Gorgon Gas Development and Jansz Feed Gas Pipeline

Horizontal Directional Drilling Management and Monitoring Plan – Addendum

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Contents

Tables

Figures

1 Introduction

Chevron Australia Pty Ltd (CAPL) is the proponent and the person taking the action for the Gorgon Gas Development and Jansz Feed Gas Pipeline on behalf of the following companies (collectively known as the Gorgon Joint Venturers):

- Chevron Australia Pty Ltd
- Shell Development (Australia) Pty Ltd
- Mobil Australia Resources Company Pty Limited
- Osaka Gas Gorgon Pty Ltd
- Tokyo Gas Gorgon Pty Ltd
- JERA Gorgon Pty Ltd.

1.1 Project

CAPL is developing the gas reserves of the Greater Gorgon Area via the Gorgon Gas Development and Jansz Feed Gas Pipeline, as described in Section 1.2 of the Horizontal Directional Drilling Management and Monitoring Plan (HDDMMP; Ref. 1). The development includes Feed Gas Pipeline Systems (FGPS) that extend subsea from the offshore gas fields to Barrow Island, through a HDD shore crossing at North Whites Beach on the west coast, and then continue below ground across Barrow Island to the Gas Treatment Plant (GTP) on the east coast. The FGPS comprise feed gas trunklines, MEG and utility pipelines as well as electro-hydraulic umbilicals that contain electrical cables and control lines that provide for remote operation of the offshore infrastructure from the onshore Central Control Room.

To maintain the operating efficiency of offshore gas gathering systems, CAPL is installing two additional subsea umbilicals to connect the offshore fields to the GTP. The additional control (fibre-optic) and electrical (up to ~132 kV AC) umbilicals will be installed adjacent to the existing subsea FGPS that extend from the fields to the shore crossing site at North Whites Beach. The shore crossing for the additional umbilicals will use the same technique used for the shore crossing of the existing FGPS, comprising horizontal directional drilling (HDD) at North Whites Beach, to minimise impacts to the beach, intertidal and nearshore marine environments. Three cased boreholes (one spare) will be established using HDD.

1.2 Environmental Approvals

Table 1-1 describes State (WA) and Commonwealth (Cth) approvals for the components of the Gorgon Gas Development.

These approvals, and projects approved under these approvals, have been and may continue to be amended (or replaced) from time to time.

Table 1-1: State and Commonwealth Approvals

Project Approval Stage	State	Commonwealth
Jansz Feed Gas Pipeline	Ministerial Statement (MS) 769 (Ref. 2) 28 May 2008	EPBC Reference: 2005/2184 (Ref. 3). 22 March 2006

Project Approval Stage	State	Commonwealth
Initial Gorgon Gas Development (2 LNG trains)	Initial Gorgon Gas Development comprising two LNG trains – MS 748 (Ref. 4). This was superseded by MS 800. 6 September 2007	Initial Gorgon Gas Development comprising two LNG trains – EPBC Reference: 2003/1294 (Ref. 5). 3 October 2007
Revised and Expanded Gorgon Gas Development (3 LNG trains)	MS 800 (Ref. 6) provides approval for both the initial Gorgon Gas Development and the Revised and Expanded Gorgon Gas Development (compromising three LNG trains). This statement supersedes MS 748. 10 August 2009	The Revised and Expanded Gorgon Gas Development (EPBC Reference: 2008/4178 [Ref. 7]) was approved, and the conditions for the initial Gorgon Gas Development (EPBC Reference: 2003/1294 [Ref. 5]) were varied. 26 August 2009
Dredging Amendment	MS 865 (Ref. 8) provides approval to establish a restart mechanism in the event of a Project-attributable coral health management trigger. This statement is an amendment to Conditions 18, 20, and 21 of MS 800. 8 June 2011	Not applicable (N/A)
Additional Support Area	MS 965 (Ref. 9) applies the conditions of MS 800 to an Additional Support Area. 2 April 2014	The conditions for the initial Gorgon Gas Development (EPBC Reference: 2003/1294 [Ref. 5]).and for the Revised and Expanded Gorgon Gas Development (EPBC Reference: 2008/4178 [Ref. 7]) were varied. 15 April 2014
Gorgon Gas Development Fourth Train Expansion	MS 1002 (Ref. 10) applies the conditions of MS 800 to the Fourth Train Expansion, and has additional conditions. 30 April 2015	EPBC Reference: 2011/5942 (Ref. 11). 12 May 2016

1.3 Scope and Purpose of this Addendum

This Addendum has been prepared to update the approved HDDMMP (Ref. 1) so it adequately covers HDD for the additional umbilicals, consistent with the requirements for review/update of the HDDMMP detailed in Section 9.4 of that document. The Addendum describes how the construction of the HDD shore crossing for the additional umbilicals will be managed in a manner that protects environmental values and reduces impacts to the environment as far as practicable.

The scope of this Addendum covers the terrestrial and marine shore crossing activities for the umbilicals, which will include HDD from the onshore HDD site at North Whites Beach, Barrow Island, to the offshore HDD exit point ~400–550 m from shore. Management of marine activities associated with the installation and stabilisation of the offshore section of umbilical, and terrestrial activities associated with the installation of the onshore umbilical, are addressed separately.

The activities covered by this Addendum comprise:

- site preparation
- construction of the HDD hardstand area and installation of equipment

- water winning
- HDD operations, including installation of three (one spare) caissons/conduits into HDD boreholes
- winching of each umbilical through its HDD borehole
- marine vessel(s) operating at the HDD exit point
- drill cuttings and drilling fluids management
- reinstatement of temporary construction areas.

Following approval, this Addendum will be considered to be approved as part of the HDDMMP (Ref. 1), but will be maintained as a stand-alone document. Where relevant, amendments made to the HDDMMP will also be considered to be amendments to this Addendum. Any matters or requirements in the Addendum that are taken from the HDDMMP (rather than MS 800, MS 769 or EPBC Reference: 2003/1294 and 2008/4178) may be amended from time to time in accordance with amendments to the HDDMMP. Note that if there is any difference or inconsistency between the HDDMMP and this Addendum in relation to Condition 22.4 or 22.5 of MS 800, Condition 13.4 of MS 769 or Condition 15.4 or 15.5 of EPBC Reference: 2003/1294 and 2008/4178 with respect to the activities covered by this Addendum, then this Addendum is to be preferred.

1.3.1 Objectives of this Addendum

The objectives of this Addendum, as stated in Condition 22.3 of MS 800, Condition 13.3 of MS 769, Condition 15.3 of EPBC Reference: 2008/4178 and 2003/1294 are to manage the HDD for the additional umbilicals to:

- *Reduce the impacts of HDD activities on the Terrestrial and Marine Disturbance Footprints as far as practicable; and*
- *Ensure that HDD activities do not cause Material or Serious Environmental Harm outside the Terrestrial and Marine Disturbance Footprints or result in coral loss beyond the coral loss limit*

1.3.2 Key Legislative Requirements

This Addendum to revise the approved HDDMMP satisfies the requirements of Condition 36.2(ii) of MS 800, Condition 21(2) of MS 769 and Condition 25 of EPBC Reference: 2003/1294 and 2008/4178 as applicable to the HDDMMP (Ref. 1).

Sections 1.5 and 2.0 of the HDDMMP provide a description of other legal requirements relevant to Gorgon Gas Development and Jansz Feed Gas Pipeline HDD activities. The following changes to legislation relevant to this Addendum are noted:

- The *Quarantine Act 1908* (Cth) has been superseded by the *Biosecurity Act 2015*
- The *Wildlife Conservation Act 1950* (WA) has been superseded by the *Biodiversity Conservation Act 2016*

1.3.3 Content of this Addendum

Table 1-2 identifies where content in this Addendum addresses relevant specific requirements of MS 800, MS 769, and EPBC Reference: 2003/1294 and 2008/4178.

Table 1-2: Condition Requirements Addressed in this Addendum

Ministerial Document	Condition No.	Requirement	Section in this Addendum
EPBC Reference: 2003/1294 and 2008/4178	3.2.1	A description of the EPBC listed species and their habitat likely to be impacted by the components of the action which are the subject of that plan.	Section 3.2, 3.3, 5
	3.2.2	An assessment of the risk to these species from the components of the action the subject of that plan, relevant to that plan.	Section 5
	3.2.3	Details of the management measures proposed in relation to these species if it is a requirement of the condition requiring that plan.	Section 5
	3.2.4	Details of monitoring proposed for that species if it is a requirement of the condition requiring that plan.	Section 6.4
	3.2.5	Performance standards in relation to that species if it is a requirement of the condition requiring that plan.	Section 5, 7
	3.2.7	Protocols for reporting impacts on the species to the Department.	Section 6.6
	15.4 (i)	Management measures to reduce the impacts from HDD activities as far as practicable.	Section 5
	15.4 (ii)	Management measures to ensure HDD activities do not cause Material or Serious Environmental Harm outside the Terrestrial and Marine Disturbance Footprints associated with those activities, or the coral loss limit in condition 15.6 to be exceeded.	Section 5
	15.4 (iii)	Performance standards against which achievement of the objectives of this condition can be determined.	Section 5, 7
	15.5 (i)	The generation and dispersion of turbidity associated with the discharge of drill cuttings and fluids to the marine environment.	Section 5.6
	15.5 (ii)	Noise and percussion.	Section 5.5
	15.5 (iii)	Direct disturbance of habitat.	Section 5.2.2, 5.3
	15.5 (iv)	Preventing harm to, or fatalities of marine turtles.	Section 5.4, 5.7.1, 5.8.3, 5.8.4, 5.8.5
	15.5 (v)	The use of low toxicity polymer drilling fluids or water based fluids unless otherwise authorised by the Western Australian Minister.	Section 2.3.3.1
	15.5 (vi)	Management and disposal of drill cuttings and fluids returned to the surface by circulation to prevent pollution.	Section 2.3.3.1, 5.6
	15.5 (vii)	A marine monitoring program to detect changes to ecological elements outside the Marine Disturbance Footprint components associated with the marine facilities listed in Condition 11.3	Section 6.4
	15.6	The Detectable Net Mortality of Coral Assemblages for the HDD activities associated with the construction of the shoreline crossing on the west coast of Barrow Island must not exceed 1.2 ha.	Section 5
	15.7	The person taking the action must implement the Plan.	Section 6.2, 6.3, 6.5

Ministerial Document	Condition No.	Requirement	Section in this Addendum
Condition 22 of MS 800 and Condition 13 of MS 769	22 (4) (i) 13 (4) (i)	Management measures to reduce the impact from HDD activities as far as practicable.	Section 5
	22 (4) (ii) 13 (4) (i)	Management measures to ensure that HDD activities do not cause Material or Serious Environmental Harm outside the Terrestrial and Marine Disturbance Footprints, or exceed the coral loss limit in Condition 22.6 (MS 800), or result in coral loss beyond the Marine Disturbance Footprint (MS 769).	Section 5
	22 (4) (iii)	Performance Standards against which achievement of the objectives of this condition can be determined.	Section 5, 7
	22 (5) (i) 13 (4) (ii) (a)	The generation and dispersion of turbidity associated with discharge of drill cuttings and fluids to the marine environment.	Section 5.6
	22 (5) (ii) 13 (4) (ii) (b)	Noise and percussion.	Section 5.5
	22 (5) (iii) 13 (4) (ii) (c)	Direct disturbance of habitat.	Section 5.2.2, 5.3
	22 (5) (iv) 13 (4) (ii) (d)	Preventing harm to, or fatalities of marine turtles.	Section 5.4, 5.7.1, 5.8.3, 5.8.4, 5.8.5
	22 (5) (v) 13 (4) (ii) (e)	The use of low toxicity polymer drilling fluids or water based fluids unless otherwise authorised by the Minister.	Section 2.3.3.1
	22 (5) (vi) 13 (4) (ii) (f)	Management and disposal of drill cuttings and fluids returned to the surface by circulation to prevent pollution.	Section 2.3.3.1, 5.6
	22 (5) (vii) 13 (4) (ii) (g)	A marine monitoring program to detect changes to ecological elements outside the Marine Disturbance Footprint identified in Condition 14.3 (MS 800) or Condition 12 (MS 769).	Section 6.4
	22 (6)	The Detectable Net Mortality of Coral Assemblages for the HDD activities associated with the construction of the shoreline crossing on the west coast of Barrow Island shall not exceed 1.2 ha.	Section 5
	13 (5)	The extent of mortality of coral assemblages for the HDD activities associated with the construction of the shoreline crossing on the west coast of Barrow Island shall not, in combination with the Gorgon proposal, exceed 1.2 ha.	Section 5
	22 (7) 13 (6)	The Proponent shall implement the Plan.	Sections 6.2, 6.3, 6.5

2 Activity Description

2.1 Overview of Shore Crossing

The shore crossing for the additional umbilicals will utilise the same HDD technique previously used for the shore crossing of the existing FGPS. The HDD technique is a trenchless installation process by which linear infrastructure is installed beneath obstacles or sensitive areas. The use of HDD for the shore crossing of the FGPS was selected due to the following factors:

- A limestone reef occurs nearshore along North Whites Beach. The HDD technique enables the pipeline system to be installed underneath the reef without causing damage to the reef and beach.
- The coastline is a high-energy environment with waves and swell that make other pipeline shore crossing techniques difficult to execute.
- The west coast of Barrow Island has high seabed rock strength. By using HDD, other techniques such as blasting and trenching are not required for the shore crossing.

An additional (spare) casing is proposed to be installed as part of this HDD campaign to reduce the requirement to re-disturb the dunes for future umbilical installation.

2.2 Location

The HDD shore crossing site is located at North Whites Beach on the north-west of Barrow Island. The shore crossing for the additional umbilicals will be immediately south of the existing FGPS shore crossing (see Figure 2-1). The shore crossing corridor is centred on the coordinates of 335024 m E, 7711185 m N (MGA 50, GDA 94) and the HDD drill site is located ~100 m from the shoreline. The HDD breakout point is planned to occur ~400 –550 m offshore in water ~12.5 -13 m deep.

Table 2–1 lists the location and area requirements for the HDD shore crossing.

Table 2–1: HDD Location and Footprint

Aspect	Description
Location	North Whites Beach
HDD Site Area	Footprint: ~5.9 ha Including part of previously cleared HDD site
Area of Clearing (additional to previous HDD Site)	Footprint: ~2.7 ha
Offshore Exit Point	Distance from HDD entry point: ~500–650 m Water depth: ~12.5-13 m below Lowest Astronomical Tide (LAT) Total width (corridor) of three exit points: ~35 m
Water Winning Intake	Previous water winning intake to be refurbished or temporary line over the foreshore used
Land Tenure for underground umbilicals	Footprint: ~0.8 ha Covers land under which the umbilicals will travel, from the HDD entry point down to LAT. This area is likely to be subject to minimal disturbance. Tenure is in place in the event of any such disturbance, such as from laying temporary water line, temporary seawall maintenance or frac-outs.

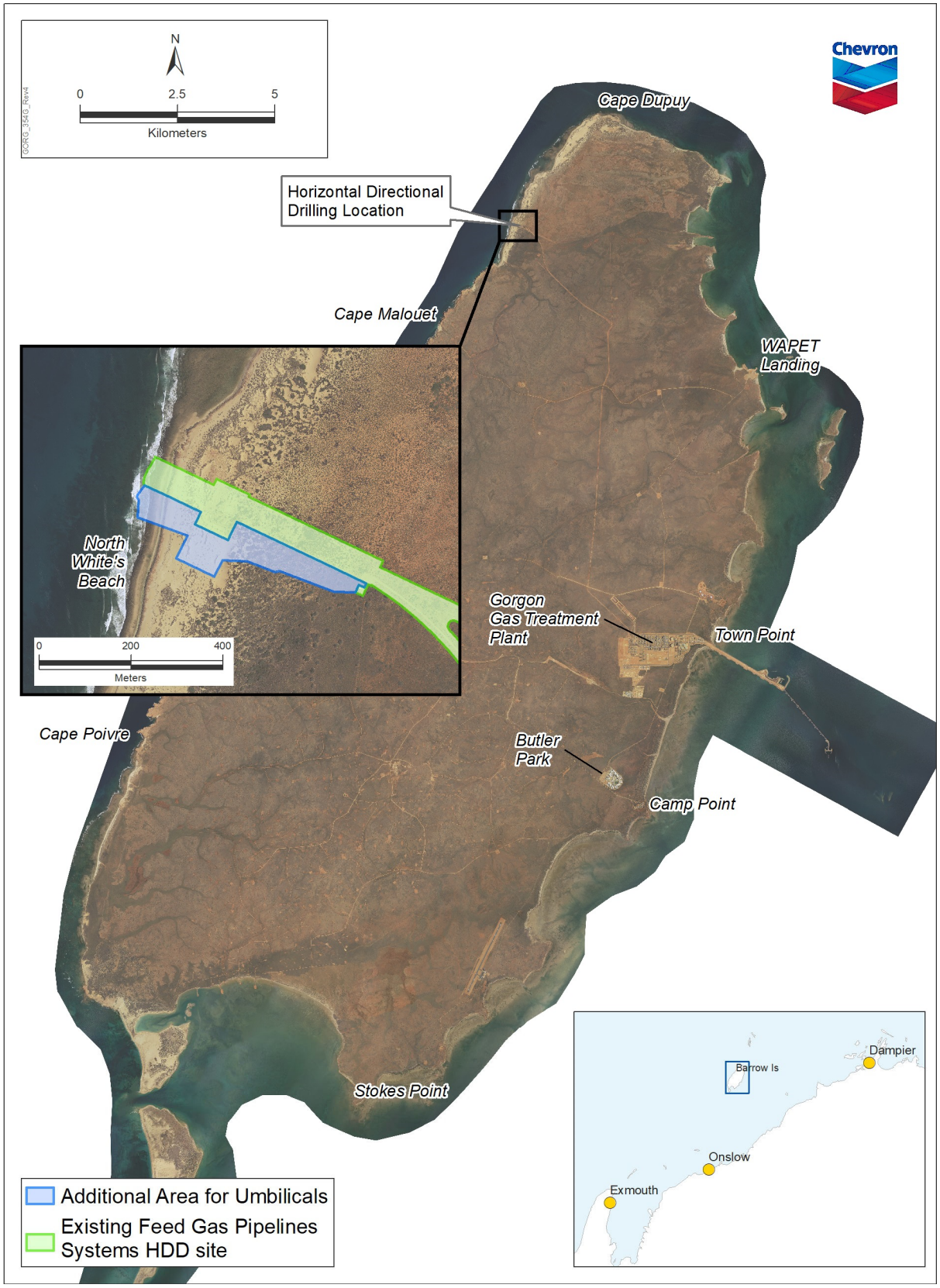

Figure 2-1: Location of HDD Facilities

2.3 HDD Work Scope

The HDD work scope involves refurbishment of the existing water winning intake and completion (drilling and casing) of up to three new parallel boreholes, including a spare borehole to allow for an additional future umbilical to be installed without the need to fully re-disturb the dunes at the shore crossing site. A hardstand area is to be constructed to provide a work area for the HDD activity and storage (Figure 2-2). Marine vessel(s) will work offshore near the HDD exit point location.

The key HDD activities include:

- site preparation and mobilisation
- construction and installation of HDD facilities
- drilling and casing installation
- umbilical installation
- site reinstatement and demobilisation.

It is anticipated that prior to drilling the umbilical boreholes, refurbishment of the water winning borehole previously drilled for the existing FGPS will be completed (if practicable) to support the water winning spread, which will provide water for the drilling activities.

The HDD boreholes are planned to be reamed to a diameter of 36'', with 630mm outer diameter (OD) HDPE casings installed. The water winning spread (pipeline for water supply to onshore HDD site) will have an ~450 mm casing.

More detail of the HDD activities is provided in the following sections.

2.3.1 Site Preparation and Mobilisation

Prior to commencement of works, the area at North Whites Beach will be surveyed to delineate the boundary of the HDD site. The existing condition of the site and adjacent areas will be photographed.

The seabed conditions at and surrounding the offshore HDD exit point(s) will also be surveyed to ensure there are no significant seafloor features or obstructions and to confirm anchoring suitability. The survey is expected to involve ROV and/or standard acoustic seabed survey techniques such as side scan sonar (SSS), multibeam echo sounder (MBES) and/or sub-bottom profiling (SBP).

Clearing will be required for the HDD site. This will be done in accordance with the CAPL permit to work system. This process involves a series of checks to ensure ground disturbing work is only undertaken in authorised areas and all mitigation measures are in place to reduce impacts of the clearing activities. Basic steps include:

- proposed clearing area is surveyed
- site assessment is undertaken
- surveyed area is checked against a land-tenure database and relevant Issued For Construction (IFC) work plans and drawings

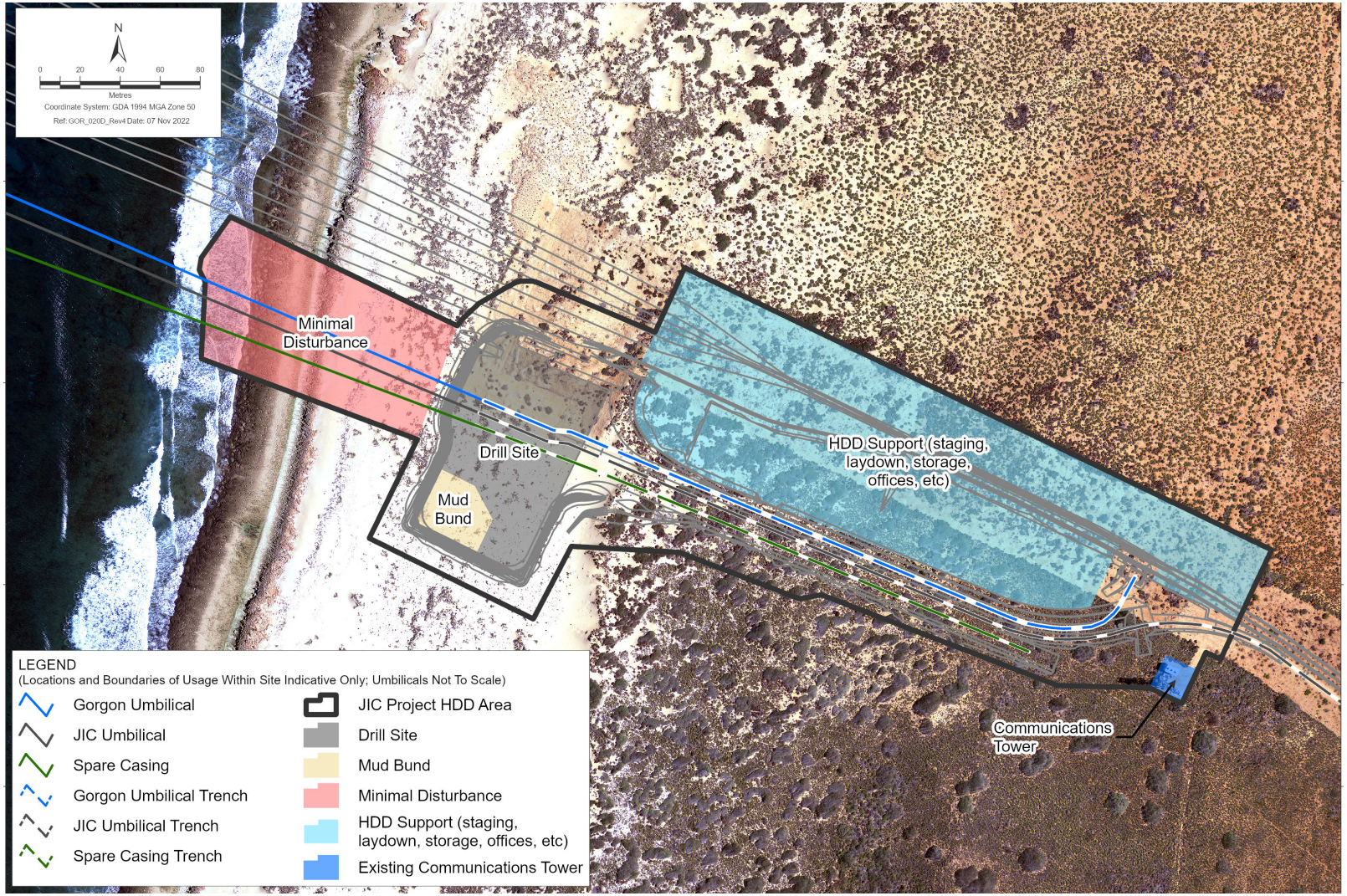

Figure 2-2: HDD Work Area

- surveyed area is checked for proximity to weed hygiene zones, specially protected vegetation and fauna habitats
- site-specific clearing methodology (depth of topsoil to be stripped, area for topsoil storage, anticipated clearing commencement date, topsoil segregation, etc.) is defined
- requirements for cultural heritage and additional pre-clearing weed, vegetation and fauna surveys are determined
- Permit is issued that includes all conditions of managing site-specific issues
- Permit close-out.

Topsoil will be stripped and stockpiled for later use in site reinstatement and vegetation appropriately stored/treated to promote rehabilitation.

A laydown area(s) is to be prepared using locally sourced materials and/or imported materials. In areas where fuels and other chemicals are to be stored, appropriate bunding will be installed.

Access to the HDD work site will be along the existing onshore FGPS ROW access track from the existing road network, eliminating the need for additional clearing beyond the HDD worksite. If additional staging, laydown, offices etc areas are required, they will be located in previously cleared areas within Gorgon tenure on Barrow Island.

2.3.2 Construction and Installation of HDD Facilities

Subject to detailed design, the HDD infrastructure is expected to include these temporary facilities:

- office administration and welfare facilities including offices, meeting rooms, first aid room, canteen, ice room, and toilet block
- sandbag seawall for storm protection of the pad
- diesel-driven mobile plant for power and light generation
- drilling spread including rig, power packs, control rooms, pumps, and mud mixing and processing units
- concrete or steel pile foundation to anchor the drill rig and for subsequent winching facilities
- storage areas including water storage, spares containers, skips, drilling fluids, and drill pipe racks
- maintenance and fabrication areas including workshops
- pull-in winch spreads comprising the winch and wire, diesel-powered hydraulic power unit, and sheave block(s)
- lifting equipment including cranes, forklifts, sidebooms, and excavators
- construction plant including graders, dozers, excavators, wheel loaders, water carts and trucks
- water winning spread
- pipe thruster.

The equipment is to be placed in its working position and the site established to commence the first borehole.

Most facilities are expected to remain in one location for the duration of construction with the exception of the drill rig which will be relocated for each borehole. Facilities such as office communications, site amenities and waste management areas are to be established at/near the site and remain in place for the duration of the installation works. The seawall, comprised of geotextile sandbags filled onsite with a sand/seawater slurry, is to remain in place to provide storm protection to the HDD site throughout installation works.

At each HDD entry point, a collection sump will be excavated to contain the drilling fluid flushed from the bore, before being recycled. A concrete and/or steel pile temporary anchor or similar structure is to be constructed to support and position the drilling rig.

Consistent with the methodology used for the existing FGPS HDD, an initial small water intake line (nominally 150 mm) will be temporarily run down to the sea to gain water for drilling the first hole (currently proposed to be refurbishment of the previously installed main water winning hole). This line will require securing to prevent movement, particularly in the high-energy surf zone, including bolting to the rocky reef platform using hand tools and/or placement of clump weights on the sea bottom, as was undertaken for the existing FGPS HDD. Anchor lines may also extend back to the beach within Gorgon tenure to secure the pump against tidal movements. The system can be configured to minimise disturbance and avoid any sensitive features that may be present. The pump and associated infrastructure will be removed when no longer required for HDD activities. In the event that the previous water winning hole cannot be refurbished, the temporary line may remain in place throughout the HDD program, after which it will be recovered and decommissioned.

2.3.3 Horizontal Directional Drilling

The first use of HDD is likely to be refurbishment of the existing water winning intake, exiting beyond the surf zone to provide seawater supply for the drilling operations.

In addition to the establishment of the water winning hole (if practicable), three parallel boreholes are to be drilled, each commencing with a pilot hole. In the event unforeseen drilling problems cause abandonment of a borehole, a replacement may be drilled. All boreholes are expected to be constructed by drill and reaming followed by direct thrusting/pushing of the casing. At the commencement of each borehole, a larger-diameter steel surface casing will be installed. This will be done by excavation and insertion, or by direct insertion using a pneumatic hammer, pushing the casing to approximately seawater level (the first ~30-50 m of each borehole). This practice is commonly used to minimise frac-outs when drilling in unstable landforms.

The HDPE casing strings will be joined (‘welded’) at the HDD site or offsite within previously cleared Gorgon tenure and tested either pneumatically or with untreated RO water prior to insertion into the HDD borehole. A push header is to be installed on each casing to prevent material ingress to the casing and lead the casing through the reamed borehole. The push header will incorporate a hydrostatic test header and the casing will be gauged and tested again prior to fitting of the ‘bell mouth‘ to facilitate umbilical installation (Section 2.3.4.1). Test fluids (RO water or seawater +/- additives) will either be retained in the casing for preservation purposes or released at the HDD exit point offshore.

Drilling and casing operations may run 24 hours a day.

2.3.3.1 Drilling Fluids and Cuttings

For all HDD boreholes, drilling fluid is to be used to lubricate the bit, to suspend and transport the cuttings away from the drill face, and to provide hole stability. Consistent with the HDD completed for the existing FGPS, the annulus will be flooded with a low toxicity drilling fluid (sea water with viscosifiers), in accordance with Condition 22 (5) of MS 800, Condition 13 (4)(ii)(e) of MS 769, and Condition 15.5 (v) of EPBC Reference: 2008/4178 and 2003/1294, with a number of other chemicals added to improve the property of the drilling fluids or to solve particular technical problems.

An indication of the chemicals likely to be used in the HDD drilling fluids, and their basic properties, is shown in Table 2–2. Most of these chemicals are considered non-toxic and are widely used in drilling programs throughout Australia. While the exact composition and concentrations of chemicals in drill fluids will depend on the HDD contractor, fluid system selected and subsurface conditions encountered during HDD, only chemicals considered acceptable for discharge to the marine environment (Section 5.6) will be used.

Table 2–2: Drilling Chemicals List for HDD Activities

Product	Primary Application	Average Concentration
Xanthan Gum	Viscosifier	1-14 kg/m^3
Guar Gum	Viscosifier	5-10 kg/m^3
Soda Ash	Reduce hardness, increase pH	0.25-0.5 kg/m^3
Defoamer	Reduce surface tension, prevent aeration of the system	0.3–0.6 L/m^3 0.05 kg/m^3
Tetrakis-Hydroxymethyl-Phosphonium-Sulfate (THPS); Hexahydro-hydroxyethyl-triazine; Isothiazolone	Biocide to prevent bacterial degradation	0.5 L/m^3
Teak Wood Pulp	Lost Circulation Material (LCM) to reduce fluid loss	10–20 kg/m^3

The fluid will be used in a closed-loop circuit where the returns are separated from the suspended cuttings and pumped back down the drill string and recirculated through the borehole, thereby minimising the volume of fluid required. The cuttings are separated from the fluid by passing the returns through a series of screens. A small amount of drill fluid and cuttings is expected to be discharged when the drill breaks through to the seabed at the exit point ~400–550 m offshore. The porous nature of the limestone is also expected to result in drill fluid losses downhole when drilling.

The drill string will be removed at the completion of drilling and reaming and the casing inserted into the annulus. If residual drilling fluids remain in the annulus, the casing will displace up to its equivalent volume of fluid; the displaced fluid will be discharged at the entry and exit points. The fluid discharged at the entry point will be contained at the entry pit and reused for subsequent hole(s). Any excess fluid at the completion of the operation will be collected and stored until residues are removed from the HDD site and appropriately disposed in accordance with the Solid and Liquid Waste Management Plan (Ref. 12).

Cuttings recovered at the HDD hardstand area will be collected and managed in accordance with the Solid and Liquid Waste Management Plan (Ref. 12).

2.3.4 Umbilical Installation

Umbilical casings (630 mm OD HDPE pipe) will be installed during drilling (see above) and messenger wires pulled through the casings from the landfall to the HDD exit point offshore and connected to temporary caps (seal plugs) ready for recovery by the umbilical installation vessel. To protect against corrosion and/or fouling within the casings between casing installation and umbilical installation, the umbilical casing(s) may be filled with nitrogen or treated (e.g. with biocide, oxygen scavenger and/or corrosion inhibitor) seawater/RO water. The treated water (if used) will be partially released when the temporary seal plugs are recovered during each umbilical installation.

A pull-in winch spread(s), typically comprising winch and wire, diesel-powered hydraulic power unit, and sheave block(s), will be set up on the HDD site at each HDD alignment and be used to pull each umbilical through its associated casing. A trial insertion of an umbilical pull-head/dummy pull-head may be undertaken, either via winching from onshore or by pigging.

To facilitate flexibility in execution methodology, the installation of the umbilical to the northernmost HDD alignment only, may involve positioning the winch spread(s) further inland of the associated HDD entry point. This would see a winch spread(s) installation temporarily in the proximity of the existing North Whites Beach communications tower.

After the subsea umbilicals have been pulled ashore through the casings, they will be connected to the onshore umbilicals/cables in subsurface transition splice pit(s) and/or junction centres.

2.3.4.1 Marine Activities

Marine HDD activities are limited to providing vessel tension assistance to drillbit alignment and casing insertion, and vessel-based ROV and/or diver support to monitor/confirm successful exit point breakthrough, complete casing debris clearance and/or testing, and to facilitate winching of the umbilical through the HDD holes from onshore. This will include removal of the push/ test header and attaching a ‘bell mouth‘ to the subsea end of each casing and (depending on timing of offshore installation activities) a seal plug on each bell mouth to prevent ingress of sediments over the period until the marine installation vessels (with umbilical) are in place at the HDD exit point.

These marine activities will require a vessel onsite intermittently for a few days at a time, over a duration of ~5 months. The HDD support vessel will likely require an anchor spread mooring but may use Dynamic Positioning (DP). Anchoring (if required) would be within the MDF and/or previously approved anchoring area designated for installation of the existing FGPS.

At the time of umbilical pull-in operations, the seal plug is removed and a winch wire connected to the pulling head on the umbilical so that it can be winched onshore through its HDD casing. This is considered part of the subsea installation activity and described in CAPL (Ref. 13).

2.3.5 Site Reinstatement and Demobilisation

At the completion of the shore crossing, temporary construction areas used for the HDD work area will be reinstated, unless required for installation/tie in of the

onshore and/or shore crossing umbilical. Reinstatement includes clean up and reconstruction of a site or area to mimic pre-existing landform, ground preparation (ripping, scarifying etc.) and the spread of topsoil and vegetative material.

Depending on the timing of HDD activities relative to the timing of winching/tie in of the shore crossing umbilical, demobilisation and reinstatement of the cleared HDD site (or parts thereof) may be staged over a period of up to 3 years. In the event that cleared areas remain inactive over a significant period, appropriate stabilisation management and monitoring activities will be completed.

At the HDD site, equipment will be dismantled and loaded onto trailers for transportation back to the eastern side of the Island and eventual barging back to the mainland. All concrete structures that are required to be removed will be saw cut or diamond wire cut (where reasonably practicable) into sections and loaded onto trailers for removal as waste. In some instances it may not be practicable to remove these structures. This is particularly the case where concrete has been installed at substantial depth below surface to provide the necessary stability and strength to support HDD activities. Where it is not practicable to remove such structures, they may be left in place consistent with the approved Post-Construction Rehabilitation Plan (Ref. 14), provided they present a low environmental risk.

Excavations will be backfilled and pits emptied. Onshore pumps, filters, and other equipment associated with HDD seawater intake are to be removed. In the event that spare boreholes are installed to provide for future umbilical installation, these will be sealed, preserved and protected for future use. The site will be left free of rubbish, spares, or HDD-specific infrastructure.

Any remaining stockpiled vegetation or topsoil will be left in a stabilised manner to aid future reinstatement of areas required for the onshore umbilical installation, or otherwise managed in accordance with the Post-Construction Rehabilitation Plan (Ref. 14).

Rehabilitation, which includes the ongoing management and monitoring of the site after reinstatement works are completed, will be undertaken in accordance with the Post-Construction Rehabilitation Plan (Ref. 14) and is outside the scope of this Addendum.

2.4 Activity Timeframe

The HDD activities are expected to involve ~20 months of site works, including site preparation and demobilisation, but activity may be staged over a period of up to 3 years. It is anticipated that, to the extent practicable, activities will be scheduled to reduce overlap with the summer cyclone (and turtle nesting) season. The drilling and umbilical installation component of the works are anticipated to take ~ 8 months and run 24 hours a day during HDD drilling and casing activities. Marine vessels associated with the HDD activities will be operating intermittently in the area over a period of ~ 5 months. Table 2–3 summarises key aspects of the timeframe.

Table 2–3: Current Estimate of HDD Activity Schedule

Phase of Construction	Approx. Duration	Operation
Mobilisation and site preparation	7 months	Day shift
Drilling and casing installation	8 months	24-hour
Demobilisation and site reinstatement	5 months	Day shift

Phase of Construction	Approx. Duration	Operation
Marine support vessels	5 months	Intermittent presence. Day shift, 24-hour when required

This schedule is an indicative representation based on the current design. Actual timing, sequencing and duration of each component is subject to change due to regulatory approvals, final contractual arrangements, operational and/or weather delays, and interfaces with both other components of the overall installation program and other operations on Barrow Island and/or in surrounding waters.

2.5 Support Services and Facilities

Construction of the shore crossing requires various support services and/or facilities that are outside the scope of this Addendum including:

- Firefighting: A centralised fire response is available on Barrow Island, including all equipment and trained personnel.
- Fuel Supply: Diesel fuel will be made available from a bowser located in the Barrow Island utilities area and transported to site by tanker truck.
- Logistics: All logistical requirements (including workforce and equipment transfers and housing at Barrow Island) will be managed via existing Barrow Island facilities and processes.
- Quarantine: A Quarantine Management System is in place, including inspections and compliance checks undertaken of all equipment and personnel prior to arriving at Barrow Island.
- Telecommunications: Provision will be made for on-site telephone, data and facsimile lines and radio channels, including upgrade/addition to the telecommunications equipment on the existing communications tower at North Whites Beach
- Waste Management: All wastes managed via the centralised solid and liquid waste handling facilities on Barrow Island.
- Water Supply: Freshwater requirements will be provided via approved facilities and/or capacities on Barrow Island, with dust suppressant additives used to reduce water demand for construction purposes.
- Other Materials: Gravel, for hardstand dressing and maintenance, as well as pre-mixed concrete where required will be provided from approved facilities on Barrow Island.

3 Existing Environment

3.1 Overview

The HDD site for the additional umbilicals overlaps and extends immediately south of the previously disturbed HDD site at North Whites Beach for the existing FGPS (Figure 2-2). Sections 4 and 5 of the HDDMMP (Ref. 1) provide a comprehensive description of the marine and terrestrial environments at this location. Details of the key environmental values specifically relevant to the area of additional disturbance for the umbilicals shore crossing are provided in the following sections.

3.2 Marine Habitats and Fauna

3.2.1 Marine Disturbance Footprint Concept

Section 6 of the HDDMMP (Ref. 1) details the rationale and definition of the MDF. The MDF encompasses the direct footprint of the subsea infrastructure and associated rock stabilisation, and the adjacent area of seabed potentially disturbed by construction or operations activities.

Figure 3-1 shows the MDF associated with the umbilicals HDD shore crossing and the dominant ecological elements within the MDF.

3.2.2 Marine Benthic Habitats

The seabed off North Whites Beach is characterised by fine to coarse sand.

Surveys using drop camera and diver photograph transects covered an area of 2 km^2 around the HDD exit point (Ref. 15) and include the exit point(s) for the additional umbilical(s). Monitoring was also conducted following the HDD for the existing FGPS (Ref. 17,18). These studies indicate that the benthos in the area largely comprises unvegetated or bare sand, or alternatively sand covering a gently sloping limestone pavement (Figure 3-1). The most common benthic primary producer is macroalgae, but coverage is generally sparse with macroalgal assemblages dominated by *Sargassum*. Seagrass was only present at very low levels of cover (~1%) at three of the five sites near the HDD exit points sampled by divers (Ref. 15). Surveys indicate there are no coral assemblages at the HDD breakout area or immediate surrounds, and any isolated colonies that may be present are likely to be dominated by *Turbinaria* spp., which is a widespread and common genus.

3.2.3 Marine Fauna

3.2.3.1 Marine Infauna, Epifauna and Invertebrates

The mobile, medium- and coarse-grained sediments common at the HDD area support infauna and epifauna communities of relatively low abundance and species richness.

Benthic macroinvertebrates in the vicinity of the HDD exits typically comprise low numbers of sponges, sea whips, and *Turbinaria* corals only. All non-coral benthic macroinvertebrate taxa recorded in this area are well represented elsewhere in Barrow Island waters (Ref. 15).

None of the benthic marine invertebrate species in the west coast waters of Barrow Island are considered to be of high conservation significance.

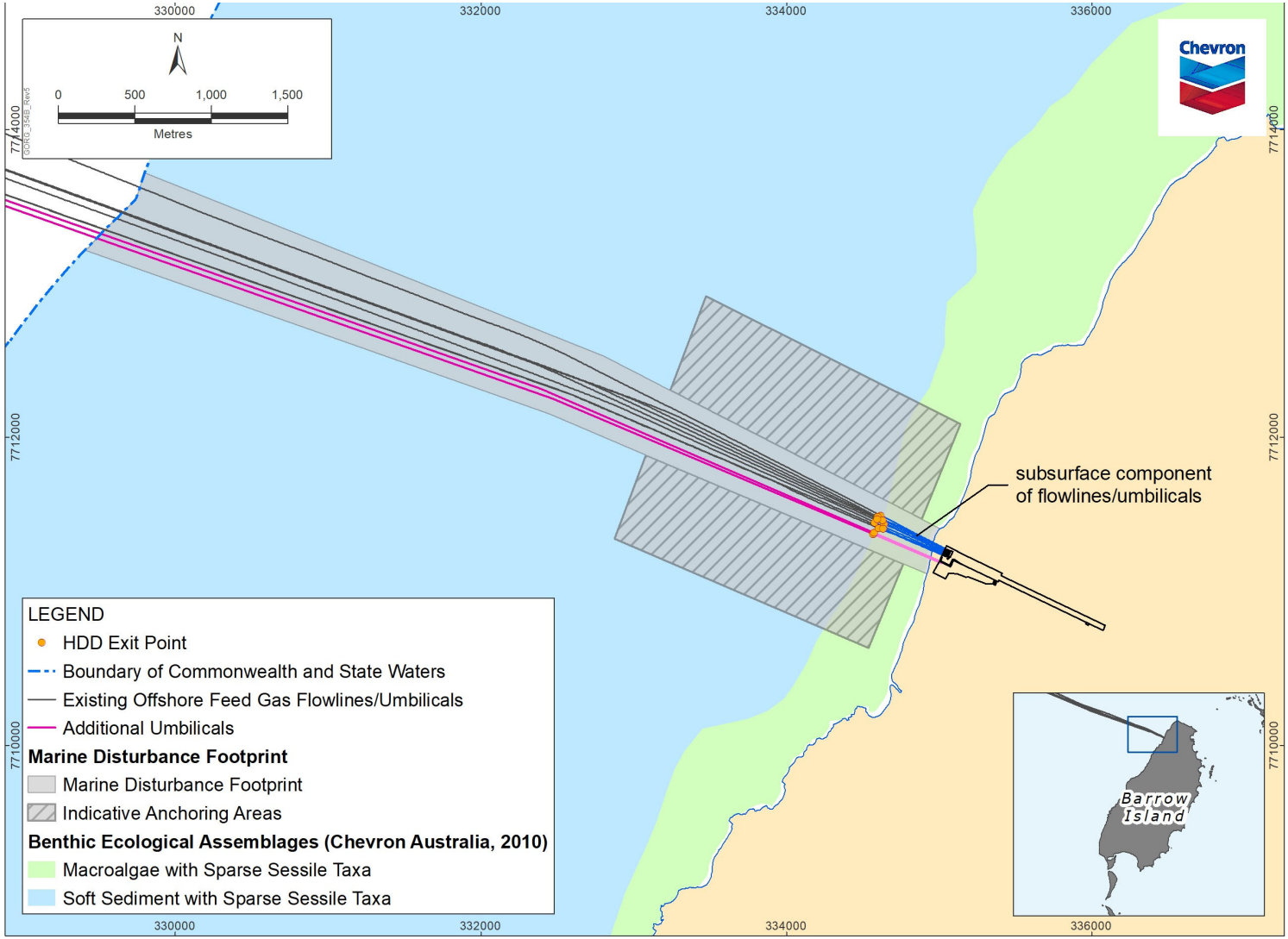

Figure 3-1: Marine Disturbance Footprint Associated with the HDD Shore Crossing

3.2.3.2 Pelagic Fauna of Conservation Significance

Marine megafauna of conservation significance known from the west coast of Barrow Island include sea turtles and whales, notably green turtles and humpback whales, and sharks. Migratory seabirds and shorebirds may also occur, but the beaches and intertidal areas of the north west coast of Barrow Island are not considered to provide important habitat for these avifauna (Ref. 31).

Mapped nesting/internesting buffers (Biologically Important Areas [BIAs]) for loggerhead, flatback, green, and hawksbill turtles all overlap the MDF (Ref. 21), but only green turtles and, to a lesser extent, hawksbill turtles are known to nest on the west coast of Barrow Island. These turtle species are listed as Threatened under both State and Commonwealth legislation (Table 3–1). Barrow Island is a regionally important nesting area for green (and flatback) turtles, whilst hawksbill turtles nest at low densities around the Island (Ref. 22).

Table 3–1: Threatened Marine Turtles Likely to Occur Near the HDD Site

Common Name	Scientific Name	Conservation Status	Comments
Green Turtle	*Chelonia mydas*	Vulnerable	High density nesting on west coast of Barrow Island
Hawksbill Turtle	*Eretmochelys imbricata*	Vulnerable	Low density nesting on west coast of Barrow Island

Green turtles are the most abundant marine turtle species on the west coast of Barrow Island (Ref. 23). Green turtles tend to nest on the west and north-east coasts of Barrow Island where beaches are high energy, deep, steeply sloped, sandy and have an unobstructed foreshore approach (Ref. 24). The shore crossing at North Whites Beach is not a locally important green turtle nesting site because the shallow sand and limestone reef, including a large limestone shelf along the waterline, make the beach unsuitable for nesting (Ref. 24; Ref. 25). Whites Beach, ~500 m south of North Whites Beach, is commonly used as a nesting site, and nesting turtles and hatchlings may be encountered onshore near the shore crossing site. Turtle surveys have shown that green turtle nesting and track activity on North Whites Beach is significantly lower than other beaches (Ref. 24; Ref. 25).

The nesting period for green turtles on the west coast of Barrow Island is between November and February (Ref. 24), with numbers peaking during December and January (Ref. 27). Green turtle hatchlings emerge from the nests from summer to early autumn.

Green turtles also mate and forage close to Barrow Island during the summer breeding season. While most green turtles migrate away from the area after breeding, some appear to be resident at Barrow Island, remaining near the Island during the winter. Resident green turtles browse on the near-shore macroalgal-dominated platform reefs all along the west coast of Barrow Island when the sea is calm (Ref. 28).

Barrow Island is not considered a regionally important nesting site for hawksbill turtles. Hawksbill turtle nesting on Barrow Island typically occurs in low numbers on beaches that are small, shallow and characterised by coarse-grained sand or coral grit interspersed with rocks and beach wrack (Ref. 24). Although their peak nesting period is between October and November, hawksbill turtles have a seasonally diffuse nesting cycle and individuals may nest at any time throughout the year (Ref. 25).

Cetaceans, including humpback whales which are seasonally abundant off the west coast of Barrow Island, are not expected to occur in substantive numbers in the shallow waters surrounding the HDD activities. Humpback whale migration off the west coast of Barrow Island is focused on the 200 m contour with the southerly migration more dispersed in waters of between 50 m and 200 m depth (Ref. 22; Ref. 29).

There are no BIAs in the vicinity of the HDD exit points for any of the conservation significant shark species that may occur off the west coast of Barrow Island (Ref. 21).

3.3 Terrestrial Habitats and Fauna

3.3.1 Disturbance Footprint Concept

The rationale and definition of the Terrestrial Disturbance Footprint (TDF) is detailed in Section 6 of the HDDMMP (Ref. 1). The TDF boundaries defined for construction activities apply to the HDD activities covered by this Addendum, extending horizontally from the boundary of the HDD site area to encompass:

- a TDF of 100 m within which potential impacts from planned stressors may manifest on non-mobile ecological elements (e.g. plants, surface water landforms)
- a TDF of 200 m within which potential impacts to groundwater may manifest
- a TDF of 1000 m within which potential impacts to mobile ecological elements (e.g. fauna) may manifest.

In addition to these horizontal TDF dimensions, a 100 m above-ground and 1 m below-ground TDF applies.

Figure 3-2 shows the horizontal dimensions of the TDF associated with the HDD shore crossing and the ecological elements within the TDF.

3.3.2 Terrestrial Flora and Vegetation

There are no Threatened Flora species (listed under the BC Act or the EPBC Act), listed Threatened Ecological Community (TEC) or vegetative Priority Ecological Community (PEC) on or in the vicinity of the HDD site. No Priority 1 or 2 Flora species as listed by DBCA are predicted to be impacted; the closest recording of a Priority 1 or 2 Flora species is ~1.15 km outside the HDD site (Ref. 30). One Priority 3 species, *Corchorus congener*, may be affected, but this plant is widely distributed across Barrow Island and on the mainland and is not considered as conservation-significant flora on Barrow Island (Ref. 31). A large community of *Erythrina vespertilio,* which is considered a restricted species of flora on Barrow Island, extends over the area north, north east of the HDD site and a few individuals are likely to occur in the area to be disturbed. Botanical survey at North Whites Beach in June and November 2021 (Ref. 30) recorded a total of 697 live *Erythrina* plants in the community, including only six individuals at two positions just within the eastern boundary of the HDD area for the additional umbilicals (Figure 3-3). This species is also known to occur in at least three other populations on Barrow Island (Ref. 32) and is widespread across northern Australia, collected from Shark Bay to the Northern Territory border south of Halls Creek on the mainland (WA Herbarium cited in Ref. 47). None of the other 40 species of significance identified on Barrow Island (Ref. 33) has been recorded in the site.

The vegetation associations mapped at the shore crossing location (within the clearing boundary, and within the 100 m TDF) comprise the same vegetation types that occur within the abutting, previously cleared FGPS HDD site. Table 3–2 summarises the additional disturbance to these vegetation associations, as shown in Figure 3-3.

Table 3–2: Vegetation Communities within the Shore Crossing Area

Vegetation Association		Area mapped on Barrow Island (ha)[1, 2]	Total Area (ha) to be Cleared
C1c1 [3]	*Spinifex longifolius tussock grassland over Threlkeldia diffusa very open herbland with Rhagodia preissii subsp. obovata and Frankenia pauciflora var.pauciflora scattered low shrubs.*	8.24 (8.98)	1.00
C4a1 [3]	*Acacia coriacea subsp. coriacea* shrubland to open shrubland over *Threlkeldia diffusa* low shrubland over *Triodia epactia* hummock grassland to closed hummock grassland.	8.96 (10.29)	0.98
C4a3	*Acacia coriacea* subsp. *coriacea* shrubland to open heath over *Rhagodia preissii* subsp. *obovata* and *Olearia* sp. Kennedy Ranges (G. Byrne 66) low open shrubland over *Triodia epactia* hummock grassland to closed hummock grassland. Sometimes with *Threlkeldia diffusa* scattered shrubs and *Spinifex longifolius* tussock grasses..	5.21 (5.64)	0.46
C4a4	*Acacia coriacea* subsp. *coriacea* tall open shrubland to tall open heath over *A. bivenosa* shrubland to open heath over *Triodia epactia* hummock grassland to closed hummock grassland.	7.24 (7.38)	0.25

Notes:

1. *Areas in parentheses denote area known on Barrow Island prior to Foundation Project vegetation clearing.*
2. *Currently, CAPL has mapped 2733 ha of vegetation on Barrow Island, which is ~11% of the total area of Barrow Island (23 567 ha). Therefore, it is likely that vegetation associations have a greater extent on Barrow Island and actual proportions of specific vegetation associations that may be cleared are less than presented.*
3. *Conservation-significant vegetation: Vegetation restricted in areal coverage on Barrow Island, based on total land area of Barrow Island (Ref. 33).*

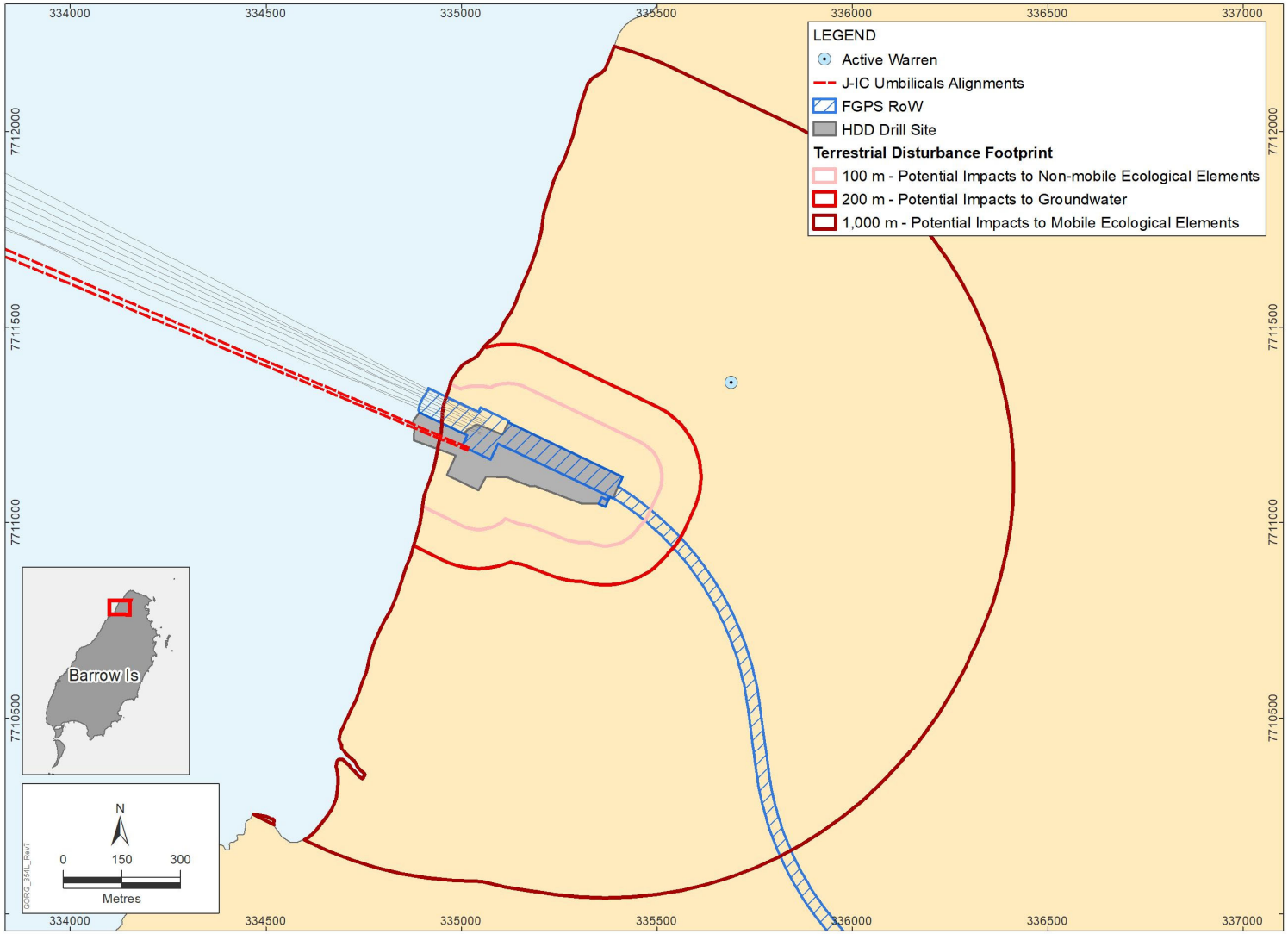

Figure 3-2: Terrestrial Disturbance Footprint Associated with the HDD Shore Crossing for the Additional Umbilicals

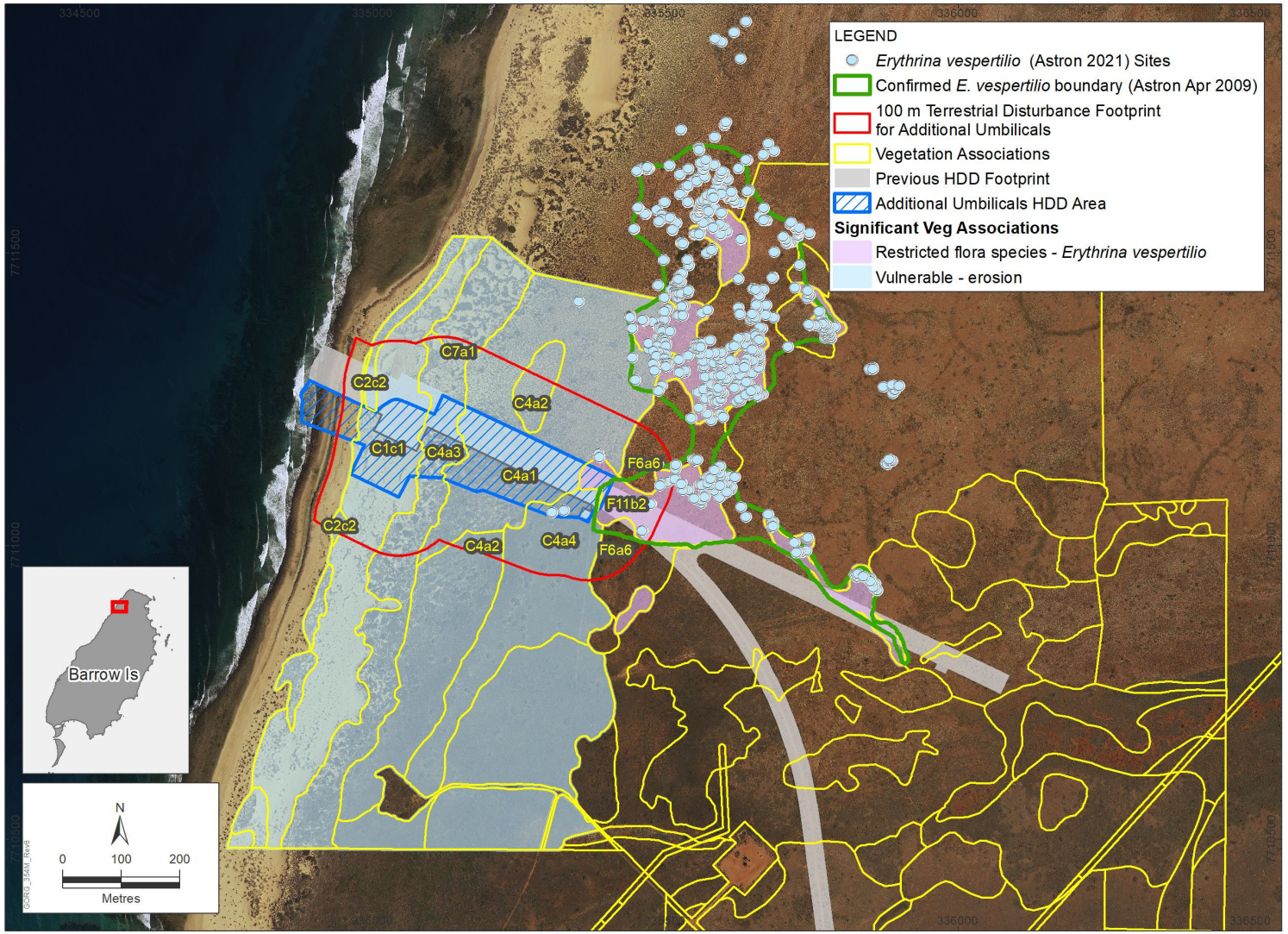

Figure 3-3 Vegetation Communities at the HDD site

3.3.3 Terrestrial Fauna and Habitat

Barrow Island supports 13 species of resident terrestrial mammal, with a further two species of bat recorded as vagrants to the Island, and 43 species of terrestrial reptile (Ref. 35). Five of the resident mammals are listed as threatened under the BC Act (WA) or the EPBC Act (Cth), with an additional one listed as Conservation Dependent under the BC Act (Table 3–3). None of the terrestrial reptile species recorded on Barrow Island are listed as threatened under the BC Act and EPBC Act.

Table 3–3: Protected Mammals on Barrow Island

Common Name	Scientific Name	Conservation Status	Comments
Burrowing Bettong / Boodie	*Bettongia lesueur lesueur*	Vulnerable[1] Specially Protected[3]	Widely distributed on Barrow Island; however, there are no Burrowing Bettong warrens located within 250 m of the HDD site.
Barrow Island Golden Bandicoot	*Isoodon auratus barrowensis*	Vulnerable[1,2]	Widespread and abundant throughout their range on Barrow Island. They are the most abundant mammal on the island with an estimated population of 60 000 to 80 000 (Ref. 34).
Spectacled Hare-wallaby	*Lagorchestes conspicillatus conspicillatus*	Vulnerable[1,2]	Widely distributed on Barrow Island generally inhabiting the tall, dense *Triodia angusta* grasslands of drainage systems. They also forage at night in other areas such as *Melaleuca* spp. and *Triodia* spp. on limestone hilltops. These vegetation species are present within the HDD area and the Spectacled Hare-wallaby may therefore also be present.
Barrow Island Euro	*Osphranter robustus isabellinus*	Vulnerable[1,2]	Small amounts of the vegetation species *Ficus platypoda* may be present within the HDD area and it provides valuable shelter for the Barrow Island Euro.
Black-flanked Rock-wallaby	*Petrogale lateralis lateralis*	Vulnerable[1] Endangered[2]	Largely confined to limestone outcrops on the west of the island; however, their range does not extend as far north as North Whites Beach.
Water Rat	*Hydromys chrysogaster*	Priority 4[4]	Generally inhabit rocky crevices and forage on adjacent sandy beaches and intertidal areas. Tracks have been observed on beaches on the west coast of Barrow Island therefore Water Rats may be present within the HDD area.

Notes:

1: Listed Threatened category under the EPBC Act (Cth)

2: Listed Threatened category under the BC Act (WA)

3: Specially Protected (Conservation Dependent) under the BC Act (WA)

4: DBCA Priority Fauna listing

Several of these species may occur on or in the vicinity of the HDD site. However, there are no fauna habitats unique to the HDD site and none of the terrestrial fauna habitats considered to be significant on Barrow Island (e.g. boodie warrens, termite mounds, raptor nests) are present in the disturbance area. A large part of the area has been previously disturbed during HDD activities for the existing

FGPS and, although subsequently reinstated, is unlikely to have yet fully regained its habitat value.

In general, the fauna habitats at the HDD site are well represented elsewhere on Barrow Island and none of the terrestrial fauna that may occur on the site are expected to be restricted to the HDD area.

3.3.4 Subterranean Fauna and Habitat

Barrow Island's subterranean fauna is considered a Priority Ecological Community (PEC) by DBCA. Subterranean fauna habitat is likely to be widespread on the west coast and across the centre of Barrow Island. However, the HDD site is not expected to be a significant site for subterranean fauna because the coast and hinterlands are typically sandy with minimal karst development (Ref. 22). Furthermore, there is a high likelihood that any fractures and cavities present at North Whites Beach would be sand-filled.

3.3.5 Avifauna and Habitat

Raptor nests, notably for the osprey, are considered a significant habitat type on Barrow Island and have been mapped and monitored under the Terrestrial and Subterranean Environmental Monitoring Program (TSEMP). There are no raptor nests on the proposed HDD site. The nearest identified nest is located on the top of the communications tower located near the south-eastern boundary of the site. It is not known if this nest is currently active.

The White-winged Fairy-wren (Barrow Island) is restricted to Barrow Island and is listed as Vulnerable under the BC Act (WA) and EPBC Act (Cth). Although it is abundant in most habitats on Barrow Island, especially those with complex vegetation structure, it is most commonly associated with *Melaleuca cardiophylla* shrublands. Vegetation within the HDD site may provide habitat for the White-winged Fairy-wren (Barrow Island) which is known to nest across Barrow Island (Ref. 36); however, melaleuca has not been recorded in vegetation monitoring within the HDD site (Ref. 37; 38; 39; 40; 41) and monitoring of White-winged Fairy-wren (Barrow Island) under the TSEMP (Ref. 52) has not identified nesting on the site.

Erythrina shrubland appears to be seasonally important for the Island's population of Singing Honeyeaters. High densities of honeyeaters were observed in February 2006 in the flowering *Erythrina* community located near the HDD site (Ref. 42).

3.4 Socioeconomic Environment

3.4.1 Petroleum Development

Barrow Island is an operating oil field and the offshore waters of the North West Shelf are a significant petroleum production province. However, there is no other petroleum infrastructure (apart from the existing FGPS) in the vicinity of the onshore or offshore HDD areas.

3.4.2 Shipping

Commercial ships are very unlikely to transit through the shallow waters of the HDD work area close to Barrow Island.

3.4.3 Commercial Fishing

A number of State managed commercial fisheries are authorised to access waters surrounding Barrow Island. However, little to no activity from these fisheries is expected in the shallow waters in the vicinity of the HDD work area.

3.4.4 Recreational Fishing

The majority of the regional population is located near the mainland coast, which means fishing, diving and other marine-based recreational pursuits are common. Small boat fishing is very popular in the Exmouth and Dampier areas, but recreational fishing vessels are unlikely to operate within the vicinity of the shore crossing.

3.4.5 Aquaculture

The proposed shore crossing is not within any aquaculture areas/zones. The nearest pearl farm lease is located in the sheltered waters of the Montebello Islands.

3.4.6 Tourism

The tourism industry is important in the region, but is oriented towards activities in the waters near the mainland or coastal islands. Access to and around the waters near the HDD activities for tourism is unlikely.

3.4.7 Marine Conservation Reserves

The Montebello-Barrow Islands Marine Conservation Reserves are located between 60 and 100 km off the north-west coast of WA, ~1600 km north of Perth (Ref. 43). The Montebello-Barrow Islands Marine Conservation Reserves comprise:

- the Montebello Islands Marine Park, which includes the waters around the Montebello Islands
- the Barrow Island Marine Park, encompassing Biggada Reef, which is one of two examples of significant fringing reef that occur in the reserves, as well as Turtle Bay, a significant aggregation/breeding area for green turtles
- the Barrow Island Marine Management Area, which includes waters surrounding Barrow Island and some of the waters around the Lowendal Islands.

The HDD exit points are within an unzoned multi-use (conservation, recreational, scientific and commercial purposes) area of the Barrow Island Marine Management Area. The Barrow Island Marine Park on the west coast of the Island is (at its nearest) >6 km away from (south of) the HDD area.

3.4.8 Cultural Heritage

Cultural heritage surveys undertaken over the onshore HDD area have not identified any heritage sites (Ref. 31).

Due to the history of Barrow Island, it is feasible that cultural heritage materials may be discovered during the project. Areas considered to have the potential to host surface or subsurface cultural heritage materials on Barrow Island typically include claypans, coastal dunes and areas adjacent to drainage lines.

No shipwreck sites or materials have been identified during the numerous surveys of the subsea FGPS shore approach at North Whites Beach (Ref. 31) or via search of the Underwater Cultural Heritage Database (Ref. 45).

4 Risk Assessment

Risk is the combination of the potential consequences arising from an environmental stressor, together with the likelihood of the stressor occurring and resulting in the consequence. CAPL has developed an internal risk management process using the Chevron Integrated Risk Prioritization Matrix (Appendix A). An environmental risk assessment for HDD for the additional umbilicals was completed using the same methodology described in Section 6 of the HDDMMP (Ref. 1).

4.1 Methodology

The main components of the internal CAPL risk assessment methodology include:

- **Specify causes:** Identify possible causes or conditions resulting in a stressor.
- **Determine potential consequences:** Determine the level of harm that could be associated with the stressor.
- **Identify and evaluate safeguards:** Identify design features and operating controls that manage the stressor or otherwise prevent exposures that can result in harm.
- **Apply the Integrated Risk Prioritization Matrix:** Using the Chevron Integrated Risk Prioritization Matrix (Appendix A), assign consequence magnitude and likelihood indices to obtain a risk priority ranking:
  - **Consequence magnitude index:** Maximum credible level of harm that could be associated with the stressor – safeguards *are not* taken into account.
  - **Likelihood index:** Expected frequency of the consequence magnitude occurring – safeguards *are* taken into account.
- **Recommend further study or risk mitigation:** Apply qualitative risk criteria and risk management guiding principles to guide further risk reduction actions, if required.

Using the Chevron Integrated Risk Prioritization Matrix, identified risks are categorised into four groups (Table 4–1), which determine the level of response and effort in managing the risks. If it is demonstrated that the cost[1] of implementing further risk reduction measures is disproportionate to the benefit gained, the risk is considered to be as low as reasonably practicable (ALARP).

Table 4–1: Risk Levels and Risk Tolerability

Risk Level	Description	Additional Risk Reduction
1, 2, 3, 4	Intolerable	Short-term, interim risk reduction required. Long-term risk reduction plan must be developed and implemented.
5	Tolerable (if ALARP and long-term risk reduction)	Risk is tolerable if reasonable safeguards / management systems are confirmed to be in place and additional long-term risk reduction is undertaken.
6	Tolerable (if ALARP)	Risk is tolerable if reasonable safeguards/management systems are confirmed to be in place.
7, 8, 9, 10	Risk Reduction Not Required	No further risk reduction required. Risk reduction at management/team discretion.

[1] Cost includes financial cost, time or duration, effort, occupational health and safety risks, or environmental impacts associated with implementing the control.

As indicated in Table 4–1, only risk levels 1 to 6 are considered to require risk treatment to reduce them to ALARP. However, all identified risks are further evaluated in relation to their potential impact on the receiving environment and proposed management measures or controls are described (see Section 4.2).

4.2 Outcomes

Stressors from activities associated with the HDD for the additional umbilicals that were identified by the risk assessment as requiring management under this Addendum comprised:

- atmospheric emissions
- clearing and earthworks
- seabed disturbance
- artificial lighting
- noise and vibration
- planned discharges (marine)
- physical interaction
- leaks and spills.

A detailed description of the risks to the environment from each of these stressors, along with the associated management measures, is provided in Section 5. The risk assessment found that with appropriate management, including the measures described in Section 5, the residual risk from the HDD for the umbilicals shore crossing is tolerable and further risk reduction is not required.

5 Management Measures

This Section describes the management measures relevant to this Addendum that CAPL has developed to reduce the impacts from HDD activities as far as practicable and to ensure HDD activities do not cause Material or Serious Environmental Harm outside the Terrestrial and Marine Disturbance Footprints associated with those activities, or the coral loss limit in Condition 15.6 to be exceeded.

Management measures listed in Sections 5.1 to 5.8 correspond to stressors identified by the risk assessment (Section 4.2) from the activities described in Section 2, and include those that apply to the relevant matters of NES identified in Section 3. Note that management of some aspects/stressors is addressed on a Development-wide basis through other approved management systems, plans, and procedures and is not duplicated in this Addendum. These include:

- Wastes management – addressed by the Solid and Liquid Waste Management Plan (Ref. 12)
- Quarantine management – addressed by the Terrestrial and Marine Quarantine Management System (Ref. 44)
- Fire management – addressed by the Fire Management Plan (Ref. 46).

5.1 Atmospheric Emissions

Hazard	
Changes to air quality can occur as a result of emissions of dust, air toxics, ozone depleting substances, and greenhouse gases (GHG) from shore crossing activities.	
Potential Consequence Summary	**Ranking**
Dust has the potential to adversely impact human health, visual amenity, vegetation and fauna in the immediate area. Elevated concentrations of air toxics have the potential for adverse effects on human health, vegetation or fauna while GHG emissions and/or ODS may result in contribution to the reduction of the global atmospheric carbon budget. Dust will be generated at the HDD site due to machinery movements during clearing, material movements during stockpiling activities, and dust generated from unpaved surfaces, either by wind action or by moving equipment and vehicles. These dust emissions are likely to be greatest during earthmoving activities but may continue to occur over the duration of the shore crossing activities until the site is reinstated. Ozone depleting substances (ODS) may be present onsite in air conditioners and refrigerators in work areas and crib rooms. Amounts held onsite are likely to be minor and are not anticipated to be released into the environment during construction. Exhaust emissions from vehicles and plant during the shore crossing works may contribute to a localised reduction in air quality via emission of various air toxics. Equipment to be used includes the drilling rig, graders, haul trucks, excavators, light vehicles and various other plant and equipment. Typically, these are diesel powered. Common emissions from exhausts include carbon monoxide, carbon dioxide, particulates, and ozone. Exhaust gases may also contribute to reduction of the global carbon budget. There is no public access to Barrow Island and no accommodation facilities in proximity of the HDD site. Potential receptors are therefore the construction workforce and vegetation and/or fauna of adjacent areas. Given the localised, transient (mobile) and short term (overall) nature of effects, the potential consequence is considered ***Incidental (6)***.	**Incidental (6)**

Management Measures
Performance Standards / Control Measures
Construction vehicles and equipment will be regularly maintained.

Management Measures
Vehicle movements reduced by measures such as: • using buses for personnel transfer • limiting the number of light vehicles available to personnel • considering vehicle movements in daily planning activities to eliminate unnecessary movements.
An IVMS will be installed in light vehicles to manage vehicle movements and speeds within the ROW
Any systems containing ODS that require recharging or replacement will be exchanged to a non ODS system.
Dust management procedures developed and include the requirement to implement dust suppression methods.
Dust suppression techniques employed where material cannot be stabilised e.g. water carts, sprays, dust suppressants (eg Dustex), dust guards, windbreaks or covers.

Likelihood and Residual Risk Summary		
Likelihood	Earthmoving activity at the HDD site is largely restricted to site preparation and reinstatement which are of short duration and the potential for significantly elevated dust and/or pollutant concentrations due to shore crossing works is limited. Monitoring of vegetation and fauna within the TDF and at reference sites during the much larger feed gas pipeline construction program did not detect any adverse impacts attributable to dust or air pollutant levels resulting from construction activities. With the proposed management measures in place, the likelihood of atmospheric emissions due to the shore crossing works reducing local air quality beyond relevant health standards or generating a material change in regional or global GHG or ozone levels is considered ***Remote (5)***.	**Remote (5)**
Residual Risk	**Low (10)**	

5.2 Clearing and Earthworks

Clearing and earthworks will be necessary during site preparation to provide a suitable work site for the HDD activities. Clearing and shallow excavation (e.g. dune and topsoil removal) are likely to extend across the entire area (~5 ha) of the HDD site, with deeper excavations required for the seawall and foundations. Clearing and earthworks have the potential to:

- Alter landform and/or disturb cultural heritage values within the HDD site
- Remove vegetation and habitat within the HDD site
- Cause erosion/sedimentation in adjacent areas outside the HDD site.

5.2.1 Landform and Heritage

Hazard	
Earthworks will alter land surface contours and disturb soils, potentially causing loss of landform features and cultural heritage values.	
Potential Consequence Summary	**Ranking**
The shore crossing will occur at North Whites Beach, where the predominant landforms comprise coastal dune and foreshore (beach). Coastal dunes are considered a significant landform on Barrow Island (Ref. 47). The shore crossing area comprises approximately 0.5 % of the mapped dune landform on Barrow Island. The west coast of Barrow Island is a high energy environment subject to prevailing winds and waves, and once exposed these disturbed	**Major (3)**

Hazard	
areas may experience ongoing erosion such that natural recovery of existing landforms could require an extended period of time. Coastal dune areas on Barrow Island are recognised to have the potential to host surface or subsurface cultural heritage materials which may be inadvertently damaged during ground-disturbing activities. Therefore, the potential worst-case consequence is considered to be localised loss of cultural heritage values. In accordance with the Integrated Risk Prioritization Matrix (Appendix A), the potential consequence is considered to be ***Major (3)***.	

Management Measures
Performance Standards / Control Measures
Clearing and earthworks managed in accordance with Ground and Vegetation Disturbance Form, as required under the PTW system
Reinstatement of landforms as required by Post-Construction Rehabilitation Plan (Ref. 14)
Potential disturbance of cultural heritage values managed per Aboriginal Cultural Heritage Management Plan (Ref. 48), including: • If surface or buried cultural heritage material is uncovered within the construction area, all construction work in the immediate vicinity of the material will cease until further notice. • An archaeologist or physical anthropologist with appropriate experience will be engaged in the event of discovering human remains in the clearing or work area.

Likelihood and Residual Risk Summary		
Likelihood	The use of HDD will essentially avoid disturbance to the foreshore. Post-installation reinstatement of disturbed dunes, including re-establishing ground contours, collection and direct replacement of soils, and monitoring/adaptive management will reduce the potential for long term impacts on landforms. Experience with reinstatement of excavated areas in the immediately adjacent and larger HDD site for the Feed Gas Pipeline Systems indicates the dunes can be successfully re-established. The HDD site has been surveyed for cultural heritage significance with no sites identified and, with appropriate management of any inadvertent discoveries, damage to heritage values is not expected. With the implementation of approved approaches to optimise rehabilitation of disturbed areas and to manage any heritage materials, in accordance with the Post-Construction Rehabilitation Plan (Ref. 14) and Aboriginal Cultural Heritage Management Plan (Ref. 48) respectively, the likelihood of earthworks subsequently resulting in the long-term reduction of landform or the loss of heritage values in the HDD site is considered ***Remote (5)***.	**Remote (5)**
Residual Risk	**Low (7)**	

5.2.2 Vegetation and Fauna Habitat

Hazard	
Clearing and earthworks may remove vegetation and disturb any structural habitat, potentially causing changes in vegetation and ecological community structure, composition, and diversity.	
Potential Consequence Summary	**Ranking**
The HDD site has previously been partially cleared, however approximately 3 ha of undisturbed vegetation will be removed for site preparation. Clearing of this vegetation will locally remove vegetation cover and any associated habitat values, and disturbance to regrowth in the previously cleared area will delay the re-establishment of the pre-existing communities and habitat. In the absence of controls, the removal of topsoil and changes to	**Major (3)**

Hazard	
landform and soil structures due to earthworks could result in ongoing erosion and an extended period before the area regained any vegetation and fauna habitat values. Therefore, the potential worst-case consequence is considered to be localised loss of vegetation and habitat values. In accordance with the Integrated Risk Prioritization Matrix (Appendix A), the potential consequence is considered to be ***Major (3)***.	

Management Measures
Performance Standards / Control Measures
Clearing and earthworks managed in accordance with Ground and Vegetation Disturbance Form, as required under the PTW system
Topsoil handled in accordance with Post-Construction Rehabilitation Plan (Ref. 14)

Likelihood and Residual Risk Summary		
Likelihood	The extent and duration of effects to vegetation and habitat from clearing and earthworks in the HDD site will depend on the extent and rate at which these areas will recover from disturbance. The HDD site does not contain threatened, Priority one or Priority two flora or any unique or restricted habitats of particular importance to fauna, such as boodie warrens. Monitoring of rehabilitation progress in disturbed areas reinstated following disturbance for the existing Feed Gas Pipeline Systems, including the adjacent HDD site, has confirmed that the areas are performing well with respect to lack of erosion and visual amenity, with most sites stabilized and undergoing anticipated successional changes. With the implementation of approved approaches to optimise rehabilitation, including landform reinstatement, collection and direct replacement of topsoil, and monitoring/adaptive management in accordance with the Post-Construction Rehabilitation Plan, the likelihood of disturbance subsequently resulting in the long-term loss of vegetation and fauna habitat in the area is considered ***Remote (5)***.	**Remote (5)**
Residual Risk	**Low (7)**	

5.2.3 Erosion and Sedimentation

Hazard	
Clearing and earthworks within the HDD site, including stockpiling of topsoil, have the potential to cause erosion or sedimentation in adjacent areas which may result in loss of vegetation and ecological community structure, composition, and diversity.	
Potential Consequence Summary	**Ranking**
The HDD site is relatively small and the volumes of disturbed soil, including topsoil, stored onsite that could be mobilised in the event of significant rainfall are limited. Nevertheless, wind and water erosion impacts can occur once sites have been disturbed and the coastal vegetation associations found at the HDD location are considered vulnerable to erosion. Without management, disturbed coastal dune/foreshore areas may be prone to 'blowouts' where vegetation is unable to establish. Therefore, the potential worst-case consequence is considered to be localised and long-term loss of flora and vegetation. In accordance with the Integrated Risk Prioritization Matrix (Appendix A), the potential consequence is considered to be ***Moderate (4)***.	**Moderate (4)**

Management Measures
Performance Standards / Control Measures
Temporary drainage management design incorporated into HDD site layout

Management Measures
Clearing and earthworks managed in accordance with Ground and Vegetation Disturbance Form, as required under the PTW system
Implementation of relevant pre and post construction drainage management measures described in the Post-Construction Rehabilitation Plan, specifically Table 4-1 in that Plan (Ref. 14)

Likelihood and Residual Risk Summary		
Likelihood	Average rainfall on Barrow Island is low and significant rainfall events are relatively infrequent. Temporary drainage management structures included in the design of the HDD site, including the soil stockpile areas, will reduce potential for erosion/sedimentation impacts to adjacent areas. Site reinstatement in accordance with the Post-Construction Rehabilitation Plan reduces the likelihood of longer-term erosion effects and proved effective in stabilising dune areas following the more extensive earthworks associated with the Feed Gas Pipeline Systems HDD. The vegetation in areas adjacent to the HDD site does not have particular conservation or ecological values and any effects are expected to be temporary. Therefore, with the implementation of established and proven controls to reduce erosion/sedimentation risks, the likelihood of long-term loss of vegetation values outside the HDD site as a result of erosion/sedimentation caused by clearing and earthworks within the HDD site is considered ***Unlikely (4)***.	**Unlikely (4)**
Residual Risk	**Low (7)**	

5.3 Seabed Disturbance

Drilling breakout at the offshore HDD exit point(s) will permanently displace a small area of seabed. However, this disturbance falls within the area where the umbilical will subsequently enter the borehole and be stabilised through rock cover – accordingly the impacts are addressed in the management plan for offshore installation (Ref. 13).

Other potential disturbance to the seabed associated with shore crossing activities will be temporary, resulting from the anchoring of the HDD support vessel(s), the footprint of the water winning pump and associated components (eg clump weights), and unplanned events such as dropped objects or vessel grounding.

Hazard	
Anchoring and installation/securing of the water winning pump can cause temporary direct disturbance to the seabed where the anchor/pump and associated chains, clump weights or hoses contact the seabed. Dropped objects or grounded vessels will disturb an area equivalent to the contact footprint. These activities, particularly anchor retrieval, will also cause sediment to be temporarily suspended in the water column and subsequently settle onto adjacent areas.	
Potential Consequence Summary	**Ranking**
Disturbance to the seabed can destroy or reduce the geographical extent of benthic features that have conservation significance (e.g. shipwrecks, KEFs), reduce local ecosystem productivity (by disturbing benthic primary producers) and/or affect fauna through reduced/altered habitat values. Consequences could be elevated if the affected area represents unique or restricted habitat of importance to threatened fauna species. There are no KEFs at or near the HDD exit point and surveys have confirmed that there is very limited BPPH in the area (Ref. 15; Ref. 16). BIA for several marine turtle species that may use the seabed extend over State waters off the entire north-west coast of Barrow Island (Ref. 21). The potential extent of short-term disturbance to the seabed within these BIA due to the HDD activities represents a very small proportion of the available habitat. Currie and Parry (Ref. 49)	**Major (3)**

Hazard	
noted that soft sediment communities are able to recover within 14 months of mechanical disturbance. The turbidity caused by HDD activities, including anchor retrieval, is expected to cause a highly localised and short-term increase in suspended sediment concentrations, dissipating rapidly once the activity is completed. Compared to natural events such as storms and cyclones that occur off the west coast of Barrow Island, which often cause large amounts of sediment to be lifted into the water column over wide areas, the turbidity generated from the installation activity represents only a minor source of localised resuspended sediment at any location. Therefore, the potential worst-case consequence is considered to be localised loss of heritage values due to inadvertent damage during the marine shore crossing activities. In accordance with the Integrated Risk Prioritization Matrix (Appendix A), the potential consequence is considered to be ***Major (3)***.	

Management Measures
Performance Standards / Control Measures
Water winning spread installation, HDD exit point, and anchoring are confined to within the approved MDF, as defined in Coastal and Marine Baseline State and Environmental Impact Report: Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing (Ref. 50).
For vessels that anchor, anchoring will be managed in accordance with maritime industry standard watchkeeping practices, e.g. STCW2010.
Where anchoring is required, a mooring analysis is conducted prior to anchoring and considers: • substrate type • tides • weather conditions to reduce the risk of anchor drag in conservation significant subtidal habitats.
Anchoring will be undertaken in accordance with Chevron Marine Standard (Ref. 51)
A 24-hour visual, radio, and radar watch will be maintained for vessels in the vicinity of the Operational Area in accordance with AMSA and/or Standards of Training, Certification and Watchkeeping (STCW2010) (1978 STCW Convention)
Lost object recovered where safe and practicable, and offers net environmental benefit
Pre-installation seabed survey to confirm HDD exit point and anchoring locations identifies any apparent shipwrecks
If any shipwreck or relics are discovered during the proposed activities, DAWE Maritime Heritage Section will be notified, including: • a detailed description of the remains of the shipwreck or the relic, which may include sonar images, electronic data, and/or digital photographs • a description of the place where the shipwreck or relic is located that is sufficiently detailed to allow it to be identified and relocated, including navigation data and datum information
Should any shipwreck or relics be discovered during the proposed activities, all Project vessels will be notified of the location.

Likelihood and Residual Risk Summary		
Likelihood	The use of HDD will largely avoid disturbance to the seabed and associated habitats within ~400 - 550 m of the shore, including the areas that support BPPH. Fish and other mobile fauna (e.g. marine turtles) are unlikely to be at any risk of physical impact or behavioural consequences due to the localised and short-term turbidity caused by the shore crossing activities. Mobile fauna may temporarily avoid the immediate area, but they are expected to move back into the impacted areas shortly after the completion of these activities. There are no known maritime heritage sites at the offshore HDD exit point or designated anchoring areas and these areas will be subject to seabed	**Remote (5)**

	survey before installation activities commence. The probability of vessel grounding is inherently low and with the management applied to reduce the potential for anchor drag and/or vessel grounding, the area that will be temporarily affected during HDD is likely to be small. The benthic habitats involved are widespread, with limited BPPH present. Monitoring during and after the larger scale HDD for the Feed Gas Pipeline Systems showed no significant impacts on ecological elements within the MDF (Ref. 19, 20). Therefore, the likelihood of the shore crossing activities resulting in the long-term loss of marine heritage or fauna habitat values is considered ***Remote (5)***.	
Residual Risk	**Low (7)**	

5.4 Artificial Lighting

Hazard	
Artificial light has the potential to alter the behaviour of fauna and reduce their chances of survival (e.g. through misorientation and exhaustion, or predation).	
Potential Consequence Summary	**Ranking**
Particular values and sensitivities considered at greatest risk of exposure to artificial light emissions from shore crossing activities were identified to be marine turtle nesting. Turtle surveys have shown that Green Turtle nesting and track activity is significantly lower at North Whites Beach than other beaches because the shallow sand and limestone reef platform at the waterline make that location unsuitable for nesting (Ref. 26). Whites Beach, ~500 m south of the HDD shore crossing, and Tortuga Beach and Flacourt Beach more than 2 km from the shore crossing are more commonly used nesting sites (Ref. 23). Where artificial lighting is used in the vicinity of the HDD shore crossing, there is the potential for behavioural change impacts to marine turtles (adults or hatchlings) if night works coincide with the nesting/breeding cycle of marine turtles. Elevated light levels can be detrimental to marine turtles because they can disrupt visual cues and alter behaviour (Ref. 66; Ref. 67; Ref. 68). Although turtle nesting at the shore crossing is significantly lower than on other beaches, Whites Beach (~500 m south of the shore crossing) is more commonly used as a nesting site (Ref. 23) and there is the potential for localised and short-term misorientation effects to individual hatchlings at Whites Beach. These misorientation effects may lead to increased predation or dehydration of marine turtle hatchlings, but given the limited exposure to turtle nesting beaches and subsequent limited exposure to local populations, consequences are expected to be localised and involve only a portion of the population. In accordance with the Integrated Risk Prioritization Matrix (Appendix A), the potential consequence is considered ***Minor (5)***.	**Minor (5)**

Management Measures
Performance Standards / Control Measures
Where practicable, night shift activities will be scheduled to avoid the turtle nesting and hatchling seasons. If night time activities are to be undertaken during turtle nesting season (October to April), contractor required to develop and implement a Lighting Management Procedure (LMP) that describes strategies to reduce lighting to the minimum necessary for safe operations and addresses the following measures to reduce light emissions: • light sources, including headlights of parked vehicles, located in such a way as to avoid illuminating beach areas, where practicable • lighting to be switched off when not in use and/or automatic timers/sensors installed • the use of shielded light fittings, directed lights and/or screens • lights to be mounted as low as practicable and focused on areas being worked on • where colour definition is not required for safety or operational purposes, lighting types that have reduced risk to turtles • fitting of blinds or curtains on windows to block out internal light sources.

Likelihood and Residual Risk Summary		
Likelihood	Shielded and directional lighting within the HDD site is not expected to, generate light spill to beaches with the intensity that might disrupt nesting activity. The potential for HDD lighting to attract or disorientate turtle hatchlings is considered to be limited. Results of the Barrow Island Hatchling Orientation Monitoring Program during season 2010–2011 suggested that artificial light from construction activities at the HDD site during the much larger HDD program for the Feed Gas Pipeline Systems did not result in hatchling orientation varying beyond that observed in baseline studies (Ref. 26). Therefore, with the implementation of the lighting management measures proposed, the likelihood of HDD night works resulting in the disorientation and mortality of particular values and sensitivities, particularly turtle hatchlings, is considered ***Unlikely (4)***.	**Unlikely (4)**
Residual Risk	**Low (8)**	

5.5 Noise and Vibration

Hazard	
The generation of noise and vibration from drilling, vehicles, construction equipment and vessels has the potential to result in fauna disturbance and behavioural changes.	
Potential Consequence Summary	**Ranking**
Impacts from noise and vibration on fauna can be indirect or direct, and include: • behavioural responses, including startle and/or avoidance of noise/ vibration sources and interruption of acoustic communications • indirect impacts on predators with fixed foraging ranges if prey species avoid an area • temporary shifts in an animal's hearing ability • acoustic trauma, e.g. damage to hearing organs • physical impact on burrows or turtle nests from vibration. These impacts can have consequences on the fitness and/or survivability of individual animals, or on local populations if important behaviours are interrupted over an extended period. The noise associated with the HDD activities does not generally have the intensity to result in permanent acoustic damage to fauna. The separation distances to boodie warrens and turtle nests makes vibration impacts highly unlikely, with monitoring at Whites Beach during HDD for the Feed Gas Pipeline Systems revealing no increase in vibration from baseline levels (Ref. 31). However, irregular loud noise from construction machinery or from vessels holding station with DP is expected to have a short-term behavioural impact on animals in the local area, with fauna potentially temporarily avoiding or vacating the immediate area, returning to normal behaviour when the noise has stopped. The particular values and sensitivities with the potential to be exposed to noise emissions include: • White-winged Fairy-wren • Seabirds and migratory shorebirds • Pygmy blue Whale • Humpback Whale • Green, Hawksbill, Loggerhead, Flatback Turtles The HDD site and immediate surrounds do not have particular value to any of these fauna, which all have widespread distributions on/around Barrow Island, and the number of any of these species that might occur within areas sufficiently close to noise generating activities to be adversely affected is expected to be relatively low. There are no	**Minor (5)**

Hazard	
geomorphological features that would prevent noise-sensitive fauna, including cetaceans, undertaking avoidance to maintain separation from the noise source. Therefore, the potential worst-case consequence is localised and short term behavioural disturbance and, in accordance with CAPL's Integrated Risk Prioritization Matrix, is considered ***Minor (5)***.	

Management Measures
Performance Standards / Control Measures
Equipment covers, mufflers and/or other noise suppression equipment fitted to combustion engines and other noise generating equipment (e.g. generators)
Vehicles and equipment maintained in accordance with Contractor's planned maintenance schedule (PMS)
Driving on the beach during turtle nesting and hatching season (October to April) is prohibited unless required under specific or unusual conditions (e.g. to access a frac-out site) and an internal permit is obtained. Driving on the beach is to be avoided at all other times where practicable.
Vessels will adhere to Part 8 of the EPBC Regulations 2000 and Division 2 of the BC Regulations 2018 where practicable for potential interactions with fauna, including: • establishing a caution zone around prescribed fauna defined as an area around the animal with a radius of 30 m for a whale shark, 100 m for a dugong or seal, 150 m for a dolphin and 300 m (or 100 m to the side) for a whale. Within the caution zone: • operate the vessel at a constant speed of less than 6 knots and minimise noise • post a lookout for fauna.

Likelihood and Residual Risk Summary		
Likelihood	With restrictions on beach access and separation distances to potentially sensitive habitats, adverse vibration effects on fauna from HDD activities are not anticipated. Monitoring undertaken during HDD for the existing Feed Gas Pipeline Systems found no changes in vibration levels at Whites beach. The shore crossing activities are expected take approximately one year in total with activities that generate the most elevated levels of noise (e.g. drilling, DP) relatively short term. The particular values and sensitivities that may be affected by construction noise have seasonal variations in presence/behaviours and the areas close to HDD activity do not provide habitat of unique or restricted value. Therefore, the likelihood that any localised and short-term disturbance to fauna behaviours will have consequences to survivability or reproductive success in particular values and sensitivities is considered to be ***Unlikely (4)***.	**Unlikely (4)**
Residual Risk	**Low (8)**	

5.6 Planned Discharges (marine)

During HDD there will be some loss of drilling fluids to the nearshore marine environment at the seabed breakout point ~400 – 550 m offshore. Treated fluids used to hydrotest the installed casings will be released at the completion of the test. Liquid wastes will also be generated during the HDD activity as a result of supporting vessel operations, and may include:

- cooling water
- sewage, greywater, and putrescible wastes

- deck drainage and bilge water
- brine.

Hazard	
Marine discharges from the activity have the potential to cause a decline in water and sediment quality, and toxicity to marine organisms.	
Potential Consequence Summary	**Ranking**
The impacts from discharges to the marine environment depends on the chemical characteristics, rate and volume of discharge, and the capacity of the receiving environment to dissipate or assimilate the constituents such that concentrations remain below thresholds for adverse effects, which is largely influenced by local metocean conditions. Drilling fluids contain barium and a variety of additives to improve drilling performance and reduce downhole losses. Some drilling fluid may be released at the seabed when the drillbit breaks through, approximately 400 – 550 m offshore. Up to 300 m^3 of treated hydrotest water (likely treated seawater) may also be released from each casing exit point at the completion of testing. The discharge of these fluids could locally increase turbidity/sediment deposition, alter water/sediment characteristics and/or cause toxicity to marine life in the vicinity of the discharge. The volumes of vessel wastes generated during the HDD marine support works is related to the number of persons on board. While not yet fully defined, this is expected to involve up to the following approximate total daily volumes: • 2-22 m^3 of sewage and greywater • 0.2 m^3 of putrescibles • 35 m^3 of brine Sewage and putrescibles contain nutrients, cooling water has elevated temperature and brine from onboard RO is typically 10% higher salinity than seawater. These discharges and deck drainage may also contain low concentrations of hydrocarbons or chemicals (e.g. chlorine, cleaning agents) that are toxic to marine life. Bilge water typically contains oils/greases from onboard engines. Values and sensitivities identified with the potential to be present in the vicinity of marine discharges during HDD works include: • foraging and inter-nesting marine turtles • foraging marine avifauna • resident dolphin populations. The west coast of Barrow Island is a high energy, open ocean environment where discharges can be expected to be rapidly dispersed. Given the short duration and relatively low volumes of discharge and the absence of conservation significant sessile receptors at the HDD breakout point, the consequences of any temporary and localised changes in water quality are considered to be ***Minor (5).***	**Minor (5)**

Management Measures
Performance Standards / Control Measures
Only water-based, biodegradable polymer drilling fluid used for HDD
All planned hazardous chemical discharges (including drilling fluids) shall be assessed and deemed acceptable before use, in accordance with the ABU Hazardous Materials Management Procedure (Ref. 69)
To the extent practicable, drilling fluids will be re-used/ recycled and managed via onsite controls that include: • ongoing monitoring of mud levels • ongoing monitoring of down-hole pressures (build-ups and losses) • drilling contractor's Frac-out Management Plan and experienced personnel • visual inspections by spotters on a regular basis whilst drilling, and particularly during pilot hole drilling where the risk of frac-out is generally higher than when reaming.
MARPOL-compliant sewage and oily water treatment systems (OWTS) present on vessels >400 T

Management Measures
In accordance with MARPOL: • sewage will not be discharged within 3 nm from land • bilge water will only be discharged if treated by OWTS to <15 ppm and vessel en-route
Vessels will have sufficient sullage capacity onboard to store sewage or bilge water for the period if/where discharge not permitted by MARPOL.
Vessels and onboard equipment (e.g. OWTS) maintained in accordance with Contractor's PMS

Likelihood and Residual Risk Summary		
Likelihood	The HDD drilling fluids will be water based (WBM) only and the hydrotest water additives (along with any other chemicals planned for discharge) will be selected to ensure potential impacts are minimised to ALARP. Monitoring of sediment composition (Ref. 18) and ecological elements (Ref. 17; 19; 20) following the larger scale HDD undertaken at the same (immediately adjacent) location for the Feed Gas Pipeline Systems showed no impacts from HDD discharges. Under MARPOL regulations, sewage and putrescible wastes are not permitted to be discharged from vessels in State waters (<3 nm from land) and oily water is required to be treated to less than 15 ppm prior to discharge. The permitted discharges will occur at a location that does not support sensitive or conservation significant benthic habitats and when noise/movement associated with project activity (e.g. drilling breakthrough) makes it highly likely mobile fauna that could be affected will avoid the immediate vicinity of the discharge. With low toxicity WBM, the relatively low volumes and short duration of the discharges expected, and the limited spatial extent of effects predicted, HDD discharges are anticipated to pose minimal risk of adverse effects to benthic or pelagic communities. Given the highly dispersive offshore environment, where ambient currents and waves facilitate dilution into the receiving water body, and the management proposed, the likelihood that the relatively small volumes of drill and hydrotest fluids, greywater, cooling water and brine that may be discharged to the ocean during HDD installation activity will cause adverse consequences to marine values and sensitivities is considered ***Seldom (3)***.	**Seldom (3)**
Residual Risk	**Low (7)**	

5.7 Physical Interaction

Physical interaction with fauna during the shore crossing activities has the potential to cause fauna injury or mortality due to:

- collision with moving vessels, vehicles, plant, or equipment
- entrapment in open excavations or the water winning intake.

There is also the potential for the presence/movement of the vessel during HDD activities to interact with other users of the area.

5.7.1 Fauna Collision

Vehicles/plant and personnel involved with HDD activities at North Whites Beach, including installation of water winning spread across the foreshore, have the potential to interact with terrestrial and marine fauna, including shorebirds and nesting turtles. Vessel movements associated with HDD activities have the

potential to interact with marine fauna that occur in the vicinity of the offshore HDD exit point.

Hazard	
Personnel, vehicles or vessels interacting with fauna have the potential to cause behavioural changes or harm to fauna due to collisions.	
Potential Consequence Summary	**Ranking**
Barrow Island provides areas of significant fauna habitat (Section 3.3) and although none of the habitats considered significant on Barrow Island for terrestrial fauna (Ref. 47) occur within the HDD site, mobile fauna and fauna that utilise the foreshore (including conservation-significant mammal, bird, or reptile species) have the potential to be encountered during the shore crossing activities. The marine species most at risk of impact from physical interaction with HDD vessels are slow moving macrofauna, particularly those that spend considerable time at or near the surface such as marine turtles. As shore crossing activities are restricted to the HDD site and vicinity of the offshore exit point and will be of relatively low intensity/duration, effects at species or island wide population levels are not credible. However, injury or mortality of fauna that may be affected by uncontrolled access to beaches or vessel movements has the potential to temporarily reduce abundance or diversity of local populations. In accordance with the Integrated Risk Prioritization Matrix (Appendix A), the potential worst-case consequence is considered ***Minor (5)*.**	**Minor (5)**

Management Measures
Performance Standards / Control Measures
An IVMS will be installed in light vehicles to manage vehicle movements and speeds
Personnel will only be eligible to drive on Barrow Island if they have: • completed a CAPL-approved driving course • completed the ABU Barrow Island Induction • completed Barrow Island on-site driver awareness training.
Vehicle/equipment/plant access to beach prohibited unless specifically authorised and accompanied by spotter
Handling of injured fauna, where required, is undertaken by a trained fauna handler
Any harm or mortality to EPBC Act listed terrestrial fauna is reported in accordance with Section 6.6.
To reduce the risk of injury or fatality to marine fauna due to boat strike, marine fauna watch will be maintained when all these conditions are in place: • daylight hours • vessel is moving (>5 knots) • vessel is close to shore (within 3 nm of the beach) • during times of high turtle activity (October to April).
Vessels will adhere to Part 8 of the EPBC Regulations 2000 and Division 2 of the BC Regulations 2018 where practicable for potential interactions with fauna, including: • establishing a caution zone around prescribed fauna defined as an area around the animal with a radius of 30 m for a whale shark, 100 m for a dugong or seal, 150 m for a dolphin and 300 m (or 100 m to the side) for a whale. Within the caution zone: • operate the vessel at a constant speed of less than 6 knots and minimise noise • post a lookout for fauna.

Likelihood and Residual Risk Summary		
Likelihood	Most onshore construction work for the shore crossing will be undertaken during day shift only, reducing the probability of encountering most	**Seldom (3)**

	mammals, and diurnal species are more likely to be visible in daylight and therefore easier to avoid. Restrictions on access to the beach reduce the probability of encountering turtles or shorebirds and requirements for vessels to maintain separation distances to marine fauna make vessel-strike unlikely. With the controls implemented, vehicle, plant/equipment and/or vessel movements associated with HDD will generally involve low speeds which will reduce both the probability of unavoidable collision and the severity of impact. Therefore, the likelihood of injury or mortality from collisions having a discernible effect on local populations of fauna is considered ***Seldom (3)***.	
Residual Risk	**Low (7)**	

5.7.2 Fauna Entrapment

Open excavations in the HDD site or containment bunding around hazardous liquid storage areas may entrap terrestrial fauna. The seawater intake of the water winning spread has the potential to entrain small mobile marine fauna.

Hazard	
Excavations left open, particularly overnight, or bunded containment areas may trap terrestrial fauna, potentially resulting in injury or mortality. Operation of the submersed water winning pump may entrain and injure small marine fauna in the vicinity of the intake.	
Potential Consequence Summary	**Ranking**
Barrow Island provides areas of significant fauna habitat (Section 3.3). Although none of the habitats considered significant for terrestrial fauna occur within the HDD site, there is a potential for mobile fauna to be attracted to open excavations or bunded areas for shelter and fauna entrapment, injury, or increased predation resulting in mortality could occur (Ref. 70; Ref. 71). The seawater intake of the water winning pump is not sufficiently large to entrain adult marine fauna of conservation significance, but smaller fauna including turtle hatchlings could potentially be entrained in the pump if they were in the immediate vicinity during its operation. As the fauna values and sensitivities that may occur near the HDD site or pump location have wider distributions at Barrow Island, the small numbers of fauna expected to be exposed to this hazard represent a small proportion of any population and individual fauna becoming trapped and sustaining an injury or being predated due to excavation works has negligible potential to result in long term population impacts. In accordance with the Integrated Risk Prioritization Matrix (Appendix A) the potential consequence is considered ***Minor (5)***.	**Minor (5)**

Management Measures
Performance Standards / Control Measures
A risk assessment will be completed as part of the PTW system and where potential risk to fauna is identified (e.g. for excavations >0.5 m left unattended overnight) appropriate controls will be identified and implemented. Controls may include: • egress or exclusion controls (e.g. ramps, scramble mats, battered slopes, ladders within a trench, exclusion fencing, backfilling) • inspection controls (e.g. inspections at prescribed intervals)
Water winning spread includes installation of suitable intake screening.

Likelihood and Residual Risk Summary		
Likelihood	The water winning pump will be installed on the seabed and operating for a relatively short time period. With screening over the intake, the probability that fauna will be injured through entrainment into the pump is low. Excavations within the HDD site (e.g. HDD sump) will typically only be open for the period that they are being actively utilised. In the unlikely event that	**Seldom (3)**

	fauna become entrapped in excavations or bunds despite required exclusion barriers and egress devices, the implementation of inspections and fauna handling procedures (where required) further reduce the potential for harm to fauna. With the controls implemented, the likelihood of injury or mortality to protected fauna due to entrapment during shore crossing activities having a discernible effect on local populations is considered ***Seldom (3)***.	
Residual Risk	**Low (7)**	

5.7.3 Disruption to other users

Hazard	
The presence and/or movement of vessels during HDD activity have the potential to displace or disrupt other users of the areas involved.	
Potential Consequence Summary	**Ranking**
The presence of HDD support vessels and associated requirement for other vessels to navigate around them, may temporarily and locally disrupt their activities in the area. The marine HDD activities are to be of very short duration and unlikely to involve more than one vessel at any time, potentially restricting access to a very small area around the HDD exit point. This represents a very small proportion of the waters off Barrow Island in a location where there are no subsea hazards or other obstructions that would prevent avoidance by other vessels. The consequences to any other users of having to navigate around the vessels and/or temporarily operate in an adjacent area of the ocean will be minimal. In accordance with the Integrated Risk Prioritization Matrix (Appendix A), the potential worst case consequence is considered ***Incidental (6)***.	**Incidental (6)**

Management Measures
Performance Standards / Control Measures
Consultation undertaken with other potential users of the area
A 24-hour visual, radio, and radar watch will be maintained for vessels in the vicinity of the Operational Area in accordance with applicable AMSA requirements and/or Standards of Training, Certification and Watchkeeping (STCW2010) (1978 STCW Convention)
Minimum lighting required for safety and navigational purposes, in accordance with the *Navigation Act 1912* (Marine Orders Part 30 [Prevention of Collisions]), is on board and operational.
The AHS will be notified sufficiently in advance of (where practicable no less than four working weeks before) marine HDD support operations commencing to enable Notices to Mariners to be published
AMSA's JRCC will be notified 24–48 hours before marine HDD support operations commence to enable AMSA to distribute an AUSCOAST warning

Likelihood and Residual Risk Summary		
Likelihood	The offshore Operational Area has limited value to other users and the probability that other vessels would be operating near the HDD exit point is low. By alerting other users to the presence of the installed umbilical, and of the installation vessels during installation works, the potential for disturbance to activities of other users will be minimised. Given the very short duration of marine HDD support activities and the management measures proposed, the likelihood of consequences to other users is considered ***Rare (6)***.	**Rare (6)**
Residual Risk	**Low (10)**	

5.8 Leaks and Spills

Operating vehicles, vessels and equipment for HDD activities requires hazardous materials, including diesel and chemicals, to be transferred, stored, and/or used onsite, presenting a potential source of leaks and spills.

Undertaking activities in proximity of operating services introduces a risk of damage and associated release of contents.

Drilling (HDD) could potentially result in the release of drilling fluids to the foreshore or nearshore environments if subsurface formations containing fractures or cavities extending to the ground/seabed surface are encountered.

Potential scenarios that could cause leaks or spills of hazardous materials to the environment therefore include:

- onshore hazardous materials storage and handling
- damage to existing services
- loss of drilling returns ('frac-outs')
- offshore single point failure (onboard [e.g. deck spill] or overboard [eg ROV leak])
- vessel collision (grounding or with another vessel).

5.8.1 Onshore Hazardous Materials Storage and Handling

Hazard	
A release of hazardous material has the potential to result in contamination of the surrounding soil and groundwater, with possible toxicological effects to subterranean fauna.	
Potential Consequence Summary	**Ranking**
The degree of impact from a leak or spill in the HDD site depends on the release volume and duration, its toxicity, and the geology of the surrounding environment, including depth to groundwater and subterranean fauna habitat (karst). The largest volumes of hazardous materials likely to be handled within the HDD site during installation works are associated with temporary storage of diesel. The worst case credible release scenario would involve loss of more than 500 L (up to ~ 20 m^3). Movement of spilled diesel would be generally downward through the unsaturated zone and, if sufficient volume was released, then radially outward when in contact with the groundwater table (Ref. 72). Given the climatic conditions on Barrow Island (high temperatures), some volatilisation of light-chain hydrocarbons is expected following a release to the ground surface. If not recovered, a portion of the release is likely to persist within the subsurface soil pores (Ref. 73). Microbial hydrocarbon degradation is also expected to occur and, if the release reaches the water table, naturally elevated sulfate concentrations in the groundwater beneath Barrow Island (sourced from the brackish groundwater) will cause degradation rates that are expected to be sufficient to make the formation of a large-scale dissolved phase hydrocarbon plume unlikely (Ref. 74). Therefore, without controls in place, there is the potential for localised impacts to groundwater and stygofauna which could be long-term. In accordance with the Integrated Risk Prioritization Matrix (Appendix A), given the worst-case potential to have localised and long-term impacts the consequence is considered to be ***Moderate (4)***.	**Moderate (4)**

Management Measures
Performance Standards / Control Measures

Management Measures
All hydrocarbon and hazardous liquids storage within secondary containment that comprises the larger of 110% of the largest tank or 25% percent of the combined tank volumes
Spill protection will be provided under hazardous liquids transfer line connections and stationary equipment containing diesel
Lifting and unloading of bulk chemical containers from vehicles will be undertaken in accordance with the appropriate work instruction / Standard Operating Procedure
Vehicles involved in transporting bulk hazardous liquids will carry a spill kit
Refuelling trucks will have double-skinned storage tank(s)
All hazardous chemicals used in the operational area will be selected and assessed in accordance with the ABU Hazardous Materials Management Procedure (Ref. 69)
• Spill response will be conducted in accordance with the Gorgon Project – Barrow Island Onshore Spill Contingency Plan

Likelihood and Residual Risk Summary		
Likelihood	Onsite storage/handling of hazardous materials will involve relatively small volumes and the control measures proposed reduce the likelihood of a release occurring, the volumes that would be released and the potential for any release to reach sensitive receptors. The HDD site is located close to the coast, where the presence and/or extent of key receptors (i.e. groundwater and subterranean fauna habitat) is expected to be low (Ref. 22, 31). Taking into account the multiple control measures described above, the likelihood of a release occurring and resulting in localised and long-term impacts to groundwater and subterranean fauna is considered ***Unlikely (4)***.	**Unlikely (4)**
Residual Risk	**Low (7)**	

5.8.2 Damage to Existing Services

Drilling (HDD) will have a minimum offset (nominally ~30 m) from existing (live) services and has limited deviation tolerance, so is not a credible source of direct damage. Similarly, the vessel (and associated anchor) size for HDD support does not present a credible source of direct damage to the installed, rock-covered Feed Gas Pipeline Systems. However, onshore excavation and/or associated vibration during shore crossing activities have the potential for hydrocarbon releases due to physical damage of existing flowlines or umbilicals.

Hazard	
Excavations near existing services have the potential to result in damage, either directly or via induced movement (eg from vibration), and subsequent release of contents, causing contamination of the surrounding soil and groundwater, with subsequent toxicological effects to subterranean fauna.	
Potential Consequence Summary	**Ranking**
The potential impacts from pipeline release depends on the release volume and duration, geology of the surrounding environment, depth to groundwater, and the location and nature of sensitive receptors. The worst case credible event would involve damage to an operating feed gas pipeline, which could result in the release of condensate. The pathway the condensate will follow will depend on the natural soils and bedrock surrounding the release. Where sands are encountered, there is more risk of contamination moving through the formation; more clayey soils will be less permeable and therefore tend to retard movement. Movement of condensate would be generally downward through the	**Moderate (4)**

Hazard	
unsaturated zone and, if sufficient volume was released, then radially outward when in contact with the groundwater table (Ref. 72). Given the climatic conditions on Barrow Island (high temperatures), some volatilisation of light-chain hydrocarbons is expected following a release from an exposed pipeline. In addition, microbial hydrocarbon degradation is also expected to occur and due to naturally elevated sulfate concentrations in the groundwater beneath Barrow Island (sourced from the brackish groundwater) degradation rates in groundwater are expected to be sufficient such that the formation of a large-scale dissolved phase hydrocarbon plume is unlikely (Ref. 74). If a sufficient volume of condensate enters the subsurface soils, a portion of the condensate is likely to persist within the soil pores (Ref. 73). Therefore, without controls in place, a condensate release may result in contamination of the area surrounding and below the release. A shallow unconfined aquifer is present below Barrow Island, which would be at risk of contamination, although it is likely to have limited extent near the coast. Potential impacts to subterranean fauna (particularly stygofauna) could occur in the contaminated area; however, the HDD site is unlikely to be highly prospective for subterranean fauna given the limited extent of aquifer and the probability that any voids would be sand filled (Ref. 22, 31). Exposure and consequences to subterranean fauna populations would be considered localised given the limited extent of the potential impact and the wider distribution of subterranean fauna identified to occur on Barrow Island. In accordance with the Integrated Risk Prioritization Matrix (Appendix A) the potential localised but long-term consequences are considered ***Moderate (4)***.	

Management Measures
Performance Standards / Control Measures
An excavation certificate, including a risk assessment, is approved prior to excavation associated with installation activities, as part of the Permit to Work system.
Engineering drawings issued for construction specify minimum separation distances to existing pipelines
Contractor installation procedure includes methods and monitoring to maintain vibration levels below required thresholds
Location information (e.g. As-Builts) for existing services known to occur within ROW provided to installation contractor.
• Spill response will be conducted in accordance with the Gorgon Project – Barrow Island Onshore Spill Contingency Plan
•

Likelihood and Residual Risk Summary		
Likelihood	The presence of existing services is known from as built drawings and previous experience with installing the existing pipeline systems. Consequently, the likelihood of inadvertent contact is very low. The low-impact nature of activity (e.g. potholing) to locate and/or expose the services makes it unlikely contact would cause a release, and the adjacent lines that might be contacted during site preparations are umbilicals. Installation procedures will include restrictions on vibration levels to below thresholds that might cause damage to existing services. A release of a sufficient volume to reach sensitive receptors, such as groundwater, is therefore extremely unlikely. Taking into account the low probability of a release, the limited presence of sensitive receptors and the multiple control measures described above, the likelihood of a pipeline leak occurring due to shoreline crossing activities resulting in localised but long-term impacts is considered ***Rare (6)***.	**Rare (6)**
Residual Risk	**Low (9)**	

5.8.3 Loss of Drilling Returns

Hazard	
HDD may encounter cavities or fractures in subsurface geology that cause lost circulation of drilling fluids. The drilling fluid pressures are not sufficient to cause fracturing of rocks, but in the event that existing cavities or fissures in the rock extend to the ground or seabed surface, the lost drilling fluids may be released to the foreshore or marine environments. These 'frac-out' discharges have the potential to cause localised sediment subsidence and/or a decline in water and sediment quality. Toxicity to marine fauna at the site of release might occur and sediments may be temporarily suspended in the water column and subsequently settle onto adjacent areas.	
Potential Consequence Summary	**Ranking**
An onshore frac-out could result in disturbance to foreshore landform or vegetation and/or the development of small 'mud pools' in which fauna could become trapped, or turtle nests destroyed. The shallow nature of the sand on the beach at North Whites Beach area is likely to limit the extent of potential erosion effects, and the sparsity of vegetation and fauna activity (including turtle nesting) in the foreshore area seaward of the HDD entry point suggests impacts are likely to be highly localised and involve a negligible proportion of any community or population. The volume of drilling fluids that may be lost to the marine environment from offshore frac-outs is difficult to predict, but experience from the Foundation Project HDD indicates that releases and any associated turbidity are rapidly dispersed (Ref. 76) suggesting potential effects on water and/or sediment quality are localised and temporary. The rock platform across the intertidal limits the use of the area by nesting turtles and the macroalgae species that form the dominant ecological community inshore of the HDD exit point have widespread distributions (Ref. 50), so the proportion of any population potentially affected will be very low. The west coast of Barrow Island is a high energy, open ocean environment where discharges can be expected to be rapidly dispersed. Compared to natural events such as storms and cyclones that occur off the west coast of Barrow Island, which often cause large amounts of sediment to be lifted into the water column over wide areas, the turbidity potentially generated by frac-outs represents only a minor source of localised resuspended sediment at any location. Given the short duration and relatively low volumes of potential releases and the absence of conservation significant sessile receptors in the areas potentially affected, the consequences of any temporary and localised changes in water or sediment quality are considered to be ***Incidental (6)***.	**Incidental (6)**

Management Measures
Performance Standards / Control Measures
Only water-based, biodegradable polymer drilling fluid used for HDD
All hazardous chemicals (including drilling additives) shall be assessed and deemed acceptable before use, in accordance with the ABU Hazardous Materials Management Procedure (Ref. 69)
Contractor Frac-out Management Plan addresses: • selection and mobilisation of LCM tailored to porosity of formations • volumetric checks of fluid use and real-time monitoring of downhole pressures during drilling • swabbing triggered where appropriate to reduce losses • visual inspections by spotters on a regular basis whilst drilling, and particularly during pilot hole drilling where the risk of frac-out is generally higher than when reaming.

Likelihood and Residual Risk Summary		
Likelihood	There were no onshore frac-outs and only five offshore frac-outs recorded during the much larger HDD undertaken for the Feed Gas Pipeline Systems (Ref. 76). By selecting a HDD alignment based on the latest geotechnical information and adopting lessons learned from the previous HDD, the likelihood of frac-outs is expected to be reduced for the smaller scale HDD for the umbilical installation.	**Remote (5)**

	The HDD drilling fluids will be water based (WBM) only and the drilling additives (including lost circulation materials [LCM]) will be selected to ensure potential toxicity impacts are minimised to ALARP. Monitoring of sediment composition (Ref. 18) and ecological elements (Ref. 17; 19; 20) following the larger scale HDD undertaken at the same (immediately adjacent) location for the Feed Gas Pipeline Systems showed no impacts from HDD discharges, including those associated with frac-outs. With the management proposed, and noting the highly dispersive marine environment, where ambient currents and waves facilitate dilution into the receiving water body, the likelihood of adverse effects to foreshore, intertidal or shallow marine communities from the relatively low volumes and short duration of releases that might occur is considered ***Remote (5)***.	
Residual Risk	**Low (10)**	

5.8.4 Offshore Single Point Failure

Hazard	
Vessel operations will involve the on-board storage of hydrocarbons, utility and hydraulic oils, and other chemicals as well as the use of in-water equipment (eg ROVs) containing hydraulic oils and/or chemicals. Onboard storage of these substances involves small volumes, generally in containers holding <1m^3. A leak or spill caused by a single point failure during storage, handling or machinery operation that reaches the marine environment has the potential to result in changes to water quality, leading to potential toxicological effects on marine fauna.	
Potential Consequence Summary	**Ranking**
The particular values and sensitivities with the potential to be impacted by small volumes of hydrocarbons or other fluids at or near the HDD exit point are: • resident dolphin populations • foraging and inter-nesting marine turtles • marine avifauna. Given the small volumes involved, discharges are expected to disperse rapidly and any effects to water quality would be expected to be highly localised and short term. Marine fauna within the affected area may suffer short-term exposure, but the scale of impact would be limited due to the small volume and rapid natural dispersion of the materials involved. In accordance with the Integrated Risk Prioritization Matrix (Appendix A), the potential consequences to particular values and sensitivities are considered ***Incidental (6)***.	**Incidental (6)**

Management Measures
Performance Standards / Control Measures
All hydrocarbon and hazardous chemical storage with secondary containment or within bunded areas.
A complete inventory of all hazardous materials stored on the vessels will be maintained on board, together with current SDSs for each hazardous or dangerous goods substance
Marine vessels will have a current Shipboard Oil Pollution Emergency Plan (SOPEP)/Shipboard Marine Pollution Emergency Plan (SMPEP) as appropriate to class
Inductions/training provided to personnel responsible for handling or responding to spills of hazardous materials
Spill containment and recovery equipment (spill kits, scupper plugs) will be provided where spills are possible (e.g. where fuel, oil, or chemicals and hazardous waste are used or stored).
All spills will be recorded as per CAPL's Incident Investigation and Reporting Process (Ref. 54)
Spills will be contained and/or cleaned up in accordance with vessel SOPEP/SMPEP

Likelihood and Residual Risk Summary		
Likelihood	Vessel operations in support of HDD will be of short duration. Accidental on-board spills of small volumes of hydrocarbons or other fluids are expected to be infrequent and isolated events and, with the specified controls in place, the likelihood of such spills reaching the marine environment is further reduced. In addition, the potential for particular values and sensitivities to be sufficiently close to the release point at the time of release for exposure to cause impacts is limited. Therefore, the likelihood of single point failures resulting in the defined consequences is considered ***Remote (5)***.	**Remote (5)**
Residual Risk	**Low (10)**	

5.8.5 Vessel Collision

More than one project vessel may be operating in the area at the same time and it is possible third party vessels could also traverse the area during installation activities, introducing the potential for a vessel collision. Operating vessels will typically be stationary or moving at low speeds in the Operational Area, but third party vessels may be travelling at higher speeds and a vessel collision could result in a spill of onboard hydrocarbons. Unplanned hydrocarbon spills resulting from vessel collision during installation activity have the potential to result in temporary declines in water and sediment quality, toxicity or physical impacts to marine fauna and flora, and potential disruptions to activities such as fishing and tourism. The consequence evaluation for this scenario included consideration of the results of 3D numerical fates and transport modelling (Ref. 13) to identify the receptors that might be exposed to hydrocarbons from a spill of this magnitude at any time of year. A separate environmental consequence assessment has been undertaken for each hydrocarbon exposure pathway, specifically:

- surface
- entrained
- shoreline.

Hazard (Surface Exposure)	
A release of hydrocarbons as a result of a vessel failure presents a hazard to the marine environment due to the resulting surface oil slick. Scholten *et al.* (Ref. 77) indicate that a hydrocarbon layer 25 g/m^2 thick would be harmful for birds that contact a surface hydrocarbon slick. Engelhardt (Ref. 78), Clark (Ref. 79), Geraci and St. Aubin (Ref. 80), and Jenssen (Ref. 81) indicate that a hydrocarbon layer of greater than 10 g/m^2 would impart a lethal dose to an intersecting wildlife individual (including marine mammals). Peakall *et al.* (Ref. 86) stated that oil concentration <1 g/m^2 (~1 µm) was not harmful to seabirds, and represents a visual aesthetics threshold. Therefore, a spill scenario involving MDO has the potential to result in acute exposures to marine fauna where surface concentrations are >10 g/m^2.	
Potential Consequence Summary	**Ranking**
Upon release, MDO will spread out quickly on the sea surface and volatile components will evaporate rapidly. Spill modelling predicted that a negligible portion of the MDO was predicted to remain on the surface two days after the spill. Surface exposures >10 g/m^2 extended up to 66 km from the release site and overlapped the Offshore Area and Barrow and Montebello Islands Area (Ref. 82). Air-breathing marine fauna and seabirds are most at risk from surface exposures of MDO, either through contact or inhalation of the VOCs, which can result in irritation to skin and eyes or damage respiratory systems (Ref. 83; Ref. 84). With particular reference to marine avifauna, fouling of marine avifauna feathers may occur (Ref. 85). As such, the particular	**Major (3)**

Hazard (Surface Exposure)	
values and sensitivities with the potential to be affected by surface hydrocarbon exposures are: • migratory marine mammals (specifically Humpback Whale and Pygmy Blue Whale) • resident dolphin populations • marine turtle foraging and internesting • marine avifauna foraging • coral reef communities (intertidal). Although the potential for acute exposure is widespread, the interaction of mobile marine fauna with surface hydrocarbons is expected to be limited because weathering will limit the duration of exposure (Ref. 82). Therefore, exposures are expected to result in acute impacts to a small number of individuals but are unlikely to impact the viability of local populations. If a spill coincided with a period of coral fertilisation, the presence of surface hydrocarbons has the potential to foul coral larvae and/or interfere with settlement, which has the potential to result in reduced reproductive success (Ref. 87). Coral recruitment from other areas would be expected to occur so impacts are not expected to result in a measurable reduction in coral reef extent, although reduction in growth rates/health may be observed (Ref. 88; Ref. 89). In accordance with the Integrated Risk Matrix, widespread, short-term consequences are considered ***Major (3)***.	

Hazard (Entrained Exposure)	
Entrained hydrocarbons represent the dispersed insoluble oil droplets phase and pose a hazard to marine life that become entrained (i.e. juvenile fish, larvae, and plankton) with the oil plume, or via direct ingestion or the consumption of contaminated prey. OSPAR (Ref. 90) describes a dispersed oil threshold of 70.5 ppb, for PNEC for chronic exposure (typically >7 days). This PNEC is relevant to organisms likely to entrain in the plume and therefore remain with the plume for an extended period of time. An acute lethal entrained concentration of 700 ppb was derived by applying an acute-to-chronic factor of ten to the PNEC (in accordance with the water quality guidelines [Ref. 91). Therefore for this spill scenario, exposure to entrained thresholds >700 ppb (or 67 200 ppb.hrs) has the potential to result in acute impacts whilst exposures >70 ppb (or 6726 ppb.hrs) has the potential to result in chronic impacts.	
Potential Consequence Summary	**Ranking**
Spill modelling predicted no entrained exposures >500 ppb and consequently there is no potential for acute exposure (>700 ppb) to occur. The potential for entrainment of MDO was found to be low, but some exposures >100 ppb were predicted to extend up to 18 km from the release location, and exposures of 10–100 ppb were predicted to extend up to 435 km, thus having the potential to elicit chronic effects at concentrations >70.5 ppb. Entrained hydrocarbons primarily affect the Barrow and Montebello Islands Area, but there is also some potential for entrained concentrations >70 ppb to reach the Offshore Area. Particular values and sensitivities with the potential to be affected by entrained hydrocarbons were identified as: • KEFs – continental slope demersal fish communities (high level of endemism) • commercial and recreational fisheries • subtidal coral reef communities. Given the mobility of marine fauna (e.g. marine mammals, marine turtles) that may be present in the area at the time of the spill, no chronic impacts or risks are expected because these fauna are unlikely to undergo prolonged exposure. Potential impacts to fish from prolonged entrained exposure are expected to be limited and localised to juvenile fish, larvae, and planktonic organisms. Given the naturally high mortality rates of juvenile fish, larvae, and plankton, any localised mortality associated with the spill are unlikely to result in any measurable reduction in finfish stock in subsequent years (Ref. 92). In addition, fish are able to tolerate low hydrocarbon levels, and elevated levels of hydrocarbons in fish tissue have been found to return to reference levels within six months (Ref. 93; Ref. 94; Ref. 95). Consequently, diverse fish assemblages and commercial and recreational fisheries are not expected to be impacted significantly in the long term. The potential for entrained MDO to contact and impact particular subtidal values and sensitivities such as coral reef communities in shallow, nearshore areas (e.g. subtidal corals	**Moderate (4)**

Hazard (Entrained Exposure)	
at Biggada Reef on the west coast of Barrow Island) was also considered as several simulations predicted moderate entrained exposures. Coral tissues that are directly contacted by droplets entrained in the upper water column may experience some degree of impaired respiration and photosynthesis, potentially leading to reduced growth rates (Ref. 89), although such impacts are expected to be limited given the limited distribution of coral reef habitat off the west coast of Barrow Island and that small (<0.006 mm) hydrocarbon droplets have not been found to adhere to living corals or be ingested by them (Ref. 96). Based on the potential for widespread and long-term effects, the consequences were assessed. OSPAR (Ref. 90) describes a dispersed oil threshold of 70.5 ppb for PNEC for chronic exposure (typically >7 days). This PNEC is relevant to organisms likely to entrain in the plume and therefore remain with the plume for an extended period of time. An acute lethal entrained concentration of 700 ppb was derived by applying an acute-to-chronic factor of ten to the PNEC (in accordance with the water quality guidelines [Ref. 91]). Therefore, for this spill scenario, exposure to entrained thresholds >700 ppb (or 67 200 ppb.hrs) has the potential to result in acute impacts, while exposures >70 ppb (or 6726 ppb.hrs) have the potential to result in chronic impacts. Given the potential for entrainment of juvenile fish, larvae, and planktonic organisms, there is the potential for widespread but short-term impacts to fish and fisheries. There is also some limited potential for localised and long-term impacts to coral habitat, if contacted. As such, in accordance with the Integrated Risk Matrix, the consequences were assessed as ***Moderate (4).***	

Hazard (Shoreline Loading Exposure)	
Lin and Mendelssohn (Ref. 97) observed hydrocarbon loading on shorelines >1000 g/m^2 to significantly impact salt marsh or mangrove plants. Owens and Sergy (Ref. 98) indicated that shoreline loading between 100 and 1000 g/m^2 has the potential to coat shoreline habitats, with thresholds >100 g/m^2 sufficient to coat the benthic organisms and likely impact their survival and reproductive capacity (Ref. 98). Based on these scientific studies, a release of MDO has the potential to result in impacts to intertidal shoreline values exposed to shoreline loading >100 g/m^2, and mangrove shoreline values where shoreline loading is >1000 g/m^2.	
Potential Consequence Summary	**Ranking**
Spill modelling predicts shoreline accumulation in the Barrow and Montebello Islands Area, with up to 8 km of the west coast of Barrow Island's shoreline exposed to shoreline accumulation concentrations >1000 g/m^2 and 21 km exposed to moderate hydrocarbon loading levels (>100 g/m^2). Therefore, the particular values and sensitivities with the potential to be affected by surface hydrocarbon exposures are: • mangroves • avifauna staging and nesting • marine turtle nesting. Spill modelling predicts that up to 2 km of shoreline containing mangroves in the Montebello Islands Group may be exposed to high shoreline accumulations levels (>1000 g/m^2) that could result in impacts to the health of the mangrove community as a result of exposure to the toxic volatile fraction and smothering of the pneumatophores by the more persistent components (Ref. 99; Ref. 100). Where mangroves are exposed to MDO, death or subsequent decay of mangrove trees may occur; rates of recovery will depend on the degree of MDO penetration into burrows and propagation root cavities (Ref. 101). Because the minimum time prior to contact is 24 hours, it can be assumed that some volatile toxic components will have weathered from the oil slick, with mangrove seedlings and saplings most susceptible to weathered oils (Ref. 102). Exposure of mangroves to high hydrocarbon loadings would likely have long-term effects on the habitat values of the mangrove community, including invertebrate communities, and potentially involve extended time frames (years) for recovery. Shoreline loading >100 g/m^2 has the potential to impact marine turtle nesting beaches and avifauna staging/nesting areas located on the west coast of Barrow Island and the Montebello Islands. Given that there are several significant staging and nesting areas for both avifauna and turtles across Barrow Island and the Montebello Islands, there is the potential to impact on these populations and affect species recruitment at a local population level. Therefore, there is the potential for long-term effects on species as local populations	**Severe (2)**

Hazard (Shoreline Loading Exposure)	
recover from interrupted recruitment. Thus impacts have been defined as having potential widespread long-term impacts to species. As such, in accordance with the Integrated Risk Matrix, the consequences were assessed as **Severe (2)**.	

Management Measures
Performance Standards / Control Measures
A 24-hour visual, radio, and radar watch will be maintained for vessels in the vicinity of the Operational Area in accordance with AMSA and/or Standards of Training, Certification and Watchkeeping (STCW2010) (1978 STCW Convention)
The AHS will be notified sufficiently in advance of (where practicable no less than four working weeks before) installation operations commence to enable Notices to Mariners to be published
Risks of vessel collisions will be detailed and managed by a SIMOPS plan (where relevant).
Marine vessels will have a SOPEP (as appropriate to class) on board
Emergency spill response activities will be implemented in accordance with the Consolidated OPEP (Ref. 103) in the event of an emergency condition leak and spill from a vessel collision

Likelihood and Residual Risk Summary		
Likelihood	The HDD vessel activities will occur in an area where the density of vessel traffic is very low. The likelihood of a vessel collision during the short duration of HDD support activity with standard maritime practices implemented is inherently low. For a collision to cause the worst-case consequences described would require: • contact of sufficient force to pierce the vessel hull • the penetration of the hull coinciding with the largest fuel tank(s) location • the tank to be full and penetration low enough to cause the entire content of the largest tank to be released, despite source control efforts • spill response to be ineffective in reducing impacts. With the control measures that will be implemented, the likelihood of a collision occurring and resulting in the consequences described was determined to be ***Rare (6)***.	**Rare (6)**
Residual Risk	**Low (7)**	

6 Monitoring and Reporting

6.1 Overview

The numerous environmental reports required to record details such as the progress of work; monitoring of key physical and environmental factors; incidents, complaints and their status and resolution; compliance; and performance for the Gorgon Gas Development and Jansz Feed Gas Pipeline are outlined in Section 7.6 of the HDDMMP (Ref. 1). This includes Environmental Performance Reporting and Compliance Reporting required under Ministerial Conditions.

6.2 Auditing

Internal and external auditing of the Gorgon Gas Development and Jansz Feed Gas Pipeline's environmental performance and compliance, including with the requirements of MS 800, MS 769, and EPBC Reference: 2003/1294 and 2008/4178, is described in Section 9.2 of the HDDMMP (Ref. 1). A record of all audits and the audit outcomes is maintained. Actions arising from audits are tracked until their close-out.

An audit table is provided in Appendix B to assist with auditing for compliance with this Addendum to meet the reporting requirements for MS 800, MS 769, and EPBC Reference: 2003/1294 and 2008/4178 (see Section 6.5).

6.3 Inspections

Regular workplace inspections will be conducted during the HDD shore crossing and will include (but not necessarily be limited to) the items listed in Table 6–1.

Table 6–1: Inspection Requirements

Inspection Requirement	Responsibility
Vessel safety systems	Construction Contractor
Anchoring inspections	Construction Contractor
Bilge oil/water separators	Construction Contractor
Vessel deck drainage systems	Construction Contractor
Offshore and onshore housekeeping	Construction Contractor
Checking of vessels, plant and equipment for leaks and spills	Construction Contractor
Offshore and onshore hazardous materials storage, drainage and bunds	Construction Contractor
Offshore and onshore waste storage areas	Construction Contractor
Equipment covers, mufflers and other noise suppression equipment	Construction Contractor

6.4 Environmental Monitoring

A summary of the comprehensive ongoing monitoring programs designed to detect changes outside the TDF attributable to Gorgon Gas Development activities is provided in Section 9.1 of the HDDMMP (Ref. 1) and detailed in the Terrestrial and Subterranean Environment Monitoring Program (TSEMP; Ref. 52). Where necessary, amendments to ongoing monitoring programs under the TSEMP will be developed to accommodate the new HDD site.

The marine monitoring program undertaken to address conditions of approval relevant to HDD activities is described in Section 9.1.2 of the HDDMMP (Ref. 1). Marine monitoring undertaken prior, during, and after the (larger scale) HDD

activities for the existing FGPS to address the requirements of Condition 22.5 (vii) of MS 800, Condition 13.4.(g) of MS 769, and Condition 15.5 (vii) of EPBC Reference: 2003/1294 and 2008/4178 found that there were no impacts to any environmental elements monitored (Ref. 16, 17, 18, 19, 20). The requirements of these conditions have therefore been met and no additional monitoring of these elements will be undertaken for the activities addressed by this Addendum.

6.5 Routine Reporting

Reports on environmental performance and compliance, which include the outcomes of audits, are provided annually in accordance with Ministerial Conditions, as described in Section 7.6 of the HDDMMP (Ref. 1).

6.6 Incident Response and Reporting

CAPL has prepared the Emergency Management Standardised OE Process (Ref. 53) and Incident Investigation and Reporting Process (Ref. 54), which it internally requires its employees, contractors, etc. to follow in the event of environmental incidents. These processes will also be internally applied to environmental incidents identified in this Addendum, where appropriate.

The environmental incidents, reporting requirements and timing specific to this Addendum are provided in Table 6–2.

Table 6–2: Incident Reporting Requirements

Incident	Reporting to	Timing
Material or Serious Environmental Harm outside the Terrestrial Disturbance Footprint (TDF)	DWER/DCCEEW	Within 48 hours of detection or as soon as reasonably practicable
Material or Serious Environmental Harm outside the Marine Disturbance Footprint (MDF)	DWER/DCCEEW	Within 48 hours of detection or as soon as reasonably practicable
Significant Impacts detected by the monitoring program on matters of National Environmental Significance attributable to the Gorgon Gas Development	DCCEEW	Within 48 hours of detection
Harm or mortality to Commonwealth EPBC Act Listed Marine Fauna (whether attributable to the Gorgon Gas Development or not)	DCCEEW	Within 24 hours of detection
Harm or mortality to Commonwealth EPBC Act Listed Terrestrial Fauna (whether attributable to the Gorgon Gas Development or not)	DCCEEW	Within 24 hours of detection
Threatened or listed fauna cared for, injured or killed within the Terrestrial Disturbance Footprint	DWER/DBCA	Annual Performance Report or as required under a fauna licence.

The external reporting requirements for marine turtle incidents (injury or mortality) are described in the Long-term Marine Turtle Management Plan (LTMTMP; Ref. 55).

7 Performance Objectives and Standards

Environmental performance is 'the measurable results of an organisation's management of its environmental aspects' (Ref. 56). For the HDD activities within the scope of this Addendum, CAPL measures environmental performance through:

- **Environmental Performance Objectives** – the objectives of the HDDMMP as defined by Condition 22.3 of MS 800, Condition 13.3 of MS 769 and Condition 15.3 of EPBC Reference: 2003/1294 and 2008/4178 (Section 1.3.1)
- **Environmental Performance Standards** – defined, in accordance with Schedule 2 of MS 800, as 'matters which are developed for assessing performance, not compliance, and are quantitative targets or where that is demonstrated to be not practicable, qualitative targets, against which progress towards achievement of the objectives of conditions can be measured'.

Performance standards specific to each aspect of the activities covered by this Addendum are detailed in Section 5. These standards have been developed specifically for assessing performance, not compliance, and so failure to meet the standards does not represent a breach of this Addendum. Rather, it indicates that an objective may not have been met and there may be a need for management action or review of this Addendum.

8 Review of this Addendum

At the completion of the HDD scope of work (including site reinstatement), this Addendum ceases to be in effect. Given the relatively short duration expected for the umbilical HDD, scheduled reviews of the Addendum are not anticipated. However, this Addendum will be reviewed in the event of a significant change to the activity described in Section 2, if a performance standard is not achieved or in the event a significant new or increased risk is identified.

9 Acronyms and Abbreviations

Table 9-1 defines the acronyms and abbreviations used in this document.

Table 9-1: Acronyms and Abbreviations

Acronym / Abbreviation	Definition
~	Approximately
ABU	Australian Business Unit
AC	Alternating current
Additional Support Area	Gorgon Gas Development Additional Construction, Laydown, and Operations Support Area
ALARP	As low as reasonably practicable
BC Act	WA *Biodiversity Conservation Act 2016*
BIA	Biologically important area
CAPL	Chevron Australia Pty Ltd
Carbon Dioxide (CO_2) Injection System	The mechanical components required to be constructed to enable the injection of reservoir carbon dioxide, including but not limited to compressors, pipelines and wells.
CO_2	Carbon dioxide
Construction	Construction includes any Proposal-related (or action-related) construction and commissioning activities within the Terrestrial and Marine Disturbance Footprints, excluding investigatory works such as, but not limited to, geotechnical, geophysical, biological and cultural heritage surveys, baseline monitoring surveys and technology trials.
Cth	Commonwealth of Australia
DCCEEW	Commonwealth Department of Climate Change, Energy the Environment and Water (formerly Department of Agriculture, Water and the Environment, Department of the Environment and Energy; Department of the Environment and Water; Department of the Environment, Water, Heritage and the Arts; Department of Sustainability, Environment, Water, Population and Communities; and Department of the Environment)
DBCA	Department of Biodiversity, Conservation and Attractions
DEC	Former Western Australian Department of Environment and Conservation (now DBCA and/or DWER)
DEWHA	Former Commonwealth Department of the Environment, Water, Heritage and the Arts (now DAWE)
DMIRS	Department of Mines, Industry Regulation and Safety
DP	Dynamic positioning
DPIRD	Department of Primary Industry and Resource Development
DWER	Department of Water and Environmental Regulation
EMP	Environmental Management Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPBC Reference: 2003/1294	Commonwealth Ministerial Approval (for the Gorgon Gas Development) as amended or replaced from time to time
EPBC Reference: 2005/2184	Commonwealth Ministerial Approval (for the Jansz Feed Gas Pipeline) as amended or replaced from time to time

Acronym / Abbreviation	Definition
EPBC Reference: 2008/4178	Commonwealth Ministerial Approval (for the Revised Gorgon Gas Development) as amended or replaced from time to time.
EPBC Reference: 2011/5942	Commonwealth Ministerial Approval (for the Fourth Train Expansion) as amended or replaced from time to time.
FGPS	Feed Gas Pipeline System
Gorgon Gas Development	The Gorgon Gas Development as approved under MS 800 and MS 965, and EPBC References: 2003/1294 and 2008/4178 (as varied by the Commonwealth Environment Minister), as amended or replaced from time to time.
Gorgon Gas Development Footprint	Consists of the cleared areas and uncleared areas approved to be cleared on Barrow Island used for the construction and operation of the Gorgon Gas Development and Jansz Feed Gas Pipeline.
GHG	Greenhouse gas
GTP	Gas Treatment Plant
ha	Hectare
HDDMMP	Horizontal Directional Drilling Management and Monitoring Plan
HES	Health, Environment and Safety
HSE	Health, Safety and Environment
IMS	Impact Mitigation Strategy
IFC	Issued for construction
“	Inch
Jansz Feed Gas Pipeline	The Jansz Feed Gas Pipeline as approved in MS 769 and EPBC Reference 2005/2184 as amended or replaced from time to time.
Kg	Kilogram
kV	Kilovolt
km	Kilometre
L	Litre
LAT	Lowest astronomical tide
LNG	Liquefied Natural Gas
LTMTMP	Long-term Marine Turtle Management Plan
m	Metre
m^3	Cubic metre
mm	Millimetre
Marine Disturbance Footprint	The area of the seabed to be disturbed by construction or operations activities associated with the Marine Facilities listed in Condition 14.3 of MS 800 and Condition 12.3 of MS 769 (excepting that area of the seabed to be disturbed by the generation of turbidity and sedimentation from dredging and dredge spoil disposal) as set out in the Coastal and Marine Baseline State Report required under Condition 14.2 of MS 800 and Condition 12.2 of MS 769.
MEG	Mono-ethylene glycol
MS	(Western Australian) Ministerial Statement
MS 1002	Western Australian Ministerial Statement 1002, issued for the Gorgon Gas Development Fourth Train Expansion Proposal, as amended from time to time.

Acronym / Abbreviation	Definition
MS 748	Western Australian Ministerial Statement No. 748 (for the Gorgon Gas Development) as amended from time to time [superseded by MS 800].
MS 769	Western Australian Ministerial Statement No. 769 (for the Jansz Feed Gas Pipeline) as amended from time to time.
MS 800	Western Australian Ministerial Statement No. 800, issued for the Revised and Expanded Gas Development, as amended from time to time. MS 800 supersedes the Gorgon Gas Development as originally approved by MS 748. The conditions of MS 800 also apply to the Additional Support Area under MS 965.
MS 865	Western Australian Ministerial Statement 865, issued to establish a restart mechanism for dredging, as amended from time to time.
MS 965	Western Australian Ministerial Statement No. 965, issued for the Additional Support Area, as amended from time to time. MS 965 applies the conditions of MS 800 to the Additional Support Area.
N/A	Not applicable
ODS	Ozone depleting substance
OE	Operational Excellence
OEMS	Operational Excellence Management System
PEC	Priority ecological community
PER	Public Environmental Review for the Gorgon Gas Development Revised and Expanded Proposal dated September 2008, as amended or supplemented from time to time.
Practicable	For the purposes of MS 800 and MS 769 means reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge.
ROW	Right of way
ROV	Remotely operated vehicle
TAPL	Texaco Australia Pty Ltd
TDF	*See* Terrestrial Disturbance Footprint
Terrestrial Disturbance Footprint (TDF)	The area to be disturbed by construction or operations activities associated with the Terrestrial Facilities listed in Condition 6.3 of MS 800, including the Additional Support Area approved by MS 965, and Condition 6.3 of MS 769. For the purpose of this Plan, the Terrestrial Disturbance Footprint is the same area as the Gorgon Gas Development Footprint.
TEC	Threatened Ecological Community
TSEMP	Terrestrial and Subterranean Environment Monitoring Program
WA	Western Australia

10 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 10-1: References

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Appendix A Chevron Integrated Risk Prioritization Matrix

Chevron Integrated Risk Prioritization Matrix

Legend (where Likelihood is with confirmed safeguards and Consequence is without safeguards)

Risk Levels 1-4: Elevated Risk. Risk reduction required.

Risk Level 5: Risk reduction is required. If risk reduction action cannot be reasonably taken, BU management approval must be obtained

Risk Levels 6: Confirm that management systems are in place. Further risk reduction unless unreasonable.

Risk Levels 7-10: Manage risk. Further risk reduction at management discretion.

Likelihood Descriptions & Index			Decreasing Likelihood	Decreasing Consequence/Impact →					
Likelihood Descriptions	Likelihood Indices			6	5	4	3	2	1
				Incidental	Minor	Moderate	Major	Severe	Catastrophic
Expected to occur	1	Likely		6	5	4	3	2	1
Conditions may allow to occur	2	Occasional		7	6	5	4	3	2
Exceptional conditions may allow to occur	3	Seldom		8	7	6	5	4	3
Reasonable to expect will not occur	4	Unlikely		9	8	7	6	5	4
Has occurred once or twice in the industry	5	Remote		10	9	8	7	6	5
Rare or unheard of	6	Rare		10	10	9	8	7	6
Consequence Descriptions & Index (without safeguards)	**Consequence Descriptions**								
	Workforce Health & Safety			One or more illness or injuries resulting in limited treatment	One or more illnesses or injuries requiring treatment but not severe	One or more severe illnesses or injuries	One to four illnesses with significant life shortening effects or fatalities	Multiple illnesses resulting in significant life shortening effects or multiple fatalities (5-50)	Multiple illnesses resulting in significant life shortening effects or multiple fatalities (>50)
	Public Health & Safety			One or more illness or injuries not resulting in treatment	One or more illness or injuries resulting in limited treatment	One or more illnesses or injuries requiring treatment but not severe	One or more severe illnesses or injuries	One to ten illnesses with significant life shortening effects or one to ten fatalities	Multiple illnesses resulting in significant life shortening effects or multiple fatalities (>10)
	Environment			Limited environmental impact	Localized, short term environmental impact	Localized, long-term environmental impact	Short-term, widespread environmental impact	Long-term, widespread environmental impact	Persistent, landscape scale environmental impact

Appendix B Compliance Reporting Table

Section No.	Actions
2.2	The shore crossing for the additional umbilicals will be immediately south of the existing FGPS shore crossing
2.3.1	Prior to commencement of works, the area at North Whites Beach will be surveyed to delineate the boundary of the HDD site. The existing condition of the site and adjacent areas will be photographed.
2.3.1	The seabed conditions at and surrounding the offshore HDD exit point(s) will also be surveyed to ensure there are no significant seafloor features or obstructions and to confirm anchoring suitability.
2.3.1	Clearing will be required for the HDD site. This will be done in accordance with the CAPL permit to work system.
2.3.1	Topsoil will be stripped and stockpiled for later use in site reinstatement and vegetation appropriately stored/treated to promote rehabilitation.
2.3.1	In areas where fuels and other chemicals are to be stored, appropriate bunding will be installed.
2.3.1	Access to the HDD work site will be along the existing onshore FGPS ROW access track from the existing road network, eliminating the need for additional clearing beyond the HDD worksite. If additional staging, laydown, offices etc areas are required, they will be located in previously cleared areas within Gorgon tenure on Barrow Island.
2.3.2	The pump and associated infrastructure will be removed when no longer required for HDD activities. In the event that the previous water winning hole cannot be refurbished, the temporary line may remain in place throughout the HDD program, after which it will be recovered and decommissioned
2.3.3	The fluid discharged at the entry point will be contained at the entry pit and reused for subsequent hole(s). Any excess fluid at the completion of the operation will be collected and stored until residues are removed from the HDD site and appropriately disposed in accordance with the Solid and Liquid Waste Management Plan (Ref. 12).
2.3.3	Cuttings recovered at the HDD hardstand area will be collected and managed in accordance with the Solid and Liquid Waste Management Plan (Ref. 12).
2.3.4.1	Anchoring (if required) would be within the MDF and/or previously approved anchoring area designated for installation of the existing FGPS.
2.3.5	At the completion of the shore crossing, temporary construction areas used for the HDD work area will be reinstated, unless required for installation/tie in of the onshore and/or shore crossing umbilical.
2.3.5	In the event that cleared areas remain inactive over a significant period, appropriate stabilisation management and monitoring activities will be completed.
2.3.5	Excavations will be backfilled and pits emptied. Onshore pumps, filters, and other equipment associated with HDD seawater intake are to be removed. In the event that spare boreholes are installed to provide for future umbilical installation, these will be sealed, preserved and protected for future use. The site will be left free of rubbish, spares, or HDD-specific infrastructure.
2.3.5	Any remaining stockpiled vegetation or topsoil will be left in a stabilised manner to aid future reinstatement of areas required for the onshore umbilical installation, or otherwise managed in accordance with the Post-Construction Rehabilitation Plan (Ref. 14).
5.1	Construction vehicles and equipment will be regularly maintained.
5.1	Vehicle movements reduced by measures such as: • using buses for personnel transfer • limiting the number of light vehicles available to personnel • considering vehicle movements in daily planning activities to eliminate unnecessary movements.

Section No.	Actions
5.1	An IVMS will be installed in light vehicles to manage vehicle movements and speeds within the ROW
5.1	Any systems containing ODS that require recharging or replacement will be exchanged to a non ODS system.
5.1	Dust management procedures developed and include the requirement to implement dust suppression methods.
5.2.1	Clearing and earthworks managed in accordance with Ground and Vegetation Disturbance Form, as required under the PTW system
5.2.1	Reinstatement of landforms as required by Post-Construction Rehabilitation Plan (Ref. 14)
5.2.1	Potential disturbance of cultural heritage values managed per Aboriginal Cultural Heritage Management Plan (Ref. 48), including: • If surface or buried cultural heritage material is uncovered within the construction area, all construction work in the immediate vicinity of the material will cease until further notice. • An archaeologist or physical anthropologist with appropriate experience will be engaged in the event of discovering human remains in the clearing or work area.
5.2.2	Clearing and earthworks managed in accordance with Ground and Vegetation Disturbance Form, as required under the PTW system
5.2.2	Topsoil handled in accordance with Post-Construction Rehabilitation Plan (Ref. 14)
5.2.3	Temporary drainage management design incorporated into HDD site layout
5.2.3	Clearing and earthworks managed in accordance with Ground and Vegetation Disturbance Form, as required under the PTW system
5.2.3	Implementation of relevant pre and post construction drainage management measures described in the Post-Construction Rehabilitation Plan, specifically Table 4-1 in that Plan (Ref. 14)
5.3	Water winning spread installation, HDD exit point, and anchoring are confined to within the approved MDF, as defined in Coastal and Marine Baseline State and Environmental Impact Report: Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing (Ref. 50).
5.3	For vessels that anchor, anchoring will be managed in accordance with maritime industry standard watchkeeping practices, e.g. STCW2010.
5.3	Where anchoring is required, a mooring analysis is conducted prior to anchoring and considers: • substrate type • tides • weather conditions to reduce the risk of anchor drag in conservation significant subtidal habitats.
5.3	Anchoring will be undertaken in accordance with Chevron Marine Standard (Ref. 51)
5.3	A 24-hour visual, radio, and radar watch will be maintained for vessels in the vicinity of the Operational Area in accordance with AMSA and/or Standards of Training, Certification and Watchkeeping (STCW2010) (1978 STCW Convention)
5.3	Lost object recovered where safe and practicable, and offers net environmental benefit
5.3	Pre-installation seabed survey to confirm HDD exit point and anchoring locations identifies any apparent shipwrecks
5.3	If any shipwreck or relics are discovered during the proposed activities, DAWE Maritime Heritage Section will be notified, including: • a detailed description of the remains of the shipwreck or the relic, which may include sonar images, electronic data, and/or digital photographs

Section No.	Actions
	• a description of the place where the shipwreck or relic is located that is sufficiently detailed to allow it to be identified and relocated, including navigation data and datum information
5.3	Should any shipwreck or relics be discovered during the proposed activities, all Project vessels will be notified of the location.
5.4	Where practicable, night shift activities will be scheduled to avoid the turtle nesting and hatchling seasons. If night time activities are to be undertaken during turtle nesting season (October to April), contractor required to develop and implement a Lighting Management Procedure (LMP) that describes strategies to reduce lighting to the minimum necessary for safe operations and addresses the following measures to reduce light emissions: • light sources, including headlights of parked vehicles, located in such a way as to avoid illuminating beach areas, where practicable • lighting to be switched off when not in use and/or automatic timers/sensors installed • the use of shielded light fittings, directed lights and/or screens • lights to be mounted as low as practicable and focused on areas being worked on • where colour definition is not required for safety or operational purposes, lighting types that have reduced risk to turtles • fitting of blinds or curtains on windows to block out internal light sources.
5.5	Equipment covers, mufflers and/or other noise suppression equipment fitted to combustion engines and other noise generating equipment (e.g. generators)
5.5	Vehicles and equipment maintained in accordance with Contractor's planned maintenance schedule (PMS)
5.5	Driving on the beach during turtle nesting and hatching season (October to April) is prohibited unless required under specific or unusual conditions (e.g. to access a frac-out site) and an internal permit is obtained. Driving on the beach is to be avoided at all other times where practicable.
5.5	Vessels will adhere to Part 8 of the EPBC Regulations 2000 and Division 2 of the BC Regulations 2018 where practicable to potential interactions with fauna, including: • establishing a caution zone around prescribed fauna defined as an area around the animal with a radius of 30 m for a whale shark, 100 m for a dugong or seal, 150 m for a dolphin and 300 m (or 100 m to the side) for a whale. Within the caution zone: • operate the vessel at a constant speed of less than 6 knots and minimise noise • post a lookout for fauna
5.6	Only water-based, biodegradable polymer drilling fluid used for HDD
5.6	All planned hazardous chemical discharges (including drilling fluids) shall be assessed and deemed acceptable before use, in accordance with the ABU Hazardous Materials Management Procedure (Ref. 69)
5.6	To the extent practicable, drilling fluids will be re-used/ recycled and managed via onsite controls that include: • ongoing monitoring of mud levels • ongoing monitoring of down-hole pressures (build-ups and losses) • drilling contractor's Frac-out Management Plan and experienced personnel • visual inspections by spotters on a regular basis whilst drilling, and particularly during pilot hole drilling where the risk of frac-out is generally higher than when reaming
5.6	MARPOL-compliant sewage and oily water treatment systems (OWTS) present on vessels >400 T
5.6	In accordance with MARPOL:

Section No.	Actions
	• sewage will not be discharged within 3 nm from land • bilge water will only be discharged if treated by OWTS to <15 ppm and vessel en-route
5.6	Vessels will have sufficient sullage capacity onboard to store sewage or bilge water for the period if/where discharge not permitted by MARPOL.
5.6	Vessels and onboard equipment (e.g. OWTS) maintained in accordance with Contractor's PMS
5.7.1	An IVMS will be installed in light vehicles to manage vehicle movements and speeds
5.7.1	Personnel will only be eligible to drive on Barrow Island if they have: • completed a CAPL-approved driving course • completed the ABU Barrow Island Induction • completed Barrow Island on-site driver awareness training.
5.7.1	Vehicle/equipment/plant access to beach prohibited unless specifically authorised and accompanied by spotter
5.7.1	Handling of injured fauna, where required, is undertaken by a trained fauna handler
5.7.1	Any harm or mortality to EPBC Act listed terrestrial fauna is reported in accordance with Section 6.6.
5.7.1	To reduce the risk of injury or fatality to marine fauna due to boat strike, marine fauna watch will be maintained when all these conditions are in place: • daylight hours • vessel is moving (>5 knots) • vessel is close to shore (within 3 nm of the beach) • during times of high turtle activity (October to April).
5.7.1	Vessels will adhere to Part 8 of the EPBC Regulations 2000 and Division 2 of the BC Regulations 2018 where practicable for potential interactions with fauna, including: • establishing a caution zone around prescribed fauna defined as an area around the animal with a radius of 30 m for a whale shark, 100 m for a dugong or seal, 150 m for a dolphin and 300 m (or 100 m to the side) for a whale. Within the caution zone: • operate the vessel at a constant speed of less than 6 knots and minimise noise • post a lookout for fauna.
5.7.2	A risk assessment will be completed as part of the PTW system and where potential risk to fauna is identified (e.g. for excavations >0.5 m left unattended overnight) appropriate controls will be identified and implemented. Controls may include: • egress or exclusion controls (e.g. ramps, scramble mats, battered slopes, ladders within a trench, exclusion fencing, backfilling) • inspection controls (e.g. inspections at prescribed intervals)
5.7.2	Water winning spread includes installation of suitable intake screening.
5.7.3	Consultation undertaken with other potential users of the area
5.7.3	A 24-hour visual, radio, and radar watch will be maintained for vessels in the vicinity of the Operational Area in accordance with applicable AMSA requirements and/or Standards of Training, Certification and Watchkeeping (STCW2010) (1978 STCW Convention)
5.7.3	Minimum lighting required for safety and navigational purposes, in accordance with the *Navigation Act 1912* (Marine Orders Part 30 [Prevention of Collisions]), is on board and operational.
5.7.3	The AHS will be notified sufficiently in advance of (where practicable no less than four working weeks before) marine HDD support operations commencing to enable Notices to Mariners to be published

Section No.	Actions
5.7.3	AMSA's JRCC will be notified 24–48 hours before marine HDD support operations commence to enable AMSA to distribute an AUSCOAST warning
5.8.1	All hydrocarbon and hazardous liquids storage within secondary containment that comprises the larger of 110% of the largest tank or 25% percent of the combined tank volumes
5.8.1	Spill protection will be provided under hazardous liquids transfer line connections and stationary equipment containing diesel
5.8.1	Lifting and unloading of bulk chemical containers from vehicles will be undertaken in accordance with the appropriate work instruction / Standard Operating Procedure
5.8.1	Vehicles involved in transporting bulk hazardous liquids will carry a spill kit
5.8.1	Refuelling trucks will have double-skinned storage tank(s)
5.8.1	All hazardous chemicals used in the operational area will be selected and assessed in accordance with the ABU Hazardous Materials Management Procedure (Ref. 69)
5.8.1	Spill response will be conducted in accordance with the Gorgon Project – Barrow Island Onshore Spill Contingency Plan
5.8.2	An excavation certificate, including a risk assessment, is approved prior to excavation associated with installation activities, as part of the Permit to Work system.
5.8.2	Engineering drawings issued for construction specify minimum separation distances to existing pipelines
5.8.2	Contractor installation procedure includes methods and monitoring to maintain vibration levels below required thresholds
5.8.2	Location information (e.g. As-Builts) for existing services known to occur within ROW provided to installation contractor.
5.8.2	Spill response will be conducted in accordance with the Gorgon Project – Barrow Island Onshore Spill Contingency Plan
5.8.3	Only water-based, biodegradable polymer drilling fluid used for HDD
5.8.3	All hazardous chemicals (including drilling additives) shall be assessed and deemed acceptable before use, in accordance with the ABU Hazardous Materials Management Procedure (Ref. 69)
5.8.3	Contractor Frac-out Management Plan addresses: • selection and mobilisation of LCM tailored to porosity of formations • volumetric checks of fluid use and real-time monitoring of downhole pressures during drilling • swabbing triggered where appropriate to reduce losses • visual inspections by spotters on a regular basis whilst drilling, and particularly during pilot hole drilling where the risk of frac-out is generally higher than when reaming.
5.8.4	All hydrocarbon and hazardous chemical storage with secondary containment or within bunded areas.
5.8.4	A complete inventory of all hazardous materials stored on the vessels will be maintained on board, together with current SDSs for each hazardous or dangerous goods substance
5.8.4	Marine vessels will have a current Shipboard Oil Pollution Emergency Plan (SOPEP)/Shipboard Marine Pollution Emergency Plan (SMPEP) as appropriate to class
5.8.4	Inductions/training provided to personnel responsible for handling or responding to spills of hazardous materials
5.8.4	Spill containment and recovery equipment (spill kits, scupper plugs) will be provided where spills are possible (e.g. where fuel, oil, or chemicals and hazardous waste are used or stored).

Section No.	Actions
5.8.4	All spills will be recorded as per CAPL's Incident Investigation and Reporting Process (Ref. 54)
5.8.4	Spills will be contained and/or cleaned up in accordance with vessel SOPEP/SMPEP
5.8.5	A 24-hour visual, radio, and radar watch will be maintained for vessels in the vicinity of the Operational Area in accordance with AMSA and/or Standards of Training, Certification and Watchkeeping (STCW2010) (1978 STCW Convention)
5.8.5	The AHS will be notified sufficiently in advance of (where practicable no less than four working weeks before) installation operations commence to enable Notices to Mariners to be published
5.8.5	Risks of vessel collisions will be detailed and managed by a SIMOPS plan (where relevant).
5.8.5	Marine vessels will have a SOPEP (as appropriate to class) on board
5.8.5	Emergency spill response activities will be implemented in accordance with the Consolidated OPEP (Ref. 103) in the event of an emergency condition leak and spill from a vessel collision
6.3	Regular workplace inspections will be conducted during the HDD shore crossing and will include (but not necessarily be limited to) the items listed in Table 6–1.
6.6	The environmental incidents, reporting requirements and timing specific to this Addendum are provided in Table 6–2.
8	However, this Addendum will be reviewed in the event of a significant change to the activity described in Section 2, if a performance standard is not achieved or in the event a significant new or increased risk is identified.