the ASS/PASS material submerged, alongside the trench within the existing pipeline disturbance footprint or disposed of at the spoil disposal ground. If this is not possible, ASS will be removed and stored onshore and treated with lime or other approved neutralising chemicals. ASS material may be used as backfill for some of the onshore trench after treatment onsite with lime. If it is not suitable for re-use, it will be removed from site for either re-use or disposal at an approved location (including the spoil disposal ground).

The Darwin Pipeline Duplication (DPD) Project NT EPA Referral (BAA-201 0003) Section 7.1.4.2 details ASS potential in the Project area.

An Acid Sulfate Soils Management Plan (ASSMP) is being developed for the Project to manage the risk of ASS.

2.4.2.2 Spoil disposal

Trenching for the Project pipeline installation will result in the requirement to dispose of an estimated 310,000m³ of spoil however a contingency of 750,000m³ has been considered. The proposed spoil disposal ground for trenched material is located to the north of Darwin Harbour, within the Beagle Gulf, approximately 12km north-west of Lee Point. This location has been selected with consideration of technical, environmental, cost and safety aspects and available information. The selected site is adjacent to the spoil disposal ground approved for use by INPEX for the Ichthys Gas Field Development Project (refer to **Figure 2-1**). The area of the spoil disposal ground is 6.25km².

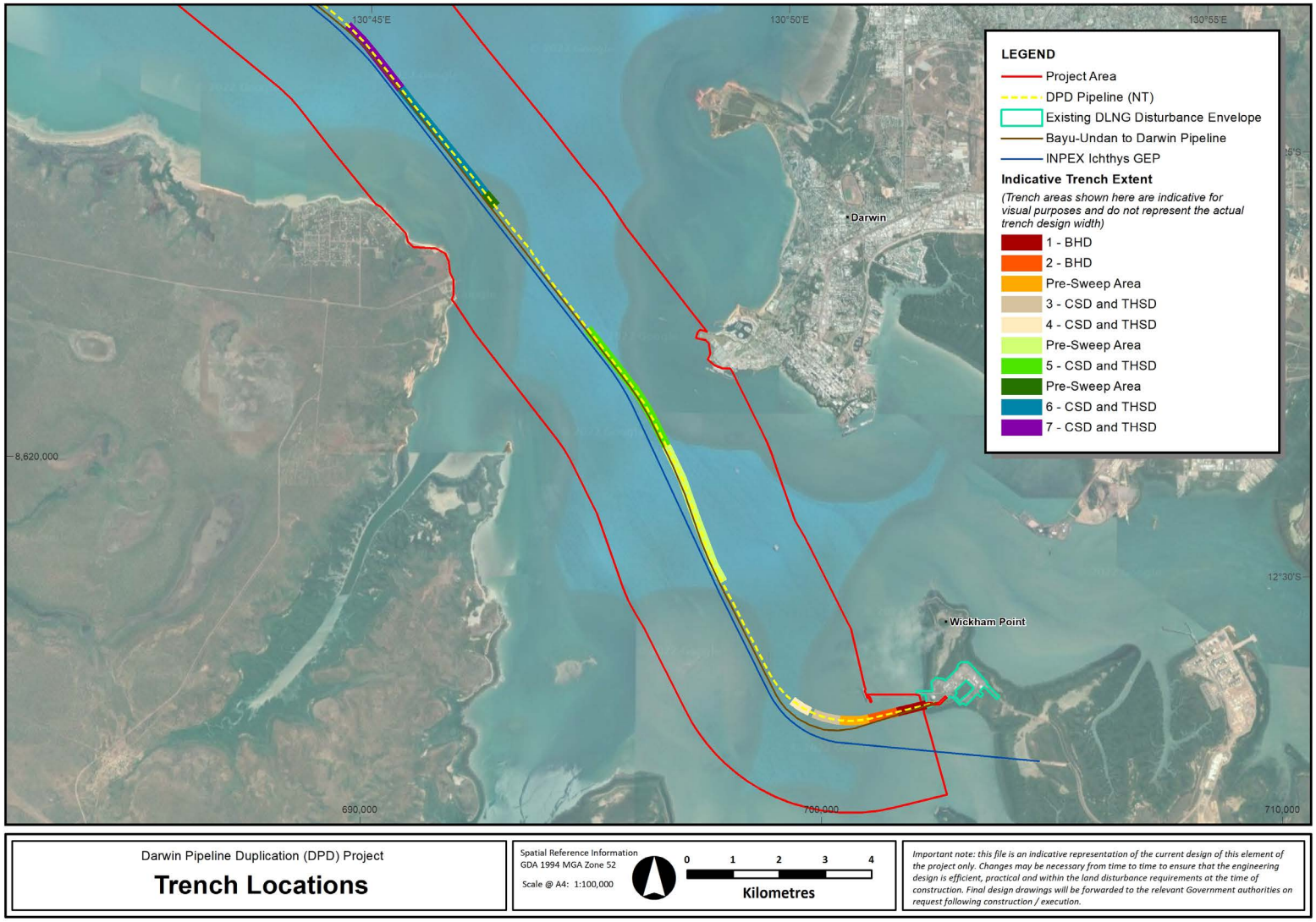


Figure 2-4: DPD Project trench locations

2.4.2.3 Pre-lay span rectification and foundation installation

Following the pre-lay survey, an assessment of the span rectifications required for installing the Project pipeline will be made. In the event that pre-lay span rectification is required, the following activities may be undertaken:

+ Installation of concrete mattresses or grout bags to act as 'bridge' or scour protection around foundations using a construction vessel. Each mattress is ~18m^2 and mattresses may be installed in groups and/or stacked on top of each other; and
+ Seabed feature (e.g. sandwaves) rectification (to stop pipeline spanning) using TSHD or BHD; or by mattress installation. Where sediment is removed, this will be disposed of in the spoil disposal ground. The volume of material for this activity would be much smaller than for pre-lay trenching and is estimated to be <30,000-60,000m^3.

It is expected that approximately 60 pipeline spans will require rectification, with individual span heights less than 1.5m.

A PLET foundation will be installed using the construction vessel. The construction vessel crane may be used to lift the PLET foundation from the deck of the vessel onto the seabed. An ROV would be used during installation to position and orientate the foundation. The protection structures will be installed after the PLET installation. The seabed footprint associated with the PLET foundation complete with anti-scour mattresses extending 5m on each side is nominally 875m^2.

The spool is supported on mattresses, complete with scour protection, which are installed on the seabed prior to spool installation. The seabed disturbance footprint of the spool and tie-in is nominally 155m^2.

The in-line tee may be installed on a pre-installed foundation or have an integrated foundation. Scour protection shall be installed around the in-line tee foundation and may take the form of mattresses, scour skirts or grout filled bags The approximate footprint is nominally 375m^2.

2.4.2.4 Cable crossings

Telecommunications and power cables in Darwin Harbour will be protected during pipelay operations using concrete mattresses if required. Supports either side of the individual cables will be provided, and it is likely that concrete mattresses will also be used to provide clearance between the Project pipeline and cable.

If concrete mattresses are to be used, it is estimated that the footprint of the mattresses over the four existing cables will each be approximately 600m^2.

For future cables, installation over the Project pipeline will be managed in consultation with the owner/operator of the future cable and Santos.

2.4.2.5 Onshore construction

The proposed method to bring the Project pipeline ashore at the shore crossing is to use a shore-based winch, as the pipeline is welded on the pipelay vessel. The onshore disturbance is located within the existing DLNG facility disturbance envelope, as shown in **Figure 2-5.**

The shore pull location and equipment layout has been designed to accommodate all contingency operations, i.e. wet buckle dewatering while the pull head is attached to the winch wire.

Onshore construction could include:

- Vegetation regrowth clearing;
- Civil works and grading of the onshore shore pull site location, construction of a levelled lay-down area for the winch foundation;
- Import of clean fill and rock;
- Preparation of lay down areas, access roads, hardstand (geotextile and road base) and site fencing;
- Installation of the winch spread, including winch pad, holdback anchor and/or sheet piling;
- Installation of bedding rock and or rollers for the shore pull; and
- Installation of facilities including offices, amenities, chemical and fuel storage, PASS storage and treatment.

The shore crossing location will be used for the flood, clean, gauge, testing (FCGT) scope once the Project pipeline has been fully installed. A hydrotest spread will be installed, with bulk chemical storage. Depending on the hydrotest concept selected, a bladder may need to be installed to temporarily store hydrotest water (i.e. an enclosed bladder within steel retaining wall).

The total area of the shore crossing location (onshore) is approximately 0.03 km^2 and is completely within the existing DLNG disturbance envelope.

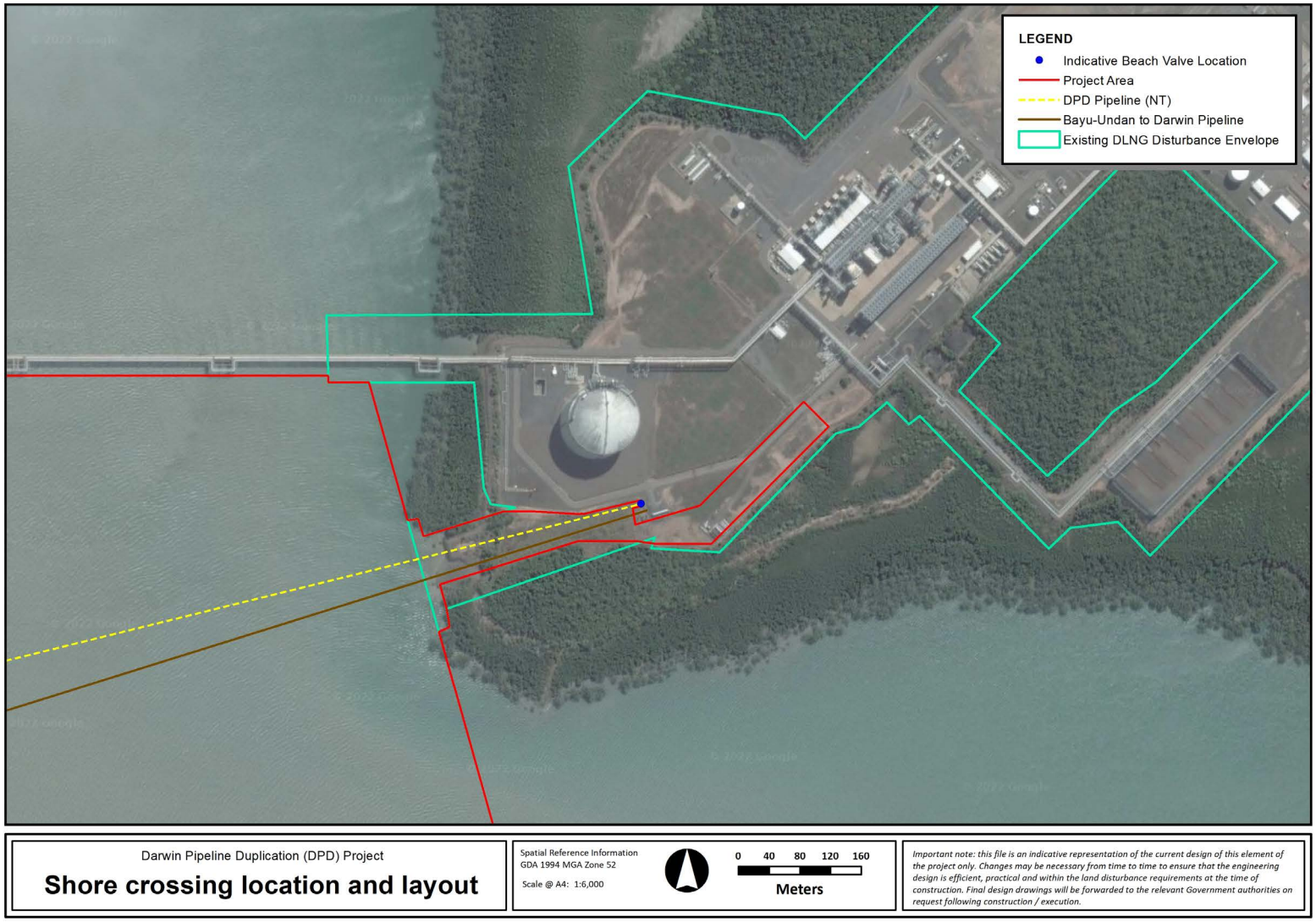


Figure 2-5 Shore crossing and onshore Project area

2.4.3 Installation and pre-commissioning

2.4.3.1 Pipelay activities

The planned pipelay activities will commence with pipelay initiating with welding commencing on the nearshore pipelay barge. Consecutive joints will be welded onto the pull-in head, which will be pulled onshore to the onshore tie-in point using the preinstalled linear winch assembly detailed in **Section 2.4.2.5**. The base case methodology is for pipelay to continue as a continuous program from nearshore to offshore and completed using the deep water pipelay vessel with laydown of the offshore DPD pipeline PLET structure on the preinstalled foundation at pipeline kilometre point (KP) 0.

For this to occur the last section of pipe laid by the nearshore pipelay barge will have a recovery head arrangement installed which will include a submersed pennant buoy, allowing this and the pipe to be recovered by the deep water pipelay vessel. Once retrieved the recovery head will be removed and recovered pipe welded to the new section of pipe to commence the deep water pipelaying process.

The base case handover point will be in approximately 20m of water, in this case the shallow water pipelay barge will have laid ~58km of pipe and the deep water pipelay vessel will lay ~65km of pipe (in NT waters). However, if there are schedule delays in deep water pipelay vessel prior activities, as a contingency action the shallow water pipelay barge may lay pipeline further offshore, which may include up to ~30 km of additional pipeline, moving the handover point into deeper water. While this would not alter the seabed disturbance from the pipeline, additional seabed disturbance would occur from shallow water pipelay barge anchors along the pipeline route.

As an alternative to the above, the pipelay activities may take place with a split campaign, with pipeline initiation for the deep water pipelay vessel occurring offshore between KP 91.5 and KP 0. This would require the installation of a deadman anchor to assist the dynamically positioned pipelay vessel to commence pipelay. This mid-line start-up would have a seabed footprint of nominally 90m^2, which would be wholly contained within the existing pipelay corridor.

In a split campaign scenario, an above water tie-in would be performed where the two sections of pipeline (laid by the deep water pipelay vessel and the nearshore pipelay barge) meet. The above water tie-in would occur using the nearshore pipelay barge and would involve recovery of pipeline end sections using davits and subsequent welding from a temporary work platform. This activity would involve the installation of buoyancy modules on the pipe tails to support the pipeline end sections and facilitate correct alignment for welding. Timing of above water tie-in operations would be done to coincide with neap tides where practicable.

The Project pipeline will be laid using a continuous assembly pipe-welding installation method, which involves the assembly of the single pipe joins (approximately 12 m in length) in a horizontal working plane onboard the pipelay vessel. The pipe joints are welded together, inspected and then the welded area is coated on board the vessel before being lowered behind the pipelay vessel. The pipelay uses an ‘S-lay’ method (with the S notation referring to the shape of the pipeline catenary as it is lowered to the seabed). As the pipeline is lowered, it is supported on board the pipelay vessel using a curved steel structure fitted with rollers known as a ‘stinger’.

The pipelay vessel that will be used is dependent on a range of factors including the availability of vessels, final pipeline parameters and water depth. Both a dynamically positioned (DP) deep water

pipelay vessel and an anchored nearshore pipelay barge will be used to perform the installation, dependant on water depth. Examples of pipelay vessels are shown in **Figure 2-6** and **Figure 2-7**.

In the Commonwealth and offshore NT waters (refer to **Section 2.3** for definition) where a deep water DP pipelay vessel will be used, pipeline will be laid at approximately 2 km/day. The installation disturbance footprint will be limited to within a 50m wide disturbance corridor.

Where the nearshore pipelay barge is used, anchoring will be required and the speed of pipelay will be reduced to ~300-400m/day, depending on the coordination of other supporting activities.

For this extent, the footprint will include the 50m disturbance corridor, plus the footprints required for vessel anchoring. It is estimated that each of the 10 anchors has a footprint of ~10m^2, including chain sweep. Between 10 – 20 anchor moves are expected each day, for a period conservatively estimated as 100 days.

When close to shore, pre-installed onshore anchors may be used by the nearshore pipelay barge. These would be within the proposed shore crossing (i.e. onshore) disturbance footprint (existing DLNG facility disturbance footprint). If onshore anchors are used, these anchors have a typical footprint of 5m x 5 m with an additional 40m^2 for anchor wire on the seabed.

Figure 2-6 Example of pipelaying vessel (deep water vessel)

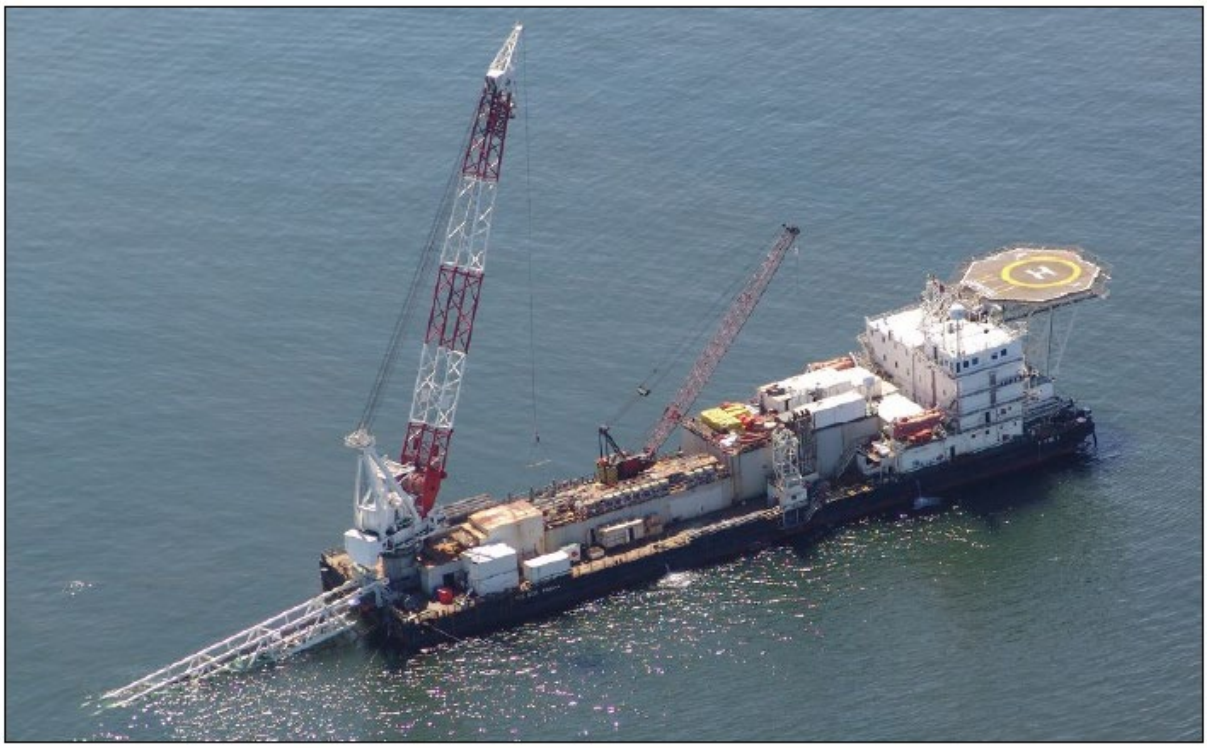


Figure 2-7 Example of pipelaying vessel (nearshore pipelay barge)

2.4.3.2 In-line tee

The ILT will be installed during the pipelay activities by the deep water DP pipelay vessel. The foundation for the ILT would be pre-installed during pre-lay works (**Section 2.4.2.3**). The ILT is welded into the Project pipeline onboard the pipelay vessel and is laid as part of normal pipelay. A protection structure, approximately 5 m high, would be installed post-pipelay by crane (guided by ROV) over the ILT assembly. Anti-scour protection in the form of concrete mattresses will also be installed and are covered by the calculated seabed disturbance figures.

2.4.3.3 DPD pipeline PLET installation

The foundation for the DPD pipeline PLET is pre-installed during pre-lay works (**Section 2.4.2.3**).

The PLET is welded into the pipeline onboard the pipelay vessel and is laid as part of normal pipelay. The PLET will be installed utilising an in-line (s-lay) methodology where the PLET (excluding mattresses/mudmats and protection structures) will be introduced into the firing line where it is then welded into the pipe string. The PLET and pipeline are progressively lowered to the seabed, as the vessel moves forwards, until the PLET/pipeline assembly is landed onto the pre-installed foundation.

Following the PLET and spool installation, a PLET protection structure will be installed and will arch over PLET. The PLET protection structure may be wet parked (if required) adjacent to the PLET location. Once in place, the PLET protection structure does not add to the seabed disturbance footprint generated by the PLET foundation.

2.4.3.4 Spool installation

The spool will be installed to connect two PLETs (**Figure 2-2**) (one PLET, the Barossa GEP PLET, is out of scope for this referral, as it is included in the *Barossa Gas Export Pipeline Installation Environment Plan (BAA-100 0329)* accepted by NOPSEMA on 9 March 2020). The spool is nominally 90 m long, 26-inch in diameter carbon steel pipeline. Concrete mattresses will be installed to support the spool (refer to **Section 2.4.2.3**). The positioning of the spool will be supported by an LBL array to be installed around the PLETs. This may be in addition to the foundation installation array (depending on timing) and thus separate seabed disturbance. It will likely be installed pre-flooded with treated seawater. **Section 2.4.3.8** details the chemical composition. Once the spool is positioned, the temporary caps will then be removed, and the spool connected to PLETs, then flushed with MEG. The nominal volumes discharged is listed in **Table 2-4**. The seabed footprint associated with installing the spool (including mattresses and LBL positioning (if required) is nominally 155m^2.

2.4.3.5 Pipeline shore pull and onshore construction

Shore-pull to bring the Project pipeline onshore within the DLNG disturbance footprint, will use a conventional winch operation. The arrangement for the shore-pull consists of a winch spread installed on a winch pad and attached to a hold back anchor located onshore.

The pipeline pull head on the shallow water pipelay vessel is connected to the winch using a pull wire and suitable rigging. The pipe will be pulled ashore from the pipelay vessel using the winch spread located onshore through the pre-constructed trench and winched up to shore pull end point (~2 m above HAT).

The pulling arrangement will allow for the shore-pull to be completed as a continuous operation, which may take approximately two weeks.

Onshore, between the shore pull end point and the proposed beach valve location (a distance of approximately 200m), trenching will be continued and pipeline installed through lowering by crane and welding of pipe lengths in-situ. Following pipeline installation and hydrostatic testing, the onshore trench will be filled. Installation of the beach valve and the pipeline between the beach valve and the DLNG facility tie-in point is not covered by this referral.

2.4.3.6 Trench backfill

The primary method of maintaining pipeline stability on the seabed will be through the concrete weighted pipeline coating. It will however also be necessary to install localised secondary stabilisation/protection for sections within Darwin Harbour where the concrete weighted coating alone is not considered sufficient to provide stability and/or protection. Secondary stabilisation/protection will be via rock placement using a fallpipe vessel (FPV) or side dump vessel (SDV); self-propelled dynamically-positioned vessels that are used to install rock (sourced onshore) on the seabed with support barges used to transport rock. A BHD shall also be used to install rock in shallow water at the shore crossing with the rock being bought alongside the BHD on barges.

2.4.3.7 Post-lay span rectification

In order to provide pipeline stability, post-lay span rectification may be required and if so, would be undertaken by the installation of grout bags using an ROV. The likely disturbance footprint for each

occasion of post-lay span rectification is 25m². Grout is an inert substance used to fill grout bags in-situ. Following grout bag filling, grout lines will be flushed resulting in small discharges of grout to the marine environment.

The actual locations would not be known until after the Project pipeline is laid and surveyed.

2.4.3.8 Pre-commissioning activities

Once the pipeline is installed, pre-commissioning (flooding, cleaning, gauging, testing (FCGT), dewatering, leak testing, preconditioning and nitrogen packing) activities will be carried out to ensure the integrity and connections of the infrastructure. Pig launcher/receivers (PLRs) will be installed on the DPD pipeline PLET and at the shore crossing. The treated seawater is typically a mixture of biocides (to prevent biofouling and bacterial corrosion on the internal surfaces), an oxygen scavenger (to control corrosion of the pipeline) and a dye (for leak detection during hydrotest). Typically, a concentration of up to 550ppm of the hydrotest package (Hydrosure, Roemex Hydro 4 or similar).

For the FCGT activities, flooding is planned to occur from onshore to the DPD pipeline PLET. Seawater will be sourced from Darwin Harbour and screened at the intake to reduce the risk of harm to marine fauna. The nominal volume of treated seawater discharged at the PLET is listed in **Table 2-4**. Once the flooding is complete and the condition of the gauge plates has been confirmed, the pipeline will be subjected to a hydrostatic pressure test (hydrotest). The hydrotest pressure will be held for a period as per the relevant standard to test the pipeline integrity. There will be small, localised discharges around the PLET during testing and pipeline depressurisation. Hydrotest depressurising is expected to be discharged over approximately half a day at the PLET; the nominal volume of treated seawater discharged is listed in **Table 2-4**.

On completion of FCGT, the flooded pipeline will be dewatered from onshore to the DPD pipeline PLET, preconditioned with MEG and filled with nitrogen. The total volume of treated seawater and MEG discharged is listed in **Table 2-4**. Dewatering is expected to take approximately one week.

A spool leak test will be performed on the tie-ins using treated seawater and MEG. The leak test pressure will be held for a period (as per the relevant standard) to test the connection integrity. The total volume of treated seawater and MEG discharged is listed in **Table 2-4**.

While the current planning is to dewater the entire DPD Project pipeline in one go as described above, if there is a failure in the pipeline during installation that requires remedial construction work on the pipeline, or if a pipeline wet buckle occurs during pipelay (a wet buckle is when there is a failure in the pipeline during installation which results in the ingress of raw / untreated seawater into the pipeline), contingency plans will be implemented (Refer to **Section 2.4.3.10**).

The preservation phase commences on completion of the nitrogen packing until commissioning. This ensures the integrity of the infrastructure is maintained.

2.4.3.9 Demobilisation at shore crossing

Following the completion of shoreline construction activities (i.e. shore-pull and winch spread) and pre-commissioning activities, the pipeline will be backfilled with the remaining 20-30 m (at the proposed beach valve location end) left in the ground unburied for a period of time ready for tie-in. As a separate campaign, not covered under the scope of this referral, Santos will install the remaining 800

m section of pipeline (including the beach valve and piping inside the DLNG facility) to the DLNG facility tie-in point.

2.4.3.10 Pipelay contingencies

While unlikely to occur, failures in the Project pipeline and the occurrence of wet buckling can occur during pipelay activities and in these situations, pipelay contingency activities will be required.

If a pig gets stuck in a pipeline during pre-commissioning, it will need to be forced out. This would require using additional treated seawater to push the pig out, resulting in a discharge to the environment.

A 'wet buckle' event may occur during installation should the pipeline become buckled and fracture during pipelay, resulting in flooding of the pipeline with raw, untreated seawater. If this occurs, the raw seawater will need to be removed from the pipeline to prevent corrosion to the undamaged section of pipeline. To remove the raw seawater, a contingency pig is launched with filtered seawater to flush the pipeline, followed by a second contingency pig which is pushed with compressed dry air. The pipeline end is then recovered and pipelay can continue.

In the event of an extended period before pipelay recommencement, the pipeline would be flushed with raw filtered seawater and then filled (from the DLNG facility end) with treated seawater to safely preserve the pipeline in the intervening period before pipelay is recommenced. If preservation is required, discharges will occur initially as over-pump of treated seawater and then through dewatering of the pipeline.

If modifications are required to the pipelay vessel or procedures that result in an extended period before pipelay can recommence, the pipeline will be flooded with treated seawater to safely preserve the pipeline until pipelay is recommenced. The pipeline will be dewatered immediately prior to pipelay recommencing in order to enable the pipeline to be recovered to the surface.

2.4.4 Commissioning and operations

The activities associated with the operations phase include:

+ Commissioning and transport of dry hydrocarbons through the pipeline; and
+ Inspection, maintenance and repair of the installed infrastructure.

Operations and maintenance of the Project pipeline is expected to follow the same, or very similar management procedures and risk-based approach currently used by Santos to operate and manage the Bayu-Undan to Darwin pipeline.

2.4.4.1 Transport of hydrocarbons

The principal activity during operations of the duplicate pipeline will be the flow and transportation of natural gas from offshore reservoirs to the DLNG facility. There will not be a separate control system for the pipeline and therefore valve discharges will not occur within NT jurisdiction.

2.4.4.2 Inspection, maintenance and repair

Inspection, maintenance and repair (IMR) of subsea and onshore infrastructure will be undertaken to ensure that the integrity of the hydrocarbon system is maintained at acceptable standards. IMR

activities will typically be vessel based, using ROV/AUV as required and may be scheduled or undertaken as a contingency.

Typical offshore IMR activities include but are not limited to:

+ Cathodic protection surveys;
+ General visual inspections;
+ Anode replacement;
+ Cathodic protection system maintenance;
+ Wall thickness measurements (ultrasonic testing);
+ Inline inspections (including pigging);
+ Pipeline / spool repairs;
+ Span rectification and pipeline stabilisation, i.e. grout bags;
+ General subsea infrastructure servicing (includes leak testing);
+ Marine growth removal;
+ Removal of fishing nets or other marine debris; and
+ Re-commissioning (similar to pre-commissioning discussed in **Section 2.4.3.8**).

In the unlikely event of pipeline failure, the pipeline may need to be repaired, which involves similar activities to decommissioning, and pre-commissioning (refer to **Section 2.4.5** and **Section 2.4.3.8**).

Typical onshore IMR activities include:

+ Cathodic protection surveys (visual, electrochemical potential survey);
+ General visual inspections for damage and missing items; and
+ Wall thickness measurements (ultrasonic testing).

2.4.5 Decommissioning

At the end of the Project, it is expected that pipeline hydrocarbons will be displaced to the DLNG facility and the pipeline will be flushed with either raw seawater, air or nitrogen. The Project pipeline, subsea infrastructure and associated facilities will then be decommissioned in accordance with regulatory requirements at that time. A decommissioning plan for DPD infrastructure will be developed closer to the end of field life.

2.4.6 Summary of vessel and support activities

Support activities associated with the Project will be undertaken throughout all phases of the Project. Support activities are likely to include vessels, helicopters, ROVs, and onshore equipment, with varying requirements depending on the Project phase.

2.4.6.1 Vessel activities

A number of vessel types will be required to complete the proposed activities, including:

- Marine survey vessels - to support pre-lay and post lay surveys of the Project pipeline, including trenching scope and spoil ground;
- Environmental monitoring vessels – to conduct environmental monitoring during construction activities;
- Pipelay vessels – A deep water pipelay vessel and a shallow water pipelay barge, to install the pipeline, ILT and DPD pipeline PLET;
- Anchor handling vessels to assist with nearshore pipelay barge anchoring;
- Construction vessels – to support installation of structures (i.e. DPD pipeline PLET foundations, spool, mattresses for scour protection, initiation site (if required), mechanical protection and stabilisation etc) and pre-commissioning activities;
- Rock installation vessels – including fall pipe vessel, side dump vessels and non-propelled barges;
- Trenching and spoil disposal vessels – including a Cutter Suction Dredge (CSD), Trailing Suction Hopper Dredge (TSHD), Backhoe Dredge (BHD) and Split Hopper Barges (SHB);
- Pipe supply vessels – to provide pipe to the pipelay vessel from General Cargo Vessel/s;
- Supply vessels – to provide general support, crew transfers, material, fuel, chemicals and supplies to all offshore activities and backload material/ waste as required; and
- Inspection, Maintenance and Repair (IMR) vessels – to provide IMR support during pipeline operations.

Supply vessels are expected to operate from local regional ports (i.e. Darwin) to transport fuel, stores, waste and specialist supplies such as rock, pipe etc.

Pipe supply vessels will be supplied by General Cargo Vessel (GCVs) but not within the Project area.

Bunkering (re-fuelling) of the vessels may take place either at sea (i.e. if required for the pipelay vessel) or in port (support and other vessels).

Vessels will vary in length, draft and number of persons on board. They may anchor depending on water depth, with varying anchor requirement and disturbance footprints however, sensitive areas as marked on Project marine charts will be avoided for anchoring disturbance.

The expected requirements for vessels over different project phases are presented in **Table 2-3.**

The greatest number of vessels are required during the construction phase. For trenching and spoil disposal activities, an expected 11 vessels will be involved, for deep water and shallow pipelay activities an expected 6 and 7 vessels, respectively, will be involved, for rock installation an expected 6 vessels will be involved and for pre-commissioning an expected 4 vessels will be involved.

Darwin Harbour is an active port supporting commercial vessel operations including trade vessel (e.g. bulk cargo and materials, LNG, livestock), oil and gas support vessels, defence vessels, fishing vessels and passenger vessels. Vessel movements within (intra-harbour) and in/out of Darwin Harbour (harbour visits) during DPD construction phase are not expected to add significantly to vessel traffic

within the harbour on an annual basis. A comparison of expected intra- harbour and harbour visit movements with historical Darwin Harbour vessel movements is provided in **Figure 2-8**. This comparison only includes larger commercial vessel, smaller recreational and commercial vessels also add to the amount of harbour traffic.

During the operations phase, vessels will only be required for intermittent activities, with the frequency dependant on the IMR schedule.

Table 2-3 Expected support vessel requirements

Support Activity type	Construction			Commissioning and Operations*
	Survey	Pre-lay Works	Pipeline Installation and Pre-commissioning	
Survey vessel	✔	✔	✔	
Supply vessel		✔	✔	
Pipelay vessels (deep water and shallow water)			✔	
Construction vessels		✔	✔	
Rock placement vessels			✔	
Dredging vessels (CSD, TSHD, BHD, SHB)		✔		
Commissioning support vessel				✔
IMR vessels			✔	✔

**Note if major repair is required during Project life, then similar vessels to construction may be required.*

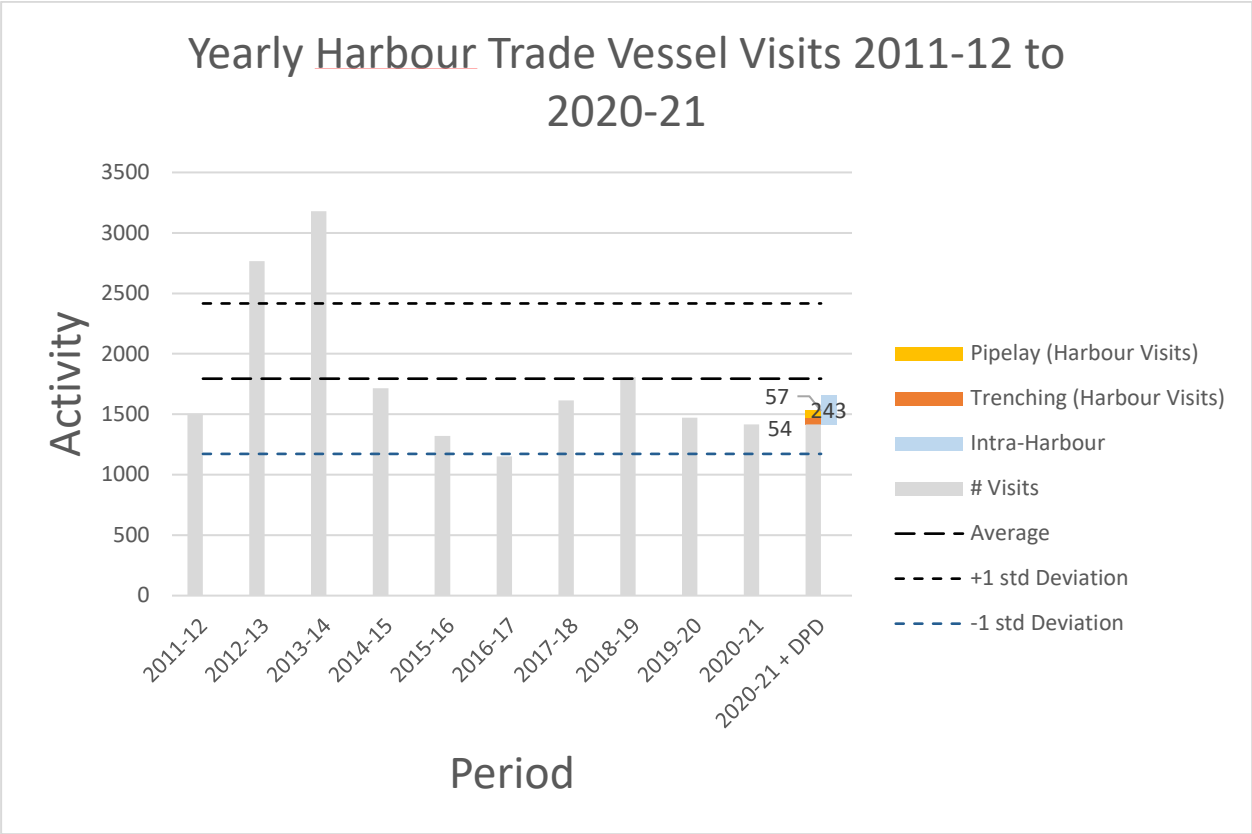


Figure 2-8: DPD Project vessel movements compared to historical Darwin Port trade vessel visit records (Darwin Port 2022)

2.4.6.2 Helicopter activities

Helicopters will be used for transporting passengers and/or urgent freight to/from the pipelay vessel and construction vessel during offshore installation and pre-commissioning activities. They are also the preferred means of evacuating personnel in the event of an emergency for vessels with suitable and approved helidecks. Helicopter support will be principally supplied from Darwin Airport. Helicopter operations will be approximately three days per week, with typically two flights each day. Helicopters will operate during daylight hours unless in the event of an emergency.

2.4.6.3 ROV / AUV activities

Throughout the Project, offshore activities will be supported by remotely operated vehicles (ROV).

The ROV can be fitted with various tools and camera systems that can be used to capture permanent records of the operations and immediate surrounding environment.

An Autonomous Unmanned Vehicle (AUV) may also be used during IMR activities undertaken during operations.

2.4.6.4 Onshore equipment

The types of equipment expected to be used include:

+ Light vehicles;

- Mobile equipment such as excavators, graders, trucks, fuel trucks, etc; and
- Heavy equipment such as cranes.

2.5 Resource requirements and access

Other components required for the Project include:

- Personnel for the construction period. Labour will be recruited from the domestic and local labour market where possible; this is subject to the contractors' resourcing requirements at the time. Accommodation may be provided for the workforce within the Darwin area;
- Power may be supplied from onsite generators to support construction amenities and operation of equipment;
- Water usage including for dust suppression, washdown facilities and ablutions supply will likely be sourced from mains water supply within the DLNG facility, or provided as self-sufficient water through containerised water trucks;
- Water required for FCGT activities will be extracted from Darwin Harbour;
- Access to the shore crossing location (i.e. onshore site) will be via the existing DLNG access at the end of Middle Arm Peninsula into Wickham Point.
- Crew and supply transfers to Project vessels will be via Darwin Port locations (vessel transfers) or Darwin Airport (helicopter transfers); and
- Loading of rock onto vessels will be via East Arm Wharf in Darwin Harbour.

2.6 Fuels and chemicals

Chemical and fuel storage will be stored onsite within the shore crossing location and may include self-bunded fuel storage/tanks. Fuel trucks will likely be used to supply fuel to construction equipment including excavators, graders, cranes and generators. Hydrotest chemicals will also be stored onshore within a hydrotest spread (i.e. biocides, oxygen scavenger and dye).

2.7 Summary of discharges and emissions

Table 2-4: Summary of Project activity planned marine discharges

Activity	Location	Discharge/waste type	Estimated total release volume (m^3)
FCGT	Commonwealth waters (vicinity of DPD Pipeline PLET)	Treated seawater	7,650
Dewatering		Treated seawater	50,000
		MEG	1,000
Spool leak testing		Treated seawater	100
		MEG	50
Spoil disposal	Offshore NT waters (spoil disposal ground)	Spoil	310,000 (up to 750,000)

Table 2-5: Summary of other typical Project discharges and emissions

Type	Description
Emissions	
Atmospheric emissions including GHGs (hydrocarbon combustion)	Emissions from Project vessels, vehicles, equipment and helicopters.
Noise emissions	+ Vessel activities (e.g. vessel engines, DP thrusters and other machinery) + Acoustic positioning systems + ROV activities + Helicopter activities
Light emissions	+ Vessel navigation and safety lighting + Spot lighting as needed + ROV underwater lighting as needed
Discharges	
Sewage and greywater	The volume of sewage and greywater directly relates to the POB number. Up to 30–40 L of sewage/greywater may be generated per person per day.

Type	Description
Deck drainage/run-off	Drainage water from activity vessels includes rainwater, seawater and washdown water. Such discharge may potentially contain small residual quantities of oil, grease and detergents if present or used on the decks.
Cooling water	Excess or unused heat in cooling water will be carried away from vessel and equipment components using seawater and returned to the sea with residual sodium hypochlorite.
Bilge water	Oily bilge water will be treated via an oily water filter system to achieve 15 mg/L after treatment, then discharged in compliance with regulatory requirements.
Brine (if a reverse osmosis unit is used for water treatment)	Brine generated from the water supply systems on vessels, where applicable, will be discharged to the ocean at a salinity of approximately 10% higher than sea water.
Putrescible food waste effluent	Putrescible waste discharge, where allowed under regulatory requirements, is estimated to be approximately 1 L of food waste per person per day.

3 Matters of National Environmental Significance

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), an action will require approval from the Commonwealth Minister for the Environment if the action has, will have, or is likely to have, a significant impact on a MNES. A search of the Commonwealth Protected Matters Search Tool (PMST) (including a 5-km buffer) was undertaken to determine MNES presence in the Project area. A summary of the search results is provided in **Table 3-1**. The full PMST report is provided **Appendix A.**

Table 3-1 Summary of relevant MNES

MNES	Relevant	Description
World heritage properties	N	There are no world heritage properties within close proximity to the Project area
National heritage places	N	There are no national heritage places within close proximity to the Project area
Wetlands of International Importance (Ramsar)	N	There are no wetlands of international importance/Ramsar wetlands within close proximity to the Project area
Great Barrier Reef Marine Park	N	Not applicable as the park is off the coast of Queensland
Commonwealth marine area	Y	The Project area extends approximately 23 kms into the Commonwealth marine area
Listed threatened ecological communities	N	There are no threatened ecological communities within close proximity to the Project area
Listed threatened species	Y	41 (birds - 13, mammals - 13, reptiles - 7, sharks - 8): + Critically endangered - 4 + Endangered - 12 + Vulnerable - 24 + Conservation dependent - 1
Listed migratory species	Y	75 (migratory marine birds - 7, migratory marine species - 28, migratory terrestrial species - 6, migratory wetland species - 34) a number of which are also listed as 'Threatened': + Critically endangered - 3 + Endangered - 6 + Vulnerable - 11

3.1 Likelihood of Occurrence

For the purposes of this referral, a desktop assessment was undertaken to determine the likelihood of the species listed in the PMST search results occurring within the Project area. The likelihood assessment considered the following information:

- CDM Smith (2021). A targeted vegetation survey of the DLNG facility shore crossing was conducted in November 2021 by a qualified and experienced botanist. Given the shore crossing has been previously cleared, it is unlikely that protected fauna of MNES would be present in this area. If they are, then only individuals would be expected. **Figure 3-1** shows a view of the DLNG facility disturbance envelope.
- CDM Smith (2021). Santos Darwin LNG Mangrove Monitoring 2021 Report 1001139. 26 December 2021. CDM Smith undertook a targeted vegetation survey of the shore crossing disturbance area conducted on 17 November 2021.
- KBR (2018). Darwin Ship Lift Facility and Marine Industries Project –Notice of Intent, prepared for Northern Ship Support Pty Ltd.
- AECOM (2021). AECOM 2021 Draft Environmental Impact Statement – Darwin Ship Lift, prepared for Department of Chief Minister and Cabinet.
- Acer Vaughan Consulting Engineers and Consulting Environmental Engineers (1993), Draft Environmental Impact Statement: Darwin Port Expansion – East Arm, prepared for the NT Department of Transport & Works, Darwin, NT.
- INPEX (2010b). Ichthys Gas Field Development Project: Draft Environmental Impact Statement, INPEX Browse, Ltd.
- URS (2002). Darwin 10 MTPA LNG facility: public environmental report, report prepared for Phillips Petroleum Company Australia Pty Ltd, Darwin, NT.
- Atlas of Living Australia, (https://ror.org/018n2ja79).
- Jasco Applied Sciences (2016). Passive Acoustic Monitoring of Noise and Marine Mammals – Barossa Field.

Figure 3-1 View of existing cleared shore crossing looking west toward Darwin Harbour (Left) and mangroves in proximity of the shore crossing within the intertidal area of DLNG facility disturbance envelope (Right)

The likelihood of occurrence assessment was based on documented records of the species within a 5-km radius of the Project area (sourced from publicly available information and previous studies of the area) and the species habitat requirements with respect to habitat features present within the vicinity of the Project area.

The criteria applied to define the likelihood of occurrence for terrestrial fauna is:

- **Unlikely**: the Project area is not within the species known distribution; and/or suitable habitat is not present within the Project area.
- **Potential**: the Project area is within the species known distribution and the Project area contains suitable habitat for the species, but the species has not been recorded within 5 km of the Project area.
- **Likely**: the species has been recorded within 5 km of the Project area in the past 10 years, and the Project area contains suitable habitat for the species.
- **Known to occur**: the species has been recorded (directly by commissioned surveys or from database records) within the Project area in the past 10 years.

The criteria applied to define the likelihood of occurrence for marine fauna is:

- **Unlikely**: the species has not been recorded within Darwin Harbour or surrounding waters; and/or its current known distribution of the species does not encompass Darwin Harbour, and surrounding water; and/or suitable habitat is generally lacking from the Project area.
- **Potential**: the species has not been recorded within Darwin Harbour or surrounding waters, although species' distribution incorporates Darwin Harbour and surrounding waters; and potentially suitable habitat occurs in the Project area.
- **Likely**: the species has been recorded within Darwin Harbour or surrounding waters in the past 10 years; and suitable habitat is present within the Project area.
- **Known to occur**: the species has been recorded (directly by commissioned surveys or from database records) within the Project area in the past 10 years.

The species taken through to the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DoE 2013) self-assessment in **Section 6** are those species that are **known to occur**, considered **likely** to occur, or considered to have the **potential** to occur, as summarised in **Table 3-2**.

For the purposes of this assessment, when referring to the Darwin Harbour, this includes the area within the Darwin Harbour Region Management Boundary (as illustrated in **Figure 3-2**).

Within this assessment, the terms 'habitat critical to the survival of a species' and 'biologically important areas' (BIAs) are used. These habitats and areas for marine turtles in Australia are defined in the Recovery Plan for Marine Turtles in Australia (DoEE 2017a), and for dolphins are defined in the Marine Bioregional Plan for the North Marine Region (DSEWPaC 2012).

Table 3-2 Likelihood of occurrence assessment

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
Threatened Species (Marine Reptiles)				
Flatback turtle	*Natator depressus*	VU/M	The Project area overlaps habitat critical to the survival of Flatback turtles and a Flatback turtle BIA (inter-nesting).	**Likely** - Species is known to occur in the Darwin Harbour and surrounding waters.
Green turtle	*Chelonia mydas*	VU/M	The Green turtle utilises Darwin Harbour regularly (Whiting 2003).	**Likely** - Species is known to occur in the Darwin Harbour and surrounding waters.
Hawksbill turtle	*Eretmochelys imbricata*	VU/M	The Hawksbill turtle utilises Darwin Harbour regularly (Whiting 2003).	**Likely** - Species is known to occur in the Darwin Harbour and surrounding waters.
Leatherback turtle	*Dermochelys coriacea*	EN/M	The Leatherback turtle is considered to be an oceanic species, which is unlikely to occur within the Darwin Harbour (Whiting 2001). The species is likely to occur in oceanic waters outside the Darwin Harbour.	**Potential** - Species unlikely to occur within the Darwin Harbour, but potentially occurs in surrounding waters.
Loggerhead turtle	*Caretta Caretta*	EN/M	Loggerhead turtles are expected to be infrequent users of the Darwin Harbour (Whiting 2003). The Loggerhead turtle is more likely to occur in oceanic areas outside the Darwin Harbour.	**Potential** - Species may occur within the Darwin Harbour, but potentially occurs in surrounding waters.
Olive Ridley turtle	*Lepidochelys olivacea*	EN/M	Habitat critical to the survival of Olive Ridley turtles and a BIA (inter-nesting) occur outside to the north and south of the Project area respectively.	**Likely** - Species is known to occur in the Darwin Harbour and surrounding waters.
Threatened Species (Terrestrial Reptile)				
Plains Death Adder	*Acanthophsis hawkei*	VU	Prefers flat, treeless, cracking soil riverine floodplains. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Whilst the species has been recorded within 5km of the Project area, the species preferred terrestrial habitat does not occur within the Project area.
Threatened Species (Terrestrial Mammals)				
Bare-rumped Sheath-tailed Bat	*Saccolaimus saccolaimus*	VU	Open Pandanus woodland fringing the and eucalypt tall open forests. It roosts in tree hollows and caves. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - No suitable habitat within the Project area.
Black-footed Tree-rat	*Mesembriomys gouldii*	EN	Occurs in the Top End of the NT in tropical woodlands and open forests in coastal areas. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - No suitable habitat within the Project area.
Brush-tailed Rabbit-rat	*Conilurus penicillatus*	VU	The preferred habitat is eucalypt tall open forest, has been known to also occur on coastal grasslands with scattered large *Casuarina equisetifolia* trees, beaches, and stunted eucalypt woodlands on stony slopes. It shelters in tree hollows, hollow logs and, less frequently, in the crowns of pandanus or sand palms. This species has not been recorded within the Project area.	**Unlikely** - No suitable habitat is within the Project area.
Fawn Antechinus	*Antechinus bellus*	VU	Occurs in savannah woodland and tall open forest of the Top End of the NT, shelters in tree hollows and fallen logs, shows a preference for areas exposed to cooler and less frequent fires. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - No suitable habitat within the Project area.
Ghost Bat	*Macroderma gigas*	VU	The distribution of this species is influenced by the availability of suitable caves and mines for roost sites. Daytime roosts may change seasonally. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - No suitable habitat within the Project area.

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
Nabarlek (Top End)	*Petrogale concinna*	EN	Nabarleks are restricted to rocky areas, especially on steep slopes, with large boulders, caves and crevices. They may move from these to forage in adjacent flat areas. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - No suitable habitat within the Project area.
Northern Brush-tailed Possum	*Trichosurus vulpecula arnhemensis*	VU	Most records are from tall open forests dominated by *Eucalyptus miniata* and *E. tetrodonta*. The species is unlikely to be present in light of recent reductions in the species range. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - No suitable habitat within the Project area.
Northern Brush-tailed Phascogale	*Phascogale pirata*	VU	The Northern Brush-tailed Phascogale is restricted to eucalypt forests in the top end of the NT. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species occurs in eucalypt forests which are not present in proximity to the Project area.
Northern Quoll	*Dasyurus hallucatus*	EN	This species formerly occurred across much of northern Australia, from south-eastern Queensland to the south-west Kimberley, with a disjunct population in the Pilbara. The most suitable habitats appear to be rocky areas. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Whilst the species has historically been recorded within 5km of the Project area there is no suitable habitat within the Project area.
Water Mouse / False Water Rat	*Xeromys myoides*	VU	Mangrove forests, freshwater swamps and floodplain saline grasslands. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species has not been recorded within 5km of the Project area and there is no suitable habitat within the Project area.
Threatened Species (Marine Mammal)				
Blue Whale	*Balaenoptera musculus*	EN/M	The Blue Whale is found in every ocean except the arctic, with a range that extends from the periphery of drift-ice in polar seas to the tropics. It follows seasonal migration pattern between summering and wintering areas although some individuals may remain in certain areas year-round. The Project area does not contain any known feeding, breeding, calving, aggregation or migratory routes. The closest known recorded blue whales was hundreds of kilometres north of the Project area.	**Unlikely** - Species is unlikely to occur within the Project area as its preferred habitat in this region is open ocean.
Fin Whale	*Balaenoptera physalus*	VU/M	The North Atlantic fin whale has an extensive distribution. In general, fin whales are more common north of approximately 30°N latitude, but considerable confusion arises about their occurrence south of 30°N latitude because of the difficulty in distinguishing fin whales from Bryde's whales. Fin whale is not known to occur even infrequently in the North Marine Region (CoA 2012), however the species is likely to occur in deeper offshore waters. The Project area does not contain any known feeding, breeding, calving, aggregation or migratory routes.	**Unlikely** - The species is unlikely to occur within the Project area.
Sei Whale	*Balaenoptera borealis*	VU/M	Sei Whales have been infrequently recorded in Australian waters. Typically occur within deeper offshore waters. The Project area does not contain any known feeding, breeding, calving, aggregation or migratory routes.	**Unlikely** - The species is unlikely to occur within the Project area as its preferred habitat is open ocean.
Threatened Species (Birds)				
Australian Painted Snipe	*Rostratula australis*	EN	Shallow, vegetated, freshwater swamps, claypans or inundated grassland. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - No suitable habitat within the Project area.
Curlew Sandpiper	*Calidris ferruginea*	CE/M	Fresh and brackish water, can include ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Whilst the species has been recorded within 5km of the Project area, there is no suitable habitat within the Project area.

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
Eastern Curlew	*Numenius madagascariensis*	CE/M	They are most common in mangrove areas but will also forage on intertidal flats and saltmarshes. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Whilst the species has been recorded within 5km of the Project area, there is no suitable habitat within the Project area.
Gouldian Finch	*Erythrura gouldiae*	EN	The species forages in open woodland with groundcover of Sorghum and other annual and perennial grasses. Nests in hollows in *Eucalyptus tintinnans.* Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Whilst the species has been recorded within 5km of the Project area, there is no suitable habitat within the Project area.
Great Knot	*Calidris tenuirostris*	CE/M	Migratory species. In the NT birds settle on large sheltered intertidal mudflats and sandflats, especially in mangrove areas. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Whilst the species has been recorded within 5km of the Project area, there is no suitable habitat within the Project area.
Greater Sand Plover	*Charadrius leschenaultii*	VU/M	In the NT, Greater Sand Plovers have been recorded from most of the coastline. In the NT they forage along sandy beaches and sheltered mudflats and have been reported them occasionally also using inland saline wetlands but always close to the coast. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Whilst the species has been recorded within 5km of the Project area, there is no suitable habitat within the Project area.
Grey Falcon	*Falco hypoleucos*	VU	Occurs in lightly timbered lowland plains, typically on inland drainage systems, where the average annual rainfall is less than 500 mm. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - This species has not been recorded within 5km of the Project area and suitable habitat does not occur within the Project area.
Lesser Sand Plover	*Charadrius mongolus*	EN/M	Migratory species. In the NT the birds forage on sheltered mudflats, sandy beaches, estuaries and mangroves. They have also been reported to use inland saline wetlands occasionally but always close to the coast. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Whilst the species has been recorded within 5km of the Project area, there is no suitable habitat within the Project area.
Masked Owl (mainland Top End)	*Tyto novaehollandiae kimberli*	VU	Occurs mainly in eucalypt tall open forests (especially those dominated by Darwin woollybutt *Eucalyptus miniata* and Darwin stringybark *E. tetrodonta*), but also roosts in monsoon rainforests, and forages in more open vegetation types, including grasslands. Although it may roost in dense foliage, it more typically roosts, and nests, in tree hollows. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur in the Project area and there is no suitable habitat within the Project area.
Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit	*Limosa lapponica baueri*	VU	Widespread in coastal areas such as wetlands, however predominantly found in New Zealand during breeding season. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur in the Project area and there is no suitable habitat within the Project area.
Partridge Pigeon	*Geophaps smithii*	VU	Occurs in open forest and woodland dominated by *Eucalyptus tetrodonta* and *E. miniata* with a structurally diverse understorey. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur in the Project area and there is no suitable habitat within the Project area.
Red Gosshawk	*Erythrotriorchis radiatus*	VU	Forest and woodland with a mosaic of vegetation types, including eucalypt woodland, open forest, gallery rainforest, swamp sclerophyll forest and rainforest margins. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur in the Project area and there is no suitable habitat within the Project area.
Red Knot	*Calidris canutus*	EN/M	Migratory species. In the NT birds settle on large sheltered intertidal mudflats and sandflats and are rarely encountered far from the coast. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Whilst the species has been recorded within 5km of the Project area, there is no suitable habitat within the Project area.
Threatened Species (Sharks)				

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
Dwarf Sawfish	*Pristis clavata*	VU/M	The species' Australian distribution is considered to extend north from Cairns around the Cape York Peninsula in QLD, across northern Australian waters to the Pilbara coast in Western Australia. The species usually inhabits shallow (2–3 m) coastal waters and estuarine habitats. The species does not utilise any purely freshwater areas, as its range is restricted to brackish and salt water. Dwarf sawfish are considered unlikely to occur in the Darwin Harbour area although an individual has been reported from Buffalo Creek (ALA 2022a) approximately 10 km east of the Project area.	**Unlikely** - The species is unlikely to occur in the Project area based on previous records.
Freshwater Sawfish	*Pristis pristis*	VU/M	The Freshwater Sawfish is a marine/estuarine species that spends its first 3-4 years in freshwater then the larger mature animals tend to occur more often in coastal and offshore waters up to 25 m depth. In the NT, Freshwater Sawfish have been recorded from the Adelaide, Victoria, Daly, East Alligator, South Alligator, Goomadeer, Roper, McArthur, Wearyan and Robinson Rivers (CoA 2015). The Project area does not contain key habitat resources for this species for foraging or breeding. The closest known record is over 20 km away from the Project area.	**Unlikely** - The species is unlikely to occur in the Project area based on previous records.
Great White Shark	*Carcharodon carcharias*	VU/M	In Australia, Great White Sharks have been recorded from central QLD around the south coast to north-west WA but may occur further north on both coasts. It has been sighted in all coastal areas except in the NT.	**Unlikely** - The species is unlikely to occur within the Project area as its preferred habitat is not typically off the NT coast.
Green Sawfish	*Pristis zijsron*	VU/M	The Green Sawfish was once widely distributed but it is now thought that northern Australia may be the last region where significant populations of Green Sawfish exist. They inhabit muddy bottom habitats and also enter estuaries where they can be found in shallow water. Individuals of this species have been recorded in the region e.g. reported from Buffalo Creek (ALA 2022b) approximately 10 km east of the Project area. The Project area does not contain key habitat resources for this species such as foraging or breeding.	**Unlikely** - The species is unlikely to occur in the Project area based on previous records.
Northern River Shark	*Glyphis garricki*	EN	Since its discovery in 1986, only 36 specimens have been recorded. Little is known of the ecology of the Northern River Shark but it is probably restricted to shallow, brackish reaches of large rivers. This conclusion is based on the fact that it has not yet been caught in the coastal marine areas despite considerable fishing and collecting activity in these habitats. In the NT this species is only known within the Adelaide and East and South Alligator River systems. Individuals of this species of have been recorded in the broader Darwin area, these records are located well away from the Project area in different habitat then what is found in the Project area. This species is not known in the Darwin Harbour area.	**Unlikely** - The species is unlikely to occur in the Project area based on previous records.
Scalloped Hammerhead	*Sphyrna lewini*	Conservation Dependent	The Scalloped Hammerhead has a circum-global distribution in tropical and sub-tropical waters. The scalloped hammerhead shows strong genetic population structuring across ocean basins as it rarely ventures into or across deep ocean waters, but ranges quite widely over shallow coastal shelf waters. One individual of this species has been recorded in the Darwin Harbour Region. The Project area does not contain key habitat resources for this species such as foraging or breeding.	**Unlikely** - The species is unlikely to occur in the Project area based on previous records and there is no suitable habitat within the Project.
Speartooth Shark	*Glyphis glypis*	CE/M	Predominantly occurs within tidal rivers and estuaries within the NT. There are records in the Adelaide River which reflects is likely distribution in tidal rivers and estuaries. No individuals have been recorded in the Darwin Harbour region.	**Unlikely** - The species is unlikely to occur in the Project area based on previous records.
Whale Shark	*Rhincodon typus*	VU/M	In Australia, the Whale Shark is most commonly seen in waters off northern WA, NT and QLD. The Whale Shark seasonally aggregates in coastal waters off Ningaloo Reef between March and July each year, at Christmas Island between December and January, and in the Coral Sea between November	**Unlikely** - The species is unlikely to occur within the Project area as its preferred habitat is open ocean.

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
			and December. The Project area does not contain any known feeding, breeding, aggregation or migratory routes.	
Migratory (Marine Birds)				
Common Noddy, Brown Noddy	*Anous stolidus*	M	Tropical seabird with worldwide distribution. They breed on tropical and subtropical inshore or oceanic islands, which have rocky cliffs and coral or sand beaches. It nests on the ground, in trees or shrubs, and on cliffs or man-made structures, such as docks and jetties. During the non-breeding season, they will spend most of its time at sea and may roost on water, rocks, islets, flotsam and even the backs of sea turtles. The species may only be seen transiting the area, but is unlikely to land onshore with no suitable foraging habitat present.	**Unlikely** - Species is unlikely to occur given the onshore component of the Project is located within the existing DLNG facility disturbance envelope and suitable habitat is not available for this species.
Fork-tailed swift	*Apus pacificus*	M	They spend most of the year relatively high in the air column, only coming down to near ground level at times of bad weather. Seen over open country from semi deserts to coasts, islands and sometimes over forests and cities. Species may be observed as an overhead visitor.	**Unlikely** - Species is aerial and unlikely to be found within the Project area.
Great Frigatebird, Greater Frigatebird	*Fregata minor*	M	It is a widespread seabird, with major colonies in the Indian Ocean, West and Central Pacific and Southern Atlantic. They inhabit remote islands in tropical and sub-tropical seas, where it breeds in small bushes, mangroves and even on the ground. The species has not been recorded in the Darwin region in the last 30 years.	**Unlikely** - Species unlikely to occur in the Project area and limited suitable habitat is present in the Project area.
Lesser Frigatebird, Least Frigatebird	*Fregata ariel*	M	It is a widespread seabird, with major colonies in the Indian Ocean, West and Central Pacific and Southern Atlantic. They inhabit remote islands in tropical and sub-tropical seas, where it breeds in small bushes, mangroves and even on the ground. Outside the breeding season it is sedentary, with immature and non-breeding individuals dispersing throughout tropical seas. The species has not been recorded in the Darwin region in the last 15 years. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Species unlikely to occur in the Project area and limited suitable habitat is present in the Project area.
Little Tern	*Sternula albifrons*	M	Inhabits coastal waters, bays, inlets, saline or brackish lakes, salt fields and sewage ponds near coast throughout northwest, north, east and southeast Australia. It can also be found further inland, sometimes up to several kilometres from the sea. The species has not been recorded in the Darwin region in the last 15 years. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Species unlikely to occur in the Project area and limited suitable habitat is present in the Project area.
Streaked Shearwater	*Calonectris leucomelas*	M	This species is pelagic and abundant off the north coasts of Australia from November to May. Occurs on the west and east coasts in summer. Species is abundant off northern Australian coasts. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - Species unlikely to occur in the Project area and the Project area does not contain suitable habitat for the species.
White-tailed Tropicbird	*Phaethon lepturus*	M	Tropicbirds are predominantly pelagic species, rarely coming to shore except to breed. The white-tailed tropicbird forages in warm waters and over long distances, moving up to 1500 kilometres from breeding sites. The main breeding site is Christmas Island. Species may be observed as an overhead visitor.	**Unlikely** - Species unlikely to occur in the Project area and the Project area does not contain suitable habitat for the species.
Migratory (Marine Species)				
Australian Snubfin dolphin	*Orcaella brevirostris*	M	The Project area intersects the Australian Snubfin dolphin BIA for breeding. This species has been recorded within the Darwin Harbour.	**Likely** - Suitable habitat for the species is present. Individuals of the species have previously been recorded in the Darwin Harbour and near Catalina Island, located to the east of the Project area.

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
Dugong	*Dugong dugon*	M	Generally occurs in wide shallow protected bays and mangrove channels that support extensive sea grass meadows. Reported to use shallow waters such as tidal sandbanks and estuaries for calving.	**Likely** - Individuals of the species are known to occur within the Darwin Harbour.
Indo-Pacific humpback dolphin	*Sousa chinensis*	M	The Project area intersects the Indo-Pacific Humpback dolphin BIA for breeding. This species has been recorded within the Darwin Harbour.	**Likely** - Suitable habitat for the species is present. The species is widely known from the Darwin Harbour.
Salt-water Crocodile	*Crocodylus porosus*	M	The Salt-water crocodile is commonly recorded in the Darwin Harbour. Nesting within Darwin Harbour is limited.	**Likely** - There is no important habitat for the species located within the Project area. Individuals of the species have been sighted on boat ramps near the Project area.
Spotted bottlenose dolphin	*Tursiops aduncus*	M	The Project area intersects the Spotted Bottlenose dolphin BIA for breeding. This species has been recorded within the Darwin Harbour.	**Likely** - Suitable habitat for the species is present. The species is widely known to occur within the Darwin Harbour.
Giant Manta Ray	*Mobula birostris*	M	This species is believed to have a wider distribution than the closely related Reef Manta Ray, and is more migratory in its behaviour. It appears to be a seasonal visitor to coastal and offshore sites, and is commonly seen along productive coastlines with regular upwellings, as well as around oceanic islands, offshore pinnacles and seamounts. The south coast of Bathurst Island but are not expected to be present in large numbers. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - No suitable habitat is present within the Project area and the species is unlikely to occur in the Project area.
Bryde's Whale	*Balaenoptera edeni*	M	The Bryde's Whale can be found in tropical and sub-tropical waters throughout the Atlantic, Pacific and Indian Oceans. There appear to be two distinct habitat preferences amongst Bryde's Whales, with some populations, usually comprising smaller-bodied individuals, occurring in coastal waters, while other populations can be found in the open ocean. The Project area does not contain any known feeding, breeding, calving, aggregation or migratory routes.	**Unlikely** - No suitable habitat is present within the Project area and the species is unlikely to occur in the Project area.
Humpback Whale	*Megaptera novaeangliae*	M	Australia has two distinct Humpback Whale populations which throughout all coastal waters surrounding Australia; east coast and west coast. Within the North Marine Region there are relatively few humpback whales known to travel north of their calving grounds located in Camden Sound (Jenner et al. 2001). No humpback whales were recorded during the 12 months of noise monitoring undertaken as part of the Barossa marine studies program (JASCO Applied Sciences 2016; McPherson et al. 2015). The Project area does not contain any known feeding, breeding, calving, aggregation or migratory routes.	**Unlikely** - The species is unlikely to occur within the Project area.
Killer Whale, Orca	*Orcinus orca*	M	The Orca is found throughout all the world's oceans. The Orca occurs in virtually every marine region, from polar waters to the equator, and has even been known to enter bays, estuaries and rivers, as well as ice flows. However, it is most commonly recorded in coastal, temperate waters and in areas of high productivity. Its preferred habitat is open ocean. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area.
Longfin Mako	*Isurus pacus*	M	Widely scattered records suggest that the Longfin Mako shark has a worldwide distribution in tropical and warm-temperate oceans; the extent of its range is difficult to determine due to confusion with the Shortfin Mako. Its preferred habitat is open ocean likely in Commonwealth waters outside of the Project area. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area.
Narrow Sawfish	*Anoxypristis cuspidata*	M	The Narrow Sawfish is found mainly in inshore coastal waters, to depths of around 40 metres, where it is thought to spend most of its time on or near the bottom. It may also enter estuaries and river deltas and has been reported to move upstream into rivers in some areas, although its occurrence in	**Unlikely** - No suitable habitat is present within the Project area and the species is unlikely to occur in the Project area.

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
			freshwater has yet to be verified. Neither this species nor preferred habitat occur within the Project area.	
Oceanic Whitetip Shark	*Carcharhinus longimanus*	M	The Oceanic Whitetip is found globally in deep, open oceans. Its preferred habitat is open ocean likely in the Commonwealth waters outside of the Project area. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area.
Reef Manta Ray	*Mobula alfredi*	M	The Reef Manta Ray is found in tropical and sub-tropical waters in the Pacific and Indian Oceans. However, within this widespread range its populations appear to be quite patchy. It is more commonly found in shallow inshore waters and typically occurs around coastal reefs, tropical island groups, atolls, bays and productive coastlines.	**Unlikely** - The species is unlikely to occur within the Project area and no suitable habitat is present within the Project area.
Shortfin Mako	*Isurus oxyrinchus*	M	The Shortfin Mako inhabits offshore temperate and tropical seas worldwide. The closely related Longfin Mako shark is found in the Gulf Stream or warmer offshore waters (for ex., New Zealand and Maine). Its preferred habitat is open ocean likely in the Commonwealth waters outside of the Project area. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area.
Migratory (Terrestrial/Wetland Birds)				
Asian Dowitcher	*Limnodromus semipalmatus*	M	In the NT the Asian Dowitcher is found in Darwin and Arnhem Land. The Asian Dowitcher occurs in sheltered coastal Environments, such as embayments, coastal lagoons, estuaries and tidal creeks. They are known to frequent shallow water and exposed mudflats or sandflats.	**Potential** - Some species recorded in proximity to the Project area. Potential habitat in the Darwin Harbour.
Common Sandpiper	*Actitis hypoleucos*	M	Shallow, pebbly, muddy or sandy edges of rivers and streams, coastal to far inland; dams, lakes, sewage ponds; margins of tidal rivers; waterways in mangroves or saltmarsh; mudflats; rocky or sandy beaches; causeways, riverside lawns, drains and street gutters.	**Potential** - The Project area does not contain suitable habitat for nesting/roosting however there is suitable habitat for foraging on either side of the Project area which may result in this species traversing the Project area.
Grey Plover	*Pluvialis squatarola*	M	Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or saltlakes.	**Potential** - The Project area does not contain suitable habitat for nesting/roosting however there is suitable habitat for foraging on either side of the Project area which may result in this species traversing the Project area.
Oriental Plover	*Charadrius veredus*	M	Oriental Plovers usually forage among short grass or on hard stony bare ground but also on mudflats or among beach cast seaweed on beaches. Oriental Plovers sometimes roost on soft wet mud or in shallow water of beaches and tidal mudflats. The species does not breed in Australia.	**Potential** - Some species recorded in proximity to the Project area. Potential habitat in the Darwin Harbour and offshore of Wagait Beach.
Osprey	*Pandion haliaetus*	M	Treated as conspecific with *P. cristatus*. The osprey is thinly distributed around the coast of Australia where they forage for fish in fresh, brackish, or saline waters of rivers, lakes, estuaries and inshore coastal waters. Nests are usually located near a suitable area of foraging habitat and are a bulky structure made from piled sticks, often positioned in a tall dead tree or artificial structures such as telecommunication towers or poles. Breeding pairs defend breeding territory against other ospreys, and active nests are usually more than 1 km apart.	**Potential** - The Project area and surrounds contain suitable foraging habitat for the species. It is noted that there is an osprey nest on the DLNG site (atop an artificial pole).

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
Bar-tailed Godwit	*Limosa lapponica*	M	The Bar-tailed Godwit has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria, including the offshore islands. Populations have also been recorded in the Top End, from Darwin and Melville Island, east to the Alligator River and Croker Island. The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh. Species has been recorded in the Darwin Harbour. Neither this species nor preferred habitat occur within the Project area	**Unlikely -** The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for this species.
Barn Swallow	*Hirundo rustica*	M	Species is found sporadically throughout northern Australia during non-breeding season. The Barn Swallow is found in vegetated areas including farmland, sports grounds, native grasslands and airstrips as well as over open water such as billabongs, lagoons, creeks and sewage treatment plants. The closest known record is over 5 km from the Project area. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for this species.
Black-tailed Godwit	*Limosa limosa*	M	The Black-tailed Godwit is found in all states and territories of Australia, however, it prefers coastal regions and the largest populations are found on the north coast between Darwin and Weipa. In Australia the Black-tailed Godwit has a primarily coastal habitat environment. The species is commonly found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit; occasionally recorded on rocky coasts or coral islets. Species has been recorded in the Darwin Harbour. Neither this species nor preferred habitat occur within the Project area	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for this species.
Broad-billed sandpiper	*Limicola falcinellus*	M	Shallow, pebbly, muddy or sandy edges of rivers and streams, coastal to far inland; dams, lakes, sewage ponds; margins of tidal rivers; waterways in mangroves or saltmarsh; mudflats; rocky or sandy beaches; causeways, riverside lawns, drains and street gutters. The closest known record is over 5 km from the Project area. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for this species.
Common Greenshank	*Tringa nebularia*	M	Species is common throughout Australia from August till March. Found in mudflats, estuaries, saltmarshes, margins of lakes, wetlands, clay pans, fresh and salines, commercial salt fields, sewage ponds. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Grey-tailed Tattler	*Tringa brevipes*	M	Found in estuaries, tidal mudflats, mangroves, wave-washed rocks and reefs, shallow river margins, coastal or inland. In Australia adults arrive in the north coast from late Aug to early Sep. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Grey Wagtail	*Motacilla cinerea*	M	Found near running water, disused quarries, sandy rocky streams in escarpments and rainforests, sewage ponds, ploughed fields and airfields. Visitor to Australia from November to April. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Little Curlew	*Numenius minutus*	M	The Little Curlew is most often found feeding in short, dry grassland and sedgeland, including dry floodplains and black soil plains, which have scattered, shallow freshwater pools or areas seasonally inundated. Open woodlands with a grassy or burnt understorey, dry saltmarshes, coastal swamps, mudflats or sandflats of estuaries or beaches on sheltered coasts, mown lawns, gardens, recreational areas, ovals, racecourses and verges of roads and airstrips are also used. The closest known record of this species is over 5 km from the Project area and was recorded 10 years ago. While the Project area does contain some attributes which are known to be utilised by this	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
			species (i.e. mudflats), they typically prefer to forage in short grasses which are not present at the site.	
Little Ringed Plover	*Charadrius dubius*	M	The species is associated with open plains; bare rolling country, often far from water; ploughed land; muddy or sandy wastes near inland swamps or tidal mudflats; bare clay pans; margins of coastal marshes; grassy airfields, sports fields and lawns. They are a regular summer migrant to Australia from Sep-Mar. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Long-toed Stint	*Calirdirs subminuta*	M	The long-toed stint breeds in Siberia during the Northern Hemisphere summer. It is a visitor to New Guinea and Australia and a vagrant to Sweden, South Africa, Melanesia, Hawaii, the northwestern USA and the vicinity of the Bering Sea. In its over-wintering range it visits a variety of wetland habitats including shallow freshwater or brackish areas, lakes, swamps, floodplains, marshes, lagoons, muddy shores and sewage ponds. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Marsh Sandpiper	*Tringa stagnatilis*	M	It is a migratory species, with majority of birds wintering in Africa, and India with fewer migrating to Southeast Asia and Australia. They prefer to winter on freshwater wetlands such as swamps and lakes and are usually seen singly or in small groups. These birds forage by probing in shallow water or on wet mud. They mainly eat insects, and similar small prey. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Oriental, Horsfield's Cuckoo	*Cuculus optatus*	M	This species is treated as conspecific with *C. saturatus* (Himalayan Cuckoo). Inhabits monsoon forests and rainforest edges; leafy trees in paddocks; river flats, roadsides, mangroves and islands. The closest known record is over 5 km from the Project area. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for this species.
Oriental Pratincole	*Glareola maldivarum*	M	Usually inhabits open plains, floodplains or short grassland, often with extensive bare areas. Often occur near terrestrial and artificial wetlands, especially around the margins. This species also occurs along the coast, inhabiting beaches, mudflats and islands, or around coastal lagoons. Does not breed in Australia. The closest known record is over 10 km from the Project area. This observation was recorded 15 years ago. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for this species.
Oriental Reed-Warbler	*Acrocephalus orientalis*	M	Rare migrant to coastal North and eastern Australia. Found in dense reeds, cumbungi, over and near water. It breeds mainly in reed beds and can also be found in marshes, paddy fields, grassland and scrub where it forages for insects and other invertebrates. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Pacific golden Plover	*Pluvialis fulva*	M	This species usually inhabits coastal habitats, though it occasionally occurs around inland wetlands. Usually occur on beaches, mudflats and sandflats in sheltered areas including harbours, estuaries and lagoons, and also in evaporation ponds in saltworks. The species is also sometimes recorded on islands, sand and coral cays and exposed reefs and rocks. Breeding occurs in dry areas of tundra away from the coast, usually on slopes of low hills, knolls or foothills vegetated with lichen and moss, or in bare, stony areas. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Pectoral Sandpiper	*Calidris melanotos*	M	Species has patchy distribution around Australia's coastline. Found in shallow fresh waters, often with low grass and other herbage; swamp margins, flooded pastures, sewage ponds; occasionally tidal areas and saltmarshes. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for the species.

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
Pin-tailed Snipe	*Gallinago stenura*	M	Pin-tailed Snipe occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. The species is also found in drier, more open wetlands such as clay pans in more arid parts of species' range. It is also commonly seen at sewage ponds; not normally in saline or inter-tidal wetlands. The closest known record is over 10 km from the Project area. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for the species.
Red-necked Stint	*Calidris ruficollis*	M	Species are found in tidal mudflats, saltmarshes; sandy or shelly beaches; saline and freshwater wetlands, coastal and inland; salt fields and sewage ponds. They are often in dense flocks, feeding or roosting. Spends the southern summer months in Australia and is found widely except in the arid inland. The closest known record is over 10 km from the Project area. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for the species.
Red-rumped Swallow	*Cecropis daurica*	M	Migratory bird that spends the winter months in northern Australia. This species is found in open hilly country and mountains, river gorges, valleys, sea cliffs, as well as in cultivated areas and human habitations, including towns. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Ruddy Turnstone	*Arenaria interpres*	M	Winters on Australian coastlines. Tidal reefs and pools, weed covered rocks, pebbly shelly and sandy shores with stranded seaweed, mudflats, occasionally inland on shallow waters, sewage ponds, commercial salt fields, open or ploughed ground. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Rufous Fantail	*Rufous rufifrons*	M	The Rufous Fantail inhabits moist and moderately dense habitats. Within these areas, it has astonishingly large variations in habitat requirements. They can be found in eucalyptus forests, mangroves, rainforests and woodlands (usually near a river or swamp). Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Sanderling	*Calidris alba*	M	Broad ocean beaches of firm sand 'where waves ebb and flow', depositing strands and heaps of seaweed; often near river mouths; also inlets, tidal mudflats and coastal lagoons. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Sharp-tailed Sandpiper	*Calidris acuminata*	M	The Sharp-tailed Sandpiper breeds in northern Siberia but migrates south to winter in Australia and New Zealand. In the non-breeding season they can be found in tidal mudflats, saltmarshes, mangroves; shallow fresh, brackish or saline inland wetlands; floodwaters, irrigated pastures and crops; sewage ponds and salt fields. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Swinhoe’s Snipe	*Gallinago megala*	M	Found on northern Australian coastlines. Non-breeding habitats include shallow freshwater wetlands of various kinds including paddy fields and sewage farms, with bare mud or shallow water for feeding, with nearby vegetation cover. The closest known record is over 10 km from the Project area. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for the species.
Terek Sandpiper	*Xenus cinereus*	M	In Australia, the Terek Sandpiper has been recorded on coastal mudflats, lagoons, creeks and estuaries. Records indicate that the species favours muddy beaches near mangroves but may also be observed on rocky pools and coral reefs and occasionally up to 10 km inland around brackish pools. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.

Common Name	Scientific Name	EPBC Act Listing	Description/Habitat	Likelihood of Occurrence
Wandering Tattler	*Tringa incana*	M	Non-breeding habitats include shallow freshwater wetlands of various kinds including paddy fields and sewage farms, with bare mud or shallow water for feeding, with nearby vegetation cover. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Whimbrel	*Numenius phaeopus*	M	Estuaries, mangroves, tidal flats, coral cays, exposed reefs, flooded paddocks, sewage ponds, bare grasslands, sports grounds and lawns. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Wood Sandpiper	*Tringa glareola*	M	The Wood Sandpiper uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, especially Melaleuca and River Red Gums *Eucalyptus camaldulensis* and often with fallen timber. They also frequent inundated grasslands, short herbage or wooded floodplains, where floodwaters are temporary or receding, and irrigated crops. They are rarely found using brackish wetlands, or dry stunted saltmarsh. Typically they do not use coastal flats, but are occasionally recorded in stony wetlands. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat.
Yellow Wagtail	*Motacilla flava*	M	Regular summer migrant to coastal Australia, especially Darwin to Broome, but also north-eastern Queensland from November to April. Found in short grass and bare ground, swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land and town lands. The closest known record over 10 km from the Project area, this observation was recorded 30 years ago. Neither this species nor preferred habitat occur within the Project area.	**Unlikely** - The species is unlikely to occur within the Project area and the Project area does not contain suitable habitat for the species.

CE – Critically endangered
EN – Endangered
VU – Vulnerable
M – Migratory

3.2 Listed Threatened Species and Ecological Communities

The PMST search identified 41 listed threatened species as occurring or potentially occurring within the vicinity of the Project area. The likelihood of occurrence assessment (refer **Section 3.1**) identified 6 species having the potential or likely to occur within or nearby to, the Project area. These species are listed as vulnerable or endangered under the EPBC Act, as shown in **Table 3-3**. Additional information on the vulnerable and endangered species is provided in **Table 3-4**.

No listed threatened ecological communities were recorded as occurring within the Project area.

Table 3-3 Listed threatened species

Common Name	Scientific Name	EPBC Act Status	Likelihood of Occurrence
Flatback turtle	*Natator depressus*	Vulnerable / Migratory	Likely
Olive Ridley turtle	*Lepidochelys olivacea*	Endangered / Migratory	Likely
Green turtle	*Chelonia mydas*	Vulnerable / Migratory	Likely
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable / Migratory	Likely
Leatherback turtle	*Dermochelys coriacea*	Endangered / Migratory	Potential
Loggerhead turtle	*Caretta caretta*	Endangered / Migratory	Potential

Table 3-4 Description of EPBC Act-listed marine turtles potentially within the Project area

Species	Distribution and habitats	Breeding areas and nesting seasons	Diet
Flatback turtle	The Flatback turtle is found only in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya and is one of only two species of sea turtle without a global distribution. There are no estimates of population size for the flatback turtle. They feed in the northern coastal regions of Australia, extending as far south as the Tropic of Capricorn. Their feeding grounds also extend to the Indonesian archipelago and the Papua New Guinea coast. Flatback turtles have a preference for shallow, soft-bottomed seabed habitats away from reefs. Post-hatchling flatback turtles do not have an oceanic dispersal phase, this species remains within the relatively shallow Australian continental shelf waters (Salmon et al. 2009). <u>Northern Territory</u> Flatback turtles are the most widely spread nesting marine turtle species in the NT, nesting on a wide variety of beach types around the entire coastline. <u>Project area</u> Flatback turtles have a preference for shallow, soft-bottomed seabed habitats away from reefs; being habitat represented within the Project area. As identified on **Figure 3-2**, the Project area intersects 'habitat critical to the survival of the flatback turtle species'. This habitat was mapped by consensus of a panel of experts in marine turtle biology and according to the EPBC Act Significant Impact Guidelines 1.1 - Matters of National Environmental Significance (DoE 2013), is defined as areas necessary: + for activities such as foraging, breeding or dispersal. + for the long-term maintenance of the species. + to maintain genetic diversity and long term evolutionary development. + for the reintroduction of populations or recovery of the species. Nesting habitat critical to the survival of Flatback turtles includes at least 70 per cent of nesting for the stock (i.e. these marine areas are extensive).	All known breeding sites of this species occur only in Australia. Flatback turtles nest on inshore islands and the mainland from Queensland to northern Western Australia. There are four major nesting areas in Australia, representing four genetic breeding stocks. The largest nesting concentration of flatback turtles is in the north-eastern Gulf of Carpentaria and western Torres Strait. In the western NT (and possibly eastern Kimberley) there is a mid-winter peak nesting season and low density summer nesting. <u>Northern Territory</u> The Flatback turtle is considered the most widespread nesting turtle species in the NT and important nesting locations have been identified in various bioregions within the NT. Flatback turtles' nest on a wide variety of beach types around the entire coastline. Through surveys held between 1994 and 2004, Chatto and Baker (2008) have identified 46 distinct areas within the NT that are confirmed (a total of 18), or inferred as highly likely to represent (28 sites), significant nesting areas for the Flatback turtle. The majority of these sites are on islands. Arnhem Land rookeries include Cobourg Peninsula and Greenhill Island, Field Island and McCluer Island. West of Darwin, significant nesting occurs in Fog Bay. Other significant sites include Turtle Point, North Perron Island and Bathurst and Melville Islands. Within the Darwin region most turtle nesting is associated with Flatback turtles. The main nesting site in the Darwin Harbour is located at Casuarina Beach. This nesting site is located approximately 8 km east of the Pipeline and approximately 15 km south of the Spoil Disposal Ground. The Cox Peninsula beaches and Mandorah Beach are infrequently used for nesting, which border the Project area. Monitoring undertaken for the Ichthys project found that the mangroves and mudflats throughout the shoreline of Darwin Harbour do not provide suitable habitat for nesting turtles (INPEX Browse 2010a). Other turtle nesting sites include Bare Sand Island and Quail Island, which are considered more significant on a regional scale than Casuarina Beach (Chatto and Baker 2008) and are located near the mouth of Bynoe Harbour (~50 km from Darwin). While peak nesting for Flatback turtles in the NT is reported to occur between June-September, a study undertaken by Chatto and Baker (2008) found that Flatback turtle nesting predominantly occurred between May and October; however, it was noted that at locations such as Casuarina Beach nesting was recorded in small numbers throughout the year. <u>Project area</u> No nesting beaches, although the Project area intersects an internesting BIA (**Figure 3-2**). This is an extensive area extending south of the Daly River to Goulburn Islands in the north, inclusive of Bathurst and Melville islands (>800 km of coastline).	The flatback turtle is carnivorous, feeding mostly on soft bodied prey such as sea cucumbers, soft corals and jellyfish. They feed mainly in subtidal, soft-bottomed habitats. <u>Project area</u> Based on surveys, there is foraging habitat (soft corals) within the Project area.
Olive Ridley turtle	The Olive Ridley turtle has a worldwide tropical and subtropical distribution, including northern Australia.	The Olive Ridley turtle is the most numerous of all marine turtles in the world, largely due to a few, but enormous, nesting aggregations found in Costa Rica, Mexico and India.	The Olive Ridley turtle is carnivorous, known to feed

Species	Distribution and habitats	Breeding areas and nesting seasons	Diet
	The turtle is the most numerous of all marine turtles in the world. Northern Territory The current area of occurrence is estimated to be in excess of 10 million km². Olive Ridley turtles typically occur in shallow soft-bottomed habitats of protected waters. In Australia, they occur along the coast from southern Queensland and the Great Barrier Reef, northwards to Torres Strait, and across to the Joseph Bonaparte Gulf in Western Australia. A 'habitat critical to the survival of the Olive Ridley species occurs around the south-western side of Bathurst Island, extending 20 km seaward and approximately 5-10 km north of the Project area. A substantial part of the immature and adult population forage over shallow benthic habitats, though large juvenile and adult olive ridley turtles have been recorded in both benthic and pelagic foraging habitats. Foraging habitat can range from depths of several metres to over 100 m. There are no records of foraging behaviour of Olive Ridley turtles within Darwin Harbour and little in the outer region, this is likely because foraging habitat is located in water depths usually greater than 10 m (WWF 2005). Project area The Project area does not intersect with a BIA or habitat critical to the survival of the species. Olive Ridley turtles typically occur in shallow soft-bottomed habitats of protected waters; being habitat represented within the Project area.	Northern Territory No large rookeries of Olive Ridley turtles have been recorded in Australia. Detailed information on the size of nesting and foraging populations is unknown although an estimate of the nesting population for Australia is 1,000-5,000 females annually. Chatto and Baker's long term study of nesting turtles in the NT (Chatto & Baker 2008) found that Olive Ridley turtles were the second most widespread nesting species (after Flatbacks) in the NT, though they nest in low numbers through much of their range. On some beaches, however, such as along the northern coast of Bathurst and Melville islands, and some islands in north-eastern Arnhem Land, they nest in nationally significant numbers (Chatto & Baker 2008). An Olive Ridley turtle BIA inter-nesting area is located south-east of Darwin Harbour, approximately 10 km from the Project area (**Figure 3-3).** This BIA is near the turtle nesting sites of Bare Sand Island, Quail Island and Indian Island, located near the mouth of Bynoe Harbour (~50 km from Darwin), however these sites are not considered significant on a regional scale with infrequent nesting recorded (Chatto and Baker 2008). Habitat critical to the survival of Olive Ridley turtle species (Nesting) encompasses nearshore waters along the north, west and east coasts of the Tiwi Islands. Internesting Olive Ridley turtles remain relatively close to nesting beaches during the nesting period (in comparison to post-nesting movements); tagged turtles remained within 48 km of the nesting beach in waters typically <30 m water depth, although the turtles moved considerable distances within this radius (up to 200 km) (Hamel et al. 2008). Within the Darwin Harbour, Casuarina Beach, Cox Peninsula Beaches and Mandorah Beach are infrequently used for nesting. In Northern Australia nesting occurs all year round, although most nesting occurs during the dry season from April to August. Hatchlings emerge from the nests about two months after laying (DoEE 2017a). Project area No nesting beaches or defined internesting area.	on shellfish, small crabs, molluscs, shrimp, tunicates, jellyfish and salps. Project area Based on surveys, there is limited foraging habitat within the Project area.
Green turtle	Green turtles are found in tropical and subtropical waters throughout the world. The global population of green turtles is estimated to be very large (~2 million). Green turtles spend their first five to ten years drifting on ocean currents (pelagic phase). They then settle in shallow benthic foraging habitats such as tropical tidal and sub-tidal coral and rocky reef habitat or inshore seagrass beds. The shallow foraging habitat of adults contains seagrass beds or algae mats on which Green turtles mainly feed. Green turtles can migrate more than 2,600 km between their feeding and nesting grounds. Northern Territory Green turtles nest, forage and migrate across tropical northern Australia. The total Australian population of green turtles is estimated to be more than 70 000 individuals, distributed across seven regional populations. Aerial turtle surveys undertaken for the INPEX nearshore environmental monitoring program (NEMP) estimated a population size of between 500 and	The Green turtle has the most numerous and widely dispersed nesting sites of the seven turtle species, known to nest in 80 countries. The largest Green turtle nesting populations in the world are found at Tortuguero on the Caribbean coast of Costa Rica (~30,000 females nest per season on average) and Raine Island on the Great Barrier Reef in Australia (peak nesting of up to 60,000 females). Northern Territory In Australia, there are seven regional populations of green turtles that nest in different areas; the southern Great Barrier Reef, the northern Great Barrier Reef, the Coral Sea, the Gulf of Carpentaria, Western Australia's north-west shelf, the Ashmore and Cartier Reefs and Scott Reef. The Gulf of Carpentaria has two main nesting areas, the Wellesley Island Group, with major rookeries at Bountiful, Pisonia and Rocky Islands, and the Eastern Arnhem Land, Groote Eylandt and Sir Edward Pellew Islands area. Nesting occurs year round, with a mid-year peak in nesting activity.	Adult Green turtles eat mainly seagrass and algae, although they will occasionally eat other items including mangroves. Young turtles tend to be more carnivorous than adults. During their pelagic phase (while drifting on ocean currents), young Green turtles also eat plankton. Project area Based on surveys, there is unlikely to be suitable habitat within the Project area.

Species	Distribution and habitats	Breeding areas and nesting seasons	Diet
	1,000 for the Darwin region (Buckee et al. 2014). Turtles were primarily observed in shallow waters (<10 m), with the highest densities recorded between East Point and Lee Point, and near Gunn Point (Cardno 2015a). Turtles were also sighted throughout Darwin Harbour, although at lower densities. It is likely that the majority of turtles observed in the harbour during these surveys were Green turtles, as they accounted for 74% of sightings during fine scale land-based observations (INPEX Browse 2018). Project area Based on surveys, the Project area is unlikely to have suitable habitat being rocky reef habitat or inshore seagrass beds. Although Green turtles may transit through the Project area.	The key nesting and inter-nesting areas (where females live between laying successive clutches in the same season) are Coburg Peninsula, between Nhulunbuy and northern Blue Mud Bay (East Arnhem Land), Groote Island, offshore islands including Crocker Island, Goulburn Island, Sir Edward Pellew Islands, Bathurst and Melville Islands, Wessel and English Islands, and Rocky Island. BIAs for green turtles occur on the north coast of the Tiwi Islands and in the vicinity of Cobourg Peninsula. Within Darwin Harbour, the Green turtle is expected to infrequently use Casuarina Beach, Cox Peninsula Beaches and Mandorah Beach for nesting. Project area No nesting beaches or defined inter-nesting area.	
Hawksbill turtle	Hawksbill turtles are found in tropical, subtropical and temperate waters in all the oceans of the world. Hawksbill turtles spend their first five to ten years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with rafts of Sargassum (a floating marine plant that is also carried by currents). They then settle and forage in tropical tidal and sub-tidal coral and rocky reef habitat. The Hawksbill turtle is known to migrate up to 2,400 km between foraging areas and nesting beaches. Northern Territory The total population of hawksbill turtles in Australia is unknown. In Australia the main feeding area extends along the east coast, including the Great Barrier Reef. Other feeding areas include Torres Strait and the archipelagos of the NT and WA, possibly as far south as Shark Bay or beyond. Hawksbill turtles also feed at Christmas Island and the Cocos (Keeling) Islands. In the NT, abundance is concentrated around north-eastern Arnhem Land and Groote Eylandt. The Hawksbill turtle utilises Darwin Harbour regularly but occur in lower abundances compared to the Green turtle (Whiting 2001, 2003). In the Darwin Harbour, immature and adult sized Hawksbill turtles have been reported as using the rocky reef habitat at Channel Island but may also utilise other habitats (Whiting 2001). Project area Soft coral and sandy habitats are widely present throughout the Project area within Darwin Harbour, therefore providing suitable foraging habitat for the Hawksbill turtle.	Global nesting is mainly confined to tropical beaches. While scattered, low density nesting still occurs throughout the tropics, only five geographic regions host more than 1,000 nesting females annually: Mexico, Seychelles, Indonesia and two in Australia. Northern Territory Australia supports the largest Hawksbill turtle nesting aggregations worldwide, with estimates of over 4,000 females nesting annually in Queensland, over 2,500 in the NT, and ~2,000 in Western Australia. In the NT, most nesting occurs on islands rather than mainland beaches. The key nesting and inter-nesting areas (where females live between laying successive clutches in the same season) in the NT area: Coburg Peninsula, between Nhulunbuy and northern Blue Mud Bay (East Arnhem Land), Groote Island, Sir Edward Pellew Islands, and Wessel and English Islands. A globally important rookery occurs on an archipelago to the north-east of Groote Eylandt. Although Hawksbill turtles breed throughout the year, the peak nesting period in Arnhem Land is between July and October. Hawksbill turtle nesting is not common in Darwin Harbour. Project area No nesting beaches or defined inter-nesting area.	The Australian stocks of Hawksbill turtles are omnivorous, eating a variety of animals and plants including sponges, hydroids, cephalopods (octopus and squid), gastropods (marine snails), cnidarians (jellyfish), seagrass and algae . Sponges make up a major part of the diet. During their pelagic phase (while drifting on ocean currents), young Hawksbill turtles eat plankton. Project area Based on surveys, there is likely to be some foraging habitat within the Project area.

Species	Distribution and habitats	Breeding areas and nesting seasons	Diet
Leatherback turtle	The Leatherback turtle has the widest global distribution of any reptile. The Leatherback turtle is a pelagic feeder, found in tropical, subtropical and temperate waters throughout the world. Although this species has an unusually wide latitudinal range as adults can withstand cold (10 °C) water. It is a highly pelagic species, venturing close to shore mainly during the nesting season, and is capable of diving to several hundred metres. Limited data indicates that Leatherback turtles concentrate in areas where currents converge with steep bathymetric contours, presumably where food is more readily available. Australia Leatherback turtles are presumed to migrate to Australian waters from nesting populations in Indonesia, Papua New Guinea and the Solomon Islands (INPEX 2010). The species has been recorded feeding in the coastal waters of all Australian States (Hamann et al. 2006). The species is most commonly reported from coastal waters in central eastern Australia (from the Sunshine Coast in southern Queensland to central NSW); south-east Australia (from Tasmania, Victoria and eastern South Australia) and in south-western Western Australia. It is regularly seen in southern Australian waters. The current area of occurrence in Australia is estimated to be ~6 million km². No estimates of the numbers of Leatherback turtles that forage in Australian waters are available. As an oceanic species, the species is unlikely to occur within the Darwin Harbour (Whiting 2001). Project area Based on surveys, there is unlikely to be suitable habitat.	Nesting beaches are primarily located in tropical latitudes around the world. Globally, the largest remaining nesting aggregations are found in Trinidad and Tobago, West-Indies (Northwest Atlantic) and Gabon, Africa (Southeast Atlantic). Australia No large rookeries have been recorded in Australia. Scattered nesting has been reported in Queensland, New South Wales and Arnhem Land. Nesting sites have been found at Cobourg Peninsula, Manangrida and Croker Island in the NT. Only very small numbers of nests are laid per year in the NT and thus would only be a minor contributor to the global population. The species is unlikely to use beaches within the Darwin Harbour for nesting (Whiting 2001). Project area No nesting beaches or defined inter-nesting area.	The Leatherback turtle is carnivorous and feeds mainly in the open ocean on jellyfish and other soft-bodied invertebrates. Soft-bodied creatures such as jellyfish and tunicates, occur in greatest concentrations at the surface in areas of upwelling or convergence. Project area Based on surveys, there is unlikely to be suitable habitat within the Project area.
Loggerhead turtle	The Loggerhead turtle has a global distribution throughout tropical, sub-tropical and temperate waters. Loggerhead turtles forage in subtidal and intertidal coral and rocky reefs and seagrass meadows in inshore waters, as well as in deeper soft-bottomed habitats. Females can migrate up to 2,600km from feeding areas to traditional nesting beaches. Australia In Australia, they occur in coral reefs, seagrass beds and muddy bays and estuaries in tropical and warm temperate waters off the coast of Queensland, NT, Western Australia and New South Wales. The current area of occurrence is estimated to be ~1.5 million km^2. In Australia, small Loggerhead turtles live at or near the surface of the ocean and move with the ocean currents, with much of their feeding in the top 5 m of water, before recruiting to their chosen inshore or neritic feeding area.	Nesting is mainly concentrated on sub-tropical beaches with major aggregations occurring in Oman, eastern USA, southern Japan, Greece, Turkey, southern Queensland and Western Australia. Australia Based on the percentage of nesting females per year, approximately 2–4% of the total global population of Loggerhead turtles occur in Australia, with the majority occurring in eastern and western Australia. The species is unlikely to use beaches within the Darwin Harbour for nesting. Project area No nesting beaches or defined inter-nesting area.	Loggerhead turtles are carnivorous, feeding primarily on benthic invertebrates in habitat ranging from nearshore to 55 m. Typical diet includes gastropod molluscs and clams, and smaller amounts of jellyfish, starfish, corals, crabs and fish. In their juvenile stage, they feed on algae, pelagic crustaceans and molluscs. Once they move to the benthic foraging habitat their diet changes. Project area

Species	Distribution and habitats	Breeding areas and nesting seasons	Diet
	Loggerhead turtles are expected to be infrequent users of the Darwin Harbour (Whiting 2003). The Loggerhead turtle is more likely to occur in oceanic areas outside the Darwin Harbour. Project area Based on surveys, there is unlikely to be suitable habitat.		Based on surveys, there is unlikely to be suitable habitat within the Project area.

Sources:

DCCEEW (2022). Species Profile and Threats Database: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

DCCEEW (2022). Marine Species Conservation, Marine Turtles: https://www.awe.gov.au/environment/marine/marine-species/marine-turtles

NWA (2022). North West Atlas, Biological Important Areas (BIAs). https://northwestatlas.org/node/27496

NT EPA (2022). https://nt.gov.au/environment/animals/threatened-animals

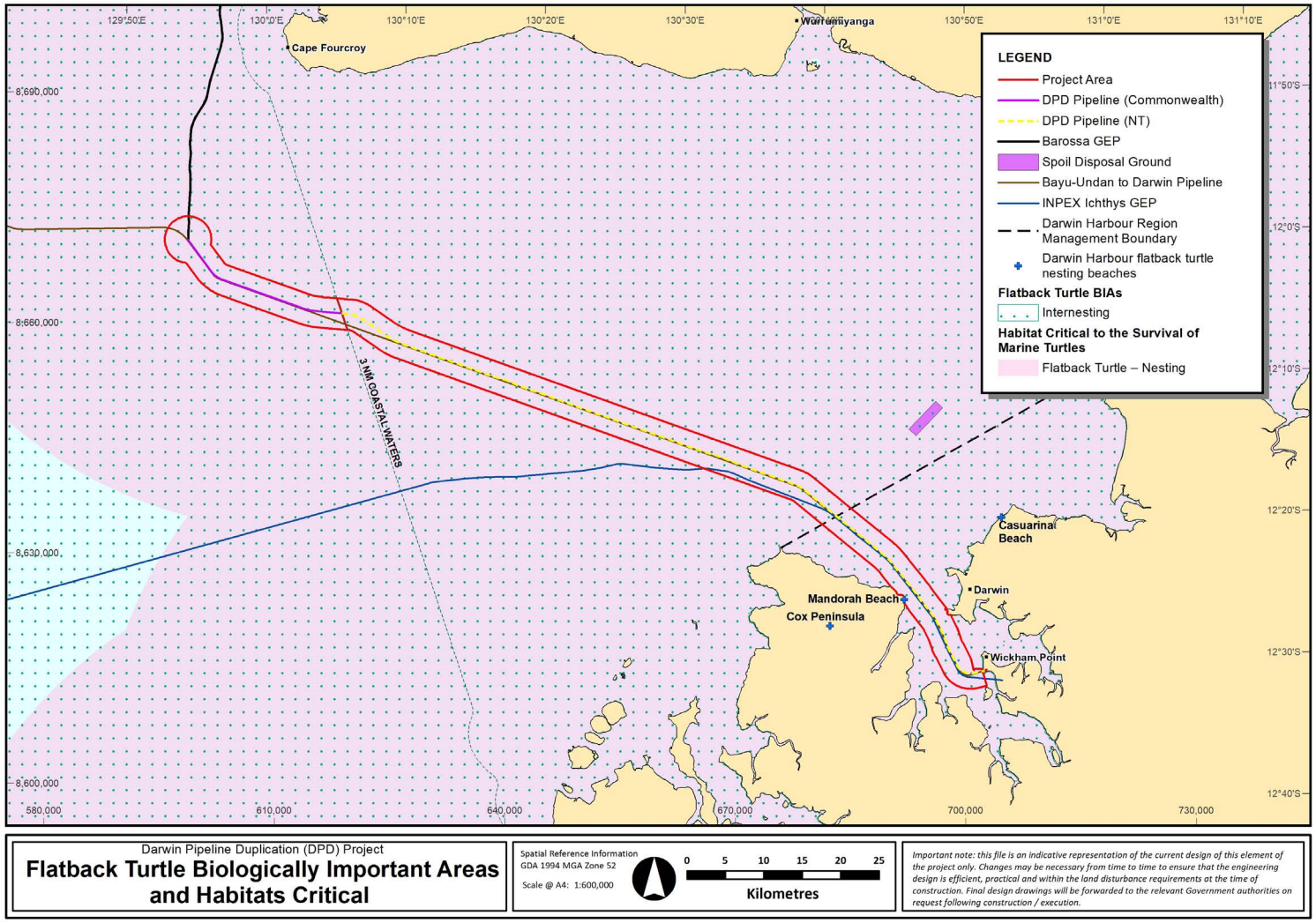


Figure 3-2 Flatback turtle biologically important areas and habitat critical to survival

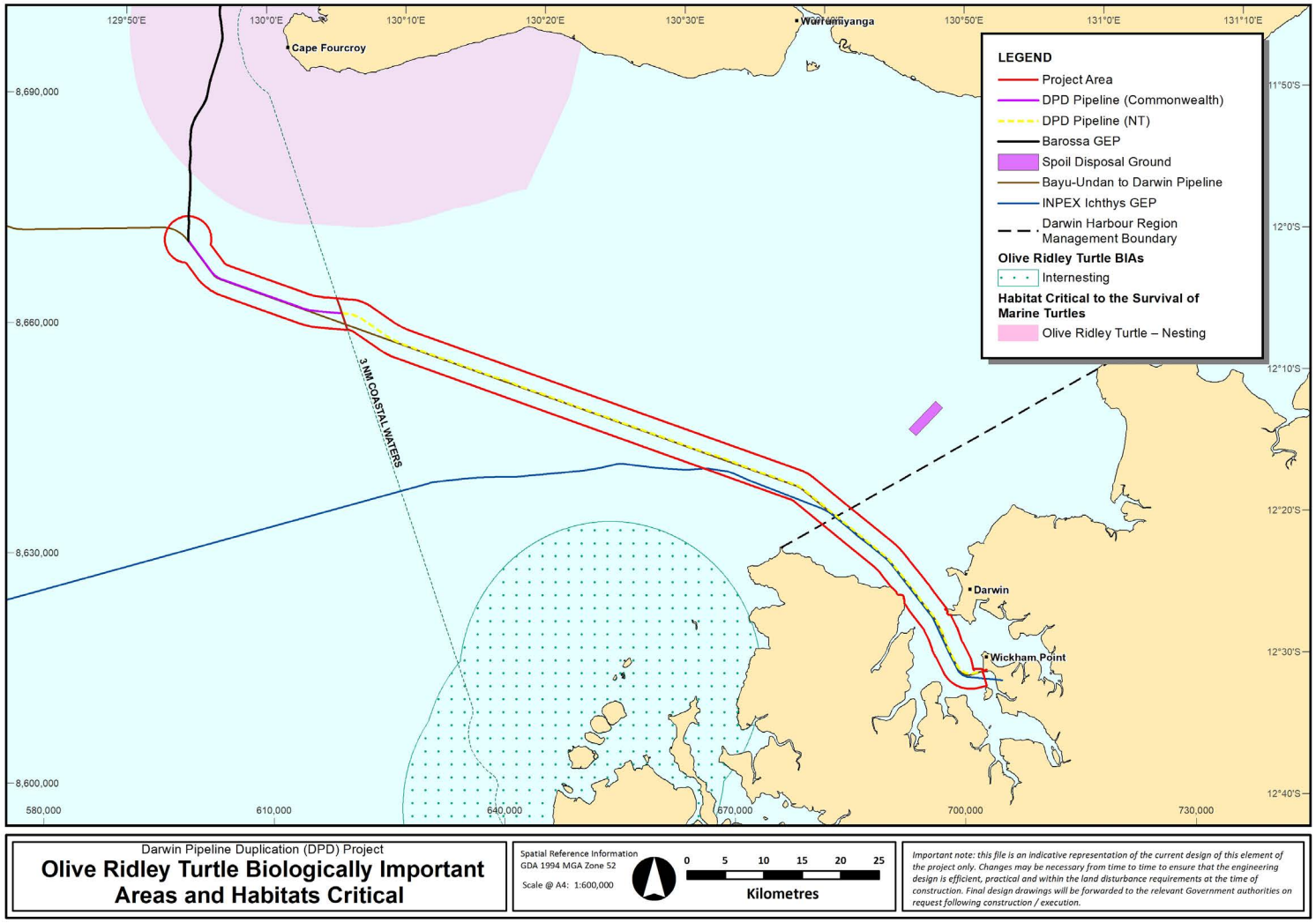


Figure 3-3 Olive Ridley turtle biologically important areas and habitat critical to survival

3.2.1 Summary of Marine Turtle Presence

A summary of the likely locations and nesting sites for threatened marine turtles in the project area and surrounding areas is provided in **Table 3-5**.

Table 3-5 Summary of likely location of MNES listed turtles

Species (Common Name)	Likely Locations		Nesting Locations Frequency		
	Inside Darwin Harbour	**Outside** Darwin Harbour	**Casuarina Beach**	**Cox Peninsula Beaches** and Mandorah Beach	**Tiwi Islands**
Flatback turtle	Frequently	Frequently	Frequently	Infrequently	Frequently
Olive Ridley turtle	Infrequently	Infrequently	Infrequently	Infrequently	Frequently
Green turtle	Frequently	Infrequently	Infrequently	Infrequently	N/A
Hawksbill turtle	Frequently	Infrequently	Infrequently	Infrequently	N/A
Leatherback turtle	Unlikely	Infrequently	Unlikely	Unlikely	N/A
Loggerhead turtle	Infrequently	Infrequently	Unlikely	Unlikely	N/A

Sources: Chatto and Baker 2008; Whiting 2003; Whiting 2001; Buckee et al. 2014; INPEX Browse 2018; O2 Marine 2019.

3.2.2 Threats and Management Plans

There are various recovery, conservation advice, threat abatement and management plans for marine turtles, including:

+ Approved Conservation Advice for *Dermochelys coriacea* (leatherback turtle) (DEWHA 2008).
+ National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (CoA 2020).
+ Recovery Plan for Marine Turtles in Australia (DoEE 2017a).
+ Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (CoA 2017).
+ Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018).
+ Threat abatement plan for predation by feral cats (Department of the Environment 2015).
+ Threat abatement plan for predation by the European red fox (Department of the Environment, Water, Heritage and the Arts 2008).

- Marine bioregional plan for the North Marine Region (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC 2012).
- Sustainable Harvest of Marine Turtles and Dugongs in Australia – A National Partnership Approach (Marine And Coastal Committee, 2005).
- Northern Prawn Fishery Bycatch Action Plan (Northern Prawn Fishery Management Advisory Committee, 2003).

Based on a review of these plans the key threats to marine turtles in the NT include:

- Fishing - commercial and recreational.
- Coastal infrastructure and development, including:

  Light pollution.

  Habitat degradation.

  Boat strike.

  Marine debris.
- Chemical and terrestrial discharge
- Animal predation.
- Seismic surveys and other noise sources.
- Indigenous harvest.
- Diseases and pathogens.
- Climate change and variability.

3.3 Listed Migratory Species

The PMST report identified 75 listed migratory species as occurring, or as potentially occurring, within the vicinity of the Project area (**Appendix A**). The likelihood of occurrence assessment (refer to **Table** 3-2) identified a number of migratory species as having the potential to or likely to occur within or nearby to, the Project area. Several of these were migratory birds, most of which would likely be transiting to areas either side of the Project area where suitable habitat is known to occur (i.e. shoreline crossing is within a disturbed area). Other than the osprey which is known to nest on tall artificial structures, migratory birds have not been considered further. In addition, given the shore crossing is located within the existing DLNG disturbance envelope and there is no suitable habitat for other migratory terrestrial species within the Project area, migratory terrestrial species have not been considered further.

Table 3-6 lists and **Table 3-7** describes the migratory species (excluding the marine turtles listed as threatened in **Table 3-3**) that may potentially be impacted by the Project and assessed against the significant impact self-assessment criteria in **Section 6**.

Table 3-6 Listed migratory species

Common Name	Scientific Name	Class	EPBC Act Status	Likelihood of Occurrence
Australian snubfin dolphin	*Orcaella heinsohni*	Mammal	Migratory	Potential
Dugong	*Dugong dugon*	Mammal	Migratory	Likely
Indo-Pacific humpback dolphin	*Sousa chinensis*	Mammal	Migratory	Likely
Salt-water crocodile	*Crocodylus porosus*	Reptile	Migratory	Likely
Spotted bottlenose dolphin	*Tursiops aduncus*	Mammal	Migratory	Likely
Osprey	*Pandion haliaetus*	Bird	Migratory	Potential

Table 3-7 Description of EPBC Act-listed migratory species potentially within the Project area

Species	Distribution and habitats	Breeding areas	Diet
Australian Snubfin dolphin	The Australian Snubfin dolphin is a recently identified species which was previously combined with the Irrawaddy dolphin (*Orcaella brevirostris*) (DoE 2019) and is considered endemic to Australia occurring in shallow coastal and estuarine waters. Australian snubfin dolphins occur only in waters off the northern half of Australia, from approximately Broome on the west coast to the Brisbane River on the east coast (Parra et al. 2002). Only a single record for the Australian snubfin dolphin exists outside Australia, and comes from Daru, Papua New Guinea (Beasley et al. 2002). Within Australia, Biologically Important Areas (BIAs) for the Snubfin dolphin (breeding, foraging and resting) have been designated along the Kimberley coastline in WA and in NT waters. <u>Northern Territory</u> The Australian Snubfin dolphin is widely distributed across NT coastal waters, with populations considered in a heathy state, as per the findings of a conservation assessment by the NT Department of Natural and Environmental Resources (DENR) (Palmer et al. 2017). From aerial surveys undertaken in 2014 and 2015, the Snubfin dolphin was identified as having an area of occupancy (AOO) of 24,900 km^2 and was calculated to occupy 89% of NT coastal waters (Palmer et al. 2017). Highest densities of sightings were from Pellew Islands, Groote Eylandt, English Company Islands / Arnhem Bay and Fog Bay (Palmer et al. 2017), these sites primarily on the east coast of NT. BIAs (breeding, foraging) have been designated at Darwin Harbour, South Alligator River, East Alligator River and Coburg Peninsula (DSEWPaC 2012). <u>Project area</u> The Project area overlaps the Darwin Harbour BIA for Australian Snubfin dolphins. This species have been monitored in the Darwin Harbour region (comprising Bynoe Harbour, Darwin Harbour and Shoal Bay) between 2011 and 2019 as per the Coastal Dolphin Monitoring Program (Griffiths et al. 2019). This study found populations of this, and the other coastal dolphin species, occurred at low densities but similar to average densities across NT coastal waters, and exhibited fluctuating temporary emigration across sites. The study noted that over the monitoring period population sizes fluctuated but showed a decline over time. The study was unable, however, to explain the reasons for year-to-year variation in abundance and declines, citing potential factors as population dynamics, environmental factors or anthropogenic factors.	<u>Northern Territory</u> For the three coastal dolphin species (including the Australian Snubfin dolphin), calving occurs in the months of October to April (Palmer 2010). BIAs (breeding, foraging) have been designated in NT, within Darwin Harbour, South Alligator River, East Alligator River and Cobourg Peninsula (DSEWPaC 2012). Given the results of NT-wide surveys of the species showing wide distribution, occurrence within nearly all coastal waters and highest densities at sites not currently designated as BIAs (Palmer et al. 2017), there are potentially important breeding sites not currently recognised as BIAs. <u>Project area</u> Calving in the Darwin Harbour BIA occurs in the months of October to April (Palmer 2010). The proportion of dolphin calves sighted has varied considerably during monitoring years (Flora and Fauna Division 2019).	The Australian Snubfin dolphin is considered an opportunistic, generalist feeder which preys on a variety of schooling, bottom dwelling and pelagic fish and cephalopods that are generally associated with mangroves, seagrass, sandy bottom or rocky coral reefs in shallow coastal waters and estuaries of tropical regions (Parra 2013) <u>Project area</u> Within the Darwin Harbour foraging has been identified as the dominant behaviour for dolphins, which is generally recorded in water depths ranging from 0.7 m to 25 m (Palmer 2010). While foraging may occur in the Project area, there are no specific habitats that are considered unique or key for this species given its generalist feeding behaviour and wide use of coastal habitats for foraging.
Spotted Bottlenose dolphin	Spotted Bottlenose dolphins are found in tropical and sub-tropical coastal and shallow offshore waters of the Indian Ocean, Indo-Pacific Region and the western Pacific Ocean (Möller & Beheregaray 2001; Rice 1998; Ross & Cockcroft 1990; Wang et al. 1999). The species is distributed continuously around the Australian mainland and have been confirmed to occur in estuarine and coastal waters of eastern, western and northern Australia (Hale et al. 2000; Möller & Beheregaray 2001; Ross & Cockcroft 1990). BIAs for the species have been designated along the Kimberley Coast in WA, in NT waters and down the entire east coast of Australia from Cape York to past the NSW-Victorian border.	<u>Northern Territory</u> For the three coastal dolphin species (including the Spotted Bottlenose dolphin), calving occurs in the months of October to April (Palmer 2010). BIAs (breeding, foraging) have been designated in NT, within Darwin Harbour and at Cobourg Peninsula (DSEWPaC 2012). Given the results of NT-wide surveys of Spotted Bottlenose dolphins showing wide distribution, occurrence within nearly all coastal waters	The Spotted Bottlenose dolphin is considered an opportunistic, generalist feeders which preys on a variety of schooling, bottom dwelling and pelagic fish and cephalopods that are generally associated with mangroves, seagrass, sandy bottom or rocky coral reefs in shallow coastal waters and estuaries of tropical regions (Parra 2013)

Species	Distribution and habitats	Breeding areas	Diet
	Northern Territory The species is widely distributed across the NT with populations considered in a heathy state as per the findings of a conservation assessment by the DENR based on 2014/2015 surveys (Palmer et al. 2017). The species was identified as having an area of occupancy (AOO) of 17,600 km^2 and occurred within 84% of NT coastal waters (Palmer et al. 2017). Highest densities were recorded from Limmen Bight, Nhulunbuy, Caledon Bay, Maningrida, Fog Bay, Anson Bay and Cape Ford (Palmer et al. 2017), these sites distributed across west, north and east coasts of NT. BIAs have been identified for the Spotted Bottlenose dolphin (foraging, provisioning of young, feeding and breeding) in Darwin Harbour and at Cobourg Peninsula (DSEWPaC 2012). Project area The Project area overlaps the Darwin Harbour BIA for this species. This species has been monitored in the Darwin Harbour region (comprising Bynoe Harbour, Darwin Harbour and Shoal Bay) between 2011 and 2019 as per the Coastal Dolphin Monitoring Program (Griffiths et al. 2019). This study found populations of this, and the other coastal dolphin species occurred at low densities but similar to average densities across NT coastal waters, and exhibited fluctuating temporary emigration across sites. The study noted that over the monitoring period population sizes fluctuated but showed a decline over time. The study was unable, however, to explain the reasons for year-to-year variation in abundance and declines, citing potential factors as population dynamics, environmental factors or anthropogenic factors.	and highest densities at sites not currently designated as BIAs (Palmer et al. 2017), there are potentially important breeding sites not currently recognised as BIAs. Project area Calving in the Darwin Harbour BIA occurs in the months of October to April (Palmer 2010). The proportion of dolphin calves sighted has varied considerably over the years with calving rates increasing from 2017 to 2018, where over the previous years the rate has generally been low (Flora and Fauna Division 2019).	Project area Within the Darwin Harbour foraging has been identified as the dominant behaviour for dolphins, which is generally recorded in water depths ranging from 0.7 m to 25 m (Palmer 2010). While foraging may occur in the Project area, there are no specific habitats that are considered key for this species given its generalist feeding behaviour and wide use of coastal habitats for foraging.
Indo-Pacific Humpback dolphin	Indo-Pacific Humpback dolphins are found in tropical/subtropical waters of the Sahul Shelf from northern Australia to the southern waters of the island of New Guinea (Jefferson and Rosenbaum 2014). In Australia, humpback dolphins are thought to be widely distributed along the northern Australian coastline from approximately the Queensland-New South Wales border to western Shark Bay, Western Australia (Parra & Cagnazzi 2016). Along the Australian coast, humpback dolphins are more likely to be found in relatively shallow and protected coastal habitats such as inlets, estuaries, major tidal rivers, shallow bays, inshore reefs and coastal archipelagos, rather than in open stretches of coastline (Parra & Cagnazzi 2016). BIAs for the Indo-Pacific humpback dolphin occur along the Kimberley coast in WA, in NT waters and down the Queensland coast from Cape York to Brisbane (DSEWPaC 2012). Northern Territory These species are widely distributed across the NT with populations considered in a heathy state as per the findings of a conservation assessment by the NT DENR conducted in 2017 based on 2014/2015 surveys (Palmer et al. 2017). The Indo-Pacific Humpback dolphin was identified as having an area of occupancy (AOO) of 16,900 km^2 as well as a calculated extent of occurrence of 88% of NT coastal waters (Palmer et al. 2017). Highest densities of sightings were from Groote Eylandt, English Company Islands, Kakadu National Park, Melville Island (Aspley Straight) (Palmer et al. 2017) which are located on northern and eastern coasts of NT. BIAs (foraging, feeding and breeding) have been designated for the Indo-Pacific Humpback dolphin in Darwin Harbour; Port Essington, Cobourg Peninsula; East Alligator River region and South Alligator River region (DSEWPaC 2012). Project area	BIAs for Indo-Pacific Humpback dolphins (breeding, foraging) have been designated in NT, within Darwin Harbour; Port Essington, Cobourg Peninsula; East Alligator River region and South Alligator River region (DSEWPaC 2012). Given the results of NT-wide surveys of Indo-Pacific Humpback dolphins showing wide distribution, occurrence within nearly all coastal waters and highest densities at sites not currently designated as BIAs (Palmer et al. 2017), there are potentially important breeding sites not currently recognised as BIAs. Project area In the Darwin Harbour BIA, calving occurs in the months of October to April (Palmer 2010). The proportion of dolphin calves sighted has varied considerably over the years with calving rates increasing from 2017 to 2018 for the Indo-Pacific Humpback dolphins, where over the previous years the rate has generally been low (Flora and Fauna Division 2019).	The Indo-Pacific Humpback dolphin is considered an opportunistic, generalist feeder which preys on a variety of schooling, bottom dwelling and pelagic fish and cephalopods that are generally associated with mangroves, seagrass, sandy bottom or rocky coral reefs in shallow coastal waters and estuaries of tropical regions (Parra 2013). Project area Within the Darwin Harbour foraging has been identified as the dominant behaviour for dolphins, which is generally recorded in water depths ranging from 0.7 m to 25 m (Palmer 2010). While foraging may occur in the Project area, there are no specific habitats that are considered unique or key for this species given its generalist feeding behaviour and wide use of coastal habitats for foraging.

Species	Distribution and habitats	Breeding areas	Diet
	The Project area overlaps the Darwin Harbour BIA for Indo-Pacific Humpback dolphins. This species has been monitored in the Darwin Harbour region (comprising Bynoe Harbour, Darwin Harbour and Shoal Bay) between 2011 and 2019 as per the Coastal Dolphin Monitoring Program (Griffiths et al., 2019). This study found populations of this, and the other coastal dolphin species occurred at low densities but similar to average densities across NT coastal waters, and exhibited fluctuating temporary emigration across sites. The study noted that over the monitoring period population sizes fluctuated but showed a decline over time. The study was unable, however, to explain the reasons for year-to-year variation in abundance and declines, citing potential factors as population dynamics, environmental factors or anthropogenic factors.		
Dugong	The dugong has a very large and fragmented Indo-West Pacific range that extends between about 26-27° north and south of the equator (Nishiwaki and Marsh 1985), encompassing some 860,000 km² of shallow marine habitat across 128,000 km of coastline (Marsh et al. 2011). Their range includes the coastal waters of between 38-44 nations and territories (Marsh et al. 2011). In Australia, dugongs are known to occur in coastal and island waters from Shark Bay in Western Australia across the northern coastline to Moreton Bay in Queensland (Marsh et al. 2002, 2011). The winter range includes about 24,000 km of Australia's coast, which represents about 19% of the global extent of occurrence along coastline habitats (Marsh et al. 2011). <u>Northern Territory</u> The NT supports a moderate population compared with the Torres Strait, which is the largest global population (Groom et al. 2017). Specific areas supporting dugongs in the NT include: the northern coast (Daly River to Millingimbi, including Melville Island and Vernon Islands and the Darwin region); and the Gulf of Carpentaria, including the Sir Edward Pellew Group of Islands, the mouth of the Limmen Bight River, and the waters between Blue Mud Bay and Groote Eylandt (Marsh et al. 2008; Grech et al. 2011). The distribution and abundance of dugongs is generally associated with extensive seagrass and algal habitats, as such they are usually found in coastal areas such as shallow protected bays, mangrove areas and leeward of large inshore islands where seagrass grows (O2 Marine 2019). Aerial surveys conducted by Groom et al. (2017) in 2015 found that the Sir Edward Pellew Island Group and Limmen Bight on the east coast of the NT have the highest population estimates for dugongs in NT consistent with earlier survey results from 2007 and 2014. There are no BIAs for dugongs in the North Marine Region (DSEWPaC 2012). <u>Project area</u> Dugong monitoring was undertaken as part of the Ichthys Nearshore Environmental Monitoring Program from 2012 to 2014 across three areas (blocks), representing Bynoe Harbour, Darwin Harbour/Hope Inlet and Vernon islands and surrounds. Population estimates calculated from sightings across these blocks ranged from approximately 120 to 300 individuals (calculated from post-dredging phase monitoring) with a clear preference of dugongs for shallow waters (0-10m) and with far fewer sightings in the inner Darwin Harbour (demarcated as a line from Mandorah to East Point) than in the outer Darwin Harbour (Cardno 2015a). Highest dugong abundances from these surveys were recorded from seagrass meadows at Casuarina Beach and Lee Point in the outer Darwin Harbour and outside of the	Dugongs are diffusely seasonal breeders and the seasonality of breeding is more marked in the sub-tropics (mostly spring, early summer calving) than in the tropics. Usually a single calf is born after a gestation period of about 14 months and nursed for 18 months or more. <u>Project area</u> There is no available evidence to suggest that the Project area or Darwin Harbour represents a critical breeding or calving area.	Dugongs are seagrass community specialists and the range of the dugong is broadly coincident with the distribution of seagrasses in the tropical and sub-tropical waters in their Australian range. <u>Project area</u> Ichthys Nearshore Environmental Monitoring Program from 2012 to 2014 recorded dugong abundances highest from seagrass meadows at Casuarina Beach and Lee Point in the outer Darwin Harbour (outside of the Project area) indicating these areas as foraging habitats. Dugongs have been observed foraging on reef flats with algae between Channel Island and the western end of Middle Arm Peninsula (INPEX Browse 2010a) and could be expected to forage in other shallow areas (<10 m) within the Darwin Harbour with seagrass and/or algae, including Weed Reef.

Species	Distribution and habitats	Breeding areas	Diet
	Project area. Within the inner harbour, dugongs were observed in highest abundance at Weed Reef (Cardno 2015a).		
Salt-water crocodile	The Salt-water crocodile is found in Australian coastal waters, estuaries, lakes, inland swamps and marshes (Webb et al. 1987). The species' distribution ranges from Rockhampton in Queensland (Miller 1993; Taplin 1987) throughout coastal NT (McNamara & Wyre 1993; Webb et al. 1987) to King Sound (near Broome) in Western Australia (Burbidge 1987; McNamara & Wyre 1993). Northern Territory In the NT, Salt-water crocodiles can be found in almost any type of water body, including fresh or saline, within their range (Saalfeld et al. 2016). There are no BIAs for the Salt-water crocodile in the North Marine Region (DSEWPaC 2012). Project area The Salt-water crocodile is common throughout the Darwin region and could occur in the Project area. In 2019/2020 a total of 249 'problem crocodiles' were removed from NT waters with nearly all of these being caught within Darwin Harbour area (DEPWS 2021).	Salt-water crocodiles breed during the wet season between October and May. Preferred nesting habitat of the Salt-water crocodile includes elevated, isolated freshwater swamps that do not experience the influence of tidal movements (Saalfeld et al. 2016). Project area Nesting within Darwin Harbour is considered limited (INPEX Browse Ltd 2010a) and the Project area does not contain suitable nesting habitat.	The Salt-water crocodile is an opportunistic feeder and uses either an 'active hunting' or a 'sit and wait' strategy (Cooper & Jenkins 1993). Project area The Project area does not contain any recognised key habitats for feeding Salt-water crocodiles.
Osprey	The osprey occurs in Indonesia, Philippines, Palau Islands, New Guinea, Solomon Islands, New Caledonia and Australia (DCCEEW 2022a). The breeding range of the osprey extends around the northern coast of Australia (including many offshore islands) from Albany in Western Australia to Lake Macquarie in NSW; with a second isolated breeding population on the coast of South Australia, extending from Head of Bight east to Cape Spencer and Kangaroo Island (DCCEEW 2022a). The osprey is thinly distributed around the coast of Australia where they forage for fish in fresh, brackish, or saline waters of rivers, lakes, estuaries and inshore coastal waters (DCCEEW 2022a). Project area There is likely to be suitable habitat for osprey in and around the Project area with a known nest on the DLNG facility.	Osprey nest on a variety of natural and artificial sites including in dead or partly dead trees or bushes; on cliffs, rocks, rock stacks or islets; on the ground on rocky headlands, coral cays, deserted beaches, sandhills or saltmarshes; and on artificial nest platforms, pylons, jetties, lighthouses, navigation towers, cranes, exposed shipwrecks and offshore drilling rigs (DCCEEW 2022a). Project area There is an osprey nest on the DLNG site (atop an artificial pole) and that this species may utilise parts of the DLNG infrastructure that are 'higher-up' for nesting.	Osprey require extensive areas of open fresh, brackish or saline water for foraging (DCCEEW 2022a). In Australia, ospreys mainly feed on fish and rarely take molluscs, crustaceans, insects, reptiles, birds and mammals (DCCEEW 2022a). Project area It is considered that the Project area may contain suitable foraging habitat as would Darwin Harbour in general, but this habitat is not considered unique or particularly significant.

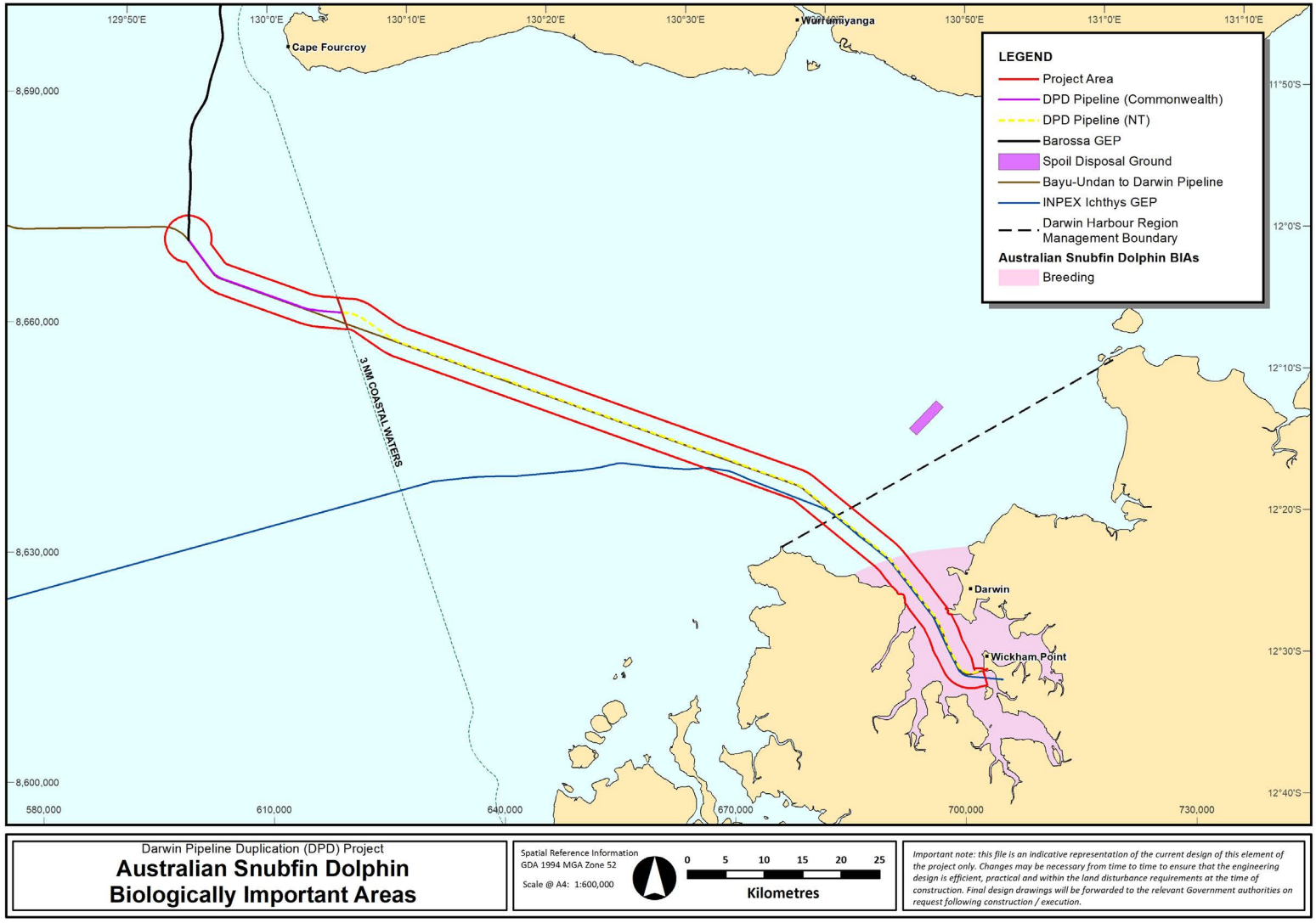


Figure 3-4 Biologically important areas for marine mammals – Australian Snubfin dolphin

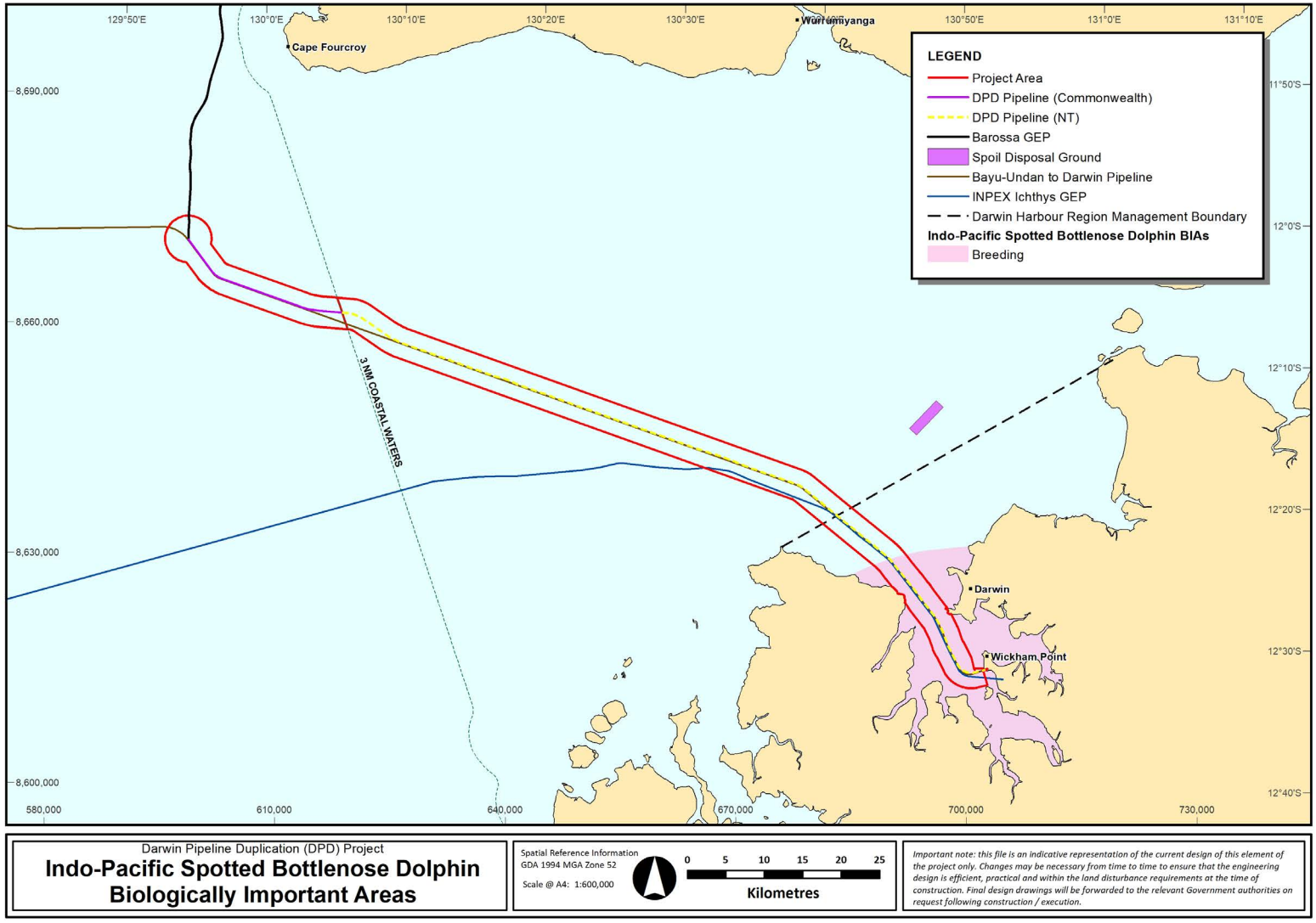


Figure 3-5 Biologically important areas for marine mammals – Indo-Pacific Humpback dolphin

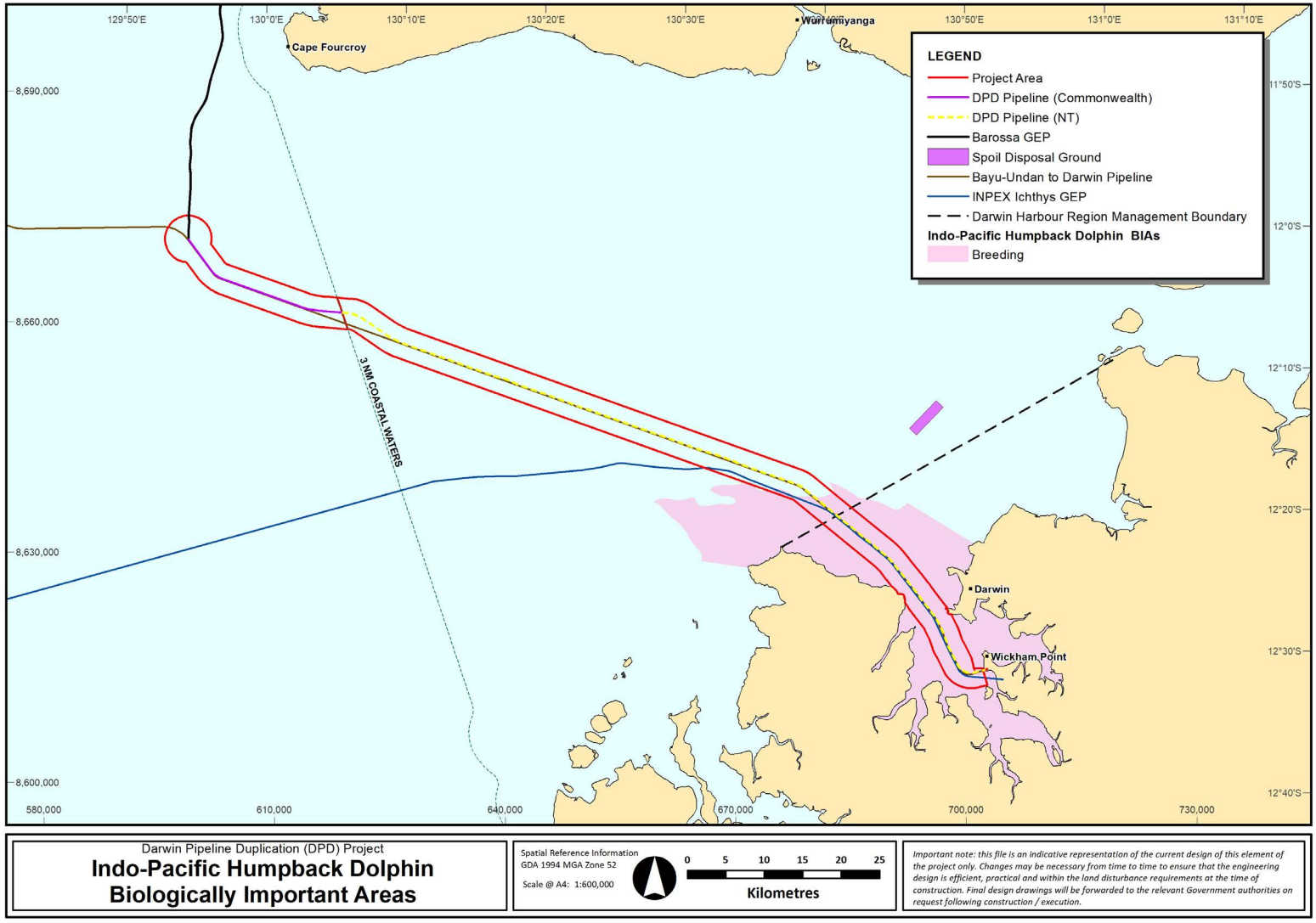


Figure 3-6 Biologically important areas for marine mammals – Indo-Pacific Spotted Bottlenose dolphin

3.3.1 Threats and Management Plans

This section summarises the requirements of the relevant plans of management for those potentially impacted migratory species (including conservation advice, recovery plans and management plans for marine fauna).

- Marine bioregional plan for the North Marine Region (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC 2012).
- National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE 2017).
- National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (CoA 2020)
- Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018).
- Sustainable Harvest of Marine Turtles and Dugongs in Australia – A National Partnership Approach (Marine and Coastal Committee 2005).
- Wildlife Conservation Plan for Seabirds (DAWE 2020).

Based on a review of these plans and the Species Profile and Threats Database, the key threats to dolphins in the NT include:

- Habitat destruction and degradation.
- Pollution of habitat.
- Fishing - commercial and recreational.
- Interaction with vessels.
- Seismic surveys and other noise sources.
- Diseases and pathogens.
- Climate change and variability.
- Vessel collision.

Based on a review of these plans and the Species Profile and Threats Database, the key threats to dugong in the NT include:

- Habitat degradation including coastal development, port expansion and aquaculture.
- Pollution.
- Entanglement and incidental bycatch in fisheries gear.
- Indigenous harvest.
- Vessel strike.
- Anthropogenic noise and acoustic disturbance.
- Climate variability and change.
- Vessel collision.

Based on a review of these plans and the Species Profile and Threats Database, the key threats to Salt-water crocodile in the NT include:

- Mortality due to fishing nets.
- Effects of habitat destruction.

Based on a review of other information sources such as the Species Profile and Threats Database for this species, the key threats to osprey species include:

- Loss, degradation or alteration of habitat for urban or tourism development.
- Pollution (light, marine debris, water).
- Invasive species
- Ingestion of prey items containing pollutants such as pesticides, heavy metals or fishing tackle.
- Competition for food with commercial and recreational fisheries.
- Reduced water quality at foraging grounds caused by discharge of effluent or runoff.
- Disturbance or persecution by humans; and accidental mortality arising from collisions with powerlines.

3.4 Commonwealth Marine Area

The DPD Project area within Commonwealth waters varies in depth from ~30m to ~60m with the end of the pipeline in ~50m of water. Regional habitat modelling and mapping, including the Commonwealth waters Project area has been conducted by the Australian Institute of Marine Sciences (AIMS) (Heyward et al. 2017) and shows that the habitat in the Project area, as with the broader region, is dominated by bare sand, filter feeders and burrowers/crinoids (**Figure 3-7**). Baseline surveys of the pipeline route, including the section in Commonwealth waters, have been undertaken by RPS (RPS, 2022a; **Appendix B**). This survey, which included collection of benthic habitat imagery and sediment samples, confirmed the habitat categorisation by Heyward et al., 2017, with all sites along the pipeline route in Commonwealth waters classified as silty/shelly sand with very sparse to sparse biota (soft corals and crinoids).

The Project area is located immediately to the east of Shepparton Shoal which is a raised seabed feature with a depth up to 30m and which habitat mapping shows has a similar benthic habitat categorisation as surrounding areas (**Figure 3-7**). The pipeline route was re-aligned during the preliminary engineering design to avoid Shepparton Shoal disturbance with the pipeline end ~3km from this feature at its closest point (**Figure 3-7**).

A key ecological feature of “Carbonate Bank and Terrace System of the Van Diemen Rise” at its closest point is approx. 4.5km east of the Project area in Commonwealth waters. This feature covers a large area (approximately 31,278 km^2) predominantly to the north of the Project area and is characterised by terrace, banks, channels and valleys (DSEWPaC, 2012).

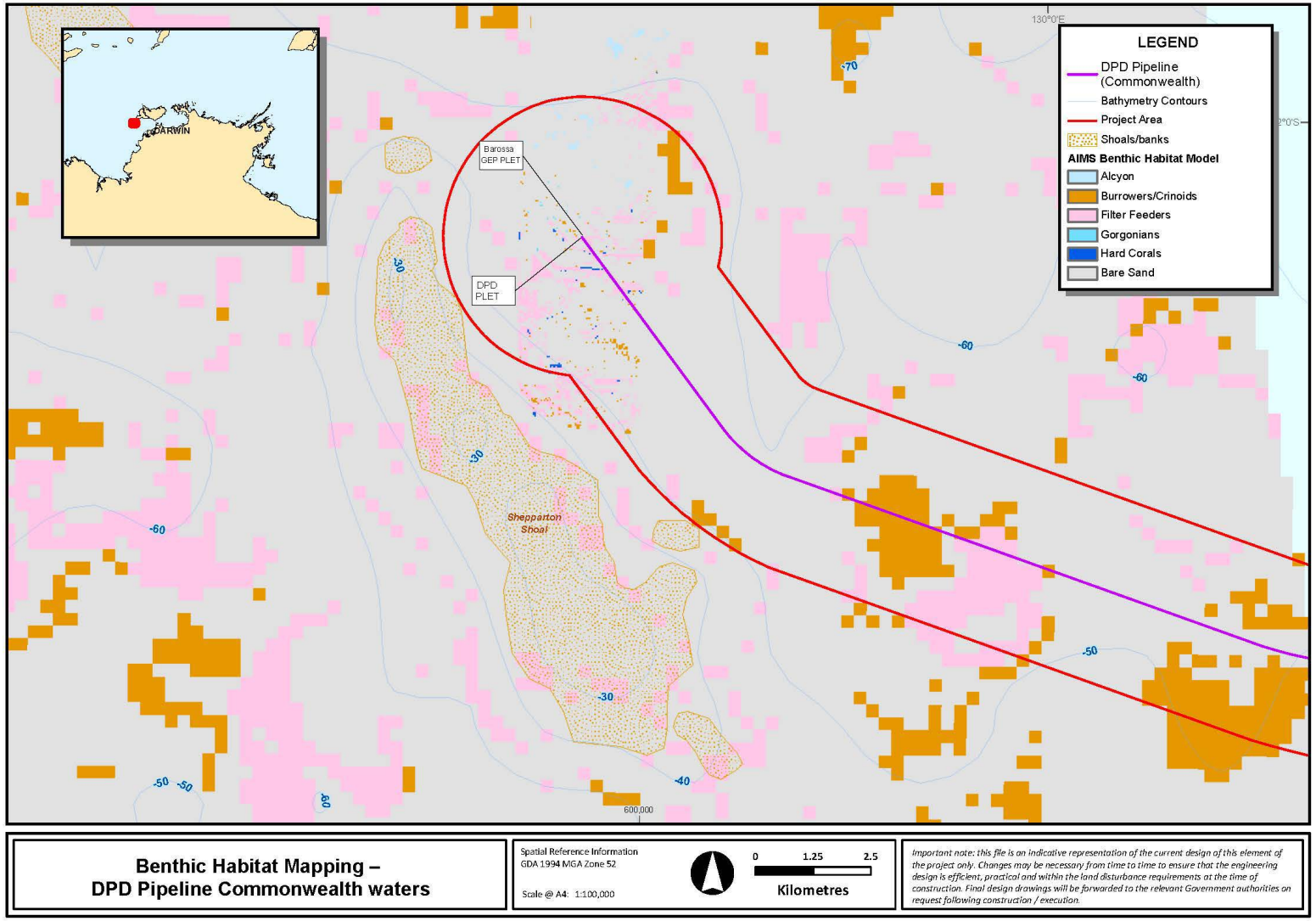


Figure 3-7: Project area benthic habitat in Commonwealth waters

4 Impact Assessment for Matters of National Environmental Significance

4.1 Impact Assessment Approach

The following section describes the approach taken to assess potential impacts to MNES from the proposed action. This approach involved the following steps:

- Identifying the existing marine and coastal environment within the Project area, outlining any ecosystems and habitats relevant to the identified MNES;
- Reviewing planned activities and associated potential planned and unplanned impacts of the Project to determine which activities have the potential to impact MNES;
- Assessing the potential planned and unplanned impacts to the MNES using supporting studies and information as required;
- Identifying suitable management measures to reduce risk of impacts to MNES; and
- Assessing potential impacts to MNES using significant impact criteria as per the MNES Significant Impact Guidelines 1.1 (DoE 2013).

When evaluating the potential Project impacts, consideration was given to the extensive studies and monitoring conducted for similar projects in Darwin Harbour and in adjacent Commonwealth waters. These include the original Bayu-Undan to Darwin pipeline and DLNG facility, the Santos Barossa Development and the INPEX Ichthys project. The INPEX Ichthys project has been utilised as a proxy to assess impacts on the basis that it undertook similar work activities within a similar area especially in NT waters (including spoil disposal) but on a greater spatial and temporal extent. The Santos Barossa project has been subject to environmental assessments under legislation governing activities in Commonwealth waters and this information is referenced here for the potential impacts of dewatering at the DPD pipeline PLET, light emissions and seabed disturbance.

INPEX's Ichthys nearshore environmental monitoring program was extensive and continues to be undertaken as part of the NT Government Darwin Harbour Integrated Marine Monitoring and Research Program. The monitoring data provides valuable insight into the natural environmental variability within Darwin Harbour and the effect of project activities on this environment.

The key findings from the Ichthys monitoring program (as reported by INPEX Browse 2014) were:

- Upon completion of dredging activities, the turbidity concentrations at the monitoring sites closest to the dredging (i.e. Northeast Wickham Point and South Shell Island) had returned to natural conditions within a single spring-neap cycle following the completion of dredging.
- No detectable dredging-related impacts to corals were observed at monitoring sites outside of East Arm.
- No dredging-related impacts to seagrass habitats were observed and turbidity measured at seagrass monitoring sites were within the general range of natural variation.
- Measurements of sedimentation levels in mangrove assemblages were below the level considered to potentially impact mangrove health.
- No evidence of dredging-related impacts to fish health and catches.

- No noticeable changes to the distribution of turtles and dugongs within Darwin Harbour that would indicate a potential influence of dredging.
- As predicted, dredging-related impacts to both infauna and epifauna were observed within the offshore spoil disposal ground following season one dredging, likely due to placement of dredge material on the seabed.

The Ichthys monitoring program in NT waters was developed to monitor and evaluate potential impacts from a scope of activities that was significantly larger than proposed for this Project. The Ichthys project was authorised to dredge and dispose of 16.1 Mm^3 of material to dredge a safe shipping channel and berthing area in East Arm which included dredging through the very hard substrate at Walker Shoal (INPEX Browse 2014).

In relation to material to be trenched for installing the Ichthys pipeline, an additional 0.466 Mm^3 of material was authorised to be trenched to 'seat' the Darwin Harbour section of the pipeline which runs just south of the existing Bayu-Undan to Darwin pipeline and which had a much longer shore crossing (INPEX Browse 2014). Spoil from the Ichthys project, both dredging and trenching, was placed in an offshore spoil disposal ground in the Beagle Gulf.

In comparison, a maximum volume of 0.75 Mm^3 (with an expected volume of approximately 0.25 Mm^3) will be trenched to install the Project pipeline in the NT waters section, with the trenched material to also be disposed of at an offshore spoil disposal ground in the Beagle Gulf (adjacent to west of the Ichthys spoil disposal ground).

Based on these monitoring observations for the significantly larger program of works and with the implementation of an appropriate management and monitoring framework, it is expected that effects from this Project would be proportionally less than those observed during the Ichthys project.

Specific to the DPD Project, a number of technical studies have been commissioned by Santos to support environmental impact and risk assessment and the development of control measures and management plans. These studies include:

- DPD Project pipeline route baseline habitat, sediment and water quality studies (RPS 2022a; **Appendix B**)
- A quantitative risk assessment study of third-party impacts to the pipeline (Intecsea, 2021)
- PLET treated seawater and MEG discharge modelling (RPS 2021; **Appendix C**)
- DPD Project contingency treated seawater discharge modelling (RPS 2022b; **Appendix D**)
- DPD Project trenching and spoil disposal sediment dispersion modelling (RPS 2022c, in draft)
- Deepwater pipelay and construction vessel light modelling (Pendoley Environmental 2022a)
- Darwin Harbour impact assessment of Project vessel lighting on marine turtles (Pendoley Environmental 2022c; **Appendix E**)
- DPD Project underwater noise assessment (Talis 2022, in draft)
- DPD Project oil spill modelling (RPS, 2022d)
- Underwater maritime heritage assessment (Cosmos Archaeology 2022, in draft)

4.2 Project Impacts and Risks

Section 2 provides a comprehensive description of the Project activities. Of the planned activities, the following aspects that may impact MNES species, their associated habitats and the Commonwealth marine environment are considered:

- Seabed disturbance.
- Noise.
- Light emissions.
- Water quality impacts.

Planned discharges associated with general vessel operations (e.g. bilge water discharges, engine exhaust, etc.) regulated under the Australian Maritime Safety Authority (AMSA) Marine Orders and international conventions (MARPOL). The impacts associated with vessel discharges are considered minor, short term and the same as other commercial vessels operating within Darwin Harbour, associated shipping fairways and surrounds. **Section 5** lists the relevant management measures to avoid or reduce these impacts and are consistent with maritime regulations and standards.

Additionally, the use of marine vessels, helicopters and vehicles/equipment (onshore construction) and associated combustion of hydrocarbons (fuel oil; diesel) is unavoidable for this Project. This will result in short term combustion emissions of greenhouse gases (GHG), considered to be an insignificant contribution to the total current Australian GHG emissions. The impact (i.e. climate change) of GHG emissions from DPD Project sources is considered to be negligible and is not discussed further in this referral supporting information. Other than from the abovementioned GHG emission sources, there are no planned GHG emissions from pipeline operations (i.e. conveyance of natural gas) within the Project area. For completeness, it is noted that the NT EPA has requested Santos to outline scope 1, 2 and 3 greenhouse gas emissions associated with the DPD Project and the broader Barossa Development in the supplementary environmental report currently being prepared in accordance with the EP Act and *Environment Protection Regulations 2020* (NT).

Of the unplanned activities, the following aspects that may impact MNES species, their associated habitats and the Commonwealth marine environment and include:

- Introduction of invasive marine species.
- Accidental marine fauna interaction.
- Accidental marine diesel releases during bunkering or a vessel collision.
- Accidental dry gas release from pipeline rupture during production operation.

An assessment of the planned and unplanned aspects that could have an impact to MNES during construction and operations is presented below. This assessment considers the potential threats to EPBC Act-listed fauna (marine mammals and marine reptiles) identified in **Sections 3.2.2** and **3.3.1** and the Commonwealth marine environment, as relevant to activities within the Project area. Due to the absence of natural osprey nest habitat within the Project area and because their foraging habitat (i.e. oceanic waters) is expansive, the impact assessment is focused primarily on marine mammals and reptiles.

4.2.1 Seabed Disturbance

The installation of the Project pipeline will directly disturb, and in some areas remove and redistribute the seabed, e.g. within trenching areas and spoil disposal ground. The potential construction of a cofferdam, trenching and the construction of a temporary rock causeway will also directly impact an intertidal area at the DLNG facility within the existing disturbance footprint.

Seabed disturbance will be within an approximate 50m disturbance corridor along the pipeline route, with additional disturbance from vessel anchoring as required for the shallow water pipelay barge. Anchoring impacts (i.e. disturbance from anchors and chain) will be temporary and, except for contingency/ emergency events, will be restricted to within 900m either side of the pipeline route where the nearshore pipelay barge is used.

Benthic habitat directly below the trenched areas, Project pipeline and stabilisation and protection structures/measures (including span rectification structures and any engineered or rock backfill) will be lost as a result of direct impact from installation, however the presence of the pipeline and rock installation will create hard surfaces that will be recolonised by benthic organisms and create new habitat. Benthic habitats within the spoil disposal ground will be partially smothered, and habitats contacted by vessel anchors will be temporarily disturbed.

Once installed, the ongoing pipeline production operations will have limited potential for seabed disturbance compared to construction. Typical activities during operations include pipeline inspections, where seabed disturbance if required (e.g. vessel anchoring), is expected to be limited. If maintenance and repairs are required to the Project pipeline during operations (e.g., span rectification or repair/replacement of a damaged a section of pipe) these activities will disturb the seabed and result in temporary and localised decreases in water quality. It should be noted that the likelihood of this occurring is low and potential impacts would be similar for other projects such as Bayu-Undan to Darwin pipeline and the Ichthys pipeline.

Based on benthic habitat mapping in the Darwin Harbour area (Galaiduk et al. 2019, Udyawer et al., 2021) and dedicated surveys along the pipeline route (RPS 2022a; **Appendix B**), the benthic habitats below the pipeline route and spoil disposal ground comprise soft sediments or hard substrate, supporting a filter feeding community (e.g. soft corals, sponges) ranging from sparse to medium density. This type of habitat is well represented in the Project area. Primary producer habitat, including seagrasses, hard corals and macroalgae are located away from the pipeline route in Darwin Harbour, typically in shallower waters (<10m) closer to shorelines (Galaiduk et al. 2019, Udyawer et al., 2021, RPS, 2022a; **Appendix B**) and therefore are not expected to be disturbed from pre-lay activities, laying of the pipeline or rock installation.

Pre-lay activities (in particular trenching and spoil disposal) will create turbidity as sediment particles of different sizes suspend in the water column. This has the potential to indirectly impact habitats through the settling of suspended particles (sedimentation), or by reducing the availability of light to photosynthetic biota on the seabed (hard corals, seagrasses, algae). Excessive sedimentation and/or prolonged reduction in light have the potential to cause mortality for these biota types. Importantly, the large tidal movements and strong currents in Darwin Harbour naturally generate high turbidity and sediment loads, particularly during spring tides, with spatial gradient observed in the harbour's water quality, with turbidity in the upper reaches higher than that of the outer harbour (ConocoPhillips 2019).

4.2.1.1 Significance of impacts to MNES species

Seabed disturbance is not expected to have any significant impact on MNES marine mammals (dolphins and dugongs) in the Project area. Dolphins have opportunistic, varied diets and there is no evidence from surveys conducted in the harbour and surrounding areas (Palmer, 2010, Brooks and Pollock 2015) that these species preferentially target habitats along the pipeline route for foraging. Dugongs are known to occur in greatest abundance in shallow seagrass and algae habitats within Darwin Harbour and surrounding areas (Cardno 2015a), however these areas will not be disturbed from pipeline installation.

While trenching and spoil disposal will generate turbidity, this is expected be within the ranges of natural variability, based on sediment dispersion modelling conducted to date, and therefore not expected to cause any loss of dugong or turtle foraging habitat (e.g. algae, seagrass habitat). A monitoring and management program, outlined within a Trenching and Spoil Disposal Monitoring and Management Plan (TSDMMP) will be in place to monitor changes in water quality (turbidity) and adapt management measures in response to water quality triggers that provide an early warning sign of potential impacts to benthic habitat.

An approved monitoring program was undertaken as part of the construction activities, including piling, dredging and spoil disposal activities, associated with the Ichthys project, as conditioned in EPBC Act approval of that project (EPBC 2008/4208). The Ichthys monitoring program did not detect any deleterious effects to turtle, dugong or dolphin distributions or population sizes in the Darwin region attributable to their dredging activities (Brooks and Pollock 2015; Cardno 2015a). Furthermore, seagrass monitoring did not indicate dredge-related (turbidity) impacts at seagrass sites known to support relatively high abundances of dugongs, with seasonal environmental factors considered the key drivers for seagrass growth and distribution at these sites (Cardno 2015a, b). Given the proposed Project is smaller in scale in comparison to the Ichthys project, and will implement similar management measures, as described in **Section 5.1,** the proposed trenching, spoil disposal and construction activities associated with the Project are not expected to significantly impact listed marine mammal species.

4.2.1.2 Significance of impacts to the Commonwealth marine area

Within the Commonwealth marine area, seabed disturbance will occur from the laying of the pipeline and associated structures. There is no planned anchoring in the Commonwealth marine area, except as required for contingency/ emergency events, as Project vessels will utilise dynamic positioning in these waters. There will be no trenching in the Commonwealth marine area and turbidity effects from disturbance of sediment due to the laying of pipeline and associated structures is expected to be very minor and temporary in nature.

The habitat within the Commonwealth waters Project area comprises bare sediments or sediment with a sparse biota of filter feeders (e.g. soft coral) and crinoids (Heyward et al 2017, RPS 2022a; **Appendix B**). This type of habitat is ubiquitous for the region (Heyward et al 2017) and therefore the disturbance to seabed is not expected to have any significant impact on the diversity of seabed habitats or ecosystem functioning on a broader scale. The installation of pipeline and associated structure will provide hard substrate which will likely be used as attachment point for biota (e.g. sessile filter feeders) and therefore may locally increase epibiota density.

The disturbance of seabed will not impact the features of the Shepparton Shoal, ~3km west of the pipeline at its closest point or the key ecological feature of Carbonate Bank and Terrace System of the Van Diemen Rise, which at its closest point is ~7.5km east of the pipeline end.

4.2.2 Light Emissions

Project vessels will be working 24 hour/day and require external lighting to provide a safe working environment and to comply with relevant maritime navigation requirements at night. Light spill from project vessels has the potential to create localised impacts to marine fauna through behavioural disturbance such as attraction, disorientation and misorientation. Given light spill is a known threat to marine turtle behaviours such as nesting and hatchling orientation and the Project area intersects area designated as habitat critical for the flatback turtles, and flatback turtle BIAs, the assessment of impacts from light spill will focus primarily on marine turtle impacts.

The Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE 2017a) highlights artificial light as a threat to marine turtles. Specifically, the plan indicates that artificial light may reduce the overall reproductive output of a stock, and therefore recovery of the species, by:

- Inhibiting nesting by females.
- Disrupting hatchling orientation and sea-finding behaviour.
- Creating pools of light that attract swimming hatchlings and increase their risk of predation.

As stated in the National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (CoA 2020) most hatchling turtles emerge at night and must rapidly reach the ocean to avoid predation. Hatchlings locate the ocean using a combination of topographic and brightness cues, orienting towards the lower, brighter oceanic horizon and away from elevated darkened silhouettes of dunes and/or vegetation behind the beach. They can also find the sea using secondary cues such as beach slope. Sea finding behaviour may be disrupted by artificial lights which interfere with natural lighting and silhouettes. Artificial lighting may adversely affect hatchling sea finding behaviour in two ways: disorientation - where hatchlings crawl on circuitous paths; or misorientation - where they move in the wrong direction, possibly attracted to artificial lights. On land, movement of hatchlings in a direction other than the sea often leads to death from predation, exhaustion, dehydration, or being crushed by vehicles on roads.

4.2.2.1 Darwin Harbour light impact assessment

Pendoley Environmental (2022b; **Appendix E**) undertook a desktop assessment of project vessel lighting impacts to marine turtles in Darwin Harbour (including trenching, pipelay and other vessels) which also included a summary of available information on turtle nesting in Darwin Harbour and the significance of sites on a regional scale. In particular, the assessment focussed on potential impacts to flatback turtle nesting and hatching at Casuarina Beach and Cox Peninsula beaches, the closest known nesting beaches to the Project area. The assessment divided vessel activity into five scenarios/ zones, representing different stages or types of Project activity (**Figure 4-1** and **Figure 4-2**). **Figure 4-1** illustrates that turtles using Casuarina and Wagait beaches will not have line-of-sight visibility of vessels within the harbour (Scenarios 1 and 2) and so are at little to no risk from exposure to vessel lighting in these areas. The outer harbour approach (Scenario 4, **Figure 4-2**) and spoil disposal area (Scenario 5, Figure 4) are 10 – 20 km from potentially impacted beaches. Over that distance, vessel lights will produce a relatively small amount of sky glow, similar in appearance to the vessels that currently use the existing offshore vessel anchorage area (visible in **Figure 4-2** and labelled in **Figure 4-3**). Pendoley

Environmental (2022b; **Appendix E**) concluded that the impact is not being currently observed from the vessel anchorage area, then it is unlikely Project vessels will cause any additional detectable impact.

The greatest risk of exposure was determined to occur when vessels are operating in the harbour mouth (Scenario 3, **Figure 4-2**) during the May to October nesting season peak. Vessels at this location will be ~12 km away from Casuarina Beach and 2 – 8 km from the Wagait and Mandorah beaches. However, the risk of impact was considered low due to the low number of turtles, nests and successfully emerged hatchlings on theses beaches, the short duration of trenching activities (i.e. expected to be limited to within one nesting season) and the large amount of urban and City light which is likely to mask vessel lighting rendering it indistinguishable from existing lighting. Project vessel lights are likely to merge with large amount of light from Darwin and the harbour when viewed from Mandorah and Wagait, also rendering them indistinguishable from the onshore lighting.

The assessment concluded overall that marine turtles that use Darwin Harbour beaches will be at low risk of impact from Project vessel lighting due to the relatively short duration of dredging and pipelay activities, and the amount of existing light pollution within Darwin Harbour and city.

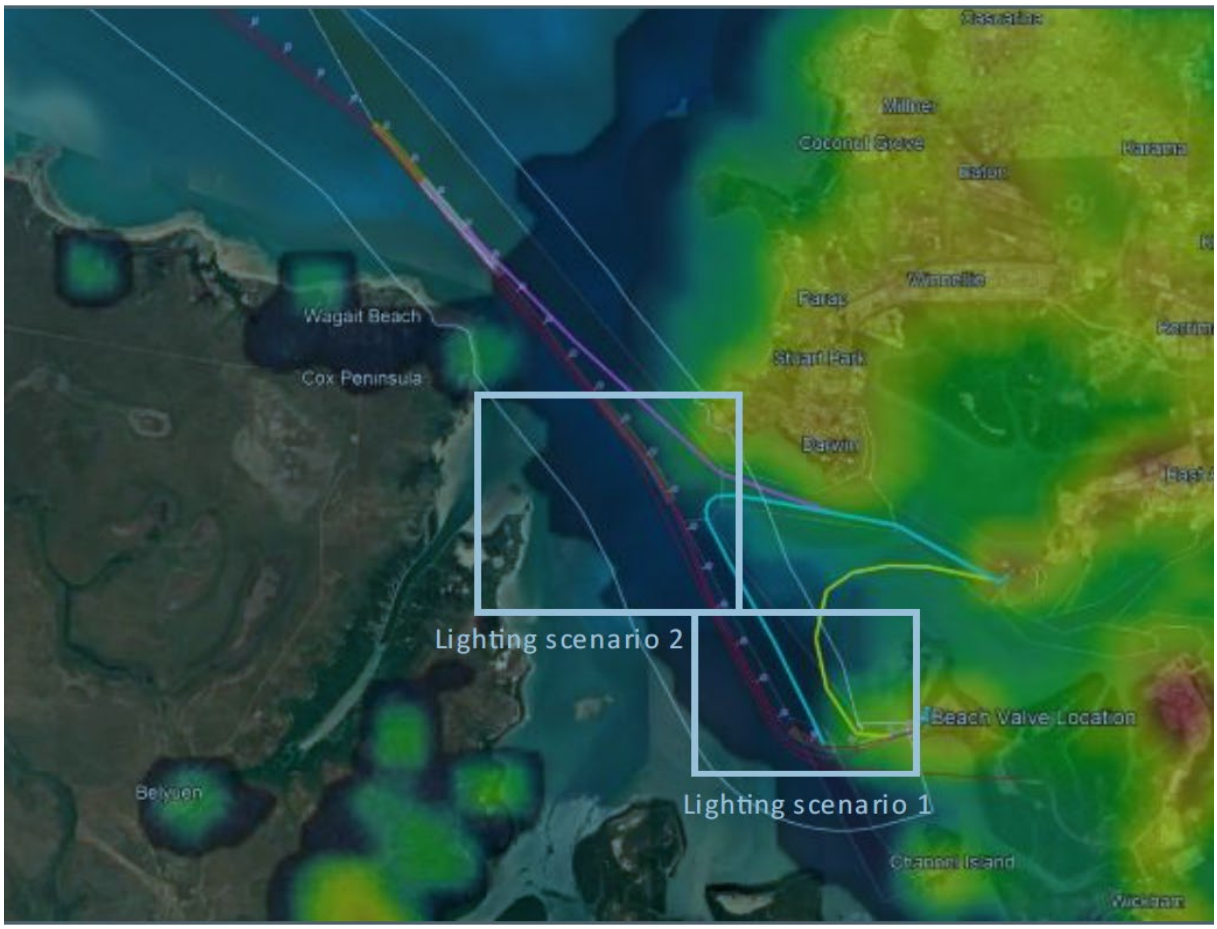


Figure 4-1: Vessel Presence Zones in Darwin Harbour

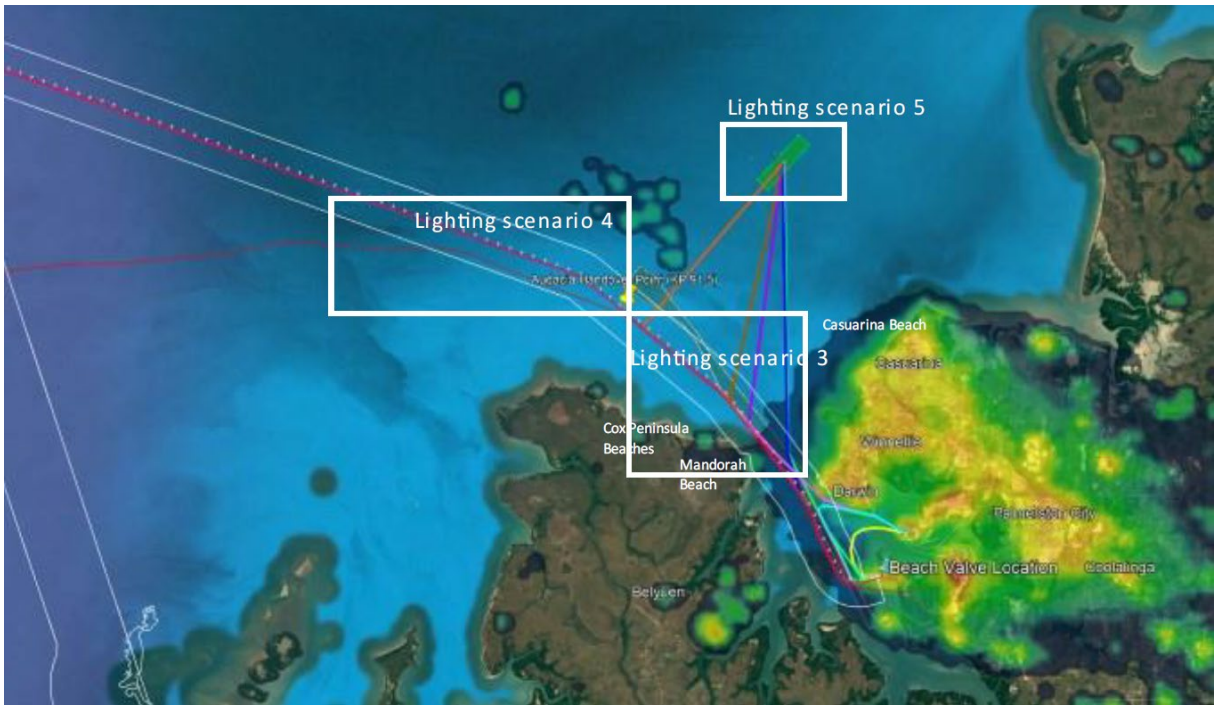
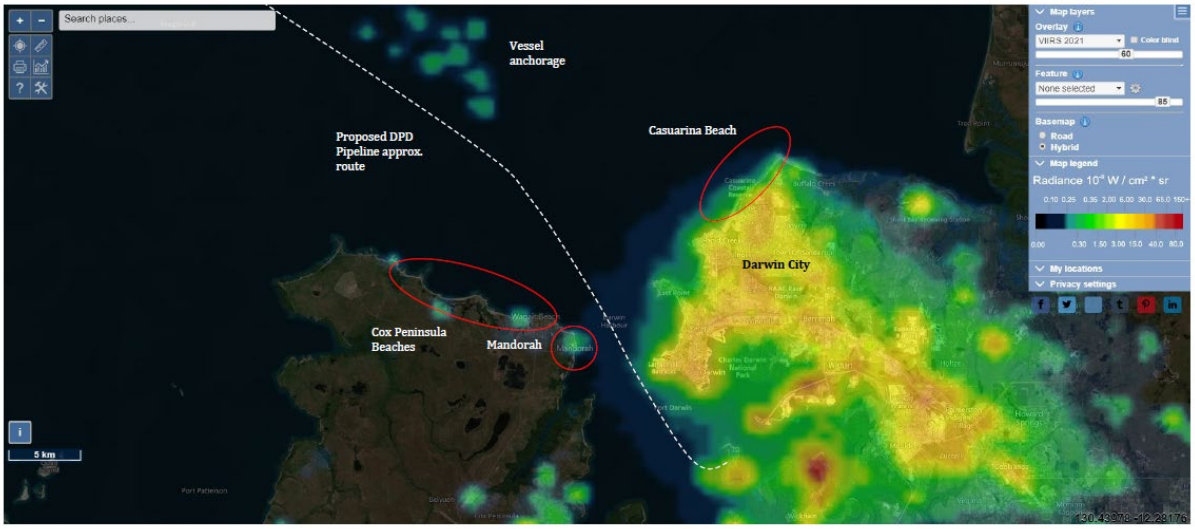


Figure 4-2: Vessel Presence Zones Approaching Darwin Harbour



Source: www.lightpollution.info, accessed 1 April 2022

Figure 4-3: 2021 Visible infrared imaging radiometer suite map and Darwin Harbour turtle nesting beaches

4.2.2.2 Deepwater pipelay and construction vessel light modelling assessment

Light modelling has been conducted by Pendoley Environmental (2022a) for the proposed offshore pipelay vessel (greatest level of light spill of project vessel fleet) and construction vessel as well as a cumulative assessment (combined light spill) of both vessels side-by-side. This scenario is not representative of vessel operating in Darwin Harbour (since a smaller shallow water pipelay barge will be used) but represents light spill associated with pipe laying and construction in Commonwealth waters. It provides information that can be used to assess potential impacts of light spill of the pipelay vessel to the closest regionally significant flatback turtle nesting site at Cape Fourcroy on Tiwi Islands (~25 km from the closest part of the Project area). ILLUMINA light modelling was undertaken for three scenarios associated with the project activities. The worst-case modelled light spill in Commonwealth waters is based on the combined offshore pipelay and construction vessels (Pendoley Environmental, 2022a) and identified that behavioural impacts are limited to ~4.5km. Hence light spill will not impact Cape Fourcroy which is also are outside of the National Light Pollution Guidelines 20km buffer (CoA 2020).

4.2.2.3 Significance of impacts to MNES species

Pendoley Environmental (2022b, **Appendix E**) concluded that with respect to Project vessel lighting in Darwin Harbour there was no discernible risk of the Project causing a significant impact to the Arafura Sea flatback turtle genetic stock based on presently and publicly available data. This conclusion was based on the short-term nature of the Project, the low nesting effort on potential impact beaches, and their low reproductive value relative to other rookeries within the wider genetic stock.

With respect to light spill impacts from the deep water pipelay vessel and construction vessel working along deeper sections of the Project route to the PLET in Commonwealth waters, light spill is not expected to effect turtle nesting or hatchling survival at the regionally important beach at Cape Fourcroy on Tiwi Islands (~25 km from offshore extent of Project area). Light modelling conducted for the deep water pipelay vessel and construction vessel demonstrated that light spill at an intensity that could lead to turtle behavioural effects would be limited to within 4.5km of the vessels, even when working side by side (Pendoley Environmental, 2022a).

Therefore, on the basis of the studies completed, it is well supported to conclude that there will be no significant impacts to turtle populations from project vessel lighting anywhere within the Project area. Project vessel light spill to the marine environment will, however, be reduced as far as practicable as per control measures identified in Section 5.1, while maintaining safety and navigational requirements for vessel lighting.

4.2.2.4 Significance of impacts to Commonwealth marine area

The worst-case potential impact from light spill in Commonwealth is behavioural disruption to marine turtles during the critical life-cycle phases of nesting and hatching. However, light spill modelling undertaken (Pendoley Environmental, 2022a) shows that light spill will reduce to a level that is considered behaviourally insignificant to marine turtles within a worst-case distance of 4.5 km. The Project area is well offshore (~25 km) from the closest significant flatback turtle nesting beaches at Cape Fourcroy and therefore significant impacts are not expected.

Other behavioural interactions with fauna in the Commonwealth marine environment include attraction of seabirds and fish to vessel light spill. Given the temporary nature of project activities and there being no aggregation areas or critical habitats for fish or birds nearby the Project area, such interactions are not expected to be significant on a population scale.

4.2.3 Underwater Noise

There will be a period of increased noise emissions during construction activities due to the operation of vessels and equipment, operation of survey and positioning equipment and from helicopters supporting the installation activity. Underwater noise emissions will be temporary and relatively short in duration as vessels move along the linear construction corridor. During operations, the only noise emissions will be vessel-based and indistinguishable from any other vessel activity within and on the approach to Darwin Harbour. As such, noise emissions during operations are unlikely to have a significant impact on marine mammals.

Noise associated with vessel activity that could impact marine fauna includes noise generated by vessel thrusters, engines and propellers, as well as noise emitted onboard which is converted to underwater noise through the hull (i.e., from heavy machinery, pipe construction works). The main source of vessel noise will be from propellers or thrusters.

Helicopters will also generate noise and the main source of noise emissions from helicopters is the engines and the rotor blades. Strong underwater sounds are detectable for only brief periods when a helicopter is directly overhead during take-off and landing (Richardson et al. 1995).

Noise will also be generated during the Project from trenching, installation activities including span rectification activities, placement of the Project pipeline and stabilisation and protection structures (including mattresses and rock placement).

If a cofferdam is required to be constructed at the shoreline crossing, then sheet piles may need to be hammered in using a vibro-hammer. Compared to piling for a jetty or similar, sheet piling generally requires more frequent strikes from a much lower energy hammer and therefore the risk of noise impacts is lower than for more substantial pile driving. The cofferdam is planned to be constructed above the water line, i.e., working up and down the shoreline with the tide, which will reduce propagation of sound underwater and reduce exposure to marine receptors.

Underwater noise emissions have the potential to affect marine mammals as they use sound for a range of functions such as social interaction, foraging and orientation. Responses and effects depend

on a number of factors, including distance from the sound source, water depth and bathymetry, the animal's hearing sensitivity, type and duration of sound exposure and the animal's activity at time of exposure. Broadly, the effects of sound on marine fauna can be categorised as:

+ Acoustic masking – Anthropogenic sounds may interfere with, or mask, biological signals, therefore reducing the communication and perceptual space of an individual.
+ Behavioural response – Behavioural impacts will depend on the audible frequency range of each potential receptor in relation to the frequency of the noise, as well as the intensity of the noise. Behavioural changes vary significantly and may include temporary avoidance, increased vigilance, reduction in foraging and reduced vocalisations.
+ Physiological impacts – Auditory threshold shift (temporary and permanent hearing loss) – marine fauna exposed to intense sound may experience a loss of hearing sensitivity, or even potentially mortal injury. Hearing loss may be in the form of a temporary threshold shift (TTS) from which an animal recovers within minutes or hours, or a permanent threshold shift (PTS) from which the animal does not recover.

4.2.3.1 Underwater noise modelling

Project-specific underwater noise modelling has been undertaken by specialist noise modelling consultant, Talis (2022) which provides an assessment of the underwater ranges to hearing impairment (PTS and TTS) and behavioural change for marine turtles and marine mammals (inshore dolphins and dugongs). The noise modelling addresses sheet piling for a potential shore crossing cofferdam (**Figure 4-4**; shoreline) and trenching activities including rock breaking by hydraulic hammering and uses thresholds for MNES species discussed with the Department of Climate Change, Energy, the Environment and Water (DCCEEW). The pipeline trenching scenarios have been modelled at three representative locations (**Figure 4-4**).:

+ Location 1 - BHD excavating and rock breaking (hydraulic hammering) in an area of hard rock;
+ Location 2 - TSHD near Weed Reef (reef supporting a mixed benthic community including hard coral and algae);
+ Location 3 - TSHD near Wagait Beach and Mandorah (low density turtle nesting beaches on Cox Peninsula)

A cumulative assessment of a CSD and TSHD working side-by-side at Location 3 was also undertaken.

Modelling of 24-hour sound exposure level (SEL_{24h}) was conducted for each scenario to provide a conservative determination of PTS and TTS ranges from the cumulative effect of noise to marine fauna of interest over a 24-hour period. This modelling method is considered industry leading practice and is a conservative way of estimating potential effect ranges, as SEL_{24h} assumes the receptor (i.e. fauna) is stationary within the noise field of the noise source. In reality, the marine fauna of interest are highly mobile species which move naturally throughout the harbour and are capable of moving away from a noise source.

Pipeline trenching and associated noise emissions will not be constant over a 24-hour period, as such, noise duration and cycle times for trenching activities have been modelled as follows:

+ BHD noise – 4 hours of hammering (impulsive noise), 4 hours no noise (switching between hammer and excavating tools) and 4 hours digging (non-impulsive, i.e. continuous noise) over a

12-hour period and repeated (2x 12-hour cycles per 24 hours) i.e., cumulative total of 8 hours each of hammering, digging and no noise.

+ TSHD noise – cycle times dependent on distance from spoil ground but nominally have been modelled as 3 hours dredging noise (non-impulsive noise, i.e. continuous noise), 2 hours transit to spoil ground and back (i.e. 'no noise' period) repeated over period of 24 hours.
+ CSD noise – 10 hours cutting (non-impulsive, i.e. continuous noise), 2 hours downtime over 12 hours (2x 12-hour cycles per 24 hour).

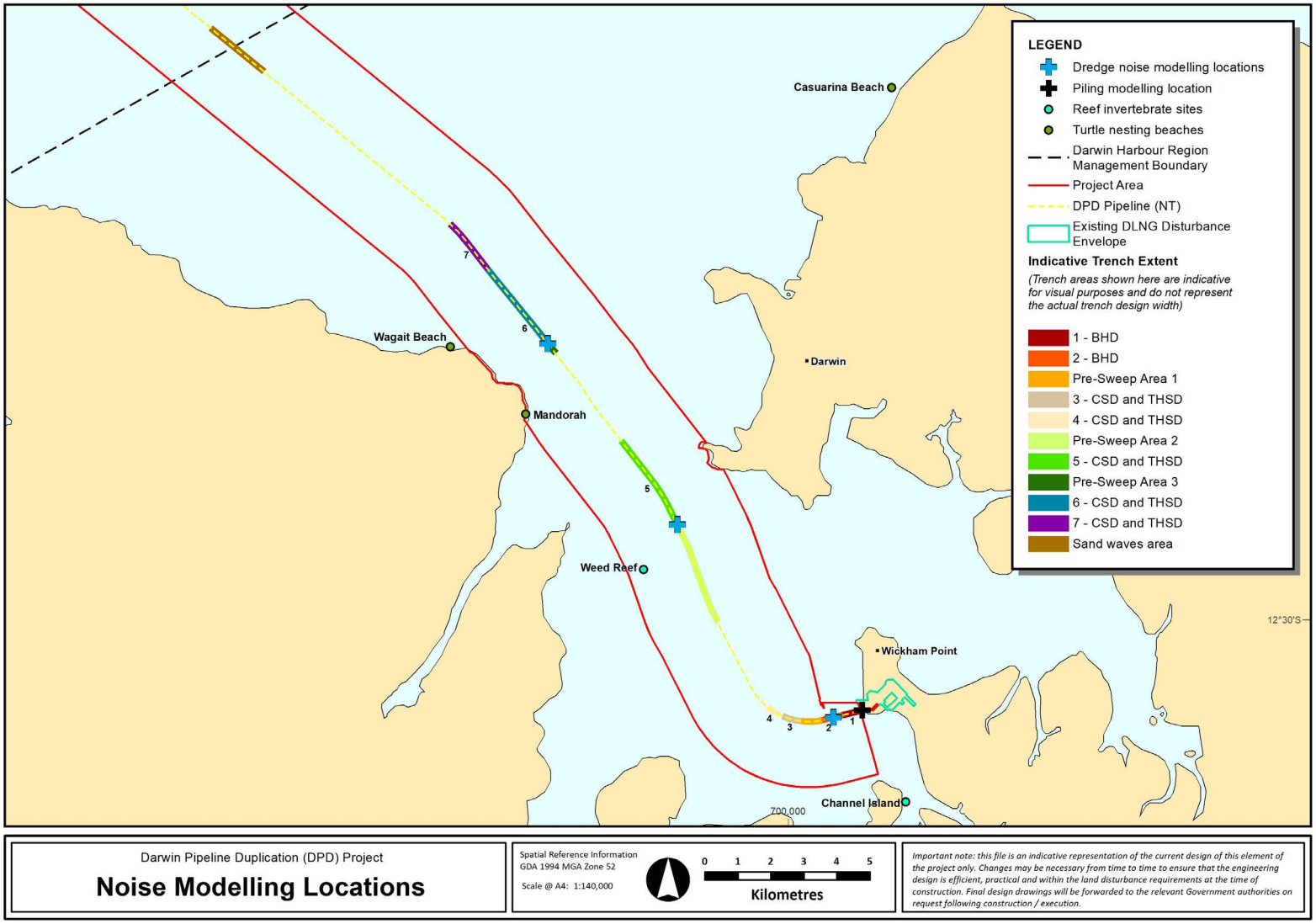


Figure 4-4: Location of noise modelling scenarios for DPD Project pipeline trenching and potential sheet piling activities

SEL_{24h} modelling was conducted based on a Mean Sea Level (MSL) over a 24-hour period to represent average water level throughout the daily tidal cycle. This was considered the most appropriate approach for SEL_{24h} modelling (in comparison to modelling over low or high tide water levels) since tide state varies significantly between low and high tide over a 24-hour period in Darwin Harbour (typically up to a ~6 m range) and low and high tides are not representative of water level over a duration of 24 hours (rather they represent extreme water levels present for short periods of time within a tidal cycle). Modelling of Sound Pressure Level (SPL) which represents an instantaneous level of noise (in contrast to SEL) has been used for determining behavioural impact ranges to fauna. For SPL modelling, modelling at high and low tide (as well as MSL) was considered appropriate to give the extremes (upper and lower ranges) in behavioural impact ranges. Highest Astronomical Tide (HAT) and Lowest Astronomical Tide (LAT) were conservatively used as water levels to represent high and low tide states, respectively, although these extremes are rarely reached. Between LAT of 0.0 m and a HAT of 8.0 m, low and high tides are on average (mean level) 2.2 m and 5.9 m, respectively as shown in **Table 4-1** (Williams et al. 2006).

Table 4-1: Tide heights within Darwin Harbour

Tide	Height above LAT
Highest Astronomical Tide (HAT)	8.0 m
Mean High Water Springs	6.9 m
Mean High Water	5.9 m
Mean High Water Neaps	4.9 m
Mean Sea Level (MSL)	4.0 m
Mean Low Water Neaps	3.1 m
Mean Low Water	2.2 m
Mean Low Water Springs	1.2 m
Lowest Astronomical Tide (LAT)	0.0 m

Table 4-2 presents PTS, TTS and behavioural thresholds for marine mammals (dolphins and dugongs) and marine turtles derived from contemporary studies and used to interpret modelling results. Where applicable, specific thresholds for continuous and impulsive noise have been provided. For turtles, a risk-based range of Low, Medium and High as outlined in Popper et al. (2014), rather than numerical thresholds was considered more appropriate for determination of continuous noise behavioural effects. Low, Medium and High risk rankings are based on fauna being present near the noise source (i.e. on a scale of 10s of metres).

Table 4-2: Behaviour, TTS and PTS onset thresholds for non-impulsive and impulsive noise

Marine fauna type	Marine mammal hearing group	Hearing bandwidth	Noise type	SEL_{24h} onset (weighted) dB re 1µ $Pa^2.s$		Possible behavioural disturbance SPL (dB re 1µ Pa)
				TTS	PTS	
Dolphins	High frequency	150 Hz to 160 kHz W(MF)	Non-impulsive	178	198	120
			Impulsive	170	185	160
Dugongs	Sirenians – Low frequency	100 Hz to 50 kHz	Non-impulsive	186	206	120
			Impulsive	175	190	160
Turtles	N/A	10 Hz to 2 kHz	Non-impulsive	200	220	Risk (Low, Medium, High)
			Impulsive	189	204	166

Threshold references

Finneran, J.J., Henderson E., Houser D.S., Jenkins K., Kotecki S., and Mulsow J. (2017). Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). pp.183.

McCauley, R.D., Fewtrell J.,. Duncan A.J, Jenner C., Jenner M.N., Penrose J.D., Prince R.I.T., Adhitya A., Murdoch J. (2000a). Marine seismic surveys: A study of environmental implications. Australian Petroleum Production Exploration Association (APPEA) Journal 40(1): pp. 692-708.

McCauley, R.D., Fewtrell J., Duncan A.J., Jenner C., Jenner M.N., Penrose J.D., Prince R.I.T., Adhitya A., Murdoch J. (2000b). Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Report Number R99-15. Prepared for Australian Petroleum Production Exploration Association by Centre for Maine Science and Technology, Western Australia. pp.198.

Popper, A.N., Hawkins A.D., Fay R.R., Mann D.A., Bartol S., Carlson T.J., Coombs S., Ellison W.T., Gentry R.L. (2014). Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014. Springer Briefs in Oceanography. ASA Press and Springer.

4.2.3.2 Underwater noise modelling results

Table 4-3 presents the threshold ranges at MSL between the noise source and the modelled PTS and TTS SEL_{24h} threshold contours for each fauna group for each of the modelled scenarios.

For all scenarios and fauna groups, PTS SEL_{24h} threshold ranges were below 50 m with the exception of the BHD impulsive noise (hammering) scenario for dolphins (70 m). These results indicate that dolphins, dugongs or turtles would have to be within close range (<50-70 m) to the trenching or piling activity over a 24-hour period for a permanent hearing injury to occur. This is considered highly unlikely given the known mobility of these species.

TTS SEL_{24h} threshold ranges at MSL varied across scenarios and fauna groups, between a low of <50 m and a high of 350 m (**Table 4-3**). Ranges were generally higher for non-impulsive dredging vessel scenarios and were greatest for a THSD and CSD working side-by-side (160-350 m). For the THSD, the ranges were similar at Location 2 and Location 3 (131-303 m and 120-303 m, respectively). Cofferdam piling had the lowest range (up to 85 m), followed by Backhoe Dredge hammering (up to 200 m). For non-impulsive noise scenarios, the largest TTS onset ranges were for dolphins (150-350 m), followed by dugongs (100-210 m) and Turtles (80-160 m). For impulsive noise scenarios, dugongs had the greatest ranges (85-200 m), followed by dolphins (53-145 m) and Turtles (<50 m). While ranges for TTS hearing effects are higher than PTS ranges, they are still considered relatively small in comparison to the mobility of the species. Furthermore, it is highly unlikely that dolphins, dugongs or turtles would remain within the TTS ranges for a period of 24 hours for temporary hearing effects to occur. If of concern, they would most likely exhibit behavioural responses and move away from the noise source.

Table 4-3: PTS and TTS SEL_{24h} threshold ranges for each fauna group for each modelled scenario at MSL

Fauna group	Sound Exposure Level (SEL_{24h}) PTS and TTS Thresholds (dB re 1µ Pa^2.s)		Threshold Range (metres) at MSL	
	TTS	PTS	TTS	PTS
Location 1 – BHD non-impulsive noise				
Turtles	200	220	80	<50
Dugongs	186	206	100	<50
Dolphins	178	198	151	<50
Location 1 – BHD impulsive noise (hammering)				
Turtles	189	204	<50	<50
Dugongs	175	190	200	<50
Dolphins	170	185	145	70
Location 2 – TSHD				
Turtles	200	220	131	<50
Dugongs	186	206	170	<50
Dolphins	178	198	303	<50
Location 3 – TSHD				
Turtles	200	220	120	<50
Dugongs	186	206	200	<50
Dolphins	178	198	303	<50
Location 3 – TSHD and CSD side-by-side				

Fauna group	Sound Exposure Level (SEL_{24h}) PTS and TTS Thresholds (dB re 1µ Pa^2.s)		Threshold Range (metres) at MSL	
	TTS	PTS	TTS	PTS
Turtles	200	220	160	<50
Dugongs	186	206	210	<50
Dolphins	178	198	350	<50
Location 4 – Vibro-hammering (cofferdam piling)				
Turtles	189	204	<50	<50
Dugongs	175	190	85	<50
Dolphins	170	185	53	<50

Table 4-4 presents the threshold ranges at LAT, MSL and HAT between the noise source and the modelled behavioural SPL threshold contours for each fauna group for each of the modelled scenarios.

Table 4-4: Behavioural effect SPL threshold ranges for each fauna group for each modelled scenario at LAT, MSL and HAT

Receptor Type	Sound Pressure Level (SPL) Behavioural Threshold (dB re 1µ Pa)	Threshold Range (metres) at tidal state		
		LAT	MSL	HAT
Location 1 – BHD non-impulsive noise				
Turtle	Risk	Low	Low	Low
Dugong	120	303	454	909
Dolphin	120	303	454	909
Location 1 – BHD impulsive noise (hammering)				
Turtle	166	<50	151	302
Dugong	160	<50	100	200
Dolphin	160	<50	100	200
Location 2 – TSHD				
Turtle	RISK	Low	Low	Medium
Dugong	120	1,450	1,667	20,000
Dolphin	120	1,450	1,667	20,000
Location 3 – TSHD				
Turtle	Risk	Low	Low	Medium

Receptor Type	Sound Pressure Level (SPL) Behavioural Threshold (dB re 1µ Pa)	Threshold Range (metres) at tidal state		
		LAT	MSL	HAT
Dugong	120	1,515	2,273	17,878
Dolphin	120	1,515	2,273	17,878
Location 3 – TSHD and CSD side-by-side				
Turtle	Risk	Low	Low	Medium
Dugong	120	3,000	3,181	20,000
Dolphin	120	3,000	3,181	20,000
Location 4 – Vibro-hammering (cofferdam piling)				
Turtle	166	<50	<50	NA
Dugong	160	<50	<50	NA
Dolphin	160	<50	<50	NA

NA=Not applicable – Vibro-hammering will only be done on dry intertidal zone on mid to low tide

Risk ranking is based on turtles being in close proximity (10s of metres) from noise source

For all scenarios and fauna groups, there was significant variation in behavioural effect ranges across the modelled tidal states. In particular, the modelled HAT behavioural effect ranges (200 m to 20 km) were considerably higher that the LAT ranges (<50 m to 3 km) and MSL ranges (<50 m to 3.2 km).

For dugongs and dolphins, the continuous noise scenarios resulted in LAT behavioural impact ranges of 303 m to 3 km and MSL behavioural impact ranges of 454 m to 3.2 km. The HAT results provided ranges of 909 m to 20 km. The smallest continuous noise ranges were for the BHD followed by the TSHD (Location 2 and 3) then the TSHD and CSD side-by-side. At MSL, these ranges were 454 m, 1.7-2.3 km and 3.2 km, respectively.

For turtles, behavioural effects from continuous noise have been based on a risk score (from Popper et al. 2014) which assumes the turtle is close (10s of metres) away from the noise source. With the exception of HAT for the TSHD scenario and TSHD and CSD working side-by-side scenario (both ranked as Medium risk for turtles close to the noise source) the risk score was ranked as Low for turtles near the noise source at LAT and MSL tidal states.

For impulsive noise (cofferdam sheet piling and BHD rock breaking), behavioural effect ranges were predicted to be much lower than those for continuous noise. For dolphins and dugongs, behavioural effect ranges at MSL were <50 m for sheet piling and 100 m for BHD hammering.

For turtles, behavioural effect zones were modelled to be <50 m for sheet piling and 151 m for BHD hammering. No results are provided for sheet piling at HAT since sheet piling will only occur above the water line within the intertidal zone and therefore a HAT scenario is not credible.

4.2.3.3 Comparison to existing Darwin Harbour underwater noise environment

Based on the behavioural effect ranges, there is the potential for species of interest (dolphins, dugongs and turtles) to be affected by noise from dredging vessels on a scale of 100s to 1000s of metres. These ranges are expected to be on a similar scale to large non-project commercial vessels that use Darwin Harbour on a daily basis, as they have similar noise source levels and operate in the same areas of the harbour. The modelled behavioural effect ranges for impulsive BHD hammering are lower i.e., in the range of 10s to 100s of metres. Given sheet piling will occur on dry land with a modelled behavioural effect range of <50 m, marine fauna behavioural effects are not expected from this activity.

The existing underwater noise environment within Darwin Harbour is influenced by noise from non-project commercial and recreational vessel traffic. Large commercial vessels, such as cargo ships, LNG tankers, cruise ships and offshore oil and gas vessels enter, exit and move around the harbour on a regular basis, as shown by vessel Automatic Identification System (AIS) screenshots (from the AIS Live program) provided in **Figure 4-5**. Vessel movements are concentrated along designated shipping channels and around berthing areas (**Figure 4-5**). The proposed DPD pipeline route and associated trenching areas are adjacent to these shipping channels and within the area of high-density vessel traffic shown in **Figure 4-6**.

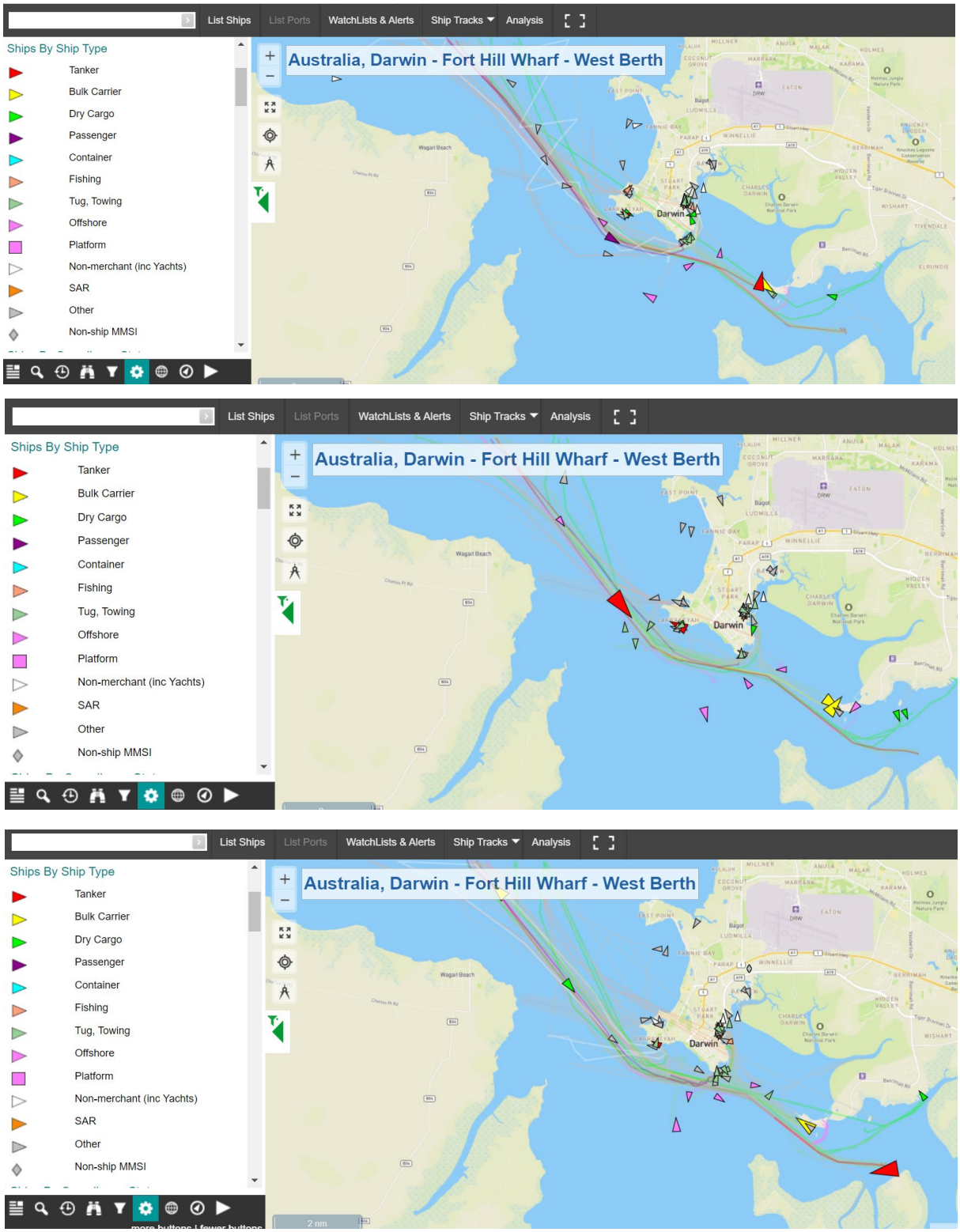


Figure 4-5: Vessel traffic by vessel type in Darwin Harbour on June 6, 7 and 8 2022 from AIS data (AIS Live)

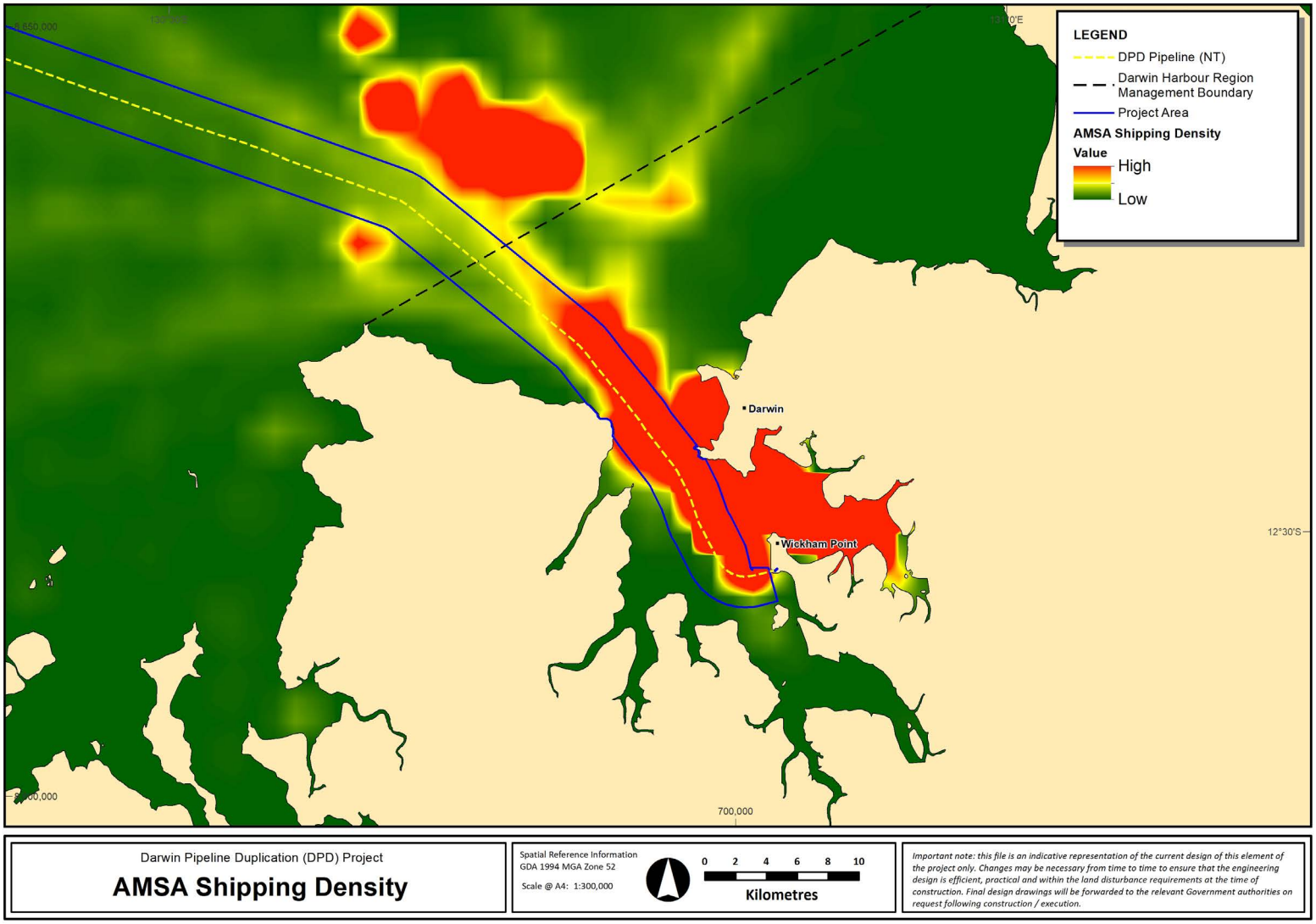


Figure 4-6: AMSA shipping density data for Darwin Harbour from January to May 2022

Indicative source levels for typical large commercial vessels using Darwin Harbour are provided in **Table 4-5** along with source levels from trenching vessels modelled for the DPD project. Trenching vessels (BHD, CSD, TSHD) are expected to produce noise intensities similar to large commercial vessels that use Darwin Harbour on a daily basis, including cargo ships, LNG tankers, cruise ships and offshore oil and gas vessels (**Table 4-5**).

Considering the similarity in noise intensity and area of operation between existing Darwin Harbour commercial vessels and DPD Project trenching vessels, the DPD Project is not expected to create underwater noise that is greater in intensity in comparison to existing shipping noise. The project will however provide a more constant noise source in areas of trenching activity, when compared to the typically transient nature of commercial vessel movements. Trenching will occur over an indicative 3-month period and will be 24h/day, notwithstanding spoil ground movements and scheduled/unscheduled downtime. Given the existing noise environment, it is expected that marine fauna will have developed some level of acclimatisation to vessel noise over a range similar to that modelled for the DPD Project. Underwater noise measurements undertaken by INPEX and provided within the Ichthys EIS show measured background noise levels within East Arm (an area of high-density vessel traffic) of 150-170 dB re 1 $\mu Pa^2/Hz$ (INPEX Browse 2011). Background noise of this intensity would likely create a 'masking' effect to additional noise sources (e.g. DPD Project vessels) thereby reducing detection and behavioural response ranges by fauna to the noise source.

Table 4-5: Indicative noise levels from typical Darwin Harbour vessels and DPD Project trenching vessels

Vessel Type	Source Level (dB)	Frequency	Reference
Tanker and bulk carriers	180-186	Low (10-30 kHz)	INPEX Browse 2011
Offshore vessels (e.g. rig tender vessels)	177	Broadband	INPEX Browse 2011
Powerboats with 80hp outboards (small recreational boats)	156-175	Broadband up to several kHz	INPEX Browse 2011
CSD	172-185	30Hz>-20kHz	Thomsen et al. 2009
TSHD	184-188	30Hz>-20kHz	de Jong et al. 2010 Robinson et al. 2011
BHD	175	30Hz>-20kHz	Reine et al. 2012

4.2.3.4 Significance of impacts to MNES species

Surveys within the harbour and surrounds identified highest density of dugongs in seagrass meadows at Casuarina Beach and Lee Point (Cardno 2015a) which are outside the behavioural effect ranges modelled for trenching vessels for all but highest tides (HAT). While dugongs are also known to forage in inner harbour locations, which may be close to or within behavioural effect ranges, such as shallow algae areas at Weed Reef and near Channel Island (INPEX Browse Ltd, 2011), the temporary nature of trenching vessel activities and presence of other foraging areas in shallow waters indicate that any behavioural effects would not likely be significant, nor significantly greater than those from existing non-project commercial vessels (of similar noise intensity) already using the harbour. The relevant significant impact criteria for noise impacts to dugongs (i.e. migratory species criteria) is as follows: "Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species". Given the limited behavioural effects to dugong foraging within Darwin Harbour from vessel noise, this criterion is not considered to be reached. With respect to the potential for hearing injury to dugongs, the modelled PTS/TTS 24-hour exposure ranges and known mobility of dugongs suggest that dugongs would not credibly be present within these ranges for periods long enough for these injuries to occur, regardless, observation and shutdown zones (with associated management actions) will be monitored to ensure this does not occur.

Three inshore species of dolphin (humpback dolphin, bottlenose dolphin, snubfin dolphin) all listed as migratory under the EPBC Act, utilise Darwin Harbour which is listed for all species as a BIA (breeding). Surveys have shown the presence of dolphin calves all year round, though suggesting a peak in calving between October and April (Palmer 2010). Surveys of dolphins within Darwin Harbour, Shoal Bay and Bynoe Harbour undertaken as part of the Coastal Dolphin Monitoring Program (Griffiths et al. 2020) found that the three species of dolphin occur in small, highly mobile groups and exhibit movements in and out of the harbour, including to the adjacent Bynoe Harbour and Shoal Bay. These surveys noted statistical declines in dolphin abundance in Darwin Harbour however could not attribute decline to any particular causal factor i.e., could not determine if this was related to natural environmental factors, population dynamics or anthropogenic causes. Broader scale surveys of NT waters have shown that the three species are distributed in coastal waters along the entire NT coastline at similar or higher densities to Darwin Harbour (Palmer et al. 2017).

The significant impact criteria relevant to noise impacts to dolphins (i.e. migratory species criteria) is as follows: "Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species". Given the high mobility of dolphins, the relatively small behavioural effect ranges (at typical tides) relative to the total area of Darwin Harbour and the relatively short duration of construction (and in particular trenching activities), the noise associated with DPD Project construction is not expected to create a significant disruption to the lifecycle of local populations of dolphins using Darwin Harbour and surrounding NT waters. Given trenching vessel noise is of a similar noise intensity to existing commercial vessel traffic and operating in the same areas, the additional noise sources are not expected to create a significant increase to the overall underwater noise environment within the harbour.

As with dugongs, the modelled PTS/TTS 24-hour exposure ranges and known mobility of dolphins suggest that dugongs would not credibly be present within these ranges for periods long enough for these injuries to occur, regardless, observation and shutdown zones (with associated management actions) will be monitored to ensure this does not occur.

4.2.3.5 Underwater Noise Management Measures for MNES species

A Marine Megafauna Noise Management Plan for the DPD Project construction activities is currently being developed which will detail how risks to marine turtles and marine mammals (including inshore dolphins and dugongs) will be managed, including underwater noise. Marine fauna mitigation measures have been drafted through workshops and in consideration of the noise modelling results and are presented below.

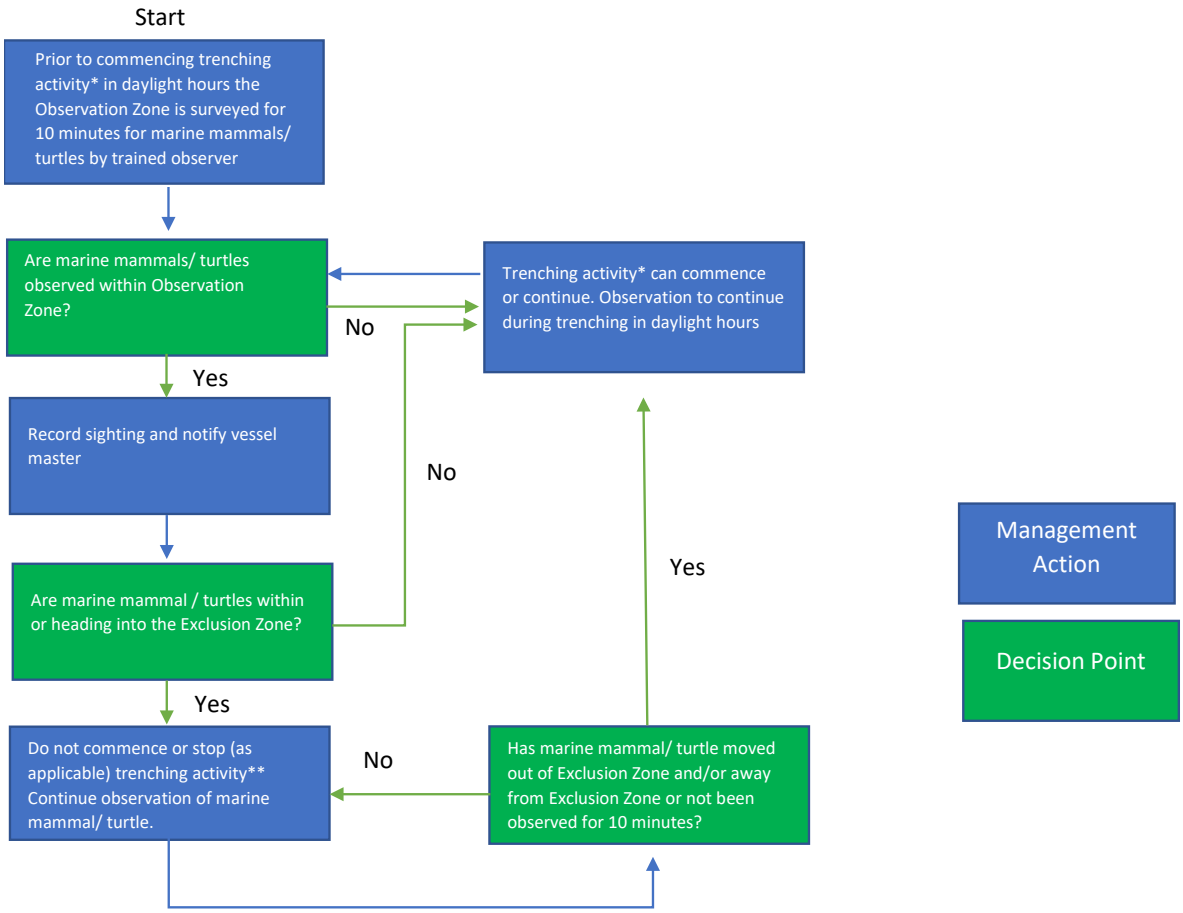
An Observation Zone of 150 m and an Exclusion Zone of 50 m has been proposed around trenching vessels engaged in trenching activities. This aligns with zones used for INPEX Ichthys dredging and construction works and with dolphin Caution Zones outlined in Part 8 of the EPBC Regulations 2000. The 150 m zone also provides an appropriate range for observing marine mammals and turtles that could potentially receive temporary hearing injury over a 24-hour period.

While DPD modelling results show that TTS ranges could extend to 350 m for dolphins at MSL, these are considered very conservative values given the known mobility and transient nature of dolphins within Darwin Harbour (Griffiths et al. 2019) and the very low likelihood of dolphins remaining within this range for a 24-hour period; a 150 m zone was considered sufficient on this basis and a more practical range for the observation of marine fauna by trained observers. For turtles, the proposed 150 m zone aligns with the TTS ranges at MSL. The 50 m Exclusion Zone aligns with PTS ranges for marine mammals and turtles (and with dolphin No Approach Zones under Part 8 EPBC Regulations) although it is inherently very unlikely these species would remain in such close proximity to a trenching vessel over a 24-hour period. Rather, the Exclusion Zone is considered to provide value in protecting marine fauna, in particular turtles, from direct interaction and injury from trenching equipment. Soft-starting equipment, where practicable, and the use of tickler chains on TSHD training arms are additional measures to mitigate this risk.

Marine fauna noise and vessel interaction controls include:

+ Personnel trained in marine fauna observation will be present on trenching vessels during daylight hours.
+ An Observation Zone of 150 m and an Exclusion Zone of 50 m for marine mammals and turtles will be in place around trenching vessels (TSHD, CSD and BHD) for trenching activities.
+ The *Marine Fauna Observation and Management Protocol for Trenching Activities* will apply to the Observation and Exclusion Zones (refer **Figure 4-7**).
+ A soft start (ramp-up) of hydraulic hammering (rock breaking) by BHD will apply.
+ A soft start (ramp-up) of trenching equipment, where practicable, will apply to the CSD and TSHD.
+ Use of turtle 'tickler' chains on the trailing arms of the TSHD.
+ Vessel movements will comply with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003), which ensures compliance with Part 8 of the EPBC Regulations 2000.
+ Vessels abide by Port of Darwin speed restrictions.
+ Vessel inductions will address marine fauna risks and the required management controls.
+ All marine fauna interactions and observations will be appropriately recorded and reported to relevant authorities.

DRAFT Marine Fauna Observation and Management Protocol for Trenching Activities



KEY

*Trenching activity means: BHD excavating or rock breaking, activation of CSD cutter head, activation of TSHD suction pump

**Not commencing or stopping trenching means the following:

- For BHD trenching – not commencing or stopping excavating or rock breaking activities
- For CSD trenching – not starting or stopping the cutter head
- For TSHD trenching – not starting or stopping the TSH suction pump

Observation Zone = 150m zone around vessel

Exclusion Zone = 50m zone around vessel

Figure 4-7: Draft Marine Fauna Observation and Management Protocol for Trenching Activities

4.2.3.6 Significance of impacts to the Commonwealth marine area

While vessels operating in the Commonwealth waters part of the Project area will create noise through use of vessel thrusters (dynamic positioning), other vessel equipment and through pipeline/seabed structure installation noise, the potential for significant noise impacts within the Commonwealth marine area is considered to be lower than within NT waters or Darwin Harbour given that key MNES

species susceptible to noise impacts (i.e. dugongs, dolphins and turtles) are expected to be less abundant and more transient in the Commonwealth water part of the Project area. Furthermore, vessels in this part of the Project area are expected to spend considerably less time than in NT waters and Darwin Harbour where activities will be additional activities (e.g. trenching, rock installation) and the pipelaying process will be slower.

4.2.4 Water quality

Key activities that may impact water quality are detailed below.

4.2.4.1 Trenching and spoil disposal

Temporary water quality impacts in Darwin Harbour and NT waters will occur from trenching and spoil disposal. These activities will create localise turbidity (suspended sediments in the water column) from the removal of sediments by dredging vessels and subsequent disposal of this spoil material at an offshore spoil ground (within NT waters). Turbidity created by trenching and spoil disposal can reduce the availability of light to photosynthetic biota on the seabed (hard corals, seagrasses, algae). Excessive sedimentation and/or prolonged reduction in light have the potential to cause mortality for these biota types. Importantly, the large tidal movements and strong currents in Darwin Harbour naturally generate high turbidity and sediment loads, particularly during spring tides, with spatial gradient observed in the harbour's water quality, with turbidity in the upper reaches higher than that of the outer harbour (ConocoPhillips 2019). Sediment dispersion modelling conducted to date (RPS, 2022c) indicates temporary excesses in turbidity outside of trenching zones or the spoil disposal ground will be within the range of natural turbidity experience within Darwin Harbour.

4.2.4.2 Contingency treated seawater discharge

Treated seawater discharges within Darwin Harbour and NT waters are not planned, with treated seawater used for FCGT activities planned to be discharged in Commonwealth waters at the PLET location (refer below). In the unlikely event of a wet buckle during pipe laying the pipeline may need to be preserved with treated seawater until such time that a repair can occur (refer **Section 2.4.3.10**). The filling and dewatering of treated seawater associated with responding to a wet buckle event would lead to discharges of treated seawater at the repair site. These discharges have been modelled and include a 600m^3 discharge over pumping scenario (release of treated sweater during pipeline filling) and pipeline dewatering scenarios (volume will depend upon length of pipeline being dewatered but three scenarios were modelled: 19,958 m^3 over 21.4 hours outside of Darwin Harbour; 10,623 m^3 over 11.4 hours at Darwin Harbour mouth and 4,400 m^3 over 4.7 hours in the inner harbour). Results have been compared to no observable effect concentrations (NOEC) derived from laboratory ecotoxicology studies and derived species protection levels. All results show that concentrations where species effects could occur did not persist for more than 48 hours (which is the typically exposure period used to determine NOE) but at a more conservative, shorter exposure time of 12 hours, 99% species protection levels were only exceeded in isolated patches within ~10 km of the discharge locations (RPS, 2022b; **Appendix D**). Based on exposure levels being less than 48 hours and the localised exceedances at 12 hours, significant impacts to water column biota or benthic habitats are not expected from contingency discharges.

4.2.4.3 Planned treated seawater discharge in Commonwealth waters

To implement flooding, cleaning, gauging and testing (FCGT) associated with pipeline pre-commissioning activities (**Section 2.4.3.8**), approximate 7,650 m^3 treated seawater discharge will occur at the DPD Pipeline PLET. On completion of FCGT, the flooded pipeline will be dewatered and conditioned with mono-ethylene glycol (MEG). The dewatering activities will result in approximately 50,000 m^3 of treated seawater and approximately 1,000 m^3 of MEG separately discharged at the DPD Pipeline PLET. In addition, nominal amounts of MEG and seawater will be discharged during the spool leak testing between the DPD Pipeline PLET and the Barossa GEP PLET (Refer to **Table 2-4**).

Monoethylene glycol (MEG) (CAS number 107-21-1) is a colourless, odourless, involatile, hygroscopic liquid. It is characterised by two hydroxyl groups, which contribute to its high water-solubility, hygroscopicity and reactivity with many organic compounds. MEG is on the OSPAR PLONOR (poses little to no risk to the environment) list and is therefore deemed safe to discharge to the marine environment. MEG is soluble in water, does not volatilise or undergo photodegradation, and is not adsorbed on to soil particles (Hook and Revill, 2016). Ethylene glycols biodegrade readily when released to the environment, and several strains of micro-organisms can use them as an energy source.

Treated seawater is seawater conditioned with a hydrotest mixture comprising biocide, oxygen scavenger, corrosion inhibitor and leak detection dye. The typical dosage rate is up to 550 mg/L using products similar to Roemex Hydro 4 and Hydrosure. Santos's chemical risk assessment process determined that Roemex Hydro 4 and Hydrosure can be used interchangeably as their chemical composition and concentration profile is similar. For the purposes of this risk assessment, Australian marine species toxicity data for Hydrosure components were used (**Table 4-7**). The constitute components of the hydrotest chemical package do not persist or accumulate within the marine environment. The mixture is therefore considered biodegradable with negligible potential for bioaccumulation.

The toxicological effects to marine organisms in the receiving water from the discharge were modelled and assessed (RPS, 2021; **Appendix C**). **Table 4-6** presents the modelling parameters applied at the PLET subsea discharge of the treated seawater volume. A 57,000 m^3 discharge was modelled over 35 hours (planned discharge volume is approximately 50,000 m^3).

Table 4-6: Summary of model parameters used in the modelling for the PLET seabed discharge

Parameter	Value/design
Maximum discharge volume	57,000 m^3
Discharge duration	35 hours
Model run duration	3 days
Discharge depth (m)	3.5 m above the seafloor
Diffuser configuration	Three 4" ports spaced 4" apart and oriented 45° vertically upwards
Exit diffuser velocity (m/s)	21.3
Hydrotest water temperature (°C)	28.2 - same as ambient
Hydrotest water salinity (psu)	34.6 - same as ambient
Initial chemical treatment concentrations	550 mg/L

For the stochastic modelling undertaken, one run of the 25 simulations (all different metocean conditions) resulted in exposure to the shoulder of Shepparton Shoal south of the release location which represents a 4% probability of exposure at the no observed effect concentration (NOEC) species protection concentration (PC) 90% (0.15 ppm or mg/L).

The NOEC values for the varying species protection levels and the dilutions to achieve the concentration based on a dosage of 550 ppm Hydrosure are presented in **Table 4-7**.

Table 4-7: Dilutions of Hydrosure required to fall below NOEC values for varying species protection levels

Species protection level	NOEC threshold (mg/L) (from Chevron 2015)	Dilutions required to achieve the NOEC threshold based on Hydrosure dosing concentration of 550 mg/L
PC99%	0.06	1:9,167
PC95%	0.10	1:5,500
PC90%	0.15	1:3,667
PC80%	0.23	1:2,391

All results show that concentrations above species protection levels did not persist for more than 48 hours (which is the typically exposure period used to determine No Observable Effect) but exceedances were modelled at more conservative, shorter exposure time of 12 hours. **Figure 4-8** illustrates the extent of the predicted Hydrosure concentrations over a 12-hour exposure time based on all 25 simulations of the stochastic modelling.

The maximum distance from the release location to the PC99% of 0.06 ppm (or mg/L) was 7.23 km, and the maximum distance from the release location to the PC95% of 0.10 ppm (or mg/L) was 5.33 km. The maximum distance based on the PC80% (0.23 mg/L) did not exceed 0.2 km.

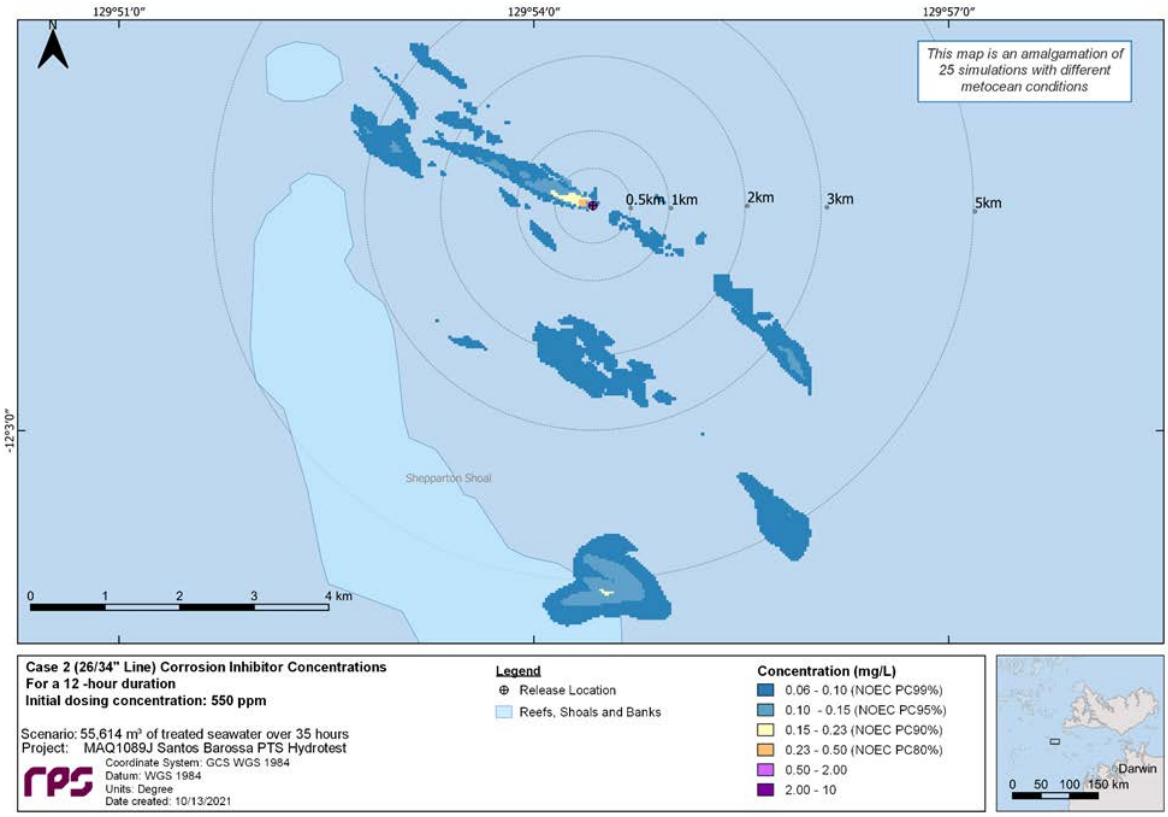


Figure 4-8 Maximum predicted Hydrosure concentrations assessed over a 12-hour continuous exposure period

The modelled results are considered to be conservative given the modelled Hydrosure discharge concentration was set at the dosing concentration of 550 mg/L. In practice, the Hydrosure concentration will biodegrade over time during the hydrotest and reduce in concentration within the pipeline. Therefore, Santos anticipates that discharge concentrations will be less than that modelled and mixing and dilution to NOEC PC90% (and other mixing zone boundaries) will occur closer to the discharge point than indicated by the modelling outputs.

For the 1,000 m^3 neat MEG conditioning discharge at the PLET the Australian and New Zealand Guidelines for Fresh and Marine Water Quality specify a marine low reliability trigger value of 50,000 µg/L (50 mg/L) for MEG in seawater. The World Health Organization (WHO) has reported a NOEC of 24,000 ppm for MEG. In accordance with the Organisation for Economic Co-operation and Development because three NOECs are described for three separate taxonomic groups, a safety factor of 10 was adopted for the protection of marine fauna and benthic habitats. Based on the NOEC provided by WHO a PNEC of 2,400 ppm (or 2,400 mg/L) was used to inform the concentration level above which there is potential to result in an environmental impact (Chevron 2020). Using the modelling data from the hydrotest water discharge at the PLET (see dispersion modelling above) where dilution of up to 10,000 occurs at Shepparton Shoal, this is of the order of 100 mg/L MEG concentration in the waters above the eastern edge of Shepparton Shoal for a one-off discharge, well below the PNEC toxicity value of 2400 mg/L. There will also be rapid biodegradation of MEG so no significant impact from the release of MEG is expected to the marine environment at the PLET.

4.2.4.4 Significance of impacts to MNES species

While trenching and spoil disposal will generate turbidity, the level of turbidity outside of trenching zones or the spoil disposal ground is expected be within the ranges of natural variability, based on sediment dispersion modelling conducted to date (RPS, 2022c), and therefore not expected to cause any loss of dugong or turtle foraging habitat (e.g. algae, seagrass habitat). A monitoring and management program, outlined within a Trenching and Spoil Disposal Monitoring and Management Plan (TSDMMP) will be in place to monitor changes in water quality (turbidity) and will include adaptive management measures in response to water quality triggers that would provide an early warning sign of potential impacts to benthic habitat.

An approved monitoring program was undertaken as part of the construction activities, including piling, dredging and spoil disposal activities, associated with the Ichthys project, as conditioned in EPBC Act approval of that project (EPBC 2008/4208). The Ichthys monitoring program did not detect any deleterious effects to turtle, dugong or dolphin distributions or population sizes in the Darwin region attributable to their dredging activities (Brooks and Pollock 2015; Cardno 2015a).

Treated seawater discharges associated with contingency pipeline filling and dewatering associated with a wet buckle event or planned FCGT and dewatering activities in Commonwealth waters at the PLET location, are not expected to impact MNES species (marine turtles, dolphins and dugongs). Treated seawater will rapidly dilute to levels that will not cause effects to these mobile species or any habitats on which they may forage (e.g. seagrass).

4.2.4.5 Significance of impacts to Commonwealth marine area

Plankton drifting past the PLET discharge location at the time of discharge may be exposed to concentrations above that which could elicit an effect. However, dilution of the plume is rapid and the exposure concentration travelling with the organism will continually reduce. There may be effects to some individuals, however, plankton are widely distributed in the ocean and regenerate rapidly.

Sediments are unlikely to be impacted as the release will be through a diffuser, three to four metres above the seabed and orientated vertically upwards.

No protected or sensitive benthic habitats have been identified with the potential to be exposed to the dewatering plume. The seabed consists predominantly bare sediments or sparse filter feeders **(Figure 3-7**). Large sensitive banks and shoals are too far away to be impacted (Santos 2022). Shepparton shoal is 3 km from the PLET at its closest point and the dewatering discharge dispersion modelling shows there is minimal residual concentration of Hydrosure in the water column, and there is no impact to the seabed.

4.2.5 Unplanned Events

4.2.5.1 Unplanned introduction of IMS

There is the potential for significant impacts to ecosystem health from the introduction of an invasive marine species (IMS) especially within Darwin Harbour. The introduction of IMS may result in considerable modification of the environment through out-competing native species and modifying existing habitats. Such modifications may result in significant environmental impact, including decrease in biodiversity, reduction in coastal aesthetics and overall ecosystem health, potentially negatively impacting MNES species.

Vessels are the most common vector for the translocation of IMS in the marine environment. IMS can be introduced or spread when vessels are mobilised to the Project area, particularly if the vessels originate from international waters with similar water temperatures (i.e., south-east Asia). IMS may be present as biofouling (i.e., adult sessile organisms) on vessel hulls and submersible equipment, and in vessel ballast water (i.e., as larvae).

IMS risks are well known, and Santos has internal company procedures and complies with Commonwealth legislation and industry standards to minimise the risk of introducing IMS to Australian waters across all its offshore operations (refer **Section 5.1**). Santos has for an extended period of time successfully applied these measures to its numerous offshore operations and consider the risk of introducing IMS to be low.

4.2.5.2 Unplanned marine fauna interaction

The risk of vessel strike to marine fauna is inherent to movements of all vessel types and is recognised as a threat to marine species of MNES.

The impact from vessel interactions with marine fauna can be as minimal as temporary behavioural changes, ranging to severe impacts, such as injury or mortality resulting from vessel strike. The potential risk of a collision with marine fauna is directly related to the abundance of marine fauna and number of vessels in the Project area, and the actual likelihood of a collision occurring is also influenced by vessel speed. As presented in DoEE's (now DCCEEW) National Strategy for Reducing Vessel Strike on Cetaceans and Other Marine Megafauna (DoEE 2017b), the majority of the reported vessel collisions have occurred along eastern or south-eastern Australia, with no reported incidences in NT waters. Additionally, a review of records of vessel collisions with marine megafauna reported a higher number of collisions with whale-watching boats, naval ships and container ships (DoEE 2017b).

Vessel speed has been demonstrated to be a key factor in relation to collision with marine fauna, particularly cetaceans and turtles, with faster moving vessels posing a greater collision risk than slower vessels (Hazel et al. 2009; Jensen and Silber 2004; Laist et al. 2001; DoEE 2017b). Laist et al. (2001) suggest the most severe and lethal injuries to cetaceans are caused by vessels travelling at 14 knots or faster.

Collisions with smaller cetaceans, such as dolphins, are very infrequent due to their high mobility allowing them to avoid vessels.

While dugongs may occur in the Project area, dugongs in the Darwin Harbour area spend most of their time in shallow tidal and subtidal seagrass meadows less than 10m water depth away from Project activities (Cardno 2015a).

Turtle/vessel interactions arising from increased vessel traffic is also recognised as one of several key impacts to marine turtles in the Recovery Plan for Marine Turtles in Australia (DoEE 2017a). In the recovery plan, vessel disturbance is identified as a risk to flatback turtles. The plan also notes that while a vessel strike can be fatal for an individual turtle, vessels strike (as a standalone threat) has not been shown to cause declines at a population or stock level and have considered vessel disturbance to be of minor consequence to turtle populations in the NT (DoEE 2017a). In the recovery plan, vessel disturbance is identified as a risk to flatback turtles. Approved Conservation Advice for *Dermochelys coriacea* (leatherback turtle) (DEWHA 2008) listed boat strike as a threat.

Project vessels present a potential risk to marine fauna. Due to the slow speed of the pipelay vessel (<1 knot) it is considered to be effectively immobile and therefore presents a very low likelihood of vessel collision with marine fauna. Other Project vessels (e.g. construction, pipe support, rock placement, 'dredging', etc.) will also move at slow speeds, will operate with Darwin Port speed limits and will be required to comply with Santos' marine fauna procedures which address the requirements of Part 8 of the EPBC Regulations 2000 and specific protocols for the observation and management of trenching operations within observation and exclusion zones. Santos consider the risk of adverse interactions with marine fauna to be low if conducted activities with these measures in place.

The likelihood of vessel strike will be no greater than for other vessels in Darwin Harbour and less so in deeper water including Commonwealth waters.

4.2.5.3 Unplanned marine diesel release

Of any potential spills associated with the Project, the accidental release of diesel from Project vessels (refuelling incident or vessel collision) was considered to have the greatest potential for impact to MNES. Other spills associated with vessel / ROV activities or onshore activities, such as minor spills of chemicals, fuels and hydraulic fluids are considered to have a lower potential for MNES impact and are prevented and mitigated through the adoption of standard practices and regulatory requirements (e.g. those implementing MARPOL) as included in **Section 5**.

With management measures in place the likelihood of a Project vessel incident resulting in a marine diesel spill (from vessel collision or refuelling spill) is considered to be low and not greater than other vessels using Darwin Harbour. Project vessel activities will be undertaken at slow speeds, lessening the potential and consequence for collision or grounding incidents and associated spills of diesel. Control measures will follow standard maritime practises as well as Project and Port of Darwin controls. As vessel-based activities are part of operations, the potential for an unplanned marine diesel release will remain during operations, although given operations support vessels are typically smaller than construction vessels the maximum potential volume of diesel spills will be lower.

Studies and field observations suggest that cetaceans may be able to detect and avoid hydrocarbon slicks (Geraci and St Aubin, 1988). Cetaceans are vulnerable to the effects of surface hydrocarbons due to the need to surface and breathe. Direct contact with surface slicks and inhalation of vapours may irritate eyes, airways and lungs. Lethal or sub-lethal effects will depend on the concentration of the hydrocarbons and the duration of exposure. Potential impacts to dugongs are expected to be similar to cetaceans given their sensitivity to hydrocarbon exposure is likely to be similar.

Marine turtles are susceptible to the effects of hydrocarbon spills during all life stages (National Oceanic and Atmospheric Administration 2014). They are in frequent contact with the sea surface and show little avoidance behaviour in response to the presence of surface hydrocarbons, which makes them vulnerable to coating and inhalation of toxic vapours.

Contact with surface slicks or entrained hydrocarbon can therefore result in hydrocarbon adherence to body surfaces (Gagnon and Rawson 2010) causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (National Oceanic and Atmospheric Administration 2014). Oiling can also irritate and injure skin which is most evident on pliable areas such as the neck and flippers (Lutcavage et al., 1995).

Given spilled diesel is expected to disperse and weather rapidly in the marine environment and in the ambient conditions, the potential for impacts to marine mammals would be expected to be concentrated around the release location. Oil Pollution Emergency Plans (OPEPs) for the Project will be in place that include Santos and Control Agency arrangements and response strategies (**Section 5.1**) informed by oil spill modelling results (RPS, 2022d). OPEPs will include oiled wildlife response arrangements applicable for local wildlife, including MNES species.

4.2.5.4 Unplanned dry gas release from pipeline rupture during operations

A worst-case pipeline rupture during operations would result in a release of 'dry' gas to the environment which would move towards the surface forming a large plume in the water column and dispersing into the atmosphere. Consequently, the gas cloud may result in impacts to air-breathing fauna, such as marine mammals, with the worst-case outcome for animals in the immediate vicinity of the release being asphyxiation, potentially resulting in mortality. Given the dispersion of gas into the atmosphere, this potential effect would be highly localised to the release location and short term while the gas supply is being isolated.

In consideration of pipeline engineering and installation design (e.g. pipeline specifications including coating, trenching, rock armouring, etc.) and mitigation measures (e.g. pipeline isolation and spill response), the potential of a dry gas release from a pipeline rupture during operations impacting marine mammals is considered to be low.

4.3 Potential Cumulative Impacts from Planned Activities

4.3.1 Seabed Disturbance

Given the pipeline route is close to existing pipelines (Bayu-Undan and Ichthys) and the linear disturbance footprint around the pipeline is narrow (~50 m) and away from significant benthic habitats and turtle nesting areas, potential cumulative impacts to marine mammals and reptiles from direct removal of habitat are not considered to be significant.

Based on pipeline route surveys and existing benthic habitat mapping (Heyward et al. 2017, Galaiduk et al. 2019; Udyawer et al., 2021, RPS 2022a; **Appendix B**) benthic habitats directly disturbed by the Project (e.g. pipelay) are considered to be well represented within the Darwin Harbour region as well as deeper waters of the Project area and surrounds and therefore the disturbance of seabed is not expected to add significantly to existing benthic habitat loss and disturbance within the Darwin Harbour area.

Effects of water quality from Project trenching and spoil disposal, and pipeline FCGT and dewatering discharges are expected to be short lived with turbidity and water quality levels returning to within natural variability levels within short temporal and spatial ranges.

Should other proponents be considering similar activities (e.g. construction or dredging activities) over similar locations and time frames to Project activities, Santos will work with other proponents to consider the potential for cumulative impacts and mitigation to as low as reasonably practicable.

4.3.2 Noise and Light Emissions

There is the potential for cumulative impacts with respect to other vessel activities within the Darwin Harbour area. Light and noise impacts from Project vessel activities are considered localised, relative to the distribution and movements of marine mammals and reptile species, and when compared to existing vessel activities occurring in and outside the Darwin Harbour, are not considered to result in a significant cumulative impact.

5 Measures to Avoid and Reduce Impacts

5.1 Management Summary

Santos is proposing to undertake the Project in a manner that that will ensure that impacts are avoided or reduced by mitigation measures to the extent that they will not be significant - that is, the action will be taken in a 'particular manner' (see proposed management measures summarised in **Section 5.2**). The energy sector has a history of successfully managing major construction projects in Darwin Harbour. The significant body of knowledge available together with the established effectiveness of previously implemented management measures provides confidence that the Project can be delivered without significant environmental impact.

Santos commits to implementing construction and operations environmental management plans to ensure impacts and risks to the receiving environment are acceptable and remain as low as reasonably practicable. A marine environmental monitoring program will be implemented to validate the environmental assessment, specific to construction activities. The environmental management plans and monitoring results will be publicly available.

Details of these plans and monitoring approach are provided in Section 12.1.2 in the Darwin Pipeline Duplication (DPD) Project NT EPA Referral (BAA-201 0003) (Santos 2021). These plans include:

+ A Trenching, Spoil Disposal Management and Monitoring Plan (TSDMMP)
+ An Acid Sulphate Soil Management Plan (ASSMP)
+ A Construction Environmental Management Plan (CEMP) for Project construction activities in NT waters and on land
+ A Pipeline Installation Plan for pipeline installation in Commonwealth waters
+ A Marine Megafauna Noise Management Plan (MMNMP)
+ An Operations Environmental Management Plan (OEMP) and an Operations Environment Plan for pipeline operations in NT and Commonwealth jurisdictions, respectively
+ Oil Pollution Emergency Plans (OPEPs) covering Project activities in NT and Commonwealth waters
+ Decommissioning Plan/s for Project pipeline decommissioning

Plans will be assessed and approved, as applicable, under relevant NT and Commonwealth petroleum legislation, that is under the following Acts:

+ Offshore Petroleum and Greenhouse Gas Storage Act 2006 and Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009.
+ NT Petroleum (Submerged Lands) Act 1981
+ NT Pipeline Energy Act 1981.

Draft versions of Environment Management Plans, including the Project CEMP, TSDMMP and MMNMP will be provided with Santos' DPD Project Supplementary Environmental Report (SER) for assessment by the NT EPA under the NT EP Act 2019.

5.2 MNES Management

Santos has included a focussed suite of management measures to manage potential MNES impacts in a 'particular manner' to provide certainty to reduce or avoid impacts on the matter(s) protected. The impact and risk assessment (Refer to **Section 4.2**) informed by the objectives and actions of the various recovery, threat abatement and management plans listed in **Sections 3.2.2** and **3.3.1** for relevant MNES species. The objectives for the plans identified are achieved by adopting the following management measures to avoid environmental impacts on MNES species or to reduce impacts to levels that are acceptable and as low as reasonably practicable (ALARP).

Avoid

- The pipeline corridor and shore crossing routes were selected due to the close (~50-100m) proximity to the pre-disturbed Bayu-Undan to Darwin pipeline route and the previously disturbed DLNG facility shore crossing location. Within Darwin Harbour the route avoids the rarer benthic primary producer habitat (e.g. seabed suitable for supporting hard corals and seagrass) primarily associated with shallower waters (<10m). The pipeline route in Commonwealth waters avoids the Shepparton Shoal raised seabed feature.
- Similarly, the spoil disposal ground was selected as it is adjacent to the spoil disposal ground approved for use by INPEX for the Ichthys project.
- Dedicated geophysical and benthic habitat surveys have been conducted and have been used to refine the pipeline route including avoiding raised seabed features.
- Dynamic Positioning (DP) pipelay vessel will be used in deeper water sections to eliminate seabed disturbance from an anchor spread.
- In shallower waters, anchors exclusion areas will be implemented to avoid sensitive habitats and heritage sites.
- Only marine diesel oil (MDO) or marine gas oil (MGO) will be used, thereby avoiding the risk of more environmentally persistent heavier fuel types, such as intermediate fuel oil (IFO) or heavy fuel oil (HFO), from being accidently released to the marine environment.
- Chemicals potentially discharged to sea are Gold/Silver/D or E rated through Offshore Chemical Notification Scheme, or PLONOR substances listed by OSPAR, or have a complete risk assessment as per Santos Offshore Division Operations Chemical Approval Procedure (EA-91-II-10001) so that only environmentally acceptable products are used.

Reduce

- A Quantitative Risk Assessment Study (Intecsea, 2021) evaluating third-party impacts on the pipeline has been conducted and used to inform requirements for pipeline trenching and rock protection. This has limited trenching and rock protection within Darwin Harbour to higher risk zones, thereby reducing the amount of trenching, spoil disposal and rock installation required and reducing the duration of trenching vessels operating in Darwin Harbour.
- Pre-lay survey will be completed to ensure the Project pipeline is laid along the approved route.
- Pipeline and installation designs will ensure the risk of pipeline damage and possible gas release is ALARP.
- The pipeline hydrotest water discharge on the seabed at the PLET employs a diffuser to maximise water column dilution to near background levels at Shepparton Shoals.

- Objects dropped overboard will be recovered to mitigate the environmental consequences from objects remaining in the marine environment, unless the environmental consequences are negligible, or safety risks are disproportionate to the environmental consequences.
- Vessel deck cleaning products that may be released to the marine environment will meet criteria for not being harmful to the marine environment as defined by MARPOL Annex V.
- Vessel based sewage will be discharged to the marine environment in accordance with MARPOL Annex IV (or equivalent Australian regulation). All vessels will have a current International Sewage Pollution Prevention Certificate which certifies that required measures to reduce impacts from sewage disposal are in place (as applicable to vessel class).
- Oily mixtures (bilge water) only discharged to sea in accordance with MARPOL Annex I (or equivalent Australian regulation).
- Pursuant to MARPOL Annex I (or equivalent Australian regulation) all vessels will have an International Oil Pollution Prevention Certificate which certifies that required measures to reduce impacts of planned oil discharges are in place (as applicable to vessel class).
- Vessels will have a waste management procedure to reduce the risk of unplanned release of waste to the marine environment including standards for bin types, lids and covers, waste segregation and bin storage.
- Ballast water discharges will comply with the requirements of the Australian Ballast Water Management Requirements, which implements the requirements of the *Biosecurity Act 2015* (Cth) and the International Convention for the Control and Management of Ships' Ballast Water and Sediments (as appropriate for vessel class).
- Vessels entering the Project area will have a suitable anti-fouling coating in accordance with the *Protection of the Sea (Harmful Anti-fouling Systems) Act 2006* (Cth) (as applicable for vessel size, type and class).
- Vessels entering the Project area will comply with International Maritime Organization (IMO) Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species (2012) (as appropriate to class).
- Dangerous goods managed in accordance with International Maritime Dangerous Goods Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.
- Documented maintenance program is in place for equipment including DP, engines and machinery on vessels that provides a status on the maintenance of equipment.
- Vessels mobilised to the operational area from international or domestic waters will comply with the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia, 2009).
- Hazardous chemical management procedures will be in place for vessels, including hydrocarbons.
- MARPOL compliant (Marine Order 97) fuel oil (MDO) will be used by vessels to minimise air emissions.
- Vessels will have and implement a Shipboard Oil Pollution and Emergency Plan (SOPEP) or Shipboard Marine Pollution Emergency Plan (SMPEP).

- Vessel navigation lighting and equipment complies with International Rules for Preventing Collisions at Sea (COLREGS)/Marine Order 30: Prevention of Collisions, and with Marine Order 21: Safety of Navigation and Emergency Procedures.
- Light spill mitigation measures will be applied for the DPD Project in NT waters including shielding, where practicable, and/or orienting operational lights (excluding navigational lighting) on vessels to limit light spill to the environment; and housekeeping measures will be adopted, including requiring all crew to keep shutters on windows closed at night, to limit light emissions from vessels.
- Santos will document vessel light spill on Darwin Harbour turtle nesting beaches as part of the Project's environmental monitoring program.
- Vessel and helicopter contractor procedures will comply with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003) which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna.
- Vessels abide by Port of Darwin speed restrictions.
- Personnel trained in marine fauna observation (MFO) will be present on pipeline, trenching and rock installation vessels during daylight hours, including one crew member with MFO training on the bridge at all times.
- An Observation Zone of 150m and an Exclusion Zone of 50m for marine mammals and turtles will be in place around trenching vessels (TSHD, CSD and BHD) for trenching activities.
- A Marine Fauna Observation and Management Protocol for Trenching Activities will apply to the Observation and Exclusion Zone (refer **Figure 4-7**).
- A soft start (ramp-up) of hydraulic hammering (rock breaking) by BHD will apply.
- A soft start (ramp-up) of trenching equipment, where practicable, will apply to the CSD and TSHD.
- Use of turtle 'tickler' chains on the trailing arms of the TSHD.
- Vessel inductions for vessels entering the Project area will address marine fauna risks and the required management controls.
- All marine fauna interactions and observations within the Project area will be appropriately recorded and reported to relevant authorities.

Manage

- A Construction Environmental Management Plan (CEMP) for NT waters and onshore and a Pipeline Installation Environment Plan for Commonwealth waters will be in place to detail how construction will be managed to mitigate impacts to the environment, including MNES.
- A Marine Megafauna Noise Management Plan (MMNMP) will be in place to mitigate impacts to marine megafauna, including MNES, from Project noise, in particular noise from trenching and cofferdam piling (if undertaken). This will include an adaptive management protocol linked to the monitoring of marine fauna within observation and exclusion zones.
- A Trenching, Spoil Disposal Management and Monitoring Plan (TSDMMP) will be in place to include controls for trenching activities required along the Project pipeline and shore crossing.

The TSDMMP will include a monitoring program within an adaptive management framework to ensure water quality effects are within acceptable limits.

+ Operations EMPs will be in place for NT and Commonwealth waters to provide for the ongoing environmental management for the operation of the Project pipeline and decommissioning plan/s will be in place prior to decommissioning in line with regulatory requirements.
+ Oil Pollution Emergency Plans will be in place for the NT and Commonwealth waters.
+ Santos will continue to implement its Stakeholder Engagement Plan to ensure that relevant stakeholders and members of the community remain informed about Project activities and have an ongoing opportunity to communicate with Santos.
+ Should other proponents be considering similar activities (e.g., construction or dredging activities) over similar locations and time frames to Project activities, Santos will work with other proponents to consider the potential for cumulative impacts and mitigate cumulative impacts to as low as reasonably practicable.

6 Significant Impact Criteria

The MNES Significant Impact Guidelines 1.1 outline criteria for assessing whether an action "will have, or is likely to have, a significant impact on a matter of national environmental significance" (DoE 2013) and have formed the basis for assessment of impact against the above listed species.

6.1 Threatened Species – Endangered

The likelihood of occurrence assessment (refer to **Section 3.1**) identified three endangered marine turtle species which are likely to, or have potential to, occur within the Project area, being the Olive Ridley turtle, Leatherback turtle and Loggerhead turtle. An assessment of the proposed action against the Significant Impact Guidelines 1.1 (DoE 2013) for these marine turtle species is provided in **Table 6-1**. Based on this assessment, it is concluded that the proposed action is not likely to have a significant impact on threatened species listed as endangered under the EPBC Act.

6.2 Threatened Species – Vulnerable

The likelihood of occurrence assessment (refer to **Section 3.1**) identifies three vulnerable marine turtle species which are likely to, or have potential to, occur within the Project area, being the Flatback turtle, Green turtle and Hawksbill turtle. An assessment of the proposed action against the Significant Impact Guidelines 1.1 (DoE 2013) is provided is **Table 6-2**. Based on this assessment, it is concluded that the proposed action is unlikely to result in a significant impact to threatened species listed as vulnerable under the EPBC Act. Based on this assessment, it is concluded that the proposed action is not likely to have a significant impact on threatened species listed as vulnerable under the EPBC Act.

6.3 Migratory Species

The likelihood of occurrence assessment (refer to **Section 3.1**) identified six migratory species (excluding the marine turtles addressed in **Section 6.1** and **Section 6.2**) which are likely to, or have potential to, occur within the Project area (being Salt-water crocodile, Australian Snubfin dolphin, Indo-Pacific Humpback dolphin, Spotted Bottlenose dolphin, dugong and osprey). An assessment of the proposed action against the Significant Impact Guidelines 1.1 (DoE 2013) for these migratory species is provided in **Table 6-3**. Based on this assessment, it is concluded that the proposed action is not likely to have a significant impact on migratory species listed under the EPBC Act.

6.4 Commonwealth Marine Area

A ~23km section of the DPD pipeline occurs within the Commonwealth marine area. An assessment of the proposed action against the Significant Impact Guidelines 1.1 (DoE 2013) for the Commonwealth Marine Area is provided in **Table 6-3**. Based on this assessment, it is concluded that the proposed action is not likely to have a significant impact on the Commonwealth marine area.

Table 6-1 Assessment of impacts to threatened species listed as endangered against the significant impact criteria

Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria	Assessment
Lead to a long-term decrease in the size of a population	Olive Ridley turtle No	The Olive Ridley turtle has a worldwide tropical and subtropical distribution, including northern Australia. The turtle is the most numerous of all marine turtles in the world, with an extensive range across the NT. The Project area does not intersect habitat critical to the survival of or a BIA for the Olive Ridley turtle. Potential impacts to the Olive Ridley turtle may include injury or mortality from vessel collision and/or changes in behaviour such as avoidance of the area due to localised increases in underwater noise (for example as a result of trenching activities) and localised increases in light emissions. The Project vessel numbers and movements will be insignificant compared to the total number of vessel movements within the Darwin Harbour (i.e. Port of Darwin recorded 2,154 vessel visits in 2018-19). As such, given the large number of vessels already utilising Darwin Harbour regularly, the increase in vessel traffic from the Project is considered unlikely to result in a greater risk of vessel collision with this species than the current environment. Underwater noise emissions have the potential to affect marine fauna, including the Olive Ridley turtle, as described in **Section 4.2**. Installation activities will contribute to the underwater noise within the area. However, given the narrow operating area for the Project, it is considered that mobile animals such as turtles will be able to move away freely before any physical or behavioural changes occur. Impacts would likely only be temporary avoidance of the area. Marine turtles are sensitive to artificial light during nesting and hatching, as described in **Section 4.2.2**. As described above, given the Project does not intersect any critical breeding or nesting habitat for the Olive Ridley turtle and they are only considered to be transiting through the area, disturbance from artificial light is considered unlikely. Operational risks to marine turtles are considered no greater than installation risks. Given the location of critical habitat and nesting areas for the Olive Ridley turtle outside of the Project area and the successful implementation of management measures for similar types of projects in the area (i.e. Ichthys GEP and Bayu-Undan to Darwin pipeline), it is considered that potential impacts from construction and operational activities can be effectively minimised and if they occur, would be short term and highly localised. An approved monitoring program was undertaken as part of dredging and spoil disposal activities associated with the Ichthys project, as conditioned in EPBC Act approval of that project (EPBC 2008/4208). The Ichthys monitoring program did not detect any deleterious effects to turtle distribution or population sizes in the Darwin region attributable to dredging and spoil disposal activities (Cardno 2015a). Given the proposed Project is smaller in scale in comparison to the Ichthys project, and will implement management measures, including those within a TSDMMP, the proposed trenching, spoil disposal and installation activities associated with the Project are not likely to have a significant impact to Olive Ridley turtle distribution or population size.
	Leatherback turtle No	The Leatherback turtle has the widest global distribution of any reptile. As an oceanic species (pelagic feeder), the species is unlikely to occur within the Darwin Harbour (Whiting 2001) and has no BIAs or habitat critical to the survival to Leatherback turtle in Project area Commonwealth waters. Hence, significant impacts to this species are not predicted.
	Loggerhead turtle No	The Loggerhead turtle has a global distribution. In Australia, the majority occur in eastern and western Australia. The Loggerhead turtle is unlikely to occur in the Darwin Harbour and has no BIAs in Project area Commonwealth waters. Hence, significant impacts to this species are not predicted.
Reduce the area of occupancy of the species	Olive Ridley turtle No	Based on the justification provided above, the Project is unlikely to reduce the area of occupancy of the Olive Ridley turtle.
	Leatherback turtle No	Based on the justification provided above, the Project is unlikely to reduce the area of occupancy of the Leatherback turtle.
	Loggerhead turtle No	Based on the justification provided above, the Project is unlikely to reduce the area of occupancy of the Loggerhead turtle.
Fragment an existing population into two or more populations	Olive Ridley turtle No	Based on the justification provided above, the Project is unlikely to fragment an existing population of the Olive Ridley turtle into two or more populations.
	Leatherback turtle No	Based on the justification provided above, the Project is unlikely to fragment an existing population of the Leatherback turtle into two or more populations.
	Loggerhead turtle No	Based on the justification provided above, the Project is unlikely to fragment an existing population of the Loggerhead turtle into two or more populations.

Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria	Assessment
Adversely affect habitat critical to the survival of a species	Olive Ridley turtle No	The Project does not intersect with any habitat critical to the survival of the Olive Ridley turtle and it is considered unlikely that the Project would adversely affect regional habitat critical to the survival of this species.
	Leatherback turtle No	The Project does not intersect and is not near habitat critical to the survival of the Leatherback turtle.
	Loggerhead turtle No	The Project does not intersect and is not near habitat critical to the survival of the Loggerhead turtle.
Disrupt the breeding cycle of a population	Olive Ridley turtle No	Based on the justification provided above, the Project is unlikely to disrupt the breeding cycle of a population of Olive Ridley turtle that may occur nearby to the Project area.
	Leatherback turtle No	Based on the justification provided above, the Project is unlikely to disrupt the breeding cycle of a Leatherback turtle population.
	Loggerhead turtle No	Based on the justification provided above, the Project is unlikely to disrupt the breeding cycle of a Loggerhead turtle population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Olive Ridley turtle No	Based on the justification provided above, the Project is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Olive Ridley turtle species is likely to decline.
	Leatherback turtle No	Based on the justification provided above, the Project is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Leatherback turtle species is likely to decline.
	Loggerhead turtle No	Based on the justification provided above, the Project is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Loggerhead turtle species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Olive Ridley turtle No	Santos will implement measures to reduce the risk of introducing invasive marine pest species, as described in **Section 5**. It is therefore unlikely that the Project would result in invasive species that are harmful to marine turtles becoming established in the species' habitat.
	Leatherback turtle No	As described above for the Olive Ridley turtle.
	Loggerhead turtle No	As described above for the Olive Ridley turtle.
Introduce disease that may cause the species to decline	Olive Ridley turtle No	Based on the justification provided above, the Project is unlikely to introduce disease that may cause the Olive Ridley turtle species to decline.
	Leatherback turtle No	Based on the justification provided above, the Project is unlikely to introduce disease that may cause the Leatherback turtle species to decline.
	Loggerhead turtle No	Based on the justification provided above, the Project is unlikely to introduce disease that may cause the Loggerhead turtle species to decline.
Interfere with the recovery of the species	Olive Ridley turtle No	Based on the justification provided above, the Project is unlikely to interfere with the recovery of the Olive Ridley turtle.
	Leatherback turtle No	Based on the justification provided above, the Project is unlikely to interfere with the recovery of the Leatherback turtle.
	Loggerhead turtle No	Based on the justification provided above, the Project is unlikely to interfere with the recovery of the Loggerhead turtle.

Table 6-2 Assessment of impacts to threatened species listed as vulnerable against the significant impact criteria

Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria	Assessment
Lead to a long-term decrease in the size of an important population of a species	Flatback turtle No	Flatback turtles are the most widely spread nesting marine turtle species in the NT, nesting on a wide variety of beach types around the entire coastline. Flatback turtles in the vicinity of Darwin Harbour and Tiwi Islands (including Casuarina/ Cox Peninsula/Mandorah/ Fourcoy Beaches) are part of the Arafura Sea genetic stock, considered the largest genetic stock within Australia. The IUCN Red List Assessment for the Arafura Sea genetic stock estimates approximately 18,000 nesting females which equates to approximately 30% of the global population for the species. In addition, the Arafura Sea genetic stock has the largest geographic breeding range of all flatback subpopulations (genetic stock) extending along the northern Australian coastline from Cape York peninsula in Queensland to Cape Scott in the NT. The beaches in proximity to Darwin Harbour are very low in the regional importance status of the flatback Arafura Sea genetic stock (Pendoley Environmental, 2022b; **Appendix E**) The Flatback turtle has a BIA of inter-nesting habitat and habitat critical to the survival of the species intersecting the Project area**.** With an assumed inter-nesting distances of 60 km offshore, there are extensive BIAs across northern Australia. For example, the Project area intersects a BIA with a coastline (islands and mainland) stretching well over 800 km. The closest beaches to the Project area considered 'significant areas' for flatback turtle Nesting in the Anson Beagle and Tiwi Bioregions are Quail Island (located approximately 28 km from the Project area), Bare Sand Island (located approximately 29 km from the Project area) and Cape Fourcroy on Tiwi Islands (located approximately 25 km from the Project area). The National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (CoA 2020) states that a 20 km buffer (based on sky glow) to important habitat for turtles should be applied when considering possible impacts. These 'significant' areas for flatback turtle Nesting are outside of the 20 km buffer the National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (CoA 2020) recommends. Marine turtles are sensitive to artificial light during nesting and hatching. Light modelling undertaken for Project vessels indicates that the distance within which behavioural impacts to turtles could occur from light spill from vessel lighting would be approximately 4.5 km (Pendoley Environmental, 2022a) when two large offshore installation vessels are operating simultaneously. This is less than the distance of Project vessels to Casuarina Beach (8 km to the east of the Project area) which is considered the main nesting site for Flatback turtles in the Darwin Harbour vicinity. The closest significant nesting beach is the Cape Fourcroy beach (approximately 25 km from the Project area) which is outside of the National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (CoA 2020) 20 km buffer to important habitat for turtles when considering possible impacts. There is no evidence, published or anecdotal, to suggest inter-nesting turtles are impacted by light from offshore vessels, and nothing in their biology would indicate this as a plausible threat (Pendoley Environmental 2019; Witherington and Martin 2003). It is therefore not expected that artificial light generated by the Project would cause an adverse impact on Flatback turtles. Underwater noise emissions have the potential to affect marine fauna, including the Flatback turtle as described in **Section 4.2**. However, given the narrow operating area for the Project, it is considered that mobile animals such as turtles will be able to move away freely before any physical or behavioural changes occur. Impacts would likely only be temporary avoidance of the area. Potential impacts to the Flatback turtle may include injury or mortality from vessel collision and/or changes in behaviour such as avoidance of the area due to localised increases in underwater noise as a result of trenching activities, and localised increases in light emissions. The Project vessel numbers and movements will be insignificant compared to the total number of vessel movements within the Darwin Harbour (i.e. Port of Darwin recorded 2,154 vessel visits in 2018-19). As such, given the large number of vessels already utilising Darwin Harbour regularly, the increase in vessel traffic from the Project is considered unlikely to result in a greater risk of vessel collision with this species than the current environment. Based on benthic habitat mapping in the Darwin Harbour area (Galaiduk et al. 2019), including within the Project area, and dedicated surveys along the pipeline route (RPS 2022a; **Appendix B**) the benthic habitats on the pipeline route are well represented and are not considered unique or critical foraging areas for marine turtles. Operations of the Project are unlikely to generate noise or light emissions of any significance to marine fauna. Furthermore, the use of operations vessels would be minimal and unlikely to increase the risk of collision with turtles than the current environment (refer to **Section 4.2**). An approved monitoring program was undertaken as part of dredging and spoil disposal activities associated with the Ichthys project, as conditioned in EPBC Act approval of that project (EPBC 2008/4208). The Ichthys monitoring program did not detect any deleterious effects to turtle distribution or population sizes in the Darwin region attributable to dredging and spoil disposal activities (Cardno 2015a). Given the proposed Project is smaller in scale in comparison to the Ichthys project, and will implement management measures, including those within a CEMP and TSDMMP, the Project is considered unlikely to lead to a long-term decrease in the size of a population of the Flatback turtle.
	Green turtle No	Green turtles are found in tropical and subtropical waters throughout the world, with the most numerous and widely dispersed nesting sites of the seven turtle species, known to nest in 80 countries. Green turtles inhabit areas of coral and rocky reefs and inshore seagrass and algal beds. Adult Green turtles are herbivorous feeding primarily on seagrasses and algae, while juveniles are carnivorous (NRETAS, 2006a). Aerial turtle surveys undertaken for the INPEX NEMP estimated a population size of between 500 and 1,000 for the Darwin region (Buckee et al. 2014). Based on surveys, the Project area is unlikely to have suitable habitat being rocky reef habitat or inshore seagrass beds. Although Green turtles may transit through the Project area.

Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria	Assessment
		As noted above, underwater noise emissions have the potential to affect marine fauna, including the Green turtle, as described in **Section 4.2**. However, given the narrow operating area for the Project, it is considered that mobile animals such as turtles will be able to move away freely before any physical or behavioural changes occur. Impacts would likely only be temporary avoidance of the area. Marine turtles are sensitive to artificial light during nesting and hatching. Project modelling indicates that lighting effects will be localised and unlikely to affect any beaches where Green turtles frequently nest. Operations of the Project are unlikely to generate noise or light emissions of any significance to marine fauna. Furthermore, the use of operations vessels would be minimal and unlikely to increase the risk of collision with turtles than the current environment (refer to **Section 4.2**). An approved monitoring program was undertaken as part of dredging and spoil disposal activities associated with the Ichthys project, as conditioned in EPBC Act approval of that project (EPBC 2008/4208). The Ichthys monitoring program did not detect any deleterious effects to turtle distribution or population sizes in the Darwin region attributable to dredging and spoil disposal activities (Cardno 2015a). Given the proposed Project is smaller in scale in comparison to the Ichthys project, and will implement management measures, including those within a TSDMMP, the Project is considered unlikely to lead to a long-term decrease in the size of a population of the Green turtle.
	Hawksbill turtle No	Hawksbill turtles are found in tropical, subtropical and temperate waters in all the oceans of the world. In the NT, most nesting occurs on islands rather than mainland beaches. The key nesting and inter-nesting areas in the NT are not close to the Project area (e.g. Groote Island). The Hawksbill turtle prefers rocky and coral reef habitats where it feeds on a wide variety of plants and animals including sponges, gastropods, seagrass and algae. Soft coral and sandy habitats are widely present throughout the Project area within Darwin Harbour, therefore providing suitable foraging habitat for the Hawksbill turtle. The Hawksbill turtle utilises Darwin Harbour regularly (Whiting 2003). In the Darwin Harbour, the Hawksbill turtles occur in lower abundances compared to the Green turtle (Whiting 2001). As noted above, underwater noise emissions have the potential to affect marine fauna, including the Hawksbill turtle, as described in **Section 4.2**. However, given the narrow operating area for the Project, it is considered that mobile animals such as turtles will be able to move away freely before any physical or behavioural changes occur. Impacts would likely only be temporary avoidance of the area. Marine turtles are sensitive to artificial light during nesting and hatching. Project modelling indicates that lighting effects will be localised and unlikely to affect any beaches where Hawksbill turtles frequently nest. Operations of the Project are unlikely to generate noise or light emissions of any significance to marine fauna. Furthermore, the use of operations vessels would be minimal and unlikely to increase the risk of collision with turtles than the current environment (refer to **Section 4.2**). An approved monitoring program was undertaken as part of dredging and spoil disposal activities associated with the Ichthys project, as conditioned in EPBC Act approval of that project (EPBC 2008/4208). The Ichthys monitoring program did not detect any deleterious effects to turtle distribution or population sizes in the Darwin region attributable to dredging and spoil disposal activities (Cardno 2015a). Given the proposed Project is smaller in scale in comparison to the Ichthys project, and will implement management measures, including those within a TSDMMP, the Project is considered unlikely to lead to a long-term decrease in the size of a population of the Hawksbill turtle.
Reduce the area of occupancy of an important population	Flatback turtle No	Based on the justification provided above, the Project is unlikely to reduce the area of occupancy of the Flatback turtle.
	Green turtle No	Based on the justification provided above, the Project is unlikely to reduce the area of occupancy of the Green turtle.
	Hawksbill turtle No	Based on the justification provided above, the Project is unlikely to reduce the area of occupancy of the Hawksbill turtle.
Fragment an existing important population into two or more populations	Flatback turtle No	Based on the justification provided above, the Project is unlikely to fragment an existing important population of Flatback turtles into two or more populations.
	Green turtle No	Based on the justification provided above, the Project is unlikely to fragment an existing important population of Green turtles into two or more populations.
	Hawksbill turtle No	Based on the justification provided above, the Project is unlikely to fragment an existing important population of Hawksbill turtles into two or more populations.
Adversely affect habitat critical to the survival of a species	Flatback turtle No	The Project intersects habitat critical to the survival of the Flatback turtle (**Figure 3-2**) and BIA, understood to be nesting and inter-nesting turtle habitat. There are, however, no nesting beaches within the Project area and no significant Flatback nesting beaches within 20 km of the Project area. The main nesting beach for Flatback turtles in Darwin Harbour is Casuarina Beach, which is approximately 8 km east of the proposed pipeline, approximately 15 km south of the spoil disposal ground. The closest significant nesting

Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria	Assessment
		beach is Cape Fourcroy located on Tiwi Islands is approximately 25 km from the Project area. These 'significant' areas for flatback turtle Nesting are outside of the National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (CoA 2020) 20 km buffer to important habitat for turtles when considering possible impacts. The Project area intersects a very small proportion of the very large inter-nesting areas, which extend 60 km offshore from the shoreline stretching with an extend of well over 800 km. It is therefore considered unlikely that the Project would adversely affect habitat critical to the survival of the species.
	Green turtle No	The Project does not intersect and is not near habitat critical to the survival of the Green turtle.
	Hawksbill turtle No	The Project does not intersect and is not near habitat critical to the survival of the Hawksbill turtle.
Disrupt the breeding cycle of an important population	Flatback turtle No	Based on the justification provided above, the Project is unlikely to disrupt the breeding cycle of an important population of the Flatback turtle.
	Green turtle No	Based on the justification provided above, the Project is unlikely to disrupt the breeding cycle of an important population of the Green turtle.
	Hawksbill turtle No	Based on the justification provided above, the Project is unlikely to disrupt the breeding cycle of an important population of the Hawksbill turtle.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Flatback turtle No	Based on the justification provided above, the Project is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Flatback turtle is likely to decline.
	Green turtle No	Based on the justification provided above, the Project is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Green turtle is likely to decline.
	Hawksbill turtle No	Based on the justification provided above, the Project is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Hawksbill turtle is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Flatback turtle No	Santos will implement measures to reduce the risk of introducing invasive marine pest species, as described in **Section 5**. It is therefore unlikely that the Project would result in invasive species that are harmful to marine turtles becoming established in the species' habitat.
	Green turtle No	As described above for the Flatback turtle.
	Hawksbill turtle No	As described above for the Flatback turtle.
Introduce disease that may cause the species to decline	Flatback turtle No	Based on the justification provided above, the Project is unlikely to introduce disease that may cause the Flatback turtle species to decline.
	Green turtle No	Based on the justification provided above, the Project is unlikely to introduce disease that may cause the Green turtle species to decline.
	Hawksbill turtle No	Based on the justification provided above, the Project is unlikely to introduce disease that may cause the Hawksbill turtle species to decline.
Interfere substantially with the recovery of the species	Flatback turtle No	Based on the justification provided above, the Project is unlikely to interfere with the recovery of the Flatback turtle species.
	Green turtle No	Based on the justification provided above, the Project is unlikely to interfere with the recovery of the Green turtle species.
	Hawksbill turtle No	Based on the justification provided above, the Project is unlikely to interfere with the recovery of the Hawksbill turtle species.

Table 6-3 Assessment of impacts to migratory species against the significant impact criteria

Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria	Assessment
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	Migratory Marine - Mammals No	The Project area intersects BIAs for the Australian snubfin dolphin, Indo-Pacific humpback dolphin and the Indo-Pacific/spotted bottlenose dolphin, known to breed, calve and forage within Darwin Harbour (refer to **Figure 3-4**, **Figure 3-5**, **Figure 3-6**). Direct impacts to migratory marine species, including interactions with vessels, have the potential to occur as a result of the proposed action. However, vessel collisions with smaller cetaceans such as dolphins are infrequent due to the mobility of these species which allows them to move out of the way. In addition, given existing commercial shipping and fishing activities occur in the area, it is considered unlikely that vessels from the proposed action would increase the risk of impact to these species. Project vessels will typically be slow moving or stationary when undertaking activities in the Project area and vessel strikes with marine fauna are not expected as a result of the proposed action Dugongs have the potential to occur in the Project area, however, typically spend most of their time in shallow tidal and subtidal seagrass meadows, outside the Project area, and would likely only be transiting through the area if observed in the vicinity of Project vessels. Similar to dolphins, dugongs are mobile species that would likely avoid vessels. Changes to fauna behaviour could also be experienced as a result of underwater noise (and to a less extent lighting for marine mammals) associated with pre-lay works (i.e. trenching), installation activities and vessels and/or equipment. However, given the nature of the construction works being short-term and temporary, and because noise emissions will be largely non-impulsive, significant impacts to species as a result of the proposed action are not likely to occur. An approved monitoring program was undertaken as part of construction activities, including piling, dredging and spoil disposal activities, associated with the Ichthys project, as conditioned in EPBC Act approval of that project (EPBC 2008/4208). The Ichthys monitoring program did not detect any deleterious effects to dugong or dolphin distributions or population sizes in the Darwin region attributable to construction activities (Brooks and Pollock 2015, Cardno 2015a). Given the proposed Project is smaller in scale in comparison to the Ichthys project, and will implement management measures, including those within a CEMP and a TSDMMP, the proposed trenching, spoil disposal and installation activities associated with the Project are not likely to have a significant impact to dugong or dolphin species distributions or population sizes in the Darwin area. Seabed disturbance from pre-lay activities and pipeline laying is not expected to impact any known important foraging habitat for dugongs and dolphins, as informed by RPS (2022a; **Appendix B**) and AIMS (Galaiduk et al., 2019) habitat mapping. Monitoring of the most significant seagrass sites in Darwin Harbour (shallow sites at Casuarina Beach, Charles Point West, Fanny Bay, East Point, Lee Point and Woods Inlet) during Ichthys dredging, trenching and spoil disposal did not detect any impacts to seagrass from dredging related turbidity in these areas (Cardno 2015b), indicating trenching and spoil disposal activities associated with the proposed Project would be highly unlikely to impact these areas or seagrass habitat in general. Given the above, the Project is unlikely to substantially modify (including by fragmenting, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for dolphins or dugongs.
	Migratory Marine – Reptiles No	There is no important habitat for the species located within the Project area. Individuals are periodically sighted inside Darwin Harbour. INPEX Browse Ltd concluded that Salt-water crocodiles (INPEX Browse 2010a) are likely to be accustomed to turbid conditions as they regularly frequent shallow coastal areas and mangroves and are not expected to be impacted by trenching activities associated with the Project. As with the other migratory species, underwater noise emissions associated with the Project as described, are not likely to result in a significant impact to crocodiles as it is considered that they would move away from the area of noise temporarily. Given the above, the Project is unlikely to substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for Salt-water crocodiles.
	Migratory – Birds No	The Project area does contain suitable nesting habitat for ospreys (or other migratory bird species). It is considered that the Project area may contain suitable foraging habitat as would Darwin Harbour in general, but this habitat is not considered unique or particularly significant. Given the above, the Project is unlikely to substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for the osprey.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	Migratory Marine - Mammals No	The only area considered to be 'important' habitat for migratory species would be Darwin Harbour which is a BIA for the Australian Snubfin dolphin, Indo-Pacific Humpback dolphin and the Indo-Pacific Spotted Bottlenose dolphin, as described above. Santos will implement measures to reduce the risk of introducing invasive marine pest species, as described in **Section 5**. It is therefore unlikely that the Project would result in invasive species that are harmful to marine mammals becoming established in the species' habitat.
	Migratory Marine – Reptiles No	As described above for Marine Mammals, noting the absence of any BIAs for crocodiles.

Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria	Assessment
	Migratory – Birds No	It is unlikely there that the Project that would result in an invasive species becoming established in important habitat for the Osprey.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	Migratory Marine - Mammals No	As described above, there are BIAs (breeding) for the Australian Snubfin dolphin, Indo-Pacific Humpback dolphin and the Indo-Pacific Spotted Bottlenose dolphin in Darwin Harbour. For the three dolphin species calving occurs in the months of October to April (Palmer 2010). Due to length of the calving period it is not practicable for the Project to avoid this period with Darwin Harbour. There is no available evidence to suggest that the Project area or Darwin Harbour represents a critical breeding or calving area. Vessel activity will be largely confined to a linear corridor, with an approximate 50-m seabed disturbance corridor. Project vessels present a very low risk to marine mammals due to their slow speeds, and because they remain in one location for a short period of time. The area of the spoil disposal ground is ~6.25 km² (includes a buffer area), which is outside the defined BIAs for the three dolphin species and not considered to be dugong habitat. An approved monitoring program was undertaken as part of construction activities, including piling, dredging and spoil disposal activities, associated with the Ichthys project, as conditioned in EPBC Act approval of that project (EPBC 2008/4208). The Ichthys monitoring program did not detect any deleterious effects to dugong or dolphin distributions or population sizes in the Darwin region attributable to construction activities (Brooks and Pollock 2015, Cardno 2015a) and therefore did not detect evidence for a project related disruption to dugong or dolphin life-cycles. Given the proposed Project is smaller in scale, in comparison to the Ichthys project, and will implement management measures, including those within a CEMP and a TSDMMP, the proposed trenching, spoil disposal and installation activities associated with the Project are not likely to lead to a significant impact to dugong or dolphin distributions or population sizes in the Darwin area. Based on the justification provided above, the Project is unlikely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.
	Migratory Marine – Reptiles No	It is unlikely that the Project will seriously disrupt the lifecycle of an ecologically significant proportion of the population of the Salt-water crocodile. Nesting within Darwin Harbour is considered limited (INPEX Browse 2010a) and the Project area does not contain suitable nesting habitat. The species is considered highly mobile and if concerned, will move away from the area until the construction works are complete.
	Migratory – Birds No	Wildlife Conservation Plan for Seabirds (CoA 2020) identifies light pollution as a minor threat to seabirds. The National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (CoA 2020) states that a 20 km buffer (based on sky glow) to important habitat for seabirds should be applied when considering possible impacts. The Project area including a 20 km buffer does not impact any seabird BIAs., therefore, therefore biologically important behaviours of breeding, feeding, migration and roosting can continue given the absence of bird BIAs. It is unlikely that the Project will seriously disrupt the lifecycle of an ecologically significant proportion of the population of the osprey as the Project area does not contain significant habitat for this species.

Table 6-4 Assessment of impacts to Commonwealth marine area against the significant impact criteria

Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria	Assessment
Result in a known or potential pest species becoming established in the Commonwealth marine area	No	IMS risks are well known, and Santos has internal company procedures and complies with Commonwealth legislation and industry standards to minimise the risk of introducing IMS to Australian waters across all its offshore operations. Santos has for an extended period of time successfully applied these measures to its numerous offshore operations and consider the risk of introducing IMS to be low. Vessel activity in Commonwealth waters will be temporary only.
Modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results	No	Disturbance to seabed habitats from pipeline installation in Commonwealth waters will not result in disturbance to important habitat or impact to a substantial area of habitat. Within the Commonwealth marine area, seabed disturbance will occur from the laying of the pipeline and associated structures. There is no planned anchoring in the Commonwealth marine area as project vessels will utilise dynamic positioning in these waters. There will be no trenching in the Commonwealth marine area and turbidity effects from disturbance of sediment due to the laying of pipeline and associated structures is expected to be very minor and temporary in nature. The habitat within the Commonwealth waters Project area comprises bare sediments or sediment with a sparse biota of filter feeders (e.g. soft coral) and crinoids (Heyward et al 2017, RPS 2022a; **Appendix B**). This type of habitat is ubiquitous for the region (Heyward et al 2017) and therefore the disturbance to seabed is not expected to have any significant impact on the diversity of seabed habitats or ecosystem functioning on a broader scale.
Have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution	No	There are not considered to be any populations of cetaceans or other marine species that use the Commonwealth waters part of the Project area that would be significantly impacted by the project. MNES species have been identified and assessed and there are no key habitats nor areas supporting key-lifecycle activities within the Commonwealth waters Project area. MNES species would be expected to be transient only within the Project area. Impact to other marine species that may be local to the Commonwealth waters Project area, e.g. fish and invertebrates, are expected to be very localised and minor in nature.
Result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity; social amenity or human health	No	There will be no substantial impact in water quality or air quality within the Commonwealth marine area. Water quality impacts will be primarily through short term discharge of treated seawater and MEG associated with pipeline pre-commissioning activities but modelling demonstrates that concentrations at levels where effects could be observed will be very short lived and localised in nature.
Result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected, or	No	Other than treated seawater and MEG discharges there will be no other planned chemical discharges associated with pipeline construction. The chemicals selected for use for the treatment of seawater have all be assessed and selected based environmental criteria. MEG is on the OSPAR PLONOR (poses little to no risk to the environment) list and is therefore deemed safe to discharge to the marine environment. The constitute components of the hydrotest chemical package do not persist or accumulate within the marine environment. The mixture is therefore considered biodegradable with negligible potential for bioaccumulation Discharges of treated seawater will be temporary and through diffusers angled upwards reducing potential for seabed contact.
Have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck	No	There are no heritage values that have been identified within the Commonwealth marine environment of the Project area.

7 Conclusion

Based on the impact assessment presented within this document, and application of significant impact criteria, the proposed action is considered unlikely to result in a significant impact to MNES.

Twelve MNES species were identified as having the potential for impact from the Project, covering two MNES categories – threatened species and migratory species. All species are well represented outside of the Project area.

Direct interactions with MNES species are considered most likely during a temporary installation phase (expected to be 15 months) with ongoing operational activities associated with the pipeline expected to have a very low level of interaction.

All MNES species with the potential to be impacted by the proposed action are mobile species including turtles, dolphins and dugongs, and it is expected that these species will avoid temporary disturbance caused by localised Project activities.

Where BIAs and habitats for MNES species have been identified that overlap the Project area, the behaviours within these areas are not likely to be significantly impacted by the Project. Benthic habitats with the Project area, as defined by surveys, are well represented elsewhere and are not considered to be locally significant.

The Project is effectively a pipeline duplication within an existing pipeline route (nominally within 100 m of the Bayu-Undan to Darwin pipeline) and 'brownfields' industrial precinct (i.e. DLNG). Given the proposed location, the narrow linear pipeline corridor (i.e., notional 50 m pipeline disturbance footprint mostly within an existing pipeline corridor with additional disturbance closer to shore due to vessel anchoring), proximity of the spoil disposal ground to an existing and much larger spoil ground, potential impacts to marine and coastal habitats are expected to be localised and reduced to as low as reasonably practicable.

Given the onshore area of the proposed action is wholly within the existing DLNG facility disturbance envelope, significant impacts to terrestrial species are not likely.

The natural environment and its potential for impact are well understood within Darwin Harbour and surrounds, with extensive Ichthys baseline and monitoring data supplemented by Santos' pipeline environmental survey and modelling data already conducted. Monitoring undertaken as part of installation activities on the Ichthys project, as conditioned in EPBC Act approval of that project (EPBC 2008/4208), did not detect any deleterious effects to MNES (including turtles, dugongs and dolphins) in the Darwin region attributable to construction activities (Brooks and Pollock 2015; Cardno 2015). Given the proposed Project is smaller in scale than the Ichthys project and will implement management measures consistent with those applied by other pipeline Projects in the area, the proposed trenching, spoil disposal and construction activities associated with the Project are not expected to lead to a significant impact to MNES distributions or population sizes in the Darwin area. The dewatering activities are considered to have negligible impacts to MNES and therefore deemed acceptable.

The proposed action will be managed to avoid impacts where possible, and where unavoidable, impacts will be mitigated with a high level of confidence. Santos commits to implementing construction and operations environmental management plans to ensure impacts and risks to the receiving environment are reduced to ALARP and to an acceptable level. A marine environmental

monitoring program will be implemented to validate the environmental assessment and ensure that impacts are within acceptable limits. The environmental management plans and monitoring results will be publicly available.

On the basis of the information presented, the following points (as per the DCCEEW Factsheet – *Submitting a referral under the EPBC Act*) are considered relevant to the assessment of the proposed action and are provided below for reference:

+ Number of MNES matters affected:

  3 (threatened species, migratory species, Commonwealth marine area).

+ Nature and scale of impacts to MNES:

  Localised and temporary.

+ Confidence in predicting impacts:

  High, impacts from similar completed Projects within the Project area have been impact assessed and monitored.

  Santos has committed to further monitoring to verify impact predictions.

+ Completeness of information:

  Good, the existing environment with the Project area and understanding of impacts is good, a small number of Project specific technical studies are proposed to supplement this information for management purposes.

+ Extent to which potential relevant impacts have already been assessed under state legislation:

  High (in progress), the NT waters section of the Project is being concurrently assessed through a referral to the NT EPA.

Santos has concluded that the proposed action is not likely to have a significant impact on a matter protected under the EPBC Act and therefore is not a controlled action.

8 References

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APPENDIX A – EPBC ACT PROTECTED MATTERS REPORT

APPENDIX B – DPD PIPELINE BENTHIC HABITAT SURVEY REPORT

APPENDIX C – PLET TREATED SEAWATER AND MEG DISCHARGE MODELLING REPORT

APPENDIX D – DPD PROJECT TREATED SEAWATER CONTINGENCY DISCHARGE MODELLING

APPENDIX E – DPD PROJECT DARWIN HARBOUR LIGHTING TECHNICAL NOTE