Chapter 8 – Marine Environmental Quality

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8 Marine Environmental Quality

8.1 Introduction

The NT EPA's objective for the marine environmental quality factor is to:

> *Protect the quality and productivity of water, sediment, and biota so that environmental values are maintained.*

This chapter describes and assesses the significance of potential impacts to water, sediment, and biota in the marine environment (marine environmental quality) associated with Project refinements made since the Draft EIS as well as addressing the responses from the NT EPA Direction. The potential impacts with regards to water, sediment and biota considered in this chapter were identified with reference to the Draft EIS TOR issued by the NT EPA, issues raised by stakeholders (refer to Appendix 1.3) and professional judgement of the SEIS team (Appendix 1.5) based on their knowledge and understanding of the Project's components and activities described in Chapter 2 Project Refinement. Potential impacts were then assessed using the EIA methods described in Chapter 3 Impact Assessment of the Draft EIS. This chapter presents the findings of the EIA process undertaken for the Marine environmental quality factor.

The Proponent met with the former DAWE (now DCCEEW) and the NT EPA where the need for more information regarding dredging and spoil disposal was discussed. In order to have the best environmental outcome, a methodology – Sediment Sampling and Analysis Plan (SAP), (Appendix 8.4) – to obtain the following information from dredging and potential spoil disposal grounds along the Subsea Cable System was drafted and executed by Guardian Geomatics:

- Detailed bathymetry
- Physical (types of materials, particle sizes, distribution), chemical and biological analysis of the sediment
- Assessment of benthic habitats
- Ecological values of sand waves including still camera survey and plume modelling.

The impacts considered in this chapter are associated with installation and maintenance of the Subsea Cable System within both NT coastal waters and the broader Cwth Marine Area to the edge of the Australian Continental Shelf. The boundary between the two jurisdictions is shown in Figure 9 - 1 of the Draft EIS and the extent is described below:

- Nearshore: NT coastal waters, which consist of the waters from Lowest Astronomic Tide (LAT) towards the limit defined under the *Coastal Waters (NT Powers) Act 1980* (Cwth) and includes the Beagle Gulf (refer to Figure 8-2). Potential impacts in this area are assessed under the *EP Act*
- Offshore: Cwth Marine Area, which extends from the boundary of the NT Coastal Waters to the edge of the Continental Shelf and includes the AEEZ. Potential impacts in this area are assessed under the *EPBC Act* and *Environment Protection (Sea Dumping) Act* 1981 (Cwth).

8.2 Information Sources

Since the Draft EIS was lodged, the following reports have been prepared which deal with marine environmental quality:

- Marine Cable Burial Risk Assessment (CONFIDENTIAL) (Appendix 8.1)
- Guardian Geomatics Interim Report (CONFIDENTIAL) (Appendix 8.2)

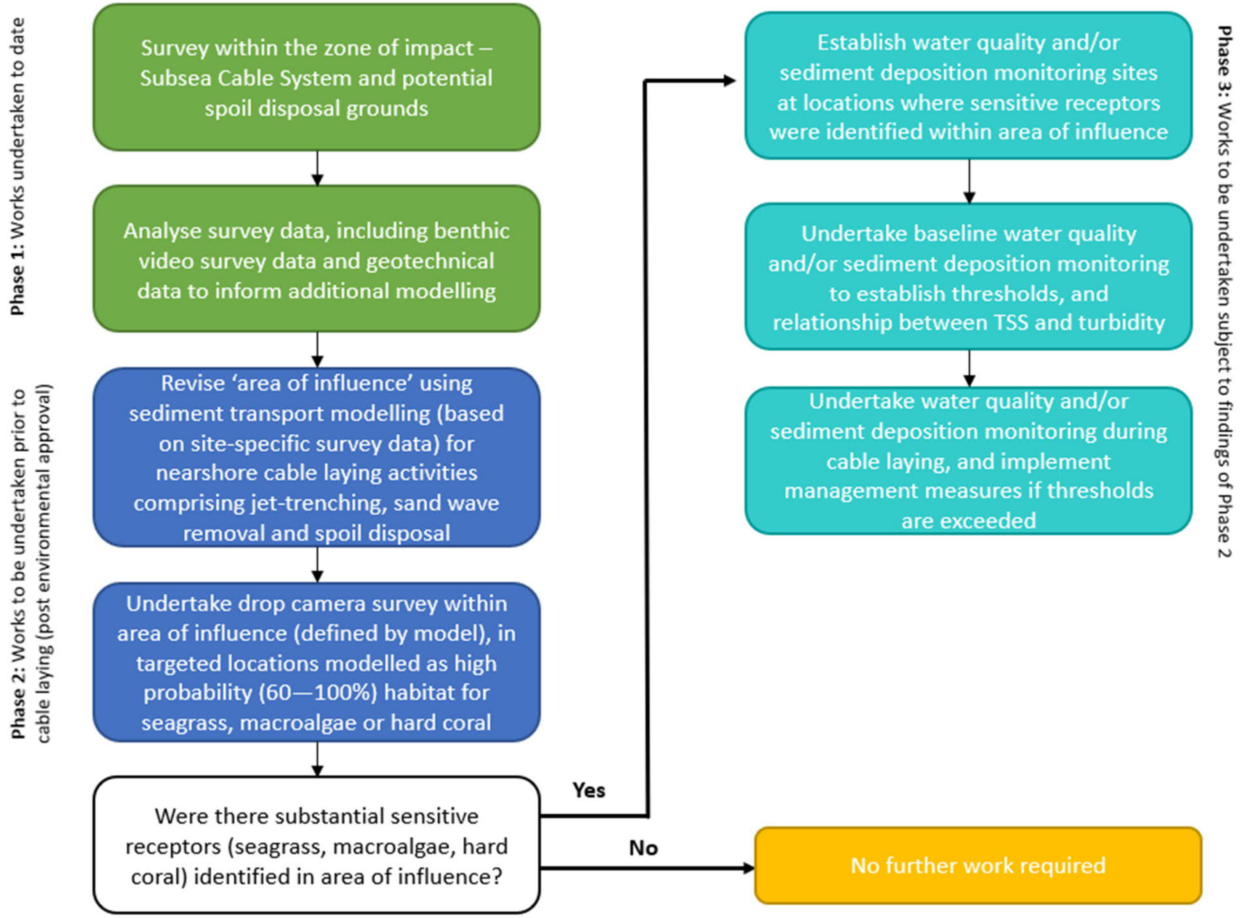
- Sediment SAPIR, (Appendix 8.3)
- Sediment SAP (CONFIDENTIAL) (Appendix 8.4)
- Memorandum – Benthic Video Footage Analysis (Appendix 9.1)
- Draft EIS Appendix Z – Cable Route Survey (CONFIDENTIAL)
- Chapter 3 of Sun Cable Influence Study: The interaction of the AAPowerLink HVDC cable systems with the surrounding environment has been assessed (CONFIDENTIAL).

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 (see Chapter 9). 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. Table 8-1 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 Table 8-1 have already been undertaken, and the results are presented and discussed in Section 9.11.6 in Chapter 9. The work undertaken in Phase 2 is also discussed in Section 9.11.9 in Chapter 9. The work that may be undertaken in Phase 3 (subject to the findings of Phase 2) is summarised in Section 9.11.9 in Chapter 9, to illustrate how to data obtained in Phases 1 and 2 will inform impact avoidance and mitigation.

Table 8-1: Flow chart of Adaptive Management Process for Mitigating Impacts in the Marine Environment (Works Undertaken and Proposed) within coastal waters[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

8.3 Project Refinements Since Draft EIS

The following project refinements included in the SEIS have included additional footprint impact on marine environmental quality which have been assessed in this section:

- Subsea Cable System - Route (Figure 8-1)
- Subsea Cable System – removal of sand waves during construction/operations (Figure 8-3).

8.3.1 Subsea Cable System – Route

Further investigations have identified Route B from the Draft EIS as the preferred Subsea Cable System route. A marine survey was completed from Gunn Point beach along Route B approximately 75 km to where Route B adjoins the original cable system route. A 600 m wide section of the route is being assessed in this chapter and in Chapter 9.

8.3.2 Subsea Cable System – Sediment Removal During Construction/Operations

8.3.2.1 Sand Waves

Prior to installation of subsea cables, twenty sand waves along the Subsea Cable System have been identified within NT Coastal Waters and the Cwth Marine Area (Figure 8-2) from the original survey for the Draft EIS and the more recent Subsea Cable System survey conducted near Murrumujuk in August 2022. Marine geotechnical/geophysical studies carried out since the Draft EIS have confirmed the need to remove eleven areas with elevated sand waves (Table 8-3) during construction to enable safe installation of the cable to a design depth of 0 to 3 m below the seabed (see Appendix 8.2 and 8.3). Sand wave sites 1 - 5 (identified in first survey for Draft EIS) and 17 - 20 (identified during the Murrumujuk survey) are located within NT's Coastal Waters and sand wave sites 15 - 16 are located close to the Australian - Indonesian maritime border, on the edge of the AEEZ. This SEIS has conducted additional works only for sand wave sites 1 - 5 and 17 - 20, and not sand wave sites 15 - 16. Therefore, sand wave sites 15 - 16 were identified in the Draft EIS and are not further explored in this SEIS.

Through detailed modelling undertaken by Primo - Marine, it was determined for sand waves 6 - 14 that dredging would not be required to lay the cable as the cable can either be routed around the sand waves or a less invasive MFE can be used. Therefore, these remaining sixteen potential sand wave dredging sites (Figure 8-2) that were previously identified for potential removal in the Sediment SAP (Appendix 8.4) no longer will be removed.

Within the Australian portion of the Subsea Cable System, four potential spoil disposal grounds (see Section 8.3.2.2) have been identified to accept the approximately 260,000 m^3 of marine sediment material that will need to be disposed of during construction these nine elevated sand waves.

The dredging vessel would, when its hopper is full, travel to the designated spoil disposal ground and release the spoil while steaming slowly forwards. Given that the sediments in the sand wave areas are mostly sandy (see particle size information below in Section 8.4.1.2), the majority of the spoil is expected to settle to the seabed below the point of discharge and little turbidity is anticipated. Subsequent sediment operations would follow a different track so as to spread the spoil over the placement site.

8.3.2.2 Potential Spoil Disposal Ground Site Selection

Figure 8-3 shows the locations of currently identified sand waves and Potential Spoil Disposal Grounds (spoil placement sites) within the Cwth Marine Area. Potential Spoil Disposal Ground locations are within the AEEZ and the Cwth Marine Area, beyond the NT's Coastal Waters.

The potential spoil disposal grounds were largely chosen due to their locations, as the sites are:

- Within areas of relatively featureless seabed
- Avoid the Bayu - Udan gas pipeline

The same criteria will be applied in finalising all Potential Spoil Disposal Ground locations.

Potential Spoil Disposal Ground locations within Cwth Waters require assessment according to the guidelines set out in the NAGD. The NAGD (NT EPA, 2013) prescribe the same for placement within the NT's Coastal Waters.

Potential spoil disposal ground locations require initial screening and potentially assessment according to the guidelines set out in the NAGD (pg. 16 - 19) before being finalised. The extent of the information required will need to be determined in consultation with NT EPA or DCCEEW, as jurisdictionally relevant. The basic requirements are:

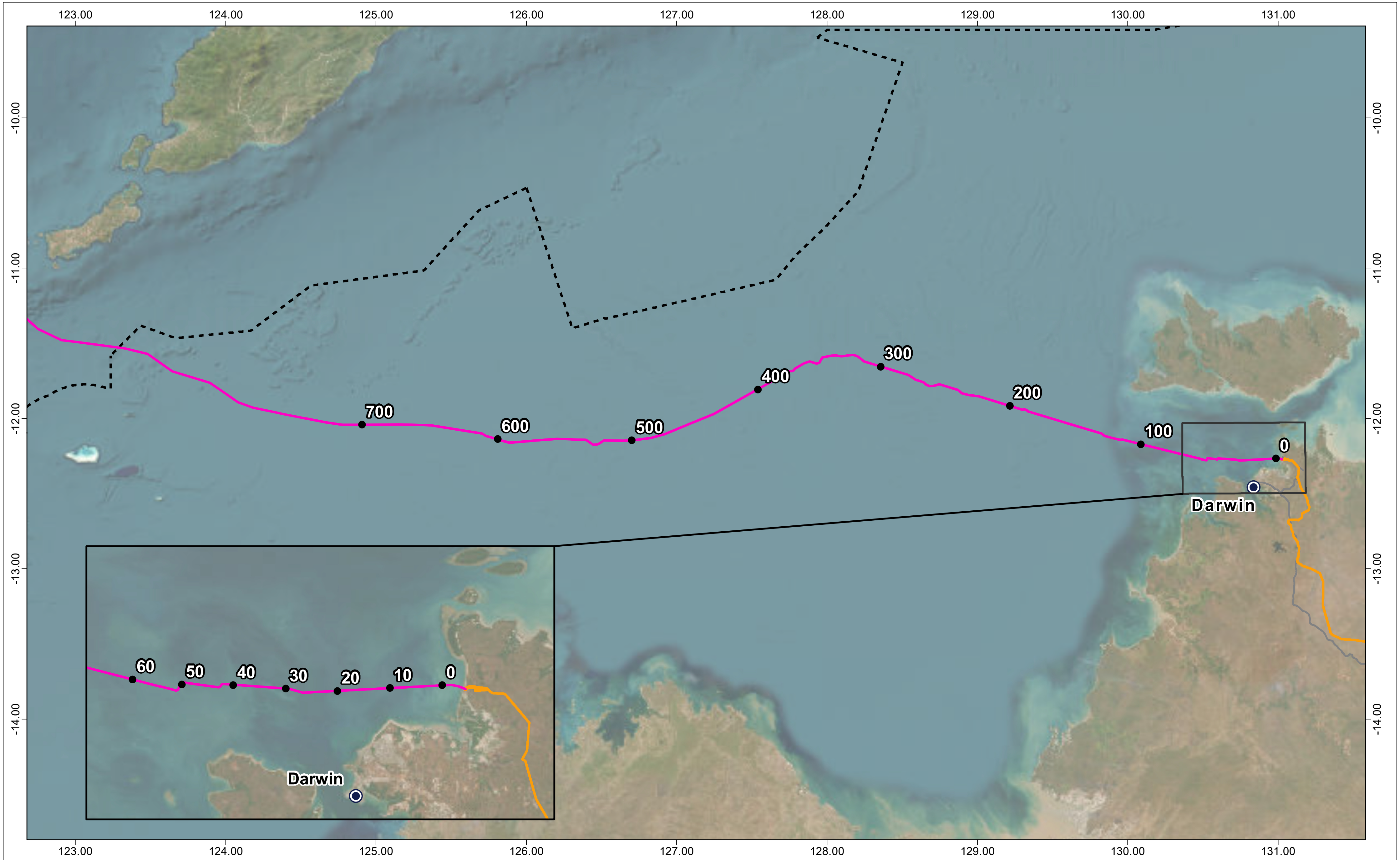
- Physical environment: Information regarding the physical, chemical, and biological characteristics of the water column and seabed are required for potential sites. This will include marine surveys.
- Biological environment: Biological characteristics of a site may include important, listed, threatened species or communities and migratory species that use the area. Temporal/Seasonal and spatial characteristics should be considered, to identify potentially critical times when loading or disposal should not take place.
- Other uses: Consultation with relevant Cwth and Territory environmental, maritime safety and fisheries agencies and other organisations may assist in determining the significance of the loading and disposal sites and nearby areas to other users.
- Economic and Operational Feasibility: The location and size of the disposal site and its proximity to the dredge site are important issues for the assessment, particularly to ensure that it is large enough to accommodate the volume of deposited spoil.

Some information on the physical environment, biological environment and economic and operational feasibility has been collected and is presented below and in Appendices 8.2 and 8.3.

The final Spoil Disposal Ground locations will be confirmed in consultation with the NT EPA and DCCEEW, where jurisdictionally relevant, by applying the following micro - siting criteria:

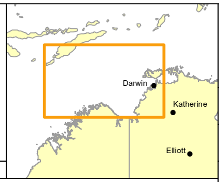
- Undertake additional marine survey prior to cable system installation to determine geotechnical suitability of final cable route.
- Determine, based on the adaptive management framework in Table 8-1, if additional modelling is required in Coastal Waters.
- Consider potential for previously unidentified marine environment and underwater heritage impacts.
- Confirmation of other secondary approvals required under NT and Cwth legislation
- Consultation with potentially affected stakeholders (where relevant).
- Consultation with the NT EPA and Cwth Government, as jurisdictionally relevant.
- Compliance with the process set out in the NAGD (refer to Appendix 8.4 for further details).
- Compliance with the process set out in the NAGD (NT EPA, 2013), where directed to by the NT EPA.

Some information on the physical environment, biological environment and economic and operational feasibility has been collected and is presented below and in Appendix 8.2 and 8.3.



Legend

- Kilometre Points
- Subsea Cable System
- Land based AAPowerLink Infrastructure
- Commonwealth Marine Area



Source: NTG data - Cadastre and roads. Imagery: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 8-1: Subsea Cable System Route

Project: Australia-Asia PowerLink	Reference #: AAPL_GNR_CTA_GEN_MAP_0384	Figure: 1 of 1	Revision: B
Coordinate System: GDA 2020	Datum: GDA 2020	Date: 06/11/2022	
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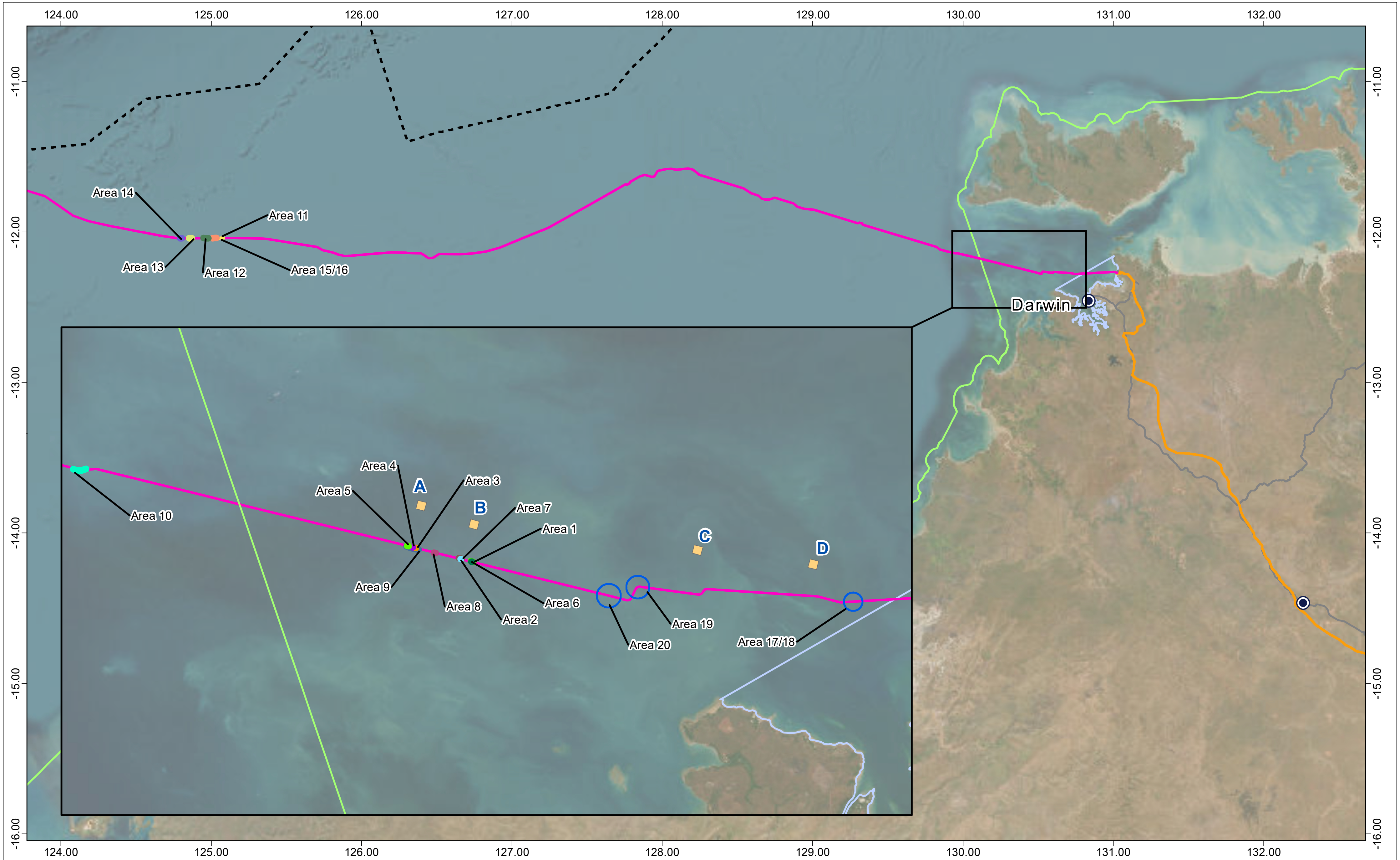

Legend

- Subsea Cable System
- Land Based AAPowerlink Infrastructure
- Commonwealth Marine Area
- Coastal Waters (State and Northern Territory Powers) Act 1980
- Darwin harbour boundary
- Potential Spoil Disposal Grounds

Source: NTG data - Cadastre and roads. Imagery: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

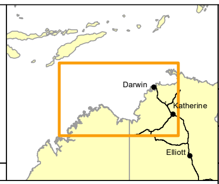

Figure 8-2: Sandwaves and Potential Spoil Disposal Grounds

Project: Australia-Asia PowerLink	Reference #: AAPL_GNR_CTA_GEN_MAP_0419	Figure: 1 of 1	Revision: A
Coordinate System: GDA 2020	Datum: GDA 2020	Date: 16/11/2022	
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8.4 Existing Environment and Values

The reports listed in Section 8.2 increased the understanding of the physical characteristics and processes of the marine environment within the project refinement footprint and surrounding areas, as well as the beneficial uses and environmental values that are present. Additional information, including benthic video survey footage, to support the Draft EIS is presented below for the new section of Route B – from Murrumujuk to the connection of where the original Subsea Cable System was assessed in the Draft EIS, which is approximately 60 km.

8.4.1 Seabed Characteristics

8.4.1.1 Bathymetry

The water depth varies throughout the route alignment, generally from approximately 10 m LAT to approximately 130 m LAT, generally becoming deeper towards the western route extent. The water depth is 11.7 m LAT at the start of the Subsea Cable System route at KP0 and 126.0 m LAT at the end of the Subsea Cable System route within Australian Waters, which is approximately at KP 748. The minimum water depth is 5.9 m LAT around KP 10.5, associated with hardground outcrops. The maximum water depths are found in the far offshore regions with the deepest section 127.8 m LAT at KP 721 (See Appendix 8.2 for bathymetric images). Local variation such as depressions and escarpments occur, often associated with hardgrounds, pockmarks, and sand wave bedform features (see Appendix 8.1).

The geophysical survey report indicates seabed gradients are generally relatively smooth, typically less than 3º, however localised variation associated with hardgrounds and sand waves is present along parts of the alignment. Larger escarpments with steep slopes (>10º) are present and represent a potential risk to trenching and cable lay operations and require careful consideration in design (see Appendix 8.1).

8.4.1.2 Geomorphology and Sedimentology

The immediate onshore geology around the proposed Murrumujuk landing site and the area around Darwin and this section of the NT is dominated by re - sedimented sandstones, claystones and siltstones of (dominantly) Cretaceous age. These sediments have undergone deep weathering during the Late Tertiary and a thick regolith surface (Koolpinyah) is present over parts of the Murrumujuk peninsula area. The Koolpinyah takes the form of laterite deposits, surficial shelly sands, calcrete rubble and cheniers. The regolith identified on the bench fringes of the lower slopes and or the flanks of the ridges is characterised by well - drained kandosols. The soils on gentle lower slopes and the extensive platforms near sea level are classed as hydrosols. Nearshore slope range does not exceed 3 % and the soils are characterised by well drained rudosols (see Appendix 8.2).

The landing beach itself is located approximately centrally along an 8 km long stretch of linear sandy beach flanked by mangroves to the north and south, at Gunn Point and Tree Point Conservation Area, respectively. The beach margin is characterised by laterised sandstones and siltstones. The westward facing beach itself shows little topography, and the profile is known to be affected by seasonal sediment build up through the monsoonal variations. The build - ups are dominated by shelly material derived from the immediate nearshore region. Perennial rivers and creeks dissect sections of the beach, with seasonal swamps developing in the back - beach zones. (Appendix 8.2).

The seabed sediments along the Subsea Cable System were found to be primarily composed of sand and grain size mixing variations (i.e., clayey sand and silty sand); clay with grain size mixing variations (sandy clay and silty clay) and hardgrounds with related small/minor zones of gravel, identified in certain areas i.e., calcarenite gravel. (Appendix 8.2).

A variety of recent seabed sediments are present across the Subsea Cable Route comprising varying proportions of gravel, silt, sand, and clay mixtures. Coarse grain dominated sediments (sand/gravel) are anticipated to be very loose to loose. Fine - grained dominated sediments (silt/clay) are expected to be very soft to soft. Seabed sediments are generally anticipated to be less than 0.5 m thick. However, they may be thicker locally. Grab samples collected 0.1 m^2 of sediment from the top 10 cm of sediment and identified:

- Five main seabed sediment types:
  - Very loose silty SAND with gravel and coral detritus
  - Very loose SAND with frequent shell fragments
  - Loose gravelly sandy SILT with occasional gravel, rock, or shell fragments
  - Very loose gravelly sandy SILT, occasionally with shell fragments
  - Residual rock clasts associated with hardground zones
- Three minor seabed sediment types:
  - Loose silty gravelly SAND
  - Silty sandy GRAVEL with bioclast and rock fragments
  - Silty gravelly SAND with rock fragments and some bioclastic fragments.

From vibrocore samples two main sediment types were identified: silty; clayey carbonate SAND and soft; sandy carbonate CLAY, as well as a minor sediment type: sandy carbonate GRAVEL.

Hardground is present in places comprising calcarenite rock outcrop and cemented carbonate sand and gravel often associated with shell beds or debris. Most hardground sections (66 %) are less than 0.35 km long, then 25 % of hardground sections are between 0.35 km and 1 km and 9 % of hardground sections are between 1 km and 8.55 km.

The main seabed features are described in Table 8-2.

Table 8-2: Main seabed features (from Appendix 8.1)

Feature	Key Aspects
Sand waves	Amplitudes of 1 m to 5 m and wavelengths in the order of 30 m to 100 m. Mainly symmetric, however some asymmetric geometry is noted. The sand wave axis orientation relative to the cable alignment varies along the route, with potential impact on pitch and roll stability of trenching and cable lay equipment, with secondary impacts such as variable burial depths achieved.
Megaripples	Often associated with and superimposed on sand wave field, megaripples generally have amplitudes less than 1 m and shorter wavelengths (< 30 m) than sand waves. Mainly symmetric, however some asymmetric geometry is noted. Indicative of mobile sediment. Cable burial below the depth of the mobile sediment zone is anticipated.
Seabed Boulders	Locations of individual boulders greater than 5 m in diameter are known. Numerous smaller surficial boulders are present within boulder field identified across specific sections of the route. Sub - surface boulders may also be present in these areas. Boulder clearance is anticipated in such zones, particularly in medium density (75 to 250 boulders per km^2) to high density (> 250 boulders per km^2).
Pockmarks	Ellipsoid depressions in seabed. Pockmark geometrics are generally as follows: diameters range from 1 m to 50 m; depths from 0.3 m to 3.0 m; and sidewall slope angles >15º. Pockmarks occur as both isolated features and in

Feature	Key Aspects
	clusters, where cluster densities range from low (< 75 per km^2), medium (75 to 250 pockmarks per km^2) to high (> 250 pockmarks per km^2). Generally, pockmarks deeper than 1.0 m should be avoided where possible. Identified pockmarks are noted to be historical features, implying that they are no longer active. However, a residual risk remains that further pockmarks may form during the lifetime of the cable. Therefore, for some types of seabed installation and maintenance equipment there is potentially a risk is instability.
Hardgrounds	Locally irregular seabed including escarpment features with slopes in excess of 10º. Routing has attempted to avoid hardground; however, some areas are unavoidable, including areas of identified escarpments. It is anticipated that this will be considered within the cable design, seabed preparation and trenching equipment requirements and cable protection requirements through such areas.
Anthropogenic	There are many areas that were classified as debris throughout the survey corridor.

8.4.1.3 Seabed Sediment Characteristics

For part of the Subsea Cable System survey of the first 60 km of Subsea Cable System from Murrumujuk, marine sediments along the proposed cable route were characterised and were found to be muddy sands or sandy muds with varying amounts of gravel.

Sand Waves

Sand waves along the Subsea Cable System route have been identified as a natural feature that may require removal for cable laying. Where the Subsea Cable System route allows for individual cables to navigate around sand waves, the constraint will be avoided. If the sand waves can't be avoided, the height of the non - mobile layer will be identified to inform whether the preferred cable installation method of the mass flow - excavator can be used. Where the non - mobile layer exceeds the mass flow - excavator capacity, dredging will be required.

The sand waves occur at several locations between approximately 20 km and 80 km from Murrumujuk. The locations of the sand waves 1 - 16 were pinpointed in a post - survey burial assessment study by the subsea survey contractor, Guardian Geomatics (Guardian). During the Subsea Cable System survey, four additional sand waves, numbered 17 - 20, were identified. Table 8-3 has the location of all nine sand waves that are proposed for dredging and includes the pre - sweeping section length that will required to dredge in order to install the Subsea Cable System in these areas.

Five of the survey sites were bare sediment, with no visible benthic habitat or epifauna (see Appendix 9.1). Macroalgae was identified at three survey sites in the sand wave area and six survey sites in the dredge Spoil Grounds (SG). Hard coral and seagrass were not identified at any sites.

Table 8-3: Location of sand waves and pre-sweep lengths

Area	From KP (km)	To KP (km)	Water depth (m)	NMRL (m)	Pre-sweep Section length (m)
1	67.269	67.587	- 35.83	Constant depth level at - 35	43
2	68.140	68.770	- 35.20	Constant depth level at - 35.2	50
3	73.887	74.107	- 35.93	Constant depth level at - 35.4	30
4	74.240	74.471	- 35.03	Constant depth level at - 35	113
5	74.845	75.055	- 34.42	Constant depth level at - 34.6	173
17	20.7	23.2	-	NA	2,500
18	23.55	23.75	-	NA	200
19	47.01	47.27	-	NA	260
20	51.28	51.36	-	NA	80

Sand Wave Dredging Areas 1 - 5 and SG A and B

Sediments from Sand Wave Dredging Areas 1 - 5 (see Table 8-3), which were sampled by vibrocoring, were predominantly sands or gravelly sands with generally minor proportions of silt - and clay - sized material. The grainsize of the upper (0 - 0.5 m) sample was slightly finer than the lower (0.5 - 1 m) sample. Sediments from the two potential spoil disposal grounds (SG A and B), which were sampled as grab samples, were muddy sands, with a gravel content of 4 - 26 %. (See Appendix 8.3, Section 4.2.1 for figures.)

As the sediments from the dredging and disposal areas are relatively similar, impacts due to turbidity and habitat modification are expected to be minor (see Figure 8-3) (Appendix 8.3).

Sand Wave Dredging Areas 17 - 18 and SG D

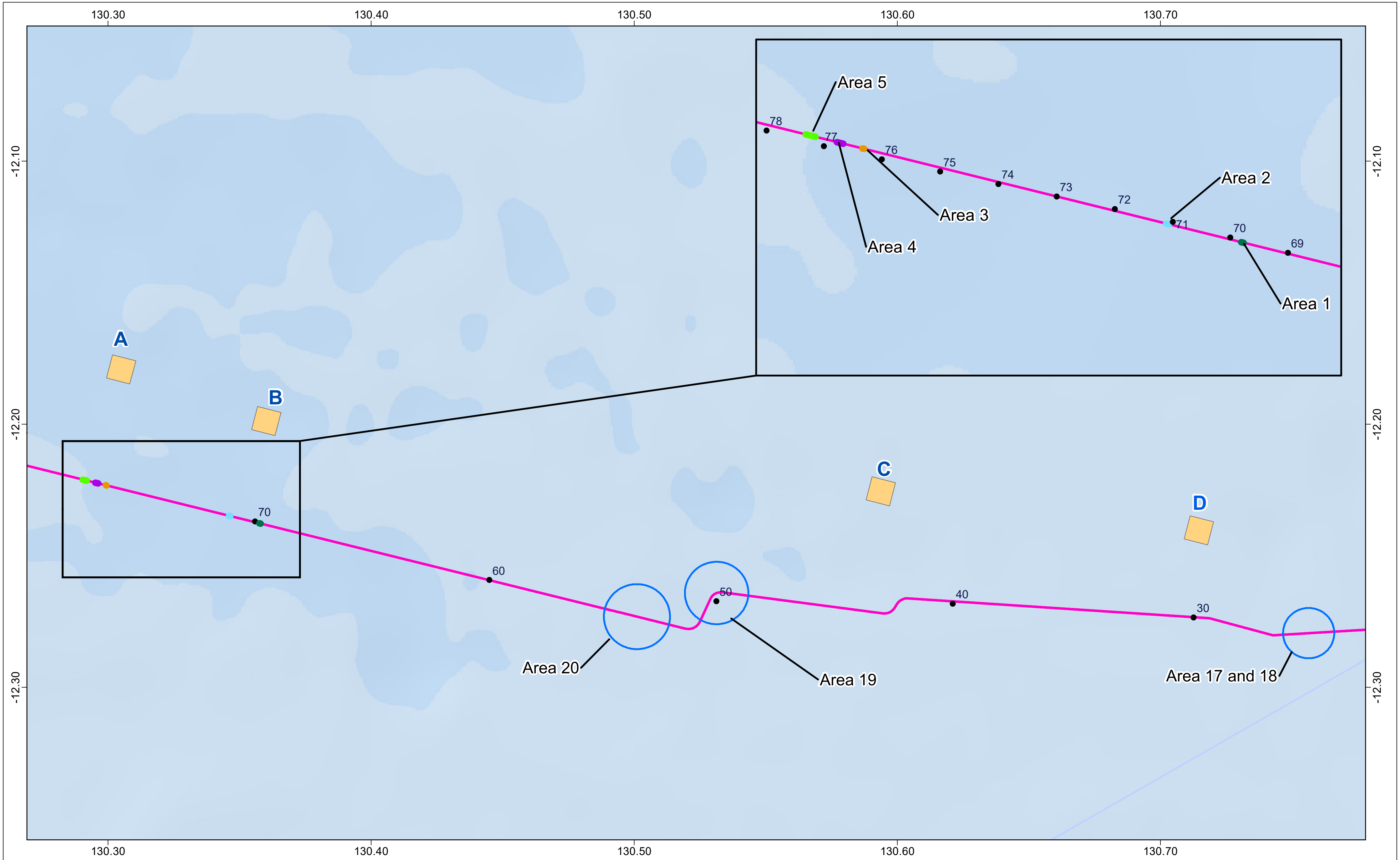
The surface and near - surface sediments from Sand Wave Dredging Areas 17 - 18 were variable in texture. Most of the sediments were sands of silty sands with minor proportions of silt, clay, and gravel, with the 0.5 - 1.0 m sample often being slightly finer than the upper (0 - 0.5 m) sample. However, in several cores from the central section of dredging area 17 the lower sample was finer or significantly finer than the upper sample. Sediments from the nearby Potential Spoil Disposal Ground D were sands with approximately 90 % sand - sized material and minor fines and gravel. (See Appendix 8.3, Section 4.2.2 for figures.)

Dredging and disposal of these sediments from these sand wave areas is likely to generate additional turbidity due to the higher proportion of fines. After settlement, the fines could modify the benthic habitat in the disposal areas (see Figure 8-3) (Appendix 8.3).

Sand Wave Dredging Areas 19-20 and SG C

Sediments from Sand Wave Dredging Areas 19 - 20 were mostly sands or gravelly sands. In two of the cores the lower sample from the core was finer than the upper half. These samples would be classified as gravelly muddy sands. Sediments from the nearby Potential Spoil Disposal Ground C were gravelly sands or gravelly muddy sands. (See Appendix 8.3, Section 4.2.3 for figures.)

Dredging and disposal of the sediments from these sand waves may generate additional turbidity due to the high proportion of fines in some subsurface samples. After settlement, the fines could modify the habitat in the disposal areas, although this is expected to be minor (see Figure 8-3) (Appendix 8.3).



Legend

- Kilometre Points
- Subsea Cable System
- Potential Spoil Disposal Grounds
- Sandwave Area

Sandwave

- Area 1
- Area 2
- Area 3
- Area 4
- Area 5

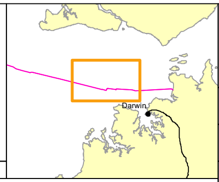


Figure 8-3: Sandwave Dredging Areas 1-5, 17-20 and Potential Spoil Disposal Grounds A, B, C and D

Project: Australia-Asia PowerLink	Reference #: AAPL_GNR_CTA_GEN_MAP_0396	Figure: 1 of 1	Revision: A
Coordinate System: GDA 2020	Datum: GDA 2020	Date: 11/11/2022	
0 2 4 6 8 Kilometres	Scale: 1:200,000	A4	

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SUN CABLE AUSTRALIA-ASIA PowerLink

Source: NTG data - Cadastre and roads. Imagery: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

8.4.2 Sediment Quality

No additional studies have been completed to provide further information on WQ. The effect of oceanic processes on the project refinements are considered to be the same as in the project footprint assessed in the Draft EIS. Core samples from the dredging areas and grab samples for the disposal areas were chemically analysed to determine the appropriateness and compatibility of the dredged and disposal areas.

8.4.2.1 Sand Wave Dredging Areas 1-5 and Potential Spoil Disposal Grounds A and B

Metals and Metalloids

The NAGD - specified metals analysed (cadmium, chromium, copper, lead, mercury, nickel, and zinc) were found to be at very low levels, typical of natural levels in uncontaminated marine sediments, in all samples. These metals were well below the NAGD 2009 Screening Levels in all samples. Cadmium was seldom detected, and mercury and antimony not detected in any sample (Table 8-4). Aluminium and iron, which are not considered toxic in marine sediments, were analysed for normalising purposes and were also present at low levels. This was consistent with other investigations in the area (Inpex, 2018; Radke et al., 2020: RPS, 2021).

The metalloid arsenic was often present at levels exceeding the NAGD Screening Level of 20 mg/kg, however arsenic is known to be naturally high in marine sediments from much of Australia, including sediments of the Darwin Outer Harbour area and Shoal Bay, where the levels reported in the scientific literature are comparable to those found in the current investigation:

- Sediments at the Inpex offshore Dredge Spoil Disposal Ground were tested in 2012, prior to any spoil disposal, and at 71 % of sampling sites arsenic was found to be above the Screening Level.
- Sediments in the Outer Darwin Harbour (ODH) Area and eastern Shoal Bay (Radke et al., 2020) contained elevated arsenic levels similar to those found in the current study.
- Elevated arsenic levels were also reported in some samples from the Darwin Harbour Channel (RPS, 2021).

The high arsenic levels are considered to be due to elevated natural arsenic levels in the source rocks from which the marine sediments are derived (Radke et al., 2020).

The only difference between the dredging areas and potential SG was that arsenic was slightly elevated in the dredging areas compared to the disposal sites (Table 8-5).

Table 8-4: Summary of Metals Results for Sand Wave Areas 1-5

Analyte	LOR (mg/kg)	NAGD Screening Level	Number of Samples	Number > LOR	Number > Screening Level*	Min	Max
Antimony	0.5	2	39	0	0	<0.5	-
Arsenic	1	20	39	39	17	9.9	41
Cadmium	0.1	1.5	39	1	0	<0.1	0.2
Chromium	1	80	39	39	0	4.8	18
Copper	1	65	39	15	0	<1	2.2
Lead	1	50	39	39	0	2.2	5.6

Analyte	LOR (mg/kg)	NAGD Screening Level	Number of Samples	Number > LOR	Number > Screening Level*	Min	Max
Mercury	0.01	0.15	39	0	0	<0.01	-
Nickel	1	21	39	39	0	2.2	7.4
Zinc	1	200	39	39	0	1.5	7.4

* 95 % UCL values will be calculated once the remaining data has been received

Table 8-5: Summary of Metals Results for Potential SG A and B

Analyte	LOR (mg/kg)	NAGD Screening Level	Number of Samples	Number > LOR	Number > Screening Level*	Min	Max
Antimony	0.5	2	8	0	0	<0.5	-
Arsenic	1	20	8	8	0	4.1	16
Cadmium	0.1	1.5	8	2	0	<0.1	0.3
Chromium	1	80	8	8	0	11	18
Copper	1	65	8	8	0	1.4	2.7
Lead	1	50	8	8	0	3.8	4.7
Mercury	0.01	0.15	8	0	0	<0.01	-
Nickel	1	21	8	8	0	4.3	7.0
Zinc	1	200	8	8	0	4.4	8.9

* 95 % UCL values will be calculated once the remaining data has been received

Organics

None of the samples from the dredging areas or the potential SG contained detectable total petroleum hydrocarbons (TPH). None of the volatile hydrocarbons (BTEXN), were detected in any sample. The low TPH and volatile hydrocarbons levels were consistent with the results of investigations at the Inpex Dredge Spoil Disposal Ground in 2012, prior to disposal (Inpex, 2018), in the ODH and Shoal Bay study (Radke et al., 2020) and along the Barossa Gasfield Project offshore pipeline route (RPS, 2021).

Because TPHs were not detected, the samples were not analysed for polycyclic aromatic hydrocarbons (PAHs), which are found in petroleum hydrocarbons.

The Total Organic Carbon (TOC) levels were very low, typically in the range of 0.1 - 0.3 %, as would be expected in sandy sediments distant from land - based sources of organic matter. The highest TOC values were found in the finer sediments, which is also normal.

8.4.2.2 Sand Wave Dredging Areas 17 - 18 and Potential Spoil Disposal Grounds D

Metals and Metalloids

The metals and metalloid levels were similar to those reported above. Cadmium, chromium, copper, lead, mercury, nickel, and zinc were present at low levels, typical of natural levels in uncontaminated marine sediments. These metals were well below the NAGD 2009 Screening Levels in all samples. Cadmium was seldom detected, and mercury and antimony not detected in any sample (Table 8-6 and Table 8-7). Some lab data is still to come. Once received, the upper 95 % confidence limits (95 % UCLs) will be calculated.

The metalloid arsenic was often present at levels exceeding the NAGD Screening Level of 20 mg/kg, however as detailed above, arsenic is known to be naturally high in marine sediments from much of Australia, including sediments of the Darwin Outer Harbour area and Shoal Bay, where the levels reported in the scientific literature are comparable to those found in the current investigation. This is considered to be due to elevated natural arsenic levels in the source rocks from which the marine sediments are derived (Radke et al., 2020).

Metal levels in the dredging areas were slightly higher than at the potential SG, though all metal levels were well below their NAGD Screening Levels in all samples, and hence the sediments are classed as uncontaminated.

Table 8-6: Summary of Metals Results for Sand Wave Areas 17 - 18

Analyte	LOR (mg/kg)	NAGD Screening Level	Number of Samples	Number > LOR	Number > Screening Level*	Min	Max
Antimony	0.5	2	52	0	0	<0.5	-
Arsenic	1	20	52	52	24	9.9	58
Cadmium	0.1	1.5	52	0	0	<0.1	0.1
Chromium	1	80	52	52	0	5.2	41
Copper	1	65	52	32	0	<1	7.4
Lead	1	50	52	52	0	3.7	18
Mercury	0.01	0.15	52	0	0	<0.01	-
Nickel	1	21	52	52	0	2.5	14
Zinc	1	200	52	52	0	2.3	20

* 95 % UCL values will be calculated once the remaining data has been received

Table 8-7: Summary of Metals Results for Potential SG D

Analyte	LOR (mg/kg)	NAGD Screening Level	Number of Samples	Number > LOR	Number > Screening Level*	Min	Max
Antimony	0.5	2	5	2	0	<0.5	0.95
Arsenic	1	20	5	5	3	16	48
Cadmium	0.1	1.5	5	0	0	<0.1	0.1
Chromium	1	80	5	5	0	5.4	19
Copper	1	65	5	3	0	<1	2.0
Lead	1	50	5	5	0	4.0	7.6
Mercury	0.01	0.15	5	0	0	<0.01	-
Nickel	1	21	5	5	0	2.8	5.6
Zinc	1	200	5	5	0	2.3	7.1

* 95 % UCL values will be calculated once the remaining data has been received

Organics

Apart from one single sample (GS21 - 4) from the dredging area, which contained TPHs slightly above the LOR (though two orders of magnitude below the NAGD Screening Level), TPHs were not detected in any sample from either the dredging areas or SG D. None of the volatile hydrocarbons, BTEXN, were detected in any sample. Accordingly, the samples were not analysed for PAHs, which are found in petroleum hydrocarbons.

The TOC levels were very low, typically in the range of 0.1 - 0.2 %, as would be expected in sandy sediments distant from land - based sources of organic matter.

There was no difference between the organics found in the dredging areas and the disposal site.

8.4.2.3 Sand Wave Dredging Areas 19-20 and Potential Spoil Disposal Grounds C

Metals and Metalloids

The metals and metalloid levels were similar to those reported above. Cadmium, chromium, copper, lead, mercury, nickel, antimony, and zinc were present at low levels, typical of natural levels in uncontaminated marine sediments. These metals were well below the NAGD Screening Levels in all samples. Cadmium was seldom detected, and mercury not detected in any sample (Table 8-8 and Table 8-9).

The metalloid arsenic was often present at levels exceeding the NAGD Screening Level of 20 mg/kg, however as detailed above arsenic is known to be naturally high in marine sediments from much of Australia, including sediments of the Darwin Outer Harbour area and Shoal Bay, where the levels reported in the scientific literature are comparable to those found in the current investigation. This is considered to be due to elevated natural arsenic levels in the source rocks from which the marine sediments are derived (Radke et al., 2020).

Metal levels in the dredging areas were similar to those at the disposal sites. All metal levels were well below their NAGD Screening Levels in all samples, and hence the sediments are classed as uncontaminated.

Table 8-8: Summary of Metals Results for Sand wave Areas 19-20

Analyte	LOR (mg/kg)	NAGD Screening Level	Number of Samples	Number > LOR	Number > Screening Level*	Min	Max
Antimony	0.5	2	7	0	0	<0.5	-
Arsenic	1	20	7	10	4	12	36
Cadmium	0.1	1.5	7	0	0	<0.1	0.1
Chromium	1	80	7	10	0	6.6	20
Copper	1	65	7	4	0	<1	2.5
Lead	1	50	7	10	0	3.2	5.5
Mercury	0.01	0.15	7	0	0	<0.01	-
Nickel	1	21	7	10	0	3.2	7.1
Zinc	1	200	7	10	0	2.2	9.3

* 95 % UCL values will be calculated once the remaining data has been received

Table 8-9: Summary of Metals Results for Potential SG C

Analyte	LOR (mg/kg)	NAGD Screening Level	Number of Samples	Number > LOR	Number > Screening Level*	Min	Max
Antimony	0.5	2	6	1	0	<0.5	0.9
Arsenic	1	20	6	6	2	13	30
Cadmium	0.1	1.5	6	0	0	<0.1	0.1
Chromium	1	80	6	6	0	13	21
Copper	1	65	6	6	0	1.8	2.9
Lead	1	50	6	6	0	4.9	6.9
Mercury	0.01	0.15	6	0	0	<0.01	-
Nickel	1	21	6	6	0	5.0	8.1
Zinc	1	200	6	6	0	5.9	10.2

* 95 % UCL values will be calculated once the remaining data has been received

Organics

TPHs were not detected in any sample from the dredging areas. Four samples from SG D contained TPHs slightly above the LOR (though two orders of magnitude below the NAGD Screening Level), None of the volatile hydrocarbons, BTEXN, were detected in any sample. The samples were not analysed for PAHs, which are found in petroleum hydrocarbons.

The TOC levels were very low, typically in the range of 0.1 - 0.3 %, as would be expected in sandy sediments distant from land - based sources of organic matter.

There was no notable difference between the organics found in the dredging areas and the potential SG.

8.4.3 Dredging and Disposal Volumes

Pre - sweeping is typically done using a TSHD or an MFE. Depending on the size of the vessel, the dredge head is a few metres wide. With each passage through the spoil removal area, and depending on seabed conditions, it will dredge a slice of a few tens of centimetres. The process is repeated various times until the required dredging depth is achieved.

Seabed spoil removal is not a precise operation. The drag head is large and heavy, and the ship is in constant movement, whilst spoil removal is dependent on the nature of sediments encountered. In practice, an over - depth will need to be removed to ensure a minimal pre - sweeping profile for cable burial. Over - depth can compensate for natural sediment infilling over time and may therefore avoid the need for maintenance between initial dredging and cable installation works.

As sand waves tend to be mobile, their peaks and troughs move with time. This study utilises a single survey dataset (Murrumjuk survey) available for this area and therefore, at the time of writing this report, it is impossible to determine migration rates of the bed forms and thus difficult to determine an NMRL that can be used for cable installation in 2025. Additional surveys by the Marine Contractor will seek to obtain more survey data prior to detailed micro - routing and installation of the cable.

The volume of material requiring removal from the sand waves is outlined in Table 8-10. As sand waves 17 - 20 were identified during the survey, pre - sweeping calculations were not completed (demonstrated by NA in Table 8-10) as this was conducted prior to the survey commencing. Table 8-10 has the sub - totals of volume required to be removed for sand waves 1 - 5 and sand waves 17 - 20 for one dredged line. As described in Chapter 2, there are two lines – Pole 1 and return, and Pole 2 – that require dredging. Therefore, the doubled sub - total reflects the volume of material required to be dredged for installation of the Subsea Cable System. The Grand Total in Table 8-10 is the total volume of material required to be dredged and subsequently disposed for two lines to be pre - swept, being the bundled metallic return and pole 1 and subsequent pole 2.

Table 8-10: Indicative volume calculations including tolerances

Area	From KP (km)	To KP (km)	NMRL (m)	Pre-sweep Section length (m)	Pre-sweep area (m^2)	Pre-sweep volume (m^3)	Pre-sweep area (m^2) + 1 m tolerance	Pre-sweep volume (m3) + 1 m tolerance
1	67.269	67.587	Constant depth level at - 35	43	766	341	1 462	1 507
2	68.140	68.770	Constant depth level at - 35.2	50	1 039	693	1 742	2 109
3	73.887	74.107	Constant depth level at - 35.4	30	507	207	1 055	1 027
4	74.240	74.471	Constant depth level at - 35	113	1 840	901	3 186	3 498
5	74.845	75.055	Constant depth level at - 34.6	173	3 231	1 412	4 865	5 459
SUB-TOTAL (for 1 line)					**7 383**	**3 554**	**12 310**	**13 600**
DOUBLED SUB-TOTAL (for 2 lines)								**27 200****
DOUBLED SUB-TOTAL plus 100% contingency					**14 766**	**7 108**	**24 620**	**54 400*****
17*	20.7	23.2	NA	2,500	NA	NA	NA	83,125
18*	23.55	23.75	NA	200	NA	NA	NA	6,650
19*	47.01	47.27	NA	260	NA	NA	NA	8,645
20*	51.28	51.36	NA	80	NA	NA	NA	2,660
SUB-TOTAL (for 1 line)					**NA**	**NA**	**NA**	**101,080**
DOUBLED SUB-TOTAL (for 2 lines)					**NA**	**NA**	**NA**	**202,160****
GRAND TOTAL (for all sand waves for 2 lines, and 100% contingency of sand waves 1-5)								**256,560**

*NOTE: These areas were identified on the Subsea Cable System survey cruise in late August 2022, and as sediment sampling was about to begin, there are not time for the detailed calculations to be made. Therefore, the pre - sweep volumes were determined pro - rata from the calculations for areas 1 - 5 and multiplied by an average factor of 33.25 (total pre - sweeping volume (m^3) + 1/tolerance total pre - sweeping section length) from areas 1 - 5 above.

**Total double, to account for 2 dredged lines.

**The doubled total (for both lines) plus 100 % contingency

NA: Not available at the time. New volume calculations have since been made and the total was 264,932 m3 for two lines plus a 100 % contingency of the dredging volume for sand waves 1 - 5.

8.5 Potential Impacts

The potential impacts to marine environmental quality values, particularly around the project refinements and the additional knowledge gained from the relevant studies (Section 8.2) 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:

- Sediment re - suspension in the water column caused by cable burial via mass flow - excavator and dredging (i.e., increased turbidity)
- Re - suspension of contaminated sediments via dredging
- Contamination of Potential SG.

The EIA identified and assessed the following impacts associated with the operations phase:

- Seabed disturbance from cable repairs.

Habitat loss, alteration or destruction is minimal in the operations phase.

The EIA considered the impact avoidance and mitigation measures detailed in Table 8-11 and assessed the residual impacts to marine environmental quality assuming these measures are effectively implemented. A residual impact rating was then assigned taking into consideration the scale, magnitude and duration of the impacts, the presence/absence of environmental values and/or sensitive receptors and the level of certainty with respect to the intensity of the impact and the effectiveness of the mitigation measures. The residual impact ratings adopted in the assessment are provided in Table 8-12 and Table 8-13.

8.5.1 Areas of Potential Impact

The proposal footprint where there will be direct disturbance of the marine environment encompasses the Shore Crossing Site located at Murrumujuk, Gunn Point Beach and the Subsea Cable System route which extends approximately 4,200 km from Darwin to Singapore. Only the 748 km section located in NT Coastal Water and the Cwth Marine Areas is assessed in the Draft EIS and in this SEIS. This SEIS only covers project refinements and additional information gained since the Draft EIS.

Cable laying and burial activities are likely to indirectly impact WQ due to sediment re - suspension and decreased water clarity. The possible area of influence is predicted to be widespread throughout nearshore shallow water where short periods of elevated turbidity could occur at some distance from the Subsea Cable System corridor, before returning to background concentrations once the cable is in place. Further impacts gain from the information gathered during the Subsea Cable Survey conducted in August 2022 is detailed below.

In micro - siting the final location of the Subsea Cable System corridor within its zone of influence, the following steps would be followed:

- Undertake a Heritage Impact Assessment (HIA) of Subsea Cable System survey data and consult with the NTG's Heritage Branch to ensure obligations under the *Heritage Act 2011* (NT) are properly considered.
- Consultation with the AAPA on Subsea Cable System Authority Certificate findings to ensure obligations under the *NT Aboriginal Sacred Sites Act 1989* (NT) are properly considered.
- Undertake additional marine survey prior to cable system installation to determine geotechnical suitability of final cable routes.
- Confirmation of other secondary approvals required under NT and Cwth legislation.
- Consultation with potentially affected stakeholders.
- Consultation with the NT EPA and Cwth Government, as jurisdictionally relevant.

8.5.2 Construction

The potential for impacts to marine WQ and sediments will be greatest during the construction phase when cable laying and burial activities will disturb the seabed and mobilise sediments into the water column. The activities described throughout this Section 8.5.2 would take place during the construction stage of the Project.

8.5.2.1 Sediment Re-suspension in the Water Column caused by Cable Burial via Mass Flow-Excavator and Dredging

As detailed in Chapter 2 the Subsea Cable System will be installed using MFE or cutter - suction dredger. Whilst the direct disturbance footprint associated with the dredging area, the cable burial process will increase suspended sediment concentration (SSC) in the water column, which can then be further distributed by tides, waves, and wind. Elevated SSC in the water column can increase turbidity (i.e., decrease light penetration) which if elevated concentrations persist for periods of time light for primary producers may be limited and can also clog gills and impact fauna feeding.

In the absence of sediment dispersion modelling, some observations based on the sediment data from the sand waves and potential spoil disposal grounds are:

- Sand waves 1 - 5 were mainly sand or gravelly sand, therefore turbidity would be lower when dredging. The potential spoil disposal ground A and B have muddy sands with 4 - 26 % gravel, and therefore would have lower turbidity when depositing the spoil.
- Sand waves 17 - 18 has the highest proportion of fine material amongst the sand waves that need to be dredged and therefore the highest potential of higher turbidity. The potential spoil disposal ground D has higher fine material content, and therefore would have a higher turbidity when depositing the spoil.
- Sand waves 19 - 20 were mainly sand and gravelly sand (similar to sand waves 1 - 5), therefore turbidity would be lower when dredging. The potential SG C has higher fine material content, and therefore would have a high turbidity when depositing the spoil.

Along the sand wave and potential dredge SG, four of the survey's sites were 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.

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.

8.5.2.2 Re-suspension of Contaminated Sediments via Dredging

Sand waves that require dredging were sampled and analysed through the Subsea Cable System surveys. Chemical characterisation shows that the sediments in the proposed dredged areas and the proposed SG are uncontaminated, that the sediment chemistry at the dredging sites is similar to that at the disposal sites (detailed in Section 8.4.2) and showed that the dredged areas are uncontaminated with the exception of naturally elevated levels of arsenic. Sand waves 1 - 5 (41 mg/kg), 17 - 18 (58 mg/kg) and 19 - 20 (36 mg/kg) and potential spoil disposal grounds D (48 mg/kg) and C (30 mg/kg), have arsenic levels higher than the NAGD Screening levels of 20 mg/kg. Uncontaminated marine sediments typically contain from 5 to 40 mg/kg dry weight total arsenic (Neff 2009), which includes the concentrations recorded for sand waves 19 - 20 and potential spoil disposal ground C. Arsenic concentrations recoded for sand waves 1 - 5 and potential spoil disposal ground D are only slightly higher than the typical values for arsenic, and sand waves 17 - 18 are quite elevated.

The dominant form of arsenic in oxygenated marine and brackish waters is arsenate, which is less toxic than arsenite. Marine algae accumulate arsenate from seawater, reduce it to arsenite, and then oxidise the arsenite to a large number of organoarsenic compounds. Dissolved arsenite and arsenate are more toxic to marine phytoplankton than the marine invertebrates and fish due to the fact that marine animals have a limited ability to bioconcentrate inorganic arsenic from seawater but can bioaccumulate organoarsenic compounds from their food (Neff 2009).

Marine algae were only sporadically recorded in the sand wave areas and potential spoil disposal grounds, therefore biologically induced redox is also unlikely. Therefore, marine environmental quality values are unlikely to be significantly affected by arsenic suspension.

However, arsenic is not likely to be mobilised into the water column during dredging and disposal because of the offshore environment key conditions such as pH and redox potential as unlikely to be changed significantly. Therefore, arsenic that is re - suspended could remain bound, but some fraction could be dissolvable and therefore bioavailable for receptors. It is anticipated that this fraction of bioavailable arsenic would have a very minor effect on receptors.

8.5.2.3 Contamination of Potential Spoil Disposal Grounds

Potential Spoil Disposal Grounds that require dredging were sampled and analysed through the Subsea Cable System surveys. Chemical characterisation was conducted (detailed in Section 8.4.2) that showed that the sediments in the Potential Spoil Disposal Grounds are uncontaminated. However Potential Spoil Disposal Grounds C and D have elevated arsenic, which can result is minor resuspension, see Section 8.5.2.2 above.

8.5.2.4 Resuspension, Transport, and Deposition of Fine Sediment during Dredging and Disposal Operations

Direct and indirect impacts will occur due to dredging and disposal operations, including:

- Within the direct disturbance footprint, there will be loss of BCH. Dredging will directly impact an area of 207 ha. Following completion of cable laying activities, there will be recolonisation of the area by fauna, and BCH will recover over time.
- At the spoil disposal grounds, smothering or burial of organisms can occur where the sediment is deposited.
- There may also be habitat changes at the spoil disposal grounds where the dredged sediment is different in grainsize to the existing sediment at the SG. However, there is little change to the substrate, as describe above in Section 8.4.1. Physical effects relate to increased sediment in the water column (turbidity) and decreased light availability at the seabed can impact benthic primary producers (e.g., seagrass, macroalgae and autotrophic coral). However, 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 (see Appendix 9.1).
- Additionally, resuspended sediment will be dispersed by oceanographic processes such as tides and currents, subsequently settling on BCH, resulting in smothering and potential impacts to ecological processes. However, these benthic communities are generally widespread in occurrence throughout this area (see Appendix 9.1 and responses to the NT EPA Direction in Chapter 9).

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 (Table 8-1). However, the additional detail of the grain - size composition of the sand wave sites and potential spoil disposal grounds, their chemistry, previous modelling conducted, further detail on the potential receptors within Coastal Waters have helped to identify the impacts of the proposed works.

8.5.3 Operation

During routine operations, there is limited potential for impacts to the marine environment. In the unlikely event of cable damage, then repair would necessitate some disturbance of the seabed and short - term WQ impacts associated with burial of the new cable section.

8.5.3.1 Seabed Disturbance from Cable Repairs

Minor sediment removal may be required to be undertaken during the operation of the Project in order to rectify service faults. However, the quantities of sediment and methods of sediment removal and placement which would be required are unlikely to trigger consideration of the NAGD, or the NAGD (NT EPA, 2013).

8.6 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 sit within an overarching EMS. This chapter has been updated for the SEIS and is found in Chapter 17.

For each of the impacts to Marine environmental quality discussed in this chapter and updated in Table 8-13, 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, operation and decommissioning 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 unacceptable impacts to marine environmental quality. 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.

In addition, the micro - siting steps set out in Section 8.5.1 will be followed in finalising the location of the Subsea Cable System route. Moreover, the micro - siting steps set out within Section 8.3.2.2 will be followed in finalising the location of SG.

Table 8-11: Marine Environmental Quality – Commitments

Impact	Avoidance	Mitigation	Monitoring	Reporting
Increased turbidity in marine waters caused by cable burial activities	Route selection avoids areas of significant marine habitat as much as possible. 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. 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.	All dredging and disposal will be conducted in accordance with the legislative framework outlined in Appendix 8.3, including the NAGD and *Environment Protection (Sea Dumping) Act 1981* (Cwth) in particular, and will draw on WAMSI to implement best management practices. Design, install and operate Subsea Cable System in accordance with the Guidelines on Best Environmental Practices in Cable Installation, and Operation (OSPAR, 2012). Disposal of spoil will avoid periods of storms when the water column is chaotic to decrease turbidity. Adaptive management process will be applied (Table 8-1)	Turbidity monitoring in impact zone and baseline/reference site during cable installation in high - risk area (shallow waters <20m depth).	External reporting in accordance with environmental approval conditions. The Proponent will respond to complaints raised
Re-suspension of contaminated sediments via dredging	Sediments to be dredged are not contaminated.	N/A.	Implementation of the Marine Environmental Management Plan (MEMP).	Reporting on the MEMP.
Contamination of Potential Spoil Disposal Grounds	Sediments to be disposed of are not contaminated and therefore will not contaminate the Potential Spoil Disposal Grounds.	N/A.	Implementation of the MEMP.	Reporting on the MEMP.

Impact	Avoidance	Mitigation	Monitoring	Reporting
Seabed disturbance from cable repairs	Minimise disturbance footprint by undertaking targeted repair as required.	Nil.	Nil.	Nil.

8.7 Residual Impact

All residual impacts have a rating of ‘minor’ and ‘moderate’, showing no change to the residual impact conclusions reached in the Draft EIS. Any identified uncertainties are addressed with monitoring and mitigation measures. All residual impacts are considered not significant.

Table 8-12: Summary of SEIS Results – Marine Environmental Quality Factor – Construction

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual Impact
Sediment re-suspension in the water column caused by cable burial via mass flow-excavator and dredging - Route B / Potential Spoil Disposal Grounds	Subsea Cable System	**Likely** Cable burial will result in disturbance of sediments and increased SSC in the water column.	**Widespread** Sediment transport modelling indicates elevated SSC could occur over a wide area of shallow waters (up to 26 km x 11 km).	**Short Term** Elevated SSC will be experienced for periods of days to weeks as the cable burial activities occur in the shallow waters of Shoal Bay.	**Moderate** WQ objective exceeded for short periods, albeit unlikely to affect marine habitats or biota adapted to high turbidity conditions.	**Medium** WQ supports little marine ecosystems and beneficial uses.	**High** Marine modelling undertaken (see Appendix R from the Draft EIS). Model assumptions are conservative.	**Moderate**
Re-suspension of contaminated sediments via dredging – Route B	Subsea Cable System	**Unlikely** The sediments proposed to be dredged are classified as uncontaminated and suitable for unconfined offshore disposal.					**High** Sediment sampling was conducted at potential spoil disposal grounds.	**Minor**
Contamination of Potential SG	Subsea Cable System	**Unlikely** The sediments proposed to be dredged are classified as uncontaminated and suitable for unconfined offshore disposal.					**High** Sediment sampling was conducted at potential spoil disposal grounds.	**Minor**

Table 8-13: Summary of SEIS Results – Marine Environmental Quality Factor - Operations

Impact	Location	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual Impact
Seabed disturbance from cable repairs – Route B	Subsea Cable System	**Possible** Repairs may require cables to be uncovered or additional cable to be laid. Potential for WQ impacts due to increased SSC.	**Limited** Repairs would only be required due to damage, in a small section of the Subsea Cable System.	**Short Term** WQ impacts could occur over days during repairs.	**Minor** Spatially restricted and over a short time frame.	**Low** Environment is generally intact and there are very few sensitive receptors according to the benthic study.	**High** Repairs would only be required if damage occurred, in a small footprint, and over a short period of time.	**Minor**

8.8 Cumulative Impact Assessment

Due to the low level of residual impact to marine environmental quality associated with the project refinements combined with no change in assessment conclusion ratings from 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.

8.9 Conclusion

Twelve submissions were received relating to marine environmental quality during the public submissions period (Section 8.10), two from the NT EPA Direction (Section 8.11), two from DILP, six DEPWS, and two from the ECNT.

A review of the project refinements identified in Chapter 2 has not identified any new significant impacts. All residual impacts have a rating of 'minor' and 'moderate' any identified uncertainties are addressed with avoidance, monitoring, and mitigating measures. Thus, the Project can achieve the objective of protect the quality and productivity of water, sediment, and biota so that environmental values are maintained.

8.10 Submission Response

During the Draft EIS Public Submissions period, DIPL and DEPWS made comments with respect to marine environmental quality. These comments relate to the key themes of Subsea Cable System routing and burial, marine sediments, WQ and baseline data, geomorphic features mapping, and sediment layers. However, these have been categorised into the other chapters of this SEIS to support the Proponents response.

The Proponent's responses to these submissions are provided in Sections 8.10.1 to 8.11.6.

8.10.1 DIPL Submission – Subsea Cable System Route

This section outlines two route options (Route A and Route B) under consideration for the subsea cable in the nearshore part of the footprint from the Shore Crossing Site out to a common point of convergence approximately 45 km northwest of Darwin. Both options have been selected to avoid known areas of environmental sensitivity and recreational fishing values such as artificial reefs and wrecks.

The current Subsea Cable System route, including two inshore route options, was selected based on review of available geophysical data. DIPL notes that further surveys of the near-shore Route options A and B are planned for early 2022 to confirm this approach.

DIPL also notes that the Subsea Cable System will comprise up to six cables, installed individually or in a bundled configuration with spacing between the cables up to 200 m (for each cable), with actual spacing requirements to be determined in detailed design. The cables will either be laid on the seafloor or trenched into the seabed generally to a depth between 0.3 – 1 m (in certain circumstances it may be necessary to bury to 3 m depth), or protected with armouring as required, subject to various hazards and sea floor conditions along the route.

DIPL notes that the location of current route Option A coincides with the location of potential, long term, dredged material disposal grounds. DIPL has engaged with the proponent in this regard and understands its preferred route is Option B. However, if Option A is to be considered, the proponent must demonstrate that these sites can still be used in the future, as dredge material disposal sites after the subsea cables have been installed (i.e., that the installation of subsea cables does not preclude the use of these areas for a long term dredged material disposal ground). The developer is encouraged to continue to engage with DIPL if it intends to pursue Option A.

8.10.1.1 Response

As discussed in Chapter 2, further investigations have selected route B (southern route) as the preferred subsea cable system alignment. There has been a minor realignment of the route to allow for increased spacing of bends where the cable crosses the Santos pipeline and Vocus fibre optic cable. There is no change in corridor width or disturbance footprint due to this realignment.

8.10.2 DIPL Submission – Subsea Cable System Burial

The section outlines 'The depth of burial will vary from 0.5 – 3 m and is dependent on the outcome of the Cable Burial Risk Assessment, which considers the sea floor properties and the risk of cable damage from anchoring and fishing gear.'

To assess significance of the impact to the community in the marine/terrestrial interface, further information is required to:

- *Inform what the 'depth of burial' will be measured against (i.e., against Lowest Astronomical Tide)*
- *Provide a Cable Burial Risk Assessment, which is important to understand and clarify risks in tidal areas.*

Include what protection measures will be implemented at the shore crossing to advise recreational users of the existence of subsea cables and mitigation measures to ensure cable protection.

8.10.2.1 Response

A Cable Burial Risk Assessment for the nearshore area has been produced and was used to inform the Draft EIS. This document is considered to be commercial in confidence and therefore have only been provided to the NT EPA and relevant consultants as Appendix 8.1.

The 'depth of burial' is referenced to mean stable seabed level, which in turn is referenced to LATs.

Natural hazards related to tides that were considered in the risk assessment were sediment mobility, waves and currents and extreme weather.

Sediment mobility is of concern because it can result in de - burial or increased burial of the cable. In areas of high mobility and/or particular concern it may be appropriate to perform a morphology or hydrodynamic study to help inform the potential development of mobile seabed over time. The preferred method to mitigate mobile sediments is to avoid them through effective routing and where this is not possible there is a list of measures that will be considered to minimise the risk.

Hydrodynamic forces from waves and currents (and as a function of water depth) can cause instability of a surface laid cable from its as - laid position as well as cable vibration and possible fatigue issues. The cables are intended to be physically protected, placed under enhanced live monitoring, or buried in water depths of up to 500 m. surface laying will be utilised for greater depths, or where suitably benign environments are identified.

Extreme weather, such as cyclones, will occur in north and north - west Australia between November and April. Therefore, sufficient Depth of Lowering (DoL) and protection will be required to deal with the effects of extreme weather.

8.10.3 DEPWS Submission – Marine Sediment Data

Information on the existing environment should incorporate geomorphic and predicted mud, sand and gravel layers and data layers and interpretation of sediment chemistry characteristics (Nicholas eta l 2019) available as part of the Darwin Harbour – Bynoe harbour habitat mapping program (data package - Siwabessy et. al. 2020).

8.10.3.1 Response

Section 8.4.1.3 – Seabed Characteristics describes the additional information gained regarding the potential dredges and the potential SG.

Appendix S in the Draft EIS details a Marine Environmental Quality Report. Nicholas *et al*., 2019 is extensively referenced in particular to: morphological features; bathymetry; spatial variation in sediment textures; sediment characteristics; geomorphology; geology; and turbidity and sediment plumes.

The Data Package – Darwin Harbour Habitat Mapping Program, NT (Siwabessy et al., 2020) report was not used in the Draft EIS, however the following reports where Siwabessy is the lead author were used:

- Siwabessy, P.J.W., Tran, M., Huang, Z, Nichol, S., Atkinson, I., 2015. Mapping and Classification of Darwin Harbour Seabed. Record 2015/18. Geoscience Australia, Canberra
- Siwabessy, P.J.W., Smit, N., Nicholas, W.A., Atkinson, I., Brinkman, R., Dando, N., Harries, S., Howard, F.J.F., Huang, Z., Li, J., Picard, K., Potter, A., Radke, L., Tran, M., Wiliams, D., Whiteway, T., 2019. Seabed Mapping Darwin Harbour Region (including Bynoe Harbour). Final Report. Department of Environment and Natural Resources. Darwin, NT, Australia.

8.10.4 DEPWS Submission – Marine WQ

Modelling the relationship between turbidity, measured as NTU, and light attenuation through the water column requires more detailed information of components of total suspended solids (TSS), including Particulate Inorganic Matter (PIM), Particulate Organic Matter (POM) and the Colour of Dissolved Organic Matter (CDOM). These relationships are site specific and cannot be reliably transferred from other regions, especially not using Cardno (2013) derived relationships which were based on inner Darwin Harbour environments that are dominated by mangrove habitats. Until this relationship is established, the proponent cannot reliably place impacts to benthic primary producer habitats from elevated TSS and changes to light availability at the seafloor into context and set triggers for mitigation actions. The Flora and Fauna Division recommends that further data is sought, and WQ monitoring is undertaken if necessary to establish:

(a) the relationship between turbidity and light attenuation, and

(b) the natural variability between seasons, so that appropriate TSS triggers for benthic primary producer habitats can be developed.

8.10.4.1 Response

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 (see Chapter 9). 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.

Table 8-1 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 within the zone of impact of the Subsea Cable System route within Coastal Waters.
- 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.
- 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.

In general, the findings of the benthic survey indicate that the modelled habitat over - estimated the presence of hard coral. Seagrass and macroalgae within the Subsea Cable System sone of impact. 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. Therefore, the effects of turbidity and light attenuation are not as important as originally thought and would only potentially impact individual organisms.

Turbidity and its effect on light attenuation is discussed in detail in the Draft EIS in Section 9.3.3.1 in Chapter 9.

8.10.5 DEPWS Submission – Geomorphic Features Mapping

Table 9-1 and Figure 9-2 seem to be incomplete. Geomorphic features from the Darwin Harbour – Bynoe Harbour habitat mapping project are not displayed in Figure 9-2 See Nichols et al (2019). Further, it is unclear how the proportion of each geomorphic feature intersecting the cable corridor is calculated in Table 9-1. Is this based solely on what was mapped by Geoscience Australia or the whole corridor area? The Flora and Fauna Division recommends including geomorphic features from the Darwin Harbour – Bynoe Harbour habitat mapping project and undertaking additional analysis of bathymetric data for which no geomorphic data are available, so that Table 9-1 will be more representative of features present.

8.10.5.1 Response

Information displayed in Table 9 - 1 and Figure 9 - 2 of the Draft EIS represents the regional geomorphological features based on Geoscience Australia data. The intent of the information presented in Table 9 - 1 and Figure 9 - 2 of the Draft EIS was to provide high level context for the geomorphic features intersected by the Subsea Cable System. The proportions of geomorphic features intersected by the Subsea Cable System, provide in Table 9 - 1 of the Draft EIS, were calculated using Geoscience Australia data and assumed a 1 km wide Subsea Cable Systems corridor. More detail is presented in Section 3 of the Marine Ecology Report – Appendix T of the Draft EIS.

It is acknowledged that the information presented in the Draft EIS did not include specific survey data for Shoal Bay. The nearshore component of the Subsea Cable Systems (i.e., the first 45 km) was not surveyed by The Proponent due to a route change after the marine survey had been undertaken. Additional marine surveys were completed in August 2022 which included bathymetric, geophysical, and geotechnical surveys to describe the seabed environment along the previously unsurveyed (by The Proponent) length of the Subsea Cable System. This information is presented in Appendix 8.2.

8.10.6 DEPWS – Predicted Sediment Layers

It is unclear why Table 9-2 states that Shoal Bay is unsurveyed, and sediments are "Thought to be sandy with scattered rocks and mud," even though in the first paragraph of section 9.3.2.4 states that it was extensively surveyed as part of the Darwin Harbour – Bynoe Harbour habitat mapping project. Information on the existing environment should incorporate predicted mud, sand, and gravel layers (Nicholas et al 2019) available as part of the Darwin Harbour – Bynoe Harbour habitat mapping program (data package - Siwabessy et. al. 2020).

8.10.6.1 Response

Detailed in the Draft EIS Appendix S Marine Environmental Quality Report are the geomorphology and geology of the nearshore and offshore. In Shoal Bay nearshore, the seabed is a low - lying, generally flat, sandy sediment plain, except at Foelsche Bank (9 km east of Gunn Point Peninsula), and the Howard River mouth where there are several low - profile sandbanks and shallow rocky outcrops that are exposed during spring low tides (Nicholas et al., 2019; Radke et al., 2020).

Also detailed in the Draft EIS Appendix S Marine Environmental Quality Report are the sediment characteristics for nearshore and offshore. The seabed sediments of the ODH areas were documented based on extensive survey data as part of the Darwin Harbour Mapping Project (Nicholas et al., 2019; Siwabessy et al., 2019). Appendix 8.3 shows spatial variation of the dominant sediment classes, such as gravel (>2,000 µm diameter), sand (>63 µm and <2,000 µm) and mud (<63 µm diameter), with mud representing a combination of silt and clay particles. The sediments of the ODH are generally muddy sands with varying amounts of gravel, although moderate to large proportions of mud were identified in shallow water on the eastern side of Shoal Bay and at various locations in deeper parts of the study area. High sand percentages were also located over shallower parts of the nearshore region between Darwin and Gunn Point. The nearshore sediments in Shoal Bay are well sorted, potentially due to wave energy in the nearshore environment (Siwabessy et al., 2019).

Further detail on seabed characteristics including sediments can be found in Section 8.4.1 above.

8.10.7 DEPWS Submission – Baseline WQ Data

The draft EIS has not collected site-specific baseline WQ data. To mitigate this information gap, the draft EIS has used INPEX monitoring data from Lee Point, Lee Point Site 02. However, there is no explanation why this site was chosen above the INPEX monitoring site SPO 01 (Cardno, 2015, report L384-AW-REP-10204), which is located between the two proposed cable routes and is more likely to be representative of WQ within the cable corridors in Shoal Bay. However, if the southern route is chosen as the cable corridor, then Lee Point sites together with SPO 01 are adequate to inform risk assessment. The proposed monitoring program is unlikely to be suitable for setting triggers (e.g., for coral communities at Gunn Point). As such, the Flora and Fauna Division recommends further WQ monitoring at selected areas where receptors occur. These monitoring sites should preferably be established before cable laying takes place, so that site specific triggers can be determined, and an appropriate reactive monitoring program can be designed. If the monitoring program is implemented, then the design of the monitoring program should include establishing turbidity/light attenuation relationships (see above), as light condition will be the main driver for health of benthic primary producer habitat.

8.10.7.1 Response

As discussed in Chapter 2, further investigations have selected route B (southern route) as the preferred subsea cable system alignment. There has been a minor realignment of the route to allow for increased spacing of bends where the cable crosses the Santos pipeline and Vocus fibre optic cable. There is no change in corridor width or disturbance footprint due to this realignment.

The Proponent's ESMS and CEMP framework are detailed in Chapter 17 of the Draft EIS in Figure 17 - 1. The CEMP includes a MEMP, which will include a WQ monitoring program include before, during and after construction monitoring.

8.10.8 DEPWS Submission – Report Cards

The use of report cards should be used carefully. The DEPWS monitoring data unpinning the report cards is collected for surveillance or ambient purposes and the data is somewhat skewed for dry season and neap tidal conditions to mitigate the confounding influence of tide and season. The report cards applicability for spring tide and/or wet season is constrained.

8.10.8.1 Response

Although the Darwin Harbour Report Cards are based on monitored and scientific data, report cards are more of a community engagement tool rather than a strict scientific reporting tool. That being said, they can offer a good indication of WQ at a high level. A WQ monitoring plan and program will be drafted following the submission of this Supplement to the EIS and with the intention of being implemented pre - construction to ensure adequate baseline data is collected.

8.10.9 ECNT Submission – Tidal Influence

Tidal movement is also poorly considered in this EIS. Tidal information within Appendix S relies on data from one IMOS buoy in the middle of the Beagle Gulf providing a very coarse indication of currents. Tidal movement within Shoal Bay is far more complex than what is captured by the single IMOS buoy as significant currents exist along the shoreline and are influenced by water draining out of Hope Inlet and the prominent reef at Tree Point. As Hope Inlet completely dries out on low spring tides nearly all marine species leave Hope Inlet and move across the cable corridor. Cable laying activity during periods of spring tides may very well exacerbate sediment deposition on surrounding coral and seagrass substrate on either side of the Murrumujuk site and have the greatest impact on marine species. Metocean data loggers should be deployed to ascertain optimal times for cable laying activities which take into consideration the observations listed above.

8.10.9.1 Response

Unfortunately, timing of works will not be restricted due to significant schedule delays, extra cost, and logistical challenges. However, environmental factors, such as increased movement of marine species in Hope Inlet during the spring tides, will be considered during establishment of environmental triggers through the CEMP – MEMP.

8.10.10 ECNT Submission – Seasonality and Water Temperature

Little attention is given to minimising the impacts on important marine species during cable laying activities. Species movement within Shoal Bay is dominated by tidal movement and water temperature. During the wet season water temperatures usually range from 30 - 32 degrees which exceeds the tolerance levels for many species in shallow inshore environments. Throughout the past 5 years wet season water temperatures during January to March have been so high that there has been an absence of most large predatory fish. At the onset of easterly trade winds in April/May water temperatures rapidly drop and large numbers of species such as Bluenose Salmon and Northern Mulloway move into shallower waters in Shoal Bay.

Many species reach peak spawning activity during the early wet season which may mean significant quantities of fish larval stages are present. Fish larvae experience greater morbidity when exposed to sediment plumes than adult fish as their gills are poorly developed and less capable of clearing particulate matter. Further research is required to identify low periods of predator abundance and spawning activity so that impacts from cable laying activities in the near shore environment can be minimised.

8.10.10.1 Response

As detailed in Chapter 9 of the Draft EIS, hydrodynamic and sediment transport modelling undertaken by Metocean (Appendix R of the Draft EIS) indicates it is likely that elevated SSC from jet - trenching will temporarily increase turbidity in the marine waters of Shoal Bay during the nearshore cable burial activities. The modelled SSC concentrations are within the natural range recorded in Shoal Bay where the receiving environment is naturally turbid for periods of time, particularly during the wet seasons. There is more detail provided in Section 9.4.2.1 in the Draft EIS and in Chapter 9 of this SEIS.

In addition, the cable laying in the nearshore will be for a limited period of time during construction. This is not an impact that will be long lasting or continuous in its implementation.

Timing of works will not be restricted due to significant schedule delays, extra cost and logistical challenges, however environmental factors, such as peak spawning activity in early wet season, will be considered during establishment of turbidity triggers through the CEMP – MEMP.

8.11 NT EPA Direction Responses

8.11.1 Cable Transition Facilities – Comment 11

The draft EIS describes the Cable Transition Facilities as three separate components to transfer power from onshore to offshore:

- *Underground Cable Corridor (2.7 km x 70 m wide = 19 ha)*
- *Land Sea Joint Station (1.5 ha fenced compound)*
- *Shore Crossing Site (temporary 500 x 500 m = 25 ha area) where offshore cables are laid across and then buried through the intertidal zone and beach.*

Figure 2-39 indicates HDD as an option in the legend; however, no corresponding text/justification is provided in the draft EIS.

The TOR for Marine Environmental Quality require description of potential impacts associated with proposed construction including direct impacts to seabed from cable laying, anchors, HDD at shore crossing, trenching and rock armouring.

The NT EPA recognises the importance of HDD to mitigate disturbance to sensitive coastal vegetation at the shore crossing site.

8.11.2 Information Required in the Supplement

Provide site layout and design information as required by the TOR for construction of the cable transition facilities, including but not limited to the:

- *Use and extent of HDD to avoid sensitive vegetation*
- *Alternatives considered and the preferred method, include consideration of Part 2 of the EP Act*
- *Justification and trade-offs for the preferred site, design, and method*
- *Timing of works*
- *Application of NT Land Clearing Guidelines, specifically buffers to sensitive and significant habitat under the Planning Act 1999*
- *Mitigation and management measures proposed to address any potentially significant impacts on terrestrial and marine ecosystem values and community access and use during construction*

- *Detail about reinstatement actions and outcomes proposed for the shore crossing site*
- *Residential and public access during construction*

8.11.3 Response

The Proponent recognises the requirements of the TOR for Marine Environmental Quality to provide impacts associated with proposed construction including direct impacts to seabed from cable laying, anchors, HDD at shore crossing, trenching and rock armouring. We are unable to provide specific site layout and design information until closer to construction.

Use and extent of HDD to avoid sensitive vegetation

The information specified in Section 2.7.3.7 in the Draft EIS is still current and relevant to this Project.

Alternatives considered and the preferred method, include consideration of Part 2 of the EP Act

Alternative methods have been considered and the information specified in Chapter 2 of the Draft EIS is still current and relevant to this Project.

Justification and trade-offs for the preferred site, design, and method

Justification and trade - offs for the preferred site, design and methods have been considered and the information specified in Chapter 2 of the Draft EIS is still current and relevant to this Project. Additional project refinement detailed in Chapter 2 of this SEIS are discussed below.

The lateral spacing between cables will be approximately 4 m apart, which may require each cable trench width to increase from 4 m wide to approximately 13.5 m wide.

There is a focus on reducing trench opening time and the associated potential for erosion and sediment impacts. Each trench will be approximately 2 m deep and is only expected to be exposed for approximately one week, subject to treatment of any PASS presence. Methodology for installations will be dependent on construction planning and availability of required resources. Final decisions on cable installation methods will be confirmed during detailed design.

Cable depth at the Land Sea Joint Station will be between 1.5 – 2 m consistent with the Underground Cable Corridor and Shore crossing depths. There is no intent or need to fence any infrastructure from the boundary of the DCS to the low water mark in Shoal Bay, including the Land Sea Joint Station once construction is complete.

Justification and trade - offs for the preferred site, design and methods will be further refined as the project details are solidified and developed.

Timing of works

The duration of cable installation activities at the shore crossing site will be approximately 10 - 12 weeks for three cables and fibre optic during optimal construction conditions (favourable tides and weather, absence of PASS etc.) If poles are not installed consecutively during one disturbance period, construction timeframes would reduce. For example, if only one pole plus fibre optic were installed initially construction timeframes may reduce to approximately four to six weeks. A second construction effort would be re - scheduled of an equivalent timeframe when pole 2 is installed.

Timing of works will not be restricted due to significant schedule delays, extra cost and logistical challenges, however environmental factors, such as increased movement of marine species in Hope

Inlet during the spring tides, will be considered during establishment of environmental triggers through the CEMP – MEMP.

Application of NT Land Clearing Guidelines, specifically buffers to sensitive and significant habitat under the Planning Act 1999

The Proponent will apply the NT Land Clearing Guidelines, particularly buffers to sensitive and significant habitat listed in the *Planning Act 1999*. These will be detailed in the CEMP – MEMP.

Mitigation and management measures proposed to address any potentially significant impacts on terrestrial and marine ecosystem values and community access and use during construction

Avoidance, mitigation, monitoring, and reporting measures are detailed for marine environmental quality above in Table 8-11, for marine ecosystems in Chapter 9, and for terrestrial ecosystems in Chapter 5.

Should PASS be encountered, mitigation measures will be taken to ensure any disturbed areas are properly managed. This may involve disposing of contaminated material to a licensed facility and the subsequent sourcing and use of clean fill to backfill the excavated trench. Construction timeframes may subsequently increase beyond the 10 - 12 weeks depending on extent of any PASS encountered.

The Subsea Cable System is not expected to produce any harmful chemical products during construction or operations. Subsea cable technology is well understood, and each cable includes multiple layers of insulation and protection to ensure adequate corrosion resistance.

Detail about reinstatement actions and outcomes proposed for the shore crossing site

The Underground Cable Corridor and Land Sea Joint Station construction areas will be reinstated by respreading the stockpiled topsoil and mulched vegetation. Surplus soil will wither be used as fill material, respread over the disturbed areas (minor quantities), or will be removed from site and transported to suitably approved and licensed waste facility. Drainage and ESCs will be installed, and grasses and shrubs will be allowed to regrow; however, trees will be excluded due to potential impacts on the buried cables.

The trenches at the Shore Crossing Site will be backfilled using the excavated material and will be returned to the pre - existing surface topography. In the areas above the high - water mark, vegetation will be re - established to protect the dune and hind dune areas. Below the high - water mark, through the intertidal areas, reinstatement of the natural substrates is expected to allow for rapid recolonization of benthic habitats and fauna; shoreline erosion protection measures will be implemented as needed.

Residential and public access during construction

The underground cable corridor, land sea joint station and shore crossing site are all on crown land and therefore there are no residents that will require access. Chapter 2 of the Draft EIS (Section 2.7.3.6), states that it is estimated that each trench will be approximately 500 m long, up to 2 m deep and 2 m wide. There will be two trenches required, therefore the direct disturbance will be 2 m wide along a route that is 1 km long from land to sea. Given the size and remote location of this beach, the construction should not limit public access to the beach during construction.

8.11.4 Marine corrosion – Comment 12

It is unclear whether there is potential for marine impacts arising from corrosion protection using a bipole with metallic return as this has not been discussed in the Draft EIS.

8.11.5 Information required in the Supplement

Provide further information on how the subsea corrosion protection system works including, but not limited to:

- *Whether any harmful chemical products would be produced in seawater*
- *Any associated impacts, particularly in sensitive areas such as marine parks and Shoal Bay*
- *Measures for avoidance and mitigation.*

Specify which subsea cable route option has been selected.

Provide confirmation about the preferred route of the subsea cable including but not limited to:

- *Any locational changes to the proposed route based on survey results*
- *Addressing EIA information requirements in the TOR about marine environmental quality and marine ecosystem values (and see below in Sea section).*

8.11.6 Response

Whether any harmful chemical products would be produced in seawater

The Subsea Cable System is not expected to produce any harmful chemical products during construction or operations. Subsea cable technology is well understood, and each cable includes multiple layers of insulation and protection to ensure adequate corrosion resistance.

Any associated impacts, particularly in sensitive areas such as marine parks and Shoal Bay

Potential impacts are detailed in Section 9.4 in Chapter 9 of the Draft EIS and in Section 8.5 above in this SEIS. Potential impacts for construction are detailed in Table 9 - 7 of Chapter 9 in the Draft EIS and in Table 8-12 of this SEIS. Potential impacts for operations are detailed in Table 9 - 8 in Chapter 9 of the Draft EIS and in Table 8-13 above in this SEIS.

Measures for avoidance and mitigation

Avoidance, mitigation, monitoring, and reporting are detailed in Table 9 - 10 in Chapter 9 of the Draft EIS and in Table 8-11 above in this SEIS.

Subsea Cable Route

As detailed above and in Chapter 2, Route B is the preferred route for the Subsea Cable System. Minor re - alignments of Route B have occurred based on further marine and engineering studies. Route B realignment allows for increased spacing of bends where the cable system will cross existing infrastructure (pipelines). The environmental impact of the changes to Route B has been considered in this SEIS.

8.11.7 Dredging Impacts – Comment 14

Tables 9 and 10 of the TOR required assessment of potential impacts on Marine environmental quality and Marine ecosystems factors including description of potential impacts associated with proposed construction including direct impacts to seabed from cable laying, anchors, HDD at shore crossing, trenching and rock armouring.

Information has not been provided regarding the location, amount, and disposal options for dredge/pre-sweeping spoil.

8.11.8 Information required in the Supplement

Address tables 9 and 10 of the TOR.

Provide information required in a dredge and dredge spoil placement management plan including:

- *Expected location of dredging/pre-sweeping*
- *Predicted zone of impact and zone of influence*
- *Expected volume of dredge/pre-sweeping spoil*
- *Location of spoil disposal*
- *Assessment of potential impacts of dredging and spoil disposal including avoidance and mitigation measures.*

8.11.8.1 Response

The above information is all provide within the chapter above.

Expected location of dredging/pre-sweeping

Section 8.3.2 details the sand waves and potential spoil disposal grounds and Figure 8-3 details the location of sand wave removal and potential spoil disposal grounds.

Predicted zone of impact and zone of influence

Areas of potential impact are detailed in Section 9.4.1 of Chapter 9 in the Draft EIS and in Section 8.5.1.

Expected volume of dredge/pre-sweeping spoil

The calculated volume required for removal is 256,560 m^3 and a breakdown of the volume from each sand wave can be found in Table 8-10.

Location of spoil disposal

Section 8.3.2 details the sand waves and potential spoil disposal grounds and Figure 8-3 details the location of sand wave removal and potential spoil disposal grounds.

Assessment of potential impacts of dredging and spoil disposal including avoidance and mitigation measures**.**

Impacts are detailed in Section 8.5 with construction specific impacts detailed in Section 8.5.2 and Table 8-12 and operation specific impacts detailed in Section 8.5.3 and Table 8-13. Avoidance, mitigation, monitoring, and reporting measures are found in Section 8.6 and detailed in Table 8-11.

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