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Our reference: 9874358

Office of the Environmental Protection Authority

File: .....

0 2 DEC 2014

A:	☐ For Information
fa:	☐ For Discussion
Officer:	☐ For Action
☐ Dir.AC	Response please:
☐ Dir. Bus Ops	☐ GM Signature
☐ Dir. SPPD	☐ Dir for GM (copy to GM)
☐ Dir. Strat Sup	☐
☐	☐

Attn: Kim Taylor
General Manager
Office of the Environmental Protection Authority
The Atrium, 168 St Georges Terrace
Perth Western Australia 6000

1 December 2014

Dear Kim

REFERRAL OF THE TOROSA SUBSEA DEVELOPMENT PROPOSAL UNDER S38 OF THE *ENVIRONMENTAL PROTECTION ACT 1986*

Woodside Energy Ltd, as Operator of the Browse Floating Liquefied Natural Gas (FLNG) Development and on behalf of the Browse Joint Venture participants, is referring the limited subsea components of the Browse FLNG Development that occur in WA State waters under Section 38(1) of the *Environmental Protection Act 1986.*

The Browse FLNG Development will involve the recovery of hydrocarbon resources from three reservoirs in the Browse Basin, approximately 425 kilometres north of Broome, Western Australia. These resources were first discovered in 1971, and their development will provide Australia with a new source of LNG to meet the world's growing demands for cleaner sources of energy.

Concurrent with this referral, the Browse FLNG Development, including those components addressed by this referral, is currently undergoing formal assessment at Environmental Impact Statement (EIS) level under the *Environment Protection and Biodiversity Conservation Act 1999*. The Draft EIS provides further detail on the aspects addressed in this Torosa Subsea Development referral.

A copy of the EPA referral form and additional supporting information in Attachment 2 is enclosed for your review.

For further information please contact Nick Jones, Development Environment Manager, on 9348 3817 or via email: Nick.Jones@woodside.com.au.

Yours sincerely

Stephen Rogers
Senior Vice President
Browse FLNG Development

Attached:
- EPA Referral From
- Attachment 2 – Referral of the Torosa Subsea Development Proposal under s 38 of the *Environmental Protection Act 1986*
- Electronic copy of spatial data

Environmental Protection Authority

GOVERNMENT OF WESTERN AUSTRALIA

EPA REFERRAL FORM PROPONENT

Referral of a Proposal by the Proponent to the Environmental Protection Authority under Section 38(1) of the *Environmental Protection Act 1986*.

PURPOSE OF THIS FORM

Section 38(1) of the *Environmental Protection Act 1986* (EP Act) provides that where a development proposal is likely to have a significant effect on the environment, a proponent may refer the proposal to the Environmental Protection Authority (EPA) for a decision on whether or not it requires assessment under the EP Act. This form sets out the information requirements for the referral of a proposal by a proponent.

Proponents are encouraged to familiarise themselves with the EPA's *General Guide on Referral of Proposals* [see Environmental Impact Assessment/Referral of Proposals and Schemes] before completing this form.

A referral under section 38(1) of the EP Act by a proponent to the EPA must be made on this form. A request to the EPA for a declaration under section 39B (derived proposal) must be made on this form. This form will be treated as a referral provided all information required by Part A has been included and all information requested by Part B has been provided to the extent that it is pertinent to the proposal being referred. Referral documents are to be submitted in two formats – hard copy and electronic copy. The electronic copy of the referral will be provided for public comment for a period of 7 days, prior to the EPA making its decision on whether or not to assess the proposal.

CHECKLIST

Before you submit this form, please check that you have:

	Yes	No
Completed all the questions in Part A (essential).	✓	
Completed all applicable questions in Part B.	✓	
Included Attachment 1 – location maps.	✓	
Included Attachment 2 – additional document(s) the proponent wishes to provide (if applicable).	✓ [1]	
Included Attachment 3 – confidential information (if applicable).		✓
Enclosed an electronic copy of all referral information, including spatial data and contextual mapping but excluding confidential information.	✓	

[1] *To assist the EPA in making its decision, Attachment 2 of this Referral Form provides a comprehensive summary of Proposal components, Proposal history, legal frameworks, stakeholder engagement, the existing environment, an assessment of potential impacts on environmental factors, proposed mitigation and management and concludes with the predicted environmental outcome. The information presented in the attachment has been guided by the requirements of various EPA Guidance Documents, including, amongst others, those addressing the key characteristics of a*

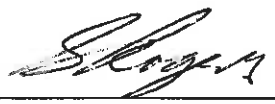
Proposal (EAG 1), environmental factors and objectives (EAG 8) and the application of a significance framework to environmental assessment (EAG 9). Cross references to more detailed information contained in Attachment 2 are made throughout this Referral Form.

Following a review of the information presented in this form, please consider the following question (a response is optional).

Do you consider the proposal requires formal environmental impact assessment? ☐ Yes ☒ No ☐ Not sure
If yes, what level of assessment? ☐ Assessment on Proponent Information ☐ Public Environmental Review

PROPONENT DECLARATION (to be completed by the proponent)

I, Steve Rogers, *(full name)* declare that I am authorised on behalf of the Browse Joint Venture Participants (being the person responsible for the proposal) to submit this form and further declare that the information contained in this form is true and not misleading.

Signature 	Name (print): Stephen Rogers
Position: Senior Vice President, Browse	Company: Woodside Energy Ltd
Date: 1 December 2014	

PART A - PROPONENT AND PROPOSAL INFORMATION

(All fields of Part A must be completed for this document to be treated as a referral)

1 PROPONENT AND PROPOSAL INFORMATION

1.1 Proponent

Name	Woodside Energy Ltd (Woodside)
Joint Venture parties (if applicable)	Woodside is Operator on behalf of the Browse Joint Venture (JV) Participants , namely: • Woodside Browse Pty Ltd • Shell Australia Pty Ltd (Shell) • BP Developments Australia Pty Ltd (BP) • Japan Australia LNG (MIMI Browse) Pty Ltd (MIMI) • PetroChina International Investment (Australia) Pty Ltd (PetroChina)
Australian Company Number (if applicable)	63005482986
Postal Address **(where the proponent is a corporation or an association of persons, whether incorporated or not, the postal address is that of the principal place of business or of the principal office in the State)**	Woodside Plaza 240 St Georges Terrace Perth WA 6000
Key proponent contact for the proposal: • **name** • **address** • **phone** • **email**	Nick Jones Environment Development Manager, Woodside Energy Limited Woodside Plaza 240 St Georges Terrace Perth WA 6000 Tel: 1800 036 654 Email: browseinfo@woodside.com.au
Consultant for the proposal (if applicable): • **name** • **address** • **phone** • **email**	Not applicable

1.2 Proposal

Title
Torosa Subsea Development Proposal (the Proposal).
Description
The Proposal involves the extraction of hydrocarbon resources from the Torosa reservoir located approximately 425 km north of Broome and approximately 290 km off the Kimberley coast in Western Australia (WA) (refer to Figure 1.1 in *Attachment 2*). The Proposal forms part of the larger Browse Floating Liquefied Natural Gas (FLNG) Development, which proposes to recover the hydrocarbon resources from three reservoirs: Brecknock, Calliance and Torosa, using up to three FLNG facilities to be located in Commonwealth waters. Infrastructure for the Browse FLNG Development will be predominantly located in Commonwealth jurisdiction. However, following advice from the National Offshore Petroleum Titles Administrator (NOPTA) in May 2014 of proposed changes to the maritime boundary around Scott Reef, some of the subsea infrastructure of the Browse FLNG Development and a portion of associated flowlines will be located in an area under State jurisdiction. The Browse FLNG Development is currently undergoing formal assessment at Environmental Impact Statement (EIS) level under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act; EPBC Reference: 2013/7079). This EPBC Act assessment includes those components addressed by this referral. The Draft EIS is available for view at: http://www.woodside.com.au/Our-Business/Browse/Pages/Draft-Environmental-Impact-Statement.aspx. The Browse JV Participants are referring the limited subsea components of the Browse FLNG Development that occur within WA State waters. The FLNG facilities are outside the scope of this referral. The Proposal comprises a limited subset of the infrastructure and activities associated with the larger Browse FLNG Development that occur within WA State jurisdiction; specifically, the drilling, installation, commissioning, operation and future decommissioning of approximately 17 wells from three drill centres and subsea infrastructure including wellheads, manifolds, flowlines and umbilicals located in State waters. The wells will target the hydrocarbon resources of the Torosa reservoir. Extracted hydrocarbons will be transferred through the wellheads, manifolds and flowlines positioned on the seabed at water depths of greater than 350 m, to FLNG facilities that are outside the scope of the Proposal. The flow of extracted hydrocarbons will be operated via umbilicals lying on the seabed and controlled remotely from the FLNG facilities. When compared to the overall Browse FLNG Development, the infrastructure and activities addressed in this Proposal are limited in scope and scale. The Proposal concept and associated activities are commonplace in the offshore oil and gas sector in WA. Additional detail about the Proposal is provided in *Attachment 2, Sections 1.0 and 3.0*. The location and layout of Proposal components is shown in Figure 3.1 of *Attachment 2.*
Extent (area) of proposed ground disturbance.
The total extent of seabed disturbed by the Proposal is estimated at approximately 8 ha. This value is subject to refinement during the design process. The disturbed area lies in water depths of greater than 350 m.

Timeframe in which the activity or development is proposed to occur (including start and finish dates where applicable).	
If the Browse Joint Venture participants sanction the Proposal, development activities for the Proposal are expected to be phased starting at one drill centre approximately four years after Final Investment Decision (FID). Overall reservoir life is expected to extend for approximately 40 to 50 years, after which decommissioning of the wells and associated subsea infrastructure will occur. Due to the subsea nature of Proposal components, surface-based activities will only occur during the drilling, installation, commissioning and decommissioning phases. For the majority of the Proposal's anticipated 40 to 50 year operational life, only periodic vessel-based monitoring and maintenance activities will be required. Further detail on the Proposal schedule is provided in Section 3.6 of *Attachment 2.*	
Details of any staging of the proposal.	It is anticipated that drilling and installation activities will be phased with activities initially being focused on one drill centre. Further detail on this phasing is provided in Section 3.6 of *Attachment 2.*
Is the proposal a strategic proposal?	No.
Is the proponent requesting a declaration that the proposal is a derived proposal? **If so, provide the following information on the strategic assessment within which the referred proposal was identified:** • **title of the strategic assessment; and** • **Ministerial Statement number.**	No.
Please indicate whether, and in what way, the proposal is related to other proposals in the region.	The Proposal forms part of the larger Browse FLNG Development, which is currently undergoing formal assessment at Environmental Impact Statement (EIS) level under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act; EPBC Reference: 2013/7079, see http://www.environment.gov.au/). This assessment includes those components addressed by this referral. Components of a previous concept for the development of the Browse resources (including Torosa), which involved the transfer of produced hydrocarbons via three infield platforms (one of which was to be located within approximately 6 km of Scott Reef) and a central Processing Facility on

	the continental shelf, to an onshore LNG processing facility at James Price Point (the 'JPP concept') were also referred and assessed under the EPBC Act via EPBC Reference: 2008/411. The JPP concept was progressed through to completion of a public review of a draft EIS before the concept was withdrawn. The components addressed by this Proposal have remained largely unchanged since the JPP concept.
Does the proponent own the land on which the proposal is to be established? If not, what other arrangements have been established to access the land?	The larger Browse FLNG Development relates to State Retention Leases R2 and TR/5 and Commonwealth retention leases WA-28-R, WA-29-R, WA-30-R, WA-31-R and WA-32-R. The present Proposal relates to the Torosa field the subject of retention leases R2, TR/5 and WA-30-R. However, the boundaries of these titles are proposed to be redrawn upon retention lease renewal under the *Petroleum Titles (Browse Basin) Bill 2014* (WA) such that proposed infrastructure and activities in WA-30-R will be located within TR/5. Proposal infrastructure addressed in this referral will therefore be limited to TR/5 (refer to Figure 3.1 in Attachment 2). State production licences (and relevant Commonwealth titles for the larger Browse FLNG Development) will be required in due course.
What is the current land use on the property, and the extent (area in hectares) of the property?	
The extent of the Proposal Area covers an area of approximately 103,000 ha, of which approximately 8 ha may be disturbed by Proposal activities. In addition to petroleum related activities, existing users of the Proposal Area include commercial fisheries, traditional fisheries, scientific research, and limited shipping and tourism. The extent of the Proposal Area is shown in Figure 3.1 of *Attachment 2.* Further detail on existing users of the Proposal Area is provided in Section 11.2 of *Attachment 2.*	

1.3 Location

Name of the Shire in which the proposal is located.	Not applicable.
For urban areas: • street address; • lot number; • suburb; and • nearest road intersection.	Not applicable.
For remote localities: • nearest town; and • distance and direction from that town to the proposal site.	Approximately 425 km north of Broome, WA.
Electronic copy of spatial data - GIS or CAD, geo-referenced and conforming to the following parameters: • GIS: polygons representing all activities and named; • CAD: simple closed polygons representing all activities and named; • datum: GDA94; • projection: Geographic (latitude/longitude) or Map Grid of Australia (MGA); • format: Arcview shapefile, Arcinfo coverages, Microstation or AutoCAD.	Refer to Enclosure 1.

1.4 Confidential Information

Does the proponent wish to request the EPA to allow any part of the referral information to be treated as confidential?	No.
If yes, is confidential information attached as a separate document in hard copy?	Not applicable.

1.5 Government Approvals

Is rezoning of any land required before the proposal can be implemented? If yes, please provide details.	Subject to *Petroleum Titles (Browse Basin) Bill 2014* (WA) receiving Royal Assent. The present Proposal relates to the Torosa field the subject of retention leases R2, TR/5 and WA-30-R. However, the boundaries of these titles are proposed to be redrawn upon retention lease renewal under the *Petroleum Titles (Browse Basin) Bill 2014* (WA) such that proposed infrastructure and activities in WA-30-R will be located within TR/5. Proposal infrastructure addressed in this referral will therefore be limited to TR/5 (refer to Figure 3.1 in Attachment 2). State production licences (and relevant Commonwealth titles for the larger Browse FLNG Development) will be required in due course.
Is approval required from any Commonwealth or State Government agency or Local Authority for any part of the proposal? If yes, please complete the table below.	Yes

Agency/Authority	Approval required	Application lodged Yes / No	Agency/Local Authority contact(s) for proposal
Western Australian Department of Mines and Petroleum (DMP) [1]	Consent to develop petroleum resources and to construct and operate petroleum wells and pipelines offshore	No	Not yet applicable
DMP [1]	Environment Plan(s) for petroleum activities under the *Petroleum (Submerged Lands) Act 1982 (WA)*	No	Not yet applicable
DMP	Safety Case	No	Not yet applicable
Commonwealth Minister for the Environment	EPBC Act Approval pertaining to matters of National Environmental Significance (EPBC Reference: 2013/7079)	Yes	Matt Whitting

[1] Note: State retention lease boundaries are proposed to be redrawn on renewal under the *Petroleum Titles (Browse Basin) Bill 2014* (WA).

PART B - ENVIRONMENTAL IMPACTS AND PROPOSED MANAGEMENT

2. ENVIRONMENTAL IMPACTS

Describe the impacts of the proposal on the following elements of the environment, by answering the questions contained in Sections 2.1-2.11:

2.1 flora and vegetation;

2.2 fauna;

2.3 rivers, creeks, wetlands and estuaries;

2.4 significant areas and/ or land features;

2.5 coastal zone areas;

2.6 marine areas and biota;

2.7 water supply and drainage catchments;

2.8 pollution;

2.9 greenhouse gas emissions;

2.10 contamination; and

2.11 social surroundings.

These features should be shown on the site plan, where appropriate.

For all information, please indicate:

(a) the source of the information; and

(b) the currency of the information.

Attachment 2 provides a comprehensive summary of the potential environmental impacts of the Proposal and their proposed management. Therefore the information presented in this form is high-level, with cross references made to relevant sections of Attachment 2. For reference, the following sections of Attachment 2 are relevant:

- *The Executive Summary and Figure ES-1 provides a summary and conclusion*
- *The approach taken to identify and assess environmental impacts is presented in Section 5*
- *Relevant environmental factors are identified in Figure 5.1*
- *Impacts on relevant environmental factors are described and discussed in Sections 6 through 12. Each section presents:*
    - *The EPA's environmental objective for the factor*
    - *A description of the existing environment relevant to each factor*
    - *The sources of potential impact*
    - *Characterisation and assessment of potential impacts*
    - *Mitigation and management measures*
    - *Expected environmental outcome.*
- *A conclusion for the assessment is presented in Section 14.*

The impacts of the Proposal can be readily managed and will meet the EPAs objectives for key environmental factors. The larger Browse FLNG Development is being assessed under the EPBC Act and will also be regulated by risk-based petroleum legislation, including the requirement for Environment Plans. Both the EPBC Act and the State or Commonwealth Environment Plan regimes recognise the principles of ecologically sustainable development. Environment Plans for petroleum activities must demonstrate that risks and impacts are both of an acceptable level and will be reduced to as low as reasonably practicable (ALARP). Performance outcomes are specified in such plans.

2.1 Flora and Vegetation

2.1.1 Do you propose to clear any native flora and vegetation as a part of this proposal?

[A proposal to clear native vegetation may require a clearing permit under Part V of the EP Act (Environmental Protection (Clearing of Native Vegetation) Regulations 2004)]. Please contact the Department of Environment and Conservation (DEC) for more information.

(please tick) ☐ Yes — **If yes**, complete the rest of this section.

☒ No — **If no**, go to the next section

2.1.2 How much vegetation are you proposing to clear (in hectares)?

2.1.3 Have you submitted an application to clear native vegetation to the DEC (unless you are exempt from such a requirement)?

☐ Yes ☐ No — **If yes**, on what date and to which office was the application submitted of the DEC?

2.1.4 Are you aware of any recent flora surveys carried out over the area to be disturbed by this proposal?

☐ Yes ☐ No — **If yes**, please attach a copy of any related survey reports and provide the date and name of persons / companies involved in the survey(s).

If no, please do not arrange to have any biological surveys conducted prior to consulting with the DEC.

2.1.5 Has a search of DEC records for known occurrences of rare or priority flora or threatened ecological communities been conducted for the site?

☐ Yes ☐ No — If you are proposing to clear native vegetation for any part of your proposal, a search of DEC records of known occurrences of rare or priority flora and threatened ecological communities will be required. Please contact DEC for more information.

2.1.6 Are there any known occurrences of rare or priority flora or threatened ecological communities on the site?

☐ Yes ☐ No **If yes**, please indicate which species or communities are involved and provide copies of any correspondence with DEC regarding these matters.

2.1.7 If located within the Perth Metropolitan Region, is the proposed development within or adjacent to a listed Bush Forever Site? (You will need to contact the Bush Forever Office, at the Department for Planning and Infrastructure)

☐ Yes ☐ No **If yes**, please indicate which Bush Forever Site is affected (site number and name of site where appropriate).

2.1.8 What is the condition of the vegetation at the site?

2.2 Fauna

2.2.1 Do you expect that any fauna or fauna habitat will be impacted by the proposal?

(please tick) ✕ Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

2.2.2 Describe the nature and extent of the expected impact.

The Proposal has the potential to impact marine benthic habitats and marine fauna. Potential impacts are described in Section 7 and 8 respectively, and are summarised in Figure ES-1 of Attachment 2. The assessment concludes that no significant adverse impacts on marine benthic communities or marine fauna are likely.

2.2.3 Are you aware of any recent fauna surveys carried out over the area to be disturbed by this proposal?

✕ Yes ☐ No **If yes**, please attach a copy of any related survey reports and provide the date and name of persons / companies involved in the survey(s).

If no, please do not arrange to have any biological surveys conducted prior to consulting with the DEC.

The environment of the Proposal Area and its surrounds has been studied extensively through scientific surveys. The Browse JV Participants have commissioned a large number of studies to support the Browse developments, spanning over approximately two decades. These studies have sought to understand the physical and environmental conditions in and around the broader Browse development area, which encompasses the Proposal Area. Key studies have included baseline and annual programs for humpback whales, marine turtles, other marine megafauna and fish species in the region, as well as long-term monitoring of coral and fish communities at Scott Reef. These studies contribute to long-term data sets for the Proposal Area and its surrounding region and results are referenced in Section 8.2 of Attachment 2.

2.2.4 Has a search of DEC records for known occurrences of Specially Protected (threatened) fauna been conducted for the site?

☒ Yes ☐ No (please tick)

A Department of Parks and Wildlife (DPaW) NatureMap search was conducted for the Proposal Area (based on a 30 km radius from the centre of Scott Reef), in addition to a Commonwealth Department of Environment (DOE) Protected Matters Search Tool (PMST) inquiry (also based on a 30 km radius from the centre of Scott Reef) to identify Listed species and communities potentially occurring in the Proposal Area. The results of the DOE PMST inquiry were cross-referenced with the Wildlife Conservation Act 1950 (WA) to identify any species present that may not have been identified from the DPaW NatureMap search.

2.2.5 Are there any known occurrences of Specially Protected (threatened) fauna on the site?

☒ Yes ☐ No **If yes**, please indicate which species or communities are involved and provide copies of any correspondence with DEC regarding these matters.

Listed species identified through the searches described in item 2.2.4 that may be present in the Proposal Area are identified, and their likely presence, abundance, habitat etc. described in Section 8.2 of Attachment 2:

In summary, Sandy Islet, approximately 7 km from the nearest drill centre (TRE), is a known nesting site for green turtles. Migratory shorebirds are occasionally observed in very low numbers at Scott Reef (within the Proposal Area), and Sandy Islet may be used as a resting point during their migration. Small numbers of seabirds also occur at Scott Reef. The Region contains habitat suitable for a diverse range of fish (including sharks), rays and sea snakes; however only a small number of the WA population of whale sharks migrate through the wider region of the Proposal Area. Other megafauna identified in the wider environs of the Proposal Area include marine mammals; pygmy blue whales transit through the deep offshore waters on their way to and from known feeding grounds and may traverse the Proposal Area. Humpback whales migrate along the Kimberley coast to the east of the Proposal Area, with a small proportion migrating through the deep (350-600 m) waters of the Proposal Area.

2.3 Rivers, Creeks, Wetlands and Estuaries

2.3.1 Will the development occur within 200 metres of a river, creek, wetland or estuary?

(please tick) ☐ Yes **If yes**, complete the rest of this section.

☒ No **If no**, go to the next section.

2.3.2 Will the development result in the clearing of vegetation within the 200 metre zone?

☐ Yes ☐ No **If yes**, please describe the extent of the expected impact.

2.3.3 Will the development result in the filling or excavation of a river, creek, wetland or estuary?

☐ Yes ☐ No **If yes**, please describe the extent of the expected impact.

2.3.4 Will the development result in the impoundment of a river, creek, wetland or estuary?

☐ Yes ☐ No **If yes**, please describe the extent of the expected impact.

2.3.5 Will the development result in draining to a river, creek, wetland or estuary?

☐ Yes ☐ No **If yes**, please describe the extent of the expected impact.

2.3.6 Are you aware if the proposal will impact on a river, creek, wetland or estuary (or its buffer) within one of the following categories? (please tick)

Conservation Category Wetland	☐ Yes	☐ No	☐ Unsure
Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998	☐ Yes	☐ No	☐ Unsure
Perth's Bush Forever site	☐ Yes	☐ No	☐ Unsure
Environmental Protection (Swan & Canning Rivers) Policy 1998	☐ Yes	☐ No	☐ Unsure
The management area as defined in s4(1) of the *Swan River Trust Act 1988*	☐ Yes	☐ No	☐ Unsure
Which is subject to an international agreement, because of the importance of the wetland for waterbirds and waterbird habitats (e.g. Ramsar, JAMBA, CAMBA)	☐ Yes	☐ No	☐ Unsure

2.4 Significant Areas and/ or Land Features

2.4.1 Is the proposed development located within or adjacent to an existing or proposed National Park or Nature Reserve?

☐ Yes ☒ No **If yes**, please provide details.

The Proposal is not located within or adjacent to any State Marine Parks. However, 'Scott Reef' and specifically Sandy Islet, East Hook Island and the inter-tidal reef flat of South Scott Reef which occur within the Proposal Area but not in the Proposal Footprint (refer to Section 1.4 of Attachment 2 for a definition of these spatial areas), are included as an area of 'reserved land' under Section 7 of the Conservation and Land Management Act (CALM

Act) 1984. The reserved land is designated for the purpose of 'conservation of flora and fauna'. Refer to item 2.6.2 of this form.

2.4.2 Are you aware of any Environmentally Sensitive Areas (as declared by the Minister under section 51B of the EP Act) that will be impacted by the proposed development?

☒ Yes ☐ No **If yes**, please provide details.

Scott Reef and its surrounds, incorporating both North and South Scott Reef and comprising the emergent reef, the partially enclosed lagoons and the surrounding oceanic waters extending to the 50 m below sea level bathymetric contour, were listed on the Register of the National Estate. Further detail on the values for which the area was inscribed, and an assessment of Proposal impacts on these values, is provided in Section 12 of Attachment 2.

2.4.3 Are you aware of any significant natural land features (e.g. caves, ranges etc) that will be impacted by the proposed development?

☐ Yes ☒ No **If yes**, please provide details.

2.5 Coastal Zone Areas (Coastal Dunes and Beaches)

2.5.1 Will the development occur within 300metres of a coastal area?

(please tick) ☐ Yes **If yes**, complete the rest of this section.

☒ No **If no**, go to the next section.

2.5.2 What is the expected setback of the development from the high tide level and from the primary dune?

2.5.3 Will the development impact on coastal areas with significant landforms including beach ridge plain, cuspate headland, coastal dunes or karst?

☐ Yes ☐ No **If yes**, please describe the extent of the expected impact.

2.5.4 Is the development likely to impact on mangroves?

☐ Yes ☐ No **If yes**, please describe the extent of the expected impact.

2.6 Marine Areas and Biota

2.6.1 Is the development likely to impact on an area of sensitive benthic communities, such as seagrasses, coral reefs or mangroves?

☐ Yes ☒ No **If yes**, please describe the extent of the expected impact.

The Proposal has the potential to impact marine benthic habitats, however the Proposal Footprint comprises relatively widespread and well represented benthic communities and habitats in water depths of greater than 350 m. While the Proposal Area, which encompasses Scott Reef, supports abundant populations of hard and soft corals, other invertebrates and a diverse fish assemblage, no significant impacts on these communities are likely. Further detail on the marine benthic habitats present in the Proposal Area and an assessment of impacts on these habitats is provided in Section 7 of Attachment 2.

The assessment concludes that no significant adverse impacts on marine benthic communities are likely.

2.6.2 Is the development likely to impact on marine conservation reserves or areas recommended for reservation (as described in *A Representative Marine Reserve System for Western Australia*, CALM, 1994)?

☐ Yes ☒ No **If yes**, please describe the extent of the expected impact.

The Proposal Footprint is located in water depths of greater than 350 m, in an area of benthic habitat that is relatively widespread and well represented in the wider region, However, the wider Proposal Area includes Sandy Islet, East Hook Island and the inter-tidal reef flat of South Scott Reef, which are included in an area of 'reserved land' (formerly C Class Nature Reserve) vested in the Conservation Commission under Section 7 of the Conservation and Land Management Act 1984 (CALM Act). The reserved land is designated for the purpose of 'conservation of flora and fauna'. North Scott Reef is not included within this area of reserved land.

The assessment in Section 12 of Attachment 2 concludes that no significant adverse impacts to the environment of this reserved land are likely.

2.6.3 Is the development likely to impact on marine areas used extensively for recreation or for commercial fishing activities?

☐ Yes ☒ No **If yes**, please describe the extent of the expected impact, and provide any written advice from relevant agencies (e.g. Fisheries WA).

Other users of the Proposal Area include commercial and traditional Indonesian fishers, scientific research organisations and occasional recreational fishers. Proposal activities during drilling, installation, commissioning and decommissioning phases have the potential to result in a minor inconvenience to these other users. However, based on the current legislative framework, no exclusion areas will apply. Further detail on the use of the Proposal Area by third parties and an assessment of likely impacts on these users, is provided in Section 11 of Attachment 2.

The assessment concludes that no significant adverse impacts on the amenity value of the Proposal Area is likely.

2.7 Water Supply and Drainage Catchments

2.7.1 Are you in a proclaimed or proposed groundwater or surface water protection area?

(You may need to contact the Department of Water (DoW) for more information on the requirements for your location, including the requirement for licences for water abstraction. Also, refer to the DoW website)

☐ Yes ☒ No **If yes**, please describe what category of area.

2.7.2 Are you in an existing or proposed Underground Water Supply and Pollution Control area?

(You may need to contact the DoW for more information on the requirements for your location, including the requirement for licences for water abstraction. Also, refer to the DoW website)

☐ Yes ☒ No **If yes**, please describe what category of area.

2.7.3 Are you in a Public Drinking Water Supply Area (PDWSA)?

(You may need to contact the DoW for more information or refer to the DoW website. A proposal to clear vegetation within a PDWSA requires approval from DoW.)

☐ Yes ☒ No **If yes**, please describe what category of area.

2.7.4 Is there sufficient water available for the proposal?

(Please consult with the DoW as to whether approvals are required to source water as you propose. Where necessary, please provide a letter of intent from the DoW)

☒ Yes ☐ No (please tick)

Sufficient water will be available for the Proposal. The Proposal will not require abstraction of groundwater. Freshwater (including potable water) requirements for Proposal activities will either be generated on board drill rigs or vessels, or loaded from supply vessels or while at port.

2.7.5 Will the proposal require drainage of the land?

☐ Yes ☒ No **If yes**, how is the site to be drained and will the drainage be connected to an existing Local Authority or Water Corporation drainage system? Please provide details.

2.7.6 Is there a water requirement for the construction and/ or operation of this proposal?

(please tick) ☒ Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

The Proposal will require seawater for development drilling, seawater or freshwater for hydrotesting and potable water for personnel use on board the drill rig and vessels. Potable water will be sourced as described in item 2.7.4 of this form.

2.7.7 What is the water requirement for the construction and operation of this proposal, in kilolitres per year?

Water demands will primarily be sourced from seawater. Only minor volumes of potable water are anticipated to be sourced from mainland ports (existing), consistent with the ongoing permitted activities of these shore-based facilities.

2.7.8 What is the proposed source of water for the proposal? (e.g. dam, bore, surface water etc.)

The main source of water for the Proposal is seawater. Seawater will be used for drilling, commissioning and personnel use on board drill rig and vessels. Potable / freshwater requirements will either be generated on board via reverse osmosis or thermal desalination or sourced from mainland ports consistent with the ongoing permitted activities of these shore-based facilities.

2.8 Pollution

2.8.1 Is there likely to be any discharge of pollutants from this development, such as noise, vibration, gaseous emissions, dust, liquid effluent, solid waste or other pollutants?

(please tick) ☒ Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

Anticipated emissions and discharges are defined in Section 3.7 of Attachment 2.

2.8.2 Is the proposal a prescribed premise, under the Environmental Protection Regulations 1987?

(Refer to the EPA's *General Guide for Referral of Proposals to the EPA under section 38(1) of the EP Act 1986* for more information)

☐ Yes ☒ No **If yes**, please describe what category of prescribed premise.

2.8.3 Will the proposal result in gaseous emissions to air?

☒ Yes ☐ No **If yes**, please briefly describe.

Atmospheric emissions are described in Section 3.7.6 of Attachment 2 and potential impacts on air quality assessed in Section 10 of Attachment 2.

2.8.4 Have you done any modelling or analysis to demonstrate that air quality standards will be met, including consideration of cumulative impacts from other emission sources?

☐ Yes ☒ No **If yes**, please briefly describe.

Given the low level and short duration of emissions anticipated and the remote offshore location, no modelling is warranted.

2.8.5 Will the proposal result in liquid effluent discharge?

☒ Yes ☐ No **If yes**, please briefly describe the nature, concentrations and receiving environment.

Liquid waste discharges are described in Sections 3.7.1 to 3.7.4 of Attachment 2. Potential impacts of these discharges on marine environmental quality, marine benthic habitats and marine fauna are assessed in Sections 6, 7 and 8 respectively. Given the nature of discharges, the comparatively low volumes discharged and the mitigation and management measures proposed (many of which are commonplace in the offshore oil and gas industry in Western Australia and some go beyond industry standard practice), the assessment concludes that no significant adverse impacts will arise from liquid effluent discharges.

2.8.6 If there is likely to be discharges to a watercourse or marine environment, has any analysis been done to demonstrate that the State Water Quality Management Strategy or other appropriate standards will be able to be met?

☐ Yes ☒ No **If yes**, please describe.

As described in item 2.8.5 of this form, the Proposal will result in a small number of discharge sources, the impacts of which are assessed in Sections 6-8 of Attachment 2. Given the nature of discharges, the comparatively low volumes discharged, specific analysis against the State Water Quality Management Strategy was not warranted. Discharges are likely to result in a highly localised and temporary reduction in water quality, and are expected to disperse and dilute rapidly given the strong surface and sub-surface currents in the Proposal Area. The assessment concludes that no significant adverse impacts will arise from proposed discharges to the marine environment.

2.8.7 Will the proposal produce or result in solid wastes?

☒ Yes ☐ No **If yes**, please briefly describe the nature, concentrations and disposal location/ method.

Given the scale and scope of the Proposal, limited solid waste is expected to be generated by the Proposal. Solid wastes potentially generated are described in Sections 3.7.8 through 3.7.10 of Attachment 2.

2.8.8 Will the proposal result in significant off-site noise emissions?

☒ Yes ☐ No **If yes**, please briefly describe.

The Proposal will generate noise as described in Section 3.7.7 of Attachment 2. However, due to the offshore location of the Proposal, noise sensitive receptors are restricted to marine fauna. Potential impacts associated with noise on marine fauna are assessed in Section 8.4.4 of Attachment 2.

2.8.9 Will the development be subject to the Environmental Protection (Noise) Regulations 1997?

☐ Yes ☒ No **If yes**, has any analysis been carried out to demonstrate that the proposal will comply with the Regulations?

Please attach the analysis.

The Environmental Protection (Noise) Regulations 1997 (WA) do not apply to the Proposal due to the offshore location of the Proposal remote from other urban or industrial areas.

2.8.10 Does the proposal have the potential to generate off-site, air quality impacts, dust, odour or another pollutant that may affect the amenity of residents and other "sensitive premises" such as schools and hospitals (proposals in this category may include intensive agriculture, aquaculture, marinas, mines and quarries etc.)?

☐ Yes ☒ No **If yes**, please describe and provide the distance to residences and other "sensitive premises".

There are no residents or sensitive premises affected given the offshore location of the Proposal.

2.8.11 If the proposal has a residential component or involves "sensitive premises", is it located near a land use that may discharge a pollutant?

☐ Yes ☒ No ☐ Not Applicable

If yes, please describe and provide the distance to the potential pollution source

2.9 Greenhouse Gas Emissions

2.9.1 Is this proposal likely to result in substantial greenhouse gas emissions (greater than 100 000 tonnes per annum of carbon dioxide equivalent emissions)?

☐ Yes ☒ No **If yes**, please provide an estimate of the annual gross emissions in absolute and in carbon dioxide equivalent figures.

Given the scope of the Proposal which excludes the processing facilities for the extracted hydrocarbons, the Proposal is not expected to result in substantial greenhouse gas emissions. Greenhouse gas emissions generated during the

processing of hydrocarbons onboard the FLNG vessels is addressed in the Draft EIS for the Browse FLNG Development.

2.9.2 Further, if yes, please describe proposed measures to minimise emissions, and any sink enhancement actions proposed to offset emissions.

2.10 Contamination

2.10.1 Has the property on which the proposal is to be located been used in the past for activities which may have caused soil or groundwater contamination?

☐ Yes ☒ No ☐ Unsure **If yes**, please describe.

Exploration and appraisal drilling at sites within the Proposal Area has occurred in the past. However, laboratory analysis of sediment samples indicated no evidence of hydrocarbon contamination in the Proposal Area, with generally low levels of metal and nutrient levels typical of carbonate-dominated sediments in remote tropical settings (Section 6.2 of Attachment 2)

2.10.2 Has any assessment been done for soil or groundwater contamination on the site?

☐ Yes ☒ No **If yes**, please describe.

2.10.3 Has the site been registered as a contaminated site under the *Contaminated Sites Act 2003*? (on finalisation of the CS Regulations and proclamation of the CS Act)

☐ Yes ☒ No **If yes**, please describe.

2.11 Social Surroundings

2.11.1 Is the proposal on a property which contains or is near a site of Aboriginal ethnographic or archaeological significance that may be disturbed?

☐ Yes ☒ No ☐ Unsure **If yes**, please describe.

No known sites of Aboriginal Heritage significance are located within the Proposal Area according to the WA Department of Aboriginal Affairs' Aboriginal Sites Inquiry System (Section 12.2 of Attachment 2). The existence of any unknown Aboriginal sites or artefacts of significance within the Proposal or the wider North-west Marine Region is considered highly unlikely due to the site's remote location offshore.

2.11.2 Is the proposal on a property which contains or is near a site of high public interest (e.g. a major recreation area or natural scenic feature)?

☐ Yes ☒ No **If yes**, please describe.

The Proposal Area is offshore and remote from other urban or industrial areas.

2.11.3 Will the proposal result in or require substantial transport of goods, which may affect the amenity of the local area?

☐ Yes ☒ No **If yes**, please describe.

Given the remote location of the Proposal, few receptors occur within the Proposal Area. Impacts on the amenity value of the Proposal are discussed in Section 11 of Attachment 2.

As described in Section 3.4.7 of Attachment 2, Proposal activities will be supported, where necessary by existing shore-based supply chain logistics and support facilities. Such facilities typically serve a number of petroleum operators and Proposal logistics through these facilities will be no different from their day to day activities. No new infrastructure on mainland WA is anticipated to be required to support the Proposal. Therefore, the transport of limited goods from the mainland to and from the Proposal Area during construction stages is not expected to be substantial or affect the amenity of the local area.

3. PROPOSED MANAGEMENT

3.1 Principles of Environmental Protection

3.1.1 Have you considered how your project gives attention to the following Principles, as set out in section 4A of the EP Act? (For information on the Principles of Environmental Protection, please see EPA Position Statement No. 7, available on the EPA website)

1. The precautionary principle.	☒ Yes	☐ No
2. The principle of intergenerational equity.	☒ Yes	☐ No
3. The principle of the conservation of biological diversity and ecological integrity.	☒ Yes	☐ No
4. Principles relating to improved valuation, pricing and incentive mechanisms.	☒ Yes	☐ No
5. The principle of waste minimisation.	☒ Yes	☐ No

Woodside's environmental management approach, described in Section 2.3 of Attachment 2, has the overall objective to conduct Proposal activities in a manner which achieves the EPA's environmental objectives and reflect the principles and objects of the EP Act. The ways in which the principles and objects of the EP Act have been considered are demonstrated in Table 2.1 of Attachment 2.

3.1.2 Is the proposal consistent with the EPA's Environmental Protection Bulletins/Position Statements and Environmental Assessment Guidelines/Guidance Statements (available on the EPA website)?

☒ Yes ☐ No

The Proposal has been considered against, and is consistent with, the following relevant Environmental Protection Bulletins/Position Statements and Environmental Assessment Guidelines/Guidance Statements of the EPA:

- *Environmental Assessment Guidelines: Protection of Benthic Primary Producer Habitats in Western Australia's Marine Environment (EAG 3).*
- *Environmental Assessment Guidelines: Environmental Assessment Guideline for Protecting Marine Turtles from Light Impacts (EAG 5).*
- *WA Environmental Offsets Policy.*
- *WA Environmental Offsets Guidelines.*
- *Environmental Protection Bulletin No. 1: Environmental Offsets – Biodiversity.*
- *Environmental Protection Bulletin No. 18: Sea Level Rise.*
- *Position Statement No. 7: Principles of Environmental Protection*.

Furthermore, the information presented in Attachment 2 has been guided by reference to the following EPA Policies and Guidance documents:

- *General Guide on Referral of Proposals to the Environmental Protection Authority under Section 38 of the EP Act.*
- *Environmental Impact Assessment (Part IV, Divisions I and II) Administrative Procedures 2012.*
- *Environmental Assessment Guideline for Defining the Key Characteristics of a Proposal (EAG 1).*
- *Environmental Assessment Guideline: Environmental factors and objectives (EAG 8).*
- *Environmental Assessment Guideline for Application of a Significance Framework in the environmental assessment process: focusing on key environmental factors (EAG 9).*

3.2 Consultation

3.2.1 Has public consultation taken place (such as with other government agencies, community groups or neighbours), or is it intended that consultation shall take place?

☒ Yes ☐ No **If yes**, please list those consulted and attach comments or summarise response on a separate sheet.

Detail on stakeholder engagement undertaken by Woodside is provided in Section 4 of Attachment 2.

Attachment 1: Location Maps

Location maps are included in *Attachment 2* as follows:

Required Map Type	Figure Reference in Attachment 2	Content
Locality Map – Broad Scale	Figure 1.1	Location of Proposal in regional context, including closest urban settlement
Site plan – Proposal Details	Figure 3.1	Extent of Proposal Area, petroleum title area boundaries and infrastructure locations, in relation to landforms and bathymetry
	Figure 3.2	Indicative Proposal Subsea Infrastructure
	Figure 3.3	Location of Well Centres in relation to Seabed Morphology
Site Plan – Existing Environment	Figure 7.1	Scott Reef Habitat Map
	Figure 9.1	Morphology of the Proposal Area

Additional maps illustrating aspects of the existing environment are available in the Draft EIS for the Browse FLNG Development, details of which are provided in *Section 1* of *Attachment 2.*

Attachment 2: Additional Information

Referral of the Torosa Subsea Development Proposal under s38 of the Environmental Protection Act: Attachment 2

1 December 2014

Rev 0: Issue to OEPA

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Executive Summary

Woodside, as Operator and on behalf of the Browse Joint Venture (JV) Participants, proposes to extract the hydrocarbon resources of the Torosa reservoir through the Torosa Subsea Development Proposal ('the Proposal'). The Proposal comprises a limited subset of the larger Browse Floating Liquefied Natural Gas (FLNG) Development.

Infrastructure for the Browse FLNG Development will be predominantly located in Commonwealth jurisdiction. However, following advice from the National Offshore Petroleum Titles Administrator (NOPTA) in May 2014 of proposed changes to the maritime boundary around Scott Reef, some of the subsea infrastructure of the Browse FLNG Development and a portion of associated flowlines will be located in an area under State jurisdiction.

The Browse JV Participants are referring the limited subsea components of the Browse FLNG Development that occur in WA State waters under Section 38(1) of the *Environmental Protection Act 1986*.

Concurrent with this Proposal, the Browse FLNG Development, including those components addressed by this referral, is currently undergoing formal assessment at Environmental Impact Statement (EIS) level under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act; EPBC Reference: 2013/7079). The Draft EIS provides further detail on the aspects addressed in this Torosa Subsea Development referral. The Draft EIS is available for view at: http://www.woodside.com.au/Our-Business/Browse/Pages/Draft-Environmental-Impact-Statement.aspx.

Components of a previous concept for the development of the Browse resources, which involved the proposed transfer of produced hydrocarbons via three infield platforms (one of which located within ~ 6 kilometres (km) of Scott Reef) and a Central Processing Facility on the continental shelf, to an onshore liquefied natural gas (LNG) processing facility at James Price Point (hereafter referred to as the 'JPP concept') were also referred and assessed under the EPBC Act via EPBC Reference: 2008/411. The JPP concept was progressed through to completion of a public review of a draft EIS (Woodside Energy Limited 2012, EPBC Reference: 2008/411) before the concept was withdrawn. The components addressed by this Torosa Subsea Development Proposal have remained largely unchanged since the JPP concept.

The Torosa reservoir is located approximately 425 km north of Broome and approximately 290 km off the Kimberley coast in Western Australia (WA) in the North-west Marine Region. The Proposal Area, within which Proposal activities will occur, encompasses Scott Reef which comprises two shelf atolls separated by a deep channel. Scott Reef supports populations of hard and soft corals, other invertebrates and a diverse fish assemblage. Sandy Islet, at Scott Reef, is a known nesting site for green turtles. Other megafauna potentially present in the area include whale sharks, whales and dolphins however neither the Proposal Area nor its surrounds are known areas of aggregation. Current activities in the Proposal Area are limited given its remote, offshore location, with scientific research and traditional Indonesian fishing being the primary users of the Proposal Area.

The Proposal comprises a limited subset of infrastructure and activities associated with the larger Browse FLNG Development that occur within WA State jurisdiction; specifically, the development of approximately 17 wells from three drill centres, supported by subsea infrastructure including wellheads, manifolds, flowlines and umbilicals. The drill centres and associated subsea infrastructure are located in water depths of greater than 350 metres (m) in the channel between North and South Scott Reef (two drill

centres) and to the north east of North Scott Reef (one drill centre). Extracted hydrocarbons will be transferred via manifolds positioned on the seabed, through subsea flowlines to FLNG facilities located in Commonwealth waters that are outside the scope of the Proposal. Operation of the wells will be controlled remotely. As such, once drilling and installation is complete, surface activities in the Proposal Area will be limited to infrequent monitoring and maintenance of the operational subsea infrastructure.

Development activities for the Proposal are expected to be phased; development drilling and associated subsea infrastructure installation activities at one drill centre is scheduled to commence approximately four years after the Final Investment Decision (FID). Development drilling at the remaining two drill centres will then be scheduled to occur a number of years later, with the timing dependent on reservoir performance. Overall reservoir life is expected to extend for approximately 40 to 50 years, after which decommissioning of the wells and associated subsea infrastructure will occur.

Environmental factors relevant to this Proposal have been identified and the likely significance of potential impacts assessed and evaluated. The assessment of impacts has been undertaken over a number of years, supported where relevant, by evidence collected from previous exploration and appraisal drilling in the Proposal Area, predictive modelling (e.g. for noise emissions, dispersion of drill cuttings discharges and oil spill fate and trajectory), third-party specialist studies and peer and independent reviews.

For each of the relevant environmental factors, a determination was made whether the Proposal met the Environmental Protection Authority (EPA)'s environmental objectives as well as the principles of the *Environmental Protection Act 1986* (WA) (EP Act), taking into account the likely significance of potential impacts, the nature and certainty of those impacts, the management and mitigation measures applied and whether other regulatory and/or legislative mechanisms apply to the management of identified impacts.

The assessment concludes that:

- Only a limited number of environmental factors are anticipated to be affected.
- The proposal is unlikely to have a significant impact on the environment.
- The potential for significant impact has been avoided or reduced through design by ensuring no infrastructure is developed on Scott Reef, including the shallow water lagoon environments.
- The EPA's environmental objectives can either be inherently met (because impacts have been avoided through design, e.g. field layout) or can readily be met through mitigation and management, much of which is common practice in the offshore oil and gas industry in WA and in some cases exceeds industry norms.
- Mitigation and management of impacts and risks associated with specific Proposal activities are required to be addressed through other established regulatory processes (Environment Plan(s) under relevant Petroleum regulations). Consistent with the EP Act, these other regulatory processes reflect the principles of ecologically sustainable development and require impacts and risks to be managed to levels that are acceptable and ALARP.

Figure ES-1 illustrates the conclusions of the assessment.

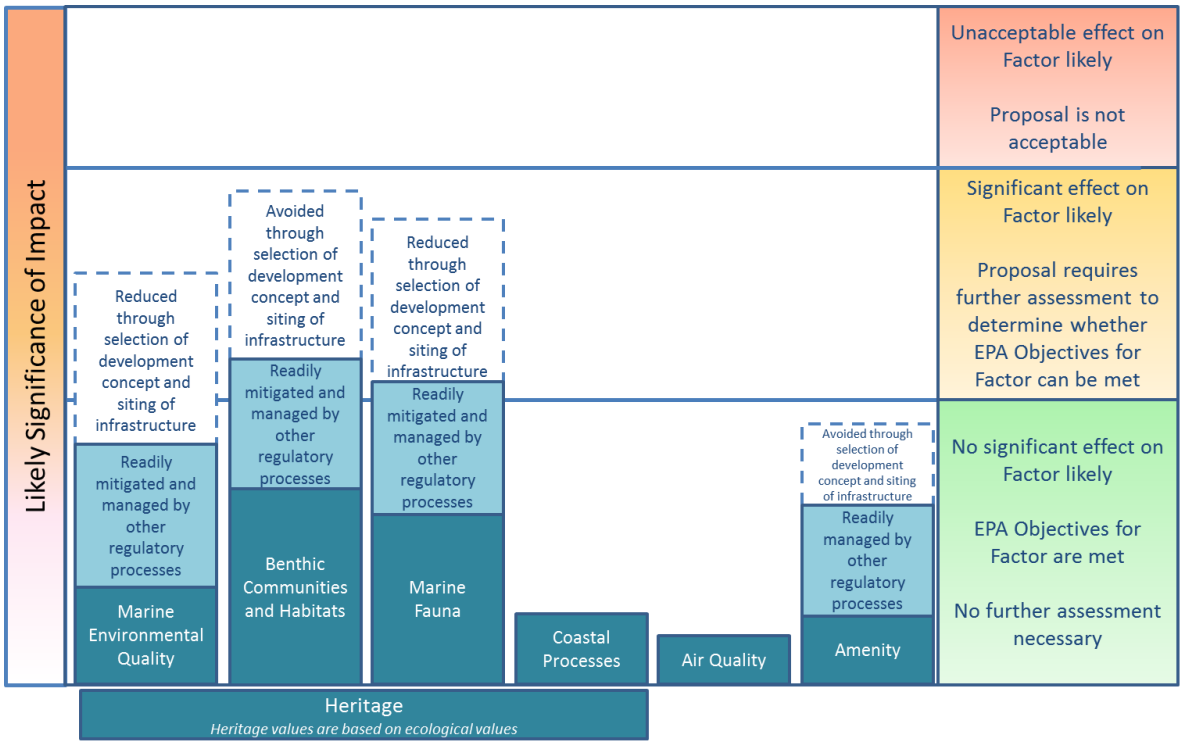

Figure ES-1 Significance of Environmental Impacts

The Browse JV Participants have considerable confidence over the results of the assessment given that:

- The overall Proposal comprises infrastructure and associated activities that are commonplace in the offshore oil and gas sector in WA.
- Environmental sensitivities in the Proposal Area and its surroundings have been studied extensively over approximately two decades.
- Potential impacts associated with the Proposal have also undergone comprehensive evaluation over a number of years, supported where relevant, by evidence collected from previous exploration and appraisal drilling in the Proposal Area, predictive modelling, third-party specialist studies and peer and independent reviews.

Woodside, on behalf of the Browse JV Participants, has engaged extensively with stakeholders over the past decade regarding the development of the Browse resources, including those components addressed by this referral. Issues raised by stakeholders that are relevant to the scope of this Proposal have been addressed through environmental assessment and, where relevant, mitigation and management commitments described in this Referral and in the Draft EIS for the Browse FLNG Development.

Finally, Woodside has an established track record in sound environmental management demonstrated through the receipt of a number of awards. Environmental aspects will be managed through the existing Woodside Management System. Woodside has also considered and demonstrates achievement of other principles and objects of the EP Act for the Proposal, including adoption of a precautionary adaptive management approach, contributing to the advancement of scientific knowledge and committing to the conservation of biodiversity and the efficient use of resources.

In conclusion, the Browse JV Participants determine that the Proposal is not likely to have a significant effect on the environment given the mitigation and management measures

that are proposed. The further definition and implementation of these mitigation and management measures will be regulated via Environment Plans under the Petroleum (Submerged Lands) (Environment) Regulations 2012. As such, the Proposal is not considered to be a significant proposal.

1. Introduction

Woodside, on behalf of the Browse Joint Venture (JV) Participants: Woodside Browse Pty Ltd, Shell Australia Pty Ltd (Shell), BP Developments Australia Pty Ltd (BP), Japan Australia LNG (MIMI Browse) Pty Ltd and PetroChina International Investment (Australia) Pty Ltd (PetroChina); proposes to extract the hydrocarbon resources of the Torosa reservoir through the Torosa Subsea Development Proposal (referred to hereafter as 'the Proposal'). The Torosa reservoir is located approximately 425 km north of Broome and approximately 290 km off the Kimberley coast in WA (Figure 1.1).

The Proposal forms part of the larger Browse FLNG Development, which will recover the hydrocarbon resources from three reservoirs (Brecknock, Calliance and Torosa), using up to three FLNG facilities, for the export of LNG and condensate.

Infrastructure for the Browse FLNG Development, including the FLNG facilities themselves, will be predominantly located in Commonwealth jurisdiction. However, in May 2014, NOPTA advised the Browse JV Participants of proposed changes to the coastal waters boundary around Scott Reef. As a result, some of the subsea infrastructure of the Browse FLNG Development and a portion of associated flowlines will be located in an area under State jurisdiction.

The Browse JV Participants are referring the subsea components of the Browse FLNG Development that occur within WA State waters under Section 38(1) of the EP Act. The components addressed by this referral are described in Section 3.

This document has been prepared to support the referral of the Proposal, which is submitted to the WA EPA under Section 38(1) of the EP Act. This document aims to assist the EPA in its decision on whether to assess the Proposal, and if so, to what level.

Concurrent with this Proposal, the Browse FLNG Development, including those components addressed by this referral, is currently undergoing formal assessment at EIS level under the EPBC Act (EPBC Reference: 2013/7079). The scope of the Draft EIS spans both State and Commonwealth jurisdiction. The Draft EIS provides further detail on the aspects addressed in this Torosa Subsea Development referral and cross references to the Draft EIS are included throughout this document. The Draft EIS is available for view at the following address: http://www.woodside.com.au/Our-Business/Browse/Pages/Draft-Environmental-Impact-Statement.aspx.

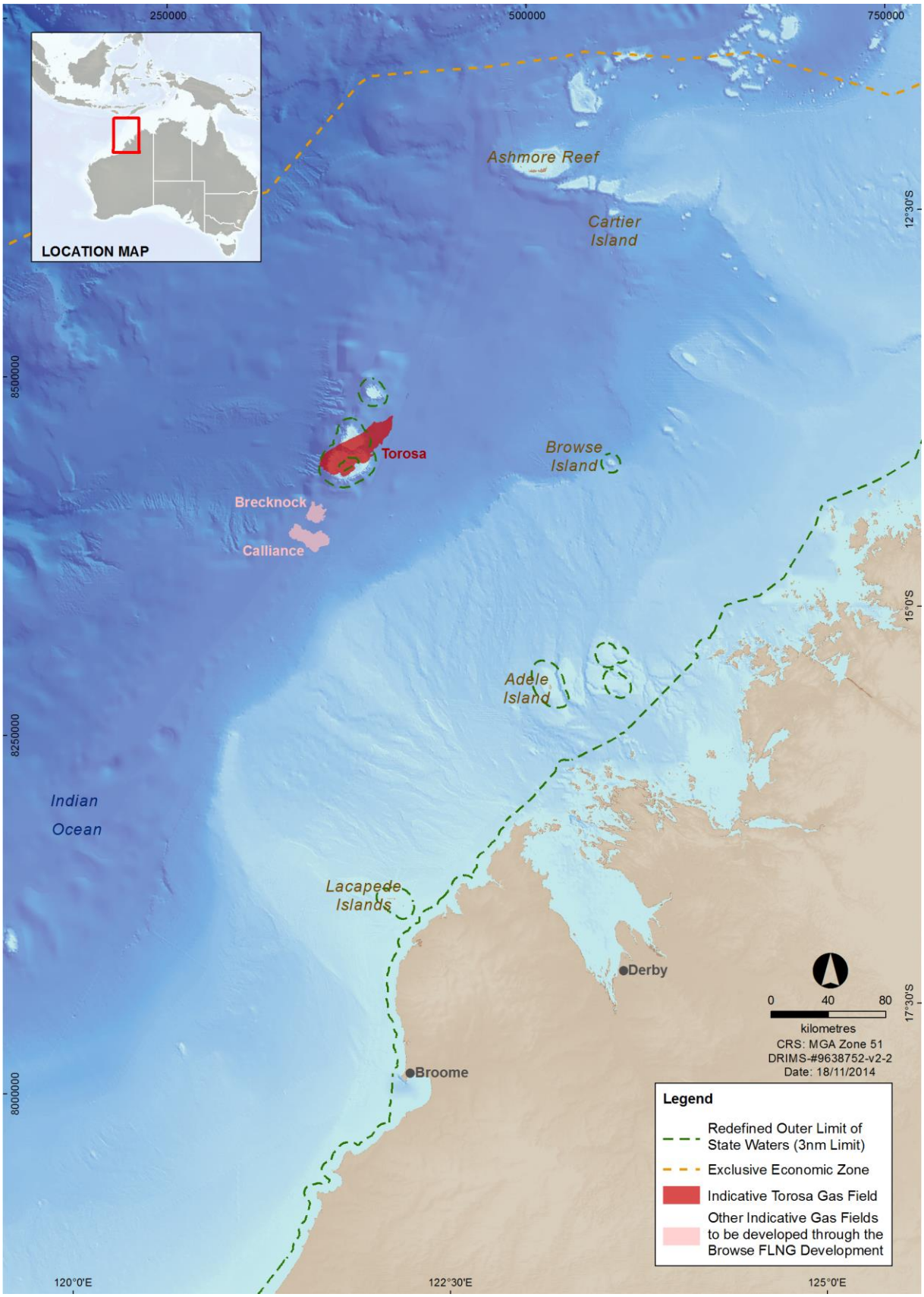

Figure 1.1 Torosa Subsea Development Proposal Location

1.1 Proponent

Woodside is Operator and Proponent of the Proposal on behalf of the Browse JV Participants. Woodside is Australia's largest independent oil and gas company and is one of the nation's most successful explorers, developers and producers. The company operates Australia's biggest resource development, the North West Shelf Project in WA. With the successful start-up of the Pluto LNG Plant in 2012, Woodside now operates six of the seven LNG processing trains in Australia.

Woodside believes excellence in environmental performance is essential to its business success worldwide and is compatible with balancing the economic, social and environmental needs of sustainable development.

Woodside's commitment to sustainable development through economic performance, environmental excellence and social contribution has been recognised through numerous awards, including as recipient of the Australian Petroleum Production and Exploration Association (APPEA) Environment Award in 2009 and 2012. The 2009 award recognised Woodside's approach and understanding in undertaking appraisal activities in the sensitive environmental setting of Scott Reef, while the 2012 award recognised Woodside's partnerships with the Australian Institute of Marine Science (AIMS) and the Western Australian Museum (WAM), which have improved understanding of biodiversity and ecological function in WA's tropical marine communities. Most recently, Woodside was named the 2014 winner of the inaugural WA State Department of Fisheries (DOF) - Excellence in Marine Biosecurity Award. The award recognises Woodside's leadership, innovation and commitment to excellence in marine biosecurity, by taking a collaborative approach with other oil and gas operators to manage biosecurity responsibly across the sector.

Further information about Woodside's commitment to environmental excellence and the latest Sustainability Report can be found at http://www.woodside.com.au/Our-Approach/Sustainable-Development/Pages/Sustainable-Development-Report.aspx

Woodside may be contacted at:

Torosa Subsea Development Proposal
Email: browseinfo@woodside.com.au
Toll free: 1800 036 654

1.2 Proposal History

Between 2006 and 2009 various development concepts were identified for the recovery of hydrocarbons contained in the Browse Basin, including the Torosa reservoir. The initial concept, progressed through technical and commercial evaluation, was to transfer produced hydrocarbons, via three infield platforms (one of which located within ~ 6 km of Scott Reef) and a Central Processing Facility on the continental shelf, to an onshore LNG processing facility at James Price Point (hereafter referred to as the 'JPP concept'). The elements of the concept in Commonwealth jurisdiction (which at the time included all components of the Torosa Subsea Development Proposal), were referred under the EPBC Act and progressed through to completion of a public review of a draft EIS (Woodside Energy Limited 2012, EPBC Reference: 2008/411) before the referral for the JPP concept was withdrawn.

In April 2013, Woodside announced that the JPP concept did not meet the company's commercial requirements for a positive FID. A new concept selection process was initiated and in September 2013 the Browse JV Participants selected FLNG technology as the preferred development concept.

Following the selection of FLNG technology as the preferred development option, the Browse FLNG Development was referred under the EPBC Act (EPBC 2013/7079), requiring assessment at the EIS level. The Browse FLNG Development Draft EIS is available for public review and comment from the addresses provided in Section 1.

The development concept for the Torosa Subsea Development Proposal has remained largely unchanged since the JPP concept. Both the Draft EIS for the components of the JPP concept in Commonwealth jurisdiction and the Browse FLNG Development Referral and Draft EIS comprehensively address the elements contained in this Proposal.

1.3 Alternatives Considered

Woodside has considered a number of alternative development themes for the recovery of the Browse reservoirs, including Torosa (Table 1.1). A detailed discussion and evaluation of alternatives is presented in Section 4 of the Browse FLNG Development Draft EIS; a summary is provided here.

Table 1.1 Development Themes Considered

Theme	Description
FLNG (Proposed / current theme)	FLNG facility mooring systems, subsea drill centres, wellheads and flowlines located predominantly offshore, away from Scott Reef (closest FLNG facility approximately 8 km). Use of existing mainland infrastructure to support marine and aviation activities.
Infield Development with Onshore / Nearshore Processing	Infield facilities away from Scott Reef with interfield pipelines connecting these facilities to a Central Processing Facility (CPF) on the continental shelf. Export pipelines connecting the CPF to an onshore/nearshore processing and export facility. Onshore/nearshore facilities including gas processing, accommodation, wastewater treatment and marine facilities.
Offshore LNG	Central gas processing complex on Scott Reef (south-east corner of the south Scott Reef lagoon) and infield platforms and interfield pipelines in close proximity to Scott Reef. Use of existing mainland infrastructure to support marine and aviation activities.

When compared to more traditional infield development and onshore processing themes, a study by Shell concluded that FLNG technology is more favourable due to FLNG's smaller overall environmental footprint. This is because it combines the traditional offshore and onshore components of an LNG development into a single, integrated FLNG facility, and in doing so:

- Avoids the need for installation of a pipeline to shore.
- Eliminates resultant land and seabed disturbance associated with clearing and seabed dredging.
- Reduces installation and operational risks in sensitive coastal and nearshore marine environments.
- Reduces volumes of construction materials required (sum of steel, concrete, asphalt, earth and rock), as well as offering the possibility for the facility itself to be refurbished and re-used at the completion of the project life cycle.

In addition, when compared to the offshore LNG processing theme, the FLNG theme is also considered more favourable particularly with respect to the specific values and sensitivities of the Proposal Area. The offshore LNG processing theme would have required processing infrastructure on Scott Reef and infield platforms and interfield pipelines in close proximity to Scott Reef (Table 1.1).

The selection of the FLNG theme for the recovery of the Browse resources, including Torosa, will eliminate or reduce otherwise potentially significant impacts to the values and sensitivities of the Proposal Area.

Furthermore, as Scott Reef is directly above part of the Torosa reservoir, the subsea layout has been optimised to balance the risk of environmental impact and efficient hydrocarbon extraction. This has been achieved by locating drill centres within the channel between North and South Scott Reef and using horizontally deviating wells to reach locations in the reservoir that would otherwise require on-reef development.

1.4 Definition of Spatial Areas used in this Document

These spatial areas are used in this document:

- Proposal Area – encompassing an area of approximately 103,000 ha of waters and emergent land in State jurisdiction as shown in Figure 3.1.
- Proposal Footprint – encompassing the area of seabed where infrastructure will be installed. This includes the footprint of the three drill centres (TRD, TRE and TRF) comprising wellheads and manifolds, the area likely to be disturbed by anchoring or mooring of the drill rig; and the footprint of other subsea infrastructure (i.e. flowlines and umbilicals).
- Scott Reef – encompassing the shallow (less than approximately100 m water depth) and emergent areas of North and South Scott Reef;
- Region – referring broadly to the North-west Marine Bioregion within which the Proposal Area is located, as defined in the North-west Marine Bioregional Plan (DEWHA 2008).

2. Legislative and Management Framework

2.1 Applicable State Legislation

2.1.1 Environmental Protection Act 1986 (WA)

The EP Act is WA's primary environmental legislation. The Act sets out to prevent, control, and abate pollution and environmental harm, for the conservation, preservation, protection, enhancement, and management of the environment. The EP Act forms the legislative basis for this referral.

The EPA has statutory obligations under the EP Act to conduct environmental impact assessments (EIAs), initiate measures to protect the environment from environmental harm and pollution and to provide advice to the Minister for Environment on environmental matters.

The EPA has developed a series of guidance statements for the assessment of environmental impacts in accordance with Part IV of the EP Act. The guidance statements are designed to assist project proponents and the public to understand the requirements for protection of the environment under the EP Act. The guidance statements referred to in preparing this referral include:

- General Guide on Referral of Proposals to the Environmental Protection Authority under Section 38 of the EP Act.
- Environmental Impact Assessment (Part IV, Divisions I and II) Administrative Procedures 2012.
- Environmental Assessment Guideline for Defining the Key Characteristics of a Proposal (EAG 1).
- Environmental Assessment Guidelines: Protection of Benthic Primary Producer Habitats in Western Australia's Marine Environment (EAG 3).
- Environmental Assessment Guidelines: Environmental Assessment Guideline for Protecting Marine Turtles from Light Impacts (EAG 5).
- Environmental Assessment Guideline: Environmental factors and objectives (EAG 8).
- Environmental Assessment Guideline for Application of a Significance Framework in the environmental assessment process: focusing on key environmental factors (EAG 9).

2.1.2 Petroleum (Submerged Lands) Act 1982 (WA)

The *Petroleum (Submerged Lands) Act 1982* (PSLA) provides the regulatory framework for the exploration and production of petroleum resources located within State marine waters, including related pipelines. Under this Act, the Petroleum (Submerged Lands) (Environment) Regulations 2012 (Environmental Regulations) provide for a risk-based approach for managing the environmental performance of petroleum activities through the preparation, approval and implementation of an Environment Plan, which must include an oil spill contingency plan.

All activities that are presented and addressed in this referral will be subject to the requirements of this Act and its associated Environment Regulations. Activities will require Department of Mines and Petroleum (DMP) approval of an Environment Plan and an associated oil spill contingency plan prior to their commencement.

The Environment Plan regime is aimed at reducing environmental impacts and risks of petroleum activities, to a level which is 'as low as reasonably practicable' (ALARP) and is acceptable. The Environment Regulations have the objective of ensuring that any petroleum activity (where applicable) is:

- Consistent with the principles of ecologically sustainable development.
- Managed in accordance with an Environment Plan that has appropriate environmental performance objectives and standards as well as measurement criteria for determining whether the objectives and standards are met.

The Environment Plan regime encourages operators to use innovative and effective environmental protection measures tailored to their specific circumstances aimed at achieving superior environmental practice and outcomes.

2.1.3 Other State Legislation

Other State legislative requirements potentially relevant to the Proposals include, but may not be limited to:

- *Biosecurity and Agriculture Management Act 2007.*
- *Conservation and Land Management Act 1984.*
- *Fish Resources Management Act 1994.*
- *Land Administration Act 1997.*
- *Maritime Archaeology Act 1973.*
- *Petroleum and Geothermal Energy Resources Act 1967.*
- *Pollution of Waters by Oil and Noxious Substances Act 1987.*
- *Wildlife Conservation Act 1950* (WA) (WC Act).

2.2 Applicable Commonwealth Legislation

2.2.1 Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The EPBC Act is the Commonwealth Government's primary environmental legislation. Actions with the potential to impact on a matter of national environmental significance (NES) trigger the environmental assessment and approval process under the EPBC Act. The matters of NES identified as relevant to the overall Browse FLNG Development and addressed in the Browse FLNG Development relate to potential impacts on EPBC Act Listed and Migratory species.

Concurrent with this Proposal, the Browse FLNG Development, including those components addressed by this referral, is currently undergoing formal assessment at EIS level under EPBC Act (EPBC Reference: 2013/7079).

2.2.2 Other Applicable Commonwealth Legislation

Other Commonwealth legislation applicable to the Proposal, including international conventions and agreements, are listed in Section 2.8 of the Draft EIS for the Browse FLNG Development.

2.3 Proponent's Management Approach

This Proposal will be managed in accordance with legislation and associated regulations applicable to petroleum activities in WA State waters to ensure environmental impacts from Proposal activities will be reduced to a level which is ALARP and acceptable. The

management commitments made in this referral will be implemented through Woodside's Management System, of which environmental management is one component. A copy of Woodside's Environment Policy is provided in Appendix 1.

Key aspects of the Proposal in relation to the principles and objects of the EP Act are presented in Table 2.1.

Table 2.1 Consideration of the Objects and Principles of the EP Act

Principle	Aim	Proposal Considerations
Precautionary	Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.	A key principle of Woodside's Environment Policy is to support research to improve understanding of the environment and use science to support impact assessments and decision making. Over the years, Woodside has conducted extensive reviews of available information related to the development of the Browse resources, Scott Reef and the broader region, including: • Peer reviewed journals. • Industry and government technical reports. • Standards and guidelines, such as the Australian and New Zealand Environment and Conservation Council (ANZECC) Water and Sediment Quality Guidelines 2000. In addition, Woodside has commissioned a large number of studies related to the development of the Browse resources, spanning over approximately two decades, to contribute to long-term data sets for the region and further the understanding of the marine environmental conditions of the area. Key studies include baseline and annual programs for humpback whale, turtle, other marine megafauna and fish species in the region, as well as the long-term monitoring of coral and fish communities at Scott Reef and physical environmental studies to understand the hydrodynamics of the area. To support the current development concept, a range of additional studies have been undertaken that included reviewing recently published data, modelling discharges and emissions, and undertaking field surveys where existing data was not available or sufficient. Woodside has also entered into partnerships with AIMS and WAM, which has been recognised by APPEA (2012 APPEA Environment Award). These long-term partnerships have improved scientists', industry's and the broader community's understandings of biodiversity and ecological function in WA's tropical marine communities. This extensive data collection and review exercise has allowed Woodside to develop a thorough and comprehensive understanding of the existing environment of the Browse basin, and the risk assessment conducted in support of the Proposal is based on sound knowledge of environmental receptors and associated potential interactions with aspects of the Proposal. However, where Woodside recognised that credible impacts associated with certain aspects of the Proposal were unknown, unpredictable or irreversible, a conservative consequence level has been assigned. The assessment was then conducted based on environmental performance outcomes defined by Woodside in accordance with legislative requirements, corporate standards, benchmarking and industry best practice as relevant. Furthermore, where relevant, additional management and mitigation measures have been identified for implementation to reduce the level of risk associated with aspects associated with the Proposal. These proposed management and mitigation measures have been developed using Woodside's adaptive management framework (Eliminate/ Substitute/ Prevent/ Reduce/ Mitigate). The adaptive management approach encompasses a range of management and mitigation measures to address uncertainties over environmental impacts and ensure that the

Principle	Aim	Proposal Considerations
		EPA's environmental objectives are met.
Inter-generational equity	The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Woodside is targeting hydrocarbon resources of the Browse reservoirs, including the Torosa reservoir located directly underneath Scott Reef. Woodside has designed the location of subsea infrastructure, including flowlines and production wells, and is utilising technology such as deviated horizontal drilling to enable extraction of hydrocarbon from the Torosa reservoir without direct physical interaction with the reef system. Furthermore, Woodside has been recognised for proactively managing a key risk to the environment, in particular at Scott Reef, associated with the introduction and settlement of invasive marine species associated with vessel movements in proximity to the reef system. Woodside was named the 2014 winner of the inaugural WA State DOF - Excellence in Marine Biosecurity Award. The award recognises Woodside's leadership, innovation and commitment to excellence in marine biosecurity, by taking a collaborative approach with other oil and gas operators to manage biosecurity responsibly across the sector. In addition, Woodside will develop a long term environmental monitoring program at Scott Reef that will be implemented prior to development at Torosa. The aim of this program is to demonstrate no significant negative effects to Scott Reef resulting from the Proposal and the broader Browse FLNG Development. Such management aims to ensure the long-term conservation of the environmental values of Scott Reef and to ensure that these values are maintained for future generations. More details are provided in the Draft EIS for the Browse FLNG Development.
Biological diversity and ecological integrity	Conservation of biological diversity and ecological integrity should be a fundamental consideration.	As part of the EIA process, management and mitigation measures have been identified to reduce the level of risk for each of the environmental aspects associated with the Proposal. These proposed management and mitigation measures have been developed using the Woodside's adaptive management framework (Eliminate/Substitute/Prevent/Reduce/Mitigate), with the overall objective to conduct activities associated with the Browse FLNG Development in a manner which does not affect Ecological Sustainable Development (ESD) outcomes, which include the principle of the EP Act, including the principle of 'biological diversity and ecological integrity'. Woodside's overall environmental objective for the Proposal is to demonstrate no significant negative effects to Scott Reef resulting from the Proposal. To achieve its overall objective, Woodside has therefore developed a range of design features, as well as management and mitigation measures to avoid significant impacts to Scott Reef. These development of these design features, management and mitigation measures has taken into consideration of the environment, based on Woodside's extensive knowledge of the environment of Scott Reef. In addition, Woodside will develop a long term environmental monitoring program at Scott Reef, including water quality and coral health monitoring, to be implemented prior to development at Torosa, to demonstrate no significant negative effects to Scott Reef from the Proposal.

Principle	Aim	Proposal Considerations
Valuation	Improved valuation, pricing, and incentive mechanisms should be promoted (e.g. 'polluter pays' principle, consideration of life cycle costs)	The Woodside Management System (WMS) defines how Woodside will deliver its business objectives and the boundaries within which all Woodside employees and contractors are expected to work. The WMS consists of a mission statement, policies, decision-making committees, framework of authorities and standards required, that when applied, provides management, governance and assurance. A key component of the WMS is Woodside's Environment Policy (Appendix A), which focuses on the use of science to support impact assessments and decision making. In line with Woodside's Environment Policy (Appendix A), Woodside has drawn from its operating experience in Australian offshore environments and its knowledge of the existing environment of the Proposal area to identify a range of design features and management measures to avoid significant impacts to Scott Reef. The selection of these measures for implementation included the following key aspects: • A comparison of net environmental benefits against a range of alternative measures. • A comparison of costs involved with management measures at various stages of the lifecycle of the Proposal. • The establishment of environmental objectives, to maximise environmental benefits in a cost effective way.
Waste Minimisation	All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Woodside are committed to managing their activities to reduce the adverse effects on the environment while balancing economic and social needs of sustainable development. A key principle of Woodside's Environment Policy is to use energy, water and other resources efficiently and reducing greenhouse gas (GHG) emissions and waste. This principle is reflected in the various design features and waste management measures to be implemented by Woodside. In the development of its management approach for the Proposal, Woodside has specifically focused on reduction at source and efficiency maximisation for emissions and discharges to the environment, as follows: • No routine discharge of non-hazardous solid waste at sea. • Chemicals selected to have the lowest environmental toxicity rating possible whilst meeting operational performance requirements. • Flowline length and subsea infrastructure installation schedule optimised to reduce the volume of hydrotest fluid discharged. • No discharge of untreated sewage within three nautical miles (nm) from Scott Reef. • Well count and design optimised thereby reducing the unnecessary use of drill fluids and generation of drill cuttings. • Solids control equipment available onboard the drill rig to reduce the amount of residual drill fluids on cuttings prior to discharge. Woodside have set performance criteria to be monitored as part of the Proposal to ensure the effective management of waste.

3. Description of the Proposal

3.1 Key Proposal Characteristics

The Proposal comprises the development of approximately 17 wells from three drill centres targeting the hydrocarbon resources of the Torosa reservoir. Extracted hydrocarbons will be transferred via subsea infrastructure, including wellheads, manifolds and flowlines, to up to three FLNG facilities located in Commonwealth waters (Figure 3.1). The FLNG facilities, and the processing and export of LNG from these facilities, are outside the scope of this referral. The key characteristics of the Proposal are described in Table 3.1.

Note that information in this section is based on knowledge of the Proposal which is currently in the Basis of Design (BOD) phase. While the Browse JV Participants expect that environmental aspects and associated potential impacts described in this document will remain unchanged overall, the Proposal concept and associated activities may be subject to amendments as the design and detailed engineering studies mature.

3.2 Proposal Scale

The Proposal comprises a limited subset of infrastructure and activities associated with the larger Browse FLNG Development. When compared to the overall Browse FLNG Development, the infrastructure and activities addressed in this Proposal are limited in scope and scale. The highest intensity of activities will likely occur during the drilling, installation and future decommissioning phases; during which time a drill rig and vessel numbers of approximately ten or less may be present in the Proposal Area. As all infrastructure is subsea, operation of the wells will be controlled remotely from the FLNG facilities that are outside the scope of this referral. Therefore, once drilling and installation is complete, surface activities in the Proposal Area will be limited to infrequent monitoring and maintenance activities involving one or two vessels.

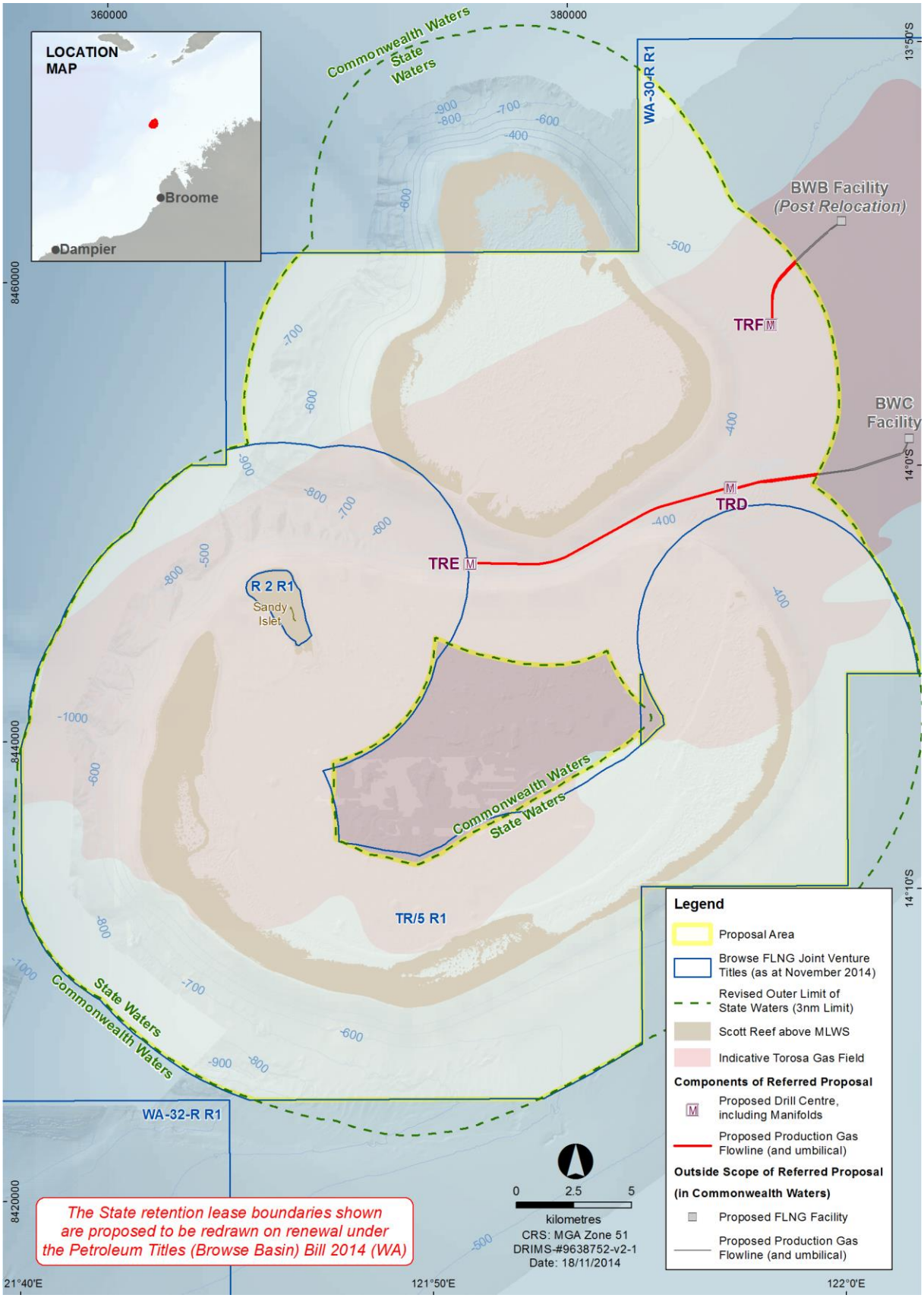

Figure 3.1 Torosa Subsea Development Proposal Area and Notional Layout

Table 3.1 Key Proposal Characteristics

Proposal Summary		
Proposal Title	Torosa Subsea Development Proposal	
Proponent Name	Woodside, on behalf of the Browse JV Participants	
Short Description	Drilling, installation, commissioning, operation, and decommissioning of subsea wells and associated subsea infrastructure located in WA State waters, to extract hydrocarbons from the Torosa reservoir, located approximately 425 km north of Broome and approximately 290 km off the Kimberley coast.	
Element	**Description**	**Proposed Authorised Extent**
Physical Elements		
Drilling of approximately 17 wells at three drill centres	Within the Proposal Area (Figure 3.1) in water depths of greater than 350 m.	Approximately 8 ha of seabed.
Associated subsea infrastructure (wellheads, manifolds, flowlines, and umbilicals)		
Mooring of vessels and drill rig		
Seabed preparation and flowline stabilisation		
Operations Elements		
Water Supply	Self-sufficient. Water requirements sourced either from seawater or loaded at port.	Limited water requirements to support drilling, vessel and drill rig water needs and potentially also for hydrotesting and decommissioning activities.
Power Supply	Self-sufficient. Power generated on board vessels and drill rig.	As required for operations and safety.
Drill rig and vessel discharges	Discharges include treated sewage and sullage and desalination brine.	Limited volumes discharged in accordance with International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78 requirements, where relevant.
Drill cuttings discharges	Disposal of drill cuttings.	Approximately 800 m^3 of cuttings are anticipated to be generated per well.
Hydrotest fluid discharge	Following installation, flowlines will be pressure tested with a hydrotest fluid comprising either treated seawater or mono-ethylene glycol (MEG). Following testing, the hydrotest fluid will typically be held inside the flowlines for at least 12 months of more after which it will either be discharged to sea at depth, or, if available, routed via the flowline to an FLNG Facility.	Required hydrotest fluid volumes will vary depending on the flowline section to be tested, from approximately 80 m^3 up to approximately 800 m^3. The frequency of hydrotest fluid discharge depends on the timing of flowline installation and hook-up to an FLNG facility, and on the fluid type used.

3.3 Proposal Infrastructure

The Proposal comprises key infrastructure components such as wells, associated well infrastructure including wellheads, manifolds, flowlines and umbilicals (Figure 3.1). Subsea infrastructure is illustrated in Figure 3.2.

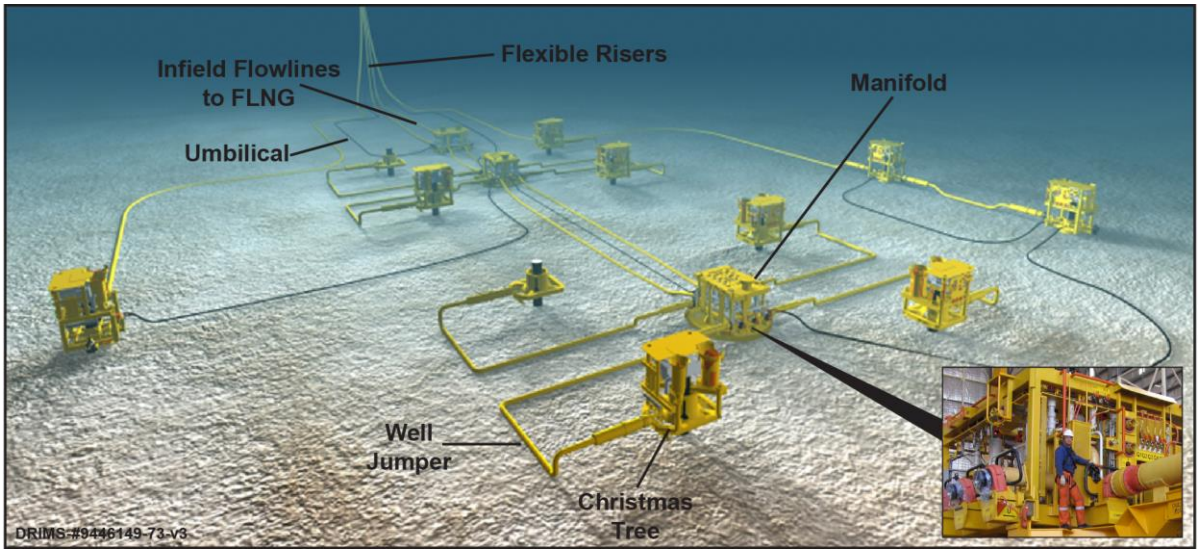

Figure 3.2 Indicative Proposal Subsea Infrastructure

Note: the 'Flexible Risers' referred to in this Figure are located in Commonwealth waters and are not included in the scope of this Proposal.

Infrastructure will be installed in water depths of greater than 350 m as shown in Figure 3.3.

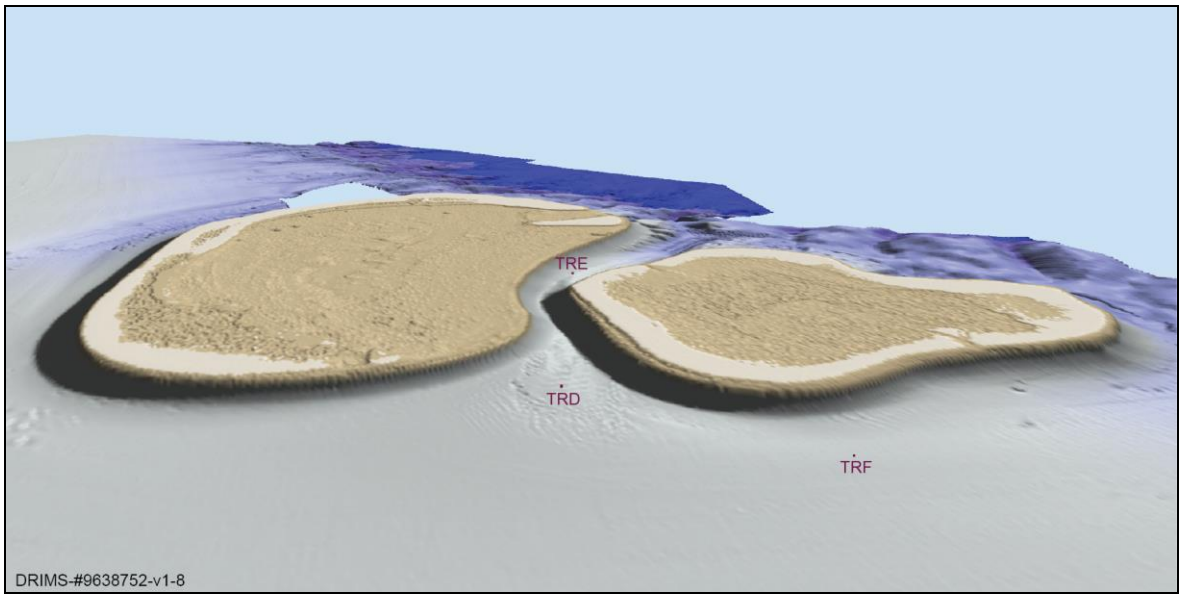

Figure 3.3 Location of Well Centres in relation to Seabed Morphology

3.3.1 Wells

The Proposal is likely to include up to approximately 17 wells located on the seabed. These wells will be grouped into three drill centres (TRD, TRE and TRF) to optimise the

layout of subsea infrastructure. The number and locations of these wells will depend on reservoir target areas and seabed bathymetry and features, and will be selected to optimise reservoir recovery.

Each well will be fitted with a christmas tree which enables reservoir fluids to flow from the well to the flowlines. Christmas trees are used to:

- Manage chemical injection, such as continuous injection of MEG to manage the potential formation of hydrates.
- Control production, whereby hydraulically controlled valves on the christmas trees are used to control flow rates and provide a well shut-off mechanism.

3.3.2 Other Subsea Infrastructure

Wells at each drill centre will be connected to a manifold by well jumpers to allow reservoir fluids to be carried from the wells to the manifolds. The manifolds will allow gathering of reservoir hydrocarbons extracted from the wells into infield flowlines.

Subsea infrastructure will be powered, monitored and controlled using a network of electro-hydraulic control umbilicals and subsea distribution units (SDUs). Each drill centre will be serviced by a dedicated MEG line and electro-hydraulic umbilical likely to follow the same alignment as the infield flowlines.

3.4 Key Proposal Activities

Key activities for the Proposal comprise:

- Drilling and completion of wells.
- Seabed preparation.
- Installation of subsea infrastructure, including umbilicals, flowlines, and manifolds.
- Commissioning of the wells and subsea infrastructure.
- Extraction of hydrocarbons.
- Decommissioning of infrastructure at the end of reservoir life.

These activities will be undertaken and/or supported by various vessel activities, helicopter movements and existing supporting infrastructure on the Australian mainland.

3.4.1 Drilling and Completion of Wells

The Proposal involves the drilling of approximately 17 wells and the installation of approximately three manifolds within three drill centres. Wells will be drilled to depths of between 3,500 and 4,500 m beneath the sea bed to intersect the Torosa reservoir (Figure 3.1).

Drilling Method

It is anticipated that a mobile offshore drilling unit (MODU) will be used to drill and complete the wells. It is anticipated that the drill rig will either be moored using anchors, suction piles or driven piles. During drilling, the drill rig will require supply vessels to visit every two or three days for replenishment of supplies.

Typically, the drilling process starts with the drilling of the largest size hole, and a smaller diameter conductor will be cemented inside this hole. Next, a smaller diameter hole section will be drilled and an intermediate casing will be run in and cemented. Intermediate casings provide structural support for the hole walls, isolate geological formations and allow pressure management that may be experienced during drilling.

A blow-out preventer (BOP) and riser system will then be installed. With the BOP in place, a hole will then be drilled to the top of the reservoir and a liner cemented over this hole section. The final hole section is then drilled through the reservoir as required based on reservoir targets. Wells are expected to be drilled to depths of between 3,500 and 4,500 m beneath sea level to intersect the reservoirs.

Wireline logging activities will be undertaken and may include Vertical Seismic Profiling (VSP) or other logging activities containing radioactive sources. All activities will be managed under accepted Environment Plans which will be prepared as part of the requirements under relevant petroleum regulations.

Once drilling of a well is completed, the BOP will be removed and replaced with a christmas tree. The well will then be flowed to the drill rig. Once stable flow is achieved the produced fluids will be sent to tanks for separation onboard the drill rig. The produced gas and condensate will be flared while the water will be treated to meet regulatory requirements and then discharged overboard. Anticipated flaring and discharges will be further detailed in the relevant Environment Plan(s). This first production to the drill rig is known as unloading and typically lasts approximately 12 hours per well, depending on operational constraints.

Once unloading activities are completed, the wells will then be isolated until they are connected up to the flowline system and commissioned to the FLNG facilities.

Drilling Fluids

Drilling fluids are used to lubricate the drill string, resist any pressure from the wellstream and return cuttings to surface. They are formulated according to the well design, the expected reservoir geological conditions and the surrounding formations. Drilling fluids comprise a base fluid, weighting agents and chemical additives used to give the fluid the exact properties required to make the drilling as efficient and safe as possible. The selection of fluid types will not be finalised until the detailed design phase when well design is confirmed. Chemical additives will be selected using Woodside's Offshore Chemicals Selection and Assessment procedure, which includes evaluation based on chemical toxicity.

The top hole sections of the well, before a riser is in place, will be drilled using seawater with bentonite and then bentonite and guar gum sweeps. Once the riser is in place the lower hole sections will be drilled with either water based fluids (WBF) or non-water based fluids (NWBF). The notional products used in the drilling fluids are listed in Table 3.2.

Table 3.2 Indicative Drilling Fluids Composition

Drilling Fluid System	Key Products / Ingredients
WBF	Seawater, Bentonite clay, Barite, Lignite, Lignosulphate, lime, brine, gellents and emulsifiers
NWBF	Synthetic organic base fluid, Bentonite clay, Barite, Lignite, Lignosulphate, lime, brine, gellents and emulsifiers

3.4.2 Site Preparation

Seabed preparation works may be required to position flowlines on a level surface, to provide stability to the subsea gathering system. Seabed preparation may be required in particular through the sand wave region at the eastern entrance to the channel between North Scott Reef and South Scott Reef and within the channel itself. Seabed preparation works will most likely be undertaken using ploughing and/or mass flow excavation techniques. Protection and additional stabilisation methods such as trenching and rock

placement may also be required to limit potential damage to flowlines and subsea infrastructure.

3.4.3 Installation of Subsea Infrastructure

Subsea infrastructure such as manifolds, flowlines and umbilicals will be transported to site by a combination of installation vessels and cargo barges. Subsea installation of equipment will be performed by specialist dynamically positioned vessels. These will be equipped with submersible Remotely Operated Vehicles (ROVs), which will aid in the installation, hook-up and commissioning processes.

Manifolds and SDUs will be lowered to the seabed with their position confirmed using acoustic transducers mounted on each manifold. Similar transducers are mounted on each wellhead to ensure the manifold does not contact the wellheads.

With the manifolds in place, the subsea well jumpers, flowlines and umbilicals will be installed on the seabed. The flowlines will be installed progressively within a defined corridor using a pipe-lay vessel, whereby each flowline is lowered to the seabed as the vessel moves forward.

3.4.4 Commissioning

Once installation and hook up of the subsea infrastructure is complete, it will be subject to pre-commissioning, required to test the integrity of the subsea infrastructure. This will be conducted using hydrotest fluids, whereby the pipeline pressure will be monitored to detect leaks. Fluids will then be left in place to provide corrosion protection prior to the introduction of reservoir fluids. The hydrotest fluid that is introduced into the subsea infrastructure will either comprise hydrotest water (typically treated seawater) or MEG.

Commissioning, supported by ROVs, barges, tugs, survey vessels and support vessels, will include testing, adjusting and monitoring of all systems prior to full operations commencing.

3.4.5 Operations

During operations, hydrocarbons extracted from the Torosa reservoir flow via the christmas trees and manifolds to the flowlines. The flow rate of hydrocarbons will be controlled by subsea choke valves at the wellheads. Subsea control fluids will be used to maintain the functionality of the choke valves by providing lubrication, corrosion protection, bacterial protection and stability. The use of subsea control fluid during operation of the Proposal is described in Section 3.7.4.

Although secondary stabilisation and corrosion resistant materials are used to protect the subsea infrastructure against integrity threats, monitoring and maintenance activities will be undertaken throughout the operational life of the subsea infrastructure.

3.4.6 Decommissioning

At the end of the Proposal life, infrastructure will be decommissioned in accordance with good oilfield practice and relevant national legislation and practice at the time. Decommissioning will occur once the Torosa reservoir has reached the end of its economic life. In the event that additional reservoirs or third-party reservoirs have been tied into subsea infrastructure, this could increase the Proposal's economic life and thus postpone decommissioning.

The extent of decommissioning activities will be agreed with the appropriate regulator prior to the commencement of decommissioning and documented in an Environment Plan that will be required under relevant Petroleum regulations. As it can be reasonably expected that Government and community expectations may have changed by the time decommissioning is to commence, the development and acceptance of a

decommissioning Environment Plan will be deferred until closer to the end of the Proposal life.

In the interim, a strategy detailing the proposed decommissioning approach has been detailed below, based on a review of current State and Commonwealth legislation, regulations and guidelines, international conventions and guidelines, and Woodside standards and guidelines.

The broad objectives and goals of the decommissioning strategy are to ensure that decommissioning activities will not cause unacceptable environmental impacts and are the most appropriate for prevailing circumstances.

The decommissioning strategy summarised as follows will be reviewed and updated during subsequent phases of the development (subject to risk assessment and acceptance of a decommissioning Environment Plan by the relevant regulatory authorities):

- Production wells plugged and abandoned and trees and wellheads will be removed down to 5 m below the seabed.
- Manifolds will be removed.
- Umbilicals will be removed.
- Infield flowlines will be purged, flushed and either left in place or removed dependent on condition.

Subsea infrastructure will be designed to enable removal wherever practicable.

3.4.7 Supporting Activities and Infrastructure

The drilling and installation phases of the Proposal will be supported by barges, tugs, survey vessels and supply vessels (hereafter referred to as support vessels) and installation vessels. Requirement for vessel support may be higher during installation and decommissioning, resulting in short term peaks in vessel movements during these phases. Given the nature and scale of the Proposal concept, and given the planned phasing of Proposal activities (Section 3.6), overall vessel numbers and movements are relatively low.

During the operations phase of the Proposal, vessels with ROVs or other subsea monitoring equipment will be required to undertake periodic monitoring and maintenance activities.

Vessel requirements during the decommissioning phase are unknown at this stage due to uncertainty regarding the methodology to be applied, but it can be expected that decommissioning will use similar vessels to those engaged for installation activities.

Requirements for supply chain logistics and support for the Proposal may include:

- Port access to supply and support vessels for people, equipment and materials transfers to and from the Proposal Area.
- Airport access to support fixed-wing aircraft and helicopters for people and supplies transfers to and from the Proposal Area.
- Search and research capabilities.
- Onshore support for receiving, storing, and distributing materials and equipment.

Supply chain logistics and support for the Proposal will use existing services and infrastructure, managed under approved environment management frameworks, services. As such, supply chain logistics and support infrastructure required for the Proposal are not considered further as part of this assessment. Only vessel movements between the

supply chain logistics and support location(s) and the Proposal Area are considered in this referral.

3.5 Personnel

Personnel will be required to man the drill rig and installation and support vessels required during the drilling, installation and decommissioning phases of the Proposal. However, during operations, subsea infrastructure will be operated remotely.

3.6 Project Schedule

It is anticipated that drilling and installation activities in the Proposal Area will be phased with activities initially being focused on extracting hydrocarbons from the wells at only one drill centre (most likely TRD). Drilling and installation activities are therefore anticipated to initially be focused on installing the wells and associated subsea infrastructure for this drill centre. Drilling, installation and associated commissioning activities at the remaining two drill centres may then be phased to occur later, meaning that drilling and installation activities are expected to occur in discrete areas over time, potentially with periods of no drilling or installation activities. Scheduling of activities at TRE and TRF is dependent on reservoir performance of the overall Browse FLNG Development.

The Proposal is nearing the finalisation of the BOD phase. Drilling is proposed to commence at the first drill centre approximately four years FID, with drilling at the remaining two drill centres scheduled to occur a number of years later. Overall reservoir life is expected to extend for approximately 40 to 50 years, after which decommissioning of the wells and associated subsea infrastructure will occur. Timeframes are indicative only and based on Woodside's estimates. The schedule is subject to change for a variety of reasons including commercial, contracting and scheduling of reservoir appraisal activities.

3.7 Anticipated Emissions and Discharges

Anticipated routine discharges and emissions as part of the Proposal summarised in this section.

Table 3.3 Anticipated Discharges, Emissions and Wastes by Activity

Description	Drilling	Installation	Commissioning	Operation	Decommissioning
Discharges					
Drill cuttings and fluids	✓				
Vessel and drill rig discharges	✓	✓		[1]	✓
Hydrotest fluid			✓		
Subsea control fluids				✓	
Emissions					
Atmospheric emissions	✓	✓		[1]	✓
Artificial light emissions	✓	✓		[1]	✓
Underwater noise emissions	✓	✓	✓	✓	✓

Description	Drilling	Installation	Commissioning	Operation	Decommissioning
Wastes					
Non-hazardous solid waste	✓	✓		[1]	✓
Hazardous waste	✓	✓		[1]	✓

[1] Vessel discharges, emissions and wastes during operation are associated with periodic monitoring and maintenance activities.

3.7.1 Drill Cuttings and Fluids

Cuttings generated during development drilling are expected to range in size from very fine to very coarse particles. Based on an indicative well design, approximately 800 m^3 of cuttings are anticipated to be generated per well (Table 3.4). Minor amounts of drilling fluid may adhere to drill cuttings, with small sized cuttings more difficult than larger cuttings to separate from drilling fluid (Neff 2005).

Table 3.4 Indicative cutting volumes for a typical Torosa Subsea Development well

Indicative Hole Size (inches)	Cuttings Volume (cubic metre (m^3))	Indicative Fluid Type
42”	45	Seawater with bentonite sweeps
26”	69	Seawater with bentonite sweeps
16”	473	Seawater with bentonite and guar sweeps with poly-3-hydroxybutyrate (PHB)
12¼”	96	WBF or NWBF
8½”	85	WBF or NWBF
Total	**768**	

Top hole sections (typically 42, 26 and 16 inch hole sections) will be drilled prior to installation of a riser. Drill cuttings generated from top hole sections during riserless drilling will be discharged directly to the seabed. Drill cuttings from bottom hole sections (typically 12 ¼ and 8 ½ inch hole sections), generated post riser installation, will be returned to the drill rig for treatment.

The drill rig to be used during development drilling will be fitted with typical solids control equipment, which may include, but is not limited to, shale shakers, cuttings dryers and centrifuges to separate the remaining fluid from the cuttings.

Typical treated WBF cuttings may contain 5 to 25 percent (%) drilling fluid after passage through solid control equipment (Neff 2005) whereas cuttings from the use of NWBFs may retain 5 to 15% of the drilling fluid (Neff et al. 2000) but will be limited to a maximum amount of 10% by dry weight of base fluid prior to disposal.

3.7.2 Vessel and Drill Rig Discharges

Sewage and Sullage

Sewage and sullage such as grey water, will be generated from domestic processes such as dish washing, laundry and showers on the drill rig and vessels.

Sewage and sullage volumes generated will vary depending on the number of personnel on board. However, given the overall nature and scale of the Proposal (Section 3.2) and the anticipated phasing of Proposal activities (Section 3.6), sewage and sullage volumes

are expected to be low (e.g. approximately 15 m^3/drill rig/day) and any discharges will be temporary (i.e. only during installation, drilling and decommissioning activities when drill rig and vessels are present).

Desalination Brine

The drill rig and vessels may either produce fresh water by means of reverse osmosis or thermal desalination, or load fresh water from supply vessels or while at port. Where fresh water is produced by a vessel or drill rig, the desalination process will result in a desalination brine discharge, typically 20-50% higher in salinity than the intake seawater (depending on the desalination process used), and may contain low concentrations of anti-scale chemicals. The volume of the desalination brine discharge will vary and be dependent on the requirement for potable water on each vessel or drill rig at any given time. Nevertheless, given the overall nature and scale of the Proposal (Section 3.2) and therefore the limited requirements for potable water, desalination brine discharges are expected to be low in volume and temporary.

Ballast Water and Biofouling

Vessels will be transiting to and from the Proposal Area regularly during the life of the Proposal. The drill rig will also transit into the Proposal Area. Therefore, there is potential for ballast water to be discharged and/or biofouling to be present on hulls, equipment and structures to be installed and operated as part of the Proposal.

3.7.3 Hydrotest Fluid

In-situ hydrostatic pressure testing will be performed following installation of all flowlines and subsea equipment. Based on indicative subsea layout and flowline installation plans, flowlines of various lengths will require hydrotesting. Hydrotest fluid volumes required will vary depending on the flowline section to be tested, from approximately 80 m^3 up to approximately 800 m^3.

The selected hydrotest fluid may either be water (typically treated seawater) or MEG as described in Section 3.4.4. If hydrotest water is selected, it may only be suitable to be left in-situ for a period of approximately 12 months, after which it is typically discharged at sea and the flowline refilled if required. If MEG is selected, it is likely that it could be left in-situ for longer, therefore reducing the frequency for discharge to sea. Based on the preliminary installation timeframes, it is anticipated that some flowlines for the Proposal will be installed and hydrotested prior to the FLNG facilities being operational. In the event flowlines need dewatering and refilling, discharges will be undertaken at various locations, in discreet volumes of approximately 300 to 800 m^3. The likelihood of discharge of hydrotest fluids at sea will vary through the life of the Proposal.

Prior to installation of the FLNG facilities as part of the larger Browse FLNG Development, flowlines containing hydrotest fluid (including those flowlines in the Proposal Area) will be dewatered by pigging using nitrogen and small volumes of MEG. Once the FLNG facilities are in place, the majority of hydrotest fluids will be recovered to each FLNG facility. As the hydrotest fluid is recirculated to the FLNG facilities, only very minor volumes of hydrotest fluids may be discharged at sea during recovery operations.

The hydrotest fluid may consist of a combination of the following chemicals:

- Biocides, corrosion inhibitor and oxygen scavenger (e.g. ammonium bisulphite) to prevent internal pipe corrosion and bacterial formations.
- Scale inhibitor to prevent build-up of scale.
- MEG.
- Fluorescein dye.

The composition of the hydrotest fluid will be determined at a later stage, with chemical selection in accordance with Woodside's chemical selection procedure.

3.7.4 Subsea Control Fluids

The Browse FLNG Development will adopt open loop subsea control systems, whereby the control fluid is pressurised on the FLNG facility in hydraulic accumulators and delivered to subsea valves via umbilicals. The selected subsea control fluid will be water-based with additives of typically 40% MEG with proportionately smaller quantities of other additives such as lubricants, corrosion inhibitors, biocides and surfactants, such that the technical performance requirements of the fluid are achieved.

In a standard open loop system, subsea control fluids are discharged during valve operation, in contrast to a closed loop system where control fluids are returned back to the FLNG facility. If the return loop of a closed loop system experiences blockage of hydrate the ability to control subsea valves can be compromised. The umbilical design incorporates a spare loop that when available can be used to return all low pressure (LP) hydraulic fluid to the FLNG facility for re-use.

Subsea control fluid discharges in open loop configuration would occur from two potential sources at each well:

- Continuous discharges, as required to maintain valve functionality, resulting in very low volumes discharged subsea at each valve (less than 6 mL/min per well).
- Intermittent discharges from the normal operation of valves, resulting in tens of litres discharged at any one time. This would result in up to approximately 460 L discharged intermittently over a year at each well.

3.7.5 Atmospheric Emissions

Atmospheric emissions will be generated from engines and diesel power generators used on the drill rig and vessels and will include GHG emissions (being carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), volatile organic compounds (VOCs), nitrogen oxides (NOx) and sulphur oxides.

The main contributor to Proposal atmospheric emissions is during drilling from diesel power generators and from flaring during well unloading (Section 3.4.1). There will be no routine flaring as part of the Proposal. However, limited, short-duration flaring will be undertaken as part of the well unloading process on the drill rig (Section 3.4.1).

Estimates of atmospheric emissions generated by the Proposal will be developed during the Front End Engineering Design (FEED) phase but given the nature, scale and phasing of Proposal activities, are anticipated to be relatively low.

3.7.6 Artificial Light Emissions

Artificial light emissions will be generated from two main sources:

- Navigational and operational lighting on drill rig and vessels.
- Flaring at the drill rig.

Functional lighting is required on vessels and the drill rig at levels that provide a safe working environment for personnel. Flaring will occur intermittently and over a short duration (hours to days) on board the drill rig during well unloading (Section 3.4.1).

3.7.7 Underwater Noise Emissions

Activities that may result in underwater noise emissions include:

- Drilling.

- Well testing (e.g. using VSP).
- Potential piling to secure mooring lines for the drill rig
- Seabed preparation.
- Vessels and helicopter movements.
- Subsea infrastructure operation (e.g. choke valves at subsea wellheads).

Drilling

Drill rigs typically produce low intensity continuous noise from a combination of onboard machinery and drill pipe operation. Noise produced from active MODUs is predominantly below 2 kilohertz (kHz), with peak frequencies below 500 hertz (Hz). Broadband source values ranging between 157 - 162 Decibel relative to one micro Pascal (dB re 1 µPa) with various tones have been recorded for semi-submersible drill rig (Hannay et al. 2004; McCauley 1998, 2003). Tones are believed to be produced by the rotating drill string.

Well Testing

VSP utilises a sound source suspended in the water column and recorders located down hole to provide a high-resolution seismic image of the immediate vicinity of the well. VSP typically uses airguns resulting in sound levels of approximately 238 dB re 1 µPa at 1m and less than 180 within 100 m (zero to peak) (Matthews 2012). The process is repeated as required for different stations in the well and may take up to 10 hours to complete.

Piling

Piling may potentially be required to secure the mooring lines for the drill rig (Section 3.4.1). Should piling be required, suction piling is the preferred method. The alternative is driven piling which may result in intermittent impulsive noise over short durations. Indicative noise levels and durations associated with suction and driven piling are described in Section 5.9.2 of the Draft EIS.

Seabed Preparation

Seabed preparation activities prior to the installation of flowlines for TRD and TRE in the channel between North and South Scott Reef (Section 3.4.2), and additional seabed trenching and /or rock dumping to provide secondary stabilisation and mechanical protection to flowlines installed in the channel will generate underwater noise. Activities such as levelling and trenching directly interact with the seabed and result in noise being transmitted through the seabed as well as through the water column (Wyatt 2008). Noise is likely to be a mixture of broadband noise and tones, and levels will depend on the physical properties of the seabed (Nedwell et al. 2003). Trenching noise has been measured at 178 dB re 1 µPa at 1m (Nedwell et al. 2003). Measurement of rock placement using a fall pipe in 60 – 70 m water depth by Nedwell and Edwards (2004) found noise levels from the activity to be below ambient. In this instance tonal component to the sound generated by the rock placement indicated strong tones at approximately 28 Hz to 70 Hz, such tonals were evident in both the measurements taken during rock placement and in those taken when no rock placement was taking place. In general, the use of thrusters for manoeuvring and positioning vessels is likely to provide the most significant source of noise during seabed preparation and stabilisation activities.

Vessel Movements

Vessel movements will be highest during the drilling, installation and decommissioning phases. Vessel noise varies with the size, speed, engine type, positioning system and the activity being undertaken. Noise levels for a range of vessels have been measured at 164 182 dB re µPa at 1 m (McCauley 2008; Blackwell and Greene 2002; MacGillivray and Racca 2006; Austin 2004; Zykov and Hannay 2006). Smaller, faster vessels typically produce higher-frequency sound at lower source levels than large, slower-moving vessels.

Noise levels decline rapidly as a vessel slows from its normal cruising speed. It is estimated that 85% of vessel noise results from propeller cavitations. As a ship's speed increases, broadband noise such as propeller cavitation and hull vibration noise become dominant over machinery related tones (NRC 2003). Cavitations are the major noise source for vessels using dynamic positioning systems (Wyatt 2008).

Underwater noise may also be associated with helicopter movements which may occur during all phases of the Proposal but are likely to be greatest during drilling, installation and decommissioning activities. The main source of noise from helicopters is from the main rotor. Dominant tones from helicopters are generally below 500 Hz (Richardson et al. 1995). The penetration of noise into the ocean is dependent on the angle of the aircraft and its distance from the sea surface. In calm conditions, most noise does not penetrate into the water at angles greater than 13 degrees (º) from the vertical, and is instead reflected. However, more noise may penetrate in rough conditions (Richardson et al. 1995). Noise levels from a Bell 212 helicopter flying at altitudes of 610 to 152 m respectively were measured at 101 – 109 Decibels (dB) at 3 m water depth (Richardson et al. 1995). Although this is not representative of the type of helicopters used to service offshore facilities, it provides an indication of received noise levels that may be expected from a helicopter.

During noise measurements taken at Scott Reef during a drilling program in 2008, the noise from helicopters operating around the drill rig was not detectable at a noise logger set 4.6 km away (McCauley 2008).

Operational Activities

Noise is emitted during operation of the subsea infrastructure. This noise is generated by choke valves at the subsea wellheads and is due to the pressure difference between the input and the output pressure of the valve as the reservoir fluid flows through the wellhead.

The potential pressure difference, and therefore the potential noise level, will be highest early in reservoir life and will diminish with time. McCauley (2002) recorded noise from an oil producing wellhead associated with the Cossack Pioneer Floating Production, Storage and Offloading (FPSO) vessel, and estimated the broadband source level to be 159 dB re 1 µPa with the noise not expected to propagate more than 1 km from the wellhead under optimal conditions. This source level was modelled to determine the geographical range over which the noise from the Torosa subsea wellheads might be expected to occur, as described below.

Modelling was conducted for the subsea wellheads located at the western (TRE) and eastern (TRD) drill centres in the channel between North Scott Reef and South Scott Reef (Figure 3.1). The modelling was based on configurations of seven wellheads at the TRD drill centre and six wellheads at the TRE drill centre, spaced 20 to 40 m apart and 4.5 m above the seabed in a water depth of approximately 400 m.

Received levels were calculated for cross-sections of the channel at the TRD and TRE drill centres, using two complimentary methods, the image method and the parabolic equation method (Duncan 2010). Results obtained using the two different methods were broadly consistent. However, the image method provided more accurate results close to and above the source, whereas the parabolic equation method provided the best results towards the edges of the channel where refraction becomes important.

The modelling indicates that noise levels will fall below 120 dB re 1 µPa within approximately 500 m of the wellheads and are not expected to propagate more than 1 km under optimal conditions. It is noted that the operating state of the Cossack Pioneer FPSO wellhead was not known at the time of measurement. However, in the absence of measured data at the Torosa reservoirs, the Cossack Pioneer wellhead data is considered a reasonable proxy.

The proximity of the FLNG facilities to the Torosa reservoir, planned subsea architecture and planned operational approach of taking more of the necessary pressure drop from the reservoir to the processing inlet on the FLNG facility (in preference to subsea) means choke noise should be less intense than would be expected for a conventional offshore subsea development connected to an onshore LNG plant. However, at times wellhead noise would be expected to be equivalent to a conventional gas gathering system.

3.7.8 Non-hazardous Solid Waste

General non-hazardous wastes may include scrap metal, packaging, wood, cardboard, paper, empty containers and other general garbage. They will be segregated at source into recyclable and non-recyclable wastes where a net environmental benefit is likely and stored in marked containers for transport onshore to a recycling contractor wherever practicable, or waste disposal site. Given the nature of Proposal activities, overall non-hazardous solid waste volumes are expected to be low during all Proposal stages. Impact assessment for non-hazardous solid waste is included in Section 10 of the Browse FLNG Development Draft EIS.

Food scraps and other putrescible waste will be produced from drill rig and vessels (approximately 1L/person/day), during all phases of the Proposal. Disposal of these wastes will be in accordance with MARPOL 73/78 requirements where relevant. Given the nature of the Proposal activities, overall putrescible waste volumes are expected to be low during all phases of the Proposal.

3.7.9 Hazardous Waste

Hazardous waste will be generated during all phases of the Proposal, and may include:

- Recovered solvents.
- Excess or spent chemicals.
- Paints and paint cans.
- Biological waste from medical facilities.
- Oil contaminated materials (e.g. sorbents, filters and rags).
- Batteries.
- Fluorescent light tubes.
- Waste oils.

Where relevant, hazardous waste will be transported to shore for disposal in accordance with MARPOL 73/78 Annex III: Packaged Harmful Substances (as implemented in Commonwealth waters by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*) and Marine Orders - Part 94: Marine Pollution Prevention – Packaged Harmful Substances. Hazardous waste will not be discharged at sea in accordance with Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* - Parts IIIA and IIIC and Marine Order 94 (pollution prevention – packaged harmful substances).

Hazardous waste will be segregated into recyclable and non-recyclable wastes where a net environmental benefit is likely and stored in clearly marked containers prior to transfer onshore to an approved recycling contractor wherever practicable, or waste disposal site. Hazardous wastes will be handled and stored in accordance with the safety data sheets (SDS) and tracked from source to its final destination.

4. Stakeholder Engagement

4.1 Overview

Since 2004, Woodside, on behalf of the Browse JV Participants, has undertaken extensive consultation in support of the development of the Browse resources with a wide variety of stakeholders. Entities consulted have included environment and conservation groups, non-government organisations (NGOs), Commonwealth, State and Local governments, tourism operators, fishing groups (commercial and recreational), Indigenous representatives, local business and service providers and local communities. The objectives of this stakeholder consultation included:

- Providing stakeholders with opportunities to obtain information regarding the development of the Browse resources.
- Working with stakeholders to understand environmental and social factors and any potential impacts.
- Gathering feedback from stakeholders on their thoughts regarding the development, and where practicable, addressing stakeholder concerns.

A number of consultation methods and tools have been used as part of the stakeholder engagement process; including community reference groups, a marine users working group, expert panels, public information sessions, fact sheets and face-to-face meetings.

Information gathered and feedback obtained from this consultation has been taken into account when planning activities associated with the development of the Torosa reservoir. Stakeholder engagement for the Proposal has not been undertaken in isolation from engagement on the broader Browse FLNG Development.

4.2 Stakeholders

Table 4.1 summarises stakeholders that have an interest in, or may be affected by the Proposal. Interested parties identified include pre-existing stakeholders, known as a result of Woodside's ongoing activities in the region, as well as those identified through engagement with regulators, government agencies, desktop research and regional contacts. Additional stakeholders may be identified through ongoing consultation.

No Indigenous stakeholders were identified as part of the EIA process undertaken for the Browse FLNG Development. Following a search of the WA Department of Aboriginal Affairs' Aboriginal Sites Inquiry System, no known sites of Aboriginal Heritage significance have been identified within the Proposal Area.

The stakeholders listed in Table 4.1 have been consulted as part of the Browse FLNG Development Commonwealth EPBC Act referral and Draft EIS and this Proposal.

Table 4.1 Browse FLNG Development Stakeholders

WA State / Local Government Agencies	
Department of Fisheries	Department of Mines and Petroleum
Department of State Development	Office of the Environmental Protection Authority
Department of Parks and Wildlife	Department of Transport
Department of Environment Regulation	Shire of Derby-West Kimberley
Shire of Broome	

	Federal Government Agencies	
	Australian Fisheries Management Authority	Department of Foreign Affairs and Trade
	Australian Maritime Safety Authority	National Offshore Petroleum Safety and Environmental Management Authority
	Department of Agriculture, including the former Australian Quarantine and Inspection Service	Department of Communications
	Department of Defence	Department of the Environment
	Department of Industry	National Offshore Petroleum Titles Administrator
	Business/ Industry	
	Australian Petroleum Production and Exploration Association	Indonesian Fishers
	Chamber of Minerals and Energy	Recfishwest
	Beche de Mer Fishery	Broome Fishing Club
	Commonwealth Fisheries Association	Mackerel Managed Fishery
	North Coast Shark Fishery	Kimberley Professional Fishermen's Association
	Southern Bluefin Tuna Fishery	Northern Demersal Scalefish Managed Fishery
	Western Skipjack Tuna Fishery	North West Slope Trawl Fishery
	WA Fishing Industry Council	Western Tuna and Billfish Fishery
	Pearl Producers Association	Pearl Oyster Managed Fishery
	NGOs	
	Australian Conservation Foundation	Conservation Council of WA
	The Wilderness Society of WA	Environs Kimberley
	International Fund Animal Welfare	Save the Kimberley
	World Wildlife Fund	
	Tourism	
	Australia's North West Tourism	Kimberley Marine Tourism Association
	Kimberley Whale Watching	Reel Teaser Charters
	Odyssey Expeditions	

4.3 Engagement Mechanism for the Proposal

Stakeholders have been engaged as part of the broader Browse FLNG Development and the Commonwealth environmental impact assessment process. A web-link to the Draft EIS was emailed to all identified stakeholders for public comment on 19 November 2014. Following the proposed change to the coastal waters boundary around Scott Reef stakeholders were advised of the change and the Browse JV Participants' intention to submit a referral to the WA EPA through face-to-face meetings and correspondence via emailed fact sheets. State agencies including the Department of Transport, Department of Fisheries, Department of Parks and Wildlife, Department of Environment Regulation,

Department of State Development and Department of Mines and Petroleum were consulted prior to the referral of the Proposal.

4.4 Outcomes of Stakeholder Consultation

Since the commencement of stakeholder engagement activities in 2004, results have been used to inform decision making processes, and provide information for implementing mitigation measures. Feedback received as part of this process has allowed for the monitoring, revaluation, and revision of both which stakeholders are engaged and through what activities.

Table 4.2 summarises key issues that have been raised by stakeholders about the wider Browse FLNG Development to date, which are also relevant to the Proposal, and where within this document these issues are addressed.

Table 4.2 Key Stakeholder Issues Raised for the Browse FLNG Development, also relevant to the Proposal

Theme	Key Issue Raised	Where Addressed in this Document
Marine environment	Stakeholders expressed concerns about the potential introduction of Invasive Marine Species (IMS), in particular the impact that this will have on the fishing industry.	Sections 8.4.5 and 11.4.2.
Hydrocarbon spill	Stakeholders expressed concerns about the potential impacts arising from a hydrocarbon spill.	Section 13
Protected areas	Stakeholders expressed interest in potential interactions of the overall Browse FLNG Development with protected areas under State and Commonwealth legislation.	Section 12
Fisheries interaction	Stakeholders expressed interest in potential interactions with fisheries in the area.	Section 11
Area characteristics	Stakeholders expressed concern regarding the level of knowledge on physical and ecological characteristics of the Proposal Area	Sections 5.2, 6.2, 7.2 and 8.2
Impacts to listed species	Stakeholders expressed concern that some petroleum development activities such as vessel movements, light, GHG and underwater noise emissions may impact upon listed species.	Section 8
Decommissioning	Stakeholders expressed interest in the decommissioning process.	Section 3.4.6

4.5 Ongoing Consultation

In addition to activities undertaken as part of this referral, Woodside, as part of its standard operating practices, will continue to consult with stakeholders. This includes ongoing consultation to inform stakeholders of key milestones and activities, and ongoing social investment in the communities in which Woodside operates.

5. Impact Assessment Approach

This section summarises the environmental assessment process conducted for aspects of the Proposal, in the context of the EPA's environmental factors and objectives and the principles and objects of the EP Act. The approach adopted has been informed by the EPA Environmental Assessment Guidance material as listed in Section 2.1.1.

The assessment approach was undertaken in the following stages:

1. Identification of the environmental aspects and factors relevant to the Proposal.
2. Definition of the existing environment relevant to identified aspects and factors.
3. Identification and characterisation of potential impacts for each environmental factor, including a review of the extent (intensity, duration, magnitude and geographic footprint).
4. Identification of management and mitigation measures.
5. Determination of the significance and expected environmental outcome for each environmental factor.

5.1 Identification of Environmental Aspects and Factors

The EPA has adopted a number of environmental factors to be considered during the assessment of a proposal (EAG 8). Each environmental factor has an associated environmental objective, which is the desired goal that, if met, will indicate that a proposal is not expected to have a significant impact on the environment and the expected impact, if any, is acceptable. The identification of the relevant environmental factors underpins the EIA process.

To facilitate identification of the environmental factors relevant to the Proposal, Proposal infrastructure and activities were reviewed and the associated aspects, being the components of an activity which may have a potential to impact on, or interact with, the environment, were determined. All phases of the Proposal were considered, from drilling, installation and commissioning, through to operations and decommissioning.

Identified environmental factors, including interactions between the aspects, key associated activities and/or infrastructure, are presented in Figure 5.1. Given the offshore location of the Proposal Area and the limited and unvegetated emergent land therein, no terrestrial environmental factors were identified to be relevant to the Proposal.

Aspect	Environmental Factor						
	Marine Environmental Quality	Benthic Communities and Habitat	Marine Fauna	Coastal Processes	Air Quality	Amenity	Heritage [3]
Development Drilling: Drilling of wells							
Physical presence (of drill rig and support vessels)		■	■			■	■
Seabed Disturbance	■	■					
Physical Interaction			■			■	■
Artificial light			■				■
Underwater noise			■				■
Invasive marine species			■			■	■
Vessel and drill rig discharges [1]	■		■				■
Planned discharge of drill cuttings and fluids	■	■	■				■
Atmospheric Emissions					■		
Unplanned leaks and spills	■	■	■			■	■
Installation: Installation of manifolds, flowlines and umbilicals							
Physical presence (of vessels)		■	■			■	
Seabed Disturbance	■	■					
Physical Interaction			■			■	■
Artificial light			■				
Underwater noise			■				
Invasive marine species			■			■	
Vessel discharges [1]	■		■				
Atmospheric Emissions					■		
Unplanned leaks and spills	■	■	■			■	■
Commissioning: pressure / leak testing of the subsea infrastructure							
Planned discharge of hydrotest fluid	■		■				
Operation: extraction of hydrocarbon from Torosa reservoir and transfer via flowlines. Operation of subsea infrastructure. Periodic monitoring and maintenance activities [2]							
Physical presence (of wells and subsea infrastructure)		■					
Seabed subsidence				■			
Planned discharge of subsea control fluids	■		■				
Unplanned leaks and spills	■	■	■			■	■
Decommissioning: production wells plugged and abandoned, christmas trees, wellheads, manifolds and umbilicals removed, infield flowlines purged, flushed and either left in place where stabilised, or removed where not							
Physical presence (of vessels)		■	■			■	
Seabed disturbance	■	■					
Physical interaction			■			■	■
Artificial light			■				
Underwater noise			■				
Invasive marine species			■			■	
Vessel discharges [1]	■		■				
Atmospheric Emissions					■		
Unplanned leaks and spills	■	■	■			■	■

Key:

Identified interaction with potential for impact ■

Notes:

[1] Includes: sewage, sullage and desalination brine, as relevant

[2] No credible interactions with environmental factors are anticipated for infrequent monitoring and maintenance of subsea wells and infrastructure

[3] The heritage value of Scott Reef is based on its ecological values

Figure 5.1 Aspects and Environmental Factors Relevant to the Proposal

5.2 Definition of Existing Environment

The Browse JV Participants have commissioned a large number of studies over the past 20 years to further the understanding of the physical, biological and socio-economic conditions in and around the area where the Browse resources are to be developed. These studies contribute to long-term data sets for the Region and the majority have been made available in the public domain. Information on the existing environment gathered through these studies has been supplemented by information from:

- Peer reviewed journals.
- Industry and government technical reports.
- Standards and guidelines.
- Department of the Environment (DOE) resources and published literature.
- Search tools such as the Department of Parks and Wildlife (DPaW) NatureMap and an EPBC Act Protected Matters database search to identify listed species and communities potentially occurring in the Proposal Area (based on a 30 km radius from the centre of Scott Reef).

The results of the EPBC Act Protected Matters database search were cross-referenced with the WC Act to identify any species present that may not have been identified from the DPaW NatureMap search.

5.3 Identification and Characterisation of Potential Impacts

Potential impacts are those changes to and/or interactions with the environment that occur taking into account inherent controls, including design features, legislative requirements and corporate standards.

A hazard identification (HAZID) process was undertaken for activities relevant to the Proposal. During the HAZID, each activity (either planned or unplanned) was considered with respect to its potential to affect environmental, social or cultural receptors and the resulting impact(s) from those interactions, taking into consideration relevant inherent controls. The HAZID process was informed by:

- Information obtained through stakeholder consultation;
- Knowledge developed by Woodside from the company's extensive prior experience in assessing and operating offshore oil and gas facilities;
- Comprehensive baseline studies; and
- HAZID workshops conducted by Woodside.

A 'worst case' potential impact approach was taken. For instance, if there was uncertainty over the exact distribution of a particular receptor, that receptor was considered to be present in the area of potential interaction with the Proposal aspect.

During this stage the extent or level of impact or consequence of a potential impact was also considered. In evaluating the extent of the impacts on each environmental factor, the following were taken into account:

- Frequency or intensity and duration: how often the impact will occur and how long the interaction will occur with the receiving environmental factor.
- Geographic footprint that may be affected.
- Magnitude or scale of the impact: whether the impact affects the local, regional or broader receiving environment.

- Sensitivity of receptor: the nature, importance (i.e. whether of local, national, regional or international importance) and the sensitivity of the receptors that could be affected. This also takes account of any laws, regulations or standards aimed at protecting the receiving environment.

The assessment of impacts on marine turtles and on benthic primary producer habitats (BPPHs) has been informed by the EPA's EAG 3 and EAG 5 respectively.

5.4 Identification of Management and Mitigation Measures

An adaptive management framework was used to identify appropriate management and mitigation measures taking into account good industry practice and professional experience:

1. Eliminating the impact by removing the source.
2. Substituting an activity and/or aspect with a lesser one.
3. Preventing a potential impact from occurring through the implementation of additional engineering control measures.
4. Reducing the extent of a potential impact through the implementation of additional engineering control measures.
5. Mitigating the potential impact on the environment through the reduction in extent of impact.
6. Emergency response and contingency planning to facilitate recovery from the potential impact of an event.

5.5 Determining Significance and the Expected Environmental Outcome

Considering the principles and object(s) of the EP Act, the significance of the Proposal was determined based on whether the Proposal is likely to meet the relevant environmental objective for the environmental factor.

In line with the guidance in the EPA's EAG 9, a number of other considerations, where relevant, were taken into account when assessing the significance of the Proposal on the environmental objective:

- Consequence of the potential impacts (or change), taking into account the extent of the potential impacts with the implementation of management and mitigation measures, and the values, sensitivity, quality and/or resilience of the receiving environment, including regard to studies or field surveys undertaken;
- Resilience of the environment to cope with the impacts or change.
- The certainty of potential impacts.
- Level of confidence in the prediction of impacts and the success of proposed mitigation, including the results of any supporting studies or modelling.
- Stakeholder consultation and any concerns raised.
- Whether an alternate regulatory process can ensure the environmental objective for the factor will be met.
- Experience within Woodside and the wider industry.

A conclusion about the expected environmental outcome has been made for each environmental factor, based on the assessment of significance and whether the environmental objective is expected to be met.

6. Marine Environmental Quality

6.1 EPA Objective

To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected.

6.2 Existing Environment

The characteristics of the marine environment of the Proposal Area are described in detail in Section 6 of the Browse FLNG Development Draft EIS. Key characteristics are summarised below.

The environment of the Proposal Area and its surrounds has been studied extensively through desktop reviews and scientific surveys. The water and sediment quality of the Proposal Area has been established from a number of surveys commissioned by Woodside in the area where Browse resources are to be developed (Brinkman et al. 2009; Gardline 2009; URS 2007b).

Water quality in the Proposal Area is typical of an unpolluted tropical offshore environment. Much of the surface water in the Proposal Area is nutrient poor water transported from the Indonesian Throughflow and has low primary productivity. However, topographic upwelling at Scott Reef draws in cool, nutrient-rich water from the channel into the South Reef lagoon supporting locally enhanced productivity. Oceanic waters around and within the Proposal Area are characterised by low turbidity, although relatively high levels of total suspended solids have been recorded near Scott Reef in winter which may reflect a peak in plankton productivity. Metal levels in the water column have been recorded as being generally below laboratory reporting levels.

Water temperatures throughout the Region are largely derived from the influence of the Indonesian Throughflow that delivers warm, lower salinity water to the Region. Surface water temperatures in the Proposal Area range between an average of approximately 27 and 29°C, although a larger temperature range is experienced in the shallower lagoonal waters of Scott Reef. Waters in the Proposal Area deeper than approximately 50 m are continuously temperature-stratified throughout the year, with warmer water overlaying denser cooler water.

The Proposal Area experiences two high tides and two low tides per day with tidal levels ranging from +2.3 m to -2.3 m above mean sea level (MSL). Currents in the Proposal Area are influenced by regional current systems such as the Indonesian Throughflow and surface winds, amongst other things. Tidal current strengths in the channel between North and South Scott Reef are approximately 1 metre per second (m/s). Wave heights in the Proposal Area average 1-2 m, peaking up to 2.3 m.

Water depths along the channel between North and South Scott Reef, where TRD and TRE drill centres are to be located, range from approximately 350 m to 600 m. The seabed in the channel is relatively flat and heavily scoured by currents; seabed sediments here comprise well-rounded cobble/ rubble and very coarse shell fragments. The seabed at the TRF drill centre, to the west of North Scott Reef, is smooth and almost flat, comprising largely soft sediments in water depths typically between 350 and 500 m. Laboratory analysis of collected sediment samples indicated no evidence of hydrocarbon contamination in the Proposal Area, generally low levels of metal, and nutrient levels typical of carbonate-dominated sediments in remote tropical settings (metal concentrations are generally below ANZECC trigger levels).

6.2.1 Existing Pressures on marine environmental quality of the Proposal Area

Given its remote location, there are limited existing anthropogenic pressures on marine environmental quality in the Proposal Area. However, the area is exposed to physical disturbances and some human pressures, including:

- *Tropical cyclones* – Tropical cyclones represent a major natural source of turbidity in the Proposal Area
- *Climate change* – Increases in seawater temperature and ocean acidification associated with climate change are acknowledged emerging pressures.
- *Natural hydrocarbon seeps* – A remote sensing study that analysed 31 suitable satellite images spanning September 1993 to November 2008, identified no definitive natural seeps occurring in the Browse basin to date (Fugro NPA Ltd 2008). However, two weak clusters and scattered slicks were provisionally identified to the south of South Scott Reef and close to the south of Scott Reef as possibly occurring due to natural seepage.

6.3 Sources of Potential Impacts

Table 6.1 summarises the sources of potential impact to marine environmental quality from the Proposal.

Table 6.1 Sources of Potential Impact to Marine Environmental Quality from the Proposal

Aspect	Source (Activity and/or Infrastructure)	Proposal Phase[1]					Potential Impact
		Dr	I	C	O	De	
Seabed disturbance	Seabed preparation, trenching and secondary stabilisation		✓				Localised change in water quality due to an increase in suspended sediments
Planned Discharges	Discharge of drill cuttings and fluids	✓					Localised change in water and sediment quality
	Vessel and drill rig discharges	✓	✓		[2]	✓	Localised change in water quality (including impacts to phytoplankton)
	Discharge of subsea control fluids				✓		
	Discharge of hydrotest fluid			✓			Temporary decline in water quality

[1] Dr = Drilling; I = Installation; C = Commissioning; O = Operation; De = Decommissioning

[2] No credible interactions are anticipated for infrequent monitoring and maintenance of subsea wells and infrastructure during the operation phase (Figure 5.1).

6.4 Characterisation and Assessment of Impacts

6.4.1 Seabed Disturbance

Seabed preparation, trenching and secondary stabilisation operations may be required at specific locations for the installation of subsea infrastructure (Section 3.4.2), and have the potential to result in a temporary localised decline in water quality due to an increase in suspended sediment concentrations. The majority of sediments suspended during these activities are expected to rapidly settle on the seabed within or relatively close to the area of disturbance. A turbid plume may develop from any fines contained in the sediment which will gradually dilute as it disperses down current and through the water column. Brinkman et al. (2009) have determined that, owing to strong stratification in the

water column, water masses deeper than 200 m are unlikely to be upwelled and reach Scott Reef. As these activities will occur in water depths greater than 350 m and the methods proposed (mass flow excavation and ploughing) do not require sediment to be brought to the surface, sediment suspended at the seabed due to these works is not expected to reach surface waters of Scott Reef. Strong currents in the Scott Reef channel (RPS Metocean 2008) will also assist in dispersing any sediment plume developing during these activities.

Compared to natural events such as storms and cyclones, which often cause large amounts of sediment to be lifted into the water column over large areas, the turbidity generated from seabed preparation, trenching and secondary stabilisation activities will be minor.

6.4.2 Drill Cuttings and Fluid Discharge

The discharge of drill cuttings and fluids has the potential to alter water quality by temporarily increasing turbidity in the water column, reduce sediment quality associated with organic enrichment and de-oxygenation of seabed sediment and cause associated toxicity to in-water and benthic organisms.

An assessment of drill cuttings discharge from the TRE and TRD drill centres was undertaken by DHI Water & Environment Pty Ltd (DHI) (DHI 2011) to determine the physical fate and dispersion of drill cuttings and fluid discharges and to help inform the management approach to be adopted during drilling (Woodside 2011). Modelling was undertaken to simulate sediment dispersion, sedimentation and re-suspension of the drill cuttings releases. At each drilling location, modelling parameters included:

- Seabed discharge from top hole sections of each well equivalent to a cuttings volume of 587 m^3.
- Sea surface discharge from bottom hole sections of each well equivalent to a cuttings volume of 181 m^3.

Although actual volumes, discharge rates and scheduling of drilling activities are yet to be confirmed, modelling assumptions provided for a conservative assessment of potential impacts from drill cuttings disposal. Further details are provided in Section 10.17 of the Draft EIS for the Browse FLNG Development.

The modelling indicated that the sea surface discharge of drill cuttings generated at the TRE and TRD drill centres resulted in incursions of sediment plumes and associated increased sedimentation at some parts of North and South Scott Reef including within the lagoons. However, seabed drill cuttings discharge resulted in sediment plumes and associated deposition of sediment being confined to the deep layers of the water column and therefore no potential for impact on deep or shallow water coral habitats at Scott Reef.

Based on seabed discharge, modelling indicated that the turbidity plume would remain in the bottom layer and would not be expected to reach surface waters or coral habitats at Scott Reef. Discharges of drill cuttings at the seabed would not be expected to impact photosynthetic activity in the water column, since plumes would be at depths below the sunlit photic zone. Furthermore, given the location of the drill centres in deep water, particularly for TRD and TRE drill centres which experience strong surface and sub-surface currents, drill cuttings and fluid discharges would be expected to disperse and dilute rapidly. Therefore, any reduction in water quality is expected to occur in a localised area around the drill centre and for a short period of time.

The deposition of discharged drill cuttings and fluids to the seabed will likely affect the grain size of bottom sediments, their chemical composition and sediment oxygen levels. These affects may in turn result in changes in benthic community composition (Section 7.4).

The sedimentation footprint associated with discharge of drill cuttings at the seabed, indicates that away from the immediate area surrounding the discharge locations, sedimentation loading over the course of the drilling program would be low, equating to a thin veneer of settled drill cuttings which will likely be naturally reworked into surficial sediment through processes including bioturbation (US EPA 2000).

Potential oxygen reduction can occur in cuttings sediment piles where the drilling process has used NWBF as the biodegradation processes for the synthetic organic base fluid requires oxygen. Once deposited to the seabed, the microbial decay of the organic content of NWBF in the top layer of the cuttings pile may reduce oxygen levels leading to secondary impacts to marine benthic communities if oxygen concentrations decline to levels where hypoxic or anoxic conditions form. This effect may be exacerbated as deposition of fines (silt and clay) can reduce pore water exchange occurring at the sediment water interface.

The surface layers of the cuttings pile, deposited immediately around the discharge location, will prevent oxygen and other seawater constituents from penetrating to the layers below (UKOOA 2002). A lack of oxygen within the deeper layers of these accumulations reduces or inhibits biodegradation. De-oxygenation of the sediments, driven by the degradation of NWBFs, is likely to be the main factor in determining potential impacts to benthic infauna. Given that the volume of sediment contributing most to the cuttings pile will stem from top hole section drill cuttings composed of seawater with sweeps (rather than NWBFs), there will be only limited potential for the long-term de-oxygenation of a localised seabed area affected by the cuttings pile formation around the well hole.

Where WBF or NWBF are used during drilling, they will be entrained with the drill cuttings and may contain chemicals that elicit toxic response, if untreated (Atema et al. 1982). Large sections of the wells will be drilled using seawater and bentonite clay, which is inert and hence non-toxic. However, deeper sections of the wells will require the use of WBFs or NWBFs. The fluids selected will meet the toxicity rating of ‘non-toxic to slightly toxic’ (APPEA 1998) and if NWBF are used, residual fluids will be limited to up to 10% residual oil on cuttings. After treatment, cuttings will therefore only contain 5-25% WBFs and 5-10% NWBFs. The potential impacts to marine water and sediment quality will be limited due to the low toxicity rating of the drill cuttings and rapid dilution to non-toxic concentrations within metres of the release point.

Woodside proposes to adopt an adaptive management strategy for the discharge of drill cuttings for the Torosa Subsea Development with the aim of avoiding impact on Scott Reef (refer to Table 6.2). As such, , impacts to marine environmental quality associated with drill cuttings discharges are expected to be localised, minor and short term.

6.4.3 Vessel and Drill Rig Discharges

Sewage and Sullage

Woodside is committing to no discharge of untreated sewage within 3 nm of Scott Reef (Table 6.2). Therefore, Scott Reef is not expected to be at risk from the discharge of untreated sewage and sullage.

However, discharges of treated sewage and sullage may occur inside the Proposal Area from vessels and the drill rig. Given the scale of the Proposal (Section 3.2), volumes of sewage and sullage are expected to be small and such discharges will occur only when vessels and the drill rig are operating in the Proposal Area.

Discharges of treated sewage and sullage are expected to disperse rapidly in close proximity to the discharge points. As described in more detail in Section 10.13 of the Draft EIS for the Browse FLNG Development, this is due to the discharge being neutrally buoyant, the strong tidal currents and wind-driven surface currents.

Therefore treated sewage and sullage discharges may result in a localised and temporary increase in the nutrient content in the water column. The organic materials from the discharges will likely exert biological oxygen demand (BOD) on the receiving waters, but is unlikely to reach levels below background ambient dissolved oxygen concentrations. Similarly while the nutrient inputs from discharged effluent will rapidly be taken up by phytoplankton, pronounced increases in productivity (as evidenced by increased chlorophyll *a* concentrations) are not expected due to the assimilative capacity of the open ocean. Nutrients are not expected to accumulate in the vicinity of the discharge locations.

Monitoring of treated sewage and sullage discharges from a drill rig located at the edge of the deep water lagoon of South Scott Reef in 2008 confirmed that discharges were rapidly diluted in the upper (less than 10 m) water layer and no elevations in water quality monitoring parameters (e.g. total nitrogen (TN), total phosphorous and selected metals) were recorded above background levels at any station (ERM and SKM 2008). Monitoring stations were located 50, 100 and 200 m downstream from the drill rig at five different water depths. This indicates that no detectable impacts due to treated sewage and sullage effluent discharges are predicted.

Given that the TRE drill centre is located in deeper waters and exposed to greater current speeds than that of the Torosa-6 drill rig monitored in 2008, discharge of treated sewage and sullage is not expected to impact sensitive habitats at Scott Reef.

Desalination Brine Discharge

As described in Section 3.7.2, desalination brine may be discharged from the drill rig and vessels operating in the Proposal Area. On discharge, the desalination brine, due to its higher density, will tend to sink in the water column and will be subject to rapid dilution and dispersion in the prevailing currents. Given the desalination brine is only 20 to 50% more saline than the intake seawater (depending on the desalination process used), only a few dilutions would be required to return the brine discharge back to ambient salinity levels, which is likely to be achieved within a short distance of the discharge point. Due to the high dilution, any elevation in salinity will be highly localised at the discharge point and is unlikely to have a perceptible effect on ambient salinity concentrations in the water column.

Given these considerations, negligible localised and temporary effects to the marine environment are expected as a result of these discharges.

6.4.4 Subsea Control Fluid Discharge

Operations of the subsea infrastructure may result in the intermittent discharge of small volumes of subsea control fluids. The subsea control fluid to be used during operations has yet to be selected, with its exact composition depending on technical performance requirements to be further defined during latter phases of the development. However, subsea control fluids are typically water-based with additives including 40% MEG and proportionately smaller quantities of other components such as lubricants, corrosion inhibitors, biocides and surfactants, resulting in an overall low toxicity to the marine environment.

Given the design of the subsea control fluid system which provides for hydraulic fluid to be returned to an FLNG facility for re-use, there would be no discharge of subsea control fluid under routine operating conditions (refer to Table 6.2). However, in the event that discharges do occur, the intermittent discharge of small volumes of low toxicity subsea control fluid may result in a minor, localised and temporary change in water quality in the deep waters of the Proposal Area (> 350 m depth). Any such discharge would be rapidly diluted in the prevailing currents within metres (or less) downstream of the discharge point with negligible effect on marine environmental quality.

6.4.5 Hydrotest Fluid Discharge

Based on indicative infrastructure layout, discreet volumes of approximately 300 to 800 m^3 of hydrotest fluid may be discharged at any one time, as discussed in Section 3.7.3. The selected hydrotest fluid may either be water (typically treated seawater) or MEG. Given the location of subsea infrastructure, such discharges will occur at water depths of > 350 m.

Discharged hydrotest fluid will contain chemical additives in low concentrations. Hydrotest chemicals will at a minimum have a Hazard Quotient (HQ) category of 'Silver' or Offshore Chemical Notification Scheme (OCNS) Category D under the UK OCNS. Should MEG be used as a hydrotest fluid, it is classed as having low toxicity and has been rated to 'Pose Little or No Risk to the Environment' (PLONOR) by The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) (2004). MEG is also readily degradable and will dilute rapidly, resulting in a highly localised, temporary and minor change in water quality in the deep water environment in the immediate vicinity of the discharge point. Biocides used in the hydrotest fluid are expected to degrade gradually over time while the hydrotest fluid is in the flowlines and equipment (typically at least 12 months) and further degrade on discharge to the marine environment, resulting in a minimal effect on water quality. Similarly, other additives in the hydrotest fluid will be in a diluted form, and when discharged to sea will be further rapidly diluted to extremely low concentrations. The potential for impacts to water quality and marine organisms will therefore be limited to be minor and localised.

Oxygen scavengers will be used in the flowlines to reduce the potential for corrosion and as a result, hydrotest fluid discharges will be low or lacking in oxygen. However, given the short duration of the discharge and discharge in open oceanic waters, oxygen depletion in the water column is expected to be temporary, minor and highly localised.

Hydrotest fluid discharges, including details on the specific chemical additives to be selected, as well as likely concentrations, volumes and frequency of discharges, will be detailed in relevant Environment Plan(s) developed for the Proposal. The Environment Plan(s) are required to demonstrate that impacts and risks associated with hydrotest discharges have been reduced to levels that are ALARP and acceptable. As a result, impacts from the discharge of hydrotest fluid, being either MEG or hydrotest water, are anticipated to result in minor, temporary and highly localised changes to the quality of water surrounding the discharge point and therefore to the overall marine environmental quality. Because of the location of discharge, no impacts to marine environmental quality of Scott Reef are expected.

6.5 Mitigation and Management

Mitigation and management measures relevant to marine environmental quality are listed in Table 6.2.

6.6 Expected Environmental Outcome

The results of the assessment and the expected environmental outcome is summarised in Table 6.2.

Table 6.2 Summary of Likely Impacts on Marine Environmental Quality and Expected Environmental Outcome

Existing Environment	Aspect	Likely Environmental Impacts	Mitigation and Management	Expected Environmental Outcome
EPA Objective: ***To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected***				
Water quality within the Proposal Area is typical of an unpolluted tropical offshore environment, with low nutrients in the upper water layers and metal concentrations generally below the minimum reporting levels. In the deeper waters of the Proposal Footprint, the water column is strongly stratified and the channel between North and South Scott Reef, within which two drill centres are located, experiences strong currents. Sediment quality within the Proposal Area is typical of an unpolluted tropical offshore environment. Nutrient levels are within the normal baseline values, metal concentrations are generally below ANZECC trigger levels (ANZECC/ARMCANZ 2000) and there is no evidence of hydrocarbon contamination in the Proposal Area.	Seabed disturbance	Temporary and localised increase in turbidity and suspended sediments as a result of seabed preparation, trenching and secondary stabilisation activities. Turbidity plume predicted to be confined to the deep water of the Proposal Footprint (given the proposed methods and stratification of the water column) and minor when compared to natural storm events. Activities are short in duration, small in scale and occur in deeper, strongly stratified waters.	The location of subsea infrastructure, in particular flowlines, has been selected to limit seabed preparation, trenching and secondary stabilisation requirements to the level necessary to ensure pipeline integrity.	Taking proposed mitigation and management measures into account, and considering the limited scope and scale of the Proposal (with no permanent facility or vessel presence) and the overall phasing of Proposal development, no significant adverse impacts on the quality of water, sediment and biota are likely. Any impacts to marine environmental quality have been evaluated to be localised, temporary to short-term and of negligible to minor magnitude with such impacts likely to be confined to the Proposal Footprint. Therefore, the environmental values, both ecological and social in the Proposal Area are protected. Impacts to marine environmental quality have been reduced by selecting FLNG as a development concept and siting infrastructure in deep waters off Scott Reef. The majority of mitigation and management measures proposed are standard maritime and offshore oil and gas industry practice. However, noting the sensitivity of Scott Reef, Woodside intends to exceed industry practice by taking a precautionary approach, for example towards the management of drill cuttings and fluids. Implementation of these mitigation and management measures to ensure impacts are acceptable and ALARP will be assured through activity specific Environment Plan(s) under other regulatory processes. The environmental objective is met.
	Drill cuttings and fluids discharge	Localised and temporary turbid plume in the water column, which is expected to disperse and dilute rapidly given the strong surface and sub-surface currents in the Proposal Area. Very minor, localised and short-term toxicity impacts to in-water organisms during drill cuttings discharge. No long-term impacts on productivity of the water column. The area of seabed potentially affected by cuttings deposition depends on the location of discharge, amongst other things, but overall is expected to be localised to the immediate area surrounding the discharge locations. Beyond this, only a thin veneer of settled drill cuttings would be expected which will likely be naturally reworked and thus only short term. Limited potential for the long-term de-oxygenation of a localised area of seabed affected by the cuttings pile formation around well centres. Activities are short in duration, small in scale and occur in deeper, strongly stratified waters.	Well design will be optimised to meet recovery objectives and operational requirements thereby reducing the unnecessary use of drill fluids and generation of drill cuttings. If well design characteristics do not allow use of WBFs for all well sections, NWBFs will be selected in accordance with Woodside's chemical selection procedure. There will be no planned discharge of whole NWBF at sea during drilling operations. Risers will be used to ensure that NWBF and associated cuttings are recirculated to the drill rig for treatment prior to discharge. Drill cuttings will be tested to confirm that residual NWBF remaining on the cuttings are limited to a maximum amount of 10% by dry weight of base fluid, prior to discharge overboard. Given the potential sensitivities of Scott Reef coral communities to sedimentation, Woodside will adopt an adaptive management strategy for the disposal of drill cuttings from Torosa wells. For those drill centres where surface discharge of drill cuttings results in impacts to the reef, alternative drill cuttings disposal techniques will be used, which may include: • Discharge from the drill rig at a sufficient depth to allow acceptable dispersion to occur. • Retain cuttings, store and ship to an offshore location away from the reef for offshore disposal. • Retain cuttings, store and transfer to shore for disposal.	
	Vessel and drill rig discharges	Only temporary, minor and highly localised impacts to water quality within the Proposal Footprint associated with planned vessel discharges given limited scale of activities, short-term presence and offshore open water environment.	There will be no discharge of untreated sewage within 3 nm of Scott Reef. In compliance with MARPOL 73/78 Annex IV: Sewage; and Australian Maritime Safety Authority (AMSA) Marine Orders - Part 96: Marine Pollution Prevention – Sewage, relevant classes of vessels will hold: • fully operational sewage, sullage and putrescible waste holding tanks; • operational on board sewage treatment plant approved by the International Maritime Organisation (IMO); and • valid International Sewage Pollution Prevention Certificate (ISPP). Monitoring and record keeping demonstrating sewage and sullage volumes generated and any non-compliance with Marine Orders.	
	Subsea control fluid discharge	If released into the sea, the small volumes of low toxicity subsea control fluid may result in a minor, highly localised	The subsea fluid control system selected for the Proposal will employ a spare return line such that, under routine operating conditions, where the spare	

Existing Environment	Aspect	Likely Environmental Impacts	Mitigation and Management	Expected Environmental Outcome
		change in water quality at valve locations in deep water, however any such discharge is expected to dilute rapidly.	return loop is not required, all LP hydraulic fluid is returned to an FLNG facility for re-use. Subsea control fluids will be selected in accordance with Woodside's chemical selection procedure on the basis of lowest health, safety and environmental risks while meeting operational requirements. Subsea fluid usage will be monitored through the life of the Proposal. Monitoring and record keeping will show subsea control fluid usage, including type and volumes of discharge, any subsea control fluid volume discrepancies, which will be investigated to identify possible integrity issues.	
	Hydrotest fluid discharge	Only temporary, minor and highly localised impacts to water quality at the point of discharge.	Total flowline length will be optimised to meet operational requirements, thereby reducing the volume of hydrotest fluid required. Subsea infrastructure installation schedule will be optimised to minimise the requirement for discharge and refill of hydrotest fluid. Hydrotest fluid will be selected for environmental performance (i.e. low toxicity chemicals) while maintaining technical performance requirements. Hydrotest fluid discharge will be detailed in relevant Environment Plan(s) for the Proposal. The Environment Plan(s) will detail hydrotesting requirements, including details on the specific chemical additives to be selected as well as likely concentrations, volumes and frequency of discharges. The Environment Plan(s) are required to demonstrate that the impacts and risks of hydrotest fluid discharge have been reduced to levels that are ALARP and acceptable. The discharge of hydrotest fluid associated with the Proposal will be conducted in a controlled manner to ensure adequate dilution. Hydrotest discharges will be conducted at depth to maximise dilution and away from sensitive receptors such as Scott Reef. Records will be kept showing hydrotest fluid usage including type, volumes and locations of discharge.	

7. Benthic Communities and Habitats

7.1 EPA Objective

To maintain the structure, function, diversity, distribution and viability of benthic communities and habitats at local and regional scales.

7.2 Existing Environment

The marine environment of the Region primarily consists of soft-sediment habitats which support sparse and scattered epifauna. Benthic habitats in the Proposal Area can be divided into those of the deep waters of the Proposal Footprint, and those of Scott Reef. A detailed account of the benthic habitats of the Proposal Area is provided in Section 6.3 of the Browse FLNG Development Draft EIS; a summary is provided below. Information is derived from a number of habitat surveys conducted by AIMS in 1999, 2004 and 2006 (Smith et al. 2006) and by Gardline during the 2009 dry winter season (June and July) (Gardline 2009).

7.2.1 Proposal Footprint

Seabed sediments within the Proposal Footprint comprise well-rounded cobble/ rubble, very coarse shell fragments and/or soft sediments. Benthic habitats and communities in these locations comprise generally sparse and scattered epifauna and burrowing infauna, consisting of a variety of common and widespread taxa (Gardline 2009).

No seagrasses and limited macroalgae occur in the Proposal Footprint due to water depth and lack of hard substrate. Similarly, during benthic surveys conducted in the deep waters of the Proposal Area, no hard or soft corals were found (Gardline 2009; Hudson & Fletcher 2006; URS 2007b). If present within the deeper waters of the Proposal Area and surrounding waters, corals are likely to be limited to scattered isolated individuals. Likewise, sponges may occur within the Proposal Footprint, but if present, are anticipated to be sparsely distributed, particularly in the channel between North and South Scott Reef due to the strong currents within the channel.

7.2.2 Scott Reef

The Proposal Area also encompasses Scott Reef, which consists of two shelf atolls, North Scott Reef and South Scott Reef, separated by a deep channel (Figure 9.1). At Scott Reef, at least 14 distinct benthic habitat types have been defined that can broadly be grouped into shallow water habitats (< 30 m), deep lagoonal habitats (between 30 – 70 m) and deep-water habitats (70 – 500 m) (Figure 7.1).

The shallow water habitats occupy 170.5 kilometres squared (km^2) and 147.1 km^2 at the South and North Scott Reef respectively, and include reef crests, flats and slopes, patch reefs and the shallow water lagoons. These habitats support more diverse coral communities than deeper waters, but are more susceptible to natural impacts such as thermally induced coral bleaching and cyclone damage.

The deep-water lagoonal habitats of South Reef are extensive, covering approximately 289 km^2. These deep-water communities of South Reef are likely to be shaped by available light, current regime and substrate type, although plankton may supplement the energy requirements of the communities.

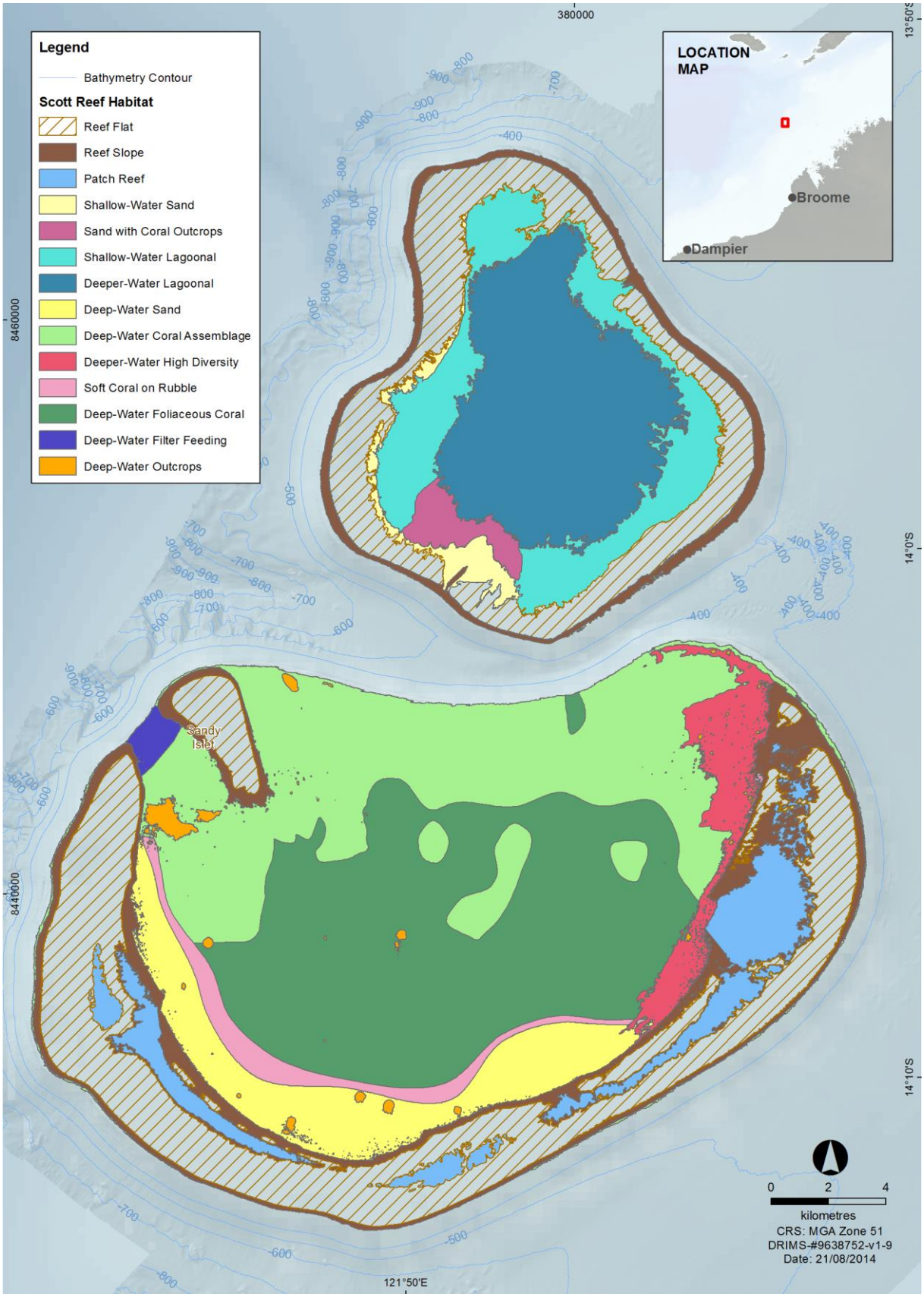

Figure 7.1 Scott Reef Habitat Map (Smith et al 2006)

A diverse assemblage of hard coral species has been recorded from Scott Reef, with 307 species from 60 genera and 14 families (Gilmour et al. 2009b). Scott Reef appears to have a comparable diversity of hard corals with other reefs in the Indo-Pacific region. All coral taxa recorded at Scott Reef are predominately widespread Indo-Pacific species that have clear affinities with coral assemblages of Ashmore Reef and the Indonesian provinces to the north. Mass spawning of corals at Scott Reef occurs twice a year, unlike single mass spawning events at most other reefs around Australia (Gilmour et al. 2009a, 2009c).

Scott Reef coral communities are largely self-seeded and rely on nearby coral areas to maintain populations and facilitate recovery following disturbances such as coral bleaching or cyclones. Furthermore, genetic research suggests that corals in shallow water habitats (less than 30 m) may tend to rely on corals from the same shallow water habitat as a source of larvae during recovery following disturbances, rather than on corals in deep lagoonal areas (greater than 30 m depth), which were found to be genetically highly distinct (Cooper et al. 2009).

Five species of seagrass have been recorded at low abundance at Scott Reef, all of which occur widely throughout the Indo-Pacific region (URS 2006). Seagrasses recorded by Skewes et al. (1999) in less than 15 m depth covered a total of 23 ha (0.22%) at North Scott Reef, and 77 ha (0.54%) at South Scott Reef.

A total of 121 algal species have been reported from Scott Reef, however, there is likely to be a number of species yet unrecorded (WAM 2009; SKM 2009). Two surveys of macroalgae at Scott Reef in 2006 found general algal cover to be between 5 and 10% in shallow and intertidal areas, although this was highly variable with some areas approaching 100% cover (WAM 2009). Species composition at Scott Reef was similar to that of Seringapatam Reef and the Rowley Shoals.

Scott Reef also supports abundant populations of sponges, crustaceans and echinoderms. A study at Scott Reef in 2006 collected 96 sponge species, with 46 unique to Scott Reef, and although low sponge density was observed, biodiversity was noted to be high (Gilmour et al. 2013a; Gilmour et al. 2013b; WAM 2009). A ROV inspection of outer-reef habitats of Scott Reef in deep waters recorded sponges from all outer-reef slope habitats (URS 2007b). Sponges were common at the lower slope, boulder zone and rampart habitat units of the outer-reef habitats.

A study by WAM (2009) identified 105 and 63 crustacean species at South and North Scott Reef (10 and 14 survey stations respectively). Crustaceans were identified as the fifth most abundant phylum recorded in benthic habitat surveys of the deep-water sands in the south-east of South Scott Reef Lagoon (URS 2007c). No invasive crustacean species have been identified during surveys at Scott Reef (SKM 2009).

At Scott Reef, the richest area for molluscs was identified to be the lower intertidal area on Sandy Islet (Wells & Slack-Smith 1986). A total of 221 mollusc species were identified from South Reef (14 survey stations) and 183 species from North Reef (10 survey stations) (WAM 2009). A survey of the deep-water sand habitats of the south-east inner reef edge at South Scott Reef found molluscs (bivalves and gastropods) to be among the most abundant phyla. Deep seabed ROV transects conducted around Scott Reef and in the channel between North and South Scott Reef did not report any significant numbers of macro-molluscs (URS 2007b).

Marsh (1986) recorded a total of 117 echinoderm species from Scott and Seringapatam reefs indicating that echinoderms are widespread across all Scott Reef habitats. Recent surveys have recorded fewer echinoderm species although did not employ comparable sampling methods or effort (URS 2006; WAM 2009). Scott Reef has been surveyed for IMS and no invasive echinoderm species were identified (SKM 2009).

7.2.3 Existing Pressures on the Benthic Communities and Habitats of the Proposal Area

There are no existing developments in the vicinity of the Proposal Area. Furthermore, the Scott Reef system in the Proposal Area is largely unaffected by many of the anthropogenic stressors that affect coral reefs close to the coast due to its isolation, distance from shore and the absence of human settlement (Gilmour et al. 2013b). However, the ecological environment of the Proposal Area is not without exposure to physical disturbances and pressures, including:

- *Tropical cyclones* – Tropical cyclones represent a major natural source of disturbance to shallow biological environments in the Region. At Scott Reef, ongoing long-term monitoring programs have documented the large scale reduction in coral cover and recovery at shallow water habitats following passage of Category 5 cyclones. Cyclones have also been documented as responsible for large scale erosion and size reduction of Sandy Islet.
- *Anomalous sea surface temperatures* – At Scott Reef, ongoing long-term monitoring programs have documented wide scale coral bleaching and associated mortality attributed to prolonged exposure to naturally elevated water temperatures.
- *Disease* – Natural outbreaks of coral disease have been documented at Scott Reef, representing an ongoing pressure on coral communities.
- *IMS* – Although there are no records of IMS occurring at Scott Reef (SKM 2009), as with all Australian waters, the threat of introduction and spread of IMS by marine users remains an ongoing pressure.
- *Climate change* – Increases in seawater temperature and ocean acidification associated with climate change are acknowledged emerging pressures particularly to coral growth rates.

7.3 Sources of Potential Impacts

Table 7.1 summaries the sources of potential impact to benthic communities and habitats from the Proposal.

Table 7.1 Sources of Potential Impacts to Benthic Communities and Habitats from the Proposal

Aspect	Source (Activity and/or Infrastructure)	Proposal Phase[1]					Potential Impact
		Dr	I	C	O	De	
Seabed disturbance	Installation of subsea infrastructure		✓				Direct loss of benthic habitats. Increase in suspended sediments resulting in smothering of benthic communities and secondary impacts to benthic habitats from increased turbidity.
	Seabed preparation, trenching and secondary stabilisation		✓				
	Anchoring or mooring of drill rig and vessels	✓	✓			✓	
Physical presence of infrastructure	Permanent presence of subsea infrastructure				✓		Creation of artificial habitat and modification of existing habitat (including from the potential alteration of sediment particle size characteristics of seabed sediment).
Planned discharges	Discharge of drill cuttings and fluids generated during drilling of wells	✓					Smothering of benthic communities and habitats from the discharge of drill cuttings and fluids. Decline in sediment quality associated with de-oxygenation of

Aspect	Source (Activity and/or Infrastructure)	Proposal Phase[1]					Potential Impact
		Dr	I	C	O	De	
							seabed sediment, with associated secondary impacts to benthic communities. Potential toxicity effects on benthic communities.
	Discharge of subsea control fluid at the seabed				✓		Decline in local water and sediment quality, with potential impacts to benthic communities.

[1] Dr = Drilling; I = Installation; C = Commissioning; O = Operation; De = Decommissioning

Note: No credible interactions are anticipated for infrequent monitoring and maintenance of subsea wells and infrastructure during the operation phase (Figure 5.1).

7.4 Characterisation and Assessment of Potential Impacts

Habitats in WA's Marine Environment (EAG 3; EPA 2009) have been taken into account in the assessment of the significance of impacts to benthic communities and habitats within the Proposal Area. However, the only direct impacts to benthic communities and habitats from Proposal activities will occur in the deep waters of the Proposal Area (350 - 600 m), which are well below the depth limit for benthic primary producers (BPPs). While indirect impacts to BPPHs at Scott Reef from Proposal activities are considered in the assessment, irreversible loss and/or serious damage to habitats as defined in EAG 3 are not expected.

7.4.1 Seabed Disturbance

Seabed disturbance as a result of Proposal activities will occur from direct placement of subsea infrastructure, seabed preparation works and anchoring or mooring of vessels and the drill rig.

Subsea infrastructure will cover a total area of approximately 8 ha and will represent a loss of benthic habitat and associated communities in this area. In addition, seabed preparation, trenching and secondary stabilisation may be required along the flowline route at the western entrance of the Scott Reef channel, resulting in the potential for further indirect impacts to habitat as a result of the suspension and subsequent deposition of sediments in the vicinity of these activities. However, as seabed sediments in the channel primarily comprise coarse material (sand and gravel), the majority of sediments suspended during these activities are expected to rapidly settle on the seabed within or relatively close to the area of disturbance.

Seabed disturbance due to anchoring or installation of moorings will be temporary and of small scale. The majority of installation and support vessels will use dynamic positioning systems to maintain position as the Proposal Area is generally too deep for most vessels to anchor (greater than 350 m) with anchoring activities generally limited to the drill rig. If used, deployment of anchors for the drill rig will be undertaken by support vessels, further reducing the area of disturbance by minimising anchor drag. Should piling be required to secure the drill rig mooring lines, suction piling is the preferred method (refer to the 'Mitigation and Management' for 'Underwater Noise' in Table 8.7). Benthic habitat survey data will be assessed to avoid high value habitats when selecting anchoring and/or mooring locations to minimise potential seabed disturbance. Following removal of anchors, disturbed seabed areas will be available for recolonisation by benthic organisms.

Benthic habitats in the deep waters of the Proposal Area appear to support sparse sessile epifauna and burrowing infauna, and the areas of affected habitat are expected to be similar to surrounding contiguous seabed areas. As such, potentially impacted benthic habitats and associated benthic communities are well represented in the region. Loss of habitat and/or

localised disturbance from the installation of subsea infrastructure, seabed preparation and anchoring/mooring will represent a very small fraction of the widespread available habitat. The loss of benthic habitat may be also partially compensated by creation of artificial habitat from installation of subsea infrastructure, which may be colonised by epifaunal organisms.

No subsea infrastructure installation, seabed preparation, trenching and secondary stabilisation activities or anchoring / mooring of installation/decommissioning vessels or drill rigs will occur in the shallower water habitats (< 70 m) of Scott Reef. Direct impacts to benthic communities or habitats from seabed disturbance are therefore avoided. Indirect impacts from suspended sediments and subsequent sediment deposition as a result of seabed preparation, trenching and secondary stabilisation activities in the Scott Reef channel (if required) are also not expected to impact the adjacent reef. As described above, seabed sediments within the channel are primarily comprised of coarse material (sand and gravel) and are therefore likely to rapidly settle on the seabed within or relatively close to the area of disturbance. Furthermore, due to strong stratification in the water column, water masses deeper than 200 m within the Scott Reef channel are unlikely to be upwelled and reach Scott Reef (Brinkman et al. 2009). As these activities will occur in water depths greater than 350 m, sediment suspended at the seabed is not expected to reach coral habitats at Scott Reef.

7.4.2 Physical Presence of Infrastructure

Subsea infrastructure has the potential to act as artificial habitat through the provision of hard surfaces for the settlement of marine organisms that would not otherwise be successful in colonising the area. Modification of existing habitat, such as a shift between sand and gravel substrate on the seabed to the hard substrate of installed subsea infrastructure can lead to an alteration of faunal and floral assemblages. However, as epibenthic fauna in the Proposal Footprint is sparse and of low diversity, the creation of artificial habitats is not likely to significantly alter the local community structure.

Impacts to benthic communities and habitats within the deep waters of the Proposal Footprint from physical presence of infrastructure are expected to be minor and localised to the immediate vicinity of the subsea infrastructure which is located in water depths of greater than 350 m. No impacts to the benthic communities and habitats of Scott Reef are anticipated.

7.4.3 Drill Cuttings and Fluid Discharge

The discharge of drill cuttings and fluids has the potential to smother benthic communities, and cause toxic effects to and/or alter the composition of benthic communities by changing the sediment particle size characteristics and de-oxygenating seabed sediment.

Modelling of the fate and dispersion of drill cuttings discharge at the TRE and the TRD drill centres has been undertaken to understand the potential for discharges to impact sensitive benthic habitats at Scott Reef. As explained in Section 6.4.2, both surface and seabed discharges were modelled with a key objective of the modelling being to understand the potential for sedimentation impacts to coral habitats at Scott Reef from the surface discharge of drill cuttings and fluids.

As described in Section 6.4.2, modelling indicated that a sea surface discharge of drill cuttings generated at the TRE and TRD drill centres would result in incursions of sediment plumes and associated increased sedimentation at some parts of North and South Scott Reef including within the lagoons. Conversely, a seabed discharge would result in sediment plumes and associated deposition of sediment being confined to the deep layers of the water column with no impact on deep or shallow water coral habitats at Scott Reef.

Woodside intends to adopt an adaptive management approach for the disposal of drill cuttings from the Proposal in recognition of the sensitivities of Scott Reef coral communities to sedimentation. This adaptive management approach is centred on the use of modelling to

determine the most appropriate method for drill cuttings disposal at each drill centre. This modelling would be undertaken during the detailed planning for drilling at each well centre and documented in the Environment Plan(s) relevant to the drilling activity. As such, no impacts to Scott Reef benthic habitats and communities are anticipated from the discharge of drill cuttings and fluids and the following assessment focuses on potential impacts to deep water benthic habitats in proximity to the drill centre locations.

Sediment Deposition

Following the discharge of drill cuttings and fluids, the coarser fractions (sand and gravel-sized particles) which comprise the majority of the drill cuttings, will rapidly settle to the seabed. This has the potential to have lethal and sub-lethal impacts to sessile benthic marine organisms, resulting in temporary loss of benthic communities and altered community structure. Sedimentation may also affect the grain size of bottom sediments resulting in changes in benthic community composition. However, sedimentation footprints associated with subsurface discharge of drill cuttings, show that away from the immediate area surrounding the discharge points, sedimentation loading over the course of the drilling program are low, equating to a thin layer of settled drill cuttings which are likely be naturally reworked into surficial sediment including by bioturbation (US EPA 2000). Sediment depositional impacts due to subsurface discharge are therefore expected to be highly localised to the drilling locations. Given that benthic infauna and epifauna are known to recover relatively quickly and affected areas of the seabed support a low density of common and widespread benthic fauna that are well represented across the wider area, the impact to benthic communities as a result of sediment deposition from drill cuttings discharge is expected to be minor.

Potential Oxygen Reduction in Sediments

WBF or NWBF may be used as drill fluids for the Proposal. Once deposited to the seabed, the microbial decay of the organic content of NWBF, a synthetic organic-based fluid, requires oxygen and may reduce oxygen levels in the top layer of the cuttings pile. If NWBF is used, this may therefore lead to secondary impacts to marine benthic communities if oxygen concentrations decline to levels where hypoxic or anoxic conditions form. This effect may be exacerbated as deposition of fines (silt and clay) can reduce pore water exchange occurring at the sediment water interface.

The surface layers of the cuttings pile, deposited immediately around the well, will prevent oxygen and other seawater constituents from penetrating to the layers below (UKOOA 2002). A lack of oxygen within the deeper layers of these accumulations reduces or inhibits biodegradation. De-oxygenation of the sediments, driven by the degradation of NWBF, is likely to be the main factor in determining potential impacts to benthic infauna. However, given that the volume of sediment contributing most to the cuttings pile will stem from top hole section drill cuttings composed of seawater with sweeps, there will be only limited potential for the long-term de-oxygenation of a localised seabed area affected by the cuttings pile formation around the well hole.

Potential Toxicity Effects

Large sections of the wells will be drilled using seawater and bentonite clay, which is inert and hence non-toxic. Only deeper sections may require NWBF. After treatment, cuttings will only contain 5-25% WBF and 5-10% NWBF. The fluids selected will meet the toxicity rating of ‘non-toxic to slightly toxic’ and if NWBF is used, residual fluids will be limited to up to 10% residual oil on cuttings. Additionally, rapid dilution within metres of the release point is expected. Subsequently, the potential for toxicity effects to benthic organisms is expected to be very minor and localised given the toxicity rating of the drill cuttings, the nature of dispersion and the rapid dilution.

7.4.4 Subsea Control Fluid Discharge

If discharged, subsea control fluid has the potential to reduce local water and sediment quality and result in secondary impacts to the local benthic communities and habitats. As described in Section 6.4.4, the non-routine intermittent discharge of small volumes of low toxicity subsea control fluid is predicted to result in only a minor, localised and temporary change in water quality in the deep waters of the Proposal Area (> 350 m depth). Given that seabed sediments surrounding the subsea infrastructure support sparse and scattered epifauna which are common to the surrounding Region, and given the low volumes of discharge (some of which will be intermittent) and the rapid dilution expected, no significant impacts on benthic communities and habitats are expected.

7.5 Mitigation and Management

Mitigation and management measures relevant to benthic communities and habitats are listed in Table 7.2.

7.6 Expected Environmental Outcome

The results of the assessment and the expected environmental outcome is summarised in Table 7.2.

Table 7.2 Summary of Likely Impacts on Benthic Communities and Habitats and Expected Environmental Outcomes

Existing Environment	Aspect	Likely Environmental Impacts	Mitigation and Management	Expected Environmental Outcome
EPA Objective: ***To maintain the structure, function, diversity, distribution and viability of benthic communities and habitats and local and regional scales***				
Seabed sediments within the Proposal Footprint comprise well-rounded cobble/ rubble, very coarse shell fragments and/or soft sediments. Benthic habitats and communities in these locations comprise generally sparse and scattered epifauna and burrowing infauna, consisting of a variety of common and widespread taxa. No seagrasses and limited macroalgae and coral (soft and hard) occur in the Proposal Footprint due to water depth and lack of hard substrate. Sponges may occur within the Proposal Footprint, but if present, are anticipated to be sparsely distributed, particularly in the channel between North and South Scott Reef due to the strong currents within the channel. The Proposal Area also encompasses Scott Reef, which supports abundant populations of hard and soft corals, sponges, crustaceans and echinoderms. Mass spawning of corals at Scott Reef occurs twice a year. Five species of seagrass occur but in low abundance.	Seabed disturbance	Benthic communities in and around the Proposal Footprint will be impacted from direct placement of subsea infrastructure, seabed preparation works and anchoring/mooring of vessels and the drill rig. Impacts to benthic habitats through direct disturbance and/or indirect smothering are confined to an area of approximately 8 ha of the Proposal Footprint at water depths greater than 350 m. Potentially affected biota regionally well represented; any losses represent a small fraction of widespread available habitat and disturbed areas likely to recolonise following completion of seabed preparation, installation, drilling and future decommissioning activities. Due to the siting of infrastructure in deepwater, no adverse direct or indirect impacts to shallow water (< 70 m) benthic habitats of Scott Reef are likely.	The location of subsea infrastructure, in particular flowlines, has been selected to limit seabed preparation, trenching and secondary stabilisation requirements to the level necessary to ensure pipeline integrity. If used, drill rig anchors will be deployed and retrieved using support vessels in order to minimise anchor drag. Benthic habitat surveys have been undertaken at subsea infrastructure locations to identify unique or sensitive habitats and biota and high value habitat for marine fauna has been avoided where practicable in the design process. No permanent moorings will be installed within the lagoon at North and South Scott Reef.	Any potentially significant impacts to benthic communities and habitats have been avoided through selecting FLNG as a development concept (i.e. no requirement for processing infrastructure on Scott Reef – see Table 1.1) and siting infrastructure in deep waters off Scott Reef. The remaining potential for impact to sensitive benthic communities and habitats has been avoided through proposed mitigation, including adoption of a precautionary approach to the management of drill cuttings and fluid discharges. As a result, impacts on benthic habitats and communities are likely to be restricted to within and around the Proposal Footprint, an area of approximately 8 ha. Affected biota are sparsely distributed in this deepwater environment (> 350 m) and consist of common and widespread taxa. As such, no significant adverse impacts on the structure, function, diversity, distribution and viability of benthic communities and habitats in the Proposal Area or beyond are likely and the environmental objective is met. In activity-specific Environment Plan(s) required under other regulatory processes, Woodside will be required to demonstrate that impacts to benthic communities and habitats are acceptable and ALARP. Implementation of the mitigation and management measures committed here is therefore assured.
	Physical presence of infrastructure	Highly localised creation of artificial habitat on subsea infrastructure in Proposal Footprint (~ 8 hectares (ha)). As epibenthic fauna in this area is sparse and of low diversity; local benthic community structure is not likely to be altered significantly. Due to the siting of infrastructure in deepwater (> 350 m), no adverse impacts to benthic habitats of Scott Reef are likely.	Benthic habitat surveys have been undertaken at subsea infrastructure locations to identify unique or sensitive habitats and biota and high value habitat for marine fauna has been avoided where practicable in the design process.	
	Drill cuttings and fluids discharge	Drill cuttings and fluid discharges from the three drill centres will smother benthic communities and may cause toxic effects to and/or alter the composition of benthic communities. Modelling has been undertaken to understand the likely dispersion of drill cuttings discharges. Given the adaptive management approach that is proposed for drill cuttings and fluids discharges (refer to Table 6.2), sediment depositional impacts, and any potential toxicity impacts, are expected to be highly localised around the drill centres and of minor consequence. Potentially affected biota are sparse and regionally well represented and are known to recover relatively quickly. Given the deepwater location of drill centres, no significant effect to habitats of Scott Reef are likely.	Refer to Table 6.2 for mitigation and management measures for drill cuttings and fluids discharges.	
	Subsea control fluid discharge	If discharged, small volumes of low toxicity subsea control fluid is likely to dilute rapidly (Table 6.2) therefore any impact on benthic communities is likely to be highly localised around the subsea valves. Potentially affected benthic communities are sparsely distributed and regionally well represented. No significant loss of benthic communities is therefore likely. No adverse impact to benthic habitats of Scott Reef is likely.	Refer to Table 6.2 for mitigation and management measures for discharges of subsea control fluids.	

8. Marine Fauna

8.1 EPA Objective

To maintain the diversity, geographic distribution and viability of fauna at the species and population levels[1].

8.2 Existing Environment

A detailed description of the marine fauna that may be present in and around the Proposal Area, including a discussion of their diversity, geographic distribution and life stages is provided in Section 6.3 of the Browse FLNG Development Draft EIS. A summary is presented below.

8.2.1 Fish

Within the Proposal Area, fish assemblages occupy a diverse range of habitats, typical of the fish communities and species represented in the Timor Province.

Scott Reef and its environs support a diverse range of fish assemblages in both shallow and deeper waters. Fish assemblages at Scott Reef may be classified into two categories: shallow water fish communities (0–20 m), and deeper water fish communities (greater than 20 m). Based on surveys undertaken by WAM in 2006 and 2009, the overall composition of shallow water fish fauna at Scott Reef is generally similar to that of oceanic reefs in the tropical Indo-west Pacific, with a stronger affinity to the islands of eastern Indonesia than to the adjacent Australian mainland. Field data collected for the deeper water fish communities found that herbivorous and corallivorous families were widespread.

Based on database searches (Section 5.2), two species of fish listed under the WC Act may be found in the Proposal Area (Table 8.1).

Table 8.1 WC Act Listed Fish Species Potentially Occurring in the Proposal Area

Common Name	Scientific Name	WC Act Status	EPBC Act Status	International Union for the Conservation of Nature (IUCN) Red List Status
Whale Shark	*Rhincodon typus*	Other Protected Fauna	Vulnerable/ Migratory	Vulnerable
Great White Shark	*Carcharodon carcharias*	Vulnerable	Vulnerable/ Migratory	Vulnerable

Whale Sharks

There is a general lack of knowledge on many aspects of whale shark biology, including definitive migration patterns. They are normally oceanic and cosmopolitan in their distribution and are known to aggregate in the reef front waters adjacent to the Ningaloo Reef, over 1000 km to the south of the Proposal Area, between March-June (Colman 1997; Wilson et al. 2006). Preliminary research on the migration patterns of whale sharks in the western Indian Ocean, and isolated and infrequent observations of individuals, indicate that a small number of the WA population migrate through the wider vicinity of the Proposal Area (Jenner et al.

[1] This section addresses potential impacts to pelagic marine fauna including marine mammals, turtles, birds and fish. Potential impacts to benthic communities and habitat is addressed in Section 7.

2009; Meekan and Radford 2010; McKinnon et al. 2002; Wilson et al. 2006). Whale sharks from Ningaloo Reef fitted with satellite trackers were observed to travel either north-east towards Timor Leste, or north-west towards the Indonesia islands of Sumatra and Java, with some individuals passing through the broad vicinity of Scott Reef (McKinnon et al. 2002, Wilson et al. 2006, Meekan and Radford 2010). Aerial (Jenner and Jenner 2009a; RPS 2010b, 2011b) and vessel (Jenner and Jenner 2009b; Jenner et al. 2009) surveys conducted in 2008 and 2009, involving over 1000 hours of observer effort, recorded one whale shark in 2008 and two whale sharks in 2010 in the Browse Basin (Jenner et al. 2009 and RPS 2011a respectively).

Great White Shark

The great white shark is found in and around the southern Australian coast from central Queensland to north-western Australia (DOE 2014a). Great white sharks are capable of crossing ocean basins, although are more frequently found from close inshore habitats (e.g. rocky reefs and shallow coastal bays) to the outer continental shelf and slope areas, with the majority of occurrences recorded between the shore and the 100 m isobath (DOE 2014a).

8.2.2 Reptiles

Marine Turtles

Marine turtles are long-lived and may take between 20 and 50 years to reach sexual maturity (Miller 1997). They display similar life cycle characteristics, including migration from foraging areas to mating and nesting areas. With the exception of flatback turtles, all species have an oceanic pelagic stage before they move into coastal or nearshore waters to begin their breeding cycles. Habitat-use varies and is dependent on the stage of the life-cycle.

The North-west Marine Region is considered to be significant for marine turtles, supporting large feeding and nesting populations of green, flatback, hawksbill and loggerhead turtles (Limpus 2007, 2008, 2009; Pendoley 2005; RPS 2010c).

Based on database searches (Section 5.2), six threatened and/or migratory marine turtle species may potentially be encountered in the Proposal Area (Table 8.2). Of the marine turtle species identified in Table 8.2, the species most likely to be encountered in the Proposal Area is the green turtle; Sandy Islet is a known nesting site for this species. Only one instance of a hawksbill turtle nesting on Sandy Islet has been recorded in during four years of monitoring (Guinea 2010). The diversity, distribution and life patterns of the green turtles of Scott Reef are outlined below.

No turtle feeding and nesting habitats are likely to be present in the Proposal Footprint due to the lack of suitable habitats in the deep water environment (> 350 m deep).

Table 8.2 WC Act-Listed Marine Turtle Species Potentially Occurring in the Proposal Area

Common Name	Scientific Name	WC Act Status	EPBC Status	IUCN Red List Status
Loggerhead turtle	*Caretta caretta*	Endangered	Endangered/ Migratory	Endangered
Green turtle	*Chelonia mydas*	Vulnerable	Vulnerable/ Migratory	Endangered
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable	Vulnerable/ Migratory	Critically Endangered
Flatback turtle	*Natator depressus*	Vulnerable	Vulnerable/ Migratory	Data Deficient
Olive Ridley turtle	*Lepidochelys olivacea*	Endangered	Endangered/ Migratory	Vulnerable

Common Name	Scientific Name	WC Act Status	EPBC Status	IUCN Red List Status
Leatherback turtle	*Dermochelys coriacea*	Vulnerable	Endangered/ Migratory	Vulnerable

Green turtles are known to forage in shallow benthic habitats including tropical tidal and sub-tidal coral and rocky reef habitat or inshore seagrass beds, feeding on seagrass beds or algae mats (DOE 2014c). Genetic studies of the WA population indicate that the nesting population of the Scott Reef-Browse Island area is generically discrete and is geographically isolated from other genetic stocks (FitzSimmons & Jensen 2008; Pendoley 2005).

The Browse JV Participants have supported studies of green turtles at Scott Reef (detailed in Guinea 2010), including nesting turtle surveys on Sandy Islet, in-water surveys of inter-nesting habitat by vessel and manta-board tow, and satellite tagging. Between 2006 and 2010 six nesting turtle surveys have been conducted at Sandy Islet, totalling 43 nights of effort.

Migration and movement of turtles is seasonal at Scott Reef, and survey data indicates that the summer months from late November to February are the preferred breeding season (Guinea 2010). Turtle numbers at Scott Reef are seen to increase during the nesting season, with aggregations in shallow reef habitat bordering Sandy Islet. Green turtles return to nest at Sandy Islet every three to six years on average (Gilmour et al. 2013b).

There is currently insufficient data to estimate population abundance; however preliminary data from tagging and mark/recapture of individuals suggests that the total nesting green turtle population at Scott Reef is between 389 and 1,476 (Guinea 2010). However, this population is not large compared to that of the Lacepede Islands, and other rookeries in WA (Guinea 2009, 2010). The mean number of nests per night has been observed to range from 2.0 + 1.0 (August 2008) to 29.1 + 4.5 (January 2009). Data obtained on hatching and emergence success was seen to be consistent with that of other rookies in northern Australia (Guinea 2009, 2010).

Green turtles nesting on Sandy Islet have an estimated 20 km inter-nesting buffer (Commonwealth of Australia 2012), located primarily to the south and west of Sandy Islet over sandy substrates, with a sand patch at the southern end of Sandy Islet Reef appearing to function as an inter-nesting area of some significance (Guinea 2009, 2010). Satellite tracking of 12 individuals found the majority of the tagged turtles to stay within 3 km of Sandy Islet during inter-nesting, although two individuals travelled approximately 15 km south to the lagoon edge of South Scott Reef (Guinea 2011). The satellite transmitters revealed re-nesting intervals to vary from 8 to 14 days.

A satellite tracking study of 12 turtles from Scott Reef in February 2010 recorded six post-nesting individuals migrating eastwards along the northern Australian coast, and two migrating south to Port Hedland (Guinea 2011).

Small and low-lying, Sandy Islet is susceptible to the effects of tides, currents, waves and storms. In March 2004, cyclone Fay caused extreme waves and storm surges that eroded Sandy Islet, reducing its size by approximately one-third (Gilmour et al. 2013b). Many eggs incubating on the island at this time may not have survived and, in the aftermath of the cyclone, nesting space would have been limited.

Sea Snakes

Surveys undertaken at Scott Reef found sea snake densities to be patchy and varied from zero to 5.3 individuals per hectare, with no peak activity periods identified (URS 2006, 2007c). No areas of Scott Reef were identified as supporting large sea snake aggregations or critical habitats for juveniles and adults; in general, juveniles and adults shared the same reef habitats.

One threatened sea snake species was identified by the database searches undertaken for this referral as being present or having species habitat within the Proposal Area (Table 8.3).

Table 8.3 WC Act Listed Sea Snake Species Potentially Occurring in the Proposal Area

Common Name	Scientific Name	WC Act Status	EPBC Status	IUCN Red List Status
Short-nosed sea snake	*Aipysurus apraefrontalis*	Critically Endangered	Critically Endangered	Critically Endangered

The short-nosed sea snake is endemic to WA and is considered to have a highly restricted distribution, confined mainly to regional offshore reefs. A survey of Sahul Shelf sea snakes in 1974 that included Scott, Ashmore, Cartier and Hibernia Reefs only recorded the short-nosed sea snake at Ashmore and Hibernia Reefs (Minton & Heatwole 1975). The short nosed sea snake was common at Ashmore Reef in surveys between 1994 and 2005, but over the past several years has become scarce despite a five-fold increase in survey efforts (DOE 2014d). Comprehensive surveys of sea snakes at Scott Reef in February, September and November 2006 similarly did not observe the short-nosed sea snake (URS 2006, 2007a). As such, the species is not considered likely to occur in the Proposal Area.

8.2.3 Seabirds and Migratory Shorebirds

Seabirds include pelagic and coastal species that will generally forage offshore and spend considerable periods at sea. Non-breeding birds will generally only gather outside the breeding season in areas where prey species are densely aggregated.

Shorebirds are generally associated with wetland or coastal environments used for feeding, nesting and/or migratory stopovers. In coastal environments, shorebirds generally feed during low tide on exposed intertidal mudflats and find areas in which to roost at high tide.

Many species of seabirds and migratory shorebirds will undertake annual migrations over thousands of kilometres. Due to the broad geographical ranges of seabirds and migratory shorebirds, many of the species in the Region have the potential to occur in the Proposal Area. There is no emergent land to support nesting or roosting birds in the Proposal Footprint, as such activities will be restricted to foraging.

Seabirds

The seabird fauna for the North-west Marine Region consists of tropical and sub-tropical breeding species and non-breeding migrants. Surveys around Ashmore Reef, Seringapatam Reef, Scott Reef and the wider Browse Basin region identified 26 species of seabird (Jenner et al. 2009; Milton 1999; Smith et al. 2004; WAM 2009).

Seabirds around Scott Reef are predominately associated with Sandy Islet, and occur in small numbers in comparison to other breeding and roosting sites in the Region. Seabird surveys conducted at Scott Reef observed greater numbers of birds during spring than winter (Jenner et al. 2009). Crested terns, brown boobies and common noddies are among the dominant species (Jenner et al. 2009; Smith et al. 2004; WAM 2009). Smith et al. (2004) carried out a survey at Scott Reef in 2003, finding that all species recorded from Scott Reef are previously known from northern Australian waters.

Based on database searches conducted for this referral (Section 5.2), one seabird species listed under the WC Act was identified as potentially occurring or having habitat that occurs within the Proposal Area (Table 8.4). The Australian lesser noddy is usually only found around its breeding islands at the Houtman Abrolhos Islands and possibly on Ashmore Reef in WA (Storr et al. 1986). It usually occupies white mangrove-fringed coral-limestone islands

and occasionally occurs on shingle or sandy beaches (Higgins & Davies 1996). Foraging may occur well out to sea (Johnstone & Storr 1998; Storr et al. 1986) or in seas close to breeding islands and fringing reefs (Storr et al. 1986; Whittell 1942).

Table 8.4 WC Act Listed Seabird and Migratory Shorebird Species Potentially Occurring in the Proposal Area

Common Name	Scientific Name	WC Act Status	EPBC Status	IUCN Red List Status
Australian Lesser Noddy	*Anous tenuirostris melanops*	Endangered	Vulnerable / Marine	Not Assessed
Lesser sand Plover	*Charadrius mongolus*	Endangered	Marine / Migratory	Least Concern

Migratory Shorebirds

Migratory shorebirds are occasionally observed in very low numbers at Scott Reef, and Sandy Islet may be used as a resting point during migrations. However, given its small size, Sandy Islet is unlikely to support large numbers of migratory shorebirds en-route to the key mainland sites (Roebuck Bay or Eighty Mile Beach) or islands such as Barrow Island. One species of migratory shorebird, listed under the WC Act, may potentially occur at the Proposal Area (Table 8.4). In WA, the lesser sand plover is found mainly between Port Hedland and Broome and breeding is not known to occur in Australia. At non-breeding grounds in Australia, this species usually occurs in coastal littoral and estuarine environments. Feeding habitat includes freshly-exposed areas of intertidal sand flats and mudflats in estuaries or beaches (DOE 2014e). Roosting habitat includes beaches, banks, spits and banks of sand or shells, and occasionally on rocky spits, islets or reefs in proximity to foraging areas (DOE 2014e).

8.2.4 Marine Mammals

Marine mammals have wide distributions that are associated primarily with seasonal feeding and migration patterns that are linked to their reproductive cycles. A total of 27 cetacean species are known to occur in the Region, including two threatened, and three priority listed cetacean species under the WC Act that may potentially be encountered in the Proposal Area (Table 8.5).

Table 8.5 WC Act Listed Marine Mammal Species Potentially Occurring in the Proposal Area

Common Name	Scientific Name	WC Act Status	EPBC Status	IUCN Red List Status
Blue whale	*Balaenoptera musculus*	Endangered	Endangered/ Migratory	Endangered
Humpback whale	*Megaptera novaeangliae*	Vulnerable	Vulnerable/ Migratory	Least Concern
Sperm whale	*Physeter macrocephalus*	Priority 4	Migratory	Vulnerable
Australian snubfin dolphin	*Orcaella heinsohni*	Priority 4	Migratory	Near Threatened
Spinner dolphin	*Stenella longirostris*	Priority 4	Cetacean	Data Deficient

Blue Whales

There are two recognised sub-species of blue whale in Australia; the 'true' blue whale (*Balaenoptera musculus intermedia*) and the 'pygmy' blue whale (*Balaenoptera musculus brevicauda*). Both sub-species are long-lived, with the true blue whales living up to 90 years and the pygmy blue whales to approximately 50 years (DOE 2014f). Based on the migration patterns, only the pygmy blue whale has the potential to be encountered in or around the Proposal Area.

Pygmy blue whales travel north along the coast from the Perth Canyon, passing the latitude of Exmouth and then Scott Reef between April and August before continuing north toward Indonesian waters. Data from noise loggers set along the WA coast and satellite tagging studies indicate that the majority of pygmy blue whales that migrate through the vicinity of the Proposal Area pass through deep water near the edge of the continental shelf to the west of Scott Reef, with a relatively small proportion passing through or in close proximity to the reef (McCauley 2011, Double et al. 2014). Noise loggers have detected low numbers of pygmy blue whales in the channel between North and South Scott Reef, but animals have not been detected inside the lagoon of South Reef, suggesting that individuals rarely enter the reef lagoon system (McCauley 2011).

North-bound pygmy blue whales have been detected to pass Scott Reef over a period of 135 days between early-April and mid-August, peaking between mid-May and mid-June (McCauley 2009, 2011). Animals travel south passing the latitude of Scott Reef from late October to late December, with most individuals passing over a period of approximately 50 days between late-October and early-December.

Humpback Whales

Humpback whales migrate annually between summer feeding grounds in Antarctica and tropical breeding aggregation areas in winter. The area north of the Lacepede Islands to Camden Sound is the northern migration destination and calving ground for the WA humpback whale population. The annual migration from the summer feeding grounds in Antarctica occurs between May and October, with breeding and calving taking place in the vicinity of Camden Sound (approximately 300 km east of the Proposal Area) between mid-August and early September. The southern migration peaks at the end of September, with females with calves the last to leave the breeding grounds (RPS 2010b).

The Proposal Area is located on the outer edge of the main humpback whale migration corridor, and humpback whales are therefore expected to only occasionally transit through this area. This is supported by data from noise loggers in the vicinity of Scott Reef that have detected humpback whales in low numbers, both inside and outside the reef, from late June to mid-October (2006-2009) (McCauley 2011). Aerial surveys conducted at Scott Reef over the migration season in 2009 and 2010 also observed low numbers of humpback whales in the vicinity of the reef (14 and 11 individuals respectively) (RPS 2010b, 2011b). The low occurrence of humpback whales at Scott Reef in 2009 and 2010 is consistent with observations from previous surveys (Jenner et al. 2009; Jenner & Jenner 2008). It is not known whether particular whales show fidelity to Scott Reef or what other factors influence whales to visit the reef.

Sperm Whale

The sperm whale is relatively abundant from polar waters to the equator, and is found in all oceans. Although both sexes range through temperate and tropical waters, only adult males occur in the higher latitudes. Sperm whales are usually found in deep offshore waters, with higher populations densities close to continental shelves and canyons (DOE 2014j), but there is limited information on their distribution in Australian waters. No sperm whales were recorded in the Proposal Area and its surroundings during aerial and vessel surveys in 2008

or 2009 (Jenner & Jenner 2009a, 2009b; Jenner et al. 2009; RPS 2010a) or from sea noise logger recordings with the Scott Reef area from 2006 to 2009 (McCauley 2009).

Australian Snubfin Dolphin

The Australian snubfin dolphin occurs in shallow, tropical and subtropical areas up to 20 km from shore. Surveys conducted in the Proposal Area did not record any snubfin dolphins (RPS 2010a).

Spinner Dolphin

Spinner dolphins are found in tropical, subtropical and, occasionally warm temperate waters. Spinner dolphins were the most commonly encountered small cetacean during aerial and vessel surveys at Scott Reef, in a variety of water depths (RPS 2011b).

8.2.5 Existing Pressures on Marine Fauna of the Proposal Area

Many of pressures on marine environmental quality and benthic communities and habitats of the Proposal Area described in Sections 6.2.1 and 7.2.3 also have the potential to affect habitats, food availability, nesting sites and refuge for marine fauna in the Proposal Area. Additional pressures on marine fauna of the Proposal Area include:

- *Current and previous commercial fishing activities, including Indonesian fishers* – The Proposal Area, including Scott Reef is subject to ongoing fishing pressure on pelagic and demersal fisheries resources, with evidence of the over-exploitation of some fisheries resources.
- *Vessel noise* – Vessel traffic from commercial fishing in the vicinity of the Proposal Area represents short-lived noise sources.
- *Oil and gas exploration activities* – Exploration activities including seismic surveys and exploratory drilling by the oil and gas sector have previously occurred within and around the Proposal Area, representing short-lived noise sources and localised seabed disturbance.

8.3 Sources of Potential Impact

Table 8.6 summarises the sources of credible impact to pelagic marine fauna from the Proposal.

Table 8.6 Sources of Potential Impact to Marine Fauna from the Proposal

Aspect	Source (Activity and/or Infrastructure)	Proposal Phase[1]					Potential Impact
		Dr	I	C	O	De	
Physical presence	Permanent subsea infrastructure				✓		Potential behavioural changes to migratory species
Physical interaction	Vessel movements	✓	✓		[2]	✓	Potential collision with marine fauna
Artificial light	Drill rig and vessels	✓	✓		[2]	✓	Localised behavioural disturbance (attraction/ repulsion, disorientation) to turtles
Underwater noise	Drill rig, vessels and choke valves at the subsea wellheads	✓	✓	✓	✓	✓	Potential behavioural disturbance to marine fauna
IMS	Vessel and rig movements Ballast water exchange	✓	✓		[2]	✓	Predation of native species (including commercial species)

Aspect	Source (Activity and/or Infrastructure)	Proposal Phase[1]					Potential Impact
		Dr	I	C	O	De	
Planned discharges	Discharge of drill cuttings and fluids	✓					Localised change in water quality through increase in suspended sediment and chemical composition of drill fluids.
	Vessel and drill rig discharges	✓	✓		[2]	✓	Localised change in water quality in offshore open ocean waters.
	Discharge of subsea control fluids				✓		
	Discharge of hydrotest fluid			✓			Temporary decline in water quality due to discharge of oxygen depleted hydrotest fluid and associated impacts to marine fauna. Toxicity to marine fauna due to chemical additives.

[1] Dr = Drilling; I = Installation; C = Commissioning; O = Operation; De = Decommissioning

[2] No credible interactions are anticipated for infrequent monitoring and maintenance of subsea wells and infrastructure during the operation phase (Figure 5.1).

8.4 Characterisation and Assessment of Potential Impacts

8.4.1 Physical Presence of Infrastructure

Marine infrastructure will be in place during the Proposal, either on a temporary basis (e.g. drill rig and vessels), or long-term basis for the operational life of the Proposal (e.g. subsea wells, manifolds, and flowlines). Drill rigs and vessels will have a temporary presence and provide relatively small obstacles that marine fauna are likely to avoid. Anchor chains or mooring lines used for the drill rig and potentially some installation and/or decommissioning vessels are unlikely to cause entanglement of marine fauna due to the dimensions of the chains and tension loads. Subsea infrastructure is unlikely to pose a significant entanglement or collision risk to mobile marine fauna, and is highly unlikely to affect marine fauna movements given the water depths within which such infrastructure is to be located (greater than 350 m). Routine operations associated with the Proposal will also result in sensory cues sufficient for marine fauna to be aware of the presence of the infrastructure, thus minimising the risk of collision.

8.4.2 Physical Interaction

Vessel interactions with marine fauna may include vessel strike and disturbance to behavioural patterns or displacement of fauna. Vessel speed has been demonstrated as a key factor in collisions with marine fauna such as marine mammals and turtles, with faster vessels having a greater collision risk than slower vessels (Hazel et al. 2007; Laist et al. 2001; Lammers et al. 2003). Laist et al. (2001) suggest that the most severe and lethal injuries to marine mammals are caused by vessels travelling at 14 knots or faster. Given the scope and nature of Proposal activities, the majority of vessels associated with the Proposal are expected to travel at relatively slow speeds in accordance with standard maritime practices (expected to be 4 to 6 knots in Scott Reef channel and 1 to 2 knots when operating near Proposal infrastructure). Vessels transiting to and from the Proposal Area and the mainland may operate at higher speeds to meet operational requirements (e.g. personnel transfers); however such movements will not represent a significant increase in vessel traffic levels associated with the potential supply chain logistics and support location(s) (Section 3.4.7), or levels observed for the wider region.

The risk of vessel strike to marine mammals is considered low as pygmy blue whales, humpback whales and other marine mammals do not occur in large numbers in the deep waters of the Proposal Area. Where practicable, vessels will take direct routes avoiding significant areas for other marine fauna such as Sandy Islet in order to minimise potential interactions with turtles. Nevertheless, despite the mitigation and management measures proposed in Table 8.7, marine fauna interactions with vessels could occur. However, any such interactions are likely to be limited to effects on individuals and are not expected to result in impacts to the viability of populations. Potential impacts from vessel interaction with marine fauna are therefore not considered significant.

The number of helicopter flights required during drilling and installation of the Proposal will be optimised to maximise efficiency and reduce the number of flights where operationally possible. Given the high visibility and noise levels associated with helicopter movements, bird species are expected to actively avoid interaction. In addition, birds are expected to be in low numbers as the Proposal Area does not represent a significant aggregation, nesting or roosting area for seabirds and migratory shorebirds, and where flights occur in proximity of areas of known importance to marine fauna or bird species, flight paths will actively avoid these areas where practicable. Potential impacts to marine fauna from helicopters are not considered significant.

8.4.3 Artificial Light

Light emissions from the Proposal are described in Section 3.7.6. A detailed assessment of the impacts of light on marine fauna is presented in Section 10.5 of the Browse FLNG Development Draft EIS; conclusions of this assessment relevant to the scope of this referral are summarised here.

Artificial light has the potential to disrupt biological processes that rely on natural light for visual cues. Potential impacts to marine fauna from light are expected to be limited to marine turtles nesting at Sandy Islet, birds and fish.

A line of sight assessment was undertaken for the drill rig at the TRE drill centre, which is the closest development activity to Sandy Islet (ERM 2010). The assessment showed that direct light emitted from a drill rig at this location will be visible to some extent from all areas of Scott Reef, including Sandy Islet (approximately 7 km distant).

Light density levels for a drill rig at the TRE drill centre were predicted by using light density data measured during the drilling of the Torosa South-1 appraisal well, located on the edge of the South Scott Reef lagoon (ERM and SKM 2008; ERM 2010). Although the rig type for drilling is yet to be confirmed, light levels are expected to be comparable. Light density levels for a drill rig at TRE were predicted to be greater than 0.1 Lux up to 800 m from the rig, which is comparable to ambient light levels during full moon to twilight (ERM 2010). Between 800 m and 1.2 km from the drill rig, the model predicted light density levels comparable to ambient light levels during a quarter moon to full moon night sky (0.01 Lux – 0.1 Lux). Between 1.2 km and 12.6 km, light density levels were predicted to be lower than 0.01 Lux, which is comparable to ambient light density levels between a moonless clear night sky and a quarter moon. Beyond 12.6 km there was no measurable change to the background light density levels predicted.

Based on these modelling results, the maximum predicted light density levels from a drill rig at TRE reaching Sandy Islet are lower than 0.01 Lux (comparable to light levels between a moonless clear night sky and a quarter moon).

Marine Turtles

Research suggests that marine turtles are most sensitive to short-wavelength light in the near-ultraviolet to yellow region of the visible spectrum, from approximately 340 to 700 nm (Witherington and Martin 2003). Artificial lighting associated with the drill rig and vessels for the Proposal will be within the visible range for marine turtles, with the spectral signature of light emissions from the drill rig at Torosa South-1 measured to be between 530 – 620 nm.

Exposure of marine turtles to artificial light can result in changes to their natural behaviour. Light pollution on nesting beaches is particularly detrimental to marine turtles as it can alter how turtles choose nesting sites, how they return to the sea after nesting, and how hatchlings find the sea after emerging from their nests (Witherington and Martin 2003). Marine turtles predominately nest at Sandy Islet between November and February, and inter-nesting turtles have been observed to aggregate primarily in an area to the south and west of Sandy Islet (Section 8.2.2). Based on the modelling results described above, maximum predicted direct light levels reaching Sandy Islet are less than 0.01 Lux from the closest drill centre (TRE; approximately 7 km away), with light appearing as a small lit object. No disturbance to the nesting behaviour of adult marine turtles is therefore expected from direct light visible at Sandy Islet.

Adult turtles passing through the Proposal Area may temporarily alter their normal behaviour whilst attracted to the light spill from infrastructure. However, the zone of influence and subsequent attraction from direct lighting is expected to be minor and a temporary disruption to a small portion of the adult turtle population.

Hatchlings differ to adults in that they primarily use light as a cue to locate the ocean. Disoriented hatchlings may perish from exhaustion, dehydration, or predation. However, light levels of less than 0.01 Lux predicted to reach Sandy Islet from the TRE drill rig are not expected to be sufficient to alter hatchling behaviour leaving the nesting site on Sandy Islet. Furthermore, any attraction of turtle hatchlings from Sandy Islet to the infrastructure would not interrupt their seaward movement as Sandy Islet is a small, low-lying sandy cay with nearby access to the water from all directions.

There will be some short duration flaring from the drill rig (Sections 3.4.1 and 3.7.6), however, spectral analysis of flares on Thevenard Island on the North West Shelf (Pendoley 2000) suggests that flare light does not contain a high proportion of light wavelengths within the range that is most disruptive to turtles. The nearest flaring light source to Sandy Islet, the drill rig at the TRE drill centre, will be approximately 7 km away and only in that location for one or two nesting seasons. The duration of controlled flaring at the drill rig typically lasts 12 hours per well. Little disturbance to nesting adult or hatchling turtles from flaring is therefore expected.

Once in the ocean, little is known of the extent to which hatchlings still use vision over wave direction and the earth's magnetic field (Lohmann 1992) for orientation. Should hatchling turtles be attracted to lights from infrastructure, they may be more vulnerable to predators that have also been attracted by the light. However, it is thought that the vision of hatchling turtles is limited in the water and that other more dominant navigational cues take over (Lohmann and Lohmann 1992; Amos 2014). A recent pilot study supported by Woodside that used acoustic telemetry to track hatchling dispersion in relation to artificial light sources at Eco Beach, WA, found that at least in the surf zone, artificial lights did not affect movement, with the hatchlings largely travelling against the direction of wave propagation (Thums et al. 2012).

Given that the drill rig at TRE will be located approximately 7 km from Sandy Islet, attraction of turtle hatchlings is considered unlikely. However, should attraction towards the direction of the drill rig occur, the fact that surface currents in the channel where the drill rig will be located are strong (averaging approximately 0.5 knots with current speeds up to and exceeding 2 knots depending on tidal conditions), means that conditions would not be

conducive for hatchlings to linger in the vicinity of the drill rig should they reach it. It is anticipated that on reaching the channel, hatchlings would disperse rapidly with the current. There is extensive evidence that when hatchlings disperse offshore, sea surface currents have considerable effects on the dispersal process (Frick 1976; Salmon and Wykenen 1987; Liew and Chan 1995; Witherington 1995; Okuyama et al. 2009). Strong currents have been observed to affect the course of hatchling dispersion during the initial 24 hour swimming frenzy, and currents may be expected to have an even more significant influence as swimming activity later declines in duration and vigour. No significant effects to hatchlings from artificial light associated with drilling and vessel activities are therefore anticipated.

Birds

Light from the drill rig and vessels is unlikely to attract a significant number of seabirds or migratory shorebirds as Proposal activities are located a considerable distance from known key aggregation areas, such as Ashmore Reef (230 km), Roebuck Bay (370 km) and Eighty Mile Beach (500 km). Migratory birds that use the East Asian-Australasian Flyway may fly over, or in the vicinity of the Proposal Area and artificial light could alter natural migratory patterns, specifically in the absence of terrestrial landmarks. Light from offshore facilities has been shown to attract migrating birds, with bird species that migrate during the night more likely to be affected (Verhejen 1985).

Birds may either be attracted by the light source itself or indirectly as lighted structures in marine environments tend to attract marine life at all trophic levels, creating food sources and shelter for seabirds. Furthermore, sources of artificial light may provide enhanced capability for sea birds to forage at night. Studies in the North Sea indicate that migratory birds may be attracted to lights on offshore platforms when travelling within a radius of 3-5 km from the light source. Outside this area their migratory paths are likely to be unaffected (Marquenie et al. 2008). Given that a relatively small number of transiting individuals are expected to pass in the vicinity of the Proposal Area and Proposal activities are small in scale and short-term, any behavioural effects on birds such as disorientation and attraction are expected to be minor and temporary.

Fish

Numerous fish species inhabit the Proposal Area and some may be attracted to offshore light sources. The response of fish to light emissions has been shown to differ depending on species and habit. Artificial lighting can change ambient light regimes and pose risks of increased mortality through changes to natural night time distribution and consequently alter predator and prey relationships (Marchesan et al. 2006; Nightingale and Simenstad 2001). The change in behaviour may benefit predatory fish species while other species will become more at risk of predation in areas of light spill. Artificial light may also exclude nocturnal foragers/predators from an area, allowing diurnal species to benefit from increased access to resources.

The whale shark and great white shark are the only threatened fish species that have the potential to occur within the Proposal Area. Impacts from light emissions are not documented for these species (Commonwealth of Australia 2012).

The potential disturbance to fish from light emissions from drill rig and vessels is expected to be restricted to localised attraction of individuals. Any potential impacts to fish arising from light emissions are considered to be minor and highly localised to a small proportion of the population.

8.4.4 Underwater Noise

A detailed assessment of likely noise impacts on marine fauna is presented in Section 10.6 of the Browse FLNG Development Draft EIS. A summary is provided here.

Noise sources and emissions associated with the Proposal are described in Section 3.7.7. Should piling be required to secure drill rig mooring lines, suction piling is the preferred method. The alternative is driven piling which may result in intermittent impulsive noise over short durations. Further geotechnical investigations of the seabed at Torosa during detailed engineering design will be used to determine the need for piling and if relevant, the piling method. Should piling be necessary to secure drill rig mooring lines, the piling activities, their associated risks and impacts, and proposed noise management measures to reduce these risks and impacts to levels that are ALARP and acceptable will be detailed in the Environment Plan(s) for the activity for submission and acceptance by the relevant regulatory authority.

Noise emissions associated with the Proposal are likely to be greatest during drilling, installation and decommissioning phases when vessel activities are highest. Nevertheless, given the overall scale of the Proposal (Section 3.2) and activity phasing (Section 3.6), noise emissions during these phases are expected to be limited and of relatively short duration. Noise associated with decommissioning is expected to result primarily from the operation of the vessels required to decommission and remove infrastructure. Noise impacts during the decommissioning phase are therefore anticipated to be similar to those during installation. The majority of individual underwater noise sources associated with the Proposal are expected to be low frequency (<5 KHz) in the approximate range 150 to 180 dB re 1 µPa at source, with audible levels decreasing with distance from the source. Well evaluation using VSP will produce noise at higher levels, but is expected to reduce to 190 dB re 1 µPa at 500 m from source. The activity will be of short duration, up to approximately 10 hours per well.

Marine Mammals

The Proposal Area is not known to provide significant feeding or breeding habitats for marine mammals that result in predictable seasonal aggregations (Section **Error! Reference source not found.**). Potential impacts will therefore be limited to occasional marine mammals that are transient within the Proposal Area. Humpback whales and pygmy blue whales occur in relatively low numbers with some predictability in the Proposal Area during their annual migrations. Pods of dolphins have been observed in larger numbers, but such pods are often fast moving and are therefore likely to be exposed to noise from Proposal activities for only a short period.

The levels of noise generated from the Torosa Subsea Development may cause masking of acoustic cues and behavioural changes in marine mammals. Masking will mostly occur in the low frequencies (below approximately 5 KHz) as continuous noise sources associated with development activities are not likely to occur at the higher frequencies used by toothed marine mammals in echolocation. There has been relatively little behavioural observation of marine mammals exposed to continuous noise sources. However, Southall et al. (2007) conducted a review of existing studies and reported indications of no (or very limited) responses of marine mammals at received levels of noise below 120 dB re 1 µPa, and an increasing probability of avoidance and other behavioural effects in the 120 to 160 dB re 1 µPa range. Estimated source levels of underwater noise from Proposal activities exceed these levels, and there is therefore potential for some degree of behavioural disturbance to marine mammals in proximity to the development. However, contextual variables (e.g. source proximity, novelty, operational features) may be at least as important as exposure level in predicting response to noise, and habituation is likely for ongoing noise sources. For example, whales are often observed in close proximity to operating offshore infrastructure such as platforms and vessels that emit underwater noise.

Potential impacts to marine mammals from underwater noise during the drilling, installation and commissioning phases will be of limited duration due to the temporary nature of activities in these phases of the Proposal. Noise sensitive individuals might be expected to temporarily avoid areas where drilling, well evaluation and vessel-based activities are taking place. Startle responses from vessel and drilling activities are unlikely as source levels at the higher

end of the potential range (e.g. from operation of bow thrusters or drilling) are not likely to occur suddenly in isolation. Vessels and drill rig will already be operating and emitting noise at lower levels prior to commencement of potentially noisier activities. While higher source levels are expected from well evaluation using VSP, any disturbance will be limited to a very short duration as this type of activity will only occur for up to 10 hours per well.

During operation of the Proposal, the main source of ongoing underwater noise will be from the subsea wellheads. Underwater noise modelling of subsea wellheads at the TRE and TRD drill centres was undertaken and predicted that noise levels will likely fall below 120 dB re 1 µPa within approximately 500 m of the wellheads (Duncan 2010). In addition, noise levels above 120 dB re 1 µPa are not predicted to reach the top 100 m of the water column, even directly above the wellheads. The modelling was based on noise source levels of 159 dB re 1 µPa, recorded from wellheads associated with the Cossack Pioneer FPSO by McCauley (2002). Should noise levels from the wellheads be greater than predicted from the Cossack Pioneer wellheads, noise levels are still expected to be within a similar range as those generated by vessels. Potential impacts to whales and other marine mammals from increased noise levels in the vicinity of the wellheads are therefore expected to be minor and highly localised, and are not expected to cause disturbance to any individuals transiting through the channel between North and South Scott Reef.

Helicopter transfers will occur during drilling, installation and decommissioning for the Proposal. In general, helicopter noise is of short duration, peaking as the helicopter passes directly overhead. Received levels are expected to be low during transit when helicopter altitude is greatest. The highest received levels will occur at lower altitudes on approach to landing. Some behavioural disturbance may occur for short periods if marine mammals are present near the surface in the vicinity of landing helicopters.

In summary, increased underwater noise associated with all phases of the Proposal may result in localised avoidance and/or behavioural disturbance in marine mammals in the vicinity of development activities. Given that relatively low numbers of transient marine mammals are expected to occur in the Proposal Area and the overall scale of the Proposal, only minor impacts are expected to occur, with no long-term effect at population level, as a result of noise emissions from the Proposal.

Marine Turtles

Hearing has been studied in only a few individual marine turtles. Turtles have been shown to respond to low frequency sound, with indications that they have the highest hearing sensitivity in the frequency range 100 - 700 Hz (Bartol and Musick 2003). A startle response has been demonstrated to sudden noises. For example, McCauley et al. (2000) found that turtles showed behavioural responses to approaching seismic survey noise at approximately 166 dB re 1 µPa, and more significant disturbance at 175 dB re 1 µPa. However, startle responses and other behavioural changes are more likely from high level pulsed noise sources such as those produced during seismic surveys compared to non-pulse sources such as vessels.

The closest drilling and installation activities in proximity to turtle nesting habitat at Sandy Islet would be at the TRE drill centre approximately 7 km to the east. Modelling of the noise from the subsea wellheads has shown that noise levels are expected to drop below 120 dB re 1 µPa at 500 m from the wellheads (Duncan 2010), which is well below noise levels at which disturbance to turtles is expected to occur. Noise from operation of the wellheads is therefore not expected to be audible in the vicinity of Sandy Islet at levels that would cause disturbance. Disruption to turtles from Proposal noise is expected to be minor due to the transient nature of noise from the majority of Proposal activities.

Fish

Fish vary widely in their vocalisations and hearing abilities, but generally hear best at low frequencies below 1 kHz (Ladich 2000). Behavioural effects of noise on fish may include

changes to schooling behaviour and avoidance of the noise source (Simmonds and MacLennan 2005).

Cartilaginous fish (such as sharks and rays) lack a swimbladder and are considered less sensitive to sound than bony fish. The hearing capabilities of the whale shark have not been studied, but it has been suggested that they are likely to be most responsive to low frequency sounds (Myberg 2001). Whale sharks have been observed to dive upon ignition of nearby inboard vessel motors, which may be a response to the low frequency sound signature of such motors (Myberg 2001).

The levels of noise generated during Proposal activities may cause some behavioural changes in fish or mask acoustic cues in the vicinity of Proposal activities. However, potential impacts are expected to be restricted to the immediate area of activities, with no permanent changes in behaviour that could impact on long-term biological or ecological functioning of fish.

8.4.5 Invasive Marine Species

There is the potential for the introduction of IMS to occur at all stages of the Proposal as vessels and drill rig will transit into the Proposal Area during its lifespan.

The introduction and establishment of IMS can result in a localised impact on native marine fauna. Such impacts include:

- Competition, predation or displacement of native species.
- Alteration of natural ecological processes.
- Introduction of pathogens with the potential to impact on ecological health.

The most common transfer mechanisms for IMS are via uptake and discharge of ballast water or due to marine fouling on the hulls and internal niches (e.g. seawater intakes) on vessels. However, not all species that are introduced to an area outside of their natural range survive to become an IMS, with the majority of introduced species failing to establish (Williamson and Fitter 1996).

Woodside has in place a comprehensive IMS Management Plan that has been developed in consultation with the relevant authorities.

In terms of ballast water exchange, all vessels mobilised from outside of Australia will undertake ballast water exchange in waters located further than 12 Nm from land and in water depths greater than 200 m.

There is therefore a low likelihood of IMS introduction and settlement resulting in significant environmental impacts in the Proposal Area.

8.4.6 Drill Cuttings and Fluid Discharge

Potential environmental impacts to marine fauna associated with the discharge of drill cuttings and fluids may result from changes in water quality and associated toxicity that were discussed in Section 6.4.2. Since the discharge of drill cuttings for the Torosa Subsea Development will be undertaken with the aim of avoiding impact to Scott Reef, no significant impacts to marine fauna present in the Scott Reef lagoon are anticipated. Furthermore, based on the modelling undertaken to predict the fate and dispersion of drill cuttings discharge at the TRE and the TRD drill centres, any changes in water quality and associated toxicity to marine fauna are expected to be localised, minor and short term (Section 6.4.2).

Increases in turbidity resulting from the discharge of cuttings and fluids may have the potential for impacts to pelagic fauna, such as fish, marine mammals and turtles. Total suspended sediment (TSS) may vary naturally in the marine environment such that many fish have evolved behavioural adaptations to tolerate changes in TSS load (e.g. clearing their

gills by flushing water over them). Adult fish are likely to move away when they detect sufficiently elevated suspended solids concentrations. As air breathing animals, marine turtles and marine mammals are not expected to be adversely impacted by any encounters with elevated suspended sediment concentrations. Impacts associated with localised elevation in suspended sediment concentrations in the water column due to drill cuttings and fluid discharges are not expected to have significant adverse impacts to pelagic communities.

Therefore, given the limited toxicity potential of drill cuttings and fluids, the localised, minor and short term nature of any changes in water quality, the likely behaviour of mobile fauna to avoid the discharge plume and the proposed management approach aimed at preventing impacts to the corals of Scott Reef, no significant effects on marine fauna are anticipated associated with the discharge of drill cuttings and fluids.

8.4.7 Vessel and Drill Rig Discharges

Sewage and Sullage

Marine fauna in the open ocean and at Scott Reef are not expected to be at risk from the discharge of treated sewage and sullage, as discharges would rapidly disperse in close proximity to the discharge points (refer to Section 6.4.3).

Desalination Brine Discharge

Given that discharges of desalination brine are predicted to result in only highly localised and temporary elevations in salinity at the discharge point which are unlikely to have a perceptible effect on ambient salinity concentrations in the water column (Section 6.4.3), such discharges are unlikely to affect marine fauna.

Similarly, the potential for toxicity effects to marine fauna due to dosing with anti-scale chemicals is unlikely as these chemicals have low inherent toxicity (i.e. fit for human consumption in potable water), will be consumed and neutralised in the desalination system and any remaining chemicals will be rapidly diluted on discharge.

Given these considerations, negligible, localised and temporary effects to marine fauna are expected from discharge of desalination brine.

8.4.8 Subsea Control Fluid Discharge

Potential impacts to marine environmental quality from the potential discharge of subsea control fluids are addressed in Section 6.4.4. The non-routine intermittent discharge of small volumes of subsea control fluids in the deep waters of the Proposal Area (> 350m) would be rapidly diluted in the prevailing currents within metres (or less) downstream of the discharge point. Given these considerations, only minor, localised and temporary effects on marine fauna would be expected.

8.4.9 Hydrotest Fluid Discharge

The assessment of impacts of hydrotest fluid discharges on marine environmental quality in Section 6.4.5 concluded that there was a limited potential for discharges to affect marine organisms. Discharges will occur at depth and away from Scott Reef (Table 6.2), and overall, any impacts on marine fauna will be temporary and localised.

8.5 Mitigation and Management

Mitigation and management measures relevant to marine fauna are listed in Table 8.7.

8.6 Expected Environmental Outcome

The results of the assessment and the expected environmental outcome is summarised in Table 8.7.

Table 8.7 Summary of Likely Impacts on Marine Fauna and Expected Environmental Outcome

Existing Environment	Aspect	Likely Environmental Impacts	Mitigation and Management	Expected Environmental Outcome
EPA Objective: ***To maintain the diversity, geographic distribution and viability of fauna at the species and population levels***				
Diverse fish assemblages in shallow and deeper waters of the Proposal Area but assemblages are typical of the fish communities and species represented within the surrounding Timor Province. Six species of marine turtle may be present the Proposal Area with green turtles being the most likely species encountered. Green turtles and a single Hawksbill turtle have been observed nesting on Sandy Islet, approximately 7 km from the closest Proposal infrastructure. Turtle feeding and nesting habitats are not found within the Proposal Footprint due to the lack of suitable habitats and deep waters. Tracking indicates that favoured inter-nesting sites are located to the south and west of Sandy Islet, distant from the Proposal Footprint. Based on isolated and infrequent observations of individuals, whale sharks are not expected in the Proposal Area, although a small number of the WA population migrate through the wider Region. Small numbers of sea snakes have been observed offshore Scott Reef. The short-nose sea snake, could occur in the Proposal Area, but based on its known distribution it is unlikely to be present. Sandy Islet, located approximately 7 km from the nearest Proposal infrastructure, supports low abundance of roosting and nesting seabirds, but due to its small size does not represent an important resting point for migratory shorebirds on the East Asian-Australasian flyway. The Proposal Area is not known to provide significant breeding, feeding or resting habitat for marine mammals. Five listed cetacean species may occur in, or migrate through, the Proposal Area including the endangered pygmy blue whale and the vulnerable humpback whale. Small numbers of pygmy blue whales have been recorded in the Proposal Area including in the vicinity of the channel between North and South Scott Reef. Potential for low numbers of humpback and pygmy blue whales to pass in the vicinity of the Proposal Area. Spinner dolphins have been the most commonly encountered cetacean	Physical Presence	Temporary presence of drill rig and vessels provide relatively small obstacles that marine fauna are likely to avoid. Anchor chains or mooring lines, if used, are unlikely to cause entanglement of marine fauna due to chain dimensions and tension loads. Subsea infrastructure is unlikely to affect marine fauna movements or present a risk of collision or entanglement as it is located on the seabed in waters greater than 350 m deep.	High value habitat for marine fauna has been avoided where practicable in the design process. Marine fauna observations will be recorded during drilling and installation activities at the TRE and TRD drill centres.	Potentially significant impacts to marine fauna that use the shallow water and emergent habitats of Scott Reef have been reduced by selecting FLNG as a development concept (i.e. no requirement for processing infrastructure on Scott Reef – see Table 1.1) and siting infrastructure in deep waters off Scott Reef. The remaining potential for impact to marine fauna will be further reduced through proposed mitigation and management measures. The majority of these measures are standard maritime and offshore oil and gas industry practice, however Woodside has also opted to exceed industry practice in some cases, for example with respect to vessel inspections of IMS. As the Proposal Area is not known to provide significant aggregation areas for birds and marine mammals, any impacts associated with Proposal activities on these fauna are likely to be limited to transient individuals. Similarly, the small scale of Proposal activities, their short-term presence and their distance from nesting and inter-nesting sites for marine turtles, only a small portion of the nesting population could be disturbed with no local population-wide impacts likely. As such, no significant adverse impacts on the diversity, geographic distribution and viability of fauna at the species and population levels are likely and the environmental objective is met. In activity-specific Environment Plan(s) required under other regulatory processes, Woodside will be required to demonstrate that impacts to marine fauna associated with the Proposal are reduced to ALARP and are acceptable. Implementation of the
	Physical Interaction	Vessel interactions with marine fauna may result in disturbance to behavioural patterns or displacement of marine fauna, or in the event of a vessel strike; injury or death. The potential for vessel strikes on marine mammals and turtles is anticipated to be low since the majority of vessels are expected to travel at relatively slow speeds, thereby reducing the risk of collision. Also, marine mammals and marine turtles are not known to occur in large numbers in the deeper waters of the Proposal Footprint. Vessels transiting to and from the Proposal Area may travel faster, but these transits will not represent a significant increase in vessel traffic levels compared to existing flows in the Region. Any interactions that do occur are likely to be limited to effects on individuals; no impacts to the viability of populations are expected. No significant impacts on birds associated with helicopter movements are expected since birds are expected to actively avoid interaction and no significant aggregations of birds occur in the Proposal Area.	Operational radar and vessel tracking equipment will be in place on the support vessels in accordance with Marine Orders 30 (Prevention of Collisions) and Marine Orders 21 (Safety of Navigational and Emergency Procedures). High value habitat for marine fauna has been avoided where practicable in the design process. Vessels associated with the Proposal will operate in accordance with EPBC Regulations 2000-Part 8 Division 8.1 and Australian National Guidelines for Whale and Dolphin Watching whereby: • Vessels will not knowingly travel greater than six knots within 300 m of a whale or 100 m of a dolphin; • Vessels will not knowingly approach closer than 100 m to a whale or 50 m to a dolphin (except if bow riding); and • Vessels will not knowingly restrict the path of marine mammals. Interactions between vessels associated with the Proposal and whale sharks will be consistent with the Whale Shark Code of Conduct (DPaW 2013), whereby vessels will not travel at speeds greater than eight knots within 250 m of a whale shark and not intentionally approach closer than 30 m of a whale shark. Interactions of helicopters associated with the Proposal with listed species will be in accordance with EPBC Regulations 2000 – Part 8 Division 8.1: • helicopters will not fly below an altitude of 1000 feet within a 300 m horizontal radius of any observed whales (unless necessary for take-off and landings); and • flights will occur predominantly in daylight. Scheduled helicopter flight paths will avoid roosting areas such as Sandy Islet. Suspected injury/mortality of marine fauna will be reported to DPaW in accordance with the WC Act. Vessels associated with the Proposal will take direct routes where possible, whilst avoiding significant areas such as Sandy Islet. Fishing will not be allowed on board the drill rig and vessels associated with the Proposal.	
	Artificial Light	No significant impacts on light-sensitive marine fauna (marine turtles, birds and fish) are anticipated given the small scale of Proposal activities, the temporary to short-term nature of light emissions and the distance between Proposal activities and areas of fauna aggregation. Light levels from the closest infrastructure to Sandy Islet (a distance of ~ 7 km) will not be sufficient to influence the nesting behaviour of marine turtles or hatchling behaviour leaving nests. Furthermore, once in the water, hatchlings are not expected to be affected by light levels given the strong surface currents in the deeper waters of the Proposal Footprint. Light is unlikely to attract significant numbers of seabirds or migratory shorebirds as	Navigation beacons and lighting will be designed in line with the safety requirements of the IALA.	

Existing Environment	Aspect	Likely Environmental Impacts	Mitigation and Management	Expected Environmental Outcome
during aerial and vessel surveys in the Proposal Area.		the Proposal Area is located a significant distance from key aggregation areas. Any potential disturbance to fish from light is expected to be restricted to localised attraction of individuals.		mitigation and management measures committed here is therefore assured.
	Underwater Noise	No significant impacts on noise-sensitive marine fauna are anticipated given the relatively low numbers of transient marine mammals (i.e. marine mammals) expected to occur in the vicinity of the Proposal Area. Any avoidance and/or behavioural disturbance to marine fauna present in the vicinity of the Proposal Area are likely to be minor, temporary and inconsequential, affecting individuals only. No long-term effects at population level are likely.	Support vessels and helicopters will operate in accordance with EPBC Regulations 2000 – Part 8 Division 8.1 and Australian National Guidelines for Whale and Dolphin Watching, as outlined under Physical Presence / Marine Fauna. Interactions between support vessels and whale sharks will be consistent with the Whale Shark Code of Conduct (DPaW 2013), as outlined under Physical Presence / Marine Fauna. Scheduled helicopter flights will avoid seabird roosting areas such as Scott Reef. If required, suction piling will be selected as the preferred mooring method for drill rigs, where practicable. Should geotechnical investigations of the seabed at Torosa indicate that driven piling will be required, Woodside will conduct a thorough impact assessment and develop and implement noise management procedures as required to demonstrate that risks and impacts have been reduced to levels that are ALARP and acceptable. These will be detailed in the relevant Environment Plan(s) for submission and acceptance by the relevant regulatory authority. Noise management measures may include a combination of soft-start procedures, identification of an appropriate 'safety zone' and other appropriate measures as necessary. If VSP is conducted at a drill centre, it will be subject to pre-start marine fauna observations and 'soft start' procedures to ensure sensitive fauna are not in the vicinity, in accordance with EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales. Marine fauna observations will be recorded during drilling and installation activities at the TRE and TRD drill centres. The operating philosophy is to minimise pressure drop over subsea choke valves, thereby reducing operational noise in the Proposal Area.	
	Invasive Marine Species	Low likelihood that IMS could be introduced and settle in the area given the mitigation and management measures in place.	Vessels will be treated with antifouling coating to control marine growth on hulls. All vessels and the drill rig required in support of the Proposal will be required to comply with the Woodside IMS Management Plan and Contractor Information Pack for Management of IMS which uses a risk based approach to determine whether inspection/cleaning is required. As a minimum, all vessels mobilised from outside of Australia will undertake ballast water exchange in waters located further than 12 Nm from land and in water depths greater than 200 m. All vessels and the drill rig required to meet both Commonwealth and State ballast water and biofouling legislation and guidelines including the Ballast Water Management Requirements (Department of Agriculture 2013) and the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia 2009). Vessels entering the Proposal Area for longer than 48 hours will be inspected for IMS, and cleaned where required.	
	Drill cuttings and fluid discharges	Since the discharge of drill cuttings for the Proposal will be undertaken with the aim of avoiding impact to Scott Reef, no significant impacts to marine fauna present in the Scott Reef lagoon are anticipated. Modelling indicates that any changes in water quality and associated toxicity to marine fauna are expected to be localised, minor and short term (Section 6.4.2).	Refer to Table 6.2 for mitigation and management measures for drill cuttings and fluids discharges.	
	Vessel and drill rig discharges	The discharge of sewage and sullage will give rise to only minor increases in nutrients above background levels in the vicinity of the discharge, potential impacts on marine fauna are expected to be localised, minor and temporary.	Refer to Table 6.2 for mitigation and management measures for vessel and drill rig discharges.	

Existing Environment	Aspect	Likely Environmental Impacts	Mitigation and Management	Expected Environmental Outcome
	Subsea control fluid discharges	Only minor, localised and temporary effects on marine fauna would be expected given the rapid dispersion and dilution of the intermittent discharge of small volumes of subsea control fluids in the deep waters of the Proposal Area (> 350m).	Refer to Table 6.2 for mitigation and management measures for subsea control fluid discharges.	
	Hydrotest fluid discharges	Limited potential for discharges to affect marine organisms. Discharges will occur at depth and away from Scott Reef, and overall, any impacts on marine fauna will be temporary and localised.	Refer to Table 6.2 for mitigation and management measures for hydrotest fluid discharges.	

9. Coastal Processes

9.1 EPA Objective

To maintain the morphology of the subtidal, intertidal and supratidal zones and the local geophysical processes that shape them.

9.2 Existing Environment

The Proposal Area encompasses Scott Reef, which consists of two shelf atolls, separated by a deep channel. North Scott Reef is an annular reef, approximately 17 km long and 16 km wide, and encloses a shallow lagoon about 20 m deep. South Reef is a crescent-shaped reef, approximately 20 km wide. The lagoon of South Reef ranges in depth from 20 m to 70 m. The morphology of the Proposal Area and Scott Reef is illustrated in Figure 9.1.

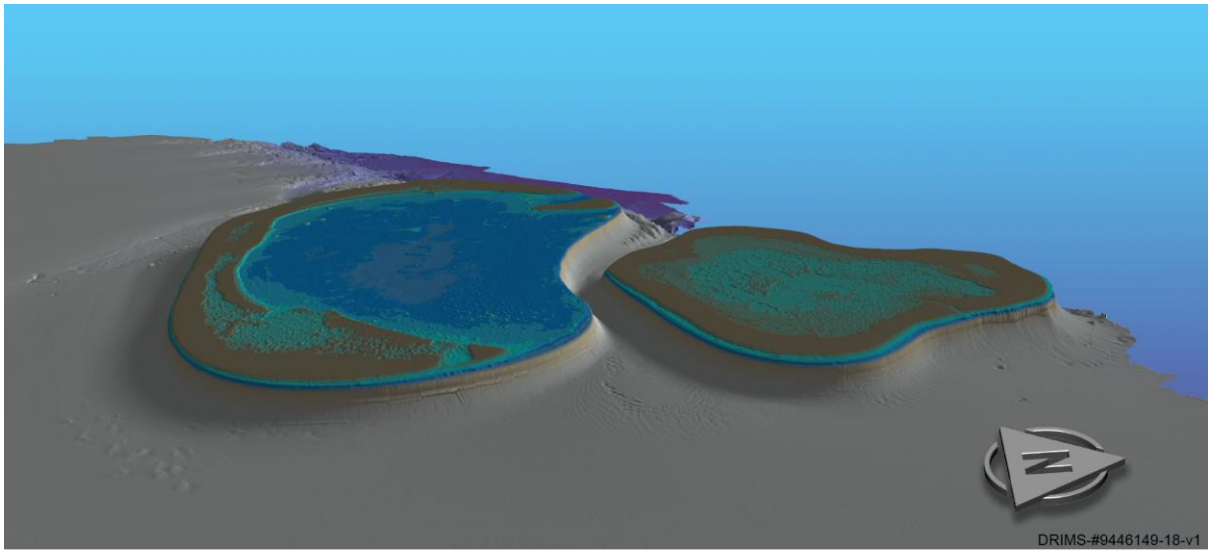

Figure 9.1 Morphology of the Proposal Area Based on a Three-dimensional Merged Bathymetric Data Set

9.3 Sources of Potential Impact

Table 9.1 summarises the sources of potential impact to coastal processes from the Proposal.

Table 9.1 Sources of Potential Impact to Coastal Processes from the Proposal

Aspect	Source (Activity and/or Infrastructure)	Proposal Phase[1]					Potential Impact
		Dr	I	C	O	De	
Subsidence	Extraction of hydrocarbons from the Torosa reservoir				✓		Reduction in light availability to corals and associated impacts to their growth rates Increase in wave exposure Change in geomorphological processes associated with wave-mediated transport of sediment (sand)

[1] Dr = Drilling; I = Installation; C = Commissioning; O = Operation; De = Decommissioning

9.4 Characterisation and Assessment of Potential Impacts

Extraction of the reservoir fluids, resulting in a reduction in the reservoir's pressure, has the potential to result in compaction of the geological layers leading to gradual low magnitude subsidence at the seabed. Gradual low magnitude subsidence from the Proposal is expected to occur at the seabed above the Torosa reservoir (including Scott Reef). The Torosa reservoir spans an area approximately 50 km by 15 km, approximately half of which lies beneath Scott Reef.

Woodside, on behalf of the Browse JV Participants, has modelled the magnitude of subsidence and associated horizontal movements for the Browse reservoirs. Analyses have taken into account a range of parameters, including the geological/fault structure of the reservoir, its spatial dimensions, the hydrocarbon reservoir thickness and its depth, reservoir temperature and pressure as well as pore compressibility in the reservoir. These analyses have been supported by field measurements and laboratory tests on core samples obtained from exploration wells within the Browse reservoirs. Initial estimates of subsidence provided in 2011 ranged from 2.1 centimetres (cm) and 7.1 cm, averaging 4.4 cm over the life of the reservoir (approximately 40 to 50 years). Subsidence estimates have since been revised, reflecting increased knowledge of the Torosa geological and reservoir characteristics. Revised estimates range between 2.6 cm and 8.9 cm, with average vertical seafloor movement totalling approximately 5.4 cm over 40 years (0.6 to 2.2 millimetres per year (mm/yr)). This estimate remains broadly similar to the original modelling estimate and provides further confidence that subsidence, as a result of gas extraction from the Torosa reservoir, will be in the order of less than 10 cm.

Average subsidence was predicted to occur over a radius of about 10 km centred on a point in deep water on the eastern side of North Scott Reef. The magnitude of subsidence is predicted to diminish away from this point up to 18 km. Beyond 20 km, the magnitude of subsidence would be virtually nil.

Potential impacts of subsidence on corals at Scott Reef are dependent on the rate of coral accretion expected at Scott Reef over the life of the Proposal. Analyses of cores taken from Scott Reef (Collins et al. 2009) indicated that Scott Reef has previously experienced sea level changes, with five growth phases identified over the past 400,000 years, each 30 to 50 m thick, corresponding to episodes of sea level rise through time. Based on these analyses, vertical accretion rates of corals at Scott Reef were found to vary from 1.4 to 3.5mm/year. This indicates that corals at Scott Reef could respond successfully to sea level changes associated with production at Torosa, with predicted subsidence well within natural vertical accretion rates observed at Scott Reef. Additionally, Scott Reef and Sandy Islet experience considerable natural variability in sea levels due to tides at Scott Reef and large-scale oceanographic and atmospheric processes, such as the passage of mesoscale ocean eddies and inverse barometer effects with the passing of cyclonic and anticyclonic pressure systems.

The impact of subsidence to Scott Reef and Sandy Islet would therefore be expected to be insignificant or temporarily positive. Based on subsidence resulting in a maximum 8.9 cm increase in water depth over a 40 year production period, there may be an initial period of increased coral cover on the reef flat and possibly an increase in the size or height of Sandy Islet during this period. At the end of the Proposal life, the reef would regain its former height in relation to sea level and the coral communities at Scott Reef and Sandy Islet would be expected to return to a state similar to that observed prior to subsidence.

Over the life of the Proposal (approximately 40 to 50 years) sea levels are predicted to be affected by climate change (IPCC 2007, 2013). As a result, Scott Reef may experience a higher rate of water depth increase from climate change than due to potential subsidence alone over that timeframe. Woodside commissioned AIMS to assess the potential impacts of subsidence on Scott Reef's coral habitats and Sandy Islet in the context of climate

change (Cooper et al. 2010; AIMS 2012). AIMS assessed both sea level changes due to subsidence and the combined sea level changes associated with a range of climate change scenarios over the life of the Torosa reservoir.

Where a net increase in sea level was predicted under the assessment, impacts due to sea level rise were forecast to occur at Scott Reef and Sandy Islet regardless of extraction-induced subsidence. At the end of Proposal life, any subsidence effects will cease, while any climate change influenced effects on sea level can be expected to continue to occur. The assessment therefore concluded that minor seabed subsidence over the life of the Torosa reservoir affecting a part of Scott Reef and Sandy Islet is not predicted to significantly contribute to sea level changes and predicted associated impacts, however, impacts from sea level rise may be brought forward slightly in time. For example, based on the assumption that the overall elevation of Sandy Islet is 4.5 m, and using the most up to date predictions of sea level rise (IPCC 2013) and subsidence (Woodside 2014), the following observations can be made:

- For a best-case scenario where sea level rise is lowest (3 millimetres per year (mm/yr) resulting from climate change), it would likely take approximately 1,500 years for the water depth to increase by 4.5 m in the absence of subsidence. Factoring in subsidence at a rate of 0.6 mm/yr over 40 years, it would take approximately 1,492 years to increase by 4.5 m.
- For a worst-case scenario, (11.4 mm/yr sea level rise resulting from climate change) it would likely take approximately 395 years for the water depth to increase by 4.5 m in the absence of subsidence. Factoring in subsidence at a rate of 2.2 mm/yr over 40 years, it would take approximately 387 years to increase by 4.5 m.

9.5 Mitigation and Management

Given the level of confidence with the low magnitude of subsidence predicted from the Proposal, no management measures are proposed to reduce the potential environmental impact associated with subsidence.

9.6 Expected Environmental Outcome

The results of the assessment and the expected environmental outcome is summarised in Table 9.2.

Table 9.2 Summary of Likely Impacts on Coastal Processes and Expected Environmental Outcome

Existing Environment	Aspect	Likely Environmental Impacts	Mitigation and Management	Expected Environmental Outcome
EPA Objective: ***To maintain the morphology of the subtidal, intertidal and supratidal zones and the local geophysical processes that shape them***				
Seabed features determined through geophysical and video surveys. Scott Reef is a large emergent shelf atoll situated on the outer edge of the continental shelf. Sandy Islet, is an unvegetated, 4.5 m high, linear-shaped sandy cay, located the north-west edge of the south reef, approximately 7 km from the closest Proposal infrastructure.	Subsidence	Based on peer- and independently reviewed studies, gradual low magnitude subsidence at the seabed above the Torosa reservoir ranging between 2.6 cm and 8.9 cm is predicted to occur over the life of the Proposal. However, this level of subsidence is considered insignificant compared to the natural variations in sea level within the Proposal Area and its surrounds and the sea level rises predicted to result from climate change. Corals at Scott Reef could respond successfully to sea level changes associated with production at Torosa.	Given the level of confidence with the low magnitude of subsidence predicted from the Proposal, no management measures are proposed to reduce the potential environmental impact associated with subsidence.	No significant adverse impacts on the morphology of the subtidal, intertidal and supratidal zones and the local geophysical processes that shape them in the Proposal Area that are distinguishable from natural or other (i.e. climate change-induced) processes are likely. Relevant impacts and risks will be further evaluated and, where relevant, managed to ALARP through activity specific Environment Plan(s) under other regulatory processes. Environmental objective is met.

10. Air Quality

10.1 EPA Objective

To maintain air quality for the protection of the environment and human health and amenity (EPA 2013).

10.2 Existing Environment

The Proposal Area experiences a tropical climate with a summer monsoon season from October to March, and a cooler dry season from April to September. Tropical cyclones pass through the Proposal Area between November and April. Given the remote, offshore location of the Proposal Area, local air quality is not expected to be significantly influenced by anthropogenic sources.

10.3 Sources of Potential Impact

Table 10.1 summarises the sources of potential impact to air quality from the Proposal.

Table 10.1 Sources of Potential Impact to Air Quality from the Proposal

Aspect	Source (Activity and/or Infrastructure)	Proposal Phase[1]					Potential Impact
		Dr	I	C	O	De	
Atmospheric Emissions	Vessel engines and power generation equipment on drill rig	✓	✓		[2]	✓	Temporary reduction in local air quality.
	Drill rig flaring	✓					

[1] Dr = Drilling; I = Installation; C = Commissioning; O = Operation; De = Decommissioning

[2] No credible interactions are anticipated for infrequent monitoring and maintenance of subsea wells and infrastructure during the operation phase (Figure 5.1).

10.4 Characterisation and Assessment of Potential Impacts

Atmospheric emissions associated with the Proposal are described in Section 3.7.5. Overall emissions are expected to be small given the overall scale of the Proposal and will occur over short periods of time during drilling, installation and decommissioning activities (Sections 3.2 and 3.7.5). The Proposal Area is located offshore, remote from urban or industrial areas and distant from sensitive receptors.

Given the low emissions levels and distance of the emissions sources from the nearest sensitive environmental receptors, it is not anticipated that emissions from the Proposal will have an impact on any sensitive receptors. The Proposal is expected to result in a localised, temporary and negligible reduction in air quality in the immediate vicinity of the release point. Overall contributions to the atmosphere are expected to be insignificant within the Proposal Area.

10.5 Mitigation and Management

Mitigation and management measures relevant to air quality are listed in Table 10.2.

10.6 Expected Environmental Outcome

The results of the assessment and the expected environmental outcome is summarised in Table 10.2.

Table 10.2 Summary of Likely Impacts on Air Quality and Expected Environmental Outcome

Existing Environment	Aspect	Likely Environmental Impacts	Mitigation and Management	Expected Environmental Outcome
EPA Objective: ***To maintain air quality for the protection of the environment and human health and amenity***				
Due to the offshore location of the Proposal Area, which is remote from urban or industrial areas, very low baseline levels of atmospheric pollutants are expected.	Atmospheric Emissions	Localised, temporary and negligible reduction in air quality in the immediate vicinity of drill rig and vessels from power generation equipment and from flaring associated with well unloading (Section 3.4.1). Emissions are expected to disperse rapidly in the offshore environment. Overall contributions to the atmosphere are expected to be insignificant within the Proposal Area.	In accordance with MARPOL 73/78 Annex VI (Prevention of Air Pollution from Ships) requirements as defined in the Marine Order 97 (Marine Pollution Prevention, Air Pollution), relevant classes of vessels will: • Hold a valid International Air Pollution Prevention (IAPP) Certificate • Implement a preventative maintenance system to confirm diesel powered equipment is maintained for efficient operation • Use low sulphur diesel when it is available. Fuel usage will be recorded for the drill rig and vessels associated with the Proposal. Emissions will be derived from fuel usage.	No significant adverse impacts on air quality are likely due to the low emissions volumes and the offshore environment. Mitigation and management measures are standard maritime and offshore oil and gas industry practice. Environmental objective is inherently met.

11. Amenity

11.1 EPA Objective

To ensure that impacts to the amenity are reduced to as low as reasonably practicable.

11.2 Existing Environment

Current activities are limited within the Proposal Area given its remote, offshore location. Scientific research and traditional Indonesian fishing are the primary activities undertaken in the Proposal Area while some limited recreational fishing and tourism activities occasionally also take place at Scott Reef. Oil and gas activities, commercial fishing and shipping occur in the wider Region. A summary is provided below; further detail is available in Section 7 of the Browse FLNG Development Draft EIS.

11.2.1 Scientific Research

Scientific research within the Proposal Area is predominately undertaken at Scott Reef. A number of marine research and monitoring programs have been ongoing, particularly those conducted by AIMS and the WA Museum in collaboration with Woodside. AIMS have been undertaking long-term monitoring of coral and fish communities at Scott Reef since 1993, involving up to six trips per year to the reef. Other organisations that have been involved in undertaking or funding research activities at Scott Reef include the Department of Fisheries Western Australia (DFWA), Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Research Council (ARC).

11.2.2 Traditional Fisheries

Under a 1974 Memorandum of Understanding between the Governments of Australia and Indonesia, Indonesian fishers are permitted to fish within a 12 mile fishing zone around Scott Reef using “methods which have been the tradition over decades of time”.

From 2006 to 2008, Woodside commissioned a series of baseline studies in partnership with the Australian National University to further understand the traditional practice of Indonesian fishers that journey to Scott Reef (ERM 2009). Journeys to Scott Reef are generally restricted to drier months (July to October), although some make the journey between April and June. Fishers were found to move from location to location during their visit to Scott Reef.

The fishers focus their activities on the exposed reef flats at spring low tides and around the shallow water lagoons of Scott Reef primarily targeting trepang, trochus shells and opportunistically taking a range of other invertebrates. Deeper waters of the lagoons provide some refuge from the intensive fishing on the shallow or exposed reef flats (AFMA, 2014, pers. comm.).

11.2.3 Commercial Fisheries

While three State, and four Commonwealth managed commercial fisheries cover the Proposal Area, only two fisheries currently have reported fishing effort in the Proposal Area, namely:

- The WA Northern Demersal Scalefish Fishery
- The WA Mackerel Managed Fishery (Area 1).

Both fisheries operate year round with estimated catch for the entire fishery being reported as 1,107 tonnes and 307 tonnes per season respectively.

11.2.4 Tourism

Recreation and tourism activities in the wider vicinity of the Proposal Area occur predominantly in waters adjacent to the mainland.

Discussions with regional tourism groups and Recfishwest indicate that only one to two recreational fishing charter operators run trips to Scott Reef. Given the distance from Broome and closest landfall and associated costs, only a limited number of charter operators are prepared to take recreational fishers out to Scott Reef. Fishing is mainly focused on the south, west and north extremities of Scott Reef, generally only going into the South Reef lagoon for snorkelling and for overnight layovers.

11.2.5 Oil and Gas Industry

The closest approved and prospective petroleum activities to the Proposal Area are listed in Table 11.1.

Table 11.1 Approved and Prospective Petroleum Activities in the vicinity of the Proposal Area

Development Name	Operator	Distance to Proposal Area	Permit Area	Activity	Status
Ichthys	INPEX	105 km	WA-285-P	Gas extraction Pipelines Central processing facility	Approved
Prelude	Shell	160 km	WA-371-P	Gas extraction FLNG facility	Approved
Greater Poseidon	ConocoPhillips	38 km	WA-314-P	Exploration and appraisal drilling	Approved
		0 km	WA-315-P		
		0 km	WA-398-P		
Schooner	Hunt Oil	108 km	WA-425-P	Exploration drilling	Approved
Pryderi-1	CalEnergy Resources	180 km	WA-424-P	Exploration drilling	Approved
Gwydion	IPB Petroleum	200 km	WA-471-P WA-485-P	Seismic exploration	Prospective

11.2.6 Shipping

Shipping activity in and around the Proposal Area is sparse with the main commercial shipping routes located approximately 50 to 100 km west of the Proposal Area and negligible shipping occurring within the Proposal Area (Commonwealth of Australia 2012). The majority of shipping activity in the Region relates to transits to and from Broome (Woodside 2009), transporting goods between Australian and international ports (Commonwealth of Australia 2012).

11.3 Sources of Potential Impact

Table 11.2 summarises the sources of potential impact to amenity from the Proposal.

Table 11.2 Sources of Potential Impact to Amenity from the Proposal

Aspect	Source (Activity and/or Infrastructure)	Proposal Phase[1]					Potential Impact
		Dr	I	C	O	De	
Physical presence	Petroleum safety zone around drill rig	✓					Temporary barrier to the movements of other users
	Presence of vessels	✓	✓		[2]	✓	
Physical interaction	Movement of vessels and positioning of drill rig	✓	✓		[2]	✓	Interactions with other users
	Presence of subsea infrastructure				✓		Entanglement of fishing gear with subsea infrastructure
IMS	IMS introduced via drill rig and/or vessels	✓	✓		[2]	✓	Introduction and establishment of IMS, reducing the viability of fisheries

[1] Dr = Drilling; I = Installation; C = Commissioning; O = Operation; De = Decommissioning

[2] No credible interactions are anticipated for infrequent monitoring and maintenance of subsea wells and infrastructure during the operation phase (Figure 5.1).

11.4 Characterisation and Assessment of Potential Impacts

11.4.1 Physical Presence and Physical Interaction

The drill rig and vessels will be present within, and will transit to and from, the Proposal Area, during different phases of the Proposal. Additionally a petroleum safety zone will be in place around the drill rig during drilling. The transit of the vessels and the use of the petroleum safety zone around the drill rig will not restrict the movements of other users within the area encompassing the Proposal Area. Other users include commercial and recreational fishers, traditional Indonesian fishers, scientific research vessels and very occasional tourism operators.

The extent of the petroleum safety zone for the drill rig is not specified under the current legislative framework applicable to the Proposal. It is proposed that a 500 m radius is used. A petroleum safety zone may also be notified to other marine users around installation and future decommissioning vessels. Vessels will be notified of Proposal activities (Table 11.3) but their access is not restricted.

Based on the relatively low-level use of the Proposal Area by third parties, the location, scale and duration of Proposal activities, the implementation of the petroleum safety zones around the drill rig for drilling and ongoing consultation with relevant stakeholders, the Proposal is not expected to impede or significantly alter the activities of other third parties in the Proposal Area.

Given the water depth at which the subsea infrastructure will be installed, no petroleum safety zones are expected to be required for the presence of the subsea infrastructure, and therefore no restrictions to other users will apply.

Entanglement of commercial, traditional and recreational fishing gear with subsea infrastructure is not expected due to the water depths at which the subsea infrastructure is installed.

11.4.2 Invasive Marine Species

There is the potential for IMS to be introduced to the Proposal Area via the drill rig and vessels during the life of the Proposal. The introduction of IMS could potentially impact upon the viability of fisheries within the wider area. The most common transfer mechanisms for IMS are via uptake and discharge of ballast water and from marine fouling on the hulls and internal niches (e.g. seawater intakes) of vessels.

Not all species that are introduced to an area outside of their natural range survive to become an IMS, with the majority of introduced species failing to establish (Williamson and Fitter 1996). The probability of successful establishment of an IMS depends on the:

- Infection at a 'source', such as a port, harbour or within coastal waters where IMS are present and reproducing.
- Survival of the IMS during their transfer to an area located beyond their natural range.
- Activities undertaken to enable a successful inoculation by the surviving IMS.
- Water temperatures, salinities and habitat that are sufficiently environmentally 'matched' to permit the IMS's survival, establishment, growth and reproduction.

All subsea infrastructure will be transported and installed in deep water (greater than 350 m) and therefore provide unfavourable environmental conditions for IMS survival, settlement and reproduction.

In line with the assessment of IMS impacts on marine fauna presented in Section 8.4.5 which concluded that there is a low likelihood of IMS introduction and settlement in the Proposal Area as a result of Proposal activities, a similarly low likelihood of impact to the amenity value of the area is predicted.

11.5 Mitigation and Management

Mitigation and management measures relevant to amenity are listed in Table 11.3.

11.6 Expected Environmental Outcome

The results of the assessment and the expected environmental outcome is summarised in Table 11.3.

Table 11.3 Summary of Likely Impacts on Amenity and Expected Environmental Outcome

Existing Environment	Aspect	Likely Environmental Impacts	Mitigation and Management	Expected Environmental Outcome
EPA Objective: ***To ensure that impacts to the amenity are reduced to as low as reasonably practicable***				
The Proposal Area is located approximately 425 km north of Broome – the nearest significant settlement. Given its remote, offshore location, current activities in the Proposal Area are limited. Scientific research and traditional Indonesian fishing are the primary activities. There are also some occasional recreational fishing and tourism activities that take place at Scott Reef. Oil and gas activities and commercial fishing occur in the wider Region although the commercial fishing effort is limited. In the wider Region, shipping is sparse (the main commercial shipping route lies approximately 50 to 100 km west of the Proposal Area).	Physical presence	Scientific research and traditional fishers may experience minor inconvenience during drilling, seabed preparation, installation, commissioning and decommissioning activities. However, given that there are no permanent sea-surface facilities and no permanent areas of exclusion in the Proposal Area, such inconvenience will only be temporary. No impact is expected to other users of the Proposal Area given their limited presence and the short duration and small scale of the Proposal. No entanglement of commercial, traditional and recreational fishing gear with subsea infrastructure is expected due to the water depths at which the subsea infrastructure is installed.	Consultation will be ongoing with commercial fishers, recreational fishing groups and other relevant stakeholders that operate in the Proposal Area. Notice to mariners issued through the Australian Hydrographic Service to alert any other users present in the Proposal Area of the location of the development infrastructure and associated activities. Petroleum safety zones around the drill rig and some vessels will be applied and a process for communicating and operating these zones developed.	No significant adverse impacts on the amenity of the Proposal Area are likely. Some minor inconvenience to scientific research activities and traditional fishers may occur but any such impact is only temporary. Consultation with potentially affected users of the Proposal Area is required during the preparation of detailed Environment Plans for Proposal activities under other regulatory processes. Mitigation and management measures are standard maritime and offshore oil and gas industry practice and their implementation assured through the Environment Plan regime of other regulatory processes. The environmental objective is met.
	Physical Interaction	Risk of collision with other users of the Proposal Area is considered low given the mitigation measures in place and the low level of third party activity in and around the Proposal Area.	Vessels greater than 300 tonnes will be fitted with the Automatic Identification System (AIS) as per IMO requirements. Operational radar and vessel tracking equipment will be in place on support vessels in accordance with Marine Orders 30 (prevention of Collisions) and Marine Orders 21 (Safety of Navigational and Emergency Procedures). Vessels will adhere to standard maritime safety procedures including radio contact with approaching vessels and display of appropriate	

Existing Environment	Aspect	Likely Environmental Impacts	Mitigation and Management	Expected Environmental Outcome
			navigational beacons and lights in accordance with Marine Orders 30 (prevention of Collisions) and Marine Orders 21 (Safety of Navigational and Emergency Procedures). Petroleum safety zones around the drill rig and some vessels will be applied and a process for communicating and operating these zones developed.	
	Invasive Marine Species	Low likelihood that IMS could be introduced and settle given all subsea infrastructure will be transported and installed in deep water (greater than 350 m) and therefore provide unfavourable environmental conditions for IMS survival, settlement and reproduction.	See Table 8.7 for management measures related to invasive marine species.	

12. Heritage

12.1 EPA Objective

To ensure that historical and cultural associations are not adversely affected.

12.2 Existing Environment

According to the WA Department of Aboriginal Affairs' Aboriginal Sites Inquiry System, no known sites of Aboriginal Heritage significance are located in the Proposal Area. The existence of any unknown Aboriginal sites or artefacts of significance within the Proposal Area or its surrounds, is considered highly unlikely due to the area's remote offshore location.

The Australian National Shipwreck database and the WA Maritime Museum Shipwreck Database list one protected historic wreck within the Proposal Area (DEWHA 2008; WAM 2009). The historic shipwreck of the Yarra, sunk in 1884, is located at Sandy Islet (South Scott Reef) (maximum latitude of 14º02'3"S and maximum longitude of 121º46'0"E) (DEWHA 2008).

Scott Reef and its surrounds, incorporating both North and South Scott Reef and comprising the emergent reef, the partially enclosed lagoons and the surrounding oceanic waters extending to the 50 m below sea level bathymetric contour are listed on the Register of the National Estate for the following ecological and physical values:

- High representation of species not found in coastal waters off WA.
- Unusual nature of fauna which has affinities with the oceanic reef habitats of the Indo-west Pacific as well as the reefs of the Indonesian region.
- Importance for its contribution to understanding long-term geomorphological and reef formation processes and past environments as a result of its sedimentary sequence that extends back to include Triassic sediments.
- Green turtle rookery at Sandy Islet (DOE 2014b).

In addition, Sandy Islet, East Hook Island and the inter-tidal reef flat of South Scott Reef are listed as an area of 'reserved land' (formerly 'C' Class Nature Reserve) and are administered by the Department of Environment Regulation (DER) on behalf of the Conservation Commission of Western Australia under Section 7 of the *Conservation and Land Management Act 1984*. The reserved land is designated for the purpose of 'conservation of flora and fauna'. North Scott Reef and surrounds is a listed heritage place by the Heritage Council of Western Australia. The Proposal Footprint is outside these heritage listed areas.

12.3 Sources of Potential Impact and Expected Environmental Outcome

Given the lack of historical associations in the Proposal Footprint, and the distance of the only identified historical site of significance (the *Yarra* shipwreck located approximately 7 km from the closest drill centre), no potential impacts to historical associations are anticipated.

Potential impacts to the ecological and geomorphological values for which Scott Reef and its surrounds, Sandy Islet, East Hook Island and the inter-tidal reef flat of South Scott Reef, and North Scott Reef are heritage listed are discussed in Sections 6 through to 9. These sections concluded that no significant impacts associated with Proposal activities are likely. The management approach and associated mitigation and management measures in place to protect the preceding environmental factors also apply to heritage. Based on the heritage values of the Proposal Area and the conclusions of the preceding sections, no significant

effects on the heritage value of the Scott Reef are predicted as a result of the Proposal and therefore the environmental objective for heritage is determined to be met.

13. Risks Associated with Unplanned Events

The nature of the offshore oil and gas industry is that unplanned events could occur. Credible unplanned event scenarios relevant to the Proposal include hydrocarbon and chemical spills, vessel groundings and collisions and dropped objects.

As part of its internal risk assessment process, Woodside has identified and evaluated the risk to the environment of credible unplanned events associated with the Browse FLNG Development. The risk assessment took into account the likelihood of the event occurring, the likelihood sensitive receptors being affected if the event were to occur and the consequence on those receptors if the event were to occur.

The likelihood of an event such as a spill occurring was determined using the Woodside Quantitative Risk Data Manual and other industry standard historical spill frequency databases developed for a range of offshore petroleum activities (i.e. SINTEF 2012 Offshore Blowout Database). These databases provide a comprehensive record of loss of containment events that have occurred in the oil and gas industry dating back to 1955. This encompasses all possible causes of a spill for any reason associated with design, equipment, operational and procedural faults. Given operations in Australian waters, and in particular within the Browse FLNG Development area, are remote and distant from heavy third-party marine traffic compared to European or Gulf of Mexico waters, application of these databases provides a highly conservative quantification of spill probability for certain scenarios (e.g. vessel collision, anchor damage, dropped objects). The measures that Woodside will implement to prevent unplanned events occurring and reduce their potential to cause impact are summarised in Table 13.1.

Table 13.1 Spill Management Measures Relevant to the Proposal

Activity	Spill Management Measures
Drilling	During drilling, well-proven and fail-safe systems and procedures will be employed. These will be applied and supervised by highly competent and experienced personnel to minimise the potential for loss of well control, leading to well blow-out. Drilling activities will only be undertaken when metocean conditions are deemed suitable for safe operations. Reservoirs will be isolated from the surface by a minimum of two independent and verifiable barriers. The configuration of isolation barriers during the drilling phase typically includes: • Overbalanced hydrostatic pressure maintained on the reservoir via the drilling fluids. Drilling fluids are contained by the cemented casing to the mud line and riser to the rig. • Seabed BOPs which can be activated to “shut in” the well in the event that well control via overbalanced drilling fluids is lost. A 500 m petroleum safety zone will be implemented at the drill rig.
Commissioning and Operation	Hydrotesting will be undertaken prior to commissioning to ensure integrity of subsea systems and that there are no leaks in the subsea infrastructure. The configuration of reservoir isolation barriers during the operations phase typically incudes: • Production tubing from the reservoir to valving on the subsea tree. • Cemented casing and associated valving on the subsea tree, plus a production packer to isolate the annulus between the casing and production tubing from the reservoir. • Although not classed as a secondary barrier, a Surface Controlled Subsurface Safety Valve will be fitted on all production wells. The wells and subsea system will utilise corrosion resistant materials and be designed to protect against integrity threats (e.g. corrosion, impact, erosion, low temperature

Activity	Spill Management Measures
	embrittlement). Wellhead valve design and configuration allowing safe operation and control of the well. Design codes and material specifications for all flowlines will be compliant with the relevant Australian and international standards. Relief well planning will be outlined in the Oil Pollution Emergency Plan (OPEP) / Oil Spill Contingency Plan accompanying the Environment Plan(s) for the activity. Flowline monitoring will be undertaken including: • monitoring of corrosion protection system; • periodic inspections using side scan sonar and ROV; and • post-cyclone inspections if design environmental conditions are reached.
Refuelling activities	Any refuelling activities will be managed to prevent leaks and spills, including: • Where practicable, refuelling of support vessels will be conducted in port. • Refuelling will only be undertaken when metocean conditions are deemed suitable for safe operations. • Refuelling will be undertaken by trained personnel using defined procedures. • During refuelling, personnel will be required to maintain continuous observation and vigilance of hoses, couplings and the sea surface, allowing for the rapid shutdown of fuel pump and spill response if necessary. • Communication (visual and/or radio) between the supply vessel or drill rig will be maintained throughout refuelling and offloading operations. • Spill clean-up equipment will be available on board the drill rig and vessels to remediate minor spills.
Spill Response	All vessels will be required to have in place a Ship-Board Oil Pollution Emergency Plan (SOPEP) including oil spill response measures. Responsibilities and accountabilities will be defined for response and notifications to Woodside and relevant authorities. Response strategies in the event of an unplanned spill will be detailed in the relevant Environment Plan(s) and OPEP(s) specifically developed for the Browse FLNG Development, following the rigorous risk assessment of a range of spill response strategies available to Woodside and other operators in the Browse Basin. These strategies include both strategies to limit the volume of hydrocarbons being released to the marine environment and strategies to reduce the volume of hydrocarbons reaching sensitive receptors and are described in more detail in Section 9.2.18 of the Browse FLNG Development Draft EIS.

Hydrocarbon spill trajectory modelling was used to help predict the fate of spilled hydrocarbons, the likelihood of sensitive receptors being affected and the potential and consequence on these receptors. The scenario identified as having the highest risk (taking into account its likelihood of occurrence as well as its potential consequence on environmental receptors if a spill did occur) was a loss of well control (well blow-out) during drilling at TRE, being the closest infrastructure to a sensitive environmental receptor. Detailed results of the modelling and a discussion on the consequent impacts on receptors are provided in Section 10.20 of the Draft EIS for the Browse FLNG Development[2]. The assessment concludes that:

[2] Note that the unplanned event scenarios addressed in Section 10.20 of the Draft EIS for the Browse FLNG Development encompass events associated with activities and infrastructure outside the scope of the Torosa

- In the highly unlikely event that a blow-out was to occur at TRE drill centre, there would be potential for large scale and long-term effects to Scott Reef (being the closest sensitive location), and the overall risk of environmental impact resulting from a blow-out spill scenario is therefore high.
- However, taking into consideration the spill prevention and response measures that are outlined in Table 13.1, the likelihood of a well blow-out occurring and resulting in worst case hydrocarbon exposure is highly unlikely.

Therefore the overall risk to environmental factors was determined to be low.

Further consideration of the impacts and risks of unplanned events is a requirement under both the State and Commonwealth Environment Plan regimes. Woodside will therefore be required to further demonstrate that impacts and risks of unplanned events associated with its specific Proposal-related activities are reduced to ALARP and are acceptable. The Environment Plans prepared in support of Proposal activities are also required to include an oil spill contingency plan / oil pollution emergency plan which must, amongst other things, demonstrate that adequate arrangements and capability will be in place to ensure a timely response to an oil spill and to test these response arrangements.

Subsea Development Proposal. The well blow-out scenario discussed in the Draft EIS is the only scenario discussed that is relevant to the scope of this Proposal.

14. Conclusion

The assessment conducted for the components of the Proposal described in this referral concludes that no significant impacts on environmental factors are likely.

Only a limited number of environmental factors are anticipated to be affected by the Proposal and the EPA's environmental objectives for these factors can either be inherently met due to the selected concept and siting of infrastructure, the limited scope and scale of the Proposal, or can be readily be met through mitigation and management that is either common practice in the offshore oil and gas industry in WA or in some cases, goes beyond industry practice (e.g. for drill cuttings and IMS management). Implementation of these mitigation and management measures is regulated through other established processes (Environment Plans and associated oil spill contingency plans /Oil Pollution Emergency Plans required under relevant Petroleum regulations).

The larger Browse FLNG Development, including the components addressed in this referral, is being formally assessed at EIS level under the EPBC Act and will also be regulated by risk-based petroleum legislation, including the requirement for Environment Plans and revisions from time to time. Both regimes recognise the principles of ecologically sustainable development. Environment Plans for petroleum activities must demonstrate that risks and impacts are both of an acceptable level and will be reduced to ALARP. Performance outcomes are specified in such plans. Oil spill scenarios and proposed responses must be addressed as part of the implementation strategy.

The overall scope and scale of the Proposal is limited, compared with the larger Browse FLNG Development, of which the Proposal is a part, and other offshore oil and gas developments that incorporate production and export infrastructure. Proposal infrastructure and associated activities are commonplace in the offshore oil and gas sector in WA.

The environment of the Proposal Area and the wider region within which the Browse FLNG Development is located has been studied comprehensively through desktop reviews and scientific surveys spanning over approximately two decades. Potential impacts associated with the Proposal have also undergone extensive assessment and evaluation over a number of years, supported where relevant, by evidence collected from previous exploration and appraisal drilling in the Proposal Area, predictive modelling, third-party specialist studies and peer and independent reviews. For these reasons, and because the Proposal infrastructure and activities are well understood in the industry, there is considerable confidence in the results of the assessment.

Nevertheless, Woodside as Operator of the Proposal on behalf of the Browse JV Participants, is proposing to adopt a precautionary adaptive management approach to the implementation of the Proposal in line with one of the principles and objects of the EP Act. The adaptive management approach encompasses a range of management and mitigation measures developed using Woodside's adaptive management framework (Eliminate/ Substitute/ Prevent/ Reduce/ Mitigate) to address uncertainties over environmental impacts and ensure that the EPA's environmental objectives are met. Woodside also demonstrates achievement of other principles and objects of the EP Act through, amongst other things:

- Developing a monitoring program at Scott Reef with the aim of ensuring no impact to the environmental values of Scott Reef as a result of Proposal implementation.
- Contributing to the advancement of scientific knowledge at Scott Reef and the potential impacts of the oil and gas industry on biodiversity, e.g. Woodside published Scott Reef Status Reports in 2009 and 2011 summarising data collated from over 15 years of studies undertaken at Scott Reef.

- Inherently committing to the conservation of biodiversity via the implementation of internal performance standards such that impacts from the Proposal are either avoided or kept to ALARP.
- Conducting its activities in accordance with the Woodside Environment Policy (Appendix A) which includes, as a key principle, the efficient use of energy, water and other resources while reducing GHG emissions and waste.

As Operator, Woodside has undertaken extensive consultation over the past decade with a wide variety of stakeholders with respect to the development of the Browse resources, including the components addressed in this referral. Furthermore, potential impacts of the Proposal have previously been subject to regulatory and public review via EPBC Reference: 2008/411 (withdrawn) and EPBC Reference: 2013/7079 (assessment currently in progress). Issues raised by stakeholders that are relevant to the scope of this Proposal have been addressed through environmental assessment and, where relevant, mitigation and management commitments described in this Referral and in the Draft EIS for the Browse FLNG Development.. Given that no significant impacts on environmental factors are anticipated, the Proposal components are being assessed under the EPBC Act, and that environmental impacts and risks associated with specific Proposal activities will need to be managed to demonstrably ALARP and acceptable levels through a secondary approval process under the Petroleum (Submerged Lands) (Environment) Regulations 2012, the Browse JV Participants propose that no further assessment under the EP Act is necessary.

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16. Terms and Acronyms

Term	Description
º	Degree(s)
%	Percent
AIMS	Australian Institute of Marine Science
AIS	Automatic Identification System
ALARP	As low as reasonably practicable
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
APPEA	Australian Petroleum Production and Exploration Association
AQIS	Australian Quarantine and Inspection Service
ARC	Australian Research Council
BOD	Basis of Design *(when referring to design parameters)* or Biological oxygen demand *(when referring to organisms)*
BOP	Blow-out preventer
BP	BP Developments Australia Pty Ltd
BPP	Benthic primary producer
BPPH	Benthic primary producer habitat
CH_4	Methane
cm	Centimetre
CO_2	Carbon dioxide
CPF	Central Processing Facility
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cth	Commonwealth
dB	Decibels
dB re 1 µPa	Decibel relative to one micro Pascal
DER	Department of Environment Regulation
DEWHA	Department of the Environment, Water, Heritage and the Arts
DFWA	Department of Fisheries Western Australia
DHI	DHI Water & Environment Pty Ltd
DMP	Department of Mines and Petroleum
DOE	Department of the Environment
DOF	Department of Fisheries
DPaW	Department of Parks and Wildlife
EAG 1	Environmental Assessment Guideline for Defining the Key Characteristics of a Proposal

Term	Description
EAG 3	Environmental Assessment Guidelines: Protection of Benthic Primary Producer Habitats in Western Australia's Marine Environment
EAG 5	Environmental Assessment Guidelines: Environmental Assessment Guideline for Protecting Marine Turtles from Light Impacts
EAG 8	Environmental Assessment Guideline: Environmental factors and objectives
EAG 9	Environmental Assessment Guideline for Application of a Significance Framework in the environmental assessment process: focusing on key environmental factors
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986* (WA)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
ESD	Ecological Sustainable Development
FEED	Front End Engineering and Design
FID	Final Investment Decision
FLNG	Floating liquefied natural gas
FPSO	Floating Production, Storage and Offloading
GHG	Greenhouse gas
ha	Hectare
HAZID	Hazard identification
HQ	Hazard quotient
Hz	Hertz
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IAPP	International Air Pollution Prevention
IMO	International Maritime Organisation
IMS	Invasive marine species
ISPP	International Sewage Pollution Prevention Certificate
IUCN	International Union for the Conservation of Nature
JPP	James Price Point
JV	Joint Venture
kHz	Kilohertz
km	Kilometre
km^2	Kilometre squared

Term	Description
LNG	Liquefied natural gas
LP	Low pressure
m	Metre
m^3	Cubic metre
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships
MEG	Mono-ethylene glycol
MIMI Browse	Japan Australia LNG (MIMI Browse) Pty Ltd
mm/yr	Millimetre per year
MODU	Mobile offshore drilling unit
m/s	Metre per second
MSL	Mean sea level
N_2O	Nitrous oxide
NES	National Environmental Significance
NGO	Non-Government Organisation
nm	Nautical miles
NOPTA	National Offshore Petroleum Titles Administrator
NOx	Nitrogen oxides
NTU	Nephelometric Turbidity Units
NWBF	Non-water based fluid
OCNS	Offshore Chemical Notification Scheme
OPEP	Oil Pollution Emergency Plan
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PetroChina	PetroChina International Investment (Australia) Pty Ltd
PHB	Poly-3-hydroxybutyrate
PLONOR	Pose Little Or No Risk
PSLA	*Petroleum (Submerged Lands) Act 1982* (WA)
ROV	Remotely Operated Vehicle
SDS	Safety data sheet
SDU	Subsea distribution unit
Shell	Shell Australia Pty Ltd
SOPEP	Ship-Board Oil Pollution Emergency Plan
TN	Total Nitrogen
TSS	Total suspended solids
VOC	Volatile organic compound
VSP	Vertical Seismic Profiling

Term	Description
WA	Western Australia
WAM	Western Australian Museum
WBF	Water based fluid
WC Act	*Wildlife Conservation Act 1950* (WA)
WMS	Woodside Management System
Woodside	Woodside Energy Limited

APPENDIX A: Woodside Environment Policy

objectives

Woodside recognises that strong environmental performance is essential to our success and our continued growth. We are committed to managing our activities to reduce the adverse effects on the environment while balancing economic and social needs of sustainable development.

Woodside will set internal targets that challenge Woodside to improve our environmental performance over time. We will also report our environmental performance openly and transparently.

principles

Woodside will achieve these objectives by:

- Being constantly aware of our major environmental risks and ensuring the right designs, plans, actions and competent people are in place to control them.
- Using energy, water and other resources efficiently and reducing greenhouse gas emissions and waste.
- Integrating environmental requirements when designing or modifying facilities in order to reduce life cycle costs and environmental impacts.
- Complying with relevant laws and regulations and applying responsible standards where laws do not exist.
- Reducing the environmental impact of our activities.
- Supporting research to improve our understanding of the environment and using science to support impact assessments and decision making.
- Taking a collaborative approach with our stakeholders.

application

Responsibility for the application of this policy rests with all Woodside employees, contractors and joint venturers engaged in activities under Woodside operational control. Woodside managers are also responsible for promotion of this policy in non-operated joint ventures.

December 2013

woodside

TRANSMITTAL

DRIMS Ref:	**#9874855**	**Date:**	**28th November 2014**
To:	**Chris Stanley**		
Company:	**Office of the Environmental Protection Authority**		
Proj. Focal Point	**Julian Seah**	**Informed: B Chapman**	
From:	**Woodside GeoTechnical Operations**		

Description

SOP 1310 –

1 x CD-ROM containing:

1. PDF of report titled "" (i.e. Browse_FLNG_State_Referral_of_the_Torosa_Subsea_Development - 1 December 2014.PDF)

2. Zip file (Proposed_Torosa_Subsea_Development_GIS_Data.zip) containing;

- Proposed_Torosa_Subsea_Development.mxd
- <**Data**>
  * Browse_FLNG_Joint_Venture_Titles_as_at_November_2014.shp
  * Indicative_Torosa_Gas_Field.shp
  * Other_Indicative_Browse_FLNG_Gas_Fields.shp
  * Proposal_Area.shp
  * Proposed_FLNG_Facilities_in_Commonwealth_Waters.shp
  * Proposed_Flowlines_in_Commonwealth_Waters.shp
  * Proposed_Manifolds.shp
  * Proposed_Production_Gas_Flowlines.shp
  * Revised_Outer_Limit_of_State_Waters_3nm_Limit.shp
  * Scott_Reef_above_MLWS.shp
  * Scott_Reef_Bathymetric_Contours.shp
  * Scott_Reef_Habitat.shp

- <**Layers**>
  * Browse_FLNG_Joint_Venture_Titles_as_at_November_2014.lyr
  * Indicative_Torosa_Gas_Field.lyr
  * Other_Indicative_Browse_FLNG_Gas_Fields.lyr
  * Proposal_Area.lyr
  * Proposed_FLNG_Facilities_in_Commonwealth_Waters.lyr
  * Proposed_Flowlines_in_Commonwealth_Waters.lyr
  * Proposed_Manifolds.lyr
  * Proposed_Production_Gas_Flowlines.lyr
  * Revised_Outer_Limit_of_State_Waters_3nm_Limit.lyr
  * Scott_Reef_above_MLWS.lyr
  * Scott_Reef_Bathymetric_Contours.lyr
  * Scott_Reef_Habitat.lyr

Notes:

Disclaimer:

Please note that the data has been prepared to the best knowledge of the authorising person, however no

guarantee for accuracy and actuality of the data can be given.
If a geospatial data set is altered or transformed in any way the authorising person cannot accept responsibility for inaccurate procedures.

Confidentiality:

The provided data must not be used for any purposes other than the project specified. Confidentiality agreements apply as per the respective Woodside contract or per attached statement.

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For any question please contact the Woodside GeoTechnical Operations Group

Please acknowledge receipt by signing and returning copy to Gillian.hall@woodside.com.au

Received by :	
Signature :	
Date :	