- Extendable Trailer Movements: 8,000 for overhead transmission poles
- Full-Trailer Loads: 6,000 for Cable Drums, poles, and transmission equipment.

2.5.5 Reinstatement

Areas of land disturbed during construction but not required during operations, will be reinstated to stabilise the ground, native vegetation will be encouraged to regenerate and weed control measures will be implemented. Along the OHTL, areas to be reinstated will include the pole construction pads, partial reinstatement of the construction access track (from areas required for construction back to 6 m wide required for ongoing maintenance access), laydown areas, temporary access tracks and fly camps. Reinstatement will occur progressively as construction activities are completed in each area.

2.5.6 Operations

During the operation of the OHTL, the main activity that will occur along the OHTL is small scale maintenance of the track to allow for regular inspections via the access road.

Scheduled large scale maintenance programs will be carried out during the operational life of the OHTL. These will be carefully planned and will involve a dedicated team who will have a specific period to complete these activities.

2.6 Darwin Converter Site

The Darwin Converter Site (DCS) is the terminal location for the OHTL and will convert electricity from High Voltage Direct Current (HVDC) to High Voltage Alternating Current (HVAC) to enable connection to the Darwin electricity system[4] before being converted back to HVDC for transmission to Singapore. The site will serve as the junction point between two independent power networks within the AAPowerLink (onshore and offshore). Approximately 800 MW will be made available for connection to the local Darwin Katherine Electrical System. Most of the power supply will be converted back to HVDC for transmission to Singapore via the Subsea Cable System.

2.6.1 Location and footprint

The Darwin Converter Site is proposed to be situated on a 124-ha site located at Murrumujuk, approximately 31 km north-east of Darwin. The site is bound by Murrumujuk Road to the north and eastern boundary, and the Project Sea Dragon hatchery site (proposed) on the western boundary. The Shoal Bay Conservation Area is over 1.5 km from the southern boundary. The locality also provides a suitable area in which to accommodate the Cable Transition Facilities without compromising the future development of adjoining land or recreational values associated with the area. Within the site, approximately 55 ha of land will be developed. The location and layout concept are shown in Figure 2-3.

[4] Powerlines required to export electricity from the Darwin Converter Site into the Darwin electricity system are the responsibility of NT Government and are not within the scope of this EIS.

2.6.2 Site selection and design

The Darwin Converter Site was selected following a thorough planning and consultation process undertaken with key NT Government agencies and other stakeholders. The original proposed location for the Darwin Converter Site was at Middle Arm, adjacent to the Weddell Power Station. However, due to reasons stated in a Notice of Variation lodged in August 2021 (Available here), the revised location was selected for the following principal reasons:

- Sub-sea congestion due to existing and planned infrastructure in Middle Arm and the inner Darwin Harbour with the potential to compromise the AAPL Subsea Cable System.
- Potential terrestrial constraints associated with the future development plans for Middle Arm as an industrial precinct.
- Identification of an alternative Darwin Converter Site at Murrumujuk with proximity to the coastline, suitable topography, and soil conditions.
- The existence of a NT Government utilities corridor providing a viable route for the OHTL from the Railway corridor to Murrumujuk.
- A suitable strategic land use planning framework under the Litchfield Sub-Regional Land Use Plan which identifies both the OHTL route and the Darwin Converter Site as suitable for project infrastructure.

An area of approximately 55 ha is required to accommodate the AAPowerLink infrastructure. To reduce the impact of the linear infrastructure on surrounding and future developments, project infrastructure is located centrally within the development footprint to the extent possible. The infrastructure will be sited to avoid direct impacts to the seasonal wetland (swamp) located in the south-west corner of the site.

2.6.3 Key components

The Darwin Converter Site will comprise up to four Voltage Source Converters (VSC), a BESS, substation and switchyard, an Operations and Maintenance Facility and ancillary infrastructure, including but not limited to parking, laydown, warehousing, staff offices, communications tower, and ablutions. The facilities will be in a fenced compound with 24-hr lighting and surveillance. The key components of the Darwin Converter Site are described below.

2.6.3.1 Access

Access to the Darwin Converter Site for delivery of equipment, materials and personnel will be via Gunn Point Road and Murrumujuk Drive, both of which are sealed public roads. Internal sealed and unsealed access roads will provide access within the Darwin Converter Site.

2.6.3.2 Site foundations and drainage

Within the Darwin Converter Site, raised compacted earth and concrete building pads will be established for critical infrastructure components that require protection from localised flooding during extreme rainfall events. Due to the low relief at the site, there will be minimal requirements for cut and fill.

The site drainage concept involves open drainage channels that route flows received from the surrounding areas, around the infrastructure. The drainage design will minimise the risk of localised flooding by managing overland flows within a drainage system, with open drains and basins designed to deal with peak rainfall events, such that surface water discharges from the site will be at rates similar to pre-development conditions.

2.6.3.3 Electrical infrastructure

The electrical infrastructure installed at the site will comprise a range of conversion, transmission and energy storage equipment as described below.

Voltage Source Converters

The Darwin Converter Site will operate with up to four VSCs. Two receiving VSCs will accept power supplied from the OHTL and convert the electricity to HVAC. A portion of that power (nominally 800 MW) will be delivered to the onsite substation, stepped down to the local transmission voltage (275 kV to be determined with the network service provider), and evacuated through the switchyard to the local Darwin electrical network. Most of the electricity will be re-converted to HVDC by a pair of export VSCs, then exported from the Darwin Converter Site via the Underground Cable Corridor to the Land Sea Joint Station before transmission to Singapore.

Each VSC is comprised of an AC switchyard, internal valve hall, converter transformers, DC switchyard, earthing mat, drainage, lightning protection and ancillary infrastructure. Each VSC footprint is approximately 260 x 260 m with the valve hall representing the tallest structure at approximately 25 m in height. The valve hall will be housed in a steel framed structure and built to Australian standards for the local wind region and other regulatory requirements. An example of VSC internal view is provided in Figure 2-31.

Figure 2-31. Internal view of a Voltage Source Converter (Source ABB Power Grids Pty Limited)

Battery Energy Storage System

A BESS will be located within the Darwin Converter Site to provide backup, fault protection and ancillary services to the Darwin electricity system and the operation of the VSCs. The Darwin BESS has two main functions, firstly to add reliability to the system by responding to grid frequency changes during abnormal situations such as an HVDC system fault, and secondly to provide extra grid services during normal operation. Capacity of the BESS will be scaled to meet demand and network service provider requirements, with a nominal capacity of 800 – 2,000 MW. As this station will enable connection to the local electricity network, it will be designed to meet the local network requirements and the grid code as specified by the network service provider.

2.6.3.4 Operations and Maintenance Facility

An Operations and Maintenance (O&M) Facility will be constructed at the site that will service the associated AAPowerLink infrastructure. The facility will include site offices and administration, parking and laydown areas, warehousing and spares storage, water storage and firefighting equipment, communications tower, utilities, security systems, fuel storage, chemicals storage, electric vehicle charging station, on site solar power and battery demonstration units, an information and education centre and other ancillary facilities. The O&M Facility will be constructed within the fenced perimeter of the Darwin Converter Site.

2.6.3.5 Services

The Darwin Converter Site will be connected to mains power and will source potable and firefighting water supply from an onsite bore or the nearby water tower under agreement with Power and Water Corporation.

2.6.3.6 Dangerous goods and hazardous chemicals storage

Hazardous chemicals storage areas will be established at the Darwin Converter Site for minor quantities of hazardous chemicals such as cleaning chemicals, herbicides (for vegetation management and weed control) and pesticides. There is no requirement for bulk storage of any dangerous goods or hazardous chemicals because power requirements during operations will be supplied by connection to mains power. Further investigation into the potential to use electric vehicles for the site fleet will be undertaken, with the potential for recharging facilities to be powered by on site solar generation. Any refuelling of vehicles will occur in Darwin and not with the facility.

The VSC transformers at the Darwin Converter Site will house synthetic ester, which is the same as the units at the Solar Precinct. This will be contained in sealed sections of the transformers.

2.6.3.7 Waste management facilities

Waste storage and transfer facilities will be established for temporary storage of wastes prior to collection and transport offsite by a licenced contractor. There is no requirement for onsite waste disposal.

2.6.4 Construction

The Darwin Converter Site will be constructed and commissioned in stages to meet the electricity demand requirements of the system. Initially two VSCs will be constructed as well as the first stage of the BESS at approximately 400 MW and the associated substation and switchyard components. Key construction stages, equipment and activities are summarised below.

2.6.4.1 Equipment and machinery

Early civil fleet assumptions adopted for project planning and the EIA indicate the following heavy equipment types will be used across different construction stages and activities at the Darwin Converter Site:

- Clear and grab – Graders, dozers, watercarts
- Formation – Graders, rollers, bitumen sprayers, haul, and tipper trucks
- Concrete structures – Agitator trucks, pump trucks, cranes
- Equipment installation – Cranes
- Personnel transport – Light vehicles

- Dust suppression – Water carts

At peak construction when multiple activities are happening concurrently, there will be in the order of 50 pieces of mobile equipment including civil plant, equipment, and vehicles, operating across the 55-ha footprint.

2.6.4.2 Construction materials

Construction materials such as cement, concrete, aggregate and others will be sourced locally where possible. Equipment and componentry that is not available in Australia, will be sourced from overseas. A concrete batching plant may be required during construction, however at this time construction planning indicates that it will be sourced from external suppliers.

2.6.4.3 Land clearing

Clearing of vegetation across the footprint will occur in a progressive manner to establish the work area required for each stage. Cleared vegetation will be mulched for use in landscaping, and erosion and sediment control. Any vegetation clearing will be completed in accordance with best practice.

2.6.4.4 Site establishment

Site establishment works will involve the following key activities and stages:

- Temporary site demarcation and security established
- Marking of sensitive areas including wetlands in accordance with site clearance procedures
- Pioneering works and construction of a new site entry from Murrumujuk Road
- Water supply, water treatment and power supply established
- Foundations for VSC's laid down
- Laydown areas for construction equipment and materials established
- Temporary site offices and amenities installed
- Site drainage installed.

2.6.4.5 Installation of infrastructure

The initial two buildings for the first VSC will be constructed in back-to-back arrangement, including the switchyards, valve halls and common busbar, after which the 275 kV substation, switchyard and first stage of the BESS will be built. The connection point to the Darwin electricity system will be constructed at the switchyard on the eastern side of the site. On the western end of the site, the jointing pits and service ducts will be installed ready for installation of the underground export cables. The O&M Facility will be constructed at the latter end of the construction campaign, utilising the laydown areas created during the initial construction effort.

The additional two buildings for the second VSC and BESS capacity will likely be constructed into the future consistent with the above methods to meet the future demand requirements of the system.

2.6.5 Reinstatement

Additional areas of land disturbed during construction but not required during operations, will be reinstated to stabilise the soils and native vegetation will be encouraged to regenerate.

2.6.6 Operations

During operations, there will be a small crew who operate and maintain the facility. Minor maintenance will be conducted withing the facility.

Water demand at the Darwin facilities will be limited to water required for potable needs and office ablutions. Water will be supplied from onsite groundwater bore subject to permit and licencing under the *Water Act*, or piped in from offsite sources under agreement with PowerWater or the relevant landowner

2.7 Cable Transition Facilities

The Cable Transition Facilities comprise three separate components to transfer power from onshore to offshore: Underground Cable Corridor, Land Sea Joint Station and Shore Crossing Site. Power leaving the Darwin Converter Site enroute to Singapore, will be transferred by underground HVDC cables laid over 2.7 km in an Underground Cable Corridor, to the Land Sea Joint Station where the onshore and offshore cables will be connected. The Shore Crossing Site is where the subsea cables will be winched from a barge located offshore across the intertidal zone and beach to the Land Sea Joint Station.

2.7.1 Location and footprint

The Cable Transition Facilities are located at Murrumujuk and extend from the Darwin Converter Site to the Shore Crossing Site at the southern end of Gunn Point Beach. The combined footprint of the facilities is approximately 19 ha. The location and site layout concept are shown in Figure 2-3.

Underground Cable Corridor

The Underground Cable Corridor is approximately 2.7 km and up to 70 m wide and is proposed to run parallel to the south of Murrumujuk Drive and north of the Gunn Point Beach access track, which will be rerouted during construction to maintain public access to the area however efforts will be made to minimise the need for this, and it will only be rerouted if no other solutions are available. The proposed corridor will be subject to geotechnical testing and assessment of Acid Sulfate Soils (ASS) risk to confirm suitability of the soils and determine whether any specific treatments are required to protect the buried cables. The corridor will be partially cleared for construction purposes and reinstated once construction is complete.

Land Sea Joint Station

The Land Sea Joint Station will be a fenced 1.5 ha site located approximately 300 m inland from the beach, near the junction of the access tracks to Gunn Point Beach and Tree Point Road. A photo taken at the site is shown in Figure 2-32.

The station will house six bays (one for each cable) excavated to dimensions of approximately 20 x 5 m, to house the physical connection between the onshore and offshore cables. The site includes provision for a temporary construction area to accommodate excavators, generators, pumps, winches, surge arrestors, joint workshop, pipe storage, and ancillary infrastructure – including construction site offices, lighting, fuel storage and amenities. On completion of construction the land surrounding the bays will be reinstated with native vegetation where possible and have signage identifying the electrical hazards within the compound. There will be no restrictions on public use or access outside of the 1.5 ha fenced area.

Figure 2-32. Photo taken at Land Sea Joint Station location (looking west towards Shoal Bay)

Shore Crossing Site

The Shore Crossing Site is located immediately to the south of the current Gunn Point Beach access track. A photo taken at the site is shown in Figure 2-33. A temporary construction corridor approximately 500 m wide and 500 m long will be established from the Land Sea Joint Station, out to the low water mark in Shoal Bay to accommodate the cable trenches and construction machinery and equipment.

Figure 2-33. Photo taken at Shore Crossing Site looking west towards Shoal Bay (top) and east toward the Land Sea Joint Station (bottom)

2.7.2 Site selection and design

The Cable Transition Facilities location was selected following consultation and planning with the NT Government and key stakeholders in the Darwin region. The original proposal identified four possible locations on the Middle Arm peninsula which were assessed for their viability.

However, due to reasons stated in a Notice of Variation lodged in August 2021 (Available here), the revised location was required to avoid potential conflicts within Darwin Harbour. Murrumujuk was identified as a suitable cable landing location for several reasons including:

- Few offshore seabed constraints identified for Subsea Cable Corridor options
- Navigable bathymetry and suitable onshore topography for cable trenching at the Shore Crossing Site
- A relatively short distance between the Darwin Converter Site and the Shore Crossing Site
- Availability of land identified for future development at Murrumujuk and proximity to the utilities corridor identified in the NTG's Litchfield Sub-Regional Land Use Plan (LSLUP)
- Absence of mangrove habitat in development footprint, thus reducing the potential for environmental impacts

The design of the facilities has considered a range of other inputs including proximity to the Tree Point Aboriginal Community, maintaining recreational access to Gunn Point Beach for fishing, camping and 4WDing, avoiding registered and recorded sacred sites including middens and burial sites, minimising impacts to cultural heritage, sensitive ecological communities and minimising other impacts to the environment.

2.7.3 Construction

The Cable Transition Facilities will be constructed in stages, initially to accommodate three cables, with subsequent cables installed in separate campaigns to meet future growth in energy demand. Key construction stages, equipment and activities are summarised below. Section 2.10 provides details of the overarching AAPowerLink construction programme.

2.7.3.1 Equipment and machinery

Early assumptions adopted for project planning and the EIA indicate the following equipment and machinery types will be used in the installation of the terrestrial cables:

- Light commercial vehicles
- Aggregates wagons
- Flat back wagons
- Crane
- Low Loader
- Escort Vehicle
- Crane support vehicle
- Excavators.

2.7.3.2 Construction materials

Construction materials requirements and sources will be determined following survey and geotechnical assessment of the Underground Cable Corridor. The surveys will assess whether the subsoil material excavated from the trench will be suitable for use in cable burial. Early assumptions adopted for the EIA are that the majority (if not all) of the subsoils will be suitable and therefore importation of fill materials will be limited to minor quantities that can be sourced from existing commercial quarries. Bedding sand required to line the trench to a depth of 15 cm will be sourced from commercial suppliers.

2.7.3.3 Site survey

A terrestrial survey will be carried out during the Underground Cable Corridor route selection. The aim of the survey is:

- Identification of detailed ground levels through LIDAR (topography)
- Identification of any additional terrestrial activities and hazards that are presently unknown
- Identification and confirmation of existing utilities that cross the route or are proximate to cable corridor
- Ensure appropriate separation distances to planned infrastructure on adjacent land and the broader locality
- Landowner delimitations, restrictions, permits and regulations
- Nature of the geo-technical conditions in each section
- Road crossing characteristics.

A system of control stations will be set out along the proposed cable route using a GPS system. The initial setting out will be conducted during route selection, with the centreline pegged out at boundaries and intersection points.

Prior to commencing construction, a routing line walk will be undertaken to review the route centreline, in order that the cable installation can be constructed in a safe, environmentally acceptable, economical, and timely fashion. The surveyor will walk the centreline and carefully examine the route together with any salient features which may cause problems during construction. Route development / re-routes may be proposed in response to factors such as:

- Landowner / tenant disturbance
- Health and safety issues
- Environmental disturbance
- Construction-associated problems

The Underground Cable Corridor and works areas associated with the Land Sea Joint Station and Shore Crossing will be flagged and/or fenced to demarcate and secure the works areas.

2.7.3.4 Land clearing

The Underground Cable Corridor will initially be cleared to 35 m wide and stripped of topsoil. The cleared vegetation and topsoil will be stockpiled along the edge of the corridor to be mulched and used in reinstating the area post-construction. A construction access track will be established along the corridor. This access track will be maintained and used to facilitate the duplication of the cable system when additional clearing of the residual 35 m width will be required. A conceptual arrangement of the 35 m wide Underground Cable Corridor construction is illustrated in Figure 2-34.

The 1.5ha Land Sea Joint Station footprint will be cleared and stripped of topsoil. The cleared vegetation and topsoil will be stockpiled along the site boundaries to be used to reinstate the construction works area post-construction.

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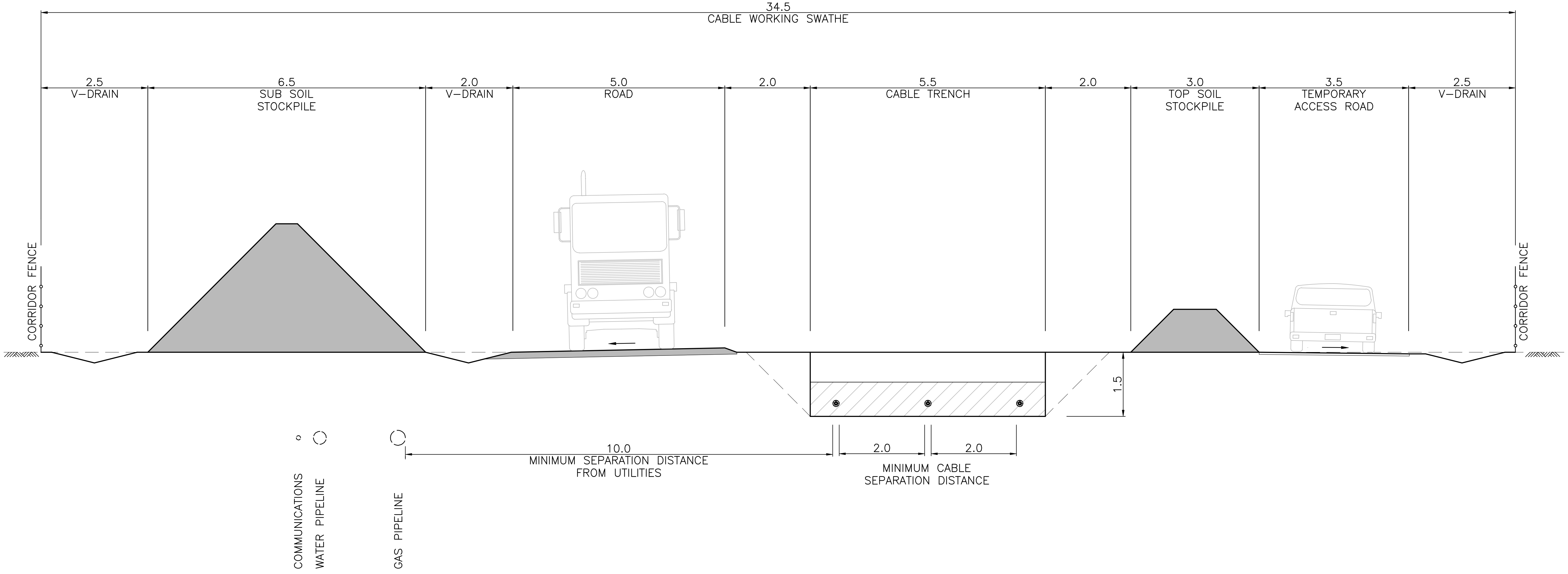


NOTES

1. CONCEPT DRAWING ONLY, LAYOUT OF INFRASTRUCTURE AND SPACING SUBJECT TO CHANGE DURING DETAILED DESIGN.
2. DRAWINGS OF INFRASTRUCTURE ARE INDICATIVE ONLY.
3. MINIMUM 10m SEPARATION DISTANCE BETWEEN HVDC CABLE AND ADJACENT UTILITIES TO MAINTAIN THERMAL INDEPENDENCE.
4. BURIED UTILITIES WITHIN CABLE CORRIDOR MUST BE INSTALLED TO WITHSTAND LOW LOADER AND CABLE DRUM CONSTRUCTION LOADS.

PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

SCALES	CLIENT	PROJECT NUMBER	PROJECT NAME
0 20 40 60 80 Full Size 1:1500 ; Half Reduction 1:3000 SCALE (m)	SUN CABLE	PROJECT NUMBER: 175-2 DRAWN V. ALONSO 12.04.21 DESIGNED K. HOLDER 12.04.21 VERIFIED APPROVED	SUNCABLE CONCEPT LAYOUT
H DATUM / V DATUM			TITLE: Figure 2-34. Indicative cross section of working swathe (units in m)
			SHEET SIZE: A1 · DRAWING NUMBER: 175-2-CI-SK-0050 · REVISION: B

2.7.3.5 Cable loading and transportation

The terrestrial cables will be wound onto drums at the designated cable factory overseas and will be shipped to Darwin Port. Each drum has a capacity of approximately 1,000 m of cable, hence approximately nine cable drums for the initial 3 underground cables will be shipped from overseas and transported by low loader trailers Figure 2-35 to a cable storage area located at the Darwin Converter Site. A typical storage area for nine drums would be approximately 70 x 130 m. From the storage area the drums will be transported to the pulling positions along the Underground Cable Corridor.

Figure 2-35. Examples of low loader trailers used to transport cable drums (Source: Prysmian)

2.7.3.6 Trenching and excavation

The onshore and offshore cables will be buried. Trenching and excavation activities that will occur in preparation for cable laying are described below.

Underground Cable Corridor

Temporary trenches will be excavated in segments along the Underground Cable Corridor with sub-soil stockpiles established adjacent to the trench for use as backfilling once the cables are laid. If required due to ground conditions, and in case it is not possible to execute a trench with side slopes, the trench will be built with sheeting, especially if there is the need to excavate at extra depth to cross existing services. Examples of sub soil excavation and a sheeted trench are shown below in Figure 2-36 and Figure 2-37.

Excavation will be carried out by hydraulic excavators and where necessary water pumps will be used to keep the trench clear of water. Indicative trench design parameters for the Underground Cable Corridor are provided in Table 2-4 with detailed design pending further studies and site survey.

Table 2-4. Preliminary trench design parameters

Parameter	Preliminary details
Depth of cable	1.5 m
Depth of bedding sand	15 cm
Fill type above bedding sand / cable marker type	Natural soil backfill
Lateral spacing between multiple cables	2 m
Total trench width	Approximately 9.5 m

Figure 2-36 – Photo of sub soil excavation in a trench with side slopes (Source: Prysmian)

Figure 2-37. Photo of a sheeted trench (Source: Prysmian)

Shore Crossing Site

Open trenches will be excavated from the Land Sea Joint Station bays across the beach and intertidal zone using conventional excavators. There will be one trench for each cable (i.e., total of three trenches for the initial system). It is estimated each trench will be approximately 500 m long, up to 2 m deep and 2 m wide. Within the beach and intertidal area, a tracked excavator (either on the shore or mounted on a shallow barge) will dig a V-shaped trench. Alternatively, temporary trench support may be installed, particularly on the sandy beach, usually in the form of steel sheet piling as illustrated in the photos above. The trenches will be excavated progressively to account for tidal differences, approximately one to two weeks. Cables will take two to three days to pull in. Once cables are winched into place, the trenches will be back filled with the excavated material.

Land Sea Joint Station

At the Land Sea Joint Station, three bays (jointing pits) (one for each cable) will be excavated to dimensions of approximately 20 x 2 m and 2 m deep. The jointing pits may be bunded with formed concrete or steel covers, subject to the local geotechnical conditions. The excavated material will be subject to geotechnical testing and assessed for the presence of PASS or ASS, to determine suitability for reuse as fill, or will be disposed of at an approved location.

2.7.3.7 Cable installation

Onshore the cables will be laid using specifically designed cable laying trailers and cable spools. Offshore, a Cable Lay Barge (CLB) will be used.

Onshore

The onshore cables will be laid using a system of winches and rollers to pull the cable off the cable drums and ensure correct placement in the trench without damage. An example of a motorised stand and roller placement used to install onshore cables is shown below in Figure 2-38. The cables will be laid on a bed of clean sand, joined together and covered by the subsoil materials excavated from the trench.

Each 1 km section of the trench, which is the length of cable each drum can carry, will be prepared by placing rollers along the trench and positioning the winch at one end and the cable drum at the other. The pulling wire from the winch is pulled out and connected to the cable, and the cable is winched through the trench on the rollers. Pulling operations will be controlled and coordinated through continuous communication between pulling crew members using radio communication equipment. When the cable length has been completely pulled in, the cable is lifted off using slings and positioned into the trench to allow the repositioning of the rollers for the next cable.

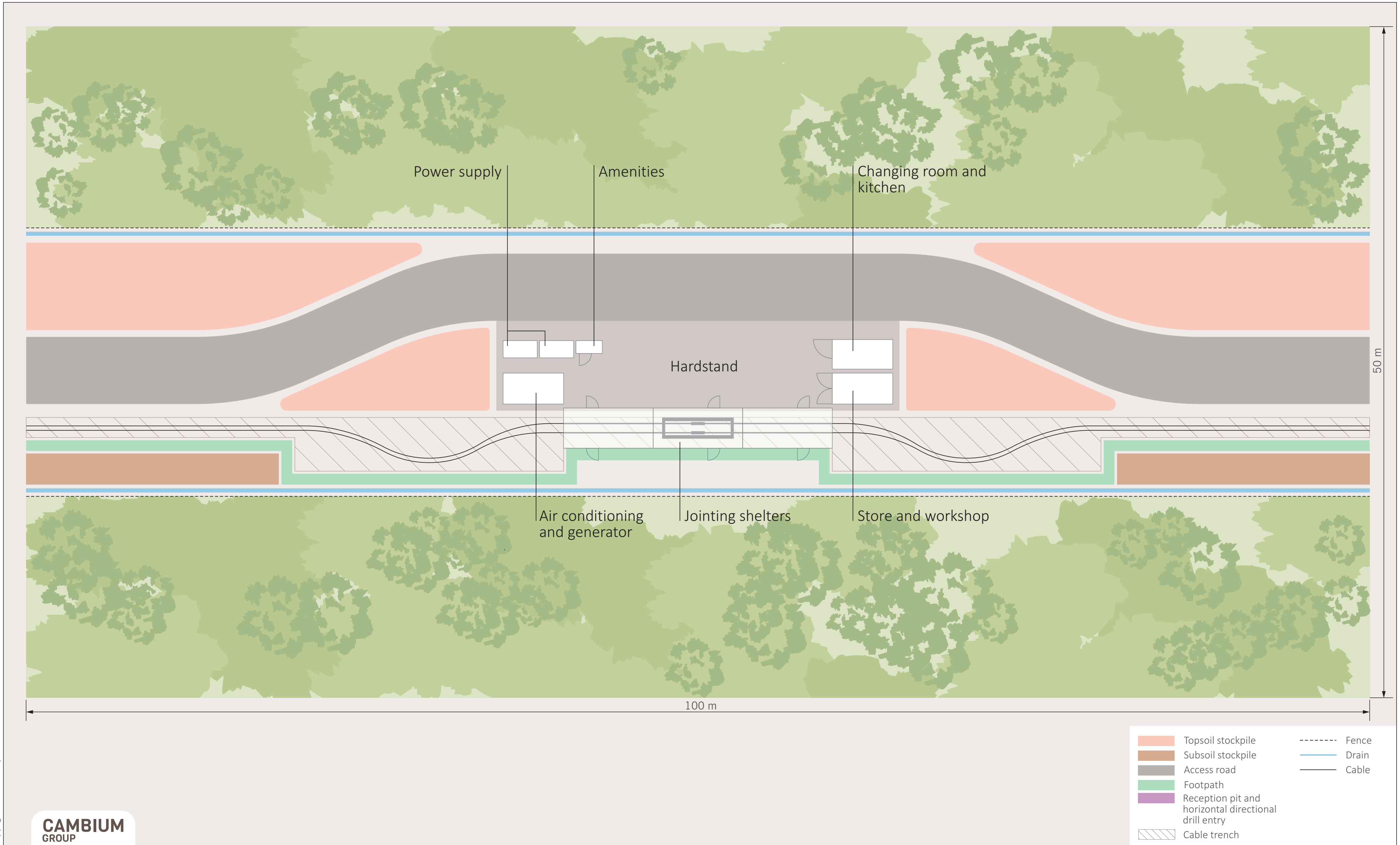
Jointing areas will be established at the locations where each of the 1 km cable lengths meet. An indicative layout of a jointing area is shown below in Figure 2-39. During jointing operations, the jointing position will be covered by a series of specialist containers in which the jointing activities will take place to connect the cables. A photo example of a jointing site is shown in Figure 2-40.

Once the cable is laid and joined, all the construction equipment is removed from the Underground Cable Corridor. The backfill will then take place using first the stockpile of subsoil, selected and sieved by removing stones and objects not applicable for backfill. All backfill will be placed in layers with each layer being compacted. The compaction will ensure level ground and to prevent any subsidence of the soil at ground level. Finally, the topsoil will be restored using the topsoil stockpiled and grasses/shrubs will be left to naturally regrow over the corridor.

Figure 2-38. Photo example of motorised stand and roller placement used to install onshore cables (Source: Prysmian)

F233 Indicative land sea jointing layout

Australia-Asia Power Link
Environmental impact statement



Source: Sun Cable

Sun Cable drawing ref: AAPL-GEN-CTA-GN-MAP-0001-A.pdf

Cambium ref: 031186_Sun_Cable_AAPL_EIS_F233_Indicative_land_sea_jointing_layout_220302_v01

Figure 2-39. Indicative jointing area layout

Figure 2-40. Photo of typical jointing containers (Source: Prysmian)

Offshore cable laying

The offshore cable will be installed from a CLB situated in shallow water offshore from the Land Sea Joint Station. The cable will be laid by a combination of floating and pulling the cable ashore using a winch anchored behind the Land Sea Joint Station. The CLB will approach the Shore Crossing Site trench as close as possible, and the cables will be floated to the start of the trench, and then winched through the open trench over the beach and secured at the Land Sea Joint Station. The floats are then deflated, and the cables will settle into the trench. A photo example of an open trench cable installation is shown in Figure 2-41.

Figure 2-41. Photo example of open cut trench at landfall (Source: Sun Cable)

2.7.4 Reinstatement

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 be either 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 erosion and sediment controls 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 area, reinstatement of the natural substrates is expected to allow for rapid recolonisation of benthic habitats and fauna; shoreline erosion protection measures will be implemented as needed.

2.8 Subsea Cable System

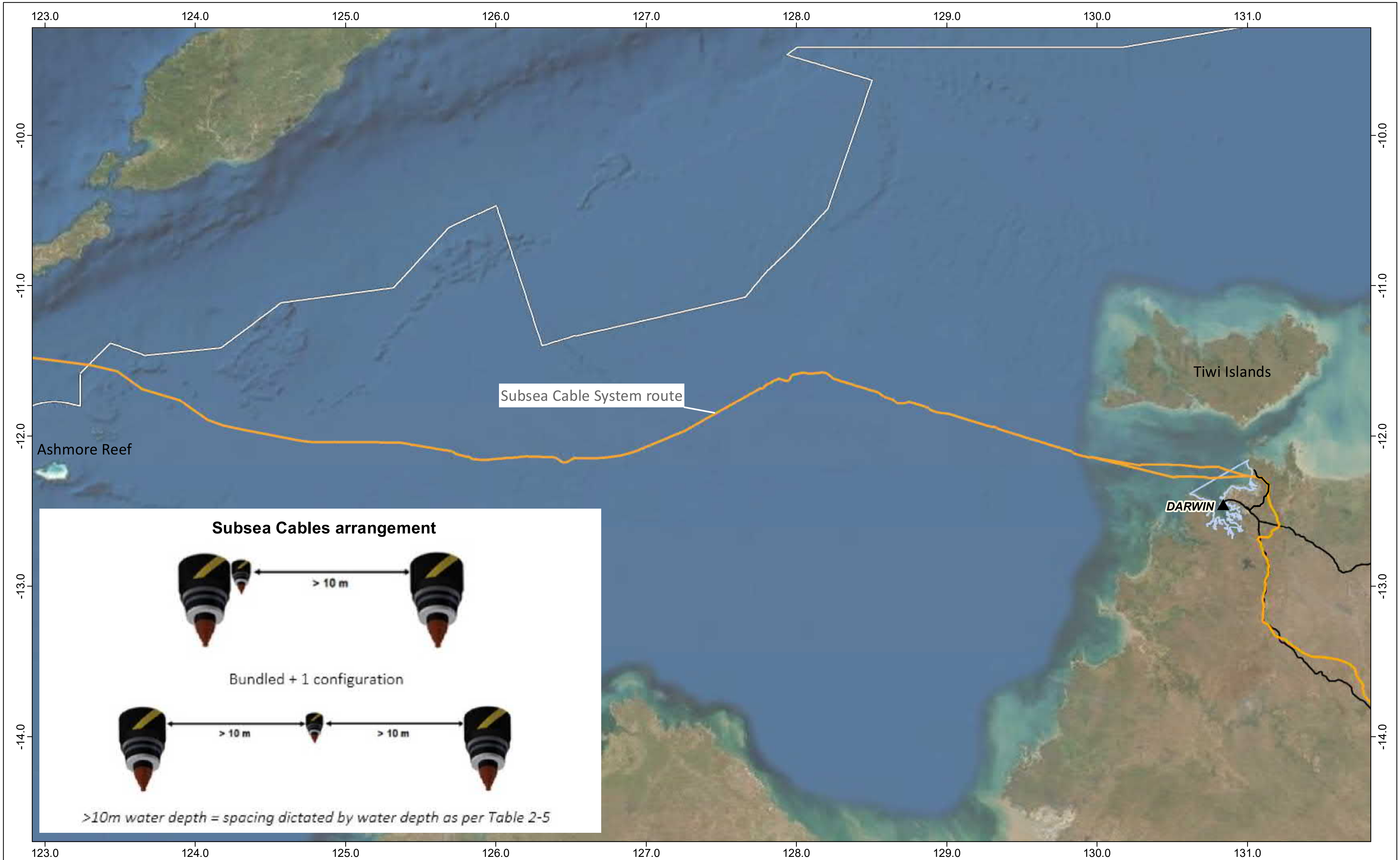
A High Voltage Direct Current (HVDC) Subsea Cable System will be installed to transfer electricity over approximately 4,200 km from Darwin to Singapore. The length of the Subsea Cable System within the AEEZ and to the limit of the Commonwealth marine area is approximately 895 km. The proposal includes an initial three cable system, and a further three cables to be installed a later date, to meet future energy demands. The proposed transmission system rating is 5.4 GW.

2.8.1 Location and footprint

The Subsea Cable System will be laid from the Land Sea Joint Station extending through outer Shoal Bay, through the outer Darwin Harbour into the Beagle Gulf within NT coastal waters and continue through the Timor Sea to the Continental Shelf (including the Perth Treaty Area) before entering the Indonesian Archipelagic Waters, enroute to Singapore. There are two route options (Route A and Route B) under consideration 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 routes will be subject to further engineering studies and marine survey.

Both routes traverse the shallow waters of Shoal Bay and the outer areas of Darwin Harbour, remaining outside the Darwin Port boundary. Route B is the closest to land and lies approximately 7 km offshore of Lee Point and 15 km offshore of Charles Point. Both routes cross the existing Bayu Undan gas pipeline. A small portion of the cable route enters the periphery of the NAXA at several locations (See Figure 2-43). Sun Cable will continue to engage with the Department of Defence to ensure NAXA activities and cable infrastructure can co-exist. The route enters the Oceanic Shoals Marine Park at approximately 270 km from the shore and traverses through the marine park for approximately 300 km, before continuing west towards Indonesian waters. The proposed Subsea Cable System route is shown on Figure 2-4.

The Subsea Cable System will comprise up to six cables to accommodate peak supply requirements and future growth in demand. Cables could be installed individually or in a bundled configuration. The spacing between the cables, will be between 50 - 200 m depending on specific sea floor features, 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. A conceptual layout is shown in Figure 2-42.



Legend

- AAPowerLink Infrastructure
- Towns
- Darwin Harbour boundary
- Commonwealth Marine Area

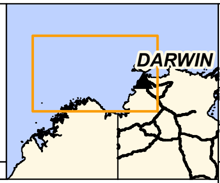


Figure 2-42: Map of Subsea Cable System conceptual layout

Project: Australia-Asia PowerLink | Reference: M-Files ID 200050 | Revision: 0

Coordinate System: GDA2020 | Date: 08/03/2022

0 50 100 150 Kilometers | Scale: 1:3,500,000 | A4

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SUN CABLE

Source: Sun Cable, EcOz, NTG (NR Maps)

2.8.2 Route selection and design

A range of route alternatives, design options and installation methods have been evaluated by Sun Cable in consultation with stakeholders including NT Government agencies, Commonwealth Government departments including Defence and Parks Australia, Darwin Harbourmaster, shipping authorities, Aboriginal Land Councils, gas pipeline operators and other interested parties. The sections below outline the key activities and alternatives considered for the Subsea Cable System.

2.8.2.1 Route selection

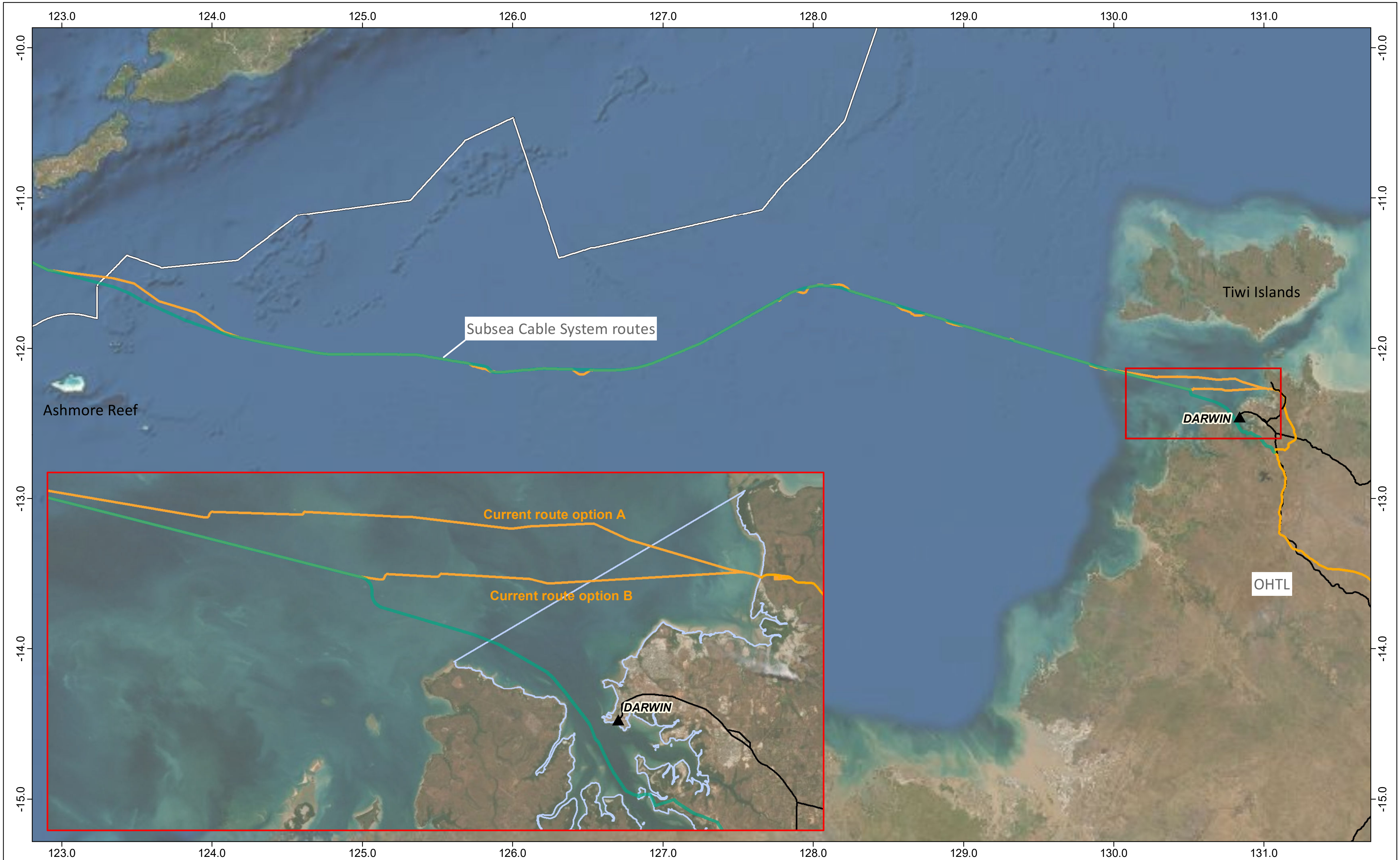
A comprehensive geophysical survey and geotechnical sampling program was undertaken from 25th August 2020 to 20th November 2020 to inform selection of the Subsea Cable System route (Guardian Geomatics, 2021[5]). A total length of approximately 748 km was surveyed. The geophysical survey consisted of multibeam echosounder, side scan sonar and sub-bottom profiler along a 500 m wide swath, while the geotechnical survey involved cone penetrometer testing and vibro coring every 10 km along the route centreline. The available survey data covers most of the route, excluding the first 45 km, which has changed due to the relocation of the Darwin Converter Site and Shore Crossing Site to Gunn Point Beach from Middle Arm in Darwin Harbour. A portion of the Commonwealth marine area is also beyond the initial survey scope.

The geophysical survey and geotechnical sampling surveys also collected information and data to inform the selection of installation methods suitable for route sections, including:

- Bathymetry and water depth
- Seabed features, such as seabed depressions, seafloor scarps/escarpments, pockmarks (isolated and clustered – low and high density), area of boulders, channels, mega ripples and sand wave crests, debris, wrecks, and unknown hard sonar contacts
- Geology and sediment characteristics
- Locations of existing cables and pipelines.

The current Subsea Cable System route, including two inshore route options, was selected based on review of available geophysical data. Further surveys of the near-shore Route options A and B are planned for early 2022 to confirm this approach, which has been amended from the original route as per the submitted variation. The preferred Subsea Cable System route option will be finalised following the surveys. The original surveyed route (through Darwin Harbour) and the new route/s under investigation are shown on Figure 2-43.

[5] Guardian Geomatics (2021) Preliminary survey report – Work Package 1.2 (Australia – Shallow/Offshore Survey)



Legend

- Current AAPowerLink infrastructure route
- Darwin Harbour boundary
- Commonwealth marine environment
- Original AAPowerLink infrastructure route

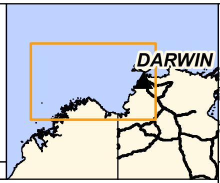


Figure 2-43: Map of Subsea Cable System routes

Project: Australia-Asia PowerLink	Reference: M-Files ID 200050	Revision: 0
Coordinate System: GDA2020	Date: 08/03/2022	
0 50 100 150 Kilometres	Scale: 1:3,500,000	A4

N

SUN CABLE

Source: Sun Cable, EcOz, NTG (NR Maps)

2.8.3 Key components

The key components of the Subsea Cable System are described below.

2.8.3.1 Cables

The preferred configuration for each of the two cable systems is a Bipole with Metallic Return, which involves three cables laid parallel:

- Positive pole (Pole 1)
- Negative pole (Pole 2)
- Metallic return.

Pole 1 and Pole 2 cables are each approximately 161 – 176 mm in diameter and weigh approximately 66 – 85 kg/m, while the Metallic return is approximately 120 mm in diameter and weighs approximately 36 kg/m.

The cables will be of Cross-Linked Polyethylene (XLPE) insulation and use either copper or aluminium conductors, or possibly a combination of both. The cables will have a lead sheath to ensure no moisture can penetrate the insulation, and heavy steel wire armour will protect the cables from external damage during installation and burial/protection. An example of a cross-section of the cable is provided in Figure 2-44.

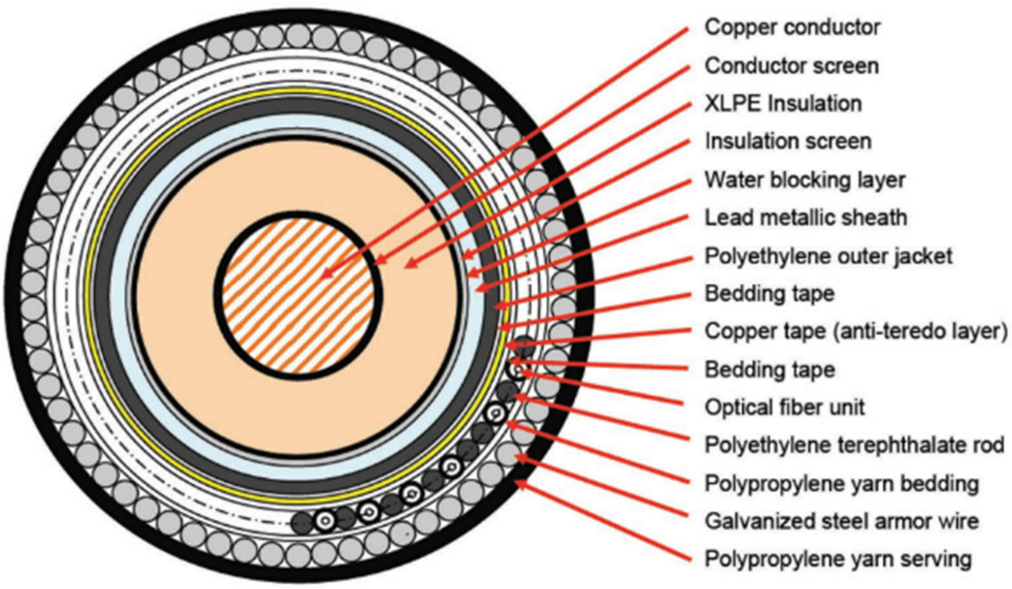


Figure 2-44. Example Cable Diagram

2.8.3.2 Configuration

The cables are planned to be laid individually. The installation footprint of each individual cable is approximately 12 m wide and is determined by the width of the machinery used to bury the cable. The cables and bundles will be spaced from 50 – 200 m apart. Cable spacing is dependent on several factors, the main being:

- Thermal spacing between adjacent cables to avoid overheating (generally minimum 10 m apart).
- Footprint of seabed installation / equipment – Where burial is required, the largest footprint of burial machinery is approximately 12 m wide. A working corridor width of approximately 50 m between each cable is required to alleviate any risk to adjacent cables during installation.

- Crossing of third-party assets (e.g., pipelines or telecommunication cables) – non-bundled cables can converge locally to a single crossing point to minimise the impact to the crossed asset.
- Access for maintenance and repair – Should there be a fault in the cable, there will be a need to locate the fault, cut and retrieve the faulty cable for forensic examination, conduct repairs and lay out the repaired cable and joint safely. The area required for the repair, and therefore the spacing of the cables, is dependent on water depth as shown in Table 2-5. Cables in deep water need to be more widely spaced to provide enough space to repair a cable without impacting the adjacent cables.

As landfall is approached, the cables will converge and the spacing is then driven by the thermal spacing or footprint of the seabed installation equipment (i.e., 10 m thermal spacing or 50 m spacing if burial is required).

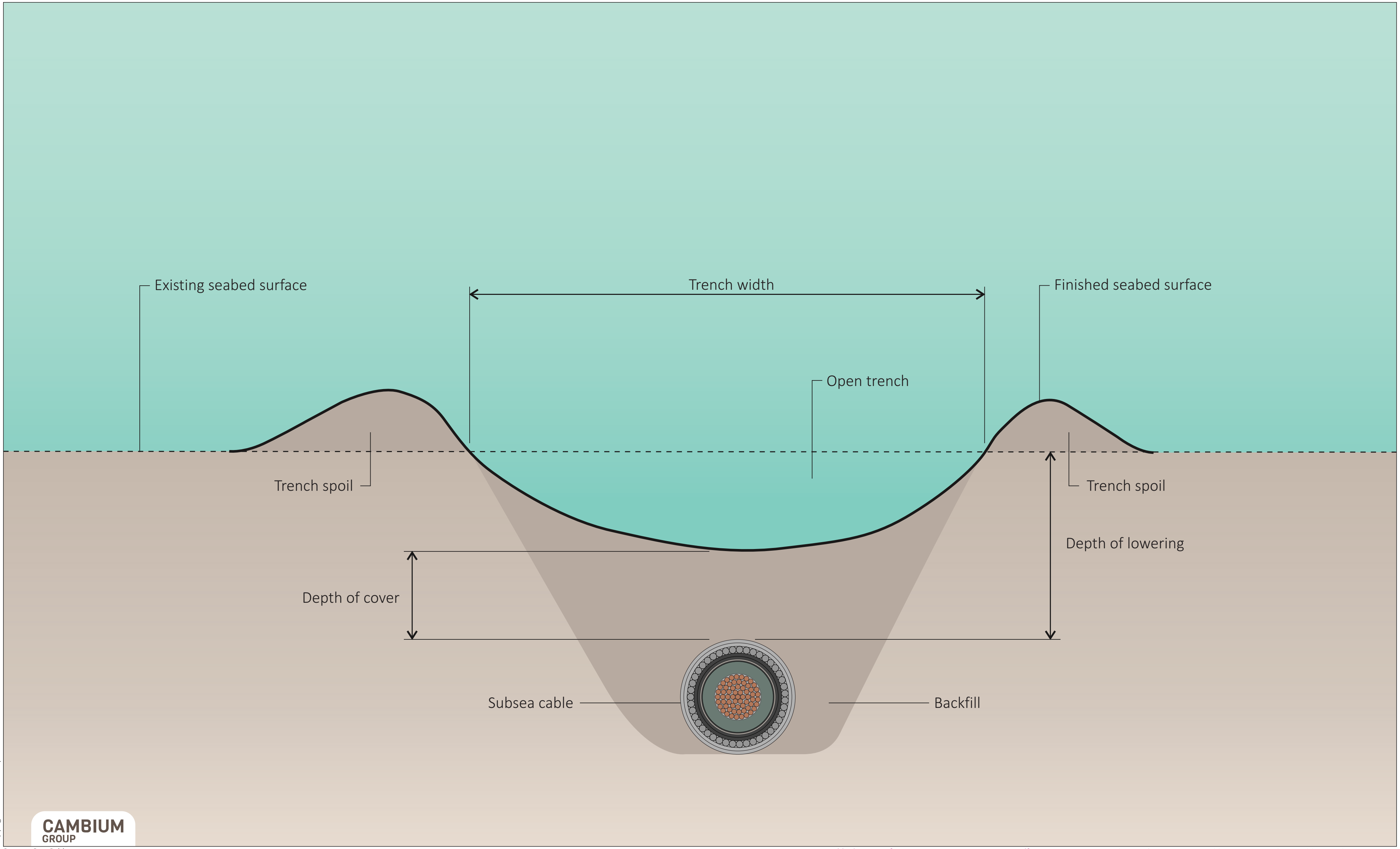
Table 2-5. Cable spacing required to accommodate cable joints at different water depths

Water depth (m)	Cable spacing for omega joint (m)
0-20	50
20-50	100
50-100	150
100 -150	200

2.8.3.3 Protection

Once laid on the seabed, the cables need to either be buried or otherwise protected from the threat of external damage such as anchors or fishing activity. Where possible, the cables will be buried in the seabed as this provides the best protection for the cable and minimises potential for interference with fishing activity. 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. A typical trench profile showing a buried cable is shown in Figure 2-45

Where the seabed composition is not suitable for burial, or where the cable crosses other infrastructure such as the Bayu Undan pipeline and other cables, external mechanical protection will be provided through either rock placement, application of concrete mattresses and/or installation of cast iron shells (Table 2-6).

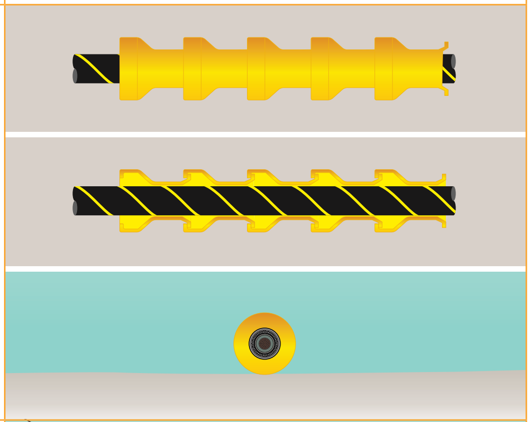
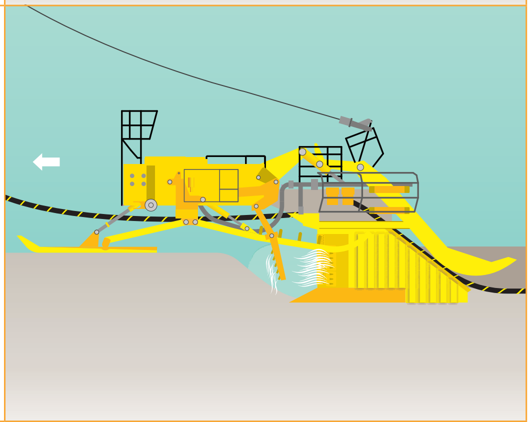
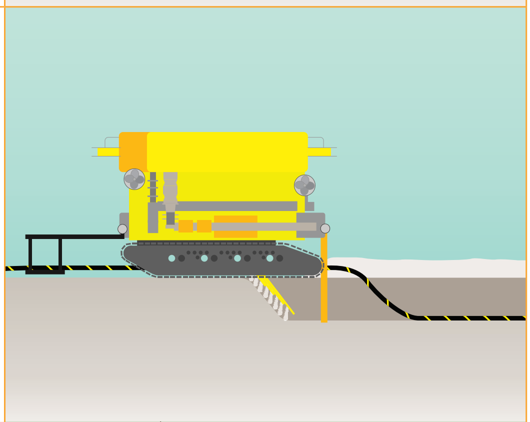
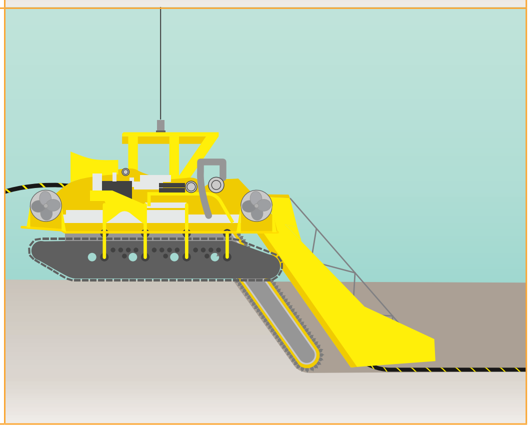


Source: Sun Cable

Sun Cable drawing ref: AAPL-GEN-CTA-GN-MAP-0001-A.pdf

Cambium ref: 031186_Sun_Cable_AAPL_EIS_Subsea_cable_trench_220225_v02

Figure 2-45. Typical cable trench profile and definitions of terminology

Method	Description	Applicable Seabed Type	Typical Equipment
Polyurethane shells	Applied to the cable as it is over boarded from the cable laying vessel to provide mechanical protection over uneven seabed and increase stability of cables in high energy areas. May also be used for crossing protection together with concrete mattresses and / or rock placement	Rock and hard sediments	
Plough	Burial by plough towed either by the cable lay vessel (simultaneous lay and burial) or by a separate vessel (post lay burial)	Sand, mud, silt, soft clay, gravel	
Jet trenching	Powerful water jetting tool used to fluidise seabed and allow surface laid cables to sink	Sand, mud, silt, soft clay	
Mechanical trenching	Cutting of a trench by a wheel or chain cutter, either pre-lay (so the cable can be laid into the trench) or post lay	Hard clay, limestone, calcarenite	

2.8.3.4 Crossings

The AAPowerLink cables will cross the Bayu Undan gas pipeline and the Northwest telecommunications cable and an out-of-service cables along the route through Australian waters.

Out-of-service cables

Disused cables will be severed with the permission of the cable owner. The cables are typically de-buried, cut and folded back on the seabed and stabilised by concrete weights or mattresses. The removal of out-of-service cables will be carried out according to the *International Cable Protection Committee (ICPC)* recommendations. Depending on burial depth of the out of service cable and local soil conditions, the cable will be exposed to the seabed surface by using jetting tools and/or a grappling hook dragged perpendicularly across the cable. One out-of-service cable is expected to be crossed in Australian waters.

Live cables and pipelines

For live cable and pipeline crossings, formal agreements will be entered into with the asset owner. The detailed methodology for crossing arrangements will be subject to the conditions of the agreement. The design of the crossing needs to protect both the cables and the third-party asset and address other aspects such as crossing angle and vertical separation.

The crossing physical design will vary according to, among other things, the size, type, location, and burial state of the crossed asset. Generally, the cables will cross over the asset on a 'bridge' comprised of either rock placement or concrete mattresses. This section will subsequently be covered over with a protective layer of either rock berm or concrete mattresses.

The minimum vertical separation between an existing cable / pipeline and the cables, typically 300 mm, will be agreed with the cable owners; and the crossing engineered to achieve the agreed vertical separation distance. The crossing design for each asset crossed will indicate the footprint of the impact to the seabed. The industry standard is a 7 m wide bridge over an existing cable.

During the operation of HVDC subsea cables, heat losses occur as a consequence of the resistance in the cable/conductor. AAPowerLink is likely to install XPLE insulated cables. These cables have maximum design operating conductor temperatures of 70°C. When the cables are in operation there will be localised heating of the environment surrounding the cables (i.e., sediment for buried cable or water in the interstitial spaces of rock armouring). The rate of heat dissipation, and magnitude of environmental heating, will be determined by a number of factors; most notably: the amount of power passing through the cables, the design of the cables and the thermal properties of the surrounding media.

2.8.4 Construction

Installation of the first Subsea Cable System (comprised of three cables) is planned to take place over 4.5 years commencing in 2024. Key construction stages, equipment and activities are summarised below. Section 2.10 provides details of the overarching AAPowerLink construction programme, including how Sun Cable will address environmental management requirements across the whole project area.

2.8.4.1 Pre-installation work

Pre-installation works are required to prepare the cable route and will comprise the following key activities:

- Marine survey
- Pre-sweeping
- Boulder clearance

- UXO (Unexploded Ordnance) clearance
- Route clearance and Pre-Lay Grapnel Run (PLGR).

Marine survey

Detailed marine surveys will be undertaken by Sun Cable to further investigate and select the preferred route option. A further survey will be undertaken by the cable installation contractor prior to commencement of installation. This typically takes place 6 to 12 months ahead of installation. The primary objective of these surveys is to obtain more detailed and current information on the seabed and complete a UXO (Unexploded Ordnance) survey. The survey will involve a range of standard geophysical survey techniques such as multi-beam echo sounder, side scan sonar, sub-bottom profiler and magnetometer; and geotechnical survey techniques such as cone penetrometer test, vibro core and piston core sampling.

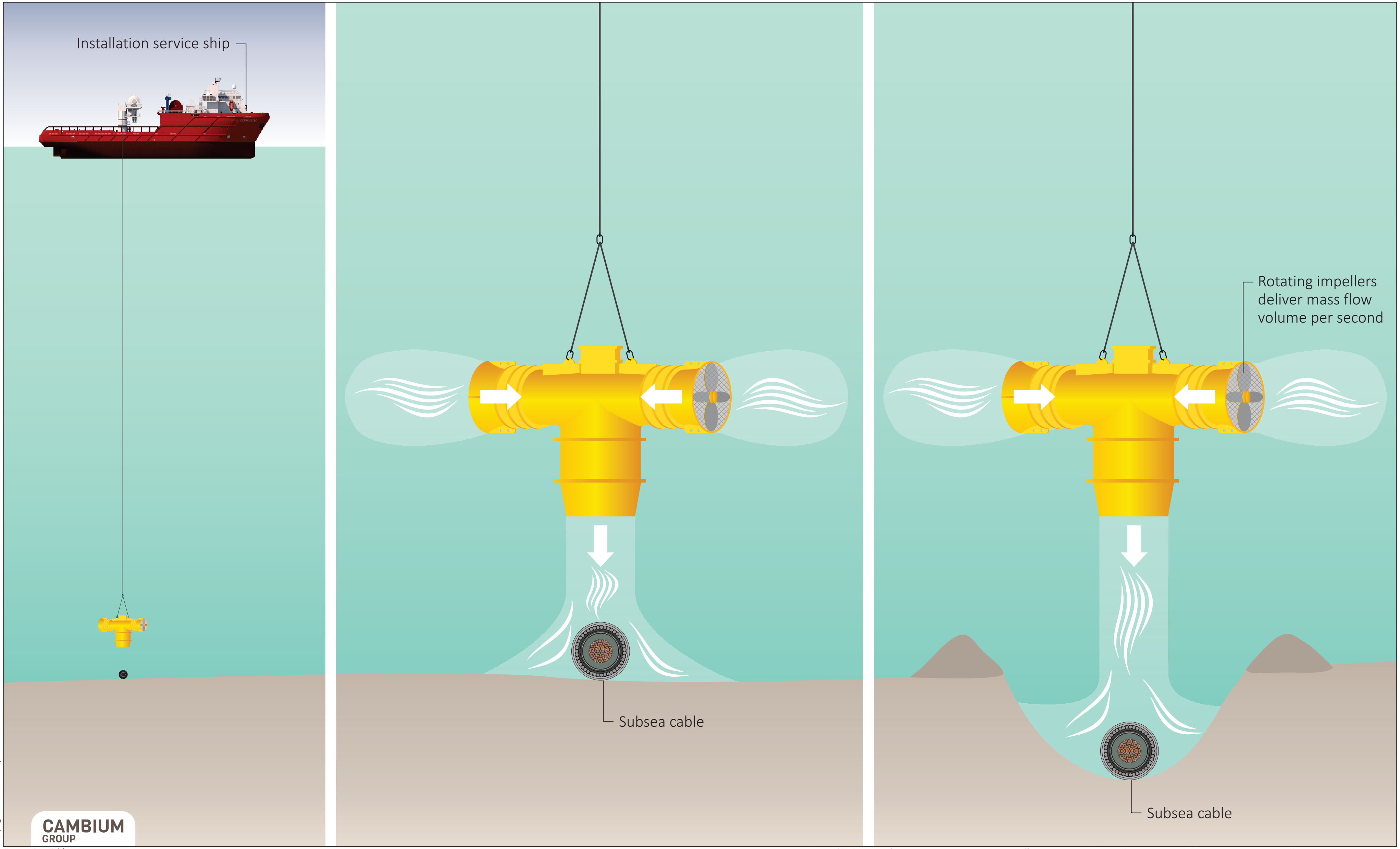
Pre sweeping

Pre-sweeping will be required in areas where there are sand waves that are elevated above 1 m to prepare a flat working profile for the cable burial machine. The selected route of the Subsea Cable System will avoid areas of sand waves where possible; however, it is expected that pre-sweeping works will be required at locations along the route. The requirement for use of pre-sweeping methods will be confirmed during detailed design.

Where pre sweeping is required, a Mass Flow Excavator (MFE) or cutter-suction dredger (Figure 2-46) will be deployed in advance of the main cable lay spread to remove the tops off the sand waves to create the necessary seabed profile based on bathymetry. A MFE produces a downwards flow of water from a nozzle suspended 1 m above the seabed that pushes sediment to either side of the cable trench. Alternatively, a trailing suction hopper dredger can be used to collect the sand using suction pressure, for disposal at an approved location. If required, the aim will be to use current spoil disposal locations where possible in lieu of setting up a new disposal area; this construction methodology will be confirmed during detailed design.

F240 Mass flow excavator

Australia-Asia Power Link
Environmental impact statement



Source: Sun Cable

Sun Cable drawing ref: AAPL-GEN-CTA-GN-MAP-0001-A.pdf

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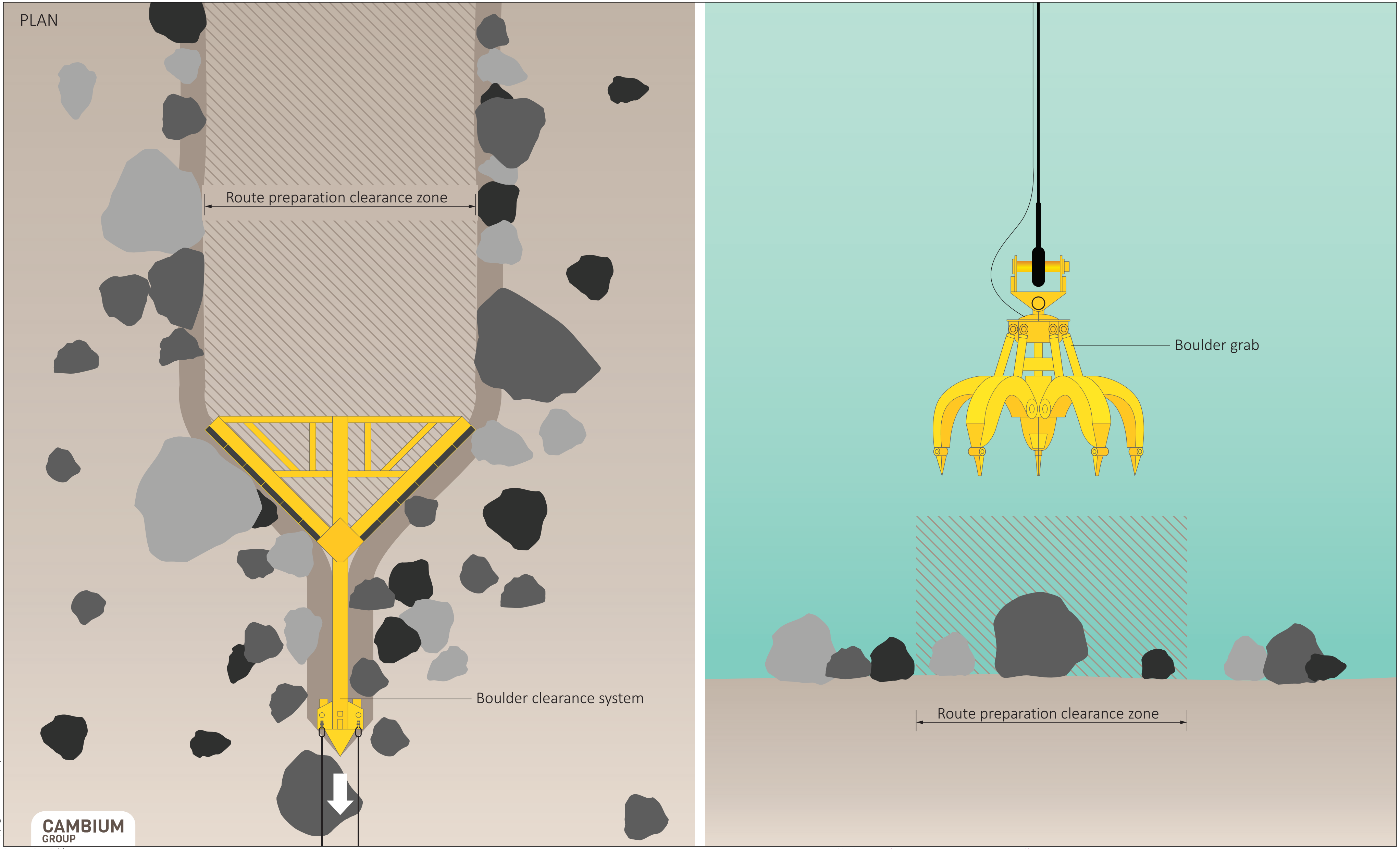
Figure 2-46. Illustrations of a Mass Flow Excavator (MFE)

Boulder clearance

To prepare a clear path for the cable to be laid and buried, in the event that there are boulders across the route, a boulder clearance operation will be undertaken. The locations will be determined during the detailed pre-construction survey. A boulder clearance plough or grab (Figure 2-47) will be used to clear a swathe between 10 m and 20 m wide. The plough method involves towing the plough across the seabed, pushing the boulders to one side. The grab method involves grabbing the boulders and moving them off the route.

F241 Boulder clearance

Australia-Asia Power Link
Environmental impact statement



Source: Sun Cable

Sun Cable drawing ref: AAPL-GEN-CTA-GN-MAP-0001-A.pdf

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Figure 2-47. Photo of a typical boulder clearance plough (left) and boulder grab (right)

UXO (Unexploded Ordnance) clearance

Any UXOs that are identified/located using a magnetometer during the marine survey, will be avoided by a minimum clearance distance where possible, or alternatively will be removed by a specialist sub-contractor. The minimum clearance distance is determined by a risk assessment that considers the UXO type and the nature of the construction activity.

Pre-Lay Grapnel Run (PLGR)

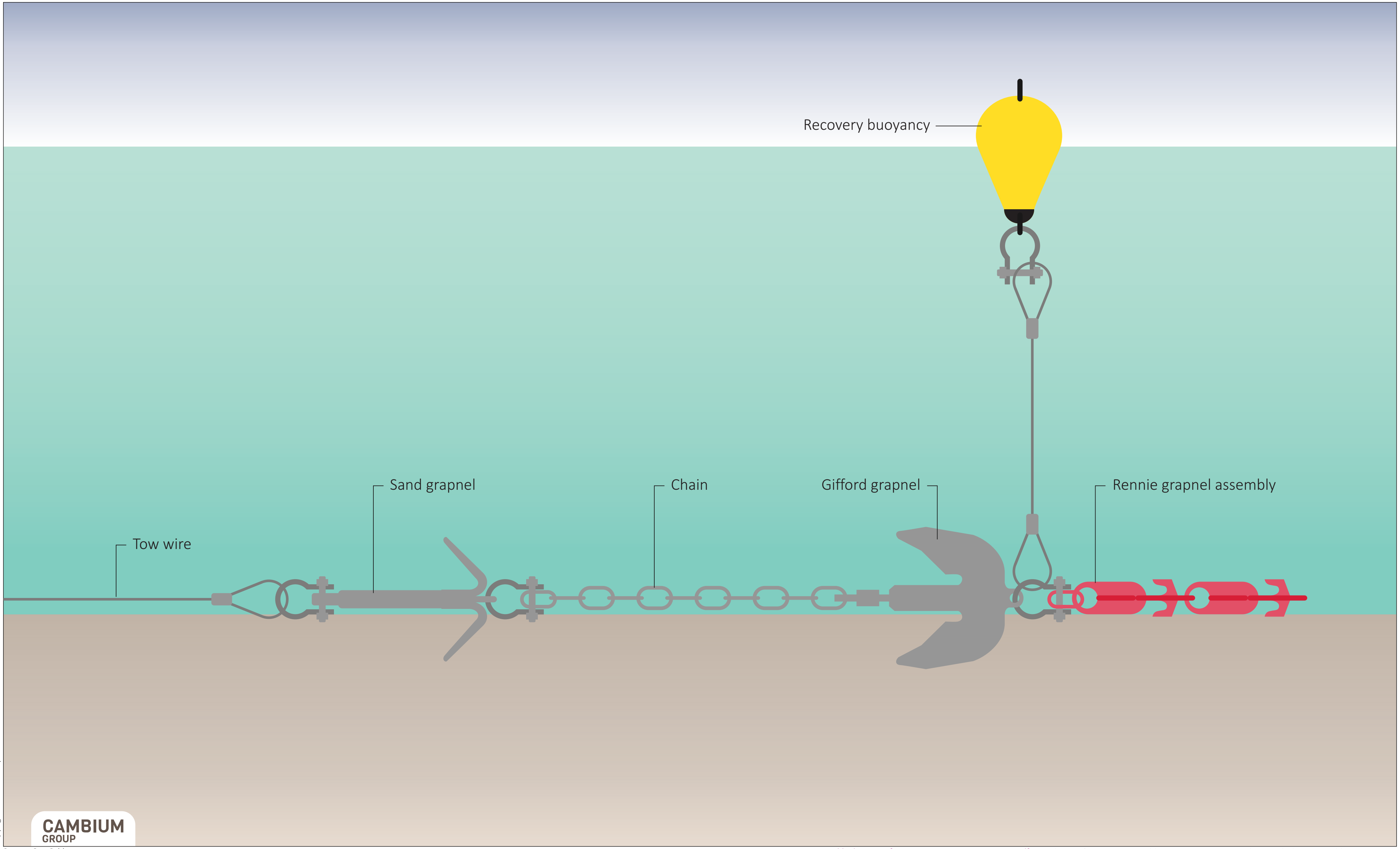
The purpose of the PLGR is to clear any debris from the cable route, such as lost fishing gear, that could impact on the cable laying and burial operations. Most old cable and scrap wire is normally found at, or just below, the seabed. To remove this debris, a heavy grapnel with a series of specially designed hooks, or grapnels – approximately 1 m in width and with 0.5 – 1 m penetration depth (Figure 2-48) will be towed along the cable route by either a work boat or the cable lay vessel.

The grapnel will not be deployed within 100 m of any live cables and will only be used following close consultation with infrastructure owners and relevant authorities, and the PLGR operation may be phased to ensure that the route is clear of any recently dumped debris before each cable laying campaign. Debris retained by the grapnel will be collected on board and disposed of appropriately through licensed onshore facilities.

F242 Typical grapnel chain assembly

Australia-Asia Power Link
Environmental impact statement

SUN CABLE AUSTRALIA-ASIA PowerLink



CAMBIUM GROUP

Source: Sun Cable

Sun Cable drawing ref: AAPL-GEN-CTA-GN-MAP-0001-A.pdf Cambium ref: 031186_Sun_Cable_AAPL_EIS_F242_Typical_grapnel_chain_assembly_220304_v01

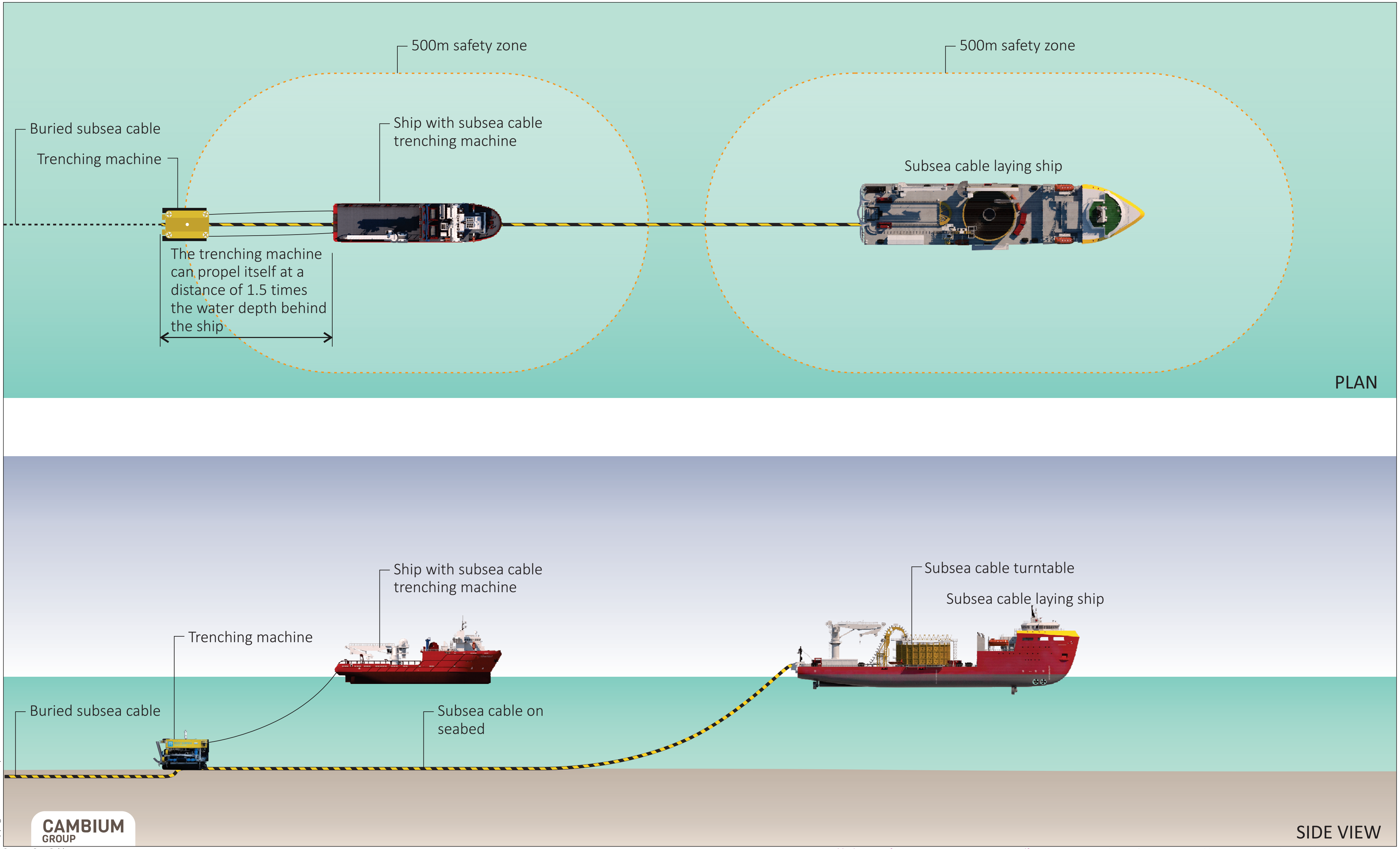
Figure 2-48. Typical grapnel chain assembly

2.8.4.2 Installation works

The proposed cable installation method involves post-lay burial, whereby the cable will be first laid on the seafloor by a cable lay vessel or barge, and then buried in a separate operation involving a cable burial vessel. The layout of a typical cable laying operation is show in Figure 2-49 and the stages and activities are described in the sections below.

Fx Subsea cable laying

Australia-Asia Power Link
Environmental impact statement



Source: Sun Cable

Sun Cable drawing ref: AAPL-GEN-CTA-GN-MAP-0001-A.pdf

Cambium ref: 031186_Sun_Cable_AAPL_EIS_Fx_Subsea_cable_laying_220228_v03

Figure 2-49. Illustration of layout of typical cable laying operation

Cable lay

The cables will first be laid out on the seafloor by a specialist cable lay vessel (CLV) or cable lay barge (CLB). CLVs are typically used in water depths of 10 m or more. For shallower waters, a CLB is used, which has the same cable lay equipment as a CLV (i.e., carousels, tensioners, winches) but is not equipped with engines or thrusters, hence minimising the draft to allow works in shallow waters. Photo examples of a CLV and CLB are shown in Figure 2-50 and Figure 2-51.

The cables will be loaded onto the CLV or CLB ship at the cable factory located overseas (location yet to be determined). Once loaded, the vessel will transit to a port close to the worksite for final mobilisation of cable handling crew, staff, and equipment, prior to heading to the work site. The vessels can carry long lengths of cable, more than 100 km, depending on the vessel used and the final design of the cable. Once the section of cable on board is laid, the ship will return to the cable factory to refill. When the CLV/CLB returns to the site of completion of the previous section of cable, the new cable section is joined to the already laid section as described in the relevant section below.

It is planned to start cable laying at the Shore Crossing Site in Shoal Bay. As described earlier in Section 2.7.3.7, the CLB will approach the Shore Crossing Site trench, and the cables would be floated to the start of the trench, winched in, and secured at the Land Sea Joint Station. The CLB would then commence laying the cable on the seafloor along the offshore route.

Cable laying can progress at speeds of up to around 500 m per hour and will be performed on a 24-hour basis to ensure minimal navigational impact on other users and to maximise efficient use of applicable weather conditions and vessel and equipment time. At this rate, laying of the Subsea Cable System within the AEEZ is anticipated to take about 2 months per cable/cable bundle, excluding any time for loading, unloading and offshore jointing.

Notifications will be issued in accordance with statutory procedures to ensure navigational and operational safety. In addition to the installation vessel(s), additional vessels (i.e., guard vessels) will be involved with the operation. This operation can continue in heavy weather. In the most severe weather, the vessel may have to cut and cap the cable and leave the worksite. In this case, the vessel will return when the weather has subsided, recover the end of the cable, make a joint and continue the laying operations.

The CLVs will be equipped with a remotely operated vehicle (ROV) and supporting camera equipment. In selected areas, such as at cable crossings and close to any sand waves/boulder areas, the ROV will be used to check the cable touch-down position to ensure correct positioning.

Figure 2-50. Examples of cable lay vessels (Source: Left: NKT, Right: Nexans)

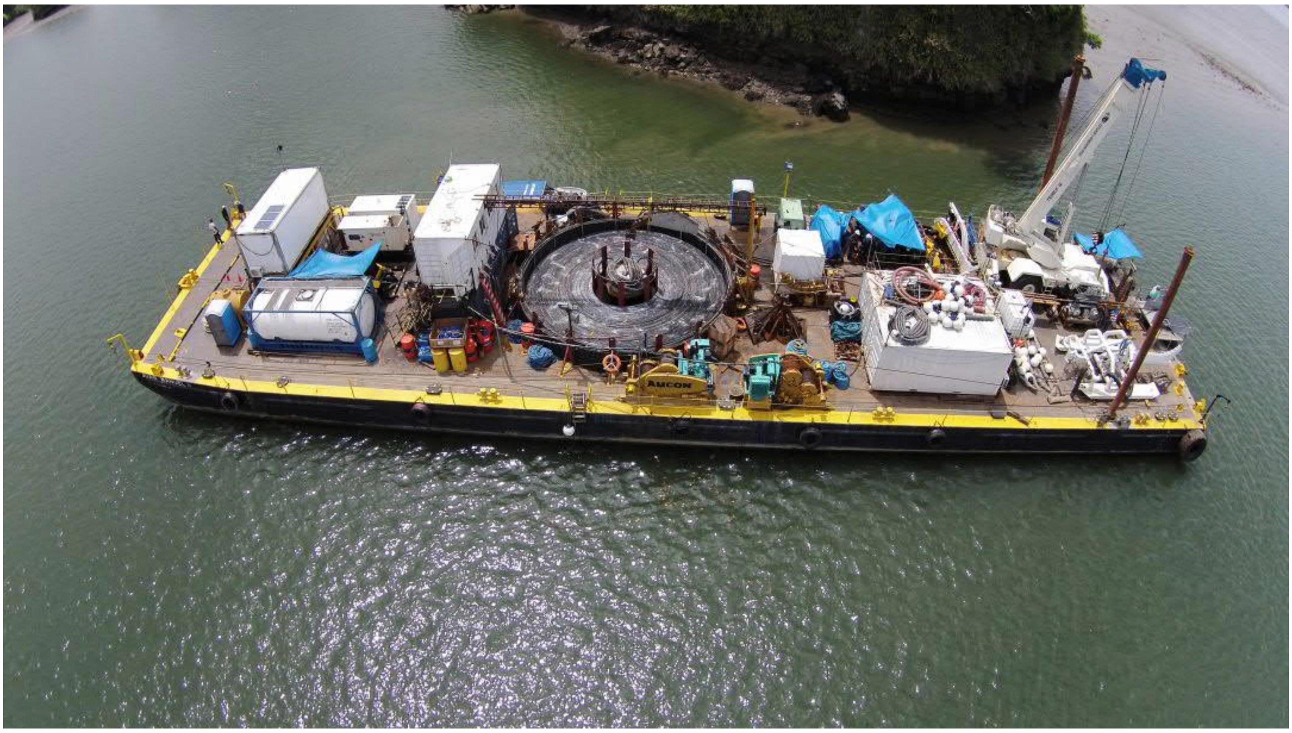


Figure 2-51. Example of cable lay barge (Source: Geomares)

Cable jointing works

Between each cable section laid by the CLV/CLB, a joint will be required. There are two jointing methods that could be used as follows:

- Inline joints
- Omega joints.

Inline joints are carried out between a new cable section on the vessel and a cable section already deployed. The end of the deployed cable is brought up from the seabed to the vessel's deck and jointed to the end of the new cable section on board the vessel. Once jointing works are complete, cable lay resumes and the joint is deployed in line with the cable. The footprint occupied on the seabed for inline joints is the same as the cable.

Omega joints (otherwise known as hairpin joints or final joints) are carried out between two cable sections which are already deployed on the seabed and overlap one another. This scenario will occur when a separate vessel is used to conduct the jointing works or where a cable repair needs to be carried out. In this case, the joints need to be on board the vessel, which means extra cable equal to twice the depth of water is introduced into each of the two cable sections to allow for the jointing operation to take place.

The jointing process is illustrated in Figure 2-52. One of the cable ends is first brought up to the vessel, followed by the other cable end. Jointing works between both cable ends are carried out on the vessel. Once complete, the joint and the cables are paid out onto the seabed, forming an omega shape due to the excess cable lengths. The footprint occupied on the seabed for omega joints is much bigger compared to inline joints; 50 m to 200 m is required for joints in the water depths encountered along the route and as explained earlier in Section 2.8.3.2, is one of the key factors that determines the spacing required between each of the cables.

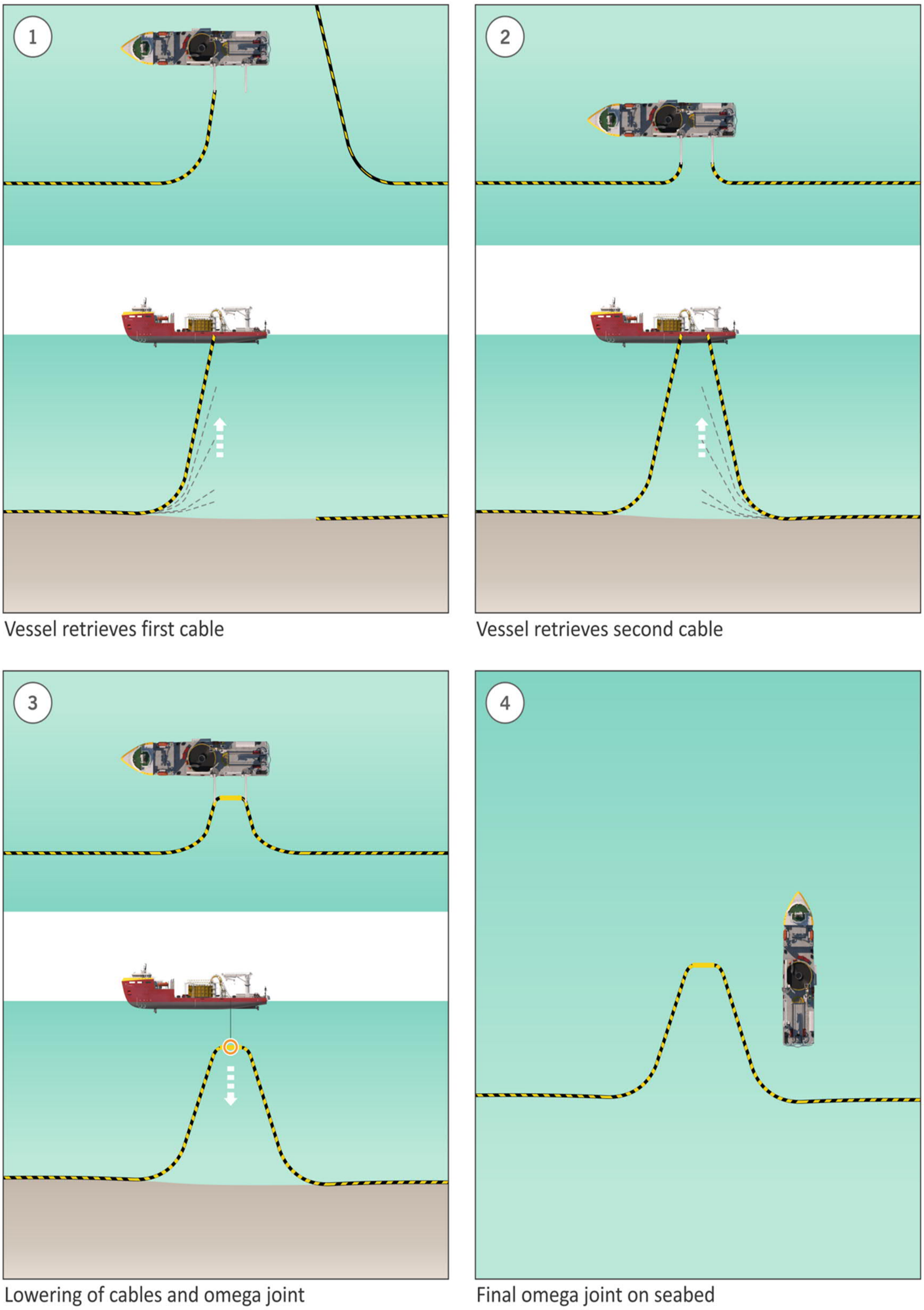


Figure 2-52. Illustration of process for installation of omega joints (Source: Cambium)

Cable burial

Over most of the route, the cables will be buried approximately 0.5 to 2 m. In areas where cable burial is not possible (e.g., at cable/pipeline crossings and areas of bedrock), or where the cable was inadequately buried during installation, the cable will be protected by installation of rock (gravel) or mattress armouring as previously described in section 2.8.3.3. The burial techniques being considered are outlined in the **Error! Reference source not found.**.

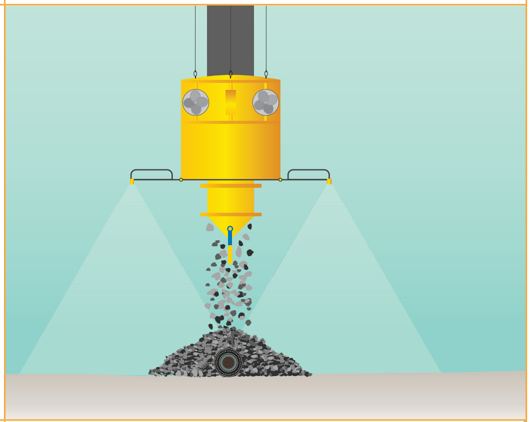
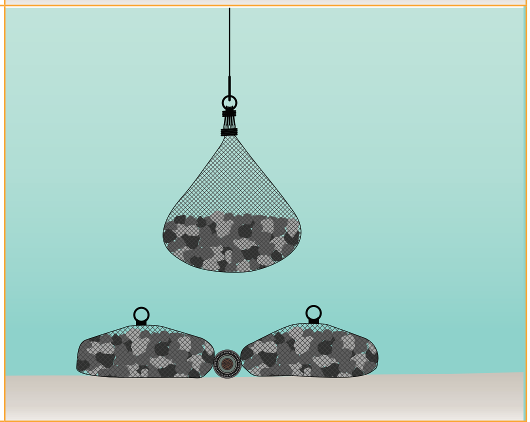
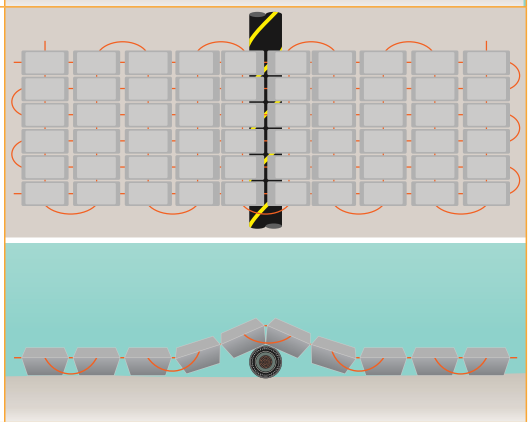
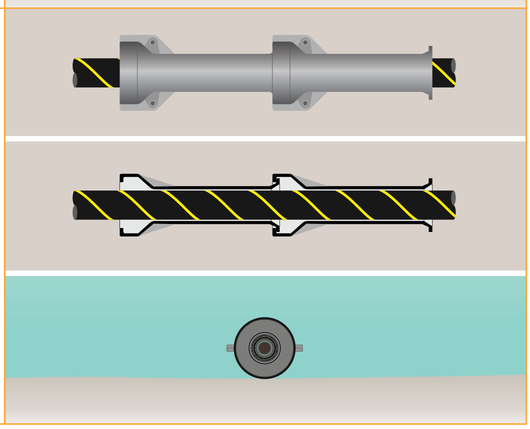
Jetting is the preferred burial method although this method may need to be augmented by mechanical trenching along short sections of the route. The choice of burial technique will vary along the route depending upon the seabed conditions in each section. This will be confirmed prior to construction.

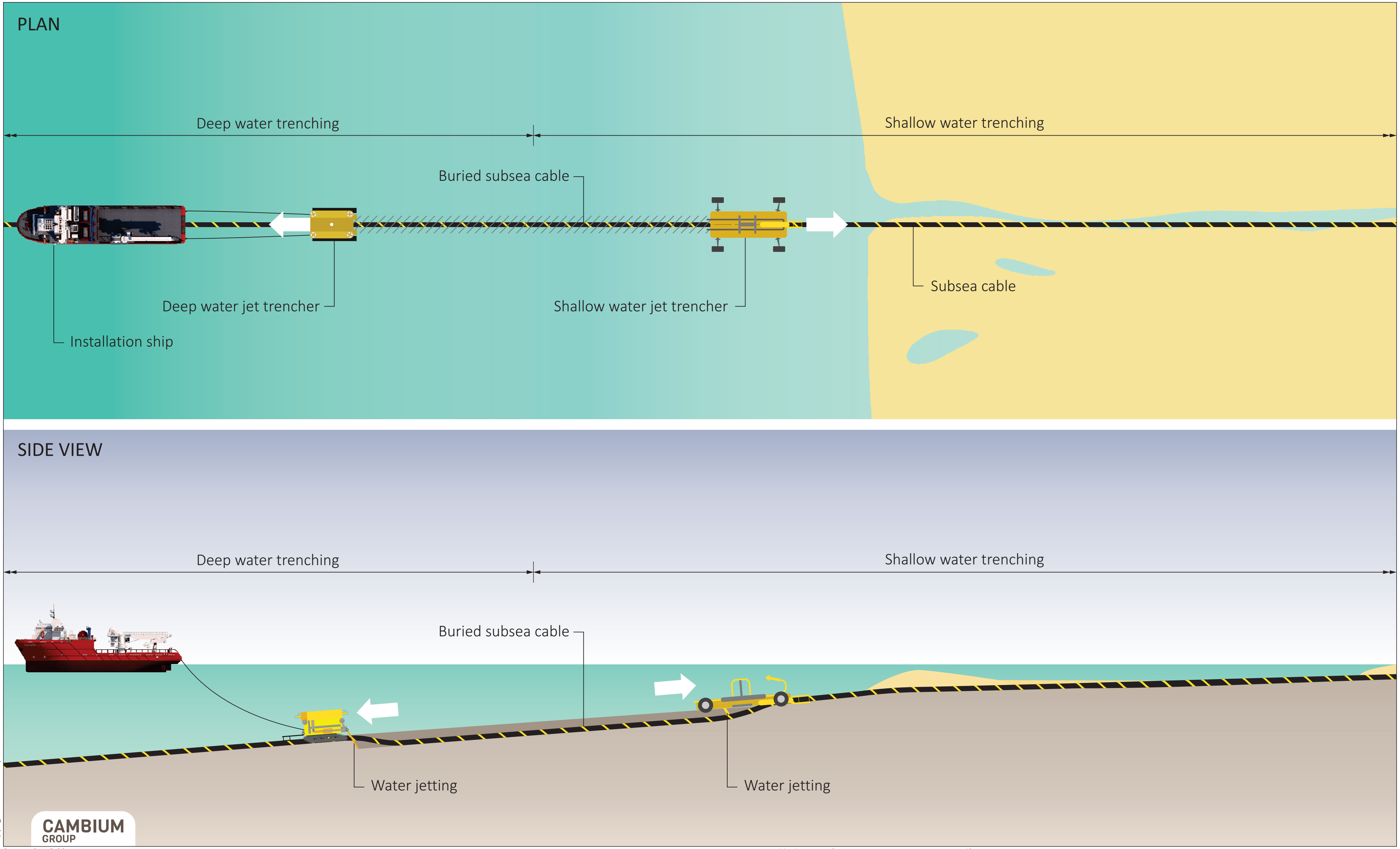
Jetting machines can be sled mounted and towed by the cable laying vessel or an auxiliary vessel, mounted on free swimming remotely operated vehicles, or mounted on self-propelled tracked vehicles. A specialised jet trencher may be used to cover the intertidal and shallow water sections of the route. Machine function is remotely controlled from the surface vessel via an umbilical cable. Examples of jetting machines are shown in Figure 2-53.

Jet trenchers sit on the seabed and follow the cable whilst employing high powered pumps to inject sea water either side of the cable which fluidises the seabed. The footprint of the trenching machine on the seabed is approximately 12 m wide, centred on the cable. As the sediments around the cable are fluidised, the cable naturally sinks between the jetting ‘swords’ and the trench left behind backfills from the natural movement of sediment on the seabed.

Post-lay survey

To ensure cables are adequately buried and to prevent navigational risk, a post-installation geophysical survey will be undertaken to demonstrate the successful burial and depth of the cables.

Method	Description	Applicable Seabed Type	Typical Equipment
Rock Placement	Construction of rock berms over laid cables by specialist contractors using dedicated vessels and equipment. Rock berms are sometimes used to stabilised a seabed prior to cable laying and are also used for crossing protection with existing cables and pipelines.	Rock and hard sediments	
Rock Bags	Placement of rock bags over laid cables by crane and from a general marine installation vessel. Rock bags are sometimes used to stabilise the seabed prior to cable lay	All	
Concrete Mattresses	Usually used for protection at specific points such as crossing of existing cable. Laid by crane from a general marine installation vessel	All	
Cast Iron Shells	Applied to the cable as it is over boarded from the cable laying vessel to provide mechanical protection over uneven seabed and increase stability of cables in high energy areas. May also be used for crossing protection together with concrete mattresses and / or rock placement	Rock and hard sediments	



Source: Sun Cable

Sun Cable drawing ref: AAPL-GEN-CTA-GN-MAP-0001-A.pdf

Cambium ref: 031186_Sun_Cable_AAPL_EIS_Fx_Deep_water_and_shallow_water_jet_trenchers_220309_v02

Figure 2-53. Illustrations of a ROV jet trencher (left) and shallow water jet trencher (right)

2.8.5 Operation and Reinstatement

The shallow trench that is left following cable burial will be left to backfill naturally in accordance with industry standard. Time-series observations of surface laid, and buried cables show that the seabed typically returns to its natural state within months to years, with the rate of recovery depending upon (i) the mode of cable deployment, (ii) wave and current regimes, (iii) rates of sediment supply to the ocean, (iv) seabed topography and geology and (v) biological activity (Clare, 2021[6]).

2.9 Climate Change Considerations

Climate change is predicted to have a substantial impact on infrastructure into the future, which makes it particularly important that climate change risks are considered when siting and designing long-term infrastructure, such as the AAPowerLink with an operational life of 70 years. The NT *Environment Protection Act 2019* Section 42 requires that activities are assessed, planned, and carried out considering the impacts of a changing climate. Climate change predictions for the NT[7] include:

- An increase in mean temperatures across the NT; the range of temperature increase varies depending on the emissions scenarios, but by 2090 will be ~0.6-1.9 °C under a low emissions scenario, and 2.8-5.6 °C under a high emissions scenario (this range represents projected temperature increases across both northern and southern NT).
- An increase in extreme heat, with a doubling of the number of days over 35 °C by mid-century (2036-2065).
- Both wetter and drier rainfall conditions could occur, depending on the emissions scenarios, and natural variability will have a greater impact in the near future. Rainfall changes toward the end of the century are unclear, with a 45% reduction and a 44% increase in annual rainfall both possible.
- The intensity of heavy rainfall events, including cyclones, is likely to increase. Tropical cyclones are likely to become less frequent but more intense.
- Time spent in drought conditions will likely increase in central and southern NT (i.e., around the Solar Precinct).
- Fire weather will become harsher and more frequent, particularly in the southern and central parts of the NT (i.e., around the Solar Precinct).
- Sea level rise is occurring; with sea levels projected to rise by 0.28 - 0.64 m by the end of the century, and up to 0.85 m under a high emissions scenario. Rising sea levels will exacerbate the impacts of storm surges and other extreme sea levels. These sea level rises are modelled into the NT Government storm surge mapping for 2100.

Flood modelling has been prepared for the Solar Precinct for several Annual Exceedance Probability (AEP) events, including extreme events - 0.1% (1 in 1,000 year), 0.2% (1 in 500 year) and 0.5% (1 in 200 year) events (Appendix N). Included is a climate change assessment of flood inundation modelling using the midpoint of the percentage rainfall increase of the RCP 4.5 and RCP 8.5 climate models. The BOM and SILO rainfall record from the Lake Woods area from the past 120 years was projected for the future 120 years and increased relative to the climate change model in accordance with the percentages provided by the ARR Data Hub (Babister, Trim, Testoni, & Retallic, 2016).

[6] International Cable Protection Committee Environment Update, Issue 220, December 2021.

[7] From *Climate change in the Northern Territory: state of the science and climate change impacts*, National Environmental Science Program (NESP) Earth Systems and Climate Change Hub (2020)

Results of the climate change modelling estimate that all Annual Exceedance Probability (AEP) levels increase by approximately 1.5mAHD[8] by 2140. Modelling also showed that when the lake exceeds 204mAHD, the lake outflows to a creek proximate to Newcastle Waters. This indicates that flood attenuation northward may reduce any potential impacts from flood inundation on the Solar Precinct. These results should be considered in light of climate change modellings inherent a level of uncertainty due to Australia's variable rainfall patterns and projections.

The Solar Precinct boundaries were established with reference to the climate change flood modelling with the objective of ensuring that most of the site is outside of all mapped flood extents. Within the site boundaries, infrastructure that is flood sensitive will be located outside of the mapped flood extents, and/or constructed on raised pads, ensuring climate change resilience for the Solar Precinct infrastructure.

Fire breaks will be installed around the site boundaries and a bushfire response capability will be maintained on site to protect people and infrastructure from increased risks associated with more severe fire weather conditions.

The OHTL infrastructure will be engineered to withstand wind gusts from severe storm events with reference to Australia Standards for the relevant wind zones, which include both inland and coastal zones of the NT. The OHTL infrastructure on the ground (i.e., poles) may become inundated near major watercourses such as the Katherine River, and inundation events may become more extreme or more frequent due to climate change. However, the OHTL poles can withstand inundation, and no poles will be located within watercourses (the maximum span between poles is 450 m). Climate change risks are not predicted to be significant for the OHTL.

The Darwin Converter Site and Cable Transition Facilities are located outside of the mapped extent for storm surge in 2100 (including 1 in 100 year and 1 in 1,000-year events). Therefore, they are not expected to become inundated, even in extreme events that could occur with a future changing climate. The infrastructure will be designed and constructed to comply with building regulations that apply in the Darwin Building Control Area, for cyclonic conditions. Fire breaks will be installed around the site boundaries and a bushfire response capability will be maintained on site to protect people and infrastructure from increased risks associated with more severe fire weather conditions.

The AAPowerLink infrastructure will be located, designed, and engineered to withstand impacts from climate change. The key climate change considerations for the AAPowerLink relate to the rainfall events and flooding around the Solar Precinct, sea level rise and storm surge at the Darwin Converter Site, intense cyclones affecting the northern parts of the OHTL and Darwin Converter Site and fire weather considerations.

Importantly, minimising greenhouse gas emissions (GHG) is essential to avoid the worst impacts of climate change, and rapid emissions reductions are required to stay below 1.5-2 degrees of warming (IPCC 2021). The AAPowerLink has been identified as a key contributor to the NT's target of achieving net zero emissions by 2050. It is estimated that the AAPowerLink when fully operational will supply ~10% of the NT's total energy needs.

This includes supplying ~30% of the Darwin Katherine Electricity System from renewable sources and supplying seven times that amount of energy to industrial customers in the NT. The averted emissions represent an opportunity for significant GHG emissions reductions as further discussed in Chapter 12 Atmospheric Processes.

[8] Australian Height Datum

2.10 Construction Schedule

The onshore construction program will run for approximately 60 months and is scheduled to commence in the first quarter of 2024. The offshore construction program will run for approximately 57 months and is scheduled to commence in the second quarter of 2024.

The construction timing sequence is as follows:

- Commence early works Q2 2023
- Commence construction at Solar Precinct Q2 2023
- Construction of OHTL Q1 2024 to Q 4 2026
- Construction of Darwin Converter Site Q1 2025
- Commence manufacture of submarine cable – 2024
- Installation of submarine cables – 2025 – 2029 (based on availability of cable)

During construction, land-based works will operate during a standard day shift. In limited cases, night shift, or 24-hours operation may be needed depending on the construction activities. Marine construction is likely to have multiple shifts operating on around the clock.

2.10.1 Workforce

Details of the onshore construction workforce numbers and locations where these personnel will be based are provided in Table 2-8. The construction workforce will operate on a roster basis, and it is anticipated that labour will be sourced labour from Tennant Creek, Elliott, Katherine, Alice Springs, and Darwin regions, as well as further abroad where specialist skills and large numbers of personnel are required.

Table 2-8. Approximate construction workforce numbers and locations

Project component	Workforce numbers	Duration (months)	Location
Solar Precinct	1000	30	Temporary construction camp established at the Solar Precinct site (refer Section 2.4.4)
Overhead Transmission Line	460	30	Mobile 'fly' camps established at localities along Stuart Highway between Elliott and Darwin. Existing accommodation providers to be used where possible. Temporary camps to be established in remote areas. (Refer Section 2.5.4.1.)
Darwin Converter Site and Cable Transition Facilities	230	30	Darwin based
Subsea cables	60	4.5yrs	Specialised contractors mobilised from overseas with additional support vessels and crew from the Darwin region

During the civil and earthworks preparation of the Solar Precinct, the workforce will be a mix of FIFO and local contractors and limited personnel transported. Personnel will fly-in for their roster predominantly from Darwin, where it will be more efficient and safer for them to do so due to time and distance. During the civil works phase, it is envisaged that the Elliott Airstrip will be utilised. Elliott Airstrip is a public airstrip and accessible by several charter companies operating out of Darwin. Elliott is suitable for Cessna C441 Conquest, a twin-engine, pressurised aircraft capable of carrying 9 Passengers.

It is estimated that approximately 16 Cessna flights per week may be required into and out of the Elliott Airstrip during the first 20 months of the construction phase, while civil and earthworks are undertaken at the site. This period also includes the construction of the airstrip at the Solar Precinct to service the main construction workforce and in support of ongoing operations.

A bus service utilising coasters and minibuses will be used to transport personnel between Elliott airstrip and the Powell Creek Solar Precinct.

2.11 Operational Details

2.11.1 Workforce

An estimated operations workforce of 350 personnel will be required to operate the Solar Precinct and Darwin Converter Site including OHTL maintenance. The Solar Precinct workforce will be a combination of local workforce sourced from regional areas proximate to the site, and fly-in-fly-out of Darwin and other capital cities in Australia to make up the balance of workforce required to operate the project. Personnel will be based at the onsite accommodation camp, with minimal requirement for use of local accommodation in Renner Springs or Elliott post-construction. Specialist technicians and contractors brought in as required from within Australia and overseas. The Darwin Converter Site will be operated by personnel based in Darwin, who will drive to and from site daily.

2.11.2 Waste management

Waste streams produced at the Solar Precinct and Darwin Converter Site as part of day-to-day operations will include:

- Inert solid wastes
- Wash bay and sediment basin solids
- Municipal solid waste
- Putrescible waste
- Listed waste
- Grey and black water
- Sewage sludge
- Waste oils/lubricants
- Industrial waste
- Electrical componentry.

In addition, the solar panels may need to be replaced or repowered after 40 years and the batteries approximately every 15 years. Large volumes of solid wastes will be produced during these events, and Sun Cable will investigate an appropriate response to waste management in consultation with licensed facilities. This may include investigation of options for component recycling to reduce waste arising from project activities generated as part of these events and for any damaged components through the project life, as detailed in Section 2.12.

The limitations of local landfill facilities in the NT are noted. Sun Cable will develop an appropriate response to waste management in consultation with licensed facilities during construction and operations.

2.11.3 Key activities offshore

Once the Subsea Cable System has been installed and suitably protected, it is not expected to require routine maintenance. Arrangements for survey and repair are described below.

2.11.3.1 In-service survey works

It is likely that routine surveys using standard geophysical survey equipment and/or ROVs to monitor buried cable depth and integrity of rock-berms will be undertaken, particularly in the initial years of operation, and should the local environmental conditions change or be suspected as having changed. This is particularly true for areas of mobile sand waves and high energy areas (e.g., nearshore). Regular survey of cable crossings may also be a requirement of a particular cable crossing agreement. Periodic inspections may be undertaken to identify cable exposures or spanning.

2.11.3.2 Submarine cable repairs

The most common reason for repair of a cable is damage caused by external interaction, typically by trawlers and commercial ship anchors. Such damage is usually localised depending on the energy of the interaction and whether the cable is merely impacted, mauled (where something is dragged with force along the cable for a distance) or dragged from the seabed.

Where a cable fault is detected, the relevant section of the cable will be located and retrieved to the surface for inspection and replacement. A repair will typically be carried out by a single vessel. A shallow water repair, in less than 10 m of water, will typically be made using an anchored or jack-up barge. In deeper water, a cable vessel will be used.

A cable repair invariably requires the insertion of additional cables and two additional cable joints. The joints for a cable repair are referred to as omega joints as described earlier in Section 2.8.4.2 and illustrated in Figure 2-52. The additional cable length required for the repair may be equal to approximately three times the depth of water at the site, and longer if the cables have been damaged over a distance or if the fault is difficult to locate. The extra length of a repaired short cable section means it cannot be returned to its exact previous alignment on the seabed, so the excess cable will be laid on the seabed in a loop off to one side of the original route. The excess cable and first joint of a longer repair section can be laid ‘in-line’ along the original route whilst the final joint will form an omega loop on the seabed. The additional joints and the extra cable length will be buried, typically using jetting machines, concrete mattresses or rock placement deployed from either the repair vessel itself or a separate specialised vessel.

A cable repair operation might be expected to have a duration of several weeks, depending on the type and extent of damage, burial requirements, and operational constraints such as weather.

2.11.3.3 Electromagnetic fields

The AAPowerLink will transmit electricity using HVDC, which is recognised as having a significantly lower level of EMF than HVAC lines, which are more typically used in Australia. Measurable EMFs are not expected from the HVDC infrastructure. The location of the cables, buried in the seabed, means very localised EMFs pose no risk to people.

2.12 Decommissioning & Rehabilitation

The transmission infrastructure is designed to have a lifespan of 70 years, whereas the solar and battery components may need to be replaced or repowered after approximately 40 and 15 years respectively. Sun Cable will investigate an appropriate response to waste management in consultation with licensed facilities during construction and decommissioning phases. This may include investigation of options for component recycling to reduce waste arising from decommissioning of project components.

Sun Cable has committed to establish a Renewable Energy Centre of Excellence in the Northern Territory of which recycling opportunities are anticipated to be an integral consideration of the Centre’s objectives.

It is expected that extraordinary advancements in recycling technology will have been made available in the timeframe proposed for decommissioning around the years 2068 – 2098. Furthermore, PV recycling facilities already exist in Australia, with a further two to be commissioned in 2021. Also, recycling sub-optimal panels is unlikely to be the best option. At 0.5% degradation per annum, they will still have plenty of life left at 50 years and will be perfectly usable for third parties.

A Decommissioning and Rehabilitation Plan, with define closure objectives and agreed criteria, will be developed in consultation with the pastoral lease holders, Traditional Owners, and relevant government agencies, prior to commencement of these activities. The plan will address the procedures for decommissioning based on the objectives identified below.

- The objective of site rehabilitation post-operations is to return the sites to a self-sustaining, free draining stable landform. The Solar Precinct will be fully decommissioned and rehabilitated post-operations with the intention of returning it to pastoral land use.
- The Railway Corridor will be rehabilitated to pre-existing land use (i.e., a utilities corridor) once the overhead transmission infrastructure is removed. Alternatively, the infrastructure may be transferred to the NT Government for ongoing use / upgrades for the purpose of supporting electricity transmission across the NT.
- Sites in Murrumujuk will be rehabilitated in accordance with the relevant master plans in place at the time, including where practical, efforts to return vegetation to the sites.
- Underground cables and the Subsea Cable System will be decommissioned and left *in situ*, subject to a final rehabilitation and decommissioning plan to be approved by the relevant authorities.

2.13 References

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