Subsea Fibre Optic Data Cable System – Cable Installation – Australia East

Appendix C – Impact Assessment

Perch Infrastructure Pty Ltd

August 11, 2025

→ **The Power of Commitment**

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1. Introduction

This Appendix has been prepared in support of an Environmental Assessment (EA) for the Subsea Fibre Optic Data Cable Systems – Australia East cable installation and should be read in conjunction with:

– Environmental Assessment Report
– Appendix A – Coastal Assessment
– Appendix B – Marine Ecology Assessment
– Appendix D – Other Considerations

This Appendix provides an assessment of the potential impacts to the marine environment along the Queensland (QLD), New South Wales (NSW) and Victoria (VIC) cable routes. The 'proposed action' is considered to be all cable installation activities related to the cable systems within the Australian Exclusive Economic Zone (EEZ).

Information reported within the Environmental Assessment for the project informs which project activities may pose a risk to Matters of National Environmental Significance (MNES) protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). To complete this risk assessment, the following process has been adopted:

– Describe which project activities have potential to harm which environmental features and why.
– Describe the consequences of the potential impact being realised.
– Identify relevant management controls to reduce or eliminate the potential environmental risk.
– Discuss overall environmental outcomes.

An outline of the report structure is provided in Table 1.1.

Table 1.1 Report structure

Report section	Description
Section 1	Introduction, purpose of the document and assumptions.
Section 2	Describes the methodology used to inform the impact identification and description, impact analysis, management controls and environmental outputs and for the significant impact assessment
Section 3	Describes the impact description, analysis, management controls and environmental outcomes for identified impacts along the QLD, NSW and VIC cable routes
Section 4	Provides a significant impact assessment for Matters of National Environmental Significance

1.1 Scope and Limitations

This Impact Assessment Report has been prepared by GHD for Perch Infrastructure Pty Ltd and may only be used and relied on by Perch Infrastructure Pty Ltd for the purpose agreed between GHD and Perch Infrastructure Pty Ltd as set out in section 1.2 of the EA Main Document.

GHD otherwise disclaims responsibility to any person other than Perch Infrastructure Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1.2 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

1.2 Assumptions

GHD has prepared this report based on information provided by SubCom and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

A list of sources used to inform the appendix includes:

– Route Position Listing and associated geospatial files
– SubCom site visit reports
– SubCom Marine Route Survey Reports and survey data
– Cosmos Archaeology, Underwater Cultural Heritage Assessment 2025.

2. Methodology

2.1 Impact identification and description

The cable routes will transect or lie in proximity to a range of marine habitats including rocky reefs and expanses of subtidal sand and soft sediments. The methods to be used during the project for cable placement will be:

– Cable burial by ploughing or jetting up to 1 m target burial depth in waters less than a water depth of 1,000m
– Direct placement on the seabed in waters greater than a water depth of 1,000m.

Vessels will be required to support the project activities, including the connection of the cables with the Pop out Points (PoP). The risks to the environment from these planned activities are:

– Disturbance of seabed within the path of cable laying
– Noise and lighting pollution from vessels
– Atmospheric emissions from activities
– Planned discharges from the vessel
– Interference with other users of the area affected by cable laying
– Potential disturbance from decommissioning.

Impacts from unplanned events may also arise from the project activities. The risks to the environment from these activities are:

– Introduction of marine pests
– Accidental release of solid waste
– Impacts to the seabed from dropped objects
– Marine fauna collisions
– Accidental release of hydrocarbon, chemicals and other liquid waste
– Seabed disturbance associated with subsea cable maintenance and repair activities
– Dropped objects.

2.2 Impact analysis

Impact analysis for each identified hazard is conducted in a systematic manner following the general process of:

– Identifying the key concerns
– Consideration of sensitive environmental features potentially affected either directly or indirectly by the activities
– Where practicable, quantification of the magnitude of the stressor, the concentration of contaminant and/or level of disturbance
– Consideration of timing, duration and other factors affecting the impact and risk (water depth, temperature, tides etc.)
– Consideration of cumulative impacts.

The impact analysis is undertaken for environmental values and protected matters identified, as detailed in the Marine Ecology and Other Considerations (Appendix B and Appendix D).

It is considered that within the natural environment, some aspects have a higher value than others, and these aspects, or sensitive receptors, have been specifically considered when determining the overall environmental consequence of an impact. In determining consequence, the potential presence of the following environmental receptors has been considered:

- Benthic primary producer habitats
- Habitats that are rare or unique
- Habitat that represents a Key Ecological Feature
- Species and ecological communities
- EPBC listed threatened species
- EPBC Act migratory species
- EPBC listed threatened ecological communities
- Commonwealth / National Heritage Areas
- Cultural heritage areas, and
- Marine conservation areas.

The following section addresses potential impacts from planned activities. Following that, potential impacts from unplanned activities are considered.

This report should be read in conjunction with the Marine Ecology Report (Appendix B) which provides a description of the environment within and adjacent to the cable route and those protected matters with which the proposed action is likely to interact.

2.3 Management controls and environmental outcomes

Following identification and analysis of the impact, management controls are proposed for reducing the impacts on matters protected by the EPBC Act and achieving favourable environmental outcomes.

2.4 Significant Impact Assessment

Potential impact to MNES is then assessed in accordance with EPBC Significant Impact Assessment Guidelines 1.1 (Department of the Environment (DoE) 2013). This assessment considers the specific controls that are identified as relevant to the proposed works for reduction of risk of potential to impact upon MNES identified (in Appendix B to Environmental Assessment Report) as “likely” to, or those that “may occur” within the cable routes at the time of project construction. Results of the significant impact assessment are provided within Section 4 of this report.

3. Planned activities

3.1 Seabed disturbance

3.1.1 Impact description

Disturbance to the seafloor and benthic habitats will occur during the subsea cable installation, which generally involves pre-lay grapnel run, surface laying, plough burial and post-lay inspection and burial along the route as described in the Environmental Assessment report. A marine route survey (MRS) was completed to inform the subsea cable alignment. The MRS data was used to inform the impact assessment, where relevant.

3.1.2 Impact analysis

3.1.2.1 Route clearance and pre-lay grapnel run

A pre-lay grapnel run (PLGR) will be completed prior to the main cable lay operation and will be carried out along the proposed cable route only where burial is required. The PLGR will clear marine debris such as wires or hawsers, out of service cables, and fishing equipment from the cable route prior to installation to support burial. Any debris recovered during these operations will be discharged ashore on completion of the operations and disposed of in accordance with local regulations. The PLGR operation will be to industry standards employing towed grapnels, with the type of grapnel being determined by the nature of the seabed.

Soft benthic habitats and the infaunal communities within them will be disturbed by PLGR activities. Small patches of hard rock veneer or similar are also expected to be crossed in shallower waters.

Taking a conservative approach, the assessment has assumed PLGR operations across the cable route requiring burial i.e., approximately 870 km. The grapnels used for PLGR activities are typically 75 cm wide. Seabed disturbance is expected to be localised and minimal, at a maximum of 0.65 km^2 across the cable route.

3.1.2.2 Plough and ROV cable burial

The subsea cable will require burying within soft sediment to a target burial depth of 1 m below seabed level to support the protection of the cable from potential damage. This will occur in most locations at up to 1000 m water depth, with exception of the NSW cable route where burial will be required to 1500 m water depth to de-risk cable damage from onshore fishing. Burial would occur using a plough that is towed along the seabed behind the cable laying vessel. Ploughing operations to bury the cable are generally conducted at low speeds, typically less than 1.5 knots. This low energy movement reduces the sediment suspension in the water column.

Where burial could not be achieved by ploughing and/or an ROV will be used to conduct post lay inspection and burial operations for areas such as cable and pipeline crossings, splice locations, or branching units in buried areas. The process involves jetting water to liquefy the sediments around the cable so that the cable sinks into the seafloor under its own weight. If existing cables need to be crossed within these water depths, a laying approach will be selected to avoid impacting the crossed cable.

The sediment and infauna communities within the area of this activity are expected to be disturbed. Mobile fauna within the area of disturbance has the potential to be temporarily displaced from the area, however, any benthic species in the direct path of activity will be directly affected by these activities. Recolonisation of disturbed sediments from adjacent habitats is expected to occur within weeks.

As discussed by the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) Commission (2009), the disturbance and habitat impact from construction of the subsea cables are not likely to be detrimental to the overall quality of a region because of the localised and temporary nature of the impacts. Burying of the cable is expected to affect a surface area width of 5 to 10 m if ploughed. The disturbance zone typically associated with ROV jetting is approximately 5 m wide (Carter et al. 2007).

Cable burial activities will be undertaken in a linear manner. As such, impacts are not expected along the entire cable route for the duration of the cable laying activities. Impacts will be temporary and habitat to be affected is considered to be well represented locally and regionally. As such, this activity is not expected to have a significant impact upon environmental matters.

Approximately 862 km of the cable route will require cable burial via use of plough. This is expected to cause a maximum of 8.62 km^2 of seabed disturbance based on a conservative 10 m disturbance corridor. Within VIC coastal waters burial will occur via the ROV for approximately 3.91 km. Based on a conservation approach of 5 m disturbance corridor, the maximum seabed disturbance using the ROV will be approximately 0.0196 km^2.

As such, this activity is not expected to have a significant impact upon environmental matters.

3.1.2.3 Cable surface lay

At water depths beyond 1,000 m, the cable route crosses a variety of habitats consisting of rocky reefs, open sandy seabed, basins and ridges. Where burial is not required for cable protection, the cable will be laid directly on the seabed. Rocky reefs in particular are less resilient to disturbance than soft sediment habitats. Survey data has been used to align the cable to avoid rocky reefs as far as practicable, thus reducing the risk of this impact. Where the cable is laid directly on the seabed, it is expected to remain stationary under its own weight with minimal lateral movement anticipated. As such, ongoing habitat disturbance from post-lay cable movement is not predicted.

Surface-laid cables in deep or hard seabed areas typically settle naturally into seabed contours, causing minimal physical disturbance. Studies have shown no significant changes in seabed morphology or benthic species distribution near surface-laid cables (ICPC & UNEP 2025). For example, research on the ATOC cable off California found no statistical difference in the abundance of 17 animal groups within 1 m and 100 m of the cable, and sediment cores showed infauna were indistinguishable whether near or distant from the cable (Kogan et al. 2003; Kogan et al. 2006; Kuhnz et al. 2015).

While short-term impacts localised to the portion of the cable being laid are likely from increased suspended sediment and turbidity, sands are predicted to settle quickly. Mobile fauna within the area of disturbance may be temporarily displaced, while benthic species in the direct path of cable laying may be directly affected. Impacts may occur from collision with equipment, burial under the cable, or sediment suspension affecting filter-feeding species (Söker et al. 2000).

Re-colonisation of disturbed areas from adjacent habitats is expected to occur relatively quickly. Nevertheless, longer-term, localised changes in the benthic environment may occur due to the cable structure encouraging biofouling species through the introduction of hard substrate (OSPAR Commission 2009; Ragnarsson et al. 2017). As the cable will cross areas of open, sandy seabed, this may cause a localised shift from the natural benthic community. However, based on previous research, this is not predicted to cause significant impact to sensitive environmental receptors.

Approximately 3,379 km of the cable route will be surface laid within State and Commonwealth Australian waters. The maximum cable diameter, assuming a double armoured cable will be used, is 37.5 mm.

The total seabed disturbance from surface laying activities is approximately 0.127 km^2.

3.1.3 Management controls

To reduce or eliminate the impact of seabed disturbance, a number of management controls can be implemented when possible.

– No anchoring of the vessel is planned during cable-lay operations. Vessels may only drop anchor during port calls or other standby periods, in dedicated mooring areas, if required.
– The cable laying route in deep waters will be positioned to avoid underwater features such as rocky reefs, other cables (as far as practicable), or debris.

– Ecologically sensitive areas from a review of benthic survey data and desktop assessments will be avoided if possible.

3.1.4 Environmental outcomes

The activities associated with the cable laying will disturb the seabed and benthic habitats within an area of up to 8.77 km^2 across the 4,249 km cable route within the Australian EEZ, with the actual area of disturbance expected to be significantly smaller. The cable laying activities will occur in/over benthic habitats that are widely represented at a regional scale. Once the cables have been installed, further disturbance or damage to soft sediment habitats and benthic communities is not anticipated. Localised, short-term disturbances to sediments and/or epibenthos living on the cable are expected to occur if any future maintenance is required. This would be an unplanned activity and is addressed in Section 3.13.

The environmental risks will be limited to the immediate surrounds of the cables, and are expected to be short term in nature, with low risk on existing species; as such, risks associated with planned seabed disturbance are considered acceptable and as low as reasonably practical.

3.2 Underwater noise emissions

3.2.1 Impact description

The installation of subsea cables involves various noise-generating activities primarily associated with the vessels and specialised equipment used in each stage of the process. Key activities include pre-lay grapnel runs, surface laying, burial operations, and post-lay inspections, each with distinct noise characteristics. Disturbance to marine fauna (including avifauna) from above ground and underwater noise may occur in response to noise generated by vessel movement as well as installation activities. These operations typically involve the use of a main vessel equipped with Dynamic Positioning (DP) systems (Nedwell et al 2003), which help maintain vessel stability and position during cable laying, adding an additional high-frequency noise source to the main vessel noise that produces noise in the lower frequencies (mainly propeller cavitation and engine/machinery noise).

Other noise-emitting equipment includes ROVs, water jetting devices, and ploughs, which are engaged at different stages, however, the noise emissions of these sources are often masked by noise from the main vessel and dynamic positioning systems (Johannson and Andersson, 2012).

3.2.1.1 Noise source characterisation

Sound emissions associated with the installation of subsea cables are considered to lead to less impacts compared to noisier activities such as seismic surveys, military activities or construction work involving pile driving (OSPAR Commission, 2012).

In the context of acoustic reception by marine fauna, the potential impact of underwater noise requires an understanding of the type and acoustic spectrum of the noise source relative to the sensory frequency range of the marine fauna of interest. Underwater noise sources can be broadly classified as either impulsive or non-impulsive.

The US National Marine Fisheries Service (NMFS, 2018) provides the following definitions:

– “Impulsive - Sounds that are typically transient, brief (less than 1 second), broadband and consist of high peak sound pressure with rapid rise time and rapid decay. Impulsive noise sources can be single pulse (e.g. single explosion, impact pile strike, sonar ping, etc.) or multiple pulses (serial explosions, multiple pile strikes, etc.)
– Non-impulsive - Sounds that can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise and decay times. Examples of non-impulsive noise sources include ship pass-by, rock dumping, etc.”

The noise-generating sources associated with the installation of the subsea cables are considered to be non-impulsive noise sources. The distinction between impulsive and non-impulsive noise sources recognises the fact that impulsive noise sources have sound characteristics that make them more injurious to marine fauna than non-impulsive sources.

For reference to noise levels of cable laying and cable burial activities refer to Table 3.1.

Table 3.1 Reference noise levels of cable-laying and cable-burial activities (non-impulsive sources)

Noise-generating activity	Noise levels[1], L_{rms} dB re 1μPa		Noise characterisation		
	SPL Measured Level	SPL Source Level at 1m	Broadband / Narrowband	Continuous or intermittent	Directivity
130 m vessel with a burial sled (water jet + ROV) (Nedwell et al, 2003)	123 dB at 160 m	178 dB	Broadband 80 Hz to 2 kHz w/ 20 kHz tonal sound	Continuous	Omni-directional
Cable laying vessel with Dynamic Positioning (DP) (Bald et al, 2015)	127.4 to 148 dB at various distances	188 dB	Broadband (peaks at 200-300 Hz and 11 kHz)	Continuous	Omni-directional
Burial vessel (pipe-laying vessel) (Johannson and Andersson, 2012)	130.5 dB at 1.5 km	183.5 dB	Broadband 20 Hz to 3.15 kHz	Continuous	Omni-directional

Note 1: Root-mean squared or L_{rms} dB re 1μPa underwater sound pressure levels (SPLs) are defined from the instantaneous fluctuating pressure (p_t), the static pressure (p_o), and a reference pressure (p_{ref}) of one micro-Pascal (1 μPa) [reference in a fluid medium].

A useful measure of sound used in underwater acoustics is the Sound Exposure Level, or SEL. This descriptor is used as a measure of the total sound energy of an event or a number of events (e.g. over the course of a day) and is normalised to one second. This allows the total acoustic energy contained in events lasting a different amount of time to be compared on a like for like basis. The SEL is typically used to assess the potential of auditory injury to a marine animal as it allows exposure duration and the effect of exposure to continuous noise over a 24-hour period to be taken into account.

To calculate the SEL_{24hr} re 1μPa²s noise level (cumulative exposure to noise over a 24-hour period) using the L_{rms} level, the following formula is used:

$$L_{rms} + 10\log_{10}(N) \ where\ N = \ no.of\ seconds\ within\ a\ 24\ hour\ period\ of\ activity\ operation$$

For the purposes of this assessment, the L_{rms} and SEL_{24hr} source levels presented in Table 3.2 have been adopted:

Table 3.2 Subsea cable installation source levels (L_{rms} and SEL_{24hr})

Activity	Source Level at 1m	
	L_{rms} dB re 1μPa	SEL_{24hr} dB re 1μPa²s
Pre-lay grapnel run (PLGR) / Cable surface laying	188	237 (assuming 24-hour continuous operation)
Cable burial	178	227 (assuming 24-hour continuous operation)

To provide context for the subsea cable installation source levels above, reference source levels (unweighted) for other anthropogenic noise sources that are non-impulsive in nature are provided in Table 3.3.

Table 3.3 Reference source levels of other non-impulsive industrial noise sources (L_{rms})

Type	Example System	SPL Source Level (L_{rms} dB re 1µPa m)	Notes	Source reference
Vessels	Bulk carrier (173m)	178 192	Travelling 8 knots Travelling 16 knots	Source List: A description of sounds commonly produced during ocean exploration and industrial activity (BOEM, 2023)
	Cruise ship (230 m)	176 195	Travelling 10 knots Travelling 19 knots	
	Chemical product tanker (149 m)	183	Travelling 13.8 knots	
Dredging	Trailer Suction Hopper Dredger (TSHD)	189	-	Attachment 7E: Underwater Piling and Dredging Noise Guidelines (SA DIT, 2023)
	Cutter Suction Dredger (CSD) - Large	186	Large (>25,000 kW total installed power)	

In summary, the overall sound pressure levels from cable installation are estimated to range between L_{rms} 178-188 dB re 1 µPa at 1m and have similar noise emissions to those associated with large vessels in transit (176 to 195 dB depending on vessel speed) and dredging operations (186 to 189 dB).

Table 3.4 Noise levels for cable installation equipment [1]

Equipment	Specification	Frequency Range (Hz)	Use (WD water depth)	Sound source level	Operation
USBL Beacons	Sonardyne WSM 6+ or similar	19 kHz to 34 kHz	10 to 1500m	187dB re 1µPA @ 1m 196dB re 1µPA @ 1m	Plough Post-lay Inspection & Burial (PLIB)
Single Beam Echo Sounder	Kongsberg EA640 or similar	12 kHz 38 kHz	1000 to 6000m	171dB re 1µPA @ 1m 185.5dB re 1µPA @ 1m	Cable Laying (Surface Lay)
ROV Burial	RovJet 400 or similar	60 Hz to 28 kHz	10 to 1500m	173dB re 1µPA @ 1m	Post-lay Inspection & Burial (PLIB)

[1] This table is provided for information and comparison purposes only and has not been used for the purposes of noise impact assessment.

3.2.2 Impact analysis

Underwater noise can impact marine life in various ways, depending on its intensity and characteristics. Richardson et al. (1995) identified four zones of noise influence that vary with distance from the source and sound level:

- **The zone of audibility:** This is the area within which a marine animal can detect the sound. However, the ability to hear the sound does not necessarily mean that it will impact the animal.
- **The zone of masking:** In this area, noise can interfere with the animal's ability to detect other important sounds, such as communication or echolocation signals. Estimating this zone is challenging due to limited data on how masking affects marine species; for instance, humans can perceive certain tones even when the overall noise level is low.
- **The zone of responsiveness:** This is the region where noise provokes a behavioural or physiological reaction from the animal. It is typically smaller than the zone of audibility, as not all audible sounds trigger a response.

– **The zone of injury/hearing loss**: In this zone, noise levels are high enough to cause ear tissue damage, potentially leading to Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS). At even closer distances, or with high-intensity sounds like underwater explosions, the risk of physical trauma or even death increases.

This assessment focuses on the zones of injury and responsiveness due to limited scientific evidence for evaluating masking effects. To determine the potential spatial range of injury and disturbance, a review has been undertaken of available evidence, including international guidance and scientific literature. The following sections summarise the relevant thresholds for onset of effects and describe the evidence used to derive them.

Guidance has been taken from the South Australia (SA) Underwater Piling and Dredging Noise Guidelines (SA DIT, 2023) which references the following documents to derive assessment criteria (injury/hearing loss and behavioural response) for marine mammals, fishes and sea turtles:

– Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects (Southall B. L., 2019)
– Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI (Popper, 2014)

Where there were discrepancies between the SA Guidelines and Southall's 2019 recommendations, Southall's 2019 recommendations have been adopted.

3.2.2.1 Assessment criteria for marine mammals

Southall et al (2019) classify cetaceans, sirenians and pinnipeds into functional hearing groups based on their auditory characteristics, into six functional hearing groups, each with an estimated auditory bandwidth as presented in Table 3.5.

Table 3.5 Marine mammals and group specific auditory frequency weightings

Functional hearing group	Generalised hearing range	Example species within hearing group	Auditory frequency weighting
Low-Frequency (LF) Cetaceans (All Baleen Whales):	7 Hz to 22 kHz	– Southern Right Whale (*Eubalaena australis*) – Minke Whale (*Balaenoptera acutorostrata*) – Bryde's Whale (*Balaenoptera edeni*) – Blue Whale (*Balaenoptera musculus*) – Pygmy Right Whale (*Caperea marginata)* – Humpback Whale (*Megaptera novaeangliae*)	LF
High-Frequency (HF) Cetaceans (Majority of Toothed Whales):	150 Hz to 160 kHz	– Bottlenose Dolphin (*Tursiops truncates*) – Common Dolphin (*Delphinus delphis*) – Dusky Dolphin (*Lagenorhynchus obscurus*) – Killer Whale (*Orcinus orca*) – Spotted Bottlenose Dolphin (*Tursiops aduncus*)	HF
Very High-Frequency (VHF)Cetaceans (Other Toothed Whales)	275 Hz to 160 kHz	– Pygmy sperm whale (*Kogia breviceps*) – Harbour Porpoise (*Phocoena dioptrica)* – Dwarf sperm whale (*Kogia sima*)	VHF
Sirenians (SI)	200 Hz and 20 kHz	– Dugong (*Dugong dugon*)	SI
Pinnipeds in Coastal Waters (PCW) Phocid carnivores	50 Hz to 86 kHz	– Leopard Seal (Hydrurga leptonyx)	PCW

Functional hearing group	Generalised hearing range	Example species within hearing group	Auditory frequency weighting
(earless seals, or true seal) in water			
Pinnipeds in Offshore (Deep) Waters (OCW) Other carnivores (eared seals: sea lions and fur seals) in water	60 Hz to 39 kHz	– Australian Sea Lion (*Neophoca cinerea*) – Australian Fur Seal (*Arctocephalus pusillus*) – New Zealand Fur Seal (*Arctocephalus forsteri*)	OCW

The general consensus is that the frequency weighting functions are applicable to the SEL where the frequency weightings reflect the hearing sensitivity of mammals and are indicated by the subscript LF, HF, VHF, SI, PCW, OCW, etc.

The threshold criteria for sound detection capabilities on marine mammals can be categorised into the following key impacts:

- Temporary Threshold Shift (TTS) where normal detection would return after some time, dependent on the intensity of the sound and the duration of exposure.
- Permanent Threshold Shift (PTS) where no recovery of the injury is possible.

The PTS and TTS onset thresholds presented in Table 3.6 have been established based on research by Southall et al. in 2019. In an applied noise management context, TTS criteria are used in preference to PTS criteria to minimise the risk of irreversible auditory damage.

Table 3.6 PTS and TTS onset threshold levels for marine mammals exposed to non-impulsive noise (Southall et al 2019)

Marine mammal hearing group	PTS and TTS threshold levels – Non-impulsive noise	
	Injury (PTS) onset	TTS onset
	SEL_{24hr}, dB re 1μPa^2·s (weighted)	SEL_{24hr}, dB re 1μPa^2·s (weighted)
Low frequency cetaceans (LF)	199	179
High frequency cetaceans (HF)	198	178
Very high frequency cetaceans (VHF)	173	153
Sirenians (SI)	206	186
Phocid Carnivores in Water (PCW)	201	181
Other Carnivores in Water (OCW)	219	199

For non-impulsive noise sources, behavioural responses in marine mammals can include changes in vocalisation, resting, diving, and avoidance of the noise source (NRC, 2005). Behavioural reactions can vary not only among individuals, but also within an individual animal, depending on previous experience with a sound sources, hearing sensitivity, sex, age, reproductive status, geographical location, season, health, social behaviour or context (Ellison et al, 2011).

These responses are influenced by factors such as the characteristics of the noise, potential co-occurrence with marine mammals, and how close the animals are to shore or specific habitats where they may not be able to avoid exposure.

Marine mammals show a wide range of responses to human-made noise, from minor to severe, depending on the received levels, with non-impulsive sources often being less disruptive than impulsive sources. The US National Oceanic and Atmospheric Administration (NOAA) sets the noise exposure criteria for behavioural responses at 120 dB L_{rms} (unweighted) for both cetaceans and pinnipeds when exposed to non-impulsive sources, though adjustments may be made if ambient noise levels are above this threshold (NMFS, 2018). Note should be made that these exposure levels may be revised in the future as further research becomes available.

3.2.2.2 Assessment criteria for fishes and marine turtles

For fish and sea turtles, the most relevant criteria for injury are outlined in the recent *Sound Exposure Guidelines for Fishes and Sea Turtles* (Popper, 2014). Rather than categorising by individual species, Popper et al. (2014) classify fish and sea turtles into groups based on their anatomy and available hearing data for similar fish and sea turtles with comparable anatomical features:

– Group 1: Fish with no swim bladder or other gas chamber, such as elasmobranchs, flatfish, and lampreys. These species are less prone to barotrauma and respond only to particle motion, not sound pressure. An example is the basking shark (*Cetorhinus maximus*), which lacks a swim bladder.
– Group 2: Fish with swim bladders that do not contribute to hearing, like salmonids. While these species are susceptible to barotrauma, they detect only particle motion, not sound pressure.
– Group 3: Fish with swim bladders that are near, but not directly connected to, the ear, such as gadoids and eels. These fish are sensitive to both particle motion and sound pressure, with a broader frequency range than Groups 1 and 2, reaching up to approximately 500 Hz.
– Group 4: Fish with special anatomical structures that connect the swim bladder to the ear, such as clupeids (e.g., herring *Clupea harengus*, sprat *Sprattus* spp., and shads from the Alosinae subfamily). These species are primarily sensitive to sound pressure, though they can also detect particle motion. They have an extended frequency range, reaching several kHz, and generally exhibit greater sensitivity to sound pressure than fish in the previous groups.
– Sea turtles: Sea turtles likely detect sound through bone conduction, which restricts hearing to low frequencies as higher frequencies are dampened by bone. For instance, the leatherback turtle (*Dermochelys coriacea*) has a recorded hearing range between 50 Hz and 1,200 Hz, with peak sensitivity between 100 Hz and 400 Hz.
– Fish eggs and larvae: These are categorised separately due to their increased vulnerability and reduced mobility. There are very few peer-reviewed studies on how eggs and larvae respond to human-made sounds.

The noise exposure criteria for shipping and continuous sounds from Popper et al (2014) are reproduced in Table 3.7.

Table 3.7 Noise exposure criteria for shipping and continuous sounds – fishes and sea turtles

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour (reference only)
		Recovery injury	TTS	Masking	
Group 1 Fish: no swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Group 2 Fish: swim bladder is not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Group 3 and 4 Fish: swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB SPL RMS for 48h	158 dB SPL RMS for 12h	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Sea turtles	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour (reference only)
		Recovery injury	TTS	Masking	
Fish eggs and fish larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) High	(N) Moderate (I) Moderate (F) Low

Notes: rms sound pressure levels (SPL RMS) dB re 1 µPa. All criteria are presented as sound pressure even for fish without swim bladders since thresholds, modelling and monitoring methods for peak particle motion sensitivity are still an active area of research. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

Within the tables, where data exist that can be used to suggest provisional guidelines, received signal levels are reported in appropriate forms (e.g., SPL L_{rms}). Where insufficient data exist to make a recommendation for guidelines, a subjective approach is adopted in which the relative risk of an effect is placed in order of rank at three distances from the source – near (N), intermediate (I), and far (F) (top to bottom within each cell of the table, respectively). In general, “near” might be in the tens of metres from the source, “intermediate” in the hundreds of metres, and “far” in the thousands of metres. The relative risk of an effect is then rated as being “high,” “moderate,” and “low” with respect to source distance and functional hearing group. The rating for effects in these tables is highly subjective and represents consensus within the working group that produced the guidelines.

No auditory frequency weightings are applied to the L_{rms} sound pressure levels (i.e., assessment of SPLs are unweighted).

3.2.2.3 Underwater noise propagation modelling

As the distance from a noise source increases, the level of received or recorded noise decreases. This reduction is mainly due to the geometric spreading of noise energy over a larger area and the absorption of noise by water molecules. Absorption causes greater attenuation at higher frequencies than at lower ones. The way noise spreads (geometrical divergence) is influenced by factors such as water column depth, pressure, temperature gradients, salinity, and the conditions of the water surface and seabed. Consequently, noise propagation can vary even at the same location due to these changing environmental factors. Generally, noise energy tends to spread spherically near the source and shifts to a cylindrical spreading pattern at greater distances, although other environmental factors can create a spread pattern between these two idealised cases. The transition to cylindrical spreading occurs sooner in shallower water, where depth limits the vertical spread of noise. However, in shallow waters, geoacoustic properties of the seabed have a greater influence in terms of sound reflection and transmission. Loosely consolidated sediment particles act like a fluid medium and attenuate sound, stratified seabeds can bend sound waves, while stiff seabed layers like rock can reflect sound, affecting energy transmission back into the water column

Various methods are available for modelling noise propagation between a source and receiver. Simple models apply basic spreading laws, such as a 10 log(R) (cylindrical spreading) or 20 log(R) (spherical spreading) relationship (where R is the distance from the source), to estimate noise levels. More advanced methods, including ray tracing, normal mode, parabolic equation, wavenumber integration, and energy flux models, provide detailed simulations but require extensive input data and computational resources.

A spherical spreading model (i.e. 20 log (R)) has been used in this assessment because it provides a straightforward way to represent noise propagation and can reasonably estimate noise levels at nominal distances from a given noise source. This modelling approach does not account for the complex effects of underwater sound propagation, such as rarefaction, scattering, and reflection from the water surface or the seafloor. The model assumes a uniform sound speed throughout the water column, resulting in sound spreading as a spherical wavefront without any interactions with the sea surface or seafloor. As a result, the sound amplitude decreases in inverse proportion to the distance from the source, and the sound intensity decreases in inverse proportion to the square of the distance from the source.

3.2.2.4 Auditory injury to marine mammals

Distances to the physiological noise exposure onset criteria provided in Table 3.8 were calculated for each marine mammal functional hearing group. SEL_{24hr} dB re 1 µPa^2·s is a cumulative metric that represents the effect of noise within the cable installation period based on the assumption that an animal is at fixed position and continuously exposed to a moving noise source (assumed to be 5 knots). This is considered an unlikely worst-case scenario since, more realistically, marine animals would not stay in the same location or at the same distance from a sound source for an extended period of time. Therefore, the estimated range to an exceedance of the SEL_{24h} criteria does not mean that any animal travelling within this radius from the source *will* be injured, but rather that it *could* be injured if it remained within that range for the entire duration of the cable installation activity.

The results are based on an animal's noise exposure to cable installation activities assuming 24-hour continuous operation. The estimated range at which a permanent threshold shift (PTS) and temporary threshold shift (TTS) could occur is based on the minimum distance from the source at which the PTS and TTS onset thresholds are exceeded. Spectral data for cable laying and cable burial activities have been sourced from the Subsea Noise Technical Report for Berwick Bank Wind Farm (RPS, 2022) and weighted as per the Southall et al. (Southall et al, 2019) auditory frequency weightings.

Table 3.8 Estimated range of auditory injury to marine mammals, metres

Group	Low frequency cetaceans	High frequency cetaceans	Very-high frequency cetaceans	Sirenians	Phocid carnivores in water	Other carnivores in water
PLGR / Cable surface laying						
TTS	290	140	1570	30	30	0
PTS	20	10	150	0	0	0
Cable burial						
TTS	80	90	160	0	10	0
PTS	0	0	10	0	0	0

3.2.2.5 Behavioural response to marine mammals

The estimated distances to the instantaneous L_{rms} 120 dB re 1 µPa level for the key noise generating activities associated with the subsea cable installation are as follows:

– PLGR / cable surface laying: 2.5 km from source
– Cable burial: 750 m from source.

Note should be made that behavioural thresholds are an active research area and behavioural responses to noise can vary significantly both within and between species (Southall, et al., 2021). Recent evidence suggests that a single threshold for behavioural disruption can lead to significant errors in predicting a response.

Applying a single behavioural threshold may oversimplify complex reactions, especially in diverse marine environments. As such, management and mitigation strategies are focused on auditory injury thresholds described in Section3.1.3.

3.2.2.6 Potential effects to fishes and marine turtles

To assess the potential risk to fish species and sea turtles, the risk ratings in Table 3.9 have been used to determine the potential for adverse impacts. The risk ratings are based on the following relative distance categories:

– 'Near' the source: tens of metres from the noise source (e.g. up to <100 metres)
– 'Intermediate' distance from the source: hundreds of metres from source (e.g. up to <1,000 metres)
– 'Far' from the source: thousands of metres from the source (e.g. up to 10,000 metres)

The following impact assessment conclusions can be made based on generic qualitative assessment criteria for fish and sea turtle species due to non-impulsive noise exposures:

– For fish species with no swim bladder (including sharks) or with a swim bladder not involved in hearing (i.e., Group 1 and Group 2):
  - the risk of mortality, potential mortality and recovery injury is ‘low’ at all distances from the source
  - the risk of TTS onset is ‘moderate’ near the source, and ‘low’ at all other distances

– For fish species with swim bladders involved in hearing (Group 3 and Group 4):
  - the risk of mortality and potential mortality is ‘low’ at all distances from the source
  - the estimated range to the auditory injury criteria is presented in Table 3.9.

Table 3.9 Estimated range to auditory injury noise exposure threshold

Activity	Auditory injury type	Estimated range to auditory injury noise threshold, metres
Pre-lay grapnel run (PLGR) / Cable surface laying	Recoverable injury	<10 m
	TTS	30 m
Cable burial	Recoverable injury	< 10 m
	TTS	< 10 m

– For sea turtles (e.g. green turtle or loggerhead turtle):
  - the risk of mortality, potential mortality and recovery injury is ‘low’ at all distances from the source
  - the risk of TTS onset is ‘moderate’ near the source, and ‘low’ at all other distances

– For fish eggs and fish larvae:
  - the risk of mortality, potential mortality and recovery injury is ‘low’ at all distances from the source
  - the risk of TTS onset is injury is ‘low’ at all distances from the source

As such, impacts on fish, sharks and marine turtles from noise sources generated during subsea cable installation activities are expected to be constrained to a short-term period and may result in behavioural responses, which reflect avoidance of the affected regions. Such actions would be temporary in nature and localised. At a population level, the behavioural responses are not expected to be significant.

3.2.3 Management controls

The following management controls would be implemented to reduce the potential for adverse impacts to marine fauna from underwater noise during the subsea cable installation activities:

– If possible, subsea cable installation activities could be timed to avoid periods when marine mammals are likely to be breeding, calving, feeding, or resting within biologically important habitats in the potential noise impact area.

– Ensure a trained crew in marine fauna observation is present during subsea cable installation activities to oversee and enforce standard operational procedures and safety zones. A report will include the location, date, start and completion time, information on the cable installation activity occurring, details of the trained crew members conducting the observations, times when observations were hampered by poor visibility or high winds, and details of any marine fauna species of concern observed including time, distance, species, number of individuals, presence of calves, and observed behaviour.

– Provide all staff with briefings on environmental regulations, marine mammals identification, and specific environmental obligations. Information about marine mammal concentration areas, migration patterns, and key feeding sites would be identified during planning and used to enhance the effectiveness of marine fauna observation.

– Vessel interactions: The interaction of all vessels with cetaceans, pinnipeds and whale sharks will be compliant with Part 8 of the EPBC Regulations (2000). The Australian Guidelines for Whale and Dolphin Watching (DoEE

2017) for sea-faring activities will be implemented across the entire project. This includes the implementation of the following guidelines:

- Caution zone (300 m either side of whales and 150 m either side of dolphins) – vessels must operate at no wake speed in this zone
- Caution zone must not be entered when calf (whale or dolphin) is present
- No approach zone (100 m either side of whales and 50 m either side of dolphins) - vessels will not enter this zone and will not wait in front of the direction of travel or an animal or pod, or follow directly behind
- If there is a need to stop, reduce speed gradually
- Do not encourage bow riding
- If animals are bow riding, do not change course or speed suddenly.

3.2.4 Environmental outcome

Underwater noise emissions generated by vessels and other equipment during subsea cable installation are anticipated to be similar to those from other marine vessels routinely transiting the area, such as commercial shipping. As the vessel is essential for cable installation activities, eliminating its presence is not considered a reasonable or feasible alternative. While noise emissions from the installation equipment may pose a risk to acoustically sensitive species in close proximity, the likelihood of significant adverse impacts remains low given the temporary and localised nature of the activity.

There is potential for migratory species to be present within the area during subsea cable installation works. Whales generally head north to warm waters to breed and give birth from late May to August and return south from September to November (DBCA 2020). Due to the transitory nature of the marine fauna, they are able to move away from noise sources without disruption to feeding and breeding ranges and therefore, it is not anticipated that construction noise would have a significant impact on marine fauna. Behavioural impacts (e.g., avoidance patterns and swimming movements away from the area) are the most probable form of impact to marine fauna as a result of anthropogenic noise generated by this activity, particularly for sensitive species such as cetaceans. Vessel and cable installation noise is anticipated to only induce temporary and localised behavioural impact if species are encountered, with afflicted marine species expected to adopt normal behavioural patterns within a short time frame in the open waters along the cable route.

Underwater noise and vessel disturbance will be temporary at any given location because the vessel will be constantly moving along a pre-determined route. Exposure duration for individual fauna will therefore be limited. The overall duration of the works is also temporary in relation to the life history of the species encountered. Population-level impacts are therefore considered to be unlikely.

3.3 Artificial light emissions

3.3.1 Impact description

Artificial light emissions are likely to occur through the use of lighting on the vessel for cable installation operations, navigation and safety at night.

3.3.2 Impact analysis

Artificial light emissions are likely to occur through the use of lighting on the vessel for operations, navigation and safety at night.

Seabirds

Birds may be attracted or deterred either directly or indirectly by the light source. Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Marquenie et al. 2008). Structures in deep water environments tend to attract marine life at all trophic levels, creating food sources and shelter for seabirds (Surman 2002), and providing enhanced capability for night foraging. Birds may also use light as a cue for migration.

However, seabirds can also be deterred by artificial light and all species are known to be vulnerable to artificial lighting, but more particularly fledglings (DCCEEW 2023). Birds most active at night can be disorientated by artificial lighting, causing collision, entrapment, stranding, grounding and interference with navigation. These behavioural responses to artificial light can yield injury or death for seabirds and light is known to impact seabirds up to 18 km from the light source (DCCEEW 2023).

Marine reptiles

Marine turtles use light for navigation. The attraction of turtles to artificial lighting occurs as the light source has a highly directed light field in comparison to the disparate light of natural navigational light sources (e.g., moonlight) (Witherington and Martin 1996; Witherington 1997). The magnitude of impact has been shown to vary between species and in relation to light wavelength and intensity. Some lights are understood not to affect nesting densities (which excludes wavelengths below 540 nm) (DCCEEW 2023).

Offshore lights can attract in-water dispersing hatchlings, causing them to linger around the light source (e.g., Thums et al. 2016; Wilson et al. 2018). However, most research to date has been on near-coastal dispersal. Dedicated environmental monitoring from drilling rigs revealed that very few, if any, turtle hatchlings approached lit drill rigs at night while those that did approach did not remain around the drill rig for very long (usually less than 30 minutes) (Apache 2007). Therefore, artificial lighting from vessels is not likely to impact on hatchlings even though they may transit through the subsea cable installation route during installation activities.

Artificial lighting is known to disrupt the normal behaviour of nesting female turtles, as well as hatchlings attempting to orient towards the ocean (Salmon 2006). Beaches in the vicinity of the subsea cable installation route are not known to host nesting turtles. It is therefore considered that nesting females and hatchlings are unlikely to occur.

Beaches along the Queensland cable route are mapped as significant turtle nesting habitat. The nesting season begins in November to January and hatching commences in January with late-season hatchlings emerging during May.

Fish and other pelagic species

The response of fish to light emissions varies according to species and habitat. According to Meekan et al. (2001), light trap experiments have shown that some fish and zooplankton species are attracted to light sources, with traps drawing catches from up to 90 m away (Milicich et al. 1992). A study of larval fish populations by Lindquist et al. (2005) around an oil and gas platform in the Gulf of Mexico found that an enhanced abundance of clupeids (herring and sardines) and engraulids (anchovies), both of which are highly photopositive, was caused by platforms' light fields.

The concentration of organisms attracted to light causes an increase in food source for predatory species; marine predators are known to aggregate at the edges of artificial light halos. Shaw et al. (2002), in a similar light trap study, noted that juvenile tunas (Scombridae) and jacks (Carangidae), which are highly predatory, might have been preying upon concentrations of zooplankton attracted to the light field from platforms. This could lead to increased predation rates compared to unlit areas.

The installation vessel will require lighting for safe navigation, security and illumination of work areas during any night works. The potential impacts from artificial lighting on fish and other coastal species are, therefore, considered temporary and mobile across the cable route. Chance of encounter with susceptible species during subsea cable installation activities is considered minimal with a temporary period of exposure. Hence, lighting is not considered likely to have long term influence on behaviour of species encountered during installation activities.

Cetaceans

Currently there is limited evidence suggesting that artificial light sources negatively impact on the migratory, feeding or breeding behaviours of cetaceans, likely because they predominantly use acoustic senses to assess their environment rather than visual stimuli and light sources (Simmonds et al. 2004). However, these species may be indirectly impacted by artificial lighting should their food sources be attracted to light, which could make cetaceans vulnerable to a secondary impact (such as vessel collision or entanglement). Migrating species may also be impacted by artificial lighting through changes to their migration patterns.

Such impacts are temporary and not considered likely to have long term influence on behaviour of species encountered during the subsea cable installation activities.

3.3.3 Management controls

To reduce or eliminate the impact of artificial lighting, the following management controls can be implemented when possible:

- Employ Best Practice Lighting Design for infrastructure that requires to be lit at night in accordance with DCCEEW (2023) National Light Pollution Guidelines for Wildlife. Measures could include modification of light wavelengths, prevention of upward light spill and limiting light intensity for seabirds and maintaining a dark zone between any turtle nesting beach and infrastructure, avoiding direct lighting onto nesting beach or screen barriers for marine turtles (DCCEEW 2023).
- Light spill from the nearshore vessel operations will be minimised where possible using directional lighting. Light shields could be considered to avoid spill if sensitive receptors are determined during activities to be negatively affected.
- Lighting on vessel decks will be managed to reduce direct light spill onto marine waters, unless such actions do not comply with navigation and vessel safety standards (AMSA Marine Orders Part 30: Prevention of Collisions; AMSA Marine Orders Part 21: Safety and Emergency Arrangements).

3.3.4 Environmental outcome

Minimum lighting is required for safety purposes on board the vessels, and for navigational purposes. Vessel presence is required to undertake the activities and therefore environmental consequences due to lighting are possible.

It is necessary for all vessels in Australian waters to comply with the navigation safety requirements prescribed within the *Navigation Act 2012* and the subordinate Marine Orders concerning workplace safety equipment (e.g., lighting) and navigation. While light spill will be reduced wherever possible, the elimination of deck lighting on vessels would result in:

- Increased probability for vessel collisions and accidents
- Presenting new safety risks to crew members
- Non-compliance with marine codes and regulations.

Turtles and shorebirds are identified as being the most sensitive to artificial light sources. Beaches in the vicinity of the subsea cable installation route are not known to host turtle nesting. It is, therefore, unlikely that artificial light generated by the construction activities will interfere with species breeding success and population longevity. Indirect impacts on these and other marine species could include changes in migration patterns; nonetheless, such impacts would be temporary and mobile across the subsea cable installation route and are not considered to pose a significant risk.

3.4 Atmospheric emissions

3.4.1 Impact description

Greenhouse gases (GHG) (including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)) and non-GHG (such as sulphur oxides (SO_X) and nitrous oxides (NO_X)) are emitted as a result of the burning of fuel to power vessel engines, generators and equipment. The fuel predominantly used for these activities would be diesel.

Ozone-depleting substances (ODS) may also be in use by closed-system rechargeable refrigeration systems on-board these vessels.

3.4.2 Impact analysis

Short-term reduction in air quality in the immediate region along the cable route may occur due to the burning of hydrocarbons. This would occur throughout the cable route activities.

Humans and seabirds in the immediate region would be affected by the localised decline in air quality accompanying the emission of non-GHG and GHG. It would also be noted that the emissions would contribute to the national GHG count.

The combustion of fuels from activities is not expected to affect the air quality of coastal communities, as the cable route activities will occur in the nearshore and offshore, away from population areas. In addition, the gaseous emissions are of relatively low quantities, and it is expected that under normal conditions these emissions would undergo rapid dissipation into the surrounding environment.

The likelihood of accidental emission of significant quantities of ODS is deemed to be rare due the maintenance of ODS-containing refrigeration systems on vessels. Despite this, there is potential for the unintentional discharge and brief emission of ODS to contribute to the depletion of the ozone layer. Maintenance of refrigeration systems containing ODS is on a routine, but infrequent basis, and with controls implemented, the likelihood of an accidental ODS release of material volume is considered rare.

Vessel gaseous emissions resulting from the combustion of hydrocarbons is permitted on Australian waters under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*. This Act meets the requirements and obligations outlined in the MARPOL Annex VI. In addition, since the activity is predominantly situated in coastal waters of some distance from populated areas, air emissions will experience rapid dissipation into the surrounding environment and are unlikely to extend to onshore communities.

3.4.3 Management controls

A variety of management controls will be implemented in order to mitigate or eliminate the occurrence of gaseous discharge, where feasible:

- All equipment will be properly maintained in good working order.
- Catalytic converters and exhaust filters will be correctly fitted where appropriate and available to minimise diesel exhaust emissions.
- Idling time of diesel engines should be limited, and engines should not be overloaded.
- Fuel oil will meet regulated sulphur content levels in order to control SO_X and particulate matter emissions.
- Engines will be operated in a manner so that regulated NO_X emission levels are achieved.
- Compliance with MARPOL Annex VI (as implemented in Commonwealth waters by the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (PSPPS Act); and Marine Order 97: Marine pollution prevention - air pollution). In particular:
  - Optimisation of fuel use to increase efficiency and minimise emissions.
  - Use of low sulphur fuel (0.5% m/m) to minimise emissions from combustible sources.

- Implementation of a planned servicing/maintenance system to manage emissions.
- Vessel engines will hold a valid and current International Air Pollution Prevention Certificate (IAPPC).
- ODS will not be deliberately discharged during the maintenance, service, repair or disposal of systems or equipment, and through good maintenance, fugitive emissions will be minimised.

3.4.4 Environmental outcome

In order to reduce emissions, low sulphur-oxide marine-grade diesel would be used to fuel the vessels, as opposed to heavy fuel oil. For the purposes of controlling sulphur oxide and particulate matter emissions into the atmosphere, the applicable fuel will satisfy standardised sulphur content quantities. Under the MARPOL Annex VI requirements, ODS use in closed-system refrigeration systems is considered acceptable. Inadequate workplace conditions (e.g. the lack of air conditioning) and unacceptable food hygiene standards would result from the lack of such systems on vessels.

As such, the removal of ODS closed-system refrigeration systems is not considered feasible. Assuming that the risk of unintentional release of ODS has been mitigated by the consistent maintenance of such systems by qualified staff it can be considered that all feasible measures have been considered and implemented, and that the anticipated environmental impacts of gaseous emissions are acceptable. Given the international acceptance and industry-wide adoption of the MARPOL standards, it is accepted that compliance with the corresponding MARPOL requirements would translate into diminished environmental impacts from atmospheric emissions to as low as reasonably possible.

3.5 Planned discharges

3.5.1 Impact description

The possible discharges to the surrounding marine environment are sewage and food waste, brine, cooling water and deck drainage.

3.5.2 Impact analysis

All waste is expected to be disposed on land at an identified licensed waste management facility and transported in accordance with its waste type classification and category.

It is envisaged that non-hazardous planned vessel discharges will be minimal and continuous. This will also be dependent on the total number of people on board the cable laying vessel and any rainfall received during the period. A reduction in water quality in associated waters is one consequence of non-hazardous substances discharge. Such effects are short-lived, lasting hours, and are typically localised and restricted to surface water layers (< 5 m). Short-term changes to existing environmental conditions are not anticipated for waters 100 m away from the source of discharge as a result of the rapid dispersion and dilution of the discharge with increasing distance from the discharge origin.

The following provides a description of possible planned discharges associated with the cable route activities. It is noted that any planned discharge is to be undertaken in accordance with state and international obligations.

Water turbidity and oleaginous discharge

Increases in water turbidity could be a possible consequence of food waste or sewage discharge into surrounding waters. The discharge of water from deck drainage and vessel discharge could lead to increases in turbidity and induce toxic effects in marine organisms within the surrounding area.

Water temperature

Water used for cooling of vessel engines and other equipment will be discharged at temperatures above surrounding seawater. The cooling water discharge will transmit heat to the surrounding waters while also mixing with the larger body of water into which it is released.

While vessel design does vary, all vessels maintain the same discharge design, where cooling water is emitted into the surrounding waters above the water line. This discharge mechanism allows for the cooling and oxygenation of the heated discharge water before it is released into the immediate marine environment. It is anticipated that the impact of cooling water discharge on the water quality of the surrounding environment will be minimal, given the relatively low quantities of discharge, minor differences in temperature, release above water line, rapid mixing and expanse of the ocean's water around the vessel.

Brine wastewater

Brine discharge is an output of the seawater desalination process part of typical onboard vessel operations. The discharged brine typically has a salt content 18-70% higher than that of seawater. Brine discharge volume is proportional to the fresh/potable water demands of the vessel and people on board. Due to the higher density of desalination brine relative to seawater, the brine discharge will sink and diffuse into the ocean currents. Furthermore, the volumes of the brine discharge is very small relative to the volume of water displaced around a vessel.

Released brine, similar to cooling waters, will mix into the surrounding environment rapidly such that differences are minor within 100 m of release point. It is therefore expected that the impact of brine discharge on the surrounding water quality of the activity zone will be minimal, given that the discharge volume and increase in salt concentration is low in comparison to the volume of water in the open sea in the area.

Nutrient enrichment

Eutrophication can be a consequence of food waste and sewage discharge. Eutrophication can lead to changes to plankton within the affected zone, affecting the marine species in the area, which feed on plankton. According to Costello and Read (1994), discharge into the sea typically dilutes to 1 in 1000 dilution levels within half an hour. These findings indicate that it is unlikely for acute toxicity to develop at ecologically significant locations nor is it likely that detectable levels would be achieved at discharge locations. On this basis, no impacts to the environment, including nutrient enrichment from sewage management are expected. Relevant legislative requirements regarding waste release to the environment will be followed by the vessel during all operations.

3.5.3 Management controls

To mitigate or lessen planned discharges, the following management plans would be implemented:

- Sewage and food waste will be collected, stored, processed and disposed of in accordance with the relevant State legislation and Australian regulations (AMSA)
- Outside of State waters, liquid substances will be discharged in compliance with MARPOL, including:
  - Untreated sewage will be stored onboard and disposed of onshore at a reception facility or to a carrier licensed to receive the waste or discharged at a distance of more than 12 nautical miles from the nearest land in accordance with Regulation 11 of MARPOL Annex IV.
  - Treated sewage will be discharged in compliance with Regulation 11 of MARPOL Annex IV.
  - Sewage system will be compliant with Regulation 9 of MARPOL Annex IV and be maintained in accordance with the vessels planned maintenance system.
  - As per MARPOL Annex IV/AMSA Marine Order 96, any vessel licensed to carry more than 15 persons will have an International Sewage Pollution Prevention Certificate.

- Vessels may discharge oily water after treatment to 15 ppm in an oily water filter system as required by MARPOL Annex I Regulations (for the prevention of pollution by oil). To discharge, the vessels will require a current International Oil Pollution Prevention (IOPP) certificate for oily water filtering equipment, and a current calibration certificate for the bilge alarm.

– Vessel masters will ensure that the maximum carrying capacity of the sewage system is not exceeded. All wastes will be disposed on land at an identified licensed waste management facility and transported in accordance with its waste type classification and category.

– Scupper plugs or equivalent will be available on vessel decks where chemicals and hydrocarbons are stored and frequently handled (i.e.' high risk' areas). Non-hazardous, biodegradable detergents will be used for deck washing.

– The vessel operator will record the quantity, time and onshore location of the oily water disposal in the vessel Oil Record Book.

3.5.4 Environmental outcomes

To undertake the subsea cable installation activities, vessel presence is required, and no alternative is available. Therefore, food, brine, cooling water, sewage and oleaginous discharge will be produced during the course of these activities. Under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, a representation of MARPOL Annex IV, V and I requirements respectively, permits the disposal of these non-hazardous substances into the sea by vessels within Australian waters.

Another possible course of action is to retain untreated sewage and food in storage until it can be disposed of at an onshore reception facility. This alternative would require one vessel, additional or currently available, to conduct regular trips to transfer and return wastes to shore.

This process would involve increases in fuel consumption and port movements, as well as the need for a licensed onshore waste treatment facility. Due to these factors, the onshore disposal option would result in an increase in environmental risk which, given the relatively small quantities of discharge involved, would be unjustifiable in comparison to the planned discharge option which is considered environmentally acceptable and preferred due to the minimal volumes of waste involved over a brief duration. The strong coastal currents and well-mixed waters that characterise the majority of the site would also enhance the dilution and dispersion of any discharge, further reducing the effects of any waste released into the surrounding waters.

The waste retention and discharge options both have minimal impact on the environment and comply with the conditions of MARPOL. Considering the operational factors mentioned previously, the onboard treatment of waste is considered more feasible and more likely to be adopted for most cases during this activity. Given the international acceptance and industry-wide adoption of the MARPOL standards, it is accepted that compliance with the corresponding MARPOL requirements would translate into diminished environmental impacts from planned discharges to as low as reasonably practicable.

3.6 Interference with other users

3.6.1 Impact description

Other impacts may arise from unrelated shipping traffic crossing the path of the cable laying vessel. Additionally, other stakeholders may also be impacted by the proposed action. Impacts to stakeholders and other users are assessed in further detail in Appendix D – Other Considerations. Given the cable route is a planned alignment which will cross navigational waters and areas utilised for both recreational and commercial fishing, this activity may result in the temporary reduction of accessibility to these areas or require other vessel operators to re-route vessel movements to avoid crossing paths with cable laying vessels. Once cables are laid on the seabed, there is also a risk that fishing equipment could interact with the cable, causing entanglement.

3.6.2 Impact analysis

The potential impact of the interim occupation of an area by subsea cable installation vessels is the temporary loss of access to fishing grounds and navigational waters within the cable route. There is potential that fishing would be disrupted, that fishing apparatus may be damaged upon catching onto the equipment or that vessels may be required to change navigational course to avoid collision risk.

The visible vessel presence at the site during the installation period may prove a reasonable and recognisable obstacle to regional shipping traffic. An installation vessel in operation will have limited manoeuvrability, meaning that all other maritime traffic may need to avoid the vessel and its associated in-water equipment. Normal maritime procedures are followed by all vessels for communications that assist with mitigation of interference risks.

Interference or entanglement risk associated with fishing activities would be minimised via appropriate stakeholder engagement and notification.

3.6.3 Management controls

The following management controls have been considered and will be implemented, where feasible, in order to mitigate or remove interference issues between cable laying vessel and other users of the sea:

– Cable laying related activities will be undertaken in accordance with all marine navigation and vessel safety requirements under the International Convention of the Safety of Life at Sea (SOLAS) 1974 and *Navigation Act 2012*. For the vessels, this requires equipment and procedures to comply with AMSA Marine Order - Part 30: Prevention of Collisions, and Marine Order - Part 21: Safety of Navigation and Emergency Procedures.
– Stakeholder consultation (local councils, fishing bodies, etc.).
– Notification to the following Australian Government agencies will be made prior to commencement of cable laying activities:
  - The Australian Hydrographic Office of proposed activity, location (i.e. vessel location) and commencement date to enable a Notice to Mariners' to be issued
  - The Australian Maritime Safety Authority (AMSA) Rescue Coordination Centre (RCC) of proposed activities, location (i.e. vessel location) and commencement date to enable an AusCoast warning to be issued
– The cable laying vessel will be equipped with all navigational and safety requirements for operation in Australian waters. These may include an automatic identification system (AIS) and an automatic radar plotting aid (ARPA) system capable of identifying, tracking and projecting the closest approach for any vessel (time and location) within radar range (up to approximately 70 km).
– Visual observations will be conducted by trained watch keepers on the cable laying vessel 24 hours per day to support management of collision risk or entanglement/interference with other users.
– Where possible, target cable burial depth of 1 m below seabed level can be achieved using plough or water jet burial to avoid interference with over users
– In shallow water depths (0 to 10 m) the cable will connect into existing infrastructure to limit any risk of entanglement or interference with inshore waterway users.

3.6.4 Environmental outcome

As cable laying-related activities cannot be undertaken without vessel presence, the vessels may not be removed to eliminate the associated issues. However, there is potential for disruption to marine vessel operations, with recreational fishing activities likely to be temporarily affected via need to adjust course to avoid collision/overlap risk during the installation period. As such, stakeholder consultation and marine user notifications, which are industry standard processes, will be implemented for the activity in order to inform and mitigate the impacts on vessels. Notifications will also be undertaken to inform all maritime users of action (including location and duration) to support management of collision risk.

Apart from engagement and consultation with other vessels, no other management controls have been identified to mitigate the possibility of disruption to commercial vessel operations. Because of this, the impacts of marine vessel disruption have been deemed reasonable and controlled to keep the effects of vessel operation to existing maritime traffic as low as reasonably possible.

3.7 Potential disturbance from decommissioning

3.7.1 Impact description

The cable has an operational life expectancy of approximately 25 years, with most cables exceeding this. When cable operations cease, there are two options for decommissioning: retaining the cable in its place (that is, not removing it) or removing the cable from the seabed.

If the cable is kept in place, there is no further disturbance impact expected on the environment as it has already been present in the environment for approximately 25 years (Taormina et al. 2018). Some exposed areas of the cable may have been overgrown by taxa and, as the cable is inert, no contamination potential apart from leaving the actual cable infrastructure in place is expected.

If the cable is to be removed, the impacts to the environment would be considered similar to the impacts of installation (Taormina et al. 2018). For example, resuspension of sediments, disturbance of established benthic habitats and organisms, entanglement of marine fauna and other potential risks associated with vessel operations previously discussed in this report may be realised.

3.7.2 Impact analysis

Leaving the cable in the environment will enable the habitat which was established post cable installation to remain as-is, with no further disturbance expected. Cables usually provide a settlement substrate and, after 25 years, can be heavily encrusted with marine life (Taormina et al. 2018). In some cases, cables may not be distinguishable from the surrounding seabed.

Removing the cable would directly impact the habitats and encrusting organisms that have developed on and around the cable, resulting in disturbance to that benthos. Removal would also resuspend and disturb sediments, carrying risk of burying nearby sedentary species and slow-moving marine fauna (Taormina et al. 2018). However, turbidity increases would be considered to be localised, with only short-term effects from which the system would recover rapidly (Taormina et al. 2018).

Operation of the vessel to remove the cable would also result in additional impacts from generation of shipping-related artificial light, artificial noise, planned discharges and atmospheric emissions. It would also carry risk of unplanned impacts discussed later in this report occurring as a result of liquid and solid waste spills and marine fauna collisions/entanglements.

3.7.3 Management Controls

While the cable design life is 25 years, the actual end of operational life may be beyond that. As such, the conditions regarding decommissioning may change from current day. Current industry practice is that disused cables are left in-situ but may be removed during future projects seeking to install overlapping new infrastructure; that removal would occur as part of a PLGR activity.

To ensure any decommissioning review is current for the time of decommissioning, requirements for this action will be reviewed in future at the time of cable decommissioning. The review will take into account the most cost effective, environmentally friendly and best practicable methods, legal requirements and industry practices at that time. The following management controls will be considered to mitigate potential disturbance from decommissioning:

– There are no management controls required for the option of retiring the cable in place; and

– If the cable is to be removed, it will be recovered with options to be salvaged in accordance with all relevant environmental legislation and following ICPC recommendations. Management controls proposed for all other impacts associated with cable laying activities will also apply here.

3.7.4 Environmental outcomes

If the cable is to remain, the environment will be maintained in the same condition as it was for the past 25 years.

Using current methods, the activities associated with removal of the cable would be expected to disturb the seabed and benthic habitats within a minimum area of 8 km^2 along the cable route, assuming a 1 m footprint. The actual distance footprint would, however, be dependent on methods to be applied for retrieval and connectivity of the cable to habitat at the time of decommissioning. The cable removal activities would, per installation, occur in/over benthic habitats that are currently widely represented at a regional scale. Localised, short term disturbances to sediments and/or epibenthos living on the cable would be expected to occur.

The environmental risks are therefore predicted to be limited to the immediate surroundings of the cable and would be expected to be short term in nature. However, any future decommissioning review will take into account potential risks at the time of the proposed action adopting leading industry practices and identify measures/strategies for any proposed action that have the lowest practical environmental impact risk.

3.8 Marine fauna collisions or entanglement

3.8.1 Impact description

There is potential for collision to occur between marine fauna and the installation vessel. This potential is low as the installation vessels, particularly when the vessel is operating at maximum speeds of 1 knots during burial operations and up to 8 knots when the cable is laid directly on seabed in >1000 m water depth.

3.8.2 Impact analysis

A number of instances of vessel collisions resulting in the death of the involved cetacean have occurred in Australian waters though data suggests that these instances are commonly associated with fast ferries and container ships (WDCS 2006). Some cetaceans are known to be capable of detecting and manoeuvring to avoid collision with vessels (WDCS 2006). Humpback whales cruise at 3.7 knots while Southern Right Whales cruise at 1.6 knots (NSW OEH 2014) and are considered relatively able to navigate away from vessels undertaking these construction activities.

There are a variety of whale responses to the advance of vessels, with some whale species known to be inquisitive and approach vessels that are slow moving or stationary, while other whale species dive or stay motionless in the presence of vessels. However, whales typically do not approach vessels and are more likely to adapt evasive behaviours to avoid nearby ships, including the employment of longer dives.

The risk of potential vessel strike is considered low for all marine species, including cetaceans, marine turtles, sirenians, pinnipeds, fish and seabirds. This risk accounts for the avoidance behaviour marine fauna species adopt to evade vessels until the vessel disruption has elapsed.

Works will occur where recreational and commercial fishing and other vessels currently traverse. The risk that the additional vessel presence in the activity location will have considerable effect on marine fauna within the area is relatively small. This is due to the relatively low vessel speeds during the activity, with installation vessel speeds typically ranging between 0.5 knots for ploughing to up to 6 knots for surface cable laying.

The subsea cable installation is planned to commence in late 2025 into 2026, as such there is potential that the activities will overlap with the migratory windows of shorebirds and marine species, such as cetaceans, given the cable installation activities will occur across an estimated timeframe of 10 to 12 months. Even if cetaceans are present, the installation vessel is not considered a direct threat as the vessels will be moving at speeds below 8 knots during surface laying operations. As such, the impact of this activity on (migratory) cetaceans is expected to be minor, as interactions with cetaceans can be avoided or minimised through available operational controls.

3.8.3 Management controls

The following controls will be adopted and implemented to mitigate or eliminate the risk of collision between installation vessel and marine fauna:

- A trained crew member will act as a Marine Megafauna Observer during cable installation operations particularly when program overlaps with peak whale migration season
- Operations of vessels will be commensurate with Part 8 of the EPBC Regulations (Interacting with Cetaceans and Whale Watching)
- The Australian Guidelines for Whale and Dolphin Watching (Commonwealth of Australia 2017) for sea-faring activities will be implemented across the entire project. This includes the implementation of the following guidelines:
  - Caution zone (300 m either side of whales and 150 m either side of dolphins) – vessels must operate at no wake speed in this zone
  - Caution zone must not be entered when calf (whale or dolphin) is present
  - No approach zone (100 m either side of whales and 50 m either side of dolphins) – vessels will not enter this zone and will not wait in front of the direction of travel or an animal or pod, or follow directly behind
  - If there is a need to stop, reduce speed gradually
  - Do not encourage bow riding
  - If animals are bow riding, do not change course or speed suddenly

3.8.4 Environmental outcomes

As the cable installation activities require the presence of vessels, there is no potential for the elimination of vessels from the locality. Vessels typically operate at maximum speeds of 1 knot during burial activities and up to 8 knots during surface lay operations. In order to reduce the chance of vessel interaction with marine fauna, the identified management and legislative control measures would be implemented. The cable laying vessel will be very slow moving so collision risk will, therefore be limited. On this basis the potential risks associated with collision and interference with marine animals from vessel activities is considered to be as low are reasonably practical.

3.9 Pest introduction and proliferation

3.9.1 Impact description

Invasive marine pests (IMPs) are identified as marine plants, animals and algae, which have been introduced into a location that is not within their natural dispersal range, but which provides conditions that support their survivorship (DAFF 2009). Vessels carrying IMPs may unintentionally but successfully introduce these species to the region where the activity is occurring. IMPs may be carried within the external biological fouling on the vessel hull, within seawater pipes (e.g., cooling water) and associated infrastructure or on submersible marine instruments and equipment. Ballast water exchange may also allow for the transportation and proliferation of IMPs within the area of activity.

Before vessels can proceed to the site location, quarantine obligations may have to be fulfilled by all vessels, particularly for vessels sourced from overseas, if any. Ballast water exchange record requirements will need to be complied with. Internationally sourced vessels will also be required to maintain possession of Australian Quarantine and Inspection Service (AQIS) Clearance documentation in order to verify compliance with Mandatory Ballast Water Requirements or verify biofouling management measures outlined by the AQIS.

3.9.2 Impact analysis

IMPs at risk of introduction to the areas along the cable route predominantly originate from Southeast Asian countries and from established IMP populations within many Australian ports.

Ecosystem health, biodiversity, fisheries, aquaculture, human health and waterway industries including tourism are at potential risk from the impacts of IMPs (DAWR 2018; Wells 2009). The extent of the detrimental effects introduced marine pests may have includes depletion of viable fishing areas and aquaculture stock, out-competing native flora and fauna, over-predation of native flora and fauna, reduction of coastal aesthetics and increased maintenance costs, human illness through released toxins, reduction in vessel performance, damage to vessel engines and propellers and damage to industrial infrastructure.

The introduction of new species is not a rare occurrence. However, the physical, chemical and biological circumstances of the environment into which the species has been introduced are important determining factors as to whether the species will successfully establish and become an invasive pest.

3.9.3 Management controls

The following controls and processes have been considered, where feasible, in order to mitigate or eliminate the risk of introducing pests:

- Vessels should be sourced locally wherever possible.
- International vessels arriving in Australia from a foreign port or location, as well as domestically sourced vessels, should adhere to Australian quarantine requirements.
- The management of ballast water prior to entry to Australian waters must follow AQIS guidelines and compliance requirements in relation to marine pest introduction risk management for any internationally sourced vessel.

3.9.4 Environmental outcomes

Organisms from the natural environment collect on vessels and submersible equipment as biofouling. Vessels also require ballast water for safe operational purposes. As such, these occurrences and risks are difficult or impractical to eliminate.

To mitigate the possibility of introducing IMPs, the planned activities will be conducted with equipment and vessels, which would ideally have been operational and active within Western Australian waters, or Commonwealth waters since their last dry-dock inspection or cleaning session. Where possible, equipment should not be obtained from higher risk areas in Southeast Asia susceptible to IMPs.

Shallow water environments are the predominant preferred habitat for the successful introduction of most known marine pests. As the location of the cable laying activities include shallow coastal waters, there is potential that an IMP would be able to adapt and develop a successful translocation to the areas within the cable route or surrounding region. However, with the adherence of vessels to biofouling regulations, the chance of a successful translocation for IMPs is considered unlikely.

Furthermore, Commonwealth government quarantine requirements and practices consistent with the National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry (MPSC 2018) will be observed and adhered to by internationally sourced vessels as is the industry standard. Biofouling legislation undergoes intermittent revision and as such, Commonwealth quarantine requirements and practices along with industry standards may change in the near future. If amendments to legislation occur, relevancy of these controls should be undertaken. At time of writing all controls applied are considered leading practice for biosecurity management such that the risk of the successful introduction of an IMP is considered as low as reasonably practicable.

3.10 Accidental release of solid waste

3.10.1 Impact description

Accidental spillage of material from vessels, and incorrectly disposed items, may cause the unintentional release of waste into the surrounding marine environment.

3.10.2 Impact analysis

There is capacity for non-hazardous solid waste such as plastic bags to detrimentally affect the environment and cause entanglement or be ingested by fauna. The entanglement and ingestion of non-hazardous solid waste is a risk particularly prevalent for seabirds and marine turtles. The ingestion of solid wastes like plastic bags can consequently result in internal tissue damage, prevention of normal feeding behaviours and potentially death of the affected fauna.

3.10.3 Management controls

The following management controls have been considered and will be implemented in order to mitigate or remove the risk of accidental solid waste release:

- Appropriate waste containment facilities will be included on the vessel as well as onshore and managed to avoid overflow or accidental release to the environment.
- No waste materials will be disposed of overboard; all non-biodegradable and hazardous wastes will be collected, stored, processed and disposed of in accordance with Regulation 9 of MARPOL Annex V.
- Hazardous wastes will be separated, labelled and retained in storage onboard within secondary containment (e.g. bin located in a bund).
- All recyclable and general wastes to be collected in labelled, covered bins (and compacted where possible) for appropriate disposal at regulated waste facility.
- Solid non-biodegradable and hazardous wastes will be collected and disposed of onshore at a suitable waste facility or to a carrier licensed to receive the waste if required by legislation.

3.10.4 Environmental outcomes

Small amounts of solid non-biodegradable and hazardous wastes will be generated during the cable laying activities. Storage of these wastes on board in fully enclosed containers is considered good (and common) practice within this industry. During the activities, removal of these wastes from the activity area to appropriate regulated waste facilities onshore should be implemented on a regular basis.

During the activities, given the adoption of the industry standard management controls listed above, it is considered that all practicable measures have been implemented and the likelihood of solid wastes being discharged to the environment has been reduced to as low as reasonably practicable.

The unplanned release of non-hazardous and hazardous solid wastes through inadequate containment and practices is unlikely to have any significant environmental effects, as impacts would be temporary and localised. The management controls are considered effective in reducing the potential environmental impact to the marine environment. As such, the risk associated with unplanned releases of non-hazardous and hazardous solid wastes is considered as low as reasonably practicable.

3.11 Accidental release of hydrocarbon, chemicals and other liquid waste

The risk from hydrocarbon release as a results of vessel collision is considered to be extremely rare and is therefore not considered as part of this assessment.

3.12 Dropped objects

3.12.1 Impact description

Damage to benthic habitats can occur due to an object being dropped overboard (e.g. equipment falling from vessel deck). Any marine organisms associated with the affected benthic habitat within the dropped object's footprint may also be harmed.

3.12.2 Impact analysis

3.12.2.1 Disruption of habitats

Disturbance of marine biota within the affected habitat would occur although the habitat itself would not be permanently destroyed. Due to the gradual infill process of such seabed disturbances, the effects on the seabed caused by a dropped object may persist for a length of time even if the object was retrieved. Physical damage of any sessile or slow-moving fauna and epibenthos may occur within the area of disturbance caused by the dropped object.

The current indicative alignment of the cable is within predominantly coarse sandy stretches; the risk from dropped object on marine fauna is therefore considered negligible.

3.12.2.2 Additional environmental implications

Injury to fauna (e.g. entanglement or ingestion) and deterioration of the habitat or water quality in the immediate area are also potential indirect consequences of dropped objects.

As noted under Section 3.10, pollution and contamination caused by the discharge of hazardous solid waste into the marine environment can have direct and indirect effects on the marine biota. Physiological injury from ingestion or absorption and other chemical impacts may affect individual organisms.

3.12.3 Management controls

The following management controls will be implemented to reduce or eliminate the impact of dropped objects on the environment:

– All equipment and gear on the vessels should be securely fastened during mobilisation/demobilisation.
– Lifting is to be carried out by competent personnel using equipment that is suitable, certified and maintained.
– Waste management controls are to remain effective to reduce risk of release of wastes that could be ingested or cause entanglement.
– During the activities, detailed records of equipment lost overboard or dropped will be maintained and reviews will be undertaken to reflect on methods to mitigate repetition of the incident.

3.12.4 Environmental outcomes

Procedures have been implemented for each specific lifting/handling requirement and would be performed should any equipment lifting be needed. The equipment used for lifting operations is to be maintained as specified in the planned maintenance system.

The chance of a dropped object affecting the environment is deemed to be reduced to levels as low as reasonably possible with the adoption of these industry accepted controls and procedures.

3.13 Seabed disturbance associated with cable maintenance

3.13.1 Impact description

The design life of the cable system is 25 years. Once the cable is installed, there is generally no requirement to access and maintain the cable.

If unplanned maintenance is required, cable maintenance activities necessitate that the cable be retrieved from the seabed. This has the potential to damage habitats and associated biota that lie within the footprint of retrieval activities and immediately adjacent to the footprint.

3.13.2 Impact analysis

Cable maintenance is typically undertaken in the following manner:

– Initial cutting drive, where the repair ship pulls a grapnel with cutting blades perpendicular across the expected cable line
– Recovery of a (expected) fault free section of the cable via grapnel retrieval
– Recovery of a section of fault free cable past the faulty section via grapnel retrieval
– Fault isolation and cable repair between the two sections retrieved
– Final splice, confirmation tests and return of the repaired cable to the seabed.

Cable maintenance operations (including associated vessel movements) have the potential to occur across a large span of marine seabed, perpendicular to the portion of the cable needing repair. The area of potential disturbance associated with cable retrieval activities depends on water depth, and the number of grapnel runs required in retrieving the cable. Grapnel size will vary depending on the benthic substrate and conditions in the area of the cable maintenance; however, the typical grapnel width is 40 cm.

Disturbance of the benthic habitat and associated communities will be realised as a result of each grapnel run. This will include direct disturbance as the grapnel creates a furrow in the seabed, or indirect disturbance associated with increased suspended sediment and turbidity. Impacts are expected to be localised to the immediate vicinity of the grapnel run and cable, and temporary, with recovery timeframes dependant on water depth, sediment type and characteristics of the in situ benthic communities.

Given the need for grapnel runs to be conducted perpendicular to the cable, there is potential for nearby sensitive habitats to be impacted during cable retrieval activities. This could include localised physical damage and mortality to the epibenthos (for example, algae and sponges) and any sessile or slowly moving fauna.

As described by preceding sections addressing disturbance to the seabed, localised disturbance impacts are expected to recover rapidly. As such, grapnel deployment for cable maintenance is not anticipated to result in permanent or long-term impacts.

3.13.3 Management controls

To reduce or eliminate the risk of habitat disturbance from cable maintenance activities, the following management controls will be implemented should cable maintenance be required (considered rare):

– The cable will have varying levels of armouring, depending on seabed conditions. This will reduce the potential for third party damage (and thus required maintenance) to the cable.

- Cable placement activities to include detailed records of cable locations to enable relative certainty of cable positioning during cable retrieval activities and increased risk from multiple grapnel runs.
- To minimise impact footprint selection of grapnel sizes is to be based on smallest available to achieve required outcome, where possible.

3.13.4 Environmental outcomes

Any cable maintenance will be performed by a specialist group who have established targeted procedures to manage identified risks. Localised, short-term disturbances to sediments and/or epibenthos living on unburied cable/within the disturbance footprint of the grapnel are expected to occur as a result of unplanned maintenance. Robust cable design and use of cable armouring will mitigate the likelihood of cable breakages, thereby reducing the number of cable maintenance events likely to be required during its design life and subsequent associated seabed disturbance. Through industry accepted controls and procedures, the likelihood of maintenance adversely impacting marine habitats in and around the cable alignment is considered to be reduced to as low as reasonably practicable.

4. Significant impact criteria assessment

Assessment indicated that activity-specific controls are relevant to proposed works for reduction of risk of potential to impact upon MNES that have been identified in Appendix B as likely to or may occur within the project area at the time of the subsea cable installation works. The potential to significantly impact MNES has, therefore, been assessed on the basis that impact mitigation controls identified in the previous sections are in place. The assessment was conducted against the EPBC Significant Impact Assessment Guidelines 1.1 (Department of the Environment (DoE) 2013) and considered:

– Species distribution and habitat requirements
– Likelihood of interaction with the timing of the cable installation
– Potential impact pathway
– Relevance of project impact management and mitigation measures at controlling risk of interference.

Findings of this assessment are split into three tables to align assessment against significant impact criteria for different MNES groupings. Threatened Ecological Communities have been assessed in Table 4.1. Additionally, Threatened species have been separated into Table 4.2 (critically endangered and endangered species) and Table 4.3 (vulnerable species), whilst migratory species are assessed within Table 4.4. Significant impacts to the Commonwealth Marine Environment are assessed within Table 4.5.

Assessment has been completed with regards to the hierarchy of protection status offered to species such that those species that are recognised to be endangered, vulnerable and migratory species are only assessed against endangered criteria. Accordingly, the migratory species assessment only includes those species that are not also considered to be endangered or vulnerable.

Importantly, the assessment found:

– There are no Wetlands of International Importance identified within the project area. As such, assessment of significant impacts to Wetlands of International Importance was not undertaken
– The Great Barrier Reef Marine Park was not identified as being in proximity to the cable route. As such, assessment of significant impacts to Great Barrier Reef Marine Park was not undertaken
– No world heritage properties were identified in proximity to the cable route. As such, assessment of significant impacts to World Heritage Properties were not undertaken
– No National Heritage Places were identified in proximity to the cable route. As such, assessment of significant impacts to National Heritage Places were not undertaken.

Table 4.1 Significant Impact Criteria Assessment for Threatened Ecological Communities

<table>
<tr><th>Significant Impact Criteria</th><th>Impact Outcome</th></tr>
<tr><td colspan="2">An action is likely to have a significant impact on extinct in the wild species if there is a real chance or possibility that it will:</td></tr>
<tr><td>Adversely affect a captive or propagated population or one recently introduced/reintroduced to the wild, or</td><td>Unlikely
Giant Kelp Marine Forests of South-East Australia
The giant kelp marine forest of south-east Australia ecological community was identified as having the potential to occur along the VIC cable route. The species are highly dependent on rocky reef habitats for their holdfasts to establish and anchor to the seafloor.
The VIC cable routes, however, intersects low to high relief high energy infralittoral rock before continuing over low relief high energy infralittoral rock out to the coastal waters limit. The presence of giant kelp was not observed along rock outcrops during the MRS.
Where rock outcrops cannot be avoided along the cable route, the cable will be laid on the seabed surface instead of ploughed. This may potentially increase the substrate area needed for kelp formation. Additionally, to reduce seabed disturbance where cable burial is proposed this will be done via the Post Lay Inspection Burial ROV.
With the implementation of identified management measures, particularly those relating to managing the risk of avoiding sensitive habitats, interference with animals, risk to prevent pest introductions occurring, adverse effects to the giant kelp TEC is unlikely to occur as a result of the cable route and associated installation activities.</td></tr>
<tr><td>Interfere with the recovery of the species or its reintroduction into the wild</td><td>Unlikely
Giant Kelp Marine Forests of South-East Australia
As identified by DCCEEW 2024 the key priority actions for the Giant Kelp Forests TEC include
– The eradication of long-spined sea urchins before seeding with kelp sporophytes
– Ongoing management of marine invertebrate populations to support lasting kelp persistence, and
– The involvement of diving communities in going stewardship
The cable route and associated installation activities are not anticipated to impact key priority actions associated with the recovery of the giant kelp species due to the nature of the works.
With the implementation of identified management measures, particularly those relating to managing the risk of avoiding sensitive habitats, interference with animals, risk to prevent pest introductions occurring, interference with the recovery of the species or its reintroduction into the wild is unlikely to occur.</td></tr>
</table>

Table 4.2 Significant Impact Criteria for Critically Endangered and Endangered Species

Significant Impact Criteria	Impact Outcome
An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population	**Unlikely** **Marine reptiles** There are three endangered marine reptiles noted within the proposed cable route. The turtle species (loggerhead turtle, leatherback turtle and olive ridley turtle) were assessed as likely to occur throughout the area. Suitable habitat for the loggerhead turtle including macroalgal beds and rocky reef outcrops identified along the cable route. Loggerback turtles are also known to inhabit shallow waters, therefore the species may occur within the immediate area around the nearshore environment. Leatherback turtles and green turtles are considered more offshore species, foraging in pelagic habitats and are therefore likely to occur around the cable route. The olive ridley turtle occupies benthic and pelagic foraging habitats at depths ranging from several m to over 100 m and is only assessed to occur within the Queensland cable route. With the implementation of identified management measures, particularly those relating to managing the risk of marine pollution and avoiding sensitive habitats, interference with animals to cause mortality and subsequent population decline is **unlikely** to occur as a result of the cable route
	Unlikely **Marine mammals** There are two species (including two sub-species) of endangered marine mammals noted within the cable route. The blue whale (including the pygmy blue whale and Antarctic blue whale), southern right whale both have the potential to be present in small numbers within the offshore areas of the cable route. The VIC coastline is known to provide core Biologically Important Areas (BIAs) for the southern right whale, particularly for calving. Blue whales are shown to migrate to cold Antarctic waters (60 - 70° S) during the southern hemisphere summer to feed primarily on krill. BIAs for both species are mapped along the cable route and will be best avoided during peak migration seasons. The cable route is not expected to influence the navigation or passage of these animals. With the implementation of identified management measures, particularly adherence to Part 8 of the EPBC Regulations (2000) and the Australian National Guidelines for Whale and Dolphin Watching 2017, potential impacts on animal navigation and passage will be mitigated. Avoiding sensitive habitats and timeframes and interference with animals to cause mortality and subsequent population decline is **unlikely to occur** as a result of the cable route.

Significant Impact Criteria	Impact Outcome
	Unlikely **Sharks** The grey nurse shark (east coast population) is critically endangered and may occur transiting the cable route along the NSW cable routes. In NSW waters, aggregations of the species occur at nearshore rocky outcrops including Julian Rocks at Byron Bay and Fish Rock at Southwest Rocks. Critical habitat for this species occurs around Magic Point at point 33° 57.359’ S and 151° 15.864 ’E, with a 200 m buffer zone. This species also resides around sandy bottomed gutters, surf zones, and shallow bays. Core habitats for these species will be avoided. Grey nurse sharks are mobile and able to relocate to adjacent habitats during cable route ship passage. With the implementation of identified management measures, particularly those relating to managing the risk of marine pollution and avoiding sensitive habitats, interference with animals to cause mortality and subsequent population decline is **unlikely** to occur as a result of the cable route.
	Unlikely **Coral** There was one endangered coral species noted along the ca the NSW cable routes. The cauliflower soft coral is endemic to eastern Australia and is generally found in estuarine habitats however may occur further offshore in depths up to 30 m. With the implementation of identified management measures, particularly those relating to managing the risk of marine pollution and avoiding sensitive habitats, interference with animals to cause mortality and subsequent population decline is **unlikely** to occur as a result of the cable route.
	Unlikely **Marine birds** There was one critically endangered marine bird and three critically endangered overfly marine bird assessed to occur within the cable route. This includes the eastern curlew, curlew sandpiper, great knot, orange-bellied parrot and swift parrot. An additional seven endangered marine birds and one endangered overfly marine birds were also assessed as having the potential to occur. With the implementation of identified management measures, particularly those relating to managing the risk of marine pollution and avoiding sensitive habitats, interference with animals to cause mortality and subsequent population decline is **unlikely** to occur as a result of the cable route.
Reduce the area of occupancy of the species	**Unlikely** **Marine mammals, marine reptiles, sharks and marine birds** The project will not reduce the area of occupancy of any of these species as these are all transient or migratory animals. Suitable habitat for the passage for each of these species will occur adjacent the cable route works, and loss of habitat access is not expected to occur. Accordingly, project activities are not predicted to impact the population distribution or habitat use of any of these species.

Significant Impact Criteria	Impact Outcome
Fragment an existing population into two or more populations	**Unlikely** **Marine mammals, marine reptiles, sharks and marine birds** The project is unlikely to fragment any of these populations into two or more populations. Due to the nature of the open ocean expanse through which the cable route will pass, and the mobility of these species, protected marine fauna are expected to swim away from the activities. During cable route these species are expected to avoid the area; if encountered mitigation measures will minimise potential for impact.
Adversely affect habitat critical to the survival of a species	**Unlikely** **Marine mammals, marine reptiles, sharks and marine birds** The project is unlikely to affect habitat critical to the survival of a species. The cable route will be targeting soft sediments and will not negatively affect critical habitats that support different life-history stages of any of these species. The area of disturbance will be a very narrow long corridor containing habitat that is well represented in the region.
Disrupt the breeding cycle of a population	**Unlikely** **Marine mammals, marine reptiles, sharks and marine birds** The works associated with the project are unlikely to disrupt the breeding cycle of these species. Most species do not breed or roost within the cable route, and the activities will not prevent movement to breeding or roosting grounds. The area is already traversed by commercial shipping traffic. Accordingly, potential to interfere with any of these species such that the breeding cycle is affected is considered unlikely.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** **Marine mammals, marine reptiles, sharks and marine birds** Subsea cable installation may temporarily disturb and modify the sediment; however, this change will be temporary, localised in nature and the habitat to be affected does not represent an important habitat supporting different life-history stages of these species. Subsea cable installation will avoid areas containing sensitive habitats as much as practicable. Hard substrates (such as rocky reefs) and other sensitive habitat (e.g., seagrass beds) will be avoided as far as practicable. The marine route survey identified areas of sensitive habitat along the cable route and adjustments were made to avoid such areas or to minimise impact. In an open ocean environment, suspended sediments will settle and are expected to disburse quickly. Any impacts to the seabed are expected to be short-term and localised and as such cause negligible ecological change. It is **unlikely** that the subsea cable installation will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the habitat of the endangered species.	**Unlikely** **Marine mammals, marine reptiles, sharks and marine birds**

Significant Impact Criteria	Impact Outcome
	Vessels and immersible equipment conducting the activity have a chance of carrying a marine pest in their ballast water or as biofouling; however, management controls applied to these vessels reduce this risk to prevent introductions occurring. The likelihood of a marine pest being introduced to the area due to this activity is considered low. Quarantine controls will be applied to vessel operations to avoid introduction of any potentially invasive species. No impacts from invasive species are therefore considered likely to occur. The subsea cable installation is **unlikely** to result in invasive species that are harmful to an endangered species becoming established in the habitat of the endangered species.
Introduce disease that may cause the species to decline	**Unlikely** **Marine mammals, marine reptiles, sharks and marine birds** Diseases are carried by diseased fauna or can be introduced in ballast water. The risk of the latter is addressed above. As no animals are being released through the course of this project’s activities, the project is not predicted to introduce disease that may impact upon fauna. Nor is the project predicted to accelerate the movements of diseased fauna to cause spread. The subsea cable installation is **unlikely** to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	**Unlikely** **Marine mammals, marine reptiles, sharks, fish and marine birds** The project is unlikely to interfere substantially with the recovery of any of these species. All these species are transient or migratory through the area, the project activities will not be conducted during turtle nesting season.

Table 4.3 Significant Impact Criteria for Vulnerable Species

<table>
<tr><th>Significant Impact Criteria</th><th>Impact Outcome</th></tr>
<tr><td colspan="2">An action is likely to have a significant impact on an vulnerable species if there is a real chance or possibility that it will:</td></tr>
<tr><td rowspan="3">Lead to a long-term decrease in the size of a population</td><td>Unlikely
Marine reptiles
Three vulnerable marine reptiles were noted within the cable route. The green turtle and hawksbill turtle are primarily benthic feeders that rely on seagrass, none of which overlaps with the cable route in shallow waters. Seagrasses are not expected to occur in the deep waters. The flatback turtle feeds primarily over the Australian continental shelf of which limits their migration. The cable route are not considered core habitat for these species, and individuals may only be present as transient visitors. Given the large expanse of potential migratory habitat and the small area of the cable route, the encounter rate with turtles is expected to be low.
The cable route does not contain core breeding, foraging or roosting habitat.
With the implementation of identified management measures, particularly those relating to managing the risk of marine pollution and avoiding sensitive habitats, interference with animals to cause mortality and subsequent population decline is unlikely to occur as a result of the cable route.</td></tr>
<tr><td>Unlikely
Marine mammals
The Australian humpback dolphin was assessed as having the potential to occur along the QLD cable route. This species primarily inhabits shallow, protected coastal waters such as estuaries, tidal rivers, inlets, and shallow bays, usually within 10–20 km of the coast. They are often found in waters less than 20 m deep, although some may venture as far as 50 km upstream in large rivers.
The cable route is not expected to influence the navigation or passage of these animals. With the implementation of identified management measures, particularly adherence to Part 8 of the EPBC Regulations (2000) and the Australian National Guidelines for Whale and Dolphin Watching 2017, potential impacts on animal navigation and passage will be mitigated. Avoiding sensitive habitats and timeframes and interference with animals to cause mortality and subsequent population decline is unlikely to occur as a result of the cable route.</td></tr>
<tr><td>Unlikely
Sharks
There is one species of vulnerable sharks recognised as having the potential to be present within along the entire cable route.
White sharks primarily inhabit temperate waters occasionally migrating into sub-tropical and tropical waters. Known aggregations of the great white shark occur in nearshore waters of NSW, the most well-known of these occurs at Stockton Beach, Newcastle. The species is considered likely to occur in the area as a transient visitor.
All species are highly mobile species that is expected to avoid direct interaction with the cable route vessel.</td></tr>
</table>

	With the implementation of identified management measures, particularly those relating to managing the risk of marine pollution and avoiding sensitive habitats, interference with animals to cause mortality and subsequent population decline is **unlikely** to occur as a result of the cable route.
	Unlikely **Marine birds** There are 19 marine birds and five overfly marine birds assessed as vulnerable that have the potential to occur within the cable route. With the implementation of identified management measures, particularly those relating to managing the risk of marine pollution and avoiding sensitive habitats, interference with animals to cause mortality and subsequent population decline is **unlikely** to occur as a result of the cable route.
Reduce the area of occupancy of the species	**Unlikely** **Marine mammals, marine reptiles, sharks, fish and marine birds** The subsea cable installation is **unlikely** to reduce the area of occupancy of any of these species as these are all transient or migratory animals. Suitable habitat for the passage for each of these species will occur adjacent the subsea cable installation works, and loss of habitat access is not expected to occur. Accordingly, project activities are not predicted to impact the population distribution or habitat use of any of these species.
Fragment an existing population into two or more populations	**Unlikely** **Marine mammals, marine reptiles, sharks, fish and marine birds** The subsea cable installation is **unlikely** to fragment any of these populations into two or more populations. Due to the nature of the open ocean expanse through which the cable will pass, and the mobility of these species, protected marine fauna are expected to swim away from the activities. During subsea cable installation these species are expected to avoid the area; if encountered mitigation measures will minimise potential for impact.
Adversely affect habitat critical to the survival of a species	**Unlikely** **Marine mammals, marine reptiles, sharks, fish and marine birds** The subsea cable installation is **unlikely** to affect habitat critical to the survival of a species. The cable route will be targeting soft sediments and will not negatively affect critical habitats that support different life-history stages of any of these species. The area of disturbance will be a very narrow long corridor containing habitat that is well represented in the region.
Disrupt the breeding cycle of a population	**Unlikely** **Marine mammals, marine reptiles, sharks, fish and marine birds** The works associated with the subsea cable installation are **unlikely** to disrupt the breeding cycle of these species. Most species do not breed or roost within the cable route, and the activities will not prevent movement to breeding or roosting grounds. The area is already traversed by commercial shipping traffic. Accordingly, potential to interfere with any of

	these species such that the breeding cycle is affected is considered unlikely.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** **Marine mammals, marine reptiles, sharks, fish and marine birds** Subsea cable installation may temporarily disturb and modify the sediment; however, this change will be temporary, localised in nature and the habitat to be affected does not represent an important habitat supporting different life-history stages of these species. Subsea cable installation will avoid areas containing sensitive habitats as much as practicable. Hard substrates (such as rocky reefs) and other sensitive habitat (e.g., seagrass beds) will be avoided as far as practicable. The marine route survey identified areas of sensitive habitat along the cable route and adjustments were made to avoid such areas or to minimise impact. In an open ocean environment, suspended sediments will settle and are expected to disburse quickly. Any impacts to the seabed are expected to be short-term and localised and as such cause negligible ecological change. It is **unlikely** that the subsea cable installation will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the habitat of the endangered species.	**Unlikely** **Marine mammals, marine reptiles, sharks, fish and marine birds** Vessels and immersible equipment conducting the activity have a chance of carrying a marine pest in their ballast water or as biofouling; however, management controls applied to these vessels reduce this risk to prevent introductions occurring. The likelihood of a marine pest being introduced to the area due to this activity is considered low. Quarantine controls will be applied to vessel operations to avoid introduction of any potentially invasive species. The subsea cable installation is **unlikely** to result in invasive species that are harmful to an endangered species becoming established in the habitat of the endangered species.
Introduce disease that may cause the species to decline	**Unlikely** **Marine mammals, marine reptiles, sharks, fish and marine birds** Diseases are carried by diseased fauna or can be introduced in ballast water. The risk of the latter is addressed above. As no animals are being released through the course of this project’s activities, the project is not predicted to introduce disease that may impact upon fauna. Nor is the project predicted to accelerate the movements of diseased fauna to cause spread. The subsea cable installation is **unlikely** to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	**Unlikely** **Marine mammals, marine reptiles, sharks, fish and marine birds** The subsea cable installation is unlikely to interfere substantially with the recovery of any of these species. All these species are transient or migratory through the area, the

	project activities will not be conducted during turtle nesting season.

Table 4.4 Significant Impact Criteria for Listed Migratory Species

Significant Impact Criteria	Impact Outcome
An action is likely to have a significant impact on a listed migratory species if there is a real chance or possibility that it will:	
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.	**Unlikely** **Marine Mammals** There are seven species of migratory marine mammals (not listed as threatened and not previously assessed) that have potential to transit the cable route during annual migrations. These species include Antarctic minke whale, bryde's whale, dusky dolphin, humpback whale, killer whale, pygmy right whale and the sperm whales. All of these animals are highly mobile species adapted to use this area in conjunction with movements of other commercial shipping and fishery traffic. They are expected to be able to avoid cable route activities. With the implementation of identified management measures, particularly adherence to Part 8 of the EPBC Regulations (2000) and the Australian National Guidelines for Whale and Dolphin Watching 2017, potential impacts on animal navigation and passage will be mitigated. Avoiding sensitive habitats and timeframes and interference with animals to cause mortality and subsequent population decline is **unlikely to occur** as a result of the Cable Systems
	Unlikely **Sharks and rays** There is three species of migratory sharks and two species of migratory four (not listed as threatened and not previously assessed) that have the potential to be present within the cable route. These species include the longfin mako, oceanic whitetip shark, shortfin mako, porbeagle. An additional two migratory rays were identified including the giant manta ray and reef manta ray. The waters within the cable route are not considered as core habitat and the species are only likely to occur as transient visitors. With the implementation of identified management measures, particularly those relating to managing the risk of marine pollution and avoiding sensitive habitats, interference with animals to cause mortality and subsequent population decline is **unlikely** to occur as a result of the cable route.
	Unlikely **Other marine mammals** There dugong was assessed to likely occur transiting the cable route in QLD along the nearshore environment. Dugongs inhabit coastal and island waters in QLD, favouring protected bays, mangrove channels and sheltered regions of islands with seagrass beds. With the implementation of identified management measures, particularly those relating to managing the risk of marine pollution and avoiding sensitive habitats, interference with animals to cause mortality and subsequent population decline is **unlikely** to occur as a result of the cable route.
	Unlikely **Marine birds** There was 31 migratory marine birds (not listed as threatened and not previously assessed) that were assessed to potentially

Significant Impact Criteria	Impact Outcome
	occur within the cable route. No core habitat for these birds were identified to occur throughout the cable route and are only likely to occur overflying or as transient visitors. With the implementation of identified management measures, particularly those relating to managing the risk of marine pollution and avoiding sensitive habitats, interference with animals to cause mortality and subsequent population decline is **unlikely** to occur as a result of the cable route
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	**Unlikely** **Marine mammals, sharks and rays and marine birds** Vessels and immersible equipment conducting the activity have a chance of carrying a marine pest in their ballast water or as biofouling; however, management controls applied to these vessels reduce this risk to prevent introductions occurring. The likelihood of a marine pest being introduced to the area due to this activity is considered low. Quarantine controls will be applied to vessel operations to avoid introduction of any potentially invasive species. The subsea cable installation is **unlikely** to result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species
Seriously disrupt the lifecycle (breeding, feeding, migration, or resting behaviour) or an ecologically significant proportion of the population of a migratory species.	**Unlikely** **Marine mammals, sharks and rays and marine birds** The works associated with the project are unlikely to disrupt the life cycle of any of the species. These species do not breed or roost exclusively within habitats crossed by the cable route, and the activities will not prevent movement to breeding or roosting grounds. Any feeding undertaken in the cable route would be by transient individuals. None of these species have important feeding grounds within the cable route. The cable route does overlap the migration pathways of these species. Due to the nature of the open oceanic expanse through which the vessel will pass, and the mobility of these species, protected marine fauna will not be impacted by the cable route activities. These species are expected to avoid cable route activities. If encountered appropriate mitigation measures, such as the adherence to Part 8 of the EPBC Regulations (2000) and the Australian National Guidelines for Whale and Dolphin Watching 2017 are in place to minimise potential for impact. Consequently, the project is not considered likely to seriously disrupt the lifecycle of any migratory species.

Table 4.5 Significant Impact Criteria for the Commonwealth Marine Environment

Significant Impact Criteria	Impact Outcome
An action is likely to have a significant impact on the environment in a Commonwealth Marine Area if there is a real chance or possibility that it will:	
Result in a known or potential pest species becoming established in the Commonwealth marine area	**Unlikely** The potential for pest species to be introduced during subsea cable installation activities will be managed via the implementation of management controls associated with equipment sourcing, ballast water exchange, vessel anti-fouling status and quarantine requirements. The management of ballast water to avoid introduction of pest species will have to adhere to AQIS requirements, found in The Australian Ballast Water Management Requirements (version 7, DAWR, 2017). Any ballast exchanges required must be conducted as far from the nearest land as possible within an area acceptable as defined in DAWR (2017). All internationally sourced vessels will adhere to Commonwealth government quarantine requirements and practices consistent with the National Biofouling Management Guidance for Petroleum Production and Exploration Industry (National System for the Prevention and Management of Marine Pest Incursions, 2009) as the industry standard. The risk of introducing an invasive marine species is therefore considered to be As Low as Reasonably Practicable and therefore **unlikely**.
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.	**Unlikely** Subsea cable installation may temporarily disturb and modify the sediment; however, this change will be temporary, localised in nature and the habitat to be affected does not represent an important habitat supporting different life-history stages of these species. Subsea cable installation will avoid areas containing sensitive habitats as much as practicable. Hard substrates (such as rocky reefs) and other sensitive habitat (e.g., seagrass beds) will be avoided as far as practicable. The marine route survey identified areas of sensitive habitat along the cable route and adjustments were made to avoid such areas or to minimise impact. In an open ocean environment, suspended sediments will settle and are expected to disburse quickly. Any impacts to the seabed are expected to be short-term and localised and as such cause negligible ecological change. It is **unlikely** that the subsea cable installation will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline in a Commonwealth marine area.
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	**Unlikely** As identified in preceding tables the subsea cable installation is considered **unlikely** to have a significant impact on any listed threatened or migratory species.
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	**Unlikely** Subsea cable installation vessels will release gaseous emissions and, outside of state waters, will release discharges to the marine environment including sewage (black water), food waste, cooling water and brine. Discharges will be managed to comply with MARPOL regulations, which is considered to be industry standard. Environmental impacts associated with these discharges are expected to be negligible. Installation vessels will comply with relevant State,

Significant Impact Criteria	Impact Outcome
	Commonwealth and International regulations in order to minimise the potential for unplanned releases of hazardous or non-hazardous substances to the marine environment. As such, substantial changes to air quality or water quality as a result of this project are **unlikely** to occur.
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	**Unlikely** Potential to accidentally release wastes or pollutants, including chemicals, into the marine environment during subsea cable installation activities have been mitigated through application of relevance industry standard controls. The subsea cable installation is therefore not expected to result in persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the marine environment and impacts are considered **unlikely**.
Have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.	**Unlikely** As part of the environmental assessment for the subsea cable installation, a maritime cultural heritage assessment was undertaken using the marine route survey outputs. This included the identification of known and potential maritime archaeological sites such as historic shipwrecks. The desktop study undertaken by maritime archaeologists was used to inform the cable route to avoid areas of cultural and heritage significance. The subsea cable installation is **unlikely** to have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.

On the basis of the preceding assessments, this project has been assessed as unlikely to have significant impact on any Matters of National Environmental Significance protected under the EPBC Act.

The mitigation measures proposed for the action are considered appropriate and relevant to control potential for impact upon the environment and the associated protected matters.

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