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Chapter 9 – Marine Ecosystems

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9 Marine Ecosystems

9.1 Introduction

The NT EPA's objective for the Marine ecosystems factor is:

Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

This chapter describes and assesses the significance of potential impacts to marine habitats and species associated with project refinements and in response to Draft EIS comments in the Direction received from the NT EPA on September 28, 2020. The assessment considers the information requirements for marine ecosystems per the TOR for the Draft EIS (Appendix A in the Draft EIS) as well as issues raised by stakeholders and the NT EPA (see Appendices 1.3 and 3.1). The assessment is informed by the experience and professional judgement of the EIS team (Appendix 1.5) based on their knowledge and understanding of the Project's components and activities described in Chapter 2 Project Refinement that could interact with the marine environment. Potential impacts were assessed using the EIA methods described in the Draft EIS Chapter 3 Impact Assessment.

This chapter focuses on impacts to marine habitats and fauna and provides an updated assessment based on newly available baseline data and refined project description information for the installation and maintenance of the Subsea Cable System route, dredging activities, and potential spoil disposal grounds. Two options for the Subsea Cable System route were proposed in the Draft EIS, however, Route B has been identified as the preferred route (see Chapter 2 Section 2.9 for the results of an alternatives assessment for the Project's Subsea Cable System options). Therefore, this SEIS addresses the potential for significant impacts for Route B, which has been optimized to increase spacing of bends where the cable system crosses the Santos pipeline and Vocus fibre optic cable.

Additionally, the Proponent met with the former DAWE (now DCCEEW) and the NT EPA where the need for more information regarding dredging and spoil deposition activities was discussed. In order to have the best environmental outcome, a methodology – Sediment SAP – to obtain the information from dredging and potential spoil disposal grounds was drafted and executed in a marine investigation by Guardian Geomatics, with input from Qualified Professionals.

Impacts to the Cwth Marine Area are regulated under the *EPBC Act* and are addressed in Chapter 16 MNES in the Draft EIS and in Chapter 15 in the SEIS.

9.2 Information Sources

Since the Draft EIS was lodged, the following reports were prepared which deal with marine ecosystems:

- Memorandum – Benthic Video Footage Analysis (Appendix 9.1)
- (Marine Sediment) Sampling Analysis Plan Implementation Report (Appendix 8.3)
- Potential Dredging and Offshore Spoil Disposal – Draft Sediment SAP (CONFIDENTIAL) (Appendix 8.5)
- Sun Cable Influence Study: The interaction of the AAPowerLink HVDC cable systems with the surrounding environment has been assessed – (CONFIDENTIAL).

9.2.1 NT EPA Direction to Prepare a Supplement - marine

The Direction to Prepare a Supplement from the NT EPA requires The Proponent to provide additional information on components of the impact assessment undertaken for marine ecosystems, specifically in relation to impacts that could result from cable laying required for construction of the Subsea Cable System (presented below). Additional marine survey work has been undertaken since submission of the Draft EIS, and further work has been commissioned, in order to address these information requirements. Figure 9-1 below summarises the phases of work that have been or will be implemented to:

- Survey the inshore section of the Subsea Cable System which was previously unsurveyed
- Identify BCH in consultation with Regulator requirements
- Undertake additional hydrodynamic and sediment plume modelling to refine the zone of impact and area of influence from cable laying activities, including adding removal of sand wave areas and potential spoil disposal grounds as part of a follow-up and adaptive management approach post-approval to mitigating site-specific impacts in the marine environment
- Identify sensitive receptors within the refined area of influence which may be impacted by cable laying
- Inform monitoring and management measures to be implemented during cable laying, to mitigate potential impacts.

The steps shown in Phase 1 of Figure 9-1 have already been undertaken, and the results are presented and discussed below. The work undertaken in Phase 2 and the work that may be undertaken in Phase 3 (subject to the findings of Phase 2) to illustrate how to data obtained in Phases 1 and 2 will inform impact avoidance and mitigation, is also discussed in below.

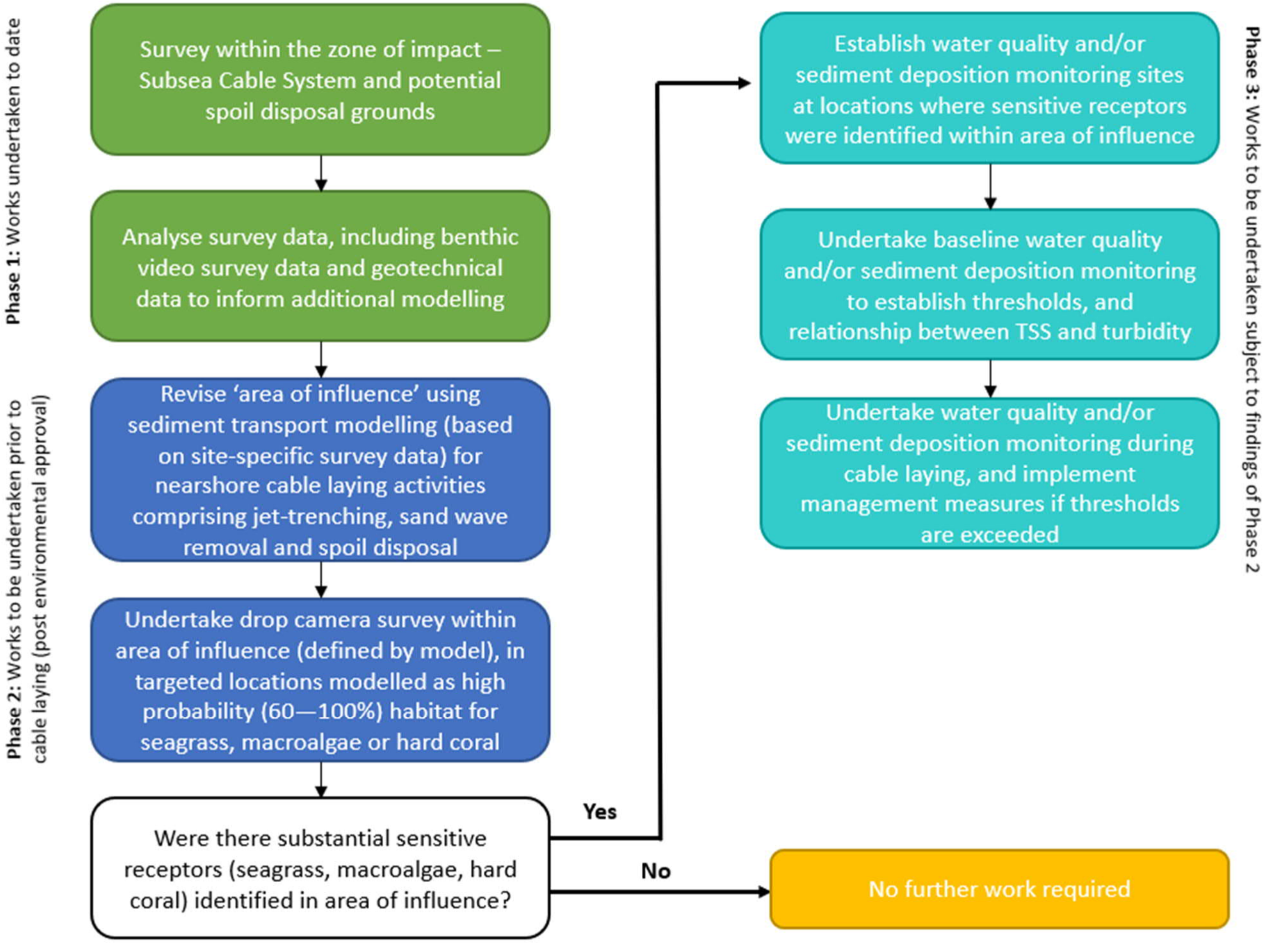


Figure 9-1: Flow chat of Adaptive Management Process for Mitigating Impacts in the Marine Environment (Works Undertaken and Proposed)[1]

[1] Further assessment and investigation outside of Coastal Waters and within the Cwth Marine Area will be undertaken in consultation with DCCEEW and in accordance with the NAGD

9.2.2 NT EPA Direction Item 27

9.2.2.1 Phase 1 – Benthic habitat surveys

A comprehensive geophysical survey and geotechnical sampling program was undertaken in November 2020 for the Subsea Cable System. As presented in the Draft EIS, the first 45 km of the Subsea Cable Route, commencing at Murrumujuk, was not surveyed due to a route change which occurred when the DCS was relocated to Murrumujuk. As such, additional surveys were required for the nearshore component of the Subsea Cable System. Note that, nearshore is defined as 3 nautical miles off the NT coast (i.e. the 'coastal waters' boundary), which includes the Tiwi Islands, Shoal Bay and the Beagle Gulf; refer to the Draft EIS, Chapter 9.

A geophysical survey and geotechnical sampling program was undertaken in August 2022 to provide survey data for the first 45 km of the Subsea Cable System, which The Proponent had not previously surveyed. The outputs from this survey will inform detailed design and cable installation methodology. Sediment sampling was also undertaken to determine the chemical and physical characteristics of sediment in sandwave areas requiring removal along the Subsea Cable System, and at four potential spoil disposal grounds. The survey was undertaken within a 600 m wide corridor, which aligns with the direct disturbance footprint for the Subsea Cable System (and the zone of impact).

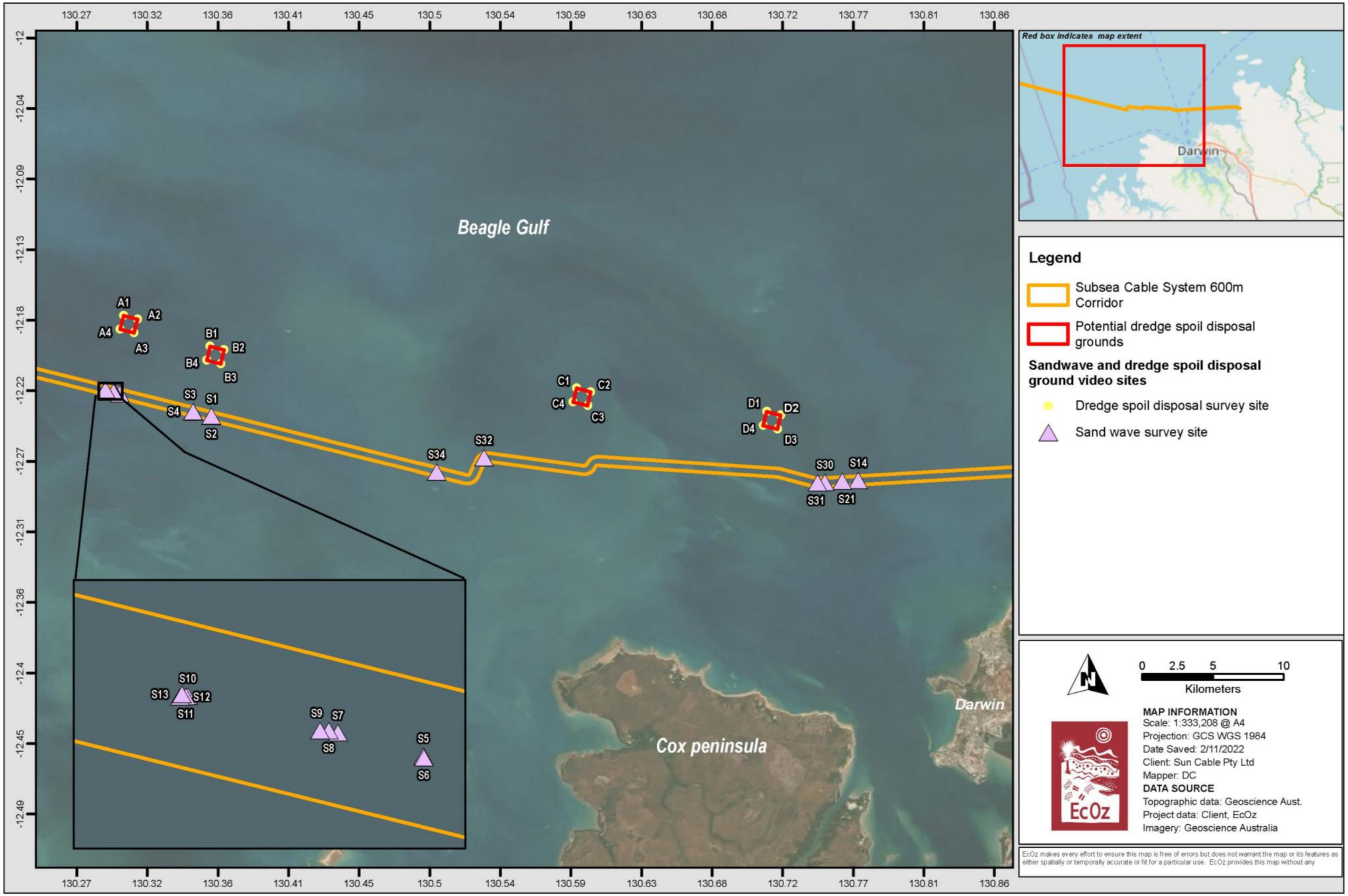
Sediment sampling was undertaken in accordance with the Draft SAP, which was developed to be consistent with the requirements of the National Assessment Guidelines for Dredging 2009 (see Sun Cable 2022). Survey and sampling results are reported in Appendix 8.3.

Concurrent with the above investigations, a benthic habitat survey was also undertaken for the first 40 km of the Subsea Cable System, and at locations where sandwaves require removal and potential spoil disposal grounds. The benthic habitat survey involved collecting underwater video footage at sampling locations within the Subsea Cable System.

Two survey tasks were undertaken for the benthic video footage survey:

- **Task 1** – survey of sandwaves within the 600 m wide Subsea Cable System survey corridor, where dredging is proposed, and at four potential spoil disposal grounds located north of the Subsea Cable System. The extent of this survey was from approximately 30 km to 80 km offshore from Murrumujuk. This survey provided high level context of the benthic environment at 19 sites along the sandwave areas, and at 16 survey sites within four different potential spoil disposal grounds (four sites in each potential spoil disposal ground). Survey locations are shown on Figure 9-2
- **Task 2** – ground-truthing of modelled BCH for approximately 30 km of the Subsea Cable System, commencing at Murrumujuk. This survey targeted 30 sites which were identified, via desktop, as high likelihood habitat for hard coral, seagrass or macroalgae, and video footage was collected to confirm presence or absence of modelled habitats. The survey was undertaken within the 600 m wide Subsea Cable System survey corridor (i.e., zone of impact) as well as a number of locations immediately outside of the corridor (within the zone of influence), which were targeted due to their proximity to the corridor. Due to technical, logistical and schedule constraints, the entire zone of influence could not be surveyed. Survey locations are shown Figure 9-3.

The survey methods and results are presented in the Memorandum – Benthic video footage analysis (Appendix 9.1). The video survey was undertaken in accordance with the Field Manuals for Marine Sampling to Monitor Australian Waters (Przeslawski and Foster 2020). The video analysis resulted in benthic environment, epifauna and structural macrobiota classification in accordance with the National Intertidal/Subtidal Benthic Habitat Classification Scheme (Mount et. al. 2007) and the Collaborative and Annotation Tools for Analysis of Marine Imagery and Video (Althaus et. al. 2013).



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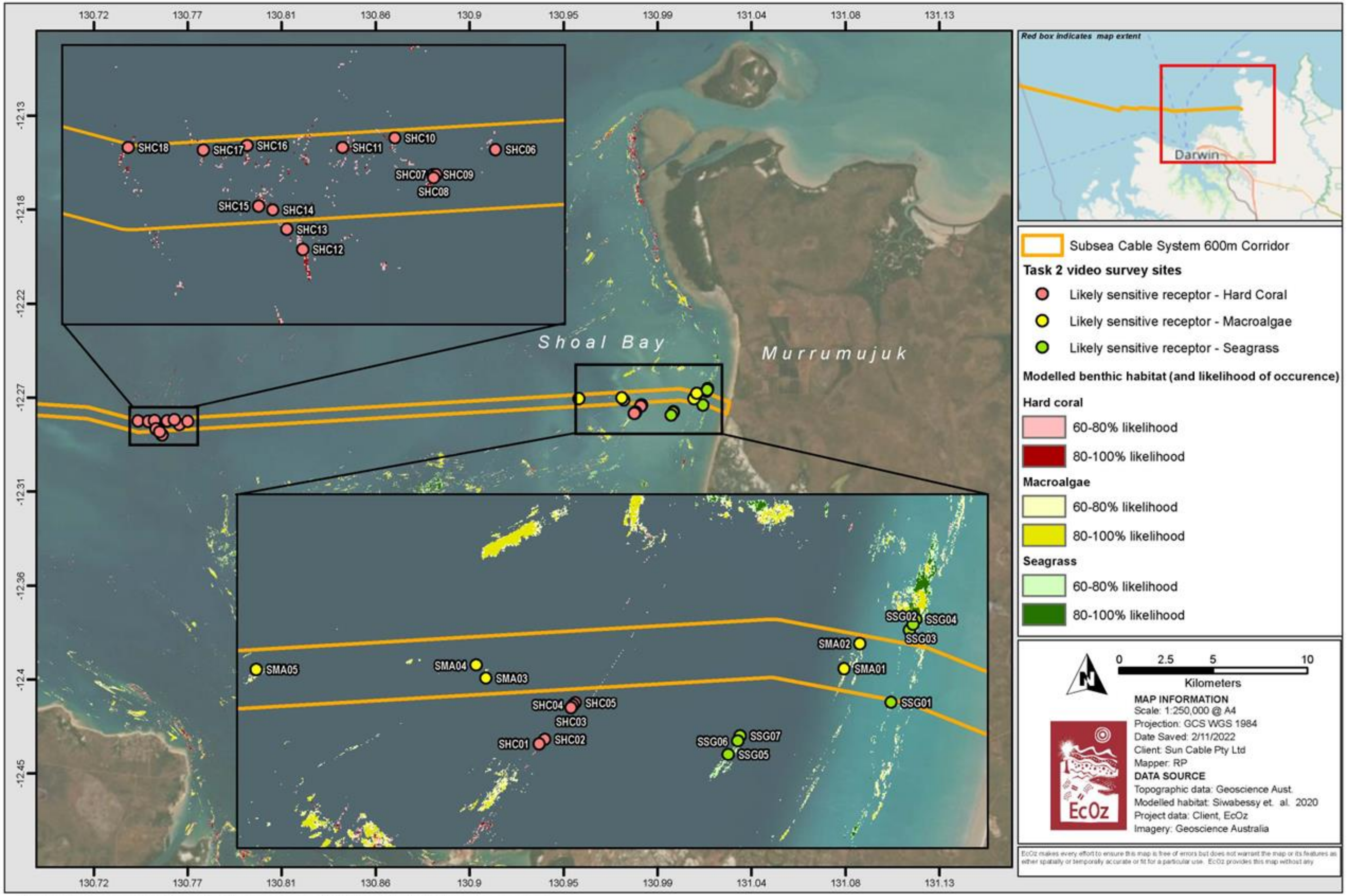

Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22088 - Sun cable supplementary\01 Project Files\Task 2 Sensitive receptor survey sites.mxd

Task 1 survey and results

Video footage was analysed from 35 survey sites. This footage provides context for interpreting survey data within the proposed sandwave removal areas and potential spoil disposal grounds, including benthic-macroinvertebrate sampling, sediment geochemistry and geotechnical data. Results of the video survey are summarised in Figure 9-4; refer to Appendix 9.1 (Memorandum – Benthic video footage analysis) for detail. In general, benthic species and epifauna were very sparse, with footage showing mostly unconsolidated sediment (to be confirmed by geotechnical surveys) with isolated occurrences of individual organisms. Vibrocore sediment samples were obtained; results are presented in Appendices 8.2 and 8.3.

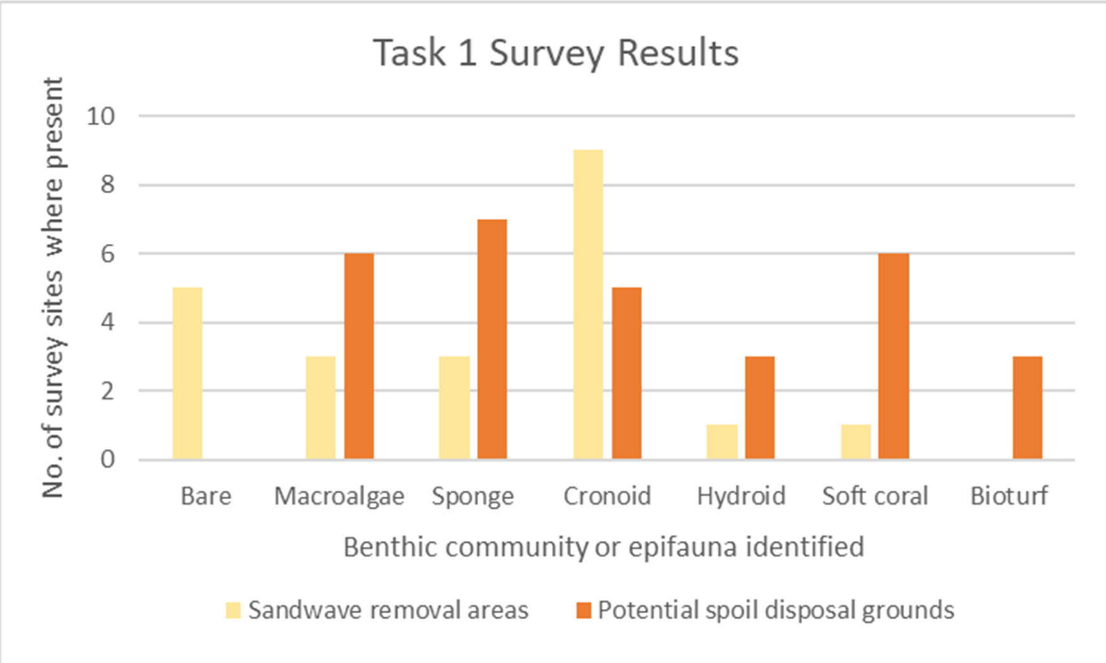

Figure 9-4: Survey results of Task 1 - Benthic communities and epifauna identified in sandwaves and potential spoil disposal grounds - Beagle Gulf (filter feeders are underlined)

Task 2 survey and results

The Draft EIS presented the potential locations of BCH within the nearshore zone of impact and area of influence based on predictive benthic habitat mapping for the Darwin and Bynoe region (see Galaiduk et. al. 2019 and Siwabessy et. al. 2020). Galaiduk et al. 2019 categorised benthic habitat into the following five classes:

- Macroalgae
- Seagrass
- Hard coral
- Filter feeders – which consist of sponges, filter feeders and octocorals
- Bare (bare substrate).

The modelling used detailed full coverage hydroacoustic datasets and some field observations using towed video to predict where major groups of benthic biota were likely to occur. There were no towed video transects that intersected the Subsea Cable System’s direct zone of impact. The towed video survey data showed that the most abundant benthic habitats in the Darwin and Bynoe regions were filter-feeding biota (e.g., sponges, filter feeders and octo-corals), and bare sediment. Three less common benthic habitats were seagrass, macroalgae (seaweed) and hard coral; their prevalence in the towed video survey data was approximately 20 times lower than other benthic classes (Galaiduk et. al. 2019). The Draft EIS considered these three benthic habitat classes higher value because they were less common and provided critical habitat for a number of marine species, therefore providing higher habitat value if present. Additionally, these three benthic habitat classes are known to be particularly impacted by dredging and cable laying activities, which may include increased sediment suspension, re-suspension and deposition, and reduced water quality (WAMSI 2021).

Locations within the zone of impact and area of influence where modelling indicated high likelihood (60 - 100 %) of seagrass, macroalgae or hard coral were identified as 'sensitive receptors' for the purpose of the impact assessment presented in the Draft EIS. Video surveys were undertaken at 30 sensitive receptor sites within the zone of impact and immediate proximity to 'ground-truth' their presence. A comparison of the modelled and ground-truthed benthic habitats are presented in Figure 9-5. The timing, spatial extent and survey methods are detailed in Appendix 9.1.

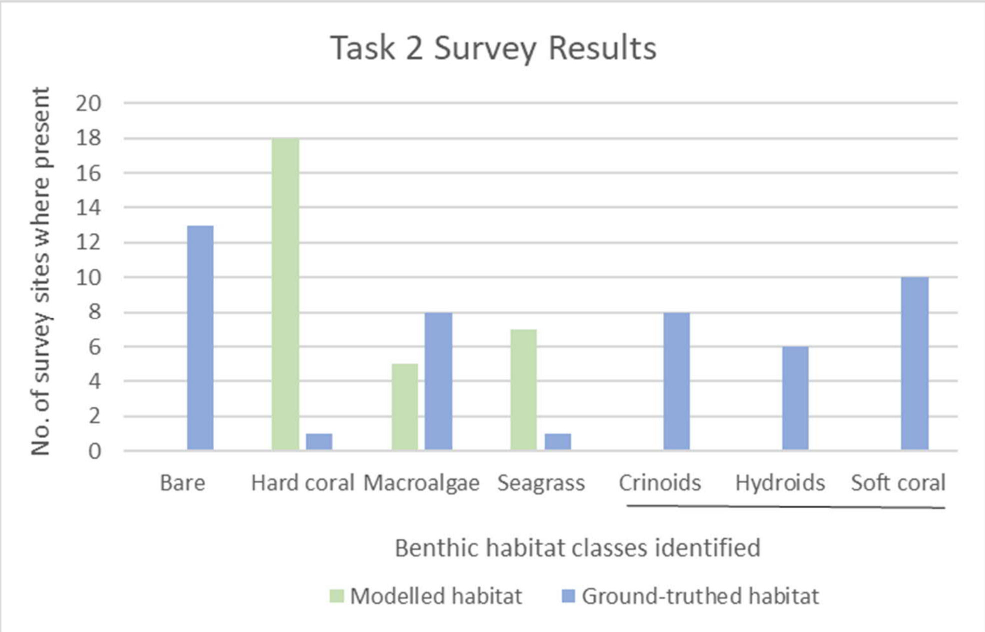

Figure 9-5: Survey results of Task 2 – Ground-truthing modelled benthic habitat classes within Shoal Bay and the inner Beagle Gulf (filter feedings are underlined)

Key findings of the video surveys are as follows:

- All substrate was classified as unconsolidated, with varying levels of bioturbation. Geotechnical sediment sampling results confirmed this as reported in Appendices 8.2 and 8.3
- Hard coral was verified at only one of the 18 modelled high likelihood (60 - 80%) survey sites.
- Macroalgae was verified at two of the five modelled high likelihood (60 - 80%) survey sites. Macroalgae was identified at six survey sites modelled high likelihood (60 - 80%) for hard coral. Therefore, macroalgae was found at eight of the 30 sample sites and was the most common 'sensitive receptor' community identified
- Seagrass was not verified at any of the seven survey sites modelled high likelihood (60 - 100 %) habitat. One 'possible' individual plant was identified at one location. Although the seagrass was not definitively identified, the precautionary principle has been applied and it is assumed that seagrass could occur at that one survey site (SSG05)
- Bare sediment with no visible epibiota was found at 14 (~43%) of the survey sites. The epibiota were generally sparse at the other survey sites and with isolated occurrences of individual organisms. No substantial benthic communities or habitat were identified (e.g., seagrass meadows, coral reef or macroalgae bed)

- Other epibiota (i.e. not seagrass, macroalgae or hard coral) were found at 15 (50 %) of the survey sites including soft coral, crinoids and hydroids, all of which are filter feeders. These epibiota were also sparse and individual organisms were isolated.

Still images were captured from the video survey and are presented in Appendix 9.1. The video survey results were limited to presence/absence at the targeted survey sites, and percentage cover was not able to be determined from these surveys due to logistical and time constraints at the survey design phase.

In general, the findings of the video survey indicate that the benthic habitat model over-estimated the presence of hard coral, seagrass and macroalgae within the Subsea Cable System zone of impact (direct disturbance footprint). Where individual organisms of macroalgae and hard coral were identified, it was very sparse. No coral reefs, seagrass meadows or macroalgae beds were observed.

It should be noted that the absence of seagrass at the survey sites is not considered to be an artefact of survey timing. The extent of seagrass is known to fluctuate in the Darwin Region, due to seasonal factors such as turbidity, wind, and wave action, which tends to be greater during the wet season. As such, the spatial extent and percentage cover of seagrass generally declines during the wet season and recovers and expands during the dry season (Cardno 2014). Cardno noted low seagrass cover in wet season months (e.g., February), but greater seagrass cover in May through to October/November. The benthic habitat survey conducted in August 2022 occurred at a time when seagrass should have been present and identifiable, as it occurred at the end of the dry season recovery period when seagrass cover is greater.

The most common BCH identified were filter feeders (crinoids, hydroids, soft coral, and sponges) and bare sediment. This finding is consistent with the findings reported in Galaiduk et. al. (2019), which noted that macroalgae, seagrass and hard coral habitats were rare in the Darwin and Bynoe regions.

The results of the survey will be used to inform future, additional video survey work and water quality monitoring (discussed below).

Additional survey work

The Direction to Prepare a Supplement (see Section 9.11.4 below) prepared by the NT EPA requested that The Proponent provide "details of proposed timing and methods of baseline benthic habitat surveys be provided to collect underwater video transect data at a sufficient density to accurately map the extent of benthic habitats within the cable corridor and the zone of influence".

The Proponent has undertaken benthic video surveys at 30 locations within the cable footprint (600 m wide Subsea Cable System survey corridor), and immediate surrounds. Sixteen sites were within the 600 m wide Subsea Cable System survey corridor (300 m width either side of the route centreline), while the remaining 14 sites were within 800 m of the Subsea Cable System centreline. Therefore, the benthic habitat surveys undertaken to date have occurred within the zone of impact, and a portion of the area of influence. Refer to the Appendix 9.1 for detail on survey methods, spatial extent, and results of benthic video surveys.

Sediment transport modelling undertaken for the Draft EIS predicted the area of influence to cover an area of up to 332 km^2 (within which SSC would exceed 10 mg/L, which was based on the Darwin Harbour Water Quality Objective [WQO]). Note this is based on the 50th percentile (i.e., the median potential extent/intensity of impact) exceeding 10 mg/L of SSC, which is conservative. Refer to Chapter 9 of the Draft EIS for detail. The modelling was not based on site-specific Particle Size Distribution (PSD) data, due to a route change after the first marine surveys had been undertaken. Therefore, the assumptions about the amount of fine sediment were conservative and likely resulted in an overestimate of the area of influence – refer to Section 9.2.3.1 below. Surveying the previously modelled area of influence is not feasible due to logistical and cost constraints. In addition, locations of sandwaves requiring removal were identified in marine studies since the Draft EIS was submitted; therefore, additional work to confirm sandwave locations is recommended prior to cable laying to support follow-up and adaptive management activities. Given the above, the following is proposed:

Additional sediment transport modelling will be undertaken using site-specific PSD data for the nearshore cable laying methods, resulting in a revision of the model outputs, and the inclusion of proposed dredge works.

- The revised modelling will refine the area of influence, within which SSC concentrations may exceed ambient conditions
- Benthic communities may be ground-truthed within the revised area of influence, defined by the model outputs. This will be done via video and/or drop camera survey at targeted locations where benthic habitat modelling (Siwabessy et. al., 2020) indicates high likelihood (60-100 %) occurrence of hard coral, seagrass or macroalgae.

All additional benthic video survey work will be undertaken in accordance with:

- Field Manuals for Marine Sampling to Monitor Australian Waters (Przeslawski and Foster, 2020)
- National Intertidal/Subtidal Benthic Habitat Classification Scheme (Mount et. al., 2007)
- Collaborative and Annotation Tools for Analysis of Marine Imagery and Video (Althaus et. al., 2013).

Refer to Section 9.2.3.1 for detail.

9.2.2.2 Benthic Communities and Timing of Works

Community groups present in zone of impact and area of influence

Benthic communities are not randomly distributed across the seafloor but are associated with physical properties and structural complexity of the surrounding region. As reported in Galaiduk et. al. (2019), shallow areas (<10 m deep) are typically characterised by autotrophic communities such as macroalgae, seagrass and hard corals. Shallow areas with more structural complexity are typically dominated by hard corals and macroalgae, whereas seagrass tends to occur in areas with lower complexity (e.g., flat sandy areas). Deeper slopes (>10 m) are highly suitable for filter feeding communities, while deep, flat areas with low complexity typically have no associated epibenthic biota. As a result, the below discussion focuses on potential impacts of cable laying works on benthic communities in Shoal Bay and the inner Beagle Gulf – i.e., in shallow waters <20 m deep.

Three benthic community groups were identified during the video survey: filter feeders; macroalgae; and hard coral (one individual at one location). Seagrass was not confirmed at any site (one 'possible' seagrass plant was noted), however the precautionary principle will be applied, and it is assumed seagrass could occur at that survey location. Benthic habitat modelling presented in Galaiduk et. al. 2019 suggests that seagrass, hard coral and macroalgae exists in the areas to the north and south of the Subsea Cable System (e.g., in the area of influence according to the modelling work submitted in the Draft EIS). For the purposes of this discussion, it is assumed that seagrass, hard coral and macroalgae may be present in the area of influence. However, it is noted that the modelling likely overestimates the presence of seagrass, hard coral and macroalgae in the area of influence, based on the findings of the benthic video surveys conducted to date (see Section 9.2.2.1).

Potential impacts from cable laying

Cable laying works are proposed using two main methods:

- Jet-trenching will be used to lay cables for the majority of the Subsea Cable System within Shoal Bay and the inner Beagle Gulf. This method involves laying the cables on the seafloor and using a powerful water-jet system to fluidise the seabed, resulting in the cables sinking and being buried
- Dredging, via an MFE or cutter-suction dredger (Figure 2-46 in the Draft EIS) is anticipated in areas where sand waves have been identified (as shown on Figure 9-2) and pre-sweeping is required. This will involve pre-sweeping and dredging to remove the sand waves and disposal of spoil at a potential spoil disposal ground. A site selection process for potential SG is discussed in Section 8.3.1 in Chapter 8. The final potential spoil ground locations will be confirmed in consultation with the NT EPA and DCCEEW, as relevant.

Direct and indirect impacts will occur from cable laying. Within the direct disturbance footprint, there will be loss of BCH. This will impact an area of approximately 12 m wide per cable for jet-trenching. Dredging will directly impact an area of approximately 160,000 m^2, and spoil disposal will occur within an area of 4 km^2. Following completion of cable laying activities, there will be recolonisation of the area by fauna (this was observed following the INPEX capital dredging program; see INPEX, 2018), and BCH will recover over time.

Indirect impacts can also occur due to the disturbance and suspension of sediment, which may result in damage or mortality of BCH through physical or chemical effects (Jones et. al., 2016). The potential for chemical effects relates to the chemical characteristics and contamination status of the sediment within the cable laying footprint. Sediment samples were analysed for a suite of parameters, consistent with the NAGD. Results of sediment sampling indicate that sediments proposed to be dredged are classified as uncontaminated and are suitable for unconfined offshore disposal (see Appendix 8.2 and Appendix 8.3).

Physical effects relate to increased sediment in the water column, which results in increased turbidity and decreased light availability at the seafloor, which can impact benthic primary producers (e.g., seagrass, macroalgae and autotrophic coral). Additionally, sediment can be suspended due to works and resuspended (i.e., spread due to oceanographic processes such as tides and currents), settling on BCH resulting in smothering and potential impacts to ecological processes. Potential impacts to different benthic community groups are presented in Table 9-1 below.

Responses from benthic community groups to cable laying

Cable laying works can affect benthic community groups in different ways. A review outlining the responses of benthic community groups to dredging has been summarised (Table 9-1) based on reports from the WAMSI Dredging Science Node (WASMI 2021). While the reports were designed specifically for dredging, their general findings are considered relevant to jet-trenching because both methods of cable laying will result in similar impacts. It is noted, however, that jet-trenching tends to have a smaller footprint than dredging, and therefore less impact, because the direct disturbance footprint is narrow, shallower, and completed more quickly, thereby suspending less sediment in the water column for shorter periods of time. The application of dredging impacts to jet-trenching is therefore conservative and likely over-estimates impacts.

Table 9-1: Responses of benthic community groups to dredging

Benthic community group	Direct sediment deposition (smothering or burial)	Suspended sediment/Light attenuation
Seagrass	• Slows growth. • Burial above species-specific thresholds can lead to mortality. • Laboratory tests for burial of *Halodule uninervis* (a dominant Darwin Harbour species) was followed by rapid growth and a lethal burial limit was unable to be determined. The sub-lethal burial rate was 70 mm for more than 14 weeks[1]. • The addition of organic matter in the burial material can reduce the burial tolerance and duration of seagrass species[1].	• Reduces species diversity, biomass, and productivity. • Sub-lethal and lethal thresholds depend on duration and magnitude of light reduction. • *H. uninervis* (a dominant species in Darwin Harbour) was found to be most sensitive to light reduction. • Dominant Darwin Harbour species may survive up to 1-3 months below minimum light requirements before mortality.[2]
Hard coral (Jones et al., 2019)	• Slows growth and increases stress. • Leads to damage such as bleaching, lesion formation and tissue mortality. • Affects massive corals (identified in Shoal Bay) more than branching corals. [3] • Massive corals can shift sediment at high rates (up to 40 mg cm^{-2} d^{-1}). [3] • Affects dense reef structures more than singular corals (singular coral was found in Shoal Bay).[3]	• Slows growth. • Affects branching corals more than massive corals.[3] • The most sensitive corals (branching corals which were not identified in the Shoal Bay video survey) can survive exceptionally high SSCs (i.e. 100 mg L^{-1} for 28 days) as long as there is sufficient light.[3] • SSC and turbidity may not be appropriate parameters to be used solely for trigger values, because the amount of light is more important.[3] • Distance-decay relationships suggest that sediment-related impacts on corals dissipate rapidly with effects limited to less than 3-4 km.[3]
Macroalgae	The 110 macroalgae species in Darwin Harbour are poorly studied, and responses to direct sediment deposition and reduced light are dependent on species and season. Some macroalgae species (*Rhodophyta*) have naturally variable growth rates and are thought to be able to withstand severe conditions, although studies are limited[4]. It is likely that species are most sensitive to light reduction and smothering during their reproductive cycle, although the timing of reproductive cycles varies significantly across species.[4]	

1. Lavery et al, 2019
2. Based on experiments in Western Australia. Darwin Harbour seagrass may have a higher tolerance due to generally lower light environments caused by the large tidal range.
3. Jones et. al. 2019
4. Fraser et. al. 2017.

Key timings for benthic communities

The Flora and Fauna Division of DEPWS noted the following in relation to benthic communities in the greater Darwin region:

- The dry season is an important period for maintaining the health of benthic primary producer habitats (e.g., seagrass and macroalgae) because it is a time when water clarity improves (compared to the wet season), and species recovery occurs (INPEX, 2018). This was noted in the Draft EIS
- Seagrass and macroalgae tend to lay dormant over the wet season, and regenerate in the dry season when there is greater light availability in the water column (INPEX, 2018)
- Early wet season (September to December) is considered (based on anecdotal evidence) to be a coral reproductive period, during which time elevated TSS up to 3.2 mg/L may cause a decline in coral health due to bleaching and tissue damage (Tittle and Donoghue 2022).

Based on the above, it was recommended that the timing of the cable laying be restricted to the late wet season to minimise impacts to BCH. While timing of works will not be restricted due to significant schedule delays, extra cost and logistical challenges, the above key timings for sensitive receptors will be considered during establishment of water quality and/or sediment deposition trigger values when monitoring is undertaken (see Section 9.2.3).

Timing of works

The timing of cable laying works in the nearshore waters will not be restricted to the late wet season. While it is acknowledged that the late wet season may be the ideal time for cable laying to reduce potential impacts to seagrass, macroalgae and hard coral communities, it is not feasible to restrict cable laying works.

There are significant logistics involved in cable-laying activities, including securing vessels and suitably qualified crew to undertake the works, and acquiring sufficient cable to lay. Cable laying will be undertaken when vessels, crew and supplies can be obtained.

Additionally, cable laying during the late wet season may result in cable laying during storms, monsoonal weather, and generally rough seas, which would add to the logistical and safety complications of an already complex construction activity.

Although the entire area of influence has not been surveyed for BCHs, the surveys that were undertaken indicated a large proportion (45 %) of sites within Shoal Bay and the inner Beagle Gulf were bare sediment. Where benthic epifauna was identified, the vast majority were filter feeders, which are known to be common across the area (Galaiduk et al., 2019). There were no coral reefs, macroalgae beds or seagrass meadows identified during the video surveys, and therefore no significant areas of benthic communities will be in the direct impact zone of the cable laying activities. Therefore, it is not considered justified to restrict the timing of cable laying, as there is unlikely to be a significant impact on BCH.

The Proponent is committed to implementing the environmental decision-making hierarchy. Avoidance and mitigation measures that will be implemented to minimise potential impacts on BCH within the zone of impact and area of influence are summarised in Table 9-2. Refer to Section 9.2.3 for detail.

Table 9-2: Cable laying avoidance and mitigation measures for potential impacts to BCHs

Measures	Description
Avoidance measures	The Subsea Cable System route has been selected, in part, because it avoids areas modelled as high likelihood habitat for seagrass, hard coral and macroalgae (i.e., the rare, and therefore high value, benthic community groups).
	Geophysical, geotechnical, and benthic habitat surveys have been undertaken within the Subsea Cable System direct disturbance footprint to confirm that the route is suitable for cable laying and to ensure the route avoids significant BCHs.
Mitigation measures	Additional sediment transport modelling will be undertaken to refine the area of influence and to add sandwave removal sites and potential spoil disposal grounds in Coastal Waters. This will identify areas in which SSC concentrations or sediment deposition concentrations may exceed thresholds[2] for seagrass, macroalgae or hard coral. This work is proposed to be undertaken post environmental approval to add further certainty to the proposed monitoring program during construction as part of a follow-up and adaptive management program to managing marine environment impacts.
	Targeted benthic habitat video/drop camera surveys may be undertaken within the revised area of influence prior to cable laying. Surveys would occur in areas modelled as high likelihood habitat (60-100 %) for seagrass, hard coral or macroalgae, in areas where modelling indicates thresholds[1] may be exceeded.
	If sensitive receptors (substantial areas of seagrass, hard coral or macroalgae) are identified within the area of influence during video/camera surveys, water quality or sediment deposition baseline monitoring is proposed to be undertaken at those locations. Site-specific water quality or sediment deposition data will inform the development of site-specific trigger values, which will inform monitoring and management responses during cable laying. This may include developing a relationship between TSS and turbidity to inform construction water quality monitoring.
	A MEMP, which will include dredge management measures and describe the proposed modelling and monitoring adaptive management program, will be developed prior to construction and implemented during cable laying. This MEMP will include management responses to be implemented in the event that water quality or sediment deposition rates and duration trigger values are exceeded. Note that the development of site-specific trigger values, and implementation of monitoring during construction, will only occur if sensitive receptors are identified in the revised area of influence.

9.2.3 NT EPA Direction Item 28

9.2.3.1 Phase 2 – works to be undertaken

Hydrodynamic and sediment transport modelling

Hydrodynamic and sediment transport modelling was undertaken to inform the impact assessment in the Draft EIS. Within the nearshore component of the Subsea Cable System two-dimensional (2D) (depth-averaged) hydrodynamic modelling was undertaken using the Delft3D modelling package, using Delft3D-FLOW (current), Delft3D-WAVE (wave) and Delft3D-WAQ (water quality for suspended sediments). The modelling considered potential impacts from jet-trenching, which was the most likely cable laying method at the time the modelling was undertaken.

While it is acknowledged that three-dimensional (3D) modelling is best practice for modelling dredging impacts (as per Sun et. Al,. 2017), 2D modelling represents good international industry practice (GIIP) and was undertaken to provide indicative results for the Draft EIS that best aligned with the level of project data and design definition available at the time. Site-specific geotechnical and geophysical marine survey data for the first 45 km of the Subsea Cable System was not available

[2] Thresholds will be based on existing information in WAMSI 2022 and INPEX 2018.

at the time, including within Shoal Bay, at sandwave locations, or potential spoil disposal grounds. Therefore, 3D modelling was not considered appropriate when considering the broader-scale assumptions and mapping-based model inputs that were available. Thus, 2D modelling was selected as the more feasible and reasonable technical approach to identify the potential for significant impacts in the marine environment.

Since the 2D modelling was complete, the Subsea Cable System has been refined, and marine surveys have been undertaken in the nearshore area which included the collection of site bathymetric and geotechnical data (see Appendix 8.1, 8.2 and 8.3). Where further modelling supports the adaptive management approach (described above in Table 9-1) this will be scoped and undertaken. The model may consider the following Project activities:

- Jet-trenching
- Removal of sandwaves through pre-sweeping and a MFEs or cutter-suction dredger
- Spoil disposal.

Modelling will be undertaken in accordance with the WAMSI Dredging Science Node Guideline on dredge plume modelling for EIA (Sun et. al., 2020). The modelling is proposed to be undertaken post environmental approval, but prior to construction commencing.

The modelling outcomes will be used to:

- Quantify the spatial extent of zones within which SSCs within the water column, or sediment deposition at the bed level, may be elevated as a result of cable laying activities
- Quantify the temporal extent of any periods of elevated suspended sediment or sediment deposition resulting from cable laying activities
- Define the extent of the zone of impact; further categorised as Zone of High Impact (ZOHI) and Zone of Moderate Impact as per the Technical Guidance: EIA of Marine Dredging Proposals (WA EPA, 2021), if appropriate. Within the zones of impact, higher magnitude changes to seagrass, macroalgae or hard coral (see below) may occur, if these receptors are present
- Define the area of influence from cable laying and dredging activities, as per the Technical Guidance: EIA of Marine Dredging Proposals (WA EPA, 2021), within which minor environmental quality (e.g., water quality or sediment deposition rates) impacts may occur with no detectible impact on benthic biota
- Identify locations where thresholds for sensitive receptors (seagrass, hard coral or macroalgae) may be exceeded (in terms of water quality or sediment deposition), to inform the need for additional ground-truthing of benthic habitat within this zone.

Baseline data (water quality and physical process) will be collected as required to inform and calibrate the model. Baseline data may be collected prior to or after the initial modelling is undertaken, and the modelling is considered an iterative process whereby the model outputs inform field studies, which then inform revisions of the model as appropriate.

The model results will be used to determine appropriate locations to ground-truth sensitive receptors. The location of sensitive receptors will dictate the requirements for additional field data collection, such as baseline water quality monitoring or sediment deposition rate monitoring (as discussed in Section 9.2.4).

The model can also be used to establish zones of impact and influence. In accordance with the WA EPA Technical Guidance: EIA of Marine Dredging Proposals (EPA, 2016), zones of impact and influence in relation to dredging are defined as follows:

- ZOHI is the area where impacts on benthic communities or habitats are predicted to be irreversible (lacking a capacity to return or recover to a state resembling that prior to impact within a timeframe of five years or less). This zone is often the dredge footprint and disposal sites, and immediate surrounds. Geophysical, geotechnical, geochemical and benthic habitat surveys have already been undertaken within the ZOHI for the Project as presented in Section 9.2.2 above and available in Appendices 8.1, 8.2 and 8.3. No substantial areas of benthic communities or habitat (including hard coral, seagrass or macroalgae) were identified within the ZOHI
- Zone of Moderate Impact (ZOMI) is the area adjacent to the ZOHI, within which predicted impacts on benthic organisms are recoverable within a period of five years following dredging. For the purposes of this, the ZOMI is considered to be the areas adjacent to the ZOHI where modelling indicates a potential for tolerance limits (described below) to be exceeded. Additional surveys within the ZOMI may be undertaken, depending on the outcomes of the modelling
- Zone of Influence (henceforth referred to as the 'area of influence' for consistency with the Draft EIS and NT EPA terminology) is the area adjacent to the ZOMI, within which changes in environmental quality associated with sediment plumes are predicted and anticipated during dredging operations, but where these changes would not result in a detectible impact on benthic biota. For the Subsea Cable System, this area is likely to include the extent of modelled elevated SSC or elevated sediment deposition rates that are below established tolerance limits (see below). Additional surveys may be undertaken within the area of influence, depending on the outcomes of the modelling based on magnitude of elevated concentrations or rate of sediment deposition.

Tolerance limits

Tolerance limits were established for some benthic habitat classes by INPEX (as reported in INPEX 2018) based on literature reviews, site-specific monitoring, and findings of ongoing monitoring, including that undertaken during and after the capital dredging program. Tolerance limits are generally considered the upper limit for SSC or sediment deposition, above which species would begin to be impacted (e.g., decreased growth or mortality). The tolerance limit does not indicate that SSC or sediment deposition above that level would result in death of benthic species, but rather provides a benchmark above which impacts would be likely to occur. Conversely, if modelling shows that SSC or sediment deposition rates are below the tolerance limits for some species, then it can be concluded that cable laying would be unlikely to impact on BCHs surrounding the Subsea Cable System.

In Shoal Bay, SSC may not be a reliable parameter to assess potential impacts on sensitive receptors alone. Additional thresholds of high SSC duration and resuspension rates of unconsolidated sediment (i.e., dredged sediment that has fallen out of the water column and is more easily resuspended) are needed to determine whether sensitive receptors will be impacted. The WAMSI reports on coral (Jones et al, 2019) and seagrass (Statton et al, 2017) both indicate that net sediment deposition is a more appropriate measure of impact than SSC alone. For example, while increased SSC over a site-specific time threshold leads to increased light attenuation and potential stress to coral and seagrass, the most likely cause of mortality is smothering and deposition. In turn, net deposition and duration of high SSC will depend on the proximity of the sensitive receptor to dredge-works, which reduces rapidly (i.e., distance increases) due to the continually moving nature of cable laying. In Shoal Bay, tidal currents are typically strong, therefore, net deposition may be small because the sediment that settles will likely be resuspended in the following tide.

Sediment deposition and SSC tolerance limits for Darwin Harbour were developed by INPEX (2018) and are shown in Table 9-3. Note there are no WAMSI nor INPEX references on the effects of sediment deposition and SSC on macroalgae, and hence tolerance limits have not yet been defined for them.

Table 9-3: EXAMPLE Tolerance limits for SSC and sedimentation rates

Benthic community group	Season	SSC tolerance limit (mg/L)	Sedimentation tolerance limit (mm)
Seagrass	Dry	13.3	40
	Wet	60.6	40
Coral	Dry	17.9	15
	Wet	64.2	15

The tolerance limits presented in Table 9-3 are based on the findings of substantial investigations undertaken by INPEX in the Darwin Harbour region and at the INPEX spoil disposal ground, which is located proximate to both the Subsea Cable System and the potential spoil disposal grounds (INPEX, 2018). The tolerance limits are therefore considered relevant to the Project areas. However, the tolerance limits are provided for seagrass and coral, which were not identified in surveys to date (hard coral was identified at one location and was an individual coral). Therefore, if tolerance limits are required to be established (which will depend on the findings of survey works described in Section 2.1.3), site-specific water quality or sediment deposition rate monitoring will be undertaken by the Proponent to refine the tolerance limits, as appropriate.

Additional benthic habitat survey

The modelling described above will redefine the ZOMI and area of influence from cable laying activities (including removal of sandwaves and potential spoil disposal). Benthic video surveys have already been undertaken within the ZOHI. Additional video transect or drop camera surveys may be undertaken within the ZOMI or area of influence, at targeted locations where benthic habitat modelling indicated a high likelihood (60 - 100 %) of presence of hard coral, seagrass or macroalgae, and where SSC and sediment deposition tolerance limits are likely to be exceeded (see Table 9-3). The additional benthic habitat survey/s will include assessment of percentage cover of benthic communities and species. If substantial areas of hard coral, seagrass or macroalgae are identified, then water quality monitoring or sediment deposition flux measurements will be undertaken at those locations to establish a baseline against which construction water quality monitoring results can be compared.

It is acknowledged that further consideration and assessment is required to establish the thresholds for which seagrass, macroalgae or hard coral would be considered substantial (and therefore of high ecosystem value), in terms of area of coverage, percentage cover and/or species complexity and diversity. The benthic communities within Shoal Bay, and throughout the NT, are generally not well studied or understood which limits the ability to define what areas of seagrass, macroalgae or coral reef would be considered substantial and therefore important. It is known that the percentage cover of seagrass along the Darwin coastline naturally fluctuates seasonally. Studies undertaken on seagrass beds between Fannie Bay and Lee Point, and some smaller isolated patches at Woods Inlet and Charles Point, noted that the percentage cover of *Halodule* varied between 5 % and 20 %, while *Halophila* varied from complete absence to 50 % cover, with lower coverage/absence noted in the wet season months (see INPEX, 2022 and Power and Water, 2016). This highlights the importance of seagrass survey timing, but also the natural fluctuation in percentage cover which makes it difficult to define a 'substantial' area of seagrass based on percentage cover.

Therefore, the Proponent will develop the definitions of 'substantial' (and therefore high value) areas of seagrass, macroalgae or hard coral in Shoal Bay in consultation with DEPWS prior to benthic habitat surveys being undertaken and/or based on the results of video survey data. If substantial areas of hard coral, seagrass or macroalgae are identified during surveys, then mitigation measures will be implemented during construction to monitor and mitigate impacts on these sensitive receptors (see Section 9.2.4 below).

9.2.4 Phase 3 – works which may be undertaken, subject to outcomes of Phase 2

The following works will be undertaken if benthic habitat surveys within the revised ZOMI or area of influence (based on modelling as per Section 9.2.2.1) identifies substantial areas of seagrass, hard coral or macroalgae ('sensitive receptors') which may be impacted by cable laying works, which is considered highly unlikely based on findings of video surveys already undertaken (Appendix 9.1). Note that if the benthic habitat surveys do not identify any sensitive receptors within the area of influence, then baseline monitoring, and monitoring during construction is not proposed.

The NT EPA Direction comment suggested trigger values be established for 'benthic communities including corals, seagrass, macro algae and filter feeders.' As presented in the Technical Report: Darwin – Bynoe Harbours predictive mapping of benthic communities (Galaiduk et. al., 2019), and confirmed by video surveys undertaken within the Subsea Cable System, filter feeders are the most common benthic community group in the Darwin and Bynoe region. Therefore, impacts to filter feeders within a relatively small area and over a short period of time is unlikely to result in a significant impact on filter feeders regionally, or the marine ecosystem in general. Monitoring and management of impacts from cable laying processes will target rare, and therefore higher value, benthic habitat classes (as discussed in Section 9.2.2.1) with higher percent cover; specifically, macroalgae, hard coral and seagrass. Therefore, no trigger values will be developed for filter feeders.

Baseline water quality monitoring at sensitive receptors prior to construction

The need for baseline water quality monitoring will depend on:

- The presence of sensitive receptors found to occur within the zones of impact and area of influence, determined by targeted benthic video/camera surveys
- The SSC or sediment deposition rates predicted by the modelling, and whether there are sensitive receptors within the area where spatial or temporal tolerance limits are likely to be exceeded (see Table 9-3)
- The requirements of the water quality model calibration and verification process (temperature, salinity, and currents).

Shoal Bay is data deficient in terms of physical and chemical water quality parameters, such as temperature, salinity, PAR environment, and turbidity and its derivatives. Therefore, baseline monitoring may be undertaken to determine natural intra-seasonal and spatial variation in the water quality characteristics within Shoal Bay and the inner Beagle Gulf. This data will be used to:

- Calibrate and verify the modelling (if and as required)
- Investigate and establish a relationship between TSS and turbidity throughout the water column[3]
- Establish site-specific trigger values for turbidity and sediment deposition, to assess impacts during cable laying and inform management measures.

The following sampling will be undertaken as part of a baseline monitoring program, to be completed prior to subsea cable laying:

[3] Note this will only be undertaken if ground-truthing benthic surveys identify substantial areas of sensitive receptors (seagrass, hard coral or macroalgae) within the area where tolerance limits for SSC or sediment deposition are likely to be exceeded (based on model outputs).

- Deployment of bed-level frames with benthic light (PAR), turbidity, temperature, salinity, and current sensors. This monitoring will be undertaken at sensitive receptor sites (i.e., seagrass, macroalgae and hard coral) if identified within the ZOMI and area of influence
- Routine and systematic water samples measuring TSS, PIM, POM and CDOM (Coloured Dissolved Organic Matter) at sensitive receptor sites (if identified) to provide a relationship between the modelling results, TSS and the turbidity measurements (NTU) – discussed further in the following section
- Deployment of temperature sondes at intervals along the Subsea Cable System to determine baseline water temperature before and after construction.

The baseline data can be used to establish site-specific trigger values, against which construction water quality monitoring can be compared (see Section 9.2.2.1). This assumes that the marine ecosystem, including BCHs, are adapted to local conditions (which will be established via site-specific monitoring), and they may be stressed if conditions regularly exceed background concentrations. See Section 9.2.2.1.

Turbidity/TSS relationship

Site-specific water quality monitoring may be undertaken to investigate the relationship between TSS and turbidity, in accordance with 9.2.4 of the Guideline on dredge plume modelling for EIA (Sun et. al., 2017). Monitoring may be undertaken within the water column to investigate the relationship between suspended sediment and light availability and quality at the seafloor. These data can also inform the modelling, as appropriate.

Significant investigations were undertaken to establish a relationship between SSC and turbidity to inform the INPEX EIS and dredge management program. The results of the studies undertaken by Cardno, on behalf of INPEX, found a 1:1 relationship between SSC and turbidity (Cardno, 2013). If site-specific data is inconclusive, the 1:1 relationship established via previous studies will be assumed to apply for monitoring of impacts resulting from construction of the Subsea Cable System. This is considered appropriate given the similar location of activities, the duration and scale of construction (i.e., short term and in a narrow corridor), and the fact that benthic video surveys undertaken to date did not identify any significant benthic communities or habitat which would be impacted by cable laying activities.

Cable laying monitoring program

If sensitive receptors are identified within the refined zones of impact and area of influence, monitoring will be undertaken during cable laying to monitor impacts to those sensitive receptors. The locations and monitoring parameters will be informed by all works described above. Monitoring may be undertaken to monitor water quality and light availability at sensitive receptors, and/or sediment deposition rates on sensitive receptors, to inform management responses. The following sections present an example of a water quality and sediment deposition monitoring program which may be implemented, noting that further works will be undertaken to determine the requirement for monitoring and further inform monitoring parameters and trigger values. Management responses to exceedances of trigger values are also provided in the section that follows.

Example water quality monitoring program

Water quality monitoring will be either undertaken as daily field measurements, or continuous measurements via deployed loggers. The following parameters will be measured, throughout the water column, including at the seafloor:

- Turbidity
- Benthic light (PAR)
- Temperature
- Salinity (EC).

Trigger values will be established for turbidity, against which monitoring data will be compared. Table 9-4 shows an example of how trigger values would be established for each benthic community group (hard coral, seagrass or macroalgae), for wet and dry season conditions. Note that the trigger values presented in Table 9-4 are examples only (sourced from INPEX 2018) and would be developed for sensitive receptors within the ZOMI or area of influence if they are present.

In the event that site-specific trigger values cannot be established (e.g., due to insufficient data obtained over the wet season), then trigger values would be established based on thresholds and environmental windows for each benthic community group, in accordance with information presented in the WAMSI Dredging Science Node reports (WAMSI, 2021).

Table 9-4: EXAMPLE trigger values for water quality monitoring during cable laying

Site ID	Season	Level 1 trigger value		Level 2 trigger value	
		Turbidity (95 %ile)	Duration (consecutive days)	Turbidity (95 %ile)	Duration (consecutive days)
Monitoring Site X (hard coral)	Wet season	27 NTU*	4 days*	35 NTU*	1 day*
	Dry season	13 NTU*	5 days*	21 NTU*	5 days*
Monitoring site X (macroalgae)	Wet season	TBC	TBC	TBC	TBC
	Dry season	TBC	TBC	TBC	TBC
Monitoring site X (seagrass)	Wet season	TBC	TBC	TBC	TBC
	Dry season	TBC	TBC	TBC	TBC

*The values provided here are from the INPEX (2018) *Maintenance Dredging and Spoil Disposal Management Plan* and are examples only. Site specific trigger values will be established based on water quality monitoring which will be undertaken as described in Section **Error! Reference source not found.**.

Example sediment deposition monitoring program

Many of the WAMSI Dredging Science Node reports stated that high sediment deposition rates are more likely to have detrimental impacts on benthic communities and biota, compared to turbidity and light attenuation impacts (WAMSI, 2022). This is particularly true in environments such as Shoal Bay, where benthic communities and biota are adapted to periods of elevated turbidity and low light due to natural processes (tides, wet season conditions etc). Therefore, an alternative method for assessing cable laying impacts is to measure sediment deposition rates at sensitive receptors.

This method would involve first undertaking site-specific monitoring over a range of tidal and seasonal conditions (i.e., at least 28 days during the dry season, and 6-8 weeks [or as long as required to capture two monsoonal events] during the wet season). Traditional sediment deposition measurement instruments, such as sediment traps, are problematic and tend to overestimate sediment deposition (Jones, 2018). Therefore, alternative methods would be sought to establish site-specific deposition rate, potentially using a deposition plate instrument (e.g., see Marine Geophysics). Trigger values for sediment deposition could then be established for each sensitive receptor type, based on a deposition rate and duration of deposition if the instrumentation were commercially available. Examples of sediment deposition rates are provided in Table 9-5, based on tolerance limits for deposition rates established by INPEX (2018) (which were determined via literature reviews, sediment deposition modelling and findings of studies undertaken during capital dredging for the Project).

Table 9-5: EXAMPLE trigger values for sediment deposition

Location	Season	Level 1 trigger value		Level 2 trigger value	
		Sediment deposition (mm)	Duration (consecutive days)	Sediment deposition (mm)	Duration (consecutive days)
Monitoring Site X (hard coral)	Wet season	10*	4 days*	15*	1 day*
	Dry season	10*	4 days*	15*	1 day*
Monitoring site X (macroalgae)	Wet season	TBC	TBC	TBC	TBC
	Dry season	TBC	TBC	TBC	TBC
Monitoring site X (seagrass)	Wet season	20*	4 days*	40*	1 day*
	Dry season	20*	4 days*	40*	1 day*

*The values provided here have been developed based on tolerance limits established for hard coral and seagrass in the INPEX (2018) *Maintenance Dredging and Spoil Disposal Management Plan* and are examples only. Site specific trigger values will be established based on sediment deposition monitoring, modelling results, and presence of sensitive receptor types as described above and in Section **Error! Reference source not found.**.

Management responses

Two levels of trigger values will be derived from site-specific monitoring data and will consist of an intensity value (parameter concentration) and a duration, both of which need to be exceeded for an exceedance to occur.

Level 1 trigger values will be considered an early warning sign which indicates turbidity or sediment deposition rates are approaching the upper limit of that which naturally occurs in the area. Note that an exceedance of a trigger value does not necessarily equate to an environmental impact, but rather prompts a management response. Table 9-6 summarises proposed management responses to an exceedance of a Level 1 trigger value.

Table 9-6: Proposed responses to Level 1 trigger value exceedance

Response	Details

Review data to confirm exceedance	Ensure data is accurate and that the trigger value exceedance is attributable to cable laying activities. This will include:
	• Ensuring data loggers are accurately measuring and are not faulty/fouled.
	• Cross checking data with other, nearby monitoring sites.
	• Reviewing other sources of data including:
	  • Recent weather and oceanographic conditions
	  • Site specific and regional water quality data from other locations
	  • Sediment characteristics
	  • Location and nature of cable laying activities at the time of the exceedance.

Review cable laying methodology	Review the cable laying methodology to identify opportunities for improvement to reduce turbidity or sediment deposition resulting from cable laying. This may include altering speed, direction, or methodology of cable laying to ensure turbidity levels at sensitive receptors remain below Level 2 trigger values.

Table 9-7: Proposed responses to Level 2 trigger value exceedance

Response	Details

Review data to confirm exceedance	Ensure data is accurate and that the trigger value exceedance is attributable to cable laying activities. This will include:
	• Ensuring data loggers are accurately measuring and are not faulty/fouled.
	• Cross checking data with other, nearby monitoring sites.
	• Reviewing other sources of data including:
	  • Recent weather and oceanographic conditions
	  • Site specific and regional water quality data from other locations
	  • Sediment characteristics
	  • Location and nature of cable laying activities at the time of the exceedance.

Alter cable laying methodology	Implement measures to alter cable laying methodology, which may include: • Change location of cable laying • Change direction of cable laying • Change speed of cable laying • Alter jet water flow velocity • Optimise sailing route (to avoid sediment resuspension from propellor wash) • For sandwave removal, alter methodologies such as overflow time, overflow height, suction flow velocity etc. • For spoil disposal, alter timing of disposals in relation to tides or alter/optimise disposal location.
Reporting	The Marine Contractor will inform the Proponent in the event of an exceedance of a Level 2 trigger value at a sensitive receptor. The Proponent will inform DPEWS and DCCEEW as required based on conditions of approvals.
Contingency measures	In the event that, following implementation of responses, turbidity or sediment deposition does not return to below Level 1 levels at the sensitive receptor within 7 days, the following will occur: • Marine Contractor and the Proponent will identify and implement additional management measures (e.g., cease cable laying in that area). • The Proponent will inform DPEWS and DCCEEW of the ongoing exceedance and management measures that were and are planned to be implemented, as required based on conditions of approvals. • Undertake additional monitoring as required to confirm turbidity or sediment deposition rates and identify the extent of exceedances.

Response	Details
	Once turbidity or sediment deposition has returned to below Level 1 trigger value at the sensitive receptor, the Marine Contractor will prepare a report which presents actions taken and effectiveness, to ensure continual improvement and inform future management actions. This would involve an investigation and identification of corrective actions, following processes established in the Environment and Social Management System and CEMP, which will detail the Project incident management procedures to be followed.

The above monitoring measures will be detailed in the MEMP (which will include the dredge management measures and trigger thresholds), which will provide controls to be implemented during cable laying works to ensure operational efficiency while minimising potential environmental impacts (Table 9-7).

Monitoring of potential spoils disposal grounds

Benthic video surveys were undertaken at four potential spoil disposal grounds, all located north of the Subsea Cable System (refer to the Appendix 9.1 for details). No significant benthic communities or habitat were identified in any of the proposed spoil disposal grounds. Filter feeders (soft coral, hydroid, crinoid, sponges) were identified at all potential spoil disposal grounds, and macroalgae was identified at three of the potential spoil disposal grounds. In all instances, only individual organisms were identified at the survey sites; there were no significant groupings of filter feeders and no macroalgae beds.

Filter feeders are the most abundant benthic habitat class in the Darwin and Bynoe region, as detailed in Galaiduk et. al. (2019). Therefore, the filter feeders identified within the potential spoil disposal grounds are not considered unique or significant, and no specific management measures are proposed.

Macroalgae was identified at some survey locations within the potential spoil disposal grounds and was also identified at survey sites in Shoal Bay. Coverage was low (e.g., individual plants rather than beds) at all survey sites. Therefore, given the fact that isolated occurrences of macroalgae were found throughout the survey areas, a loss of some isolated macroalgae in the potential spoil disposal grounds is not considered significant and no specific management measures are proposed.

INPEX undertook a significant dredging campaign and disposed of dredge spoil in a location close to the Subsea Cable System and proposed spoil disposal grounds. INPEX undertook monitoring of subtidal benthos during and after the capital dredging program to monitor the impacts of dredging and dredge spoil disposal. Monitoring data indicated that, following dredge spoil disposal, there was significant recovery in both the abundance and taxa richness of benthic infauna, back to baseline levels, within the INPEX Dredge Spoil Disposal Area (INPEX, 2018). This recovery was observed within one to two years following the completion of dredging and dredge spoil disposal.

Given spoil volumes and 10-12 weeks duration of these works will be significantly less for the Subsea Cable System[4], and spoil disposal will occur in a similar location to INPEX, combined with the lack of presence or notable coverage/occurrence of sensitive receptors within the potential dredge SG, it can be concluded that:

- Potential impacts resulting from spoil disposal will be significantly less than that observed at the INPEX disposal site

[4] Spoil volumes for construction of the Subsea Cable System are estimated as ~230,000m^3 (or 0.22 million cubic meters (Mm^3)). During capital dredging, INPEX removed and disposed of approximately 16.1 Mm^3. Additionally, sandwave removal and spoil disposal for construction of the Subsea Cable System will occur over 10-12 weeks, while the capital dredging undertaken by INPEX occurred over 2 years (NT EPA 2022).

- Recovery of benthic infauna will occur within the spoil disposal area, as was observed at the INPEX disposal site.

Therefore, no further monitoring or specific management measures are proposed at the potential spoil disposal grounds in NT Coastal Waters. Additional monitoring may be required for any proposed spoil disposal in Cwth waters, as triggered under the NAGD.

9.2.5 Underwater noise

International industry practice for establishing underwater noise limits commonly follows the United States National Oceanic and Atmospheric Administration (NOAA, 2018) guidelines. The NOAA 2018 separates the impact of underwater noise on marine fauna into the following categories:

- Permanent threshold shift (PTS), this is indicative of permanent tissue injury amongst organisms
- Temporary threshold shift (TTS), this results with reversible tissue damage
- Possible Behavioural Disturbance (PBD), this results with temporary behavioural changes.

The PTS and TTS categories are further split into:

- Non-impulsive. These include brief, intermittent, or continuous noise consistent in pattern, level, or tone (i.e., dredging, drilling and vessel noise)
- Impulsive thresholds. These are sounds that last less than a second with rapid high peak pressure followed by a decay (i.e., pile-driving and blasting).

The conservation significant species at risk from the impacts of underwater noise during cable installation in Australian waters include:

- Dugongs and dolphins, for which TTS and PTS are defined by (Southall et al., 2019) and (NOAA, 2018). PBD have been defined by Dunlop et al., 2017
- Turtles and sawfish for which thresholds determined by Cavanagh (2000) and McCauley et al., (2000) are used to predict the onset of the TTS and PTS. PBD have been defined by McCauley et al., (2000).

Table 9-8 summarises the weighted cumulative sound exposure levels over 24 hours (SEL_{24hr}) for TTS, PTS, and PBD onset criteria with respect to impulsive and non-impulsive noise types in Australian waters. Further limitations on the un-weighted impulsive peak sound pressure level (SPL_{pk}) are included strictly for instantaneous impulsive activities.

Table 9-8: TSS, PTS, PBD Thresholds for Non-Impulsive and Impulsive Noise

Marine Fauna Type	Hearing Bandwidth	Noise Type	SEL_{24hr} dB re 1µ Pa^2.s			SPL_{pk} dB re 1µ Pa^2	
			TTS	PTS	PBD	TTS	PTS
Dugongs	100 Hz – 50kHz	Non-Impulsive	186	206	140	-	-
		Impulsive	175	190		220	226
Dolphins	150 Hz – 160 kHz	Non-Impulsive	178	198		-	-
		Impulsive	170	185		224	230
Turtles and Sawfish	100 Hz – 1 kHz	Non-Impulsive	175	183	175	-	-
		Impulsive	175	183		-	-

9.3 Project Amendments since Draft EIS

The following project refinements included in the SEIS (Chapter 2) have included additional footprint impact on marine ecosystems which have been assessed in this section:

- Subsea Cable System - Route B (Figure 8-1)
- Subsea Cable System – Sediment removal and spoil disposal during construction/operations (Figure 8-3).

9.3.1 Subsea Cable System – Route B

Further investigations have identified Route B presented as an option in the Draft EIS as the preferred Subsea Cable System alignment. A marine survey was completed from Gunn Point beach along Route B for the approximately 60 km length to where Route B adjoins the originally proposed cable system route. This footprint and associated direct zone of impact and indirect areas of influence are assessed in this chapter, which is informed by the conclusions reached in Chapter 8 of this SEIS.

9.3.2 Subsea Cable System – Sediment removal during construction and operations

Marine geotechnical/geophysical studies carried out since the Draft EIS have confirmed the need to remove areas with elevated sandwaves during construction to enable safe installation of the cable to a design depth of 0 to 3 m below the seabed. There are nine sandwave areas that need to be dredged (see Chapter 8 and Appendices 8.1, 8.2 and 8.3 for additional details).

Minor sediment removal may be required during the operation of the Project to rectify any potential fault malfunctions in the cable.

Four potential spoil disposal grounds have been identified to accept approximately 260,000 m^3 of marine sediment material that will need to be disposed of during construction, and which would also be used infrequently during operations, as and when needed.

9.4 Existing Environment and Values

The reports listed in Section 9.2 increased the understanding of marine ecosystems present within the project refinement footprint and surrounding areas, as well as the beneficial uses and environmental values that are present. Additional information to support the Draft EIS is presented below for Route B – from Murrumujuk to the connection of the originally proposed Subsea Cable System assessed in the Draft EIS, which is approximately 60 km.

The additional marine investigations conducted for this SEIS took place from the shore at Murrumujuk out for 75 km along Route B and also covered all four potential spoil disposal grounds which are assessed in this chapter. This survey was conducted as it had not yet been surveyed for the project. The investigation also included all sandwaves proposed for removal, with the exception of sandwave areas 15/16, as these sandwaves had already been surveyed for the Draft EIS. Therefore sandwaves 15/16 are not discussed in this chapter.

9.4.1 Habitats

The Draft EIS identified a number of 'sensitive receptors' within the zone of impact and area of influence of the Subsea Cable System, which were based on modelled habitat with a high potential (60-100%) for seagrasses or hard corals (as present in Galaiduk et al. 2019 and Siwabessy et al., 2020). These three community groups were identified as sensitive receptors because they:

- Are less common in the region (the two most common modelled habitat types are filter feeders [i.e., sponges and octo-coral] and bare sediment)
- Provide habitat and/or food sources for a number of marine species
- Have potential to be impacted by dredging, cable laying and spoil disposal activities (i.e., via sediment resuspension and deposition, and light attenuation; see WAMSI, 2021).

Additional surveys of the marine environment along the Subsea Cable System Route B in the Shoal Bay and Beagle Gulf were carried out in August 2022. Additional surveys included:

- Sampling of sandwaves and potential spoils disposal sites to assess sediment characteristics, bedforms, topographic features, and to identify benthic habitats and communities (seagrass, macroalgae, corals or filter feeders), if present
- Determination of presence/absence of BCH within the zone of impact of the Subsea Cable System Route B and to ground-truth the benthic habitat modelling which was presented in the Draft EIS.

The August 2020 survey work characterised surveyed substrates as unconsolidated (i.e., usually containing little/no vegetation and fine to gravelly sands), with varying levels of bioturbation.

Sandwaves

Within the newly surveyed direct project footprint area (i.e., sandwave dredging locations and potential spoil disposal grounds), four of the survey sites were characterized as bare sediment, with no epifauna identified. Some isolated patches of soft coral and macroalgae were identified, along with hydroids, anemones, teleost fish, an octopus, crinoids (attached and unattached), sea urchin, bryozoans, ascidian, giant sea tulip, sponges (multiple species) and starfish. Appendix 9.1 provides the results of the underwater camera surveys undertaken in these locations.

These sandwave areas are discussed in detail in Chapter 8. Section 8.4.2 in particular provides a description of the sediment quality of those sandwave areas which were surveyed.

BCH

In general, field results did not support the modelled BCH for the region (provided in Galaiduk et al. 2019 and Siwabessy et al., 2020) (Figure 6 from report). Surveys took place within Shoal Bay and Beagle Gulf and of the 30 sites surveyed, only four were confirmed as comprising the predicted, modelled benthic habitat:

- Hard coral was modelled as highly probably at 18 sites, but was only identified at one site
- Macroalgae was modelled as highly probable at five sites. Macroalgae was identified at two of those five sites, and at another six sites which were modelled as hard coral – eight sites in total
- Seagrass was modelled as highly probably at seven sites. Seagrass was not identified at any site, although a ‘possible’ seagrass sp. was observed at one location.

The benthic communities and epifauna that were identified were sparse and isolated to individual organisms. For example, coral and macroalgae were present, however there were no coral reefs or macroalgae bed. Similarly, although large areas of the survey region were modelled as likely seagrass habitat, no seagrass meadows were identified, and one individual plant was ‘potentially’ present at one site. Thirteen of the 30 survey sites (approximately 43 %) were bare sediment, with no visible benthic communities, habitat or epifauna.

In general, the finding of the video survey indicate that the modelled habitat over-estimated the presence of hard coral, seagrass and macroalgae within the Subsea Cable System zone of impact (direct disturbance footprint). Where macroalgae and hard coral was identified, it was very sparse, with individual organisms identified. No significant occurrences or cover of the three sensitive receptor marine community groups of coral reefs, seagrass meadow or macroalgae beds were observed.

9.4.2 Important Areas

The nearshore and offshore important areas that intersect the proposed Subsea Cable System route were extensively detailed in Chapter 10 of the Draft EIS. Nationally significant values in the nearshore include extensive tidal flats that support migratory birds, as well as rainforest patches occurring on the margin of the tidal flats. These tidal flats are mostly located within the Tree Point Conservation Area and the Shoal Bay Coastal Reserve, both of which are not intersected by the Subsea Cable System footprint. Marine parks that are protected under the *EPBC Act* are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management, and where low-level, non-industrial use of natural resources compatible with nature conservation is one of the main aims. The three KEFs that are nationally or regionally significant biodiversity or ecosystem features, present within the area of influence of the Subsea Cable System include Van Diemen Rise, Sahul Shelf and Pinnacles of the Bonaparte Basin; these were assessed in the Draft EIS. No other KEFs were discovered during the August 2022 survey of sand waves 1 - 5 and 17 - 20 and the four potential spoil disposal grounds.

9.4.3 Condition of the existing marine environment

The condition of the existing marine environment was assessed in the Draft EIS. Water quality in the Shoal Bay area has been assessed in the Darwin Harbour Report Cards for the 2009 to 2019 period for the following indicators: nutrients; water clarity (turbidity); dissolved oxygen; and algae. Outer Shoal Bay has been graded A or ‘excellent’ eight times and B or ‘very good’ three times over this period, indicating that the water quality complies with the Darwin Harbour WQ Objectives indicators at least 85 % of the time. In the near coast region, a key potential threatening process is the introduction of marine pests, introduced species that have been moved from their natural distribution into areas where they may threaten biodiversity, or commercial and recreational values. The introduction of marine pests was assessed in the Draft EIS and was determined to be a minor residual impact.

9.4.4 Fauna

All species identified in the TOR with potential to occur in the Project's footprint were considered in the Draft EIS and in the Marine Ecology report (Appendix T in the Draft EIS). The listed marine species have been further assessed for potential impacts due to project refinements and/or resulting from comments on the Draft EIS, and the results of their assessments are detailed in Chapter 15 (Table 15-3).

9.4.5 Beneficial uses

The main beneficial uses of the marine ecosystem in the regions traversed by the Subsea Cable System are recreational and commercial fishing. Recreational and commercial fishing is detailed in Section 10.3.5 in Chapter 10 of the Draft EIS and remains accurate for the updated project footprint, including the sandwaves proposed for removal and the potential spoil disposal grounds.

9.5 Potential Impacts

The potential impacts to marine ecosystems within the area of influence of the Subsea Cable System and/or sensitive receptors located within the area of influence of the Subsea Cable System (as a result of the project refinements or to respond to NT EPA comments) and informed by the additional knowledge gained from new investigations (Section 9.2) have been assessed using the EIA methodology described in Chapter 3 of the Draft EIS. The following impacts were identified and assessed as possibly occurring during the construction phase:

- Direct loss or disturbance of BCH for seagrass, coral and macroalgae due to dredging and spoil disposal
- Habitat degradation due to elevated turbidity in marine waters as a result of increased SSC during sand wave removal and spoil disposal
- Mortality or impaired function to benthos and fish due to smothering as a result of increased sedimentation
- Gradual change in habitat/benthic community as a result of disposal sediment dredged that is of a different sediment type to potential spoil disposal ground (i.e., muddy sand onto a fine sand or gravelly sand areas)
- Changes to marine fauna behaviour due to noise and light disturbance during sand wave removal and spoil disposal
- Direct fauna mortality or injury due to vessel collision or spoil disposal.

The EIS identified and assessed the following impacts that could occur during operation of the Subsea Cable System:

- Habitat loss and degradation associated with cable repairs
- Changes to marine fauna behaviour due to EMF and heat
- Changes to benthic communities due to increase of temperature within the sediments.

9.5.1 Areas of Potential Impact

Sensitive receptors within the zone of impact (direct disturbance footprint) of the Subsea Cable System Route B, dredging and disposal areas, and in the surrounding area of influence will potentially be impacted via:

- Direct loss of benthic species and habitat
- Smothering due to sediment resuspending and deposition
- Water quality impacts (increased SSCs) and associated increased turbidity and light attenuation.

9.5.2 Construction

The potential for impacts to marine ecosystems will be greatest during the construction phase when dredging and disposal of spoil along Route B will disturb the seabed and mobilise sediments into the water column.

9.5.2.1 Sedimentation/Turbidity impacts regarding species, habitat, dredging and spoil disposal

During construction, physical changes to the seabed may lead to benthic habitat loss or degradation within the direct disturbance footprint of the Subsea Cable System. However, the following statements can be made from the video surveys taken within the Subsea Cable System between Murrumujuk and 75 km along the route:

- The modelled habitat over-estimated the presence of sensitive benthic habitat within the Subsea Cable System zone of impact (direct disturbance footprint). Where macroalgae and hard coral was identified, it was very sparse, with individual organisms identified. No coral reef, seagrass meadow or macroalgae beds were observed
- These benthic communities are not unique, rare, or sensitive and are common and generally widespread throughout the region
- There are no significant KEF or significant ecological communities are expected to be disturbed with the Subsea Cable System route
- Disturbance within these footprint areas is not expected to result in any significant reduction of habitat that supports sensitive life-stages for listed species at risk.

Cable installation along Route B, sand wave removal and spoil disposal will result in periods of elevated SSC and turbidity, which could impact benthic biota such as seagrass, macroalgae and coral, although these sensitive benthic communities are sparse across the Project footprint. It is assumed that elevated SSC will affect an area less than what was modelled in the Draft EIS, due to the material being sand. Detailed in Section 8.5.2.1 in Chapter 8 sand waves 17 - 18 has the highest proportion of fine material amongst the sandwaves that need to be dredged and therefore the highest potential of higher turbidity. The potential spoil disposal ground D has higher fine material content as well, and therefore would have a higher turbidity when depositing the spoil. Also, potential spoil disposal ground C had a higher fine material content, therefore disposal at this potential spoil disposal ground is also higher

Construction and therefore impact will be temporary and short-term (approximately 10 - 12 weeks to install the Subsea Cable System within Australian waters). As installation progresses benthic habitats will be able to recover quickly in soft sediment habitats. All the of the proposed sandwaves for removal and potential spoil disposal grounds had unconsolidated substrate, indicating these habitats will recover more quickly.

How quickly the seafloor recovery depends primary on the environmental setting and natural processes, which recover fastest in areas with high sediment supply due to waves, currents, tides and/or run-off (Chapter 10 Draft EIS). Physical recovery within the inner to middle continental shelf (0 to 80 m water depth) can occur within weeks to less than years but may be longer in deeper water because sediment supply generally (but not always) decreases offshore. (Kraus and Carter, 2018) The sandwaves to be dredged and the potential spoil disposal grounds all have a water depth of less than 80 m (Appendix 8.3). Therefore, these areas would recover more quickly, posing loss of a mortality or impaired function risk to benthos and fish from smothering

Long-term changes to substrate in potential spoil disposal ground will be minimal as the substrate being dredge is similar to the proposed potential spoil disposal ground (see Section 8.4.1 in Chapter 8). Therefore, gradual change in habitat/benthic community as a result of the differences between dredged spoil and potential spoil disposal grounds is unlikely.

9.5.2.2 Changes to marine fauna behaviour due to noise and light disturbance during sandwave removal and spoil disposal

Refer to Sections 9.2.5 and 9.5.2.4 above for consideration of these matters.

9.5.2.3 Direct fauna mortality or injury due to vessel collision or spoil disposal

Direct fauna mortality or injury due to vessel collision is assessed in Chapter 10 of the Draft EIS. National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (Cwth of Australia, 2017) provides guidance on understanding and reducing the risk of vessel collisions and the impacts they may have on marine megafauna. The strategy has been used to inform the EIA for marine ecosystems within the Draft EIS and the selection of mitigation measures that will reduce vessel strike incidents. The impacts of fauna mortality or injury due to spoil disposal would be minimal for mobile fauna, as they can move away from the area. For sessile fauna the impacts would be greater as they cannot move away from the area. However, the lack of habitat within the potential spoil disposal grounds indicates that the presence of sessile fauna is unlikely.

9.5.2.4 Indirect marine fauna impacts due to construction noise

The Underwater Noise Technical Report recently prepared by Talis Consultants in support of the Darwin Shiplift EIS (2021) undertook underwater noise modelling to assess the impacts of 24-hour dredging within Darwin Harbour, primarily considering the impacts of continuous 24-hour dredging as well as associated land reclamation activities, over a period of approximately seven months within a singular location (i.e., within Darwin Harbour). That assessment also considered the potential impacts of pile driving within the same area of impact in Darwin Harbour over a period of around five months.

The Subsea Cable System to be delivered as part of the AAPowerLink project would be installed as a linear piece of infrastructure, and areas of sandwave removal and disposal are isolated in their position along the overall Subsea Cable System alignment. This means that the same marine fauna habitat locations would not be continuously, significantly impacted by noise during the cable laying works, as the linear cable laying method would simply continue along its route, along with any associated dredging and placement. The short duration of sandwave removal and disposal works indicates that any impacts to marine fauna resulting from noise will be minor and temporary. Moreover, the noise generated from cable laying and sandwave removal and placement is considered to create a neutral or even potentially positive result in that it is likely to encourage fauna to move away from locations where the cable is being laid/sediments are being placed. This could reduce the risk of vessel strike and other such direct impacts to marine fauna.

Furthermore, suitable mitigation measures for noise impacts to marine fauna tend to include consideration of undertaking shallow water works during low tide conditions. Consideration of how tidal regimes may impact the marine environment, particularly in the nearshore area, is already part of the AAPowerlink Project's overall approach to managing marine works. Therefore, there is considered to be no further benefit in formally modelling these impacts in order to support this conclusion.

9.5.3 Operations

During routine operations, there is limited potential for impacts to marine ecosystems.

9.5.3.1 Habitat loss and degradation associated with cable repairs

In the unlikely event of cable damage or a system fault, repairs would be required that may cause extremely localized disturbance of the seabed, and short-term water quality impacts associated with retrieval and installation of the new or repaired cable section.

9.5.3.2 Changes to marine fauna behaviour due to EMF and heat and changes to benthic communities due to increase of temperature within the sediments

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an internationally recognised body that sets guidelines for protection against adverse health effects of non-ionising radiation. EMF calculations at 21 different locations have shown that field intensities resulting from the presence of the Subsea Cable System are well within internationally recognised guidelines (400 mT for the general public, not someone who could suffer from occupational EMF exposure).

The field intensity[5] and the magnetic field intensity[6] is at its highest when the cables are laying directly on the seabed surface and decreases as the depth of burial increases. When something such as sea water or marine life moves through a magnetic field an electric field is induced in the object. The ICNIRP issued an Environmental Update in December 2021 regarding the overview of interactions between subsea cables and the marine environment (biota means flora and fauna in this context):

Until recently, knowledge of EMF on sensitive marine biota was limited. This situation partly reflected a dearth of real-world field studies. Uncertainty was compounded by complexities associated with the different responses of various marine organisms to EMF that themselves varied as a function of (i) cable voltage, (ii) AC or DC systems, (iii) depth of cable burial, (iv) cable orientation and other factors. However, at least three major reviews and several field studies have been completed that provide a more informed perspective. The common finding of this research is that there is a lack of evidence for positive or negative effects of cable EMF on the species studied and therefore the effects are uncertain.

The Draft EIS stated that the ICPIC (2021) reviewed studies of EMF impact on marine biota and found that research undertaken to-date indicates a lack of evidence for positive or negative effects of cable EMF on the species studied, with studies finding no change in biological assemblages along energised cables.

A that heat produced by the cable system and resulting localised increases in surrounding temperature are typical of those for similarly rated HVDC interconnectors such as those in service and being constructed in European waters. Assuming the cable is buried at 0.5 m below seabed, the centre of the cable will reach 57.1ºC, with the cable surface reaching 40ºC, and the temperature at the seabed is around 25ºC.

[5] The magnetic field is the result of the electric current that flows along the cable corridor. The field extends outside of a cable and it is usual to express the magnitude of the field in terms of flux density or field intensity.
[6] The magnetic field intensity is dependent on the electrical current that flows in the cable and the distance from the cable: as current increases, the intensity increases and as distance from the cable increases, the intensity decreases.

When a cable is sitting on the seabed surface, heat transfer from the cable is by conduction, natural convection (caused by heat generated by the cable), forced convection (caused by the natural movement of seawater) and radiation.

9.6 Avoidance, Mitigation, and Monitoring

The Proponent is committed to applying the environmental decision-making hierarchy. Consistent with Section 26 of the *EP Act*, this involves applying the following approaches in order of priority:

1. Avoid – Ensure that actions are designed to avoid adverse impacts on the environment
2. Mitigate – identify management options to mitigate adverse impacts on the environment to the greatest extent practicable
3. Offset – If appropriate, provide for environmental offsets for residual adverse impacts on the environment that cannot be avoided or mitigated.

The environmental management framework that will be adopted for the construction and operation of the Project is detailed in Chapter 17 Environmental Management of the Draft EIS. The framework comprises a CEMP and OEMP that sits within an overarching EMS. Chapter 17 of the SEIS provides additional mitigation measures or commitments identified to address Project refinements, as needed.

For each of the impacts to marine ecosystems discussed in this chapter, an updated Table 9-9, which summarises the actions that will be taken to avoid environmental impacts (through site selection and design) and actions proposed to minimise impacts during construction, and operation of the proposal is provided below. Relevant measures have been referred to in the above discussion of the likelihood and severity of potential impacts associated with each component of the Project. The proposed controls are routine for marine developments and industrial operations and, assuming proper implementation and adaptive management, are expected to be effective in ensuring no significant impacts to marine ecosystems. The measures provided in this chapter, along with any additional measures required to address conditions of approvals, permits and licences, will be integrated into the CEMP and OEMP prepared for the Project.

Table 9-9: Marine ecosystems - Avoidance, mitigation, monitoring, and reporting commitments

Impact	Avoidance	Mitigation	Monitoring	Reporting
Direct loss or disturbance of BCH for seagrass, coral and macroalgae due to dredging and spoil disposal.	Route B design and selection of potential spoil disposal grounds, where possible, have avoided topographical areas along the sea floor which are associated with areas of higher habitat value. Placement of materials/equipment in sensitive areas will be avoided. Cable burial methods will be selected to suit the local seabed conditions and limit the amount of material that requires dredging.	Design, install and operate Subsea Cable System in accordance with the Guidelines on Best Environmental Practices in Cable Installation, and Operation (OSPAR, 2012). All dredging and disposal will be conducted in accordance with the legislative framework outlined in Appendix 8.3, including the National Assessment Guidelines for Dredging 2009 and Sea Dumping Act in particular, and will draw on WAMSI to implement best management practices. Disposal of spoil will avoid periods of storms when the water column is chaotic to decrease turbidity. Adaptive management process will be applied (Figure 9-1).	Turbidity monitoring in impact zone and baseline/reference site during cable installation in high-risk area (shallow, <10 m depth).	Internal reporting on environmental performance. External reporting in accordance with environmental approval conditions.
Habitat degradation due to elevated turbidity in marine waters as a result of increased SSCs during sandwave removal and spoil disposal.	Route B design and selection of potential spoil disposal grounds, where possible, have avoided topographical areas along the sea floor which are associated with areas of higher habitat value. Impact avoidance measures as per to minimise habitat loss, degradation and direct fauna mortality and spills.	Design, install and operate Subsea Cable System in accordance with the Guidelines on Best Environmental Practices in Cable Installation, and Operation (OSPAR, 2012). North Marine Parks Network Management Plan and National Light Pollution Guidelines for Wildlife will be adhered to during construction of the Subsea Cable System. Mitigations as per above to minimise habitat loss, degradation and direct fauna mortality and spills.	Turbidity monitoring in impact zone and baseline/reference site during cable installation in high-risk area (shallow, <10 m depth).	Internal reporting on environmental performance. External reporting in accordance with environmental approval conditions.

Impact	Avoidance	Mitigation	Monitoring	Reporting
Mortality or impaired function to benthos and fish due to smothering as a result of increased sedimentation.	Route B design and selection of potential spoil disposal grounds, where possible, have avoided topographical areas along the sea floor which are associated with areas of higher habitat value. During dredging and deposition, a fauna spotter will be utilised to minimise any harm to fauna and to conduct visual inspections of the works aiming to limit environmental impact.	Design, install and operate Subsea Cable System in accordance with the Guidelines on Best Environmental Practices in Cable Installation, and Operation (OSPAR, 2012). All dredging and disposal will be conducted in accordance with the legislative framework outlined in Appendix 8.3, including the National Assessment Guidelines for Dredging 2009 and Sea Dumping Act in particular, and will draw on WAMSI to implement best management practices.	Visual observation for marine fauna activity in accordance with the Marine Environment Management Plan.	Internal incident reporting.
Gradual change in habitat/benthic community as a result of disposal sediment dredged that is of a different sediment type to potential spoil disposal ground (ie. muddy sand onto a fine sand or gravelly sand areas).	Nil.	Sandwaves proposed to be dredged and potential spoil disposal grounds are of similar grainsize where possible.	Nil.	Nil.
Changes to marine fauna behaviour due to noise and light disturbance during sandwave removal and spoil disposal.	Route B design and selection of potential spoil disposal grounds, where possible, have avoided topographical areas along the sea floor which are associated with areas of higher habitat value.	Lighting will be energy efficient and designed to minimise hard contrasts, without compromising navigation safety and security. Minimised use of lights at night as feasible to reduce light trespass and to maintain dark skies.	Visual observations for signs of changes in behaviour of marine fauna activity in accordance with the Marine Environment Management Plan.	Visual observations reporting as required.

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Impact	Avoidance	Mitigation	Monitoring	Reporting
	Cable paying activities move up to 600 m per hour which limited the duration of noise emissions in any given area.	Where possible, lights will be shielded with exterior cut-off fixtures to limit light emissions at a vertical angle of no more than 90 degrees from straight down.		
Direct fauna mortality or injury due to vessel collision or spoil disposal	During dredging and deposition, a fauna spotter will be utilised to minimise any harm to fauna. Adhere to National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (Cwth of Australia 2017)	If a listed species is injured or killed, the proponent must ensure that: • All use of the equipment that injured or killed the listed species ceases immediately • The activity does not resume without the written permission of the Director.	Visual observation for marine fauna activity in accordance with the Marine Environment Management Plan.	Within the Oceanic Shoals Marine Park (OSMP) where a 'listed species' as defined by the Environment Protection and Biodiversity Conservation Regulations 2000, is injured or killed in undertaking the Activities, the proponent must notify the Director's Duty Officer on 0419 293 465, as soon as practicable, and in any case no longer than 72 hours, following that event. Any interference with a cetacean (even unintentional) is to be notified to DCCEEW as per the requirements of Division 3, Part 13 of the *EPBC Act* the *EPBC Act*.
Habitat loss and degradation associated with cable repairs.	Minimal disturbance to the area while cables are being repaired.	Where there is a repair option with less disturbance, the option with less disturbance will always be attempted first.	Nil.	Internal reporting on environmental performance. External reporting in accordance with environmental approval conditions.
Changes to marine fauna behaviour	The Subsea Cable System will be buried 0.5 – 3 m below the seabed, decreasing the effects of	Nil.	Nil.	Nil.

Impact	Avoidance	Mitigation	Monitoring	Reporting
due to EMF and heat.	EMF and surface temperature of maximum 25ºC.			
Changes to benthic communities due to increase of temperature within the sediments.	The Subsea Cable System will be buried 0.5 – 3 m below the seabed, decreasing the temperature of the sediments closer to the surface of the seabed.	Nil.	Nil.	Nil.

9.7 Residual Impact

Most of the residual impacts have a rating of ‘minor,’ showing no change to the residual impact conclusions reaches in the Draft EIS. A residual impact of moderate was determined for ‘habitat degradation due to elevated turbidity in marine waters due to sandwave removal and spoil disposal.’ However, the certainty is moderate as the areas that have been surveyed showed a lack of habitat and the area of influence has not yet been determined or surveyed. Any identified uncertainties are addressed with monitoring and mitigation measures. All residual impacts are considered not significant.

Table 9-10: Summary of SEIS results - Marine ecosystems – Construction

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual Impact
Direct loss or disturbance of BCH for seagrass, coral and macroalgae due to dredging and spoil disposal.	Subsea Cable System.	**Likely** Direct loss of BCH will occur due to approximately 260,000 m^3 of sandwave removal. Direct loss of BCH will occur in spoil disposal locations.	**Regional** Sandwave removal will occur within a 600 m wide corridor at 10 locations along the Subsea Cable System, with a total footprint of approximately 207 ha. Spoil disposal will potentially occur in up to four x 1 km^2 disposal grounds, with a total direct disturbance footprint of up to 4 km^2 (400 ha).	**Medium Term** Sandwave removal will be undertaken during construction only, for a period of 10 - 12 weeks. Spoil disposal will occur for the duration of sandwave removal, during construction only 10-12 weeks.	**Minor** Footprint is small in relation to the habitat provided in the broader region, and benthic habitat surveys did not identify any sensitive benthic communities or habitat within direct disturbance footprint.	**Low** Benthic habitat surveys via video identified sparse benthic biota, and no sensitive receptors (patches of hard coral, seagrass or macroalgae).	**High** Benthic video surveys have been undertaken at locations where sandwave removal is proposed.	**Minor**
Habitat degradation due to elevated turbidity in marine waters as a result of increased	Subsea Cable System.	**Possible** Sandwave removal and spoil disposal will result in periods of elevated SSC and turbidity, which can impact on	**Localised** Elevated turbidity could be widespread; however, any impact to benthic habitats would be	**Medium Term** Sandwave removal and spoil disposal will be undertaken during construction	**Moderate** SSC and turbidity are likely to exceed thresholds for some sensitive receptors.	**Low** Based on initial benthic habitat survey results there is unlikely to be sensitive receptors in the	**High** Benthic habitat surveys indicates there are no seagrass, hard coral and macroalgae within the	**Moderate**

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual Impact
SSCs during sandwave removal and spoil disposal.		benthic biota such as seagrass, macroalgae, and coral.	localised as only small patches of sensitive habitats occur in the area of influence.	only, for a 10 - 12 weeks.		area of influence.	proposed areas for sandwave dredging and potential spoil disposal grounds.	
Mortality or impaired function to benthos and fish due to smothering as a result of increased sedimentation.	Subsea Cable System.	**Possible** Mortality or impaired function of benthos is possible but unlikely for fish as they can move away from the deposition area.	**Localised** Potential spoil deposition grounds are 1 km^2 in area each, with a total of 4 km^2.	**Medium Term** Spoil disposal will occur for the duration of sandwave removal, during construction only 10-12 weeks.	**Minor** Footprint is small in relation to the habitat provided in the broader region, and benthic habitat surveys did not identify any sensitive benthic communities or habitat within direct disturbance footprint.	**Low** Benthic habitat surveys via video identified sparse benthic biota, and no sensitive receptors (patches of hard coral, seagrass or macroalgae).	**High** Benthic video surveys have been undertaken at locations where sandwave removal is proposed.	**Minor**
Gradual change in habitat/benthic community as a result of disposal sediment dredged that is of a different sediment type to potential spoil disposal	Subsea Cable System.	**Unlikely** Change is unlikely as sediments in sandwaves are similar to those in the potential spoils disposal grounds.	**Localised** Potential spoil deposition grounds are 1 km^2 in area each, with a total of 4 km^2.	**Medium Term** Spoil disposal will occur for the duration of sandwave removal, during construction only 10-12 weeks.	**Minor** Footprint is small in relation to the habitat provided in the broader region, and benthic habitat surveys did not identify any sensitive benthic communities or habitat within direct disturbance footprint.	**Low** Benthic habitat surveys via video identified sparse benthic biota, and no sensitive receptors (patches of hard coral, seagrass or macroalgae).	**High** Benthic video surveys have been undertaken at locations where sandwave removal is proposed.	**Minor**

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual Impact
ground (ie. muddy sand onto a fine sand or gravelly sand areas).								
Changes to marine fauna behaviour due to noise and light disturbance during sandwave removal and spoil disposal.	Subsea Cable System.	**Likely** Sandwave removal and spoil disposal will create disturbances, including noise, and light.	**Localised** Noise and light disturbance will occur within the direct vicinity of the sandwave removal and spoil disposal activities which is predicted to have a deterrent effect on fauna.	**Medium Term** Sandwave removal and spoil disposal will be undertaken during construction only, for a period of 10 - 12 weeks. Activities will be undertaken for 24 hours per day.	**Minor** Noise and light could deter or attract marine fauna moving through the area; however, there is unlikely to be a measurable change in any population due to the low level and short duration of noise and light impacts.	**Medium** Threatened species, migratory species and highly valued species such as turtles, dugong and sawfish are known to occur in the Shoal Bay and Beagle Gulf region. However, their habitat covers a large area and is not restricted to the area of influence.	**Moderate** Specific noise assessments have not been undertaken as the literature shows that underwater noise emissions from cable laying is not a significant concern.	**Moderate**
Direct fauna mortality or injury due to vessel	Subsea Cable System.	**Possible** Vessels will be moving through areas where	**Isolated** Impacts will be limited to the area directly proximate to	**Medium Term** Sandwave removal and spoil disposal will be	**Minor** Given low speeds of vessels, and deterrent effect of noise and	**Medium** Threatened species, migratory species and	**High** Speed is known to be a key contributing factor associated	**Minor**

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual Impact
collision or spoil disposal		fauna are known to occur. Sandwave removal and spoil disposal will be undertaken in areas where fauna is known to occur.	vessels, sandwaves and potential spoil disposal grounds.	undertaken during construction only, for a period of 10 - 12 weeks.	disturbance, fauna are likely to move away from vessels before collision. If collision occurred, the low speeds mean death would be unlikely.	highly valued species such as turtles, dugong and sawfish are known to occur in the Shoal Bay and Beagle Gulf region. However, injury or death of one individual is unlikely to have a significant impact on the population.	with fauna strikes, and vessel speeds will be low during activities. Marine mammal visual observations allow for the establishment of an exclusion zone if required.	

Table 9-11: Summary of SEIS results - Marine ecosystems – Operations

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual Impact
Habitat loss and degradation associated with cable repairs.	Subsea Cable System.	**Possible** Cable repair (if required) will disturb benthic habitat.	**Limited** Only a small area of benthic habitat would be disturbed during repairs.	**Long Term** Benthic habitat will recover following construction, and habitat disturbed during repairs should also recover. Recovery of habitat occurring over months or years, depending on the type of benthic habitat.	**Minor** Habitat loss will occur but unlikely to impact on surrounding environment or other uses.	**Low** Most of the habitat in the footprint is bare substrate. Modelled habitat over-estimated the presence of hard coral, seagrass and macroalgae.	**High** Nearshore cable route has been surveyed for benthic habitat.	**Minor**
Changes to fauna behaviour due to EMF and heat.	Subsea Cable System.	**Likely** Operation of the HVDC cables will generate heat and EMP that could deter or attract fauna or increase bacterial growth.	**Limited** EMF and heat emissions from the cables will be minor and restricted to the sediment directly around the cable.	**Long Term** Impacts will occur for the duration of operations.	**Minor** The behaviour of some species will be impacted, and not in a way that significantly alters local biodiversity. Cable will be buried to minimize heat emissions.	**Low** Most of the habitat in the footprint is bare substrate. Modelled habitat over-estimated the presence of hard coral, seagrass and macroalgae.	**High** Nearshore cable route has been surveyed for benthic habitat.	**Minor**
Changes to benthic communities due to increase of temperature	Subsea Cable System.	**Possible** If the cable is buried at 0.5 m below seabed, the centre of the cable will reach	**Limited** EMF and heat emissions from the cables will be minor and	**Long Term** Impacts will occur for the duration of operations.	**Minor** The behaviour of some species will be impacted, and not in a way that	**Low** Most of the habitat in the footprint is bare substrate. Modelled habitat	**High** Nearshore cable route has been surveyed for benthic habitat.	**Minor**

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual Impact
within the sediments.		57.1ºC, with the cable surface reaching 40ºC, and the temperature at the seabed is around 25ºC.	restricted to the sediment directly around the cable.		significantly alters local biodiversity.	over-estimated the presence of hard coral, seagrass and macroalgae.		

9.8 Cumulative Impact Assessment

Due to the low level of residual impact to marine ecosystem associated with the project refinements combined with no change in assessment conclusion ratings for the Draft EIS, there is limited potential for new cumulative impacts for the laying of the Subsea Cable System not previously considered to occur. Potential cumulative impacts associated with project refinements for the Project identified in the Draft EIS are consistent with that described in the Draft EIS.

9.9 Conclusion

Twenty-six submissions were received relating to marine ecosystems during the public submissions period (Section 9.10), four from the NT EPA Direction (Section 9.11), nine from DCCEEW, seven from DEPWS, five from ECNT, one from a public community member, and one from Anonymous.

A review of the project refinements identified in Chapter 2 have not identified any new significant impacts. Most of the residual impacts have a rating of ‘minor’ and any identified uncertainties are addressed with avoidance, monitoring, and mitigating measures. Uncertainties around elevated turbidity levels, mobilisation of bioavailable arsenic, and habitat degradation need to be further explored based on the adaptive management strategy (Figure 9-1). However, only a few localised areas were identified as having relatively high silt/clay percentages and couple with short construction periods, it is not expected that the project would result in significant sediment mobilisation impacts. Thus, the Project can achieve the objective of protect the quality and productivity of water, sediment, and biota so that environmental values are maintained.

9.10 Submission Response

During the Draft EIS Public Submissions period, DCCEEW, DEPWS, and ECNT all made comments with respect to benthic habitats and impacts, concern for specific fauna (whales, turtles, dolphins, and sharks), and thermal and radiation effects of the Subsea Cable System. Other comments were with respect to fauna strike and notification, timing of construction, and TSS and sediment plumes. All submissions, including those from public community members, made comments with respect to marine ecosystems as a whole.

The Proponent’s responses to the submissions received are provided in Sections 9.10.1 to 9.11.9.

9.10.1 DCCEEW Submission – Whole of Environment Assessment

The offshore component of the project sits within Cwth marine waters. This means that a whole of environment assessment is required, and this assessment must include any relevant marine species not only EPBC Act protected species within Cwth waters. Therefore, the Department requires a discussion about substantial adverse effects of the project on populations of any NT listed marine species (if any) that also occur within Cwth waters.

9.10.1.1 Response

A whole of environment assessment has been completed, including an impact self-assessment of the Cwth Marine Waters. Section 9.5, above describes the impact assessment undertaken for this area. Also see chapter 10 in the Draft EIS for the initial impact assessment which assesses all species present within the Project area. Listed species are also assessed in Table 15-3 in Chapter 15.

9.10.2 DCCEEW Submission – Marine Environment Management Plan

In Chapter 10 – Marine Ecosystems, several "impact mitigations and monitoring measures" reference a Marine Environment Management Plan. The effectiveness of these mitigation and monitoring measures cannot be adequately assessed without reviewing the Plan. The Department requests that this Plan be included in the Supplementary EIS for review and must not be inconsistent with the North Marine Parks Network Management Plan 2018.

9.10.2.1 Response

The Proponent recognises the need to develop a suite of NTG approved EMPs to demonstrate how the risks of impacts on all aspects of the environment will be mitigated through the implementation of thorough monitoring and management frameworks. Detailed in Figure 17-1 in the Draft EIS is a comprehensive list of environmental management sub-plans, including a MEMP, that the Proponent has committed to creating, seeking approval, and implementing. Existing relevant EMP Frameworks (i.e., Darwin Ship Lift) will be used as an example when drafting similar documents as proposed construction is more than 1 year away and further decisions must be made in order to draft an effective EMP. Also see the Project response to comments 27 and 28 below in which the Proponent has committed to an adaptive management process to manage potential impacts in the marine environment.

9.10.3 DCCEEW Submission – Whales and Turtles

The project crosses biologically important areas for the Pygmy Blue Whale (Balaenoptera musculus brevicauda), Whale Shark (Rhincodon typus) and the Flatback Turtle (Natator depressus). Therefore, the Department expects to see adequate avoidance and mitigation measures for these species in the Marine Environment Management Plan.

9.10.3.1 Response

Avoidance and mitigation measures for all significant and listed marine species (including but not limited to: Pygmy Blue Whale (*Balaenoptera musculus brevicauda*), Whale Shark (*Rhincodon typus*) and the Flatback Turtle (*Natator depressus*) are detailed Table 15-3 in Chapter 15 in Table 10-7 of Chapter 10 in the Draft EIS and in Table 17-7 of Chapter 17 in the Draft EIS and will be included in the Environmental Management Framework outlined above (see Section 9.10.2.1 Response to DCCEEW Submission on MEMP). The sub-plans under the CEMP will be developed and approved by the NT EPA in advance of the project works. The MEMP will be consistent with the *North Marine Parks Network Management Plan 2018*.

The detail of the MEMP will aim to prevent or reduce the potential environmental impacts the Project may have during the construction of the Subsea Cable System. In addition to the elements described in Section 17.2 of the Draft EIS and above, the plan will also include determination if underwater noise thresholds and mitigation measures are sufficient, visual marine mammal observations, marine flora, and fauna management, and identify marine pest risks and detail management measures in line with relevant guidelines and requirements.

In addition, under the *EPBC Act*, the Blue Whale (*Balaenoptera musculus)*, which includes the Pygmy Blue Whale (*Balaenoptera musculus brevicauda*) is listed as endangered, the Whale Shark (*Rhincodon typus*) is listed as vulnerable and migratory, and the Flatback Turtle (*Natator depressus*) is listed at vulnerable. All Cetacean species more broadly are also protected under the *EPBC Act* regardless of their individual conservation status. All conservation management plan requirements specified in the *EPBC Act* for these species will be met and detailed in the Marine EMP.

9.10.4 DCCEEW Submission – Dolphins

The Australian Snubfin Dolphin (Orcaella heinsohni), Indo-Pacific Bottlenose Dolphin (Tursiops aduncus) and Indo-Pacific Humpback Dolphin (Sousa chinensis) are EPBC Act migratory species expected to be present and foraging in the Gunn Point region and Shoal area. Therefore, the Department expects to see adequate avoidance and mitigation measures for these species in the Marine Environment Management Plan.

9.10.4.1 Response

See Section 9.10.3.1 above, the response to DCCEEW Submission – Whales and Turtles. Table 15-3 in Chapter 15 detailed the potential impacts for marine and migratory species listed under the *EPBC Act*.

The Australian Snubfin and Indo-Pacific Humpback are priority species within the National Dolphin Conservation Plan. The Whale and Dolphin Protection Plan is made up of three components, the National Dolphin Conservation Plan, the National Whale Trail and the National Strandings and Entanglement Action Plan. The Proponent will ensure that AA PowerLink adhere to any laws, regulations, and guidelines in order to protect whales and dolphins within the project area.

9.10.5 DCCEEW Submission – Habitat Value

In table 10-7 of Chapter 10, it is unclear what is meant by areas of higher habitat value. Please define and expand on it in the context of habitat loss and degradation.

9.10.5.1 Response

By design, the Subsea Cable System route predominantly transects largely featureless shelfs and basins. It has been chosen to avoid areas of higher habitat value. Areas of higher habitat value that are areas of significant topography comprised of key features that may support higher biodiversity values relative to surrounding habitats. These are:

- Sections of terrace with rocky areas in the Van Diemen Rise region, although these are quite deep, which reduces the likelihood of higher biodiversity
- Pinnacles but at depths much greater than those associated with high biodiversity
- Two banks in the Sahul Shelf region that rise to 60 m depth, have some rock, and therefore may support hard corals
- A valley in western Sahul Shelf region
- A saddle between two reefs on the continental shelf.

9.10.6 DCCEEW Submission – Impacts to Key Ecological Features (KEF)

The KEF which are located within and outside of the Ocean Shoals Marine Park are mentioned in section 10.3.2.2 Offshore Environmental values (Chapter 10); however, the potential impacts to these KEF haven't been addressed in the avoidance, mitigation and monitoring section. The Department requests that consideration is given to these features.

9.10.6.1 Response

As stated in Section 10.3.2.2 of the Draft EIS, the Subsea Cable System footprint traverses two zones of the OSMP. Three KEF exist within the OSMP in these areas: Van Diemen Rise, Sahul Shelf, and Pinnacles of the Bonaparte Basin. All three KEF have a Category VI designated protection under the *EPBC Act*, which is for the conservation of ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. More detail regarding these systems can be found in Section 10.3.2.2 of the Draft EIS.

We have considered the three KEF in the avoidance, mitigation, and monitoring section (Table 10-7) in the Draft EIS, under habitat loss and degradation:

- Avoidance – Route design, where possible, has avoided topographical areas along the sea floor which are associated with areas of higher habitat value
- Mitigation – Design, install and operate Subsea Cable System in accordance with the Guidelines on Best Environmental Practices in Cable Installation and Operation (OSPAR, 2012)
- Monitoring – Turbidity monitoring in impact zone and baseline/reference site during cable installation in high-risk area (shallow, <10 m depth)
- Reporting – Internal report on environmental performance. External reporting in accordance with environmental approval conditions.

9.10.7 DCCEEW Submission – Fauna Strike

The Department notes that there are no avoidance measures listed for direct fauna mortality/collision with vessels. The Department requests that further consideration is given to measures to avoid species which are known to occur in the area, including Flatback Turtle, Loggerhead Turtle, Olive Ridley Turtle, Pygmy Blue Whale and Whale Shark.

9.10.7.1 Response

As discussed in Section 10.4 of the Draft EIS, direct fauna mortality/collision with vessels was identified as a potential impact during the construction of the Subsea Cable System. With the addition of dredging and spoil disposal into this SEIS, Section 9.5.2.3 also discusses direct fauna mortality/collision with vessels or spoil disposal.

The impact of direct fauna mortality/collision with vessels is considered in Table 10-7 of the Draft EIS. Although there are no avoidance measures listed, mitigation measures, monitoring and reporting measures are detailed. In essence, the vessels for cable laying move slowly and all support vehicles will also move slowly as a mitigation measure.

Detailed in Section 10.4.2.6 in the Draft EIS, the *National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (Cwth of Australia 2017)* states that vessel speed is a key factor in fauna strikes. This strategy provides guidance on understanding and reducing the risk of vessel collisions and the impacts they may have on marine megafauna. The strategy has been used to inform the EIA for marine ecosystems and the selection of mitigation measures that will reduce vessel strike incidents.

9.10.8 DCCEEW Submission – Notifications

The Department notes that there are currently nil reporting requirements relating to incidents within the OSMP where marine fauna are impacted. Thus, the Department requests that measures are put in place to notify the Director of any incidents while the activity is undertaken. Suggested reporting: Where a 'listed species' as defined by the Environment Protection and Biodiversity Conservation Regulations 2000, is injured or killed in undertaking the Activities, the proponent must notify the Director's Duty Officer on 0419 293 465, as soon as practicable, and in any case no longer than 72 hours, following that event. If a listed species is injured or killed, the proponent must ensure that:

- *all use of the equipment that injured or killed the listed species ceases immediately*
- *the activity does not resume without the written permission of the Director*

9.10.8.1 Response

Notifications to the Director has been included as a reporting measure in the avoidance, mitigation, monitoring, and reporting section of this SEIS in Table 9-9.

9.10.9 DCCEEW Submission – Radiation Impacts

Due to the lack of knowledge of thermal radiation impacts, its long-term effects and cumulative impacts nearshore and offshore. The Department takes a precautionary approach and suggests that the proponent commits to monitoring these impacts along the subsea cables and implementing adaptive management measures to reinstate and recover the surrounding habitats that could be negatively impacted. Additionally, appropriate mitigation measures should be provided to minimise thermal radiation impacts such as cables buried at an appropriate distance from the seabed, etc.

9.10.9.1 Response

The ICNIRP is an internationally recognized body the sets guidelines for protection against adverse health effects on non-ionising radiation. For static magnetic field – like the Subsea Cable System – the ICNIRP publishes guidelines for limiting exposure. The magnetic field intensity is at its highest when the cables are lying directly on the seabed surface. The general public limit is over 80 times the exposure limit that was calculated for the Subsea Cable System. The Subsea Cable System will be buried at a depth between 0.5-3 m, decreasing the exposure limit even more.

Detailed in Section 9.5.3.2, where sensitive marine biota is concerned the common finding of this research is that there is a lack of evidence for positive or negative effects of cable EMF on the species studied and therefore the effects are uncertain.

Detailed in the Draft EIS, the International Cable Protection Committee (ICPC, 2021) reviewed studies of EMP impact on marine biota and found that the research undertaken to- date indicates a lack of evidence for positive or negative effects of cable EMF on the species studied, with studies finding no change in biological assemblages along energized cables. Therefore, it is reasonable to conclude that any potential impact of EMF on marine biota will be very localized.

The detail in Response Section 9.10.2.1 is also relevant for this section.

9.10.10 DEPWS Submission – Hawksbill Turtle

The Draft EIS states: "Threatened and/or migratory species which may occur, or which utilise benthic habitat, within the area of influence include turtles (Loggerhead, Flatback and Olive-Ridley), Dugongs, Sea snakes, elasmobranchs, Estuarine Crocodiles, Pygmy Blue Whale, and Whale Shark" Although Appendix T (Marine Ecology Report) notes that Hawksbill turtles are likely present within the zone of influence, the draft EIS seems to have omitted that they may occur in Shoal Bay. The Flora and Fauna Division recommends that the Hawksbill turtle is incorporated into the risk assessment for nearshore waters.

9.10.10.1 Response

See Section 9.10.3.1 above, the response to DCCEEW Submission – Whales and Turtles. Table 15-3 in Chapter 15 detailed the potential impacts for marine and migratory species listed under the *EPBC Act*.

The hawksbill turtle is not specifically mentioned in the risk assessment as they do not forage or have nesting habitat within Shoal Bay. It is understood that the hawksbill turtle would only swim past Shoal Bay, and was therefore, along with any other similar species, was not specially mentioned within the risk assessment. The risk assessment was considered by impact – noise, vessel collision, etc. – where all marine species were considered.

9.10.11 DEPWS Submission – Benthic Environment

The Flora and Fauna Division supports Sun Cable's commitment to undertake additional benthic surveys for either the southern or northern cable route to verify predicted modelling outputs and characterise the benthic physical environment. Besides characterising the benthic environment solely within the cable corridor, the proponent should map/characterise sensitive receptors within the zone of influence, in particular for benthic primary producer habitats (corals, macro-algae and seagrass, or a mixture of these communities). This will inform site selection for WQ monitoring sites to monitor TSS/SSC and light availability at the seafloor (see Factor Marine Environmental Quality) during and post cable lying activities within NT waters.

9.10.11.1 Response

This was also identified by the NT EPA in their Direction and fully detailed in Section 9.2.2 and 9.2.3.

In general, the finding of the video survey indicate that the modelled habitat over-estimated the presence of hard coral, seagrass and macroalgae within the Subsea Cable System zone of impact (direct disturbance footprint). Where macroalgae and hard coral was identified, it was very sparse, with individual organisms identified. No coral reef, seagrass meadow or macroalgae beds were observed.

9.10.12 DEPWS Submission – Timing of Subsea Cable System Burial

Turbidity will increase for about a month during cable laying activities in nearshore waters. To mitigate this impact, the Flora and Fauna Division recommends that, if possible, cable laying is confined to the late Wet, when nearshore waters generally have elevated total suspended sediments and seagrass habitats remain dormant until light availability at the seafloor improves at the start of the Dry and triggers seagrass regeneration (see factor Marine Ecosystems).

The Flora and Fauna Division agrees with the conclusion in the draft EIS that the Dry season period is important for maintaining health of benthic primary producer habitats. Therefore, the Flora and Fauna Division recommends that, if possible, cable laying is restricted to the late Wet when monsoonal activity is at its greatest, where WQ is at its poorest, and when seagrass/macro-algal habitats remain dormant until light availability at the seafloor improves at the start of the Dry and triggers regeneration. Further, early Wet (September – December) is also considered unfavourable for cable laying as anecdotal evidence points towards this being a coral reproductive period, and elevated TSS up to 3.2 mg/L may cause decline of coral health through bleaching and tissue damage.

9.10.12.1 Response

This was also identified by the NT EPA in their Direction and fully detailed in Section 9.2.2 and 9.2.3.

In general, the finding of the video survey indicate that the modelled habitat over-estimated the presence of hard coral, seagrass and macroalgae within the Subsea Cable System zone of impact (direct disturbance footprint). Where macroalgae and hard coral was identified, it was very sparse, with individual organisms identified. No coral reef, seagrass meadow or macroalgae beds were observed.

Unfortunately, timing of works will not be restricted due to significant schedule delays, extra cost, and logistical challenges. However, environmental factors, such as increased turbidity for maintaining the health of benthic primary producer habitats, will be considered during establishment of environmental triggers through the CEMP – MEMP.

9.10.13 DEPWS Submission – Benthic Habitats

The draft EIS concluded that the residual impact to benthic habitats from direct disturbance or loss of benthic habitat is minor.

The Flora and Fauna Division considers lumping benthic habitat into a single category is not appropriate.

The potential impacts of cable laying on benthic species depend on biological processes including feeding mechanism, mobility, life history characteristics, stage of development and environmental conditions. These drivers are different for each community group (corals, macro-algae, seagrass and filter feeder communities).

As such, the Flora and Fauna Division recommends that the draft EIS reviews impacts to each of the individual community types in terms of their tolerance to changing environmental conditions, the duration of these changes and mitigation options, such as timing of project activities to minimise their vulnerability to cable laying.

9.10.13.1 Response

This was also identified by the NT EPA in their Direction and fully detailed in Section 9.2.2 and 9.2.3.

In general, the finding of the video survey indicate that the modelled habitat over-estimated the presence of hard coral, seagrass and macroalgae within the Subsea Cable System zone of impact (direct disturbance footprint). Where macroalgae and hard coral was identified, it was very sparse, with individual organisms identified. No coral reef, seagrass meadow or macroalgae beds were observed.

9.10.14 DEPWS Submission – Western Australia Marine Science Institution Data

The draft EIS briefly refers to WAMSI (2019) on page 10-32. However, it should apply the recommendations provided in various reports presented on the WAMSI Dredging Science Node1 in more detail, so there is a clearer understanding of site-specific impacts and changes of environmental conditions specific to the individual sensitive receptors.

9.10.14.1 Response

This was also identified by the NT EPA in their Direction and fully detailed in Section 9.2.2 and 9.2.3.

In general, the finding of the video survey indicate that the modelled habitat over-estimated the presence of hard coral, seagrass and macroalgae within the Subsea Cable System zone of impact (direct disturbance footprint). Where macroalgae and hard coral was identified, it was very sparse, with individual organisms identified. No coral reef, seagrass meadow or macroalgae beds were observed.

9.10.15 DEPWS Submission – TSS

Further, using time series plots and accompanying assessment in conjunction with sensitive receptors is not meaningful. Figures 10-7 and 10-8 seem to suggest that elevated TSS will not impact on sensitive receptors. However, it only can show the relationship between elevated TSS and WQO at a chosen site. The draft EIS cannot state with any confidence that a sensitive receptor is actually present at a chosen site, because it is based on predicted models. The use of the predictive benthic habitat map should be used carefully as there are known errors in the predictive benthic habitat model. For example, it is unlikely that coral exist at HC3 and HC4, as this location consists of large sand waves devoid of any benthos (DEPWS, towed video benthic habitat database). However, the substrate type (i.e. sand) does explain why elevated TSS are lower than other plots in Figure 10-7.

For the draft EIS to relate modelled TSS concentrations to sensitive receptors, the Flora and Fauna Division recommends that further benthic habitat mapping is undertaken where sensitive receptors are likely to occur, followed by WQ sampling/monitoring at sites with known sensitive receptors. This will help establish the tolerance to TSS and setting of appropriate triggers for adaptive management.

9.10.15.1 Response

This was also identified by the NT EPA in their Direction and fully detailed in Section 9.2.2 and 9.2.3.

In general, the finding of the video survey indicate that the modelled habitat over-estimated the presence of hard coral, seagrass and macroalgae within the Subsea Cable System zone of impact (direct disturbance footprint). Where macroalgae and hard coral was identified, it was very sparse, with individual organisms identified. No coral reef, seagrass meadow or macroalgae beds were observed.

9.10.16 DEPWS Submission – Plume Modelling

Plume modelling undertaken and outputs in the draft EIS are acceptable, given the underlying data and assumptions, and modelling approach. However, the Western Australian Marine Institute – Dredging Science Program recommends that hydrodynamic model and associated plume/sediment transport modelling is undertaken in 3D, rather than 2D4. Once the proponent has decided on the cable laying path and undertaken benthic and geotechnical surveys for the preferred path in Shoal Bay, the Flora and Fauna Division recommends that they revisit plume modelling and sediment transport modelling for the Shoal Bay cable laying campaign and consider using 3D modelling techniques in conjunction with the below mentioned long-term monitoring data.

9.10.16.1 Response

This was also identified by the NT EPA in their Direction and fully detailed in Section 9.2.2 and 9.2.3.

In general, the finding of the video survey indicate that the modelled habitat over-estimated the presence of hard coral, seagrass and macroalgae within the Subsea Cable System zone of impact (direct disturbance footprint). Where macroalgae and hard coral was identified, it was very sparse, with individual organisms identified. No coral reef, seagrass meadow or macroalgae beds were observed.

9.10.17 ECNT Submission – Shoal Bay Ecosystem

Shoal Bay remains the most at risk near shore marine ecosystem under the current AAPowerLink proposal. Shoal Bay consists of a large network of drying sandbars interlaced with tidal channels and fringed by large, healthy mangrove ecosystems. The rocky reef at the end of Tree Point provides unique habitat for the region and attracts a wide variety of reef fish that would otherwise be absent.

The Shoal Bay ecosystem is an important nursery system for a wide array of species because of the productive macrotidal habitat offering protection from predation during any tide level. Many species present are not accounted for in appendix T (Marine ecology report). For example, juvenile stages of the commercially valuable narrow-barred Spanish mackerel (Scomberomorus commerson) can be found in significant numbers within Hope Inlet during the dry season indicating the importance of protecting this habitat for commercial fishing. Recreationally important species such as Northern Mulloway, Bluenose Salmon, Golden Trevally, Queenfish, Barramundi and Mudcrabs are prolific within the area and present some of the most exciting fishing opportunities within the greater Darwin region.

9.10.17.1 Response

Similar to the response (Section 9.10.10.1) to a comment from DEPWS on Hawksbill Turtles, in the Draft EIS the risk assessment was considered by impact – noise, vessel collision, etc. – where all marine species were considered. The risk assessment only specifically mentioned species that are known to forage or nest within Shoal Bay. This is detailed in Appendix T in the Draft EIS.

9.10.18 ECNT Submission – Dolphins

Protected coastal dolphins are regularly sighted within Shoal Bay and a Dolphin protection zone exists within Hope inlet. Large pods of the Vulnerable listed Australian Humpback Dolphins (Sousa Sahulensis) frequent the coastline between Gunn Point and Hope Inlet and these dolphins regularly hunt within Hope Inlet during high tide. Sightings of Snubfin Dolphins (Orcaella heinsohni) are also common but usually found further offshore.

9.10.18.1 Response

See Section 9.10.3.1 above, the response to DCCEEW Submission – Whales and Turtles. Table 15-3 in Chapter 15 detailed the potential impacts for marine and migratory species listed under the *EPBC Act*.

The Project's impacts on marine fauna were considered in Chapter 10 of the Draft EIS and included:

- Construction
  - Changes to fauna behaviours due to noise or light
  - Marine habitat and fauna impact due to spills of fuels or hazardous chemicals
  - Introduction of marine pests
  - Direct fauna mortality/collision with vessels
- Operation
  - Changes to fauna behaviour due to EMP or heat

All of the above impacts had a residual impact of minor. Table 10-7 in the Draft EIS details the avoidance, mitigation, monitoring, and reporting commitments made with regards to the above impacts.

9.10.19 ECNT Submission – Sharks

Elasmobranch species are also very common within Shoal Bay with sightings of large Winghead Sharks (Eusphyra blochii) and subsequent captures of newly born juveniles along the shoreline indicating the region is critical breeding/nursery habitat for the species (pers obs J Fowler, pers comm P. Kyne). Winghead sharks are globally endangered and Vulnerable listed in Australia and yet the desk top report conducted for this EIS (appendix T) does not consider these species. Clearly further biodiversity surveys of the region are required and the desk top report provided in this EIS is not adequate to assess protected species impacts.

Further research is essential to understand how elasmobranch behaviour may be affected in the shallow tropical seas of northern Australia as current research is limited to Bass Strait in Tasmania. The assumption of a minor impact of cable operation (table 10-8) from heat and EMR cannot be scientifically justified with the evidence provided.

9.10.19.1 Response

Similar to the response (Section 9.10.10.1) to a comment from DEPWS on Hawksbill Turtles, in the Draft EIS the risk assessment was considered by impact – noise, vessel collision, etc. – where all marine species were considered. The risk assessment only specifically mentioned species that are known to forage or nest within Shoal Bay.

See Section 9.10.3.1 above, the response to DCCEEW Submission – Whales and Turtles. Table 15-3 in Chapter 15 detailed the potential impacts for marine and migratory species listed under the *EPBC Act*.

Winghead Sharks (*Eusphyra blochii*) are not listed in Australia as Vulnerable in the *EPBC Act* nor are they listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The DCCEEW website has limited information on *Eusphyra blochii* but does indicate their distribution includes the NT, Queensland and Western Australia. Also, AquaMaps (aquamaps.org) a tool for generating model-based, large-scale predictions of natural occurrences of marine species, shows the distribution range of *Eusphyra blochii* to be the entire Indo-West Pacific, Persian Gulf to the Philippines, north to China and south to Australia.

9.10.20 ECNT Submission – Electromagnetic Radiation (EMR)

Shoal Bay and the Beagle Gulf contains large numbers of bottom dwelling elasmobranchs such as Rays and Guitar fish. These large species are a very important part of the inshore marine ecosystem as they modify habitat by digging holes and plough through the soft substrate in search of food. Creating multiple bands of EMR across tidal streams may well affect behavioural patterns of these bottom dwelling species as they are highly evolved to detect prey in soft substrate. Impacts on bottom dwelling elasmobranchs may have profound effects on ecosystem productivity as they are the largest and most abundant animals in the nearshore environment.

Further research is essential to understand how elasmobranch behaviour may be affected in the shallow tropical seas of northern Australia as current research is limited to Bass Strait in Tasmania. The assumption of a minor impact of cable operation (table 10-8) from heat and EMR cannot be scientifically justified with the evidence provided.

9.10.20.1 Response

EMF is discussed above in Section 9.5.3.2, it's impacts during operation are detailed in Table 9-11 and avoidance, mitigation, monitoring and reporting measures are detailed in Table 9-9.

Similar to the response (Section 9.10.10.1) to a comment from DEPWS on Hawksbill Turtles, in the Draft EIS the risk assessment was considered by impact – noise, vessel collision, etc. – where all marine species were considered. The risk assessment only specifically mentioned species that are known to forage or nest within Shoal Bay.

See Section 9.10.3.1 above, the response to DCCEEW Submission – Whales and Turtles. Table 15-3 in Chapter 15 detailed the potential impacts for marine and migratory species listed under the *EPBC Act*.

EMF and it's impacts on human health are discussed in Chapter 14 Human Health (Section 14.4.4). EMF and it's impacts on shorebirds are discussed in Chapter 5 Terrestrial Ecosystems (Section 5.5).

9.10.21 ECNT Submission – Thermal Radiation

The impacts of thermal radiation is poorly considered in the EIS. Providing examples of heat impacts from HVDC cables in Bass Strait, Baltic Sea and Monterey Bay, California provides a poor indication of potential impacts in the much hotter tropical seas of the Beagle Gulf. With sea temperatures reaching new heights in northern Australia in recent years, a corridor of increased temperature along the seafloor may well act as a barrier to bottom dwelling species. Further data is required to assess the impacts of thermal radiation throughout the cable corridor in the Beagle Gulf and the Timor Sea.

9.10.21.1 Response

Thermal radiation is discussed in the Draft EIS in Section 10.4.3.2 in a Section call changes to fauna behaviour due to heat or EMF. It describes that for buried cables, of which the Subsea Cable System will be, the effect of thermal radiation is restricted to, at most, a metre from the cable – depending on the cohesiveness of the sediments. The Proponent is suggesting that the cable is buried 0.5-3 m below the sea level, and therefore would have little or no impact on the temperature of the seabed and therefore little or no impact on the water temperature or benthic communities.

9.10.22 Sharon Scur Submission – Concern Regarding the Project

In relation to the submarine cable I have concerns about the impact on the sea floor. We have seen the impact of the submarine gas cable on Darwin harbour, the beaches no longer white due to the sludge, loss of sea grass for the dugongs. We used to see dolphins in the harbour but we don't anymore and fishing was good in the harbour and along the nearby coastline but not anymore. I believe relevant studies must be undertaken to identify the best route for both overland and undersea cables to mitigate the risks that are posed to our natural environment.

9.10.22.1 Response

Further sediment characterisation was completed and detailed in Section 8.4.1.3 in Chapter 8.

There is more detail provided in Section 9.4.2.1 and 10.4.2.2 in the Draft EIS. The hydrodynamic and sediment transport modelling (Appendix R of the Draft EIS) predicts that elevated SSC (exceeding the Darwin Harbour WQO of 10 mg/L) will occur over a large area of Shoal Bay, for short windows during the cable burial activities. The predicted SSC concentrations are within the natural variability experienced by the marine environment of Shoal Bay during the wet season but will exceed the lower background levels typical during the dry season.

The Proponent has thoroughly considered two Routes for the Subsea Cable System and have decided to implement Route B from the Draft EIS.

The majority of the impacts would be during construction and would be short-term and localised. Once operational, impacts from sediments would be very minor.

9.10.23 Anonymous Submissions

One anonymous community submission was received regarding potential marine ecosystems impacts, as follows:

Although it has not been the focus of my assessment under time constraints, I am concerned about the environmental impacted around the coastal zone of Murrumujuk, which is virtually untouched in terms of development on land, and under sea. As a recreational fisher, a day out on the water is not just about catching fish, but enjoying the many rare and special encounters with dolphins, dugongs, and other species we have recorded seeing in the area. These are exceedingly rare in the wider Darwin Harbour region following other coastal industry and sea-traffic impacts.

9.10.23.1 Response

The potential impacts from construction and operation are detailed above in Sections 9.5.2 and 9.5.3, respectively. Avoidance, mitigation, monitoring and reporting measures for each impact is detailed in Section 9.6 above. The residual risk is minor-moderate.

9.11 NT EPA Direction Responses

9.11.1 Marine Ecosystems – Comment 26

Changes to marine fauna behaviours as a result of noise or lighting from proposal areas are described in the draft EIS.

The draft EIS considers the impact from lighting to be low based on the absence of important turtle breeding habitat on Gunn Point and within 20 km from the proposed action using criteria from the National Light Pollution Guidelines for Wildlife Including Marine turtles, Seabirds and Migratory Shorebirds (Cwth of Australia 2020).

Based on threatened species data held on *NR Maps*, turtle species (flatback and green turtles) are recorded within the intertidal zone and less than 200 m from the shore crossing site.

The DEPWS Flora and Fauna Division submission notes the low topography of the Darwin convertor site and cable transition facilities and recommends that infrastructure design follows National Light Pollution Guidelines.

The draft EIS concludes that noise impacts as a result of cable laying and burial are likely to have a short-term deterrent impact on marine animals but are unlikely to result in any significant impacts to the marine ecosystem. The impact from noise from construction of the shore crossing facilities has not been assessed.

9.11.2 Information required in the Supplement

Provide information about noise and lighting impacts during construction and operational stages of the DCS and Cable Transition Facilities, based on referenced literature and ecological project reports as relevant.

9.11.3 Response

Changes to fauna behaviours due to noise or light was an impact that was assessed for construction within the Draft EIS and had a residual impact of minor after applying the following commitments:

- Avoidance
  - Route selection avoids important turtle breeding beaches
  - Cable laying activities move up to 600 m per hour which limits the duration of noise emissions in any given area
- Mitigation
  - Lighting will be energy efficient and designed to minimise hard contrasts, without compromising navigation safety and security
  - Minimised use of lights at night as feasible to reduce light trespass and to maintain dark skies
  - Where possible, lights will be shielded with exterior cut-off fixtures to limit light emissions at a vertical angle of no more than 90 degrees from straight down
- Monitoring
  - Visual observation for signs of changes in behaviour of marine fauna activity in accordance with the Marine Environment Management Plan
- Reporting
  - Visual observations reporting as required.

To some degree, the presence of artificial lighting inevitably changes the behaviour of all local wildlife. In the marine context, it is known that this impact can be particularly significant for marine turtles. Light pollution has been known to disorientate marine turtles, particularly nesting females and hatchlings making their way to the sea from the shore (Pendoley 2005). Light pollution is considered of greater risk if it can be seen from the nesting beach, nearshore or adjacent waters, which could attract turtles and hatchlings away from the water (DEE 2020). Artificial lights can also interfere with the in-water dispersal of hatchlings (Witherington & Bjorndal 1991) in coastal waters. With this impact in mind the Proponent has further committed to another monitoring measure: North Marine Parks Network Management Plan and National Light Pollution Guidelines for Wildlife will be adhered to during construction of the Subsea Cable System.

Any impacts to do with light and noise in the operational phase of the Project are minimal and infrequent.

9.11.4 Marine Ecosystems – Comment 27

The proponent used a predictive benthic habitat mapping tool developed by the DEPWS in 2019 to determine the potential impacts of the action on physical and biological benthic habitats within a local and regional context, including seagrass, hard corals, macroalgae, filter feeder and bare seafloor habitats.

Site specific mapping of benthic habitats and communities was not undertaken for the draft EIS. Therefore, a comparison of modelled results against field-based survey results within the predicted-zone of influence has not been undertaken to validate (ground truth) the modelled predictions.

The proponent has committed to undertake additional benthic surveys for the chosen alternative and the NT EPA considers that benthic habitat survey and mapping is required to increase the level of confidence in predicted the potential significant impacts of the proposed action.

The draft EIS concluded that the residual impact to benthic habitat is minor and refers to WAMSI (2019). The DEPWS Flora and Fauna Division considers combining benthic habitat into a single category is not appropriate.

The potential impacts of cable laying on benthic species depend on seasonal biological processes and environmental conditions the drivers of which are different for each community group.

The draft EIS correctly concludes that the dry season period is important for maintaining health of benthic primary producer habitats. DEPWS identifies that the early wet (September – December) is also important biologically due to coral reproduction (elevated TSS up to 3.2 mg/L may cause decline of coral health through bleaching and tissue damage). Confining cable laying to the late wet could mitigate impacts due to timing activity when nearshore waters generally have elevated total suspended sediments and seagrass habitats remain dormant until light availability at the seafloor improves at the start of the dry and triggers seagrass regeneration. During nearshore disposal of dredge spoil (1 month), benthic communities within the zone of influence would be exposed to increased SSC and reduced light availability and quality, potentially leading to stress and mortality. Therefore, there is a need to understand the TSS (mg/L)/turbidity (NTU) – light intensity relationship at the seafloor to assist with setting appropriate turbidity triggers for benthic communities and primary productivity.

9.11.5 Information required in the Supplement

Provide the following information:

- Provide details of the proposed timing and methods of baseline benthic habitat surveys to:
  - Collect underwater video transect data at a sufficient density to accurately map the extent of benthic habitats within the cable corridor and the zone of influence at an appropriate scale (see point 2 below)
- Identify and describe the type and spatial extent (with consideration of temporal/seasonal variation) of benthic substrates and biota within the zone of impact and zone of influence
- Provide sufficient ground-truth data to assess the accuracy of the DEPWS predictive benthic habitat model
- Confirm that benthic habitat survey and classification would be undertaken in accordance with the following guidance:
  - *National Environmental Science Program Field Manuals for Marine Sampling to Monitor Australian Waters*

  - *National Intertidal/Subtidal Benthic (NISB) Habitat Classification Scheme*
  - *Collaborative and Annotation Tools for Analysis of Marine Imagery and Video (CATAMI) classification scheme.*
- The timing of works requires consideration of each community group (corals, macro-algae, seagrass and filter feeder communities). Provide detail about how the results of the benthic survey and mapping would be taken into account for timing of cable laying works. Demonstrate how the environmental decision-making hierarchy will be applied to
- Avoid and mitigate impacts by the timing of works. Include feasibility assessment of confining cable laying in nearshore waters to the late wet season
- Include detail about how potential impacts (related to sediment deposition, suspended sediment, turbidity and PAR levels) on BCHs (corals, seagrass, macro algae and filter feeders) would be managed
- Include detail about how benthic impacts from dredge spoil disposal would be monitored and measured, and the expected duration of recovery periods where impacts are predicted or observed
- Use the information obtained from surveys to inform revised triggers for TSS and site selection for WQ monitoring sites to monitor TSS/SSC and light availability at the seafloor during and post cable lying activities within NT waters.

9.11.6 Response

9.11.6.1 Phase 1 – Benthic Habitat Surveys

Please refer to Section 9.2.2.

9.11.7 Marine Ecosystems – Comment 28

The proponent conducted two-dimensional (depth-averaged) hydrodynamic modelling in the 'Eulerian' Delft3D modelling package, using Delft3D-FLOW (current), Delft3D-WAVE (wave) and Delft3D-WAQ (water quality for suspended sediments).

Three dimensional (3D) modelling is considered best practice in most marine environments in order to predict dredging impacts to hydrodynamics, plume and sediment transport modelling. The Western Australian Marine Science Institution (WAMSI) Dredge Science Node Guideline on dredge plume modelling for EIA discusses 2D vs 3D hydrodynamic modelling to allow for accuracy and certainty in the assessment of impacts of changes in current strength to benthic communities; sediment transport along the seafloor, and plume density within the water column.

Further justification should be provided to support use of the 2D model for the prediction of sediment plume, transport and deposition impacts from the proposed dredging. The justification should provide information to support the decision not to use a 2D model. The justification should describe how sediment transport within ambient settings and after sediment is deposited from dredge spoil or sediment plumes is addressed by the modelling.

Further information should be provided to describe how:

- *The transport and fate of sediments (course and fine) has been quantified and modelled*
- *The transport*
- *Sediment rates and implications for water quality (TSS and turbidity) and benthic communities / habitats has been assessed.*

Describe how to modelling allows for determination of the susceptibility of marine and benthic values and sensitivities of the proposed water quality trigger levels that would be applied during dredging to avoid significant impacts.

The models should be calibrated and verified by comparing modelled results against field-based measurements collected at selected areas where receptors occur.

The revised modelling and setting of trigger values should be informed by the outcomes of the benthic survey and mapping (refer to item above).

9.11.8 Information required in the Supplement

Provide additional information to improve confidence in the hydrodynamic model outputs, results and impact predictions, and to assess the significant of potential impacts of suspended, deposited and remobilised sediments on the marine environment.

Provide a detailed justification with information to support the use of a 2D hydrodynamic model for the prediction of dredging impacts from the proposal.

Provide details and justification of the baseline data (including from field observations) used in the development, calibration and validation of the model. Describe how the baseline and model input data used are consistent with the requirements of the WAMSI Dredge Science Node Guideline on dredge plume modelling for EIA (specifically sections 3, 4 and 5 of the guideline).

Confirm that the timing of baseline data collection corresponds to the time of year that dredging is proposed to occur. As a guide, if dredging is proposed in the dry season/build-up, data should be provided for a minimum of 28 days. If in the wet season, data should be provided for 6-8 weeks (ie. to capture at least two monsoonal events). Provide the baseline data as part of the information response to this Direction (either from existing or new site specific monitoring).

Described how the following has been considered in development of the model and the prediction of impacts:

- *The composition of TSS*
- *How TSS concentration data correlated to turbidity (NTU) level data at the proposed monitoring locations*
- *The relationship between suspended sediment and light availability and quality at the seafloor.*

Revise the monitoring program to include further water quality monitoring at selected areas where receptors occur based on benthic habitat mapping; these sites should be established before cable laying occurs to enable site specific trigger values and post cable laying activities within NT waters.

Review trigger values that would initiate a management response during nearshore spoil disposal and include triggers for time duration of exceedances for specific benthic communities including corals, seagrass, macro algae and filter feeders (where presence is confirmed during field survey). Interim triggers should be established from baseline TSS, turbidity and PAR level data with consideration of the WAMSI Dredge Science Node research reports on ecological thresholds and environmental windows at https://www.wamsi.org.au/dredging-science-node/dsn- reports.

As an example, in the case that only dry season site-specific data is available, this should be cross referenced with established guideline values (for the benthic communities present) in the WAMSI data, to establish interim guideline values for the wet season, which could be used until sufficient site-specific wet season monitoring data is available. In the case that existing site-specific seasonal baseline monitoring data is not currently available, the proponent should first obtain data for the seasons in which the initial dredging works are proposed to be undertaken.

9.11.9 Response

This has been addressed throughout this chapter.

9.11.9.1 Phase 2 – works to be undertaken

Please refer to Section 9.2.3.

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