Department of Industry and Resources

NDT

Northern Development Taskforce

Site Evaluation Report, Part B

September 2008

Table of Contents

Part B Site Evaluation Summary 1

1. Introduction 3

1.1. Region of Interest – The Browse Basin 3
1.2. Sources of Information 3
1.3. Structure of the Report 3

2. The Northern Development Taskforce 5

2.1. Background 5
2.2. Purpose of the Taskforce 5
2.3. Strategic Assessment Agreement 5
2.4. Interim Report July 2008 5

3. The Browse Basin 6

3.1. Overview 6
3.2. The Woodside Joint Venture (Browse JV) 7
3.3. The Ichthys Joint Venture 7
3.4. Shell Development (Australia) 8
3.5. Other Projects under Consideration in the Browse Basin 8
3.5.1. Nexus Energy 8
3.5.2. BHP Billiton 9
3.5.3. ConocoPhillips Australia Pty/Karoon Gas Australia (KGA) 9

4. Site Evaluation and Selection Process 10

4.1. Regional Setting 10
4.2. Site and Project Development Options - Evaluation Framework 10
4.2.1 Review of Alternative Pilbara Regional Locations to Kimberley 10

5. Methodological Considerations 12

5.1. An Across-Government Approach 12
5.2. Aboriginal Consultation and Kimberley Land Council Agreement 12
5.3. Consultation with the Environmental Sector 13
5.4. Consultation with the Tourism Sector 13
5.5. Community Consultation 13
5.6. Consultation with the Fisheries Sector 13
5.7. Industry Consultation 14

6. Site Evaluation Workshops 15

6.1. Background 15
6.2. The Environmental Context 15
6.2.1. Commonwealth Assessment of Matters of National Environmental Significance and National Heritage Value 15
6.2.2. Approach to Site Evaluation – Marine Environmental Experts Working Group 16
6.2.3. Approach to Site Evaluation – Terrestrial Experts Working Group 18
6.3. The Broome Workshop 20
6.4. The Perth Workshops – Contextual Issues 23

7. Site Attributes - Summary 26

7.1. Introduction 26
7.1.1. Overview of West Kimberley Regional Terrestrial and Marine Environmental Characteristics 26
7.1.2. Kimberley Plateau - North Kimberley IBRA Region 27

7.1.3. Canning Basin Dampierland IBRA Region 27
7.1.4. Coastal Environments 28
7.1.5. Coastal Marine Environments 29
7.1.6. Marine Threatened Fauna 29
7.2. Site Descriptions and Attributes 30
7.2.1. Gourdon Bay 30
7.2.2. Quondong Point 33
7.2.3. James Price Point to Flat Rock 35
7.2.4. North Head 38
7.2.5. Perpendicular Head/Emeriau Point 40
7.2.6. Packer Island/Black Rod Rock/Lombadina Point 43
7.2.7. Koolan Island 46
7.2.8. Wilson Point 48
7.2.9. Maret Islands 50
7.2.10. Cape Voltaire 53
7.2.11. Anjo Peninsula 55
8. Site Evaluation 57
8.1. Objectives and Method 57
8.2. The Site Evaluation Criteria Assessment 58
8.3. Outcomes 59
8.4. Further Studies 59
9. Additional Sources of Information 62
List of Appendices 63

Part B Site Evaluation Summary

The Northern Development Taskforce (NDT) Site Evaluation Report responds to the findings and evaluation processes identified and formalised in the NDT Interim Report released on 4 July 2008.

This Site Evaluation Part B Report provides an assessment of the 11 sites identified as potentially technically viable for the processing of Liquefied Natural Gas from the Browse Basin. The evaluation of these sites was aimed at determining the key environmental, heritage, technical and socio-economic constraints potentially impacted upon by the development of a Liquefied Natural Gas (LNG) processing hub.

This report will assist industry and the lead Browse Basin gas processing proponents in assessing the opportunity and viability of locating their gas processing functions within a LNG hub. It will also assist the Indigenous Traditional Owners to understand the environmental, heritage and socio economic impacts associated with the development of LNG processing on their country, prior to their decision to proceed with the strategic assessment of an LNG hub site.

The environmental, heritage and socio-economic analysis undertaken in preparation for this report has also identified:

- a range of sensitivities that need to be addressed through the strategic assessment process;
- further field studies that need to be undertaken; and
- where continued and more focused consultation with industry and the many stakeholders is required in this process.

The methodology used to undertake the evaluation of Kimberley sites began with the establishment in August 2007 of the NDT working groups.

The working groups represent a vast array of experience across many relevant fields of knowledge and this report draws upon their combined judgement alongside available data, extant reports and the outcome of NDT commissioned studies of the marine and terrestrial environment. The NDT wishes to acknowledge the assistance of the WA Marine Science Institution and its partners in the execution of these studies.

Industry has willingly assisted the NDT through the provision of important data, technical information and advice.

To undertake an evaluation of sites, the NDT established a Site Evaluation Panel made up of senior officers with relevant expertise from a range of government departments. In addition, the NDT invited members of the working groups to independently evaluate the sites. The two lead proponents, Woodside Energy Ltd on behalf of the Browse Joint Venture (JV) and INPEX Browse Ltd. on behalf of the Ichthys JV also provided an independent view on site viability.

In parallel with the preparation of this report, the Kimberley Land Council Traditional Owner Taskforce (TOTF) has been undertaking extensive consultations with all stakeholders and participating in environmental and heritage studies, visits to country and a visit to the Burrup Peninsula.

The Kimberley Land Council (KLC) has indicated the support of the TOTF to allow the NDT to continue with the evaluation of sites as outlined in this report.

The environmental analyses of all sites have highlighted the rich biodiversity of the Kimberley region and its role in supporting the recovery of the Humpback whale population. Studies are underway to better understand the migration of whales along the coast of the Dampier Peninsula.

It is acknowledged that the environmental non government organisations associated with this site evaluation process would prefer national heritage values assessment and evaluation of options for development outside of the Kimberley, to occur prior to the shortlisting of sites. The NDT is committed to the evaluation of alternative development options as part of the next phase of the strategic assessment process.

The NDT has commissioned WorleyParsons Services Pty Ltd to undertake a design concept study for the hub. This study will seek to determine the contribution design solutions can play in avoiding or minimising impacts on key environmental constraints from the hub development. In addition, the NDT will continue the environmental, heritage and geotechnical studies and surveys and begin the assessment of regional impacts on people, towns, industries, infrastructure and services.

The sites recommended for further consideration in this report will be subjected to geotechnical investigation in both the terrestrial and marine areas as well as subjected to Aboriginal heritage surveys. WorleyParsons Services Pty Ltd will prepare a design concept for each site cognisant of the environmental and technical constraints identified in this report. The outcome of this process will be an indication of the capacity to design a hub avoiding or minimising environmental, heritage or socio-economic impacts. It is anticipated these studies along with the considered opinion of the Traditional Owners will lead to the identification of a preferred site.

The outcomes of the site evaluations made by the Site Evaluation Panel are detailed in the Northern Development Taskforce Site Evaluation Report **Part A**.

1. Introduction

1.1. Region of Interest – The Browse Basin

The Browse Basin is a large (180,000km^2) basin located within the Australian North West Shelf. The Basin has a 40 year history of exploration. It is a world class petroleum region of continental margin sedimentary basin that comprises part of the North West Shelf hydrocarbon province, located offshore in Western Australia. The Browse Basin is estimated to contain 20 to 25 percent of Australia's remaining gas reserves.

1.2. Sources of Information

Information used in the course of the site evaluation process includes Geographic Information System (GIS) based assessment, data and reports from the State Department of Indigenous Affairs (DIA), Department of Planning and Infrastructure (DPI), Department of Industry and Resources, Department of Environment and Conservation, Office of Native Title, Tourism Western Australia, Department of Fisheries, WA Museum and the Kimberley Development Commission. The Taskforce also commissioned studies from a number of sources including the Western Australian Marine Science Institution (WAMSI) and partner organisations, including the Australian Institute of Marine Science, CSIRO, and the WA Museum along with terrestrial studies undertaken by ENV Consulting. Data, comments and reports were obtained from a number of Commonwealth government departments including the Department of the Environment, Water, Heritage and the Arts (DEWHA) and the Department of Resources, Energy and Tourism. A variety of industry reports and published documents together with substantial information obtained in the course of extensive consultation and stakeholder meetings form an integral part of this report. The Taskforce also had access to 'commercial in confidence' information from a number of industry sources including Woodside Energy Ltd, (Woodside), Shell Development (Australia) Pty Ltd (Shell) and INPEX Browse Ltd (INPEX).

1.3. Structure of the Report

This report is comprised of nine sections and twelve appendices. The content is as follows:

Section 1 introduces the report, defines the region of interest and summarises the sources of information used.

Section 2 describes the background of the Northern Development Taskforce (NDT).

Section 3 provides an overview of the Browse Basin.

Section 4 provides an explanation of the site evaluation and selection process.

Section 5 addresses methodological issues and considerations, including underlining assumptions and details of the range of comprehensive consultations undertaken with key stakeholders.

Section 6 outlines the details and outcomes of the site evaluation workshops undertaken in Broome and Perth in July and August 2008.

Section 7 provides a summary of the technical attributes and environmental, heritage and socio economic constraints of each site.

Section 8 explains the guidelines, matrix table and outcomes of the site evaluation and selection ranking undertaken by the range of stakeholders at the workshops.

Section 9 presents the references for the additional sources of information used in the report.

Appendix 1 Gaffney Cline and Associates Reports 1-3

Appendix 2 Broome workshop presentations

Appendix 3 Site location maps and GIS attribute data for the site maps

Appendix 4 Marine Studies Reports

Appendix 5 Western Australian Museum, Intertidal study

Appendix 6 Edith Cowan University, historical datasets of dugong observations in the Kimberley region of Western Australia

Appendix 7 Damara WA, Coastal Geomorphology report

Appendix 8 ENV Consultants reports:
8.1 Flora assessment
8.2 Vegetation assessment
8.3 Vertebrate fauna assessment

Appendix 9 Richard Hammond, Visual landscape study
9.1 Maps of Visual Landscape Character-Significance Ratings
9.2 Key Travel Routes and Use Areas
9.3 Visual Landscape Summary-Site Characteristics and Issues Matrix

Appendix 10 Environmental Experts Working Groups matrix assessments:
10.1 Marine
10.2 Terrestrial

Appendix 11 Site Evaluation criteria matrix

Appendix 12 Independent Assessment Panel comments

This report along with the appendices can be viewed on the NDT's website from **14 October 2008**. www.doir.wa.gov.au/ndt

2. The Northern Development Taskforce

2.1. Background

The Northern Development Taskforce was established by the Government of Western Australia in June 2007 to negotiate and coordinate the many issues associated with the development of the Browse Basin balanced against the wilderness, tourism, environmental and heritage values of the Kimberley. The NDT established a secretariat for the Kimberley, consisting of senior public servants from a range of key government departments and agencies.

2.2. Purpose of the Taskforce

The main purpose of the NDT is to manage across-government planning processes and stakeholder consultation with regard to the selection and development of a suitable location or locations for the processing of Browse Basin gas reserves in the Kimberley. A prime consideration for the NDT is to recommend a location or locations for the processing of natural gas from the Browse Basin by one or more operators, giving full consideration to Indigenous, community, environmental, tourism and heritage issues.

2.3. Strategic Assessment Agreement

In recognition of the importance of such a project, the State Government of Western Australia entered into an agreement with the Commonwealth Government to undertake a strategic assessment of a preferred hub site and an assessment of the national heritage values of the West Kimberley region.

The Strategic Assessment Agreement will run under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The planned hub will also be assessed under the strategic assessment provisions of the Western Australian *Environmental Protection Act 1986* (EP Act) through a concurrent and collaborative process.

The Agreement recognises the environmental and heritage values of the Kimberley, as well as the significant economic potential of the development of Browse Basin gas reserves.

2.4. Interim Report July 2008

The NDT released an Interim Report In July 2008. This Interim Report detailed the establishment of the NDT, the commencement of the across-government coordination process, initiated stakeholder consultations and established initial site selection criteria.

The key finding in the Interim Report was the Gaffney, Cline and Associates (GCA) selection validation process that reduced the number of Kimberley sites from a potential of 43 to a shortlist of nine. A further two sites were added by the Traditional Owners Taskforce established by the Kimberley Land Council. This shortlist of 11 sites was then subject to further evaluation and selection.

The three GCA reports are presented in **Appendix 1**.

3. The Browse Basin

3.1. Overview

The Browse Basin, offshore of north west Western Australia, holds substantial resources of natural gas. There are currently three gas processing proponents in the Browse Basin. These include the Woodside Browse Joint Venture, Ichthys Joint Venture and Shell. All three proponents are planning to use their known gas resources for Liquefied Natural Gas (LNG) projects with Browse JV and Ichthys JV seeking onshore LNG processing facilities.

These three projects are based on total gas resources of approximately 33.8 Trillion cubic feet (Tcf). While some of these resources were discovered over thirty years ago, the Basin is “gas prone” and has been relatively under explored.

A forecast reserve estimation based on the committed exploration wells to be drilled in the next three years (2008-2011) will likely add a risked mean expectation of finding recoverable petroleum resources of 34.4Tcf (973.6 Mm3) gas and 2274.2MMStb (361.6Mm3) condensate.

By comparison to a similar discovery and developmental timeframe for the North West Shelf, the potential reserves for the Browse Basin, based on internal government analysis, are reasonably expected to exceed those in the North West Shelf.

The Browse Basin is one of three basin formations in the Kimberley region that is subject to gas exploration, the others are the Canning Basin and Roebuck Basin. Current and future releases of exploration permits potentially extend the offshore gas fields geographically from west of Broome to west of Cape Bougainville, a distance of over 500 kilometres.

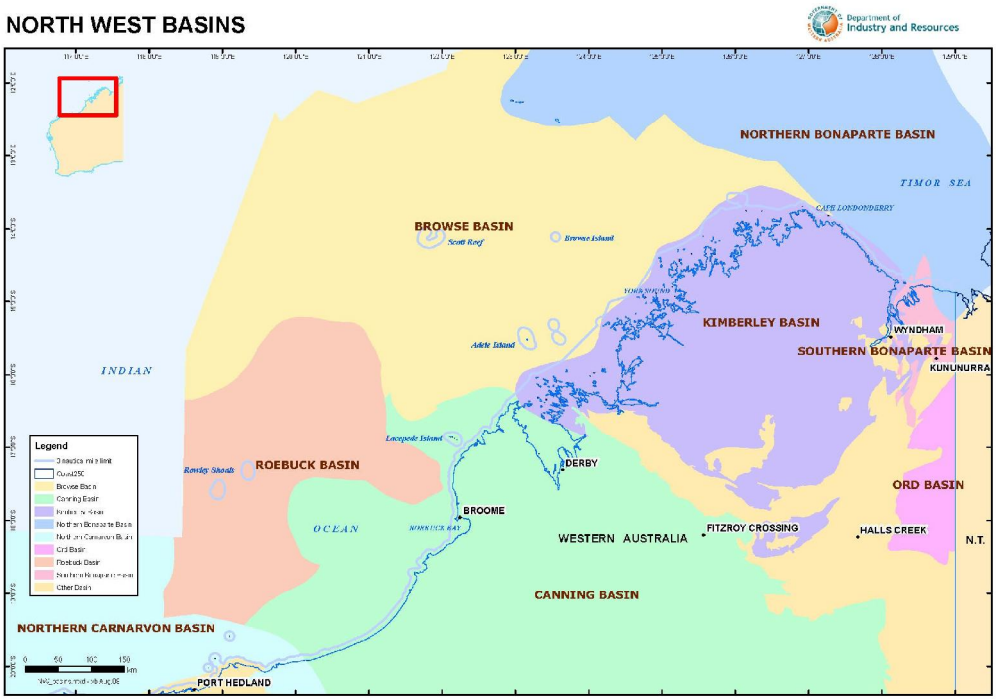

Figure 1: North West Basins

3.2. The Woodside Joint Venture (Browse JV)

The Browse LNG development operated by Woodside Energy Ltd (Browse JV) entails the development of three offshore gas-condensate fields in the Browse Basin; Torosa, Brecknock and Calliance (as well the JV in respect to WA-275-P and the Snarf-1 exploration well where a significant program of appraisal has been underway since 2005). Current estimated contingent resource for the three fields is approximately 18 Trillion cubic feet (Tcf) of gas and 300 million barrels of condensate.

These gas fields were discovered between 1971 and 2000, and are situated approximately 400 kilometres north north-west of Broome and approximately 290 kilometres off the Kimberley coast of Western Australia.

Woodside is expecting a decision on the preferred development concept and location of a gas processing hub on the Kimberley coast by October 2008. The Browse JV is scheduled to make a financial investment decision in 2010. Based on key-terms-agreements with two customers, PetroChina and CPC Corporation Taiwan, the Joint Venture is proposing to commence the processing of gas within the period 2013-2015.

The Browse JV submitted a referral under the EPBC Act for the upstream component of their proposed development in March 2008. The project was deemed by the Commonwealth Government to be a controlled action under the EPBC Act and will be assessed by an environmental impact statement.

3.3. The Ichthys Joint Venture

The Ichthys JV plans to develop the Ichthys gas and condensate field, which is located in the Browse Basin approximately 440 kilometres north of Broome, and has current estimated recoverable resource of approximately 12.8 Tcf of gas, and 312 mmbbl of condensate and LPGs. INPEX Browse Ltd, the major partner of the Ichthys JV recently confirmed the discovery of gas and condensate at their Mimia -1 well in close proximity of the existing Ichthys field.

The Ichthys JV is due to make its final investment decision in October 2008. The JV proposes to ship its first LNG cargo in 2013/14.

The Maret Islands are the Ichthys JV preferred location for its LNG processing facilities, where approximately 8 Mtpa of LNG will be produced for export to the Asia-Pacific market.

In May 2006, the Ichthys JV commenced its state environmental assessment process for the Maret Islands site and on 14 May 2006 the proposal was deemed by the Commonwealth Government to be a controlled action under the EPBC Act. On 10 July 2006, the Commonwealth Government agreed to a joint assessment process between the Commonwealth and the State Government of Western Australia.

The Ichthys JV has confirmed its interest in establishing a single operator LNG processing hub on the Maret Islands with a capacity to process up to 31 million tones of LNG per year, inclusive of third party owned gas.

On 27 February 2008, the Ichthys JV announced that it had signed a project facilitation agreement with the Northern Territory Government. The agreement supports the Ichthys JV undertaking a range of studies to assess the viability of a Northern Territory location for its LNG processing facilities, in parallel with its continuing studies for the Maret Islands.

In May 2008, INPEX Browse Ltd submitted a referral under the EPBC Act to develop onshore gas processing facilities at Blaydin Point in Darwin. The project was deemed by the Commonwealth Government to be a controlled action under the EPBC Act and will be assessed by an environmental impact statement.

3.4. Shell Development (Australia)

In January 2006, Shell was awarded Exploration Permit WA-371-P in the northern Browse Basin. The block is located adjacent to the Ichthys Field. Shell began a three-year drilling program in November 2006 with the first of 12 exploration wells completed in late March 2007. Based on the expected gas reserves in the Ichthys Field, there could be up to 10 Tcf of gas discovered in WA-371-P.

Shell has undertaken exploration work on WA-371-P and began a three-year drilling program in November 2006 with the first of 12 exploration wells completed in late March 2007. Shell announced a discovery of 2-3 Tcf of gas as a result of its Prelude Well in 2007. Eight wells have now been completed and further exploration work is planned.

A range of onshore and offshore development options has been considered by Shell for its Prelude discovery, with the company recently indicating that the preferred development option for this gas field may be to pursue a floating LNG processing plant capable of processing up to 3.5 million tonnes of LNG per year.

On 7 May 2008 the referral by Shell of its floating LNG plant proposal was deemed by the Commonwealth Government to be a controlled action under the EPBC Act given the likelihood of significant impacts on matters of national environmental significance. The proposal will be assessed under the EPBC Act by an environmental impact statement.

3.5. Other Projects under Consideration in the Browse Basin

3.5.1. Nexus Energy

In January 2007, Nexus Energy (Operator) finalised an agreement with Shell for the two companies to jointly commence the appraisal of the Echuca Shoals gas discovery in Nexus's WA-377-P exploration permit, located immediately adjacent to Shell's WA-371-P permit area.

Nexus will provide a reassessment of the Echuca Shoals resource potential following a complete technical evaluation incorporating the results of the Fossetmaker-1. Previous reports from Nexus suggest that expected gas reserves in the Echuca Shoals Field could be 5 Tcf.

3.5.2. BHP Billiton

BHP Billiton is the operator of five permits in the deepwater outer Browse Basin, located west of the Brecknock and Torosa discoveries. The outer Browse is a relatively high risk frontier basin with the potential to deliver large volumes of gas for LNG supply.

Exploration drilling at the Snarf-1 exploration well in permit WA-275-P also commenced during 2007, but will not be completed until late 2008 due to issues relating to rig availability.

BHP Billiton also holds a 100% working interest in retention lease AC/RL8 over the Argus gas discovery, located around 100 kilometres north east of the Torosa Field.

3.5.3. ConocoPhillips Australia Pty/Karoon Gas Australia (KGA)

ConocoPhillips (51 per cent) has completed a farm-out agreement with KGA (49 per cent) in exploration permits WA-314-P/WA-315-P. ConocoPhillips can earn up to 60 per cent equity in the permit. The permit areas are approximately 10 kilometres north east of Woodside's Browse permits.

Karoon estimates that the seven prospects identified in the permits contain a contingent resource estimate of over 20 Tcf of gas plus associated liquids (risked).

New 2D and 3D seismic is partly interpreted by Karoon, confirming the potential of the prospects. Karoon plans to drill three wells in the third quarter 2008.

New acreage has also been awarded to Karoon (40 per cent) and ConocoPhillips (WA-398-P).

4. Site Evaluation and Selection Process

4.1. Regional Setting

The Kimberley region of Western Australia is large, environmentally varied and diverse. According to the Kimberley Development Commission, the region covers an area of over 420,000 sq kilometres and has a relatively small population estimated at just under 30,000 people (ABS Census 2006). The region also has a very high proportion of Aboriginal persons compared to other regions in Western Australia. The 2006 Census recorded that 47.7 per cent of the Kimberley resident population identified themselves as Indigenous. This is much higher than the State average, estimated to be closer to 4 per cent. In addition, the median age of the Indigenous population in the Kimberley was 22 years of age compared to the Western Australian median age of 36 years.

The tourism, fishing and aquaculture industries are also recognised to form a critical part of the Kimberley economy and reflect the unique history, culture and lifestyle of the region.

4.2. Site and Project Development Options - Evaluation Framework

The NDT is focused on the identification of a site or sites suitable for processing gas from the Browse Basin. It does, however, recognise that the oil and gas industry has under consideration a range of alternative gas processing options inclusive of gas processing offshore, gas processing in Darwin, gas processing on the Burrup and the use of a floating gas processing infrastructure.

The NDT recognises that several development options suited to the particular nature and circumstances of different Browse projects have emerged and are likely to be developed in parallel with an onshore gas hub.

4.2.1 Review of Alternative Pilbara Regional Locations to Kimberley

In addition to the 11 sites, in the Kimberley, identified in the NDT interim report the NDT undertook a preliminary assessment of the coastal area from the Kimberley to the Burrup Peninsula seeking alternative sites that could potentially meet the technical criteria for an LNG processing hub.

The area from Cape Bossut to Port Hedland is characterised by shallow coastal marine bathymetry with 10 metre deep water being up to 20 kilometres off the coast and low near shore coastal topography well below the 10 - 15 metres required to ensure protection from surge tides.

Port Hedland offers brownfield industrial development sites but does not have deep water nor does it have 10+ metre elevated land close to the coast.

Cape Lambert and the Burrup Peninsula meet the basic marine and terrestrial criteria as a site for LNG processing with the Burrup offering the advantage of existing LNG infrastructure and the availability of disturbed industrial land with developed port facilities and shipping channels.

No LNG processing proponent has expressed interest in establishing a Greenfield LNG processing facility in the Pilbara north of the Burrup Peninsula.

The NDT considers that the technically viable options for processing Browse Basin gas in the Pilbara as an alternative to the Kimberley include the Woodside Browse development theme of piping the gas to the existing LNG processing facilities on the Burrup via an off shore pipeline or the alternative proposal to use an onshore pipeline from the Dampier Peninsula to the Burrup.

The NDT will consider these alternatives prior to the Strategic Assessment of the preferred Kimberley site.

5. Methodological Considerations

5.1. An Across-Government Approach

The main purpose of the NDT is to manage across-government planning processes and stakeholder consultation with regard to the selection and development of a suitable location or locations for the processing of Browse Basin gas reserves in the Kimberley.

Since its inception, the NDT has had a close working relationship with the Commonwealth Government, in particular, DEWHA and the Department of Resources Energy and Tourism. Senior officers from DEWHA attended the initial issues scoping workshop in Broome on 17-18 October 2007.

On 6 February 2008, the Strategic Assessment Agreement was jointly signed between the Commonwealth and the State Government of Western Australia.

At the state level, the NDT works very closely with a range of government departments and agencies. These include the Departments of Industry and Resources, Environment and Conservation, Fisheries, Indigenous Affairs, Planning and Infrastructure, Tourism Western Australia, The Heritage Council, Office of Native Title and the Kimberley Development Commission.

The NDT also manages this across-government planning approach with the key local government authorities in the Kimberley region. These include the Shires of Broome, Derby/West Kimberley and Wyndham East Kimberley.

5.2. Aboriginal Consultation and Kimberley Land Council Agreement

For the purposes of the *Native Title Act, 1993* (Cth), the Kimberley Land Council (KLC) is the recognised Native Title Representative Body for the Kimberley region, representing Traditional Owners in the Kimberley. The KLC is therefore the appropriate organisation to facilitate comprehensive engagement with Kimberley native title holders and claimants and other Aboriginal community members and the NDT has signed a Financial Assistance Agreement with the KLC to support this process.

It has been agreed with the KLC that they will facilitate consultations with all coastal native title holders, claimants and Aboriginal communities from Cape Bougainville in the north to the Kimberley/Pilbara representative area in the south. The KLC program of consultation has involved over 30 community and Traditional Owner representative meetings held between March and July 2008.

The KLC and the NDT have agreed a work plan to ensure that native title holders, claimants and Aboriginal communities on the Kimberley coast have the opportunity to be fully informed about the Browse Basin gas development and any proposals to process the gas onshore.

The KLC and the Traditional Owners have actively participated in NDT working groups or in field studies and workshops.

In addition, other Aboriginal interests such as Aboriginal tourism businesses and community organisations have contributed to knowledge sharing.

5.3. Consultation with the Environmental Sector

Environmental issues and considerations played a major part in the NDT consultation strategy. The NDT, working with the Commonwealth Government, identified a range of environmental concerns which needed to be appropriately addressed in a formal strategic assessment process under both State and Commonwealth legislation.

Accordingly, a range of environmental working groups was established to address the various issues. Some of these groups focused on a particular area such as the marine environment, while others examined the environmental implications of the project from a more strategic perspective. Three separate but related environmental working groups were set up, each with their own schedule of meetings and work plans. These included a marine environment experts group, a terrestrial environment experts group and a general environment group with representation from the environmental non government organisations. The NDT regularly attended the group meetings and consistently consulted and liaised with these groups.

5.4. Consultation with the Tourism Sector

The Tourism Working Group consists of key industry representatives from various sectors within the tourism industry; including marine tourism, land-based tourism, visitor servicing and marketing. The Working Group was established to address some of the tourism issues that may arise from the establishment of a gas processing hub in the Kimberley. The tourism sector desires to minimise the impact on an existing successful and productive tourism industry by avoiding a site that impinges on the wilderness and uniqueness of the Kimberley coastline. The main areas of potential impact include; accommodation availability both short and long term, airline seat availability and related price increases, exacerbation of the Kimberley permanent part-time and full-time labour shortages and increases in shipping movements along the Kimberley coast.

The Tourism Working Group participated in the assessment of sites and presented the outcomes at the Broome workshop in July 2008.

5.5. Community Consultation

The community consultation strategy involved the setting up of the Community Reference Group consisting of representatives from local government, business and community service delivery agencies. The NDT organised a series of public meetings throughout the Kimberley region in 2008. The Community Reference Group responded by preparing a report on their preliminary analysis of the shortlisted sites in advance of the Broome workshop in July 2008. This community work further informed the Broome workshop and enriched the NDT's consultations with the broader Kimberley community.

5.6. Consultation with the Fisheries Sector

The Fisheries Working Group was established to address some of the fishing and fishing related issues that may arise from the establishment of a gas processing hub in the Kimberley. These included possible impacts on the pearling sector, aspects of marine safety and the labour force implications for the fishing industry itself. Members of the Working Group included the Pearling Producers Association, WAFIC, Recreational Fish WA and the WA Department of Fisheries.

The Fisheries Working Group has met on a regular basis and also presented at the Broome workshop.

5.7. Industry Consultation

With a project of this size and complexity, key industry players in the oil and gas sector had a number of key issues and concerns. These included timeframes relating to site identification, the operator model for a common-user hub as well as the potential impact of the hub on the environment of the chosen site.

In response to these and other issues, the NDT established the Industry Reference Group. This group consisted of representatives from Woodside, BP, Shell, BHP Billiton, Chevron, Total, INPEX, Arc Energy and the Australian Petroleum Production and Exploration Association (APPEA).

A number of meetings were held in 2008 to help industry understand the progress of the strategic assessment process. During this consultation phase, the NDT has worked closely with the Industry Reference Group to ensure that the strategic assessment process occurs within viable developmental timeframes.

The NDT has worked closely with the two lead proponents, Woodside Energy Ltd on behalf of the Browse Joint Venture and INPEX on behalf of the Ichthys Joint Venture.

Both projects have provided extensive technical information to the NDT consultants, Gaffney Cline and Associates and satisfied, where possible, all requests for information and data required by the NDT for this report.

6. Site Evaluation Workshops

6.1. Background

The site evaluation process consisted of working group analysis which culminated in a series of community based evaluation workshops in Broome and Perth, leading to the identification of those sites recommended for further evaluation for suitability as a gas processing hub. All working groups and industry presented information at the Broome workshop in July 2008. The subsequent Perth workshops consisted of a two day evaluation by the NDT panel of the selection criteria. In addition, members of the environmental and fisheries working groups independently evaluated the environmental criteria in the presence of observers from the environmental Non Government Organisations (eNGOs) stakeholders. The eNGOs did not participate in site evaluation due to their view that there was insufficient knowledge of the Kimberley environment to be able to undertake a comparative analysis at this time.

The KLC, on behalf of the Traditional Owners, were also provided with the NDT Site Evaluation Panel ratings for their consideration.

Woodside and INPEX were also provided the opportunity to independently assess each site using the NDT criteria.

A summary workshop was held on the 7 August 2008 to compare each group's evaluation perspectives.

6.2. The Environmental Context

6.2.1. Commonwealth Assessment of Matters of National Environmental Significance and National Heritage Value

The Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) provided information on matters of national environmental significance.

Information on matters of national environmental significance can be found at the DEWHA web site http://www.environment.gov.au/epbc/index.html (EPBC Act website which has links to the protected matters search tool and species profile and threats database).

Further information on Ramsar wetlands and the Directory of Important Wetlands in Australia can be found at:

http://www.environment.gov.au/water/publications/environmental/wetlands/database/index.html

Matters of national environmental significance (especially threatened and migratory species) may occur at the proposed hub site and in some instances are protected under both State and Commonwealth legislation. These matters of national environmental significance/State protected species will be taken into account during the shortlisting and assessment process.

An Australian Heritage Council (AHC) preliminary assessment of national heritage values for the Kimberley coast (from Eighty-mile Beach to Cape Ruhlieres) is being undertaken to form part of DEWHA's 2008 Kimberley strategic assessment.

The criteria applied to national heritage list assessments will be used as the basis for analysis in the NDT's assessment of each site. A preliminary assessment has been made as to whether there are likely or unlikely to be national heritage values of outstanding significance found on the Kimberley coast. DEWHA's heritage division will shortly provide information on potential national heritage values for the NDT site evaluation process.

6.2.2. Approach to Site Evaluation – Marine Environmental Experts Working Group

The Marine Environmental Experts Working Group (MEEWG) was established to assess the marine environmental sensitivity of a number of sites in the context of the threats and pressures associated with the construction and operation of a large scale LHG hub at that locality. The approach and considerations associated with the appraisal are outlined below.

Construction: The construction of large-scale marine infrastructure generally involves dredging that can liberate large quantities of fine particles to the water column. Those particles can clog the feeding appendages of filter-feeding organisms such as corals, soft corals and sponges and reduce light available for light dependent organisms such as seagrass, algae and reef-building corals. Drilling and pile driving typically used in the construction of wharves and load-outs can generate significant percussion that can damage or kill marine fauna such as turtles and underwater noise that can cause adverse behavioural responses, such as displacement from critical habitats in some marine life such as whales and dolphins.

Operations: The impacts of the planned day to day operation of an LNG hub will include active components such as wastewater discharges, vessel and aircraft movements and associated noise as well as passive components such as altered hydrodynamic and sediment transport regimes due to the presence of physical infrastructure. It is expected that the LNG hub facility will have an operational life in excess of 50 years with significant quantities of wastewater generated and multiple ship movements each day. Ship traffic and noise emissions can alter patterns of usage by marine fauna and interfere with critical life cycle processes such as breeding. Activities located in critical habitats and over long periods have potential to cause population altering impacts. Ship movements also have the potential to transfer invasive marine species through discharge of ballast water.

Area of effect: For the purposes of the evaluation, an area 3 kilometres long-shore and 4 kilometres offshore was considered to be the 'footprint' associated with construction, where direct environmental impacts would be high. Turbidity from dredging and reclamation would have effects extending beyond the footprint over a notional 5000ha (10 kilometres long-shore and 5 kilometres offshore) zone of effect but impacts in this zone were assumed to be moderate, attenuating to low with distance from the footprint. It was felt that planned discharges (e.g. desal brine, domestic wastewater, process water) could be managed to ensure impacts would be contained within the infrastructure footprint. The zone of influence of unplanned discharges (leaks/spills) was notionally set at ~20 kilometres down current. Vessel movements and noise were considered to affect an area surrounding the marine facilities and extending seaward as a broad band centred along the likely navigation channels.

Environmental sensitivities: The environmental consequences of an LNG hub at any particular site will depend on both the relative susceptibility of the ecological communities to the pressures posed by the hub and on their ecological significance or importance. The most sensitive marine benthic communities were considered to be corals, seagrass, filter-feeders, mangrove and algae. The most sensitive marine fauna were the listed species such as whales, sea turtles, dugong and sawfish. The importance for seabirds was also considered.

The relative ecological significance of any marine biological community is related to characteristics of that community both locally and regionally. In general, areas of high productivity, high biological diversity, high density or with communities that have a limited distribution would be more important, and therefore more sensitive to the effects of an LNG hub, than areas of low productivity, low diversity and with communities with low density and widespread distributions. Similarly, areas in or close to important fauna habitat would be more sensitive than areas more distant to those important habitats.

Information base: While there is a broad understanding of the regional biophysical and marine biodiversity characteristics of the Kimberley region, detailed survey information is patchy and incomplete. There is some existing project and site specific information gathered by industry that supplements existing knowledge for particular sites. This is supplemented by recent Department of Environment and Conservation field studies that provide an improved regional contextual understanding of the characteristic benthic community patterns and distribution. More comprehensive studies commissioned by the NDT have been undertaken to provide detailed map-based data on benthic community types, habitats and bathymetry for study areas around each of the short listed sites in the southern Kimberley. Information for Gourdon Bay, Coulomb to Quondong Point, North Head - Perpendicular Head and Anjo Peninsula areas are included in the Appendices to this report.

Some key elements of marine fauna such as Humpback whales have been studied for a number of years, and their broad migration patterns and key areas for calving and resting have been identified. Further studies are underway during this year's annual migration, particularly targeting the southern shortlisted sites, to help inform site selection and any subsequent environmental assessment processes.

Knowledge of sea turtle nesting beaches in the region is incomplete, but the importance of key islands as nesting sites is recognized. The general beach and foredune landform requirements for successful turtle nesting are also well understood and can be used to eliminate most coastal areas as potential nesting sites. Some information is available on dugong feeding habitat requirements and foraging areas and studies of dugong seasonal distribution and movement patterns are ongoing. Some information is also available on important seabird feeding/nesting sites and seasonal usage of intertidal habitats, and for important fish species including those that are listed as threatened or endangered.

The information base used for the biohabitat and faunal assessment is summarized in **Table A** below.

Table A. Sources of information used to identify key habitats and importance to marine fauna for each locality.

Site/Aspect	Information Base
Gourdon Bay	Preliminary site investigation**. Quantitative benthic habitat surveys***. Intertidal survey****.
Quondong Pt.	Preliminary site inspection*. Quantitative benthic habitat surveys***.
James Price Pt.	Preliminary site inspection*. Quantitative benthic habitat surveys***.
Coulomb Pt.	Preliminary site inspection*. Quantitative benthic habitat surveys***.
North Head	Preliminary site inspection*. Quantitative benthic habitat surveys***.
Perpendicular Head	Preliminary site inspection*. Quantitative benthic habitat surveys***. Intertidal survey****.
Packer Is.	Preliminary site inspection**. Quantitative benthic habitat surveys***. Intertidal survey****.
Koolan Is.	Preliminary site inspection*. Industry information exists.
Wilson Pt.	Preliminary site inspection*. Woodside supplied data from intertidal survey.
Maret Is.	Short site visit. INPEX have substantial data.
Cape Voltaire	Remote sensing information.
Anjo Peninsula	Remote sensing information. Preliminary reconnaissance benthic habitat survey *****
Seabirds	Unpublished data, WA Museum. Professional opinion#.
Fish	Unpublished data, Department of Fisheries. Professional opinion#.
Cetaceans	Unpublished data, Centre for Whale Research. Professional opinion#.
Turtles	Unpublished data, DEC. Professional opinion#.

* DEC, November 2007
** DEC, April 2008
*** AIMS/CSIRO, June 2008
**** WA Museum, May – June 2008
***** DEC August 2008
# includes information from members of the MEEWG, other scientists, naturalists and local/Indigenous knowledge.

The MEEWG data is presented in **Appendices 4, 5, 6 and 10.**

6.2.3. Approach to Site Evaluation – Terrestrial Experts Working Group

An Environmental Experts Working Group (Terrestrial) was formed in November 2007 to assess and integrate available knowledge on sites along the Kimberley coast that have been identified by industry as potentially suitable for a gas processing plant. The working group developed a site characteristics and issues matrix, as a consistent framework for summarising the terrestrial biophysical attributes of each site, so that comparisons could be made (an advanced draft was provided as Appendix 7 in the NDT Interim Report July 2008). The Matrix makes use of consistent region-wide geological mapping as an initial discriminator of site substrate and landform characteristics, which also informs expert knowledge of the range of vegetation types and fauna habitats likely on sites. The Terrestrial Experts Working Group assessment matrix is presented in **Appendix 10.**

Environmental consultants were employed to carry out on-ground flora, vegetation and fauna surveys, coastal geomorphology and stability assessments, landscape quality assessments and intertidal surveys of sites for which information was insufficient to allow assessment. Industry-sourced information was sought for sites where this had been collected (Koolan Island, Wilson Point and the Maret Islands). INPEX was unable to provide access to the detailed survey information that they had collected for the Maret Islands.

The Cape Voltaire and Anjo Peninsula areas have only recently been added as potential sites by the KLC at the request of Traditional Owners. Studies covering flora, fauna, vegetation and coastal geomorphology have now been undertaken in respect of the Anjo Peninsula. Access restrictions to the Quondong and James Price Point sites for terrestrial surveys due to conflicting native title claims to this area have recently been addressed, enabling some access for initial dry season flora and fauna studies to be undertaken. Vegetation mapping of the Quondong and James Price Point areas has been undertaken from helicopter. These areas are reasonably well known to experts on or accessed by the group and have the simplest terrestrial environments of all the potential locations.

The Terrestrial Experts Working Group met in late July 2008 to bring together the available information and do a preliminary comparison of the potential environmental threats and pressures associated with the construction and operation of a LNG hub on these locations. This included specialists in coastal geomorphology, landscape quality assessment, and detailed site assessments. Botanical and faunal specialists provided compilations of available data, knowledge and expert judgement to further inform this process. Sites were appraised in terms of 11 environmental factors used in the matrices that are intended to help inform various components of the Site Selection Criteria.

Geological province and surface management – Geological characteristics and diversity - site access, topographical constraints, earthmoving required, capacity to absorb/manage stormwater and sediment discharge, size of area available to facilitate management of impacts on site;
Coastal geomorphology/stability - Coastal processes, characteristics and stability of the coastal environment that could have implications for construction and management of a hub;
Diversity and significance of vegetation communities - Consideration of the significance of the site vegetation communities in the context of the local area and region. Sites with relatively simple widespread landform vegetation types are preferred in preference to sites with a diversity of landform and vegetation types, and threatened or significant vegetation communities that are restricted to limited areas, or at risk in the region;
Threatened and significant flora - Consideration of the significance of the flora on the site or potentially on the site. Knowledge of the distribution of species in the region is patchy and incomplete, so current known occurrences and distribution of species identified from surveys needs to be considered as preliminary;
Threatened and significant fauna - Consideration of the significance of the fauna (fauna habitat) on the site or potentially on the site. Knowledge of the distribution of species in the region is patchy and incomplete, so current known occurrences and distribution of species identified from surveys needs to be considered as preliminary;
Short range endemics - Short range endemics are particularly associated with habitats that are patchy and isolated in their distribution – usually Monsoonal Vine Thickets, isolated limestone environments and islands. A risk-based approach has been used;
Natural heritage significance - Preliminary consideration of the likely national heritage values found for each of the potential hub sites in the context of coastal areas of the Kimberley;
Visual landscape significance - Assessment of visual landscape significance of the site and its surrounding areas, using standard methodologies adopted by the Department of Environment and Conservation (DEC), other state agencies and at the national level;

Remote area quarantine risk - The potential impact of the introduction of pest weed species and diseases to the site. Islands that are significant as refugea, and sites that are remote from vehicle access development and largely pest and weed free are more sensitive than sites that have a history of development disturbance, weeds and land-based vehicle access;
Remote area infrastructure risk - The potential for environmental impacts should a future decision be made to establish land-based infrastructure and or access to a site that may initially be serviced by sea and air. Remote mainland sites pose a potential for major cross-region scale future impacts. Mainland sites with existing access and developments have limited potential for impact. Island sites are self-contained; and
Existing/proposed marine or terrestrial conservation reserves - Recognition of conflicts with existing or formally recommended terrestrial or marine conservation reserves and Indigenous Protected Areas.

The sites showed significant differences in their environmental characteristics, values and potential for impacts. At a meeting on 1 August 2008, members of an Independent Assessment Panel used this information to rate each site's characteristics against the Site Selection Criteria on a scale from 1 to 6.

The Terrestrial Experts Working Group data is presented in **Appendices 7, 8, 9 and 10.**

6.3. The Broome Workshop

Over 120 people attended the three day site evaluation workshop in Broome in July 2008. There were representatives from the NDT, Commonwealth Government, Community Reference Group, various environmental groups, Fisheries Working Group, Northern Development Taskforce Independent Assessment Panel, Tourism Working Group, West Kimberley Working Group, Industry, Traditional Owners, recreational fishermen and members of the general community.
The objectives of the Broome workshops were to:

- Bring together a broad range of knowledge specific to the region and selected locations;
- Identify potential technical, environmental and heritage constraints relative to each location;
- Provide the Traditional Owners with information that will assist in their decision making;
- Gain an industry perspective on development approaches and site evaluation;
- Gain a Traditional Owner perspective on the proposed LNG development and its likely impact on Aboriginal communities, culture and heritage; and
- Help identify knowledge gaps that will inform additional environmental, socio-economic and heritage studies.

Representatives of the eight NDT working groups made presentations at the Broome workshop. These are presented in **Appendix 2**. The presentations along with a range of data, reports and the analysis previously undertaken within the working groups would later inform the completion of the Strategic Assessment Site Evaluation Criteria Matrix.

Significant matters raised at the workshop included the significance of the Kimberley coast to the Humpback and other whale species and the role the region plays as a whale calving and resting ground. The Centre for Whale Research (WA) produced evidence of the Camden Sound area near Wilson Point as the core area of the Humpback whale calving grounds and the area off the west coast of the Dampier Peninsula, north from the Lacepede Islands is an important resting and aggregation area for Humpback cows and calves before they begin their southward migration.

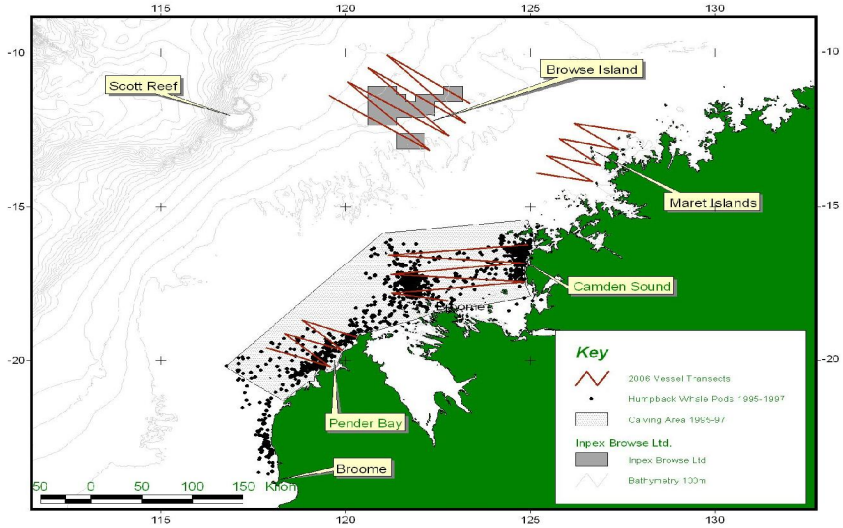

Figure 2 Whale Aggregation Areas, Dampier Peninsula, (Centre for Whale Research WA).

The Environs Kimberley and Save the Kimberley organisations argued for full protection of the Kimberley and the adoption of alternative development themes such as Gas to Darwin and Gas to the Pilbara.

"In a world where billions of human footprints have taken a heavy toll, the Kimberley stands as a rare example of how things once were, in the pre-industrial world, when natural systems were healthy and flourishing".
(Environs Kimberley 2008)

Other eNGOs urged that the development of the Kimberley was inappropriate, given the few areas left on the planet that are not significantly impacted upon by industrialisation.

"A sustainable future for the Kimberley can only be achieved through broad-scale and long-term planning, in which primacy is given to the national and international significance of the natural landscapes."
(Conservation Council of Western Australia, presentation Broome workshop).

The Australian Conservation Foundation and the WWF expressed concern over the 'Greenhouse impact' of the high CO_2 content arising from potential Browse Basin developments.

"Processing Browse LNG will result in significant carbon dioxide emissions for WA. The WA Government target is likely to be ~26mtpa by 2050. If there is no policy on CO_2 emissions for major projects like the Browse Basin, INPEX and Woodside projects are estimated to add 18mtpa."
(eNGO presentation Broome workshop).

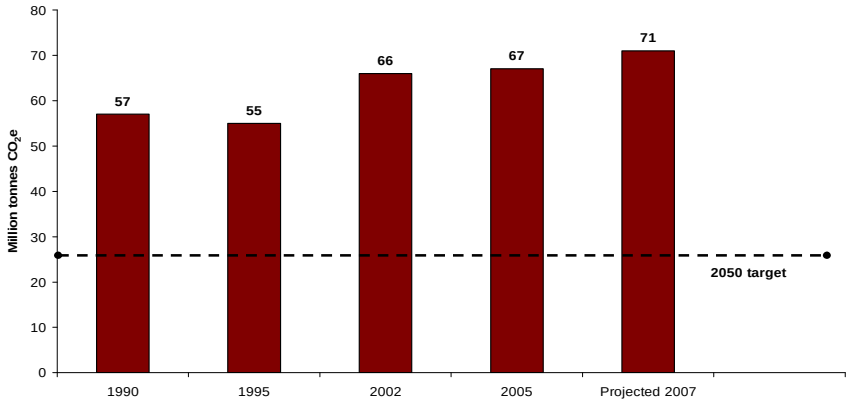

Figure 3 Western Australia Carbon Dioxide (CO_2) Emissions 1990 to 2007.

The Tourism Industry Working Group presentation outlined the industry's opposition to any development in the Kimberley, due to a range of direct and indirect impacts and cited the Pilbara as an example of the resources sector driving the tourism industry out of the region due to competition for labour, accommodation, high use of available flights and the adverse visual impact on the natural environment.

This working group has maintained two clear messages throughout the consultation process. These are:

- There should be no development on the Maret Islands; and
- The least impact on the tourism industry would result from the Browse Basin gas being processed away from the Kimberley.

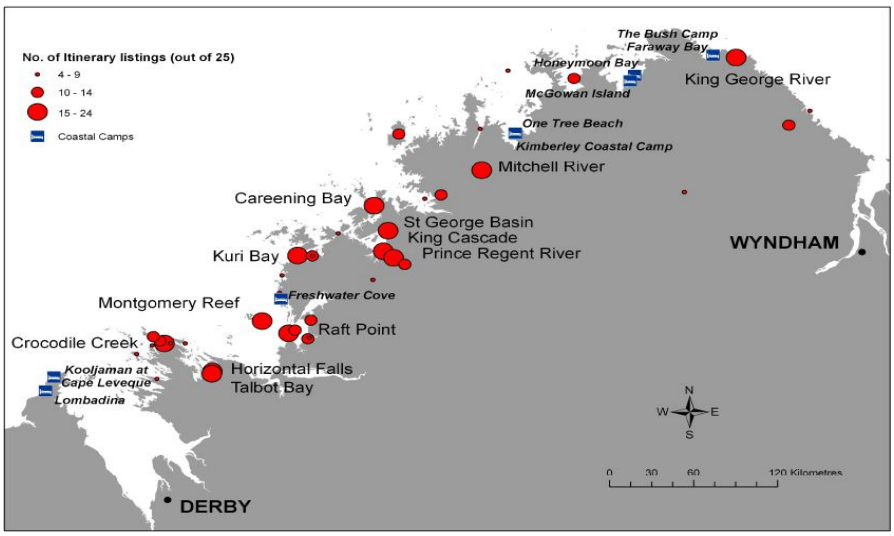

Figure 4 Tourism Hotspots West Kimberley (Tourism Western Australia).

The Community and Local Government Working Group identified sites in the north Kimberley as having less significant direct impacts on existing regional towns and communities. However, impacts associated with the southern sites are considered to be manageable and there is recognition of the benefits of locating the proposed hub closer to existing infrastructure and services.

In all Local Government submissions, it was stressed that the regional planning process would need to allow for the significant additional infrastructure resources that would need to be in place to mitigate the impact of a gas processing development in the Kimberley, particularly if the development was close to Broome. Overall, the Community Working Group was in favour of gas development in the Kimberley.

6.4. The Perth Workshops – Contextual Issues

Environmental experts
The environmental experts that participated in both the NDT panel and Independent panel, indicated that though their assessments were subjective, they were based on a body of evidence including personal experience and academic research going back a significant time which provided a basis to determine the likely impact of development on various ecosystems and which of those ecosystems were already degraded.

It was recognised that the evaluation of the Anjo Peninsula and Cape Voltaire were preliminary and that terrestrial environmental studies will be undertaken in the week commencing 9 August 2008 and marine studies the week of 25 August 2008.

In assessing both locations the precautionary principle was applied.

It was disclosed that Humpback whale migration data just received from the Centre for Whale Research indicated whales transited past the Gourdon Bay area on their northward migration. This information was previously unrecorded.

It was also noted that the field studies being used for the site evaluation was dry season data and that wet season information was being extrapolated from the findings.

Kimberley Land Council
The KLC provided a Traditional Owner perspective indicating the Uunguu, Nyul Nyul, Jabirr Jabirr and Karajarri people were still considering the sites identified in their country and that this enabled a more focused examination of heritage and ethno-biological issues prior to a decision.

The KLC indicated that Dr Kim Doohan was nearing completion of a preliminary assessment of the Aboriginal heritage and cultural values significance of the sites under consideration.

The KLC reported that comments from the Traditional Owners Taskforce which indicated that the “people” are really happy with the scientific information that has been presented to them and that it reinforced the view that project impacts needed full investigation.

The Traditional Owners were not prepared to publicly release all heritage information available due to its cultural sensitivity and the historic vulnerability of registered heritage sites to development approval and subsequent disturbance of the sites.

The KLC will provide the EPA and the DEWHA with summary heritage information from Dr Doohan's report for use in the site evaluation. The KLC have also been researching potential socio-economic impacts on their community and this information will form part of their decision making process.

Industry

The industry response recognised that all sites had significant constraints but identified that they could avoid, minimise or mitigate the potential impacts and develop a LNG project that did not significantly impact on key stakeholder interests including sensitive environments.

Woodside on behalf of the Browse JV independently evaluated the 11 sites using the NDT environmental and technical site selection criteria. The methodology applied rated sites according to the likelihood of an impact as a result of the project or not and the ability to avoid, minimise or mitigate the impact. This contrasted with the NDT evaluation which related to the sensitivity of the criteria to impacts.

Woodside identified sites closer to the Calliance gas field and Canning Basin as positive for their CO_2 sequestration potential. It was agreed that an Emissions Trading Scheme (ETS) would determine the viability of carbon capture methodologies.

Woodside is confident the design of the hub could accommodate sensitive environmental and heritage concerns. It also believes that the boat movements from a hub (approximately 4 per day at 50 Mtpa) were significantly less than experienced out of ports such as Fremantle and Dampier and would pose little threat to whale migration and calving in the region. Woodside Browse supports the continued investigation of Quondong, James Price Point, North Head and Perpendicular head as hub locations within its theme select processes. Woodside indicated the Anjo Peninsula and Gourdon Bay were at the limit of the economic range for a pipeline to a greenfield LNG processing plant.

INPEX also independently assessed the 11 sites and indicated the NDT research validated its own site selection process.

INPEX applied a similar methodology to Woodside rating sites by the capacity to avoid major impacts on the environment, heritage and the community. INPEX believes the workshop outcome continues to support the Maret Islands as the most sustainable site for a single operator LNG processing only hub location. INPEX identified the lack of a need to dredge and maintain shipping channels on the Maret Islands as a significant advantage over any other site along with the Marets being outside of the whale aggregation areas, reducing both direct impacts and the impact of shipping moving through the migration route.

INPEX has indicated it would consider its view on Anjo Peninsula following the outcome of further studies by the NDT. INPEX rejected the balance of sites from being viable, based on their analysis of major environmental constraints, particularly those related to whale migration and aggregation areas.

Environmental Non Government Organisations (eNGOs)
The eNGOs provided comments on process and environmental values and social values and expressed concern that socio-economic impacts were being subjectively assessed without the same level of science being applied to technical and environmental constraints. The NDT responded that socio-economic factors become most relevant in the comparison between each of the shortlisted sites and that appropriate studies and consultations were anticipated in the next phase of the strategic assessment.

The eNGO position remains that the Kimberley needs to be subjected to the regional assessment on values prior to any one location being assessed for development.

7. Site Attributes - Summary

7.1. Introduction

The NDT has undertaken the evaluation on the 11 sites within the constraints of available knowledge. This final assessment was undertaken by the NDT's Assessment Panel made up of senior officers from the Department of Industry and Resources, Department of Environment and Conservation, Department of Fisheries, Department of Indigenous Affairs, Department of Planning and Infrastructure, Office of Native Title, Tourism Western Australia, LandCorp and the Kimberley Development Commission.

As a result of the advanced nature of the Ichthys project and the existing environmental impact assessment, together with documents for a proposed iron ore mine and port on Koolan Island, these two areas have been subjected to comprehensive technical, environmental and heritage studies. The Koolan Island studies are public and have been used in assessing the site.

Due to the 'commercial in confidence' nature of the INPEX studies at this stage, the NDT working groups and assessment panel have not had access to all available data and has applied the precautionary principle in accessing potential risks associated with an LNG processing facility being established on the Maret Islands.

The INPEX presentation to the NDT workshop indicated that the company had identified a range of environmental constraints but had also prepared a response on how to avoid, minimise or mitigate any significant impacts. It is anticipated this information may be placed before the EPA and the DEWHA prior to any advice on sites being provided to the NDT.

The Wilson Point site had also been subjected to extensive study by Woodside and information related to these studies has been made available to the NDT.

The NDT itself commissioned marine and terrestrial studies where there was limited data available from previous research. This study program is ongoing and will be extended to the sites recently identified by the KLC and Traditional Owners as potential hub sites. These sites, Cape Voltaire and the Anjo Peninsula have been evaluated but again due to limited data, the precautionary principle has been applied and a more comprehensive assessment of Anjo Peninsula was conducted after the site evaluation workshops were concluded.

The West Kimberley environments are strongly determined by the characteristics of the regional geological province in which they occur. The two Geological Provinces – Canning Basin Sandplains and Kimberley Plateau – have different geological histories and have resulted in regional environments with very divergent characteristics.

7.1.1. Overview of West Kimberley Regional Terrestrial and Marine Environmental Characteristics

The environmental characteristics of the West Kimberley are very diverse and strongly influenced by the underlying geology, geomorphology, the region's macrotidal regime, climatic conditions and rainfall gradients.

These differences in environmental characteristics are recognised in the positioning of the established bioregional **(**Interim Biogeographic Regionalisation of Australia (IBRA) and Interim Marine and Coastal Regionalization of Australia (IMCRA)**)** boundaries for the terrestrial and marine environments. (see map from the NDT Interim Report page 44).

7.1.2. Kimberley Plateau - North Kimberley IBRA Region

The northern part of the region includes the high rainfall areas of the Kimberley Plateau. This is an extensive elevated and highly dissected region of massive largely flat lying sandstone. This is an ancient eroding surface, with skeletal soils of very low fertility. Erosion is strongly controlled by jointing in the sandstone substrate, creating an extremely rugged terrain criss-crossed by gullies along joint lines. The diverse topography formed where volcanic rocks have been intruded is also significant in the region. These areas produce rocky environments, but lack the jointing and generally form less rugged terrain. Basalt rocks underlie the development of Bauxitic laterite duricrust on areas such as the Mitchell Plateau and Maret Islands.

The southern margin of the Kimberley Plateau, south of Walcott Inlet, is marked by a zone of tightly folded and faulted geology. The Yampi Peninsula and further inland, the King Leopold Ranges are representative of this country. Tight folding and faulting has produced elongated ridges and peaks of resistant rocks separated by long narrow valleys.

The rugged terrain provides a diverse range of landform and substrate characteristics ranging from shallow highly infertile skeletal soils high on the massive sandstone plateau that are saturated during the wet season and baked dry and extremely hot during the dry, to more fertile sites on volcanic soils and sheltered slopes below cliffs that support extensive rain forest patches, to sheltered permanently wet springs and stream environment in gorges and closed mangrove forests in inlets and creeks. Rugged cliff and rock surfaces and diverse vegetation and habitats in combination with extreme inaccessibility and poor soils have protected this region as an intact landscape, free from the impact of clearing for agriculture or pastoral grazing activities and as yet, still largely unaffected by mining and related industrial activities.

In combination with high and reliable rainfall, it has produced a region that is recognized as one of Australia's biodiversity 'hot spots' and one of the few regions in Australia where no plants or animals have become extinct. In combination with the extensive island archipelago, the high rainfall coastal areas of the Kimberley Plateau are a refuge of national and international significance.

It is recognised that Aboriginal people have interacted with the landscape for thousands of years, with traditional fire management contributing to biodiversity values.

7.1.3. Canning Basin Dampierland IBRA Region

South of the Kimberley Plateau, the geology of the Canning Basin is more subdued, producing generally low lying landscapes, developed on largely flat lying sedimentary formations of sandstones and siltstones. The broad valley of the Fitzroy River empties into King Sound. On the Dampier Peninsula and areas south of Broome the sandstone are mostly mantled by reddish sandplains and soils generally known as Pindan that typify the Dampier Peninsula and Broome area. Underlying sandstone strata are exposed in places along the coast (eg Broome Sandstone at Gantheaume Point and Emeriau Sandstone at Perpendicular Head). The Dampier Peninsula forms a gently domed surface sloping gradually to the east and west coasts of the peninsula.

A significant coastal rainfall gradient from some 500 mm at the southern end of the Dampier Peninsula to over 800 mm towards the northern end is a primary determinant of the Pindan vegetation type. Pindan Acacia dominated shrublands over grasses, with emergent eucalypts is the dominant vegetation in the driest areas, grading to a low open eucalyptus dominated woodland in the intermediate rainfall areas, and to eucalyptus dominated woodland to open forest in the higher rainfall areas towards the northern end of the peninsula. Coastal dunes, vine thickets in sheltered drainage-impeded areas behind the dunes, mangrove communities, supratidal flats, riparian wetlands, springs and limited areas of exposed rock surface add to the diversity.

The Dampierland Region does not have topographical barriers to land access and has for the most part been used for pastoral grazing. The region supports over 1200 Aboriginal people in communities and outstations.

7.1.4. Coastal Environments

The rise of the sea level from some 150 meters below the present level following the end of the last Ice Age some 17000 years ago, flooded extensive areas of the continental shelf that had previously been exposed.

The effect of this inundation on the rugged highly joint controlled landscape of the Kimberley Plateau and the tightly folded and faulted geology of the Yampi Peninsula, produced a classic and extremely complex coastline with drowned river valleys forming deep complex and narrow inlets, and isolated ridges forming extensive island archipelagos that are a dominant feature of this coastal region. In the approximately 500 kilometres direct line from the Yampi Peninsula to the King Edward River, there are some 12850 kilometres of coastline, including 2581 mapped islands. This represents 40% of the entire length of the WA coastline.

The rising seas along the Canning Basin coastline flooded the then lower Fitzroy River valley and forming the extensive King Sound and the less complex coastline of the Dampier Peninsula.

Coastal geomorphology and geomorphological processes are dominated by the influence of the regions macro-tidal regime and the force of cyclonic waves and storm surge.

Tidal amplitudes which reach 11 meters in the King Sound and Yampi Peninsula areas are among the highest tides in the world. In combination with the extensive and complex coastline, they produce a very extensive ecologically diverse and highly productive intertidal zone with environments ranging from vertical cliffed coasts to wide expanses of mudflats, sand banks, coral and algal reef flats, mangrove forests and beaches. The high tidal regime and strong currents transports large quantities of sediments and nutrients. The gently shelving topography of the Dampier Peninsula produces areas of extensive mudflats, sand banks and coastal wetlands. The mangrove communities of Roebuck Bay and the Eighty Mile Beach south of Broome are internationally significant as Ramsar listed wetlands because of the numbers of migratory wading birds they support, particularly seasonally when the migrating flocks use these coastal mudflats as the primary landing and departing point from the west coast of Australia to Asia.

7.1.5. Coastal Marine Environments

As with the Terrestrial Environments Interim Marine and Coastal Regionalisation of Australia (IMCRA), recognizes boundaries that relate to regional geological provinces, with a Kimberley IMCRA region corresponding broadly to the offshore extent of the Kimberley Basin (Plateau) and North Kimberley IBRA Region and Canning IMCRA Region to the Canning Basin.

Primary drivers at the regional scale are geological substrate and geological history and circulation patterns, with site characteristics substrate and exposure including tidal currents influencing local site characteristics and communities.

The Kimberley region is characterized by the complex highly heterogeneous landforms with deeply incised channels between headlands and islands, underlying geology and terrestrial sediments, strong tidal currents and seasonal fresh water inputs from river systems.

Recent surveys have indicated that marine communities in this region have a high degree of heterogeneity, with fringing coral reefs grading into diverse filter-feeding communities where light becomes limiting for corals. Mangals and extensive mudflats are common in embayments and estuarine environments.

The Canning region by contrast, is dominated by calcareous and biogenic substrates, typically gently shelving bathymetry, long sandy beaches, and occasional sandstone headlands. Reflecting these bathymetric characteristics, the benthic communities are relatively homogeneous. Typically in the near-shore environments, macro algae dominate the reefs with scattered corals present but not to the extent that they form biogenic reefs. Filter-feeding (sponge, sea-whip) communities and extensive patches of seagrass are prevalent in deeper waters, where substrate and exposure conditions are suitable.

Mangals and extensive mudflats and sandbanks are present in embayments in the V-shaped bays towards the northern end of the Dampier Peninsula and south of Broome in Roebuck Bay.

7.1.6. Marine Threatened Fauna

The region provides an important habitat for a range of EPBC Act and *Wildlife Conservation Act 1950* (*WA*) listed marine fauna, including a number of turtle species, Humpback whales, Snub-fin dolphins and sawfish.

The areas of particular significance for Humpback whales are becoming well known following significant survey effort over the past decade. The region is the primary terminus for the northward migration of Humpback whales from Antarctic waters. The areas of greatest significance are Camden Sound (calving) and off Pender Bay (resting and aggregating area for cow and calf pods).

The key technical, social, environmental and economic attributes of each onshore site location are summarised in the following section, and are separated into Canning Basin sandplain sites of the south west Kimberley and Kimberley Plateau sites in the north west Kimberley.

7.2. Site Descriptions and Attributes

The key technical, social, environmental, and economic attributes for each of the 11 onshore site locations are summarised in the following sections.

7.2.1. Gourdon Bay

Gourdon Bay is approximately 160 kilometres south of Broome by sealed road. The Port Smith caravan park is 8 kilometres south of the site. The Bidyadanga Aboriginal community is approximately 27 kilometres away. The site has sufficient elevation, particularly if the main plant can be set back from Cape Latouche Treville. Over 1000 hectares of relatively level land is available, which is sufficient for the development of a gas processing hub. This site is very accessible as it is within a few kilometres of the Great Northern Highway and has had a long history of pastoral land use as part of the La Grange pastoral lease.

The western edge of the proposed site is likely to be set as close to Cape Latouche Traville as possible, to enable the closest access to deep water and the shortest pipeline distance from the plant to storage tanks and then from storage tanks to jetty loading point (cryogenic pipeline distance is a major cost of an LNG plant with an estimated cost between US$25 million to $30 million per kilometre and a distance of 5 kilometres from plant to storage tank and another 5 kilometres from storage tank to loading jetty considered close to maximum lengths; 1 kilometre is the preferred distance to minimise costs). It is unlikely the site will be located in Gourdon Bay, due to the increased distance to deep water.

There is over 950 hectares of relatively level land with sufficient elevation starting within 1 kilometre of the coast, available for the development of a gas processing hub. The soil is generally Pindan and sandy earth which is suitable for construction. The closer the site is positioned to Cape Latouche Traville, the narrower is the area of land with sufficient elevation. The reduced land area width close to the coast may make it difficult for multiple operators to equally place infrastructure and access port facilities, particularly if buffer zones are required between facilities. Pipeline access to the site is likely to be good, assuming the pipelines cross the shallow slopes of the Gourdan Bay beach (pipelines are likely to be buried to reduce their impact).

Access to deep water is a significant issue for this site. Charts indicate that access to between 10 and 20 metres water depth is between 4 to 6 kilometres away, depending on the position of the loading jetties, and access to water depth of 20 to 50 metres is up to 15 to 20 kilometres away. Shoal banks extend offshore and may require additional dredging. More recent NDT bathymetric studies have, however, provided more accurate data with 10 metres+ water being closer to the coast than originally thought, potentially reducing the length of a dredged channel. Further work needs to be done on accurate bathymetric studies. However, even with revised bathymetric figures, this site is likely to require a jetty of significant length, turning basin and channel.

The site is also exposed to the south west summer swells and will require a significant breakwater. Currents are not likely to be a major issue at this site and offshore navigation for LNG tankers is unlikely to be a difficulty until they are required to negotiate the narrow channel.

The major technical disadvantage of this site is its distance from the gas fields being over 500 kilometres from the Ichthys field which would then require a gas compression platform to be sited part way along the pipeline, adding both additional costs (estimated US$300 million) and gas processing inefficiency. The Woodside Browse fields are similarly over 400 kilometres from this site. In addition, water bathymetry issues for the pipeline access route could be problematic.

Marine Environment:

Gourdon Bay is at the southern end of a large sandy embayment that is exposed to the north west and sheltered to the south by Cape Latouche Treville. Little is known of the importance of this area for seabirds however, Gourdon Bay does not have extensive supratidal beach/mudflat habitats. Roebuck Bay, 20 kilometres to the north and Eighty Mile Beach some 70 kilometres to the south are Ramsar wetlands in recognition of their importance for migratory waders. The inshore waters are relatively protected and the seabed is comprised mainly of sandy sediments with small areas of rubble and patchy reefs inshore and near offshore shoals which support a wide variety of fish life. The inshore and offshore waters are characterized by relatively low turbidity and moderate tidal currents. The sediments in the bay have extensive areas of algal film and sparse seagrass that may be seasonally abundant. Heart urchins are very abundant grazing the algal film both inside the bay and in offshore waters. The west facing coastline to the south of Cape Latouche Treville is exposed to wave energy from the south west. Filter-feeding communities occur in deeper waters but they are generally more patchily distributed and generally not as diverse or dense as in other locations further north on the Dampier Peninsula. Sawfish may be present and turtles are common within sheltered areas. Dugong are known to occur in the area and further north in Roebuck Bay. The waters along this stretch of coast, from near the shore to about 20 kilometres out to sea, are part of a high density migratory corridor for Humpback whales. Although the significance of this area from initial surveys appears to be high, it may not be as high as areas further north on the Dampier Peninsula. The overall sensitivity of the marine environment at this site is considered to be moderate.

Terrestrial Environment:

The dominant surface at Gourdon Bay is Pindan sandplain, which is very extensive in this region. Coastal areas facing Gourdon Bay feature a consolidated calcareous sandstone cliff and wash zone with areas of Frezier/Broome Sandstone near Cape Du Boulay and as intertidal rock platforms at several locations. An area of prominent red vegetated sand dunes occurs near the point of Cape Latouche Treville. Port Smith, located some 8 kilometres south of Cape Latouche Treville is a significant tidal inlet with mangrove creek and supratidal flats. Overall, the coastline is stable and robust, but consideration will need to be given to design of access across the coast under conditions of high cross-shore sediment transport. Away from the coast, the vegetation on the site is arid Pindan, the characteristic and dominant vegetation of the region. The vegetation on the site and surrounding areas has been extensively degraded by frequent widespread fire to the extent that Acacias that should be a prominent component of the vegetation have been largely eliminated. Widespread coastal vegetation communities are located along much of the coastline, with coastal swale thickets present in the dunes at Cape Latouche Treville and at a smaller area of dunes near the eastern end of Gourdon Bay. Small ephemeral claypans are located inland of cemented coastal cliffs in locations that represent fossil shorelines.

Despite the condition of the vegetation, the Traditional Owners report sightings of Bilbies, a threatened fauna species. This species is considered to be present in low numbers in suitable habitat in near-coastal sand environments across the region. Visual landscape significance assessment of the site, rates it as moderately significant and "suitable", with landscape character significance as moderate inland and high in coastal areas, moderate levels of public concern based on visual values, and low to moderate visual absorption capability.
The overall relative sensitivity of the terrestrial environment at this site is considered to be low, however, it is in the vicinity of the Ramsar wetlands.

Gourdon Bay

Gourdon Bay is a high-value area for both recreational and commercial fishing. There are also several pearling leases in the area. The main pearl oyster fishing grounds start approximately 40 kilometres south of Cape Bossut and extend southward along the Eighty Mile Beach. One small and one large eco-tourism business operate close to the site and the tourism industry is concerned about overall impacts on Broome acting as a transition centre for the anticipated fly in/out workforce, including impact on air services, short stay accommodation, potential loss of tourism product and increased pressure on the available workforce.

Gourdon Bay is significant to Aboriginal people for customary practice, supplementation of food and for mythological significance. It is also close to the Bidyadanga Aboriginal community, the largest Aboriginal community/town in Western Australia.

See maps 1 and 2 in **Appendix 3.**

7.2.2. Quondong Point

The Quondong Point site is located approximately 20 kilometres north of Willie Creek and approximately 48 kilometres north of Broome by road. The coastline is exposed to the south west. The site is a popular tourist and recreational fishing destination. Apart from the current unsealed road, which runs close to the coast in this location, there are no constraints on the position or shape of the site at Quondong Point. There is over 950 hectares of relatively level land within 1 kilometre of the coast (assuming a re-routed road) with sufficient elevation available for the development of a gas processing hub. The soil is generally Pindan soils and sandy earth which is suitable for construction. Pipeline access to the site is likely to be good, assuming the pipelines cross the shallow slopes and sand dunes of Quondong beach (pipelines are likely to be buried to reduce their impact).

Charts indicate that access to between 10 and 20 metres and 20 to 50 metres water depth is 6 to 7 kilometres away. More recent NDT bathymetric studies will, however, provide more accurate data on water depth which may indicate deeper water closer to shore. However, even with revised bathymetric figures, this site is likely to require a significant jetty, turning basin and possibly channel (although likely to be shorter than Gourdon Bay).

The site is also exposed to the south west summer swells and will require a significant breakwater. Currents are not likely to be a major issue at this site and offshore navigation for LNG tankers is unlikely to be a difficulty until they are required to negotiate any narrow channel.

The site is approximately 470 kilometres from the Ichthys field and 420 kilometres from Woodside's Browse fields (taking into account some diversion required due to the shallow water bathymetry extending out from the Dampier Peninsula). The actual pipeline distance required may mean that a gas compression platform is required if the pipeline distance is more than 500 kilometres.

Marine Environment:

Quondong Point is a small rocky point on the west facing sandy coast of the Dampier Peninsula. This west facing area of coastline is fully exposed to wave energy and the waters are characterized by moderate tidal currents and low turbidity, although turbidity can increase inshore, particularly to the south. Although there are few bird records from the area, the beaches and flats are likely to be utilized by terns and waders. Patches of dense seagrass are common in sheltered areas between inshore reefs and large areas of seagrass are seasonally present in deeper offshore waters in stable areas between rock pavements. Corals occur as isolated colonies or at generally sparse density amongst algae on reefs to about 10 metres of water depth. The area supports a wide range of fish species. Turtles are common and dugong are known to occur in the area. The waters along this stretch of coast, from near the shore to about 20 kilometres out to sea, are part of an unusually high density migratory corridor for Humpback whales. The overall sensitivity of the marine environment at this site is considered to be moderate to high.

Terrestrial Environment:

The site is located in an intermediate rainfall area of the extensive Pindan sandplain surfaces that are characteristic of the Canning Basin sandplain region. This area features a relatively straight sandy beach coastline anchored by low rock bars of Broome Sandstone at Quondong Point, James Price Point to the north, and some lime-indurated beach-rock. The Quondong coastline is subject to episodic erosion during extreme meteorological events. The coastal form also indicates this area experiences significant longshore sediment transport which would need to be considered in the design of coastal structures. Between Quondong Point and James Price Point, the coastal Pindan cliffs are covered by partially vegetated coastal dunes. These dunes hold moisture from wet season rains and impede drainage from the Pindan surface behind, creating seasonal wetland areas and an extensive linear patch of monsoonal vine thicket, a Threatened Ecological Community (TEC). The wetland and monsoon vine thicket provides significant fauna habitat, but has been degraded by invasive pasture grasses originating from pastoral land use and/or vehicle access to the area. This area also supports a population of the priority flora species*, Pittosporum molluccanum*. The Pindan vegetation has been impacted by excessive burning.

In terms of landscape quality assessment, Quondong Point is assessed as "suitable with reservations" from a visual landscape significance perspective, having landscape quality that is moderate to high on the coast, with moderate levels of public concern based on visual values, and a low to moderate visual absorption capability.

Overall, the sensitivity of the terrestrial environments at Quondong Point is considered to be low to moderate.

Quondong Point

Quondong Point is the site of the Kimberley's only deep water pearling operation. It is utilized by commercial fishers and is a popular recreational fishing area (seasonal aggregations of sailfish). It is also recognised as a fish aggregation area and is adjacent to an aquaculture lease at Carnot Bay.

While Quondong Point is seen as being technically viable, other socio-economic considerations include its proximity to Broome and the area is regularly accessed by Broome locals and tourists for camping and fishing purposes. Tourism impacts are also anticipated on Broome as a result of its close proximity to this site, including impact on air services, short stay accommodation, potential loss of tourism product, increased pressure on the available workforce and risks associated from accidents and spills. An advantage of this site is its proximity to existing infrastructure and services, thus reducing the need for additional infrastructure on the peninsula.

The site is in an area under a Native Title Claim (Goolarabooloo Jabirr Jabirr) WAG 6002/98. The claim is yet to be determined. The tourist and cultural Lurujarri heritage trail passes through the area. It is a recognised law ground with numerous heritage sites registered in the coastal zone.

7.2.3. James Price Point to Flat Rock

The James Price Point – Flat Rock site is approximately 58-68 kilometres north of Broome by road via Quondong Point. The area is a popular tourism and recreational fishing destination in an area that was formerly part of Waterbank station, and has had a long history of pastoral land use. The coastline is exposed to the south west. There is a 20 metre level *AHD* available at a distance of approximately 1.5 kilometres from the shoreline. There is no apparent restriction on the area.

The shoreline faces west and there is no natural protection from the prevailing south westerly winds and waves. Pindan cliffs are approximately 6 metres high and form the boundary of the shoreline. The Pindan shoreline face shows some sign of episodic drainage erosion but appears quite stable. Weathered sandstone is visible along the beach line and extends into the shallow water. The berth location would be directly offshore in a westerly direction, based on the shortest distance to deep water. Deep water is approximately 5 kilometres offshore, requiring a dredged channel and breakwater.

Due to the similarity of the landscape and marine topography, there is the capacity to move the location for the hub along the coastal area to try and avoid significant environmental and heritage sites.

Apart from the current unsealed road, which runs close to the coast in this location, there are no constraints on the position or shape of the site at James Price Point. There is over 950 hectares of relatively level land within 1 kilometre of the coast with sufficient elevation available for the development of a gas processing hub. The soil is generally Pindan soils and sandy earth which is suitable for construction. Pipeline access to the site may need to negotiate 5 metre Pindan cliffs at the beach, but these are not considered to be a major impediment due to the suitable geotechnical conditions (pipelines are likely to be buried to reduce their impact).

Charts indicate that access to water depth of between 10 and 20 metres is 6 kilometres away and 20 to 50 metres is 7 kilometres away. More recent NDT bathymetric studies will, however, provide more accurate data on water depth which may indicate deeper water closer to shore. However, even with revised bathymetric figures, this site is likely to require a significant jetty, turning basin and possibly channel (although likely to be shorter than Gourdon Bay).

The site is also exposed to the south west summer swells and will require a significant breakwater. Currents are not likely to be a major issue at this site and offshore navigation for LNG tankers is unlikely to be a difficulty until they are required to negotiate any narrow channel.

The site is approximately 460 kilometres from the Ichthys field and 410 kilometres from Woodside's Browse fields (taking into account some diversion required due to the shallow water bathymetry extending out from the Dampier Peninsula). The actual pipeline distance required may mean that a gas compression platform is required if the pipeline distance is more than 500 kilometres.

Marine Environment:

Significant areas of low relief reef with dense algal cover occur inshore and particularly to the north of Coulomb Point which is north of James Price Point. Extensive filter-feeding communities occur in deeper waters and are particularly species diverse and abundant, offshore and to the north of James Price Point. Sawfish are likely to occur in the area and turtles are common, though utilization of beaches for turtle nesting is understood to be uncommon in the area. Dugongs have been reported in the area and the waters along this stretch of coast, from near the shore to about 20 kilometres out to sea, are part of an unusually high density migratory corridor for Humpback whales. Although the significance of this area is high, it may not be as high as areas further north on the Dampier Peninsula. The overall sensitivity of the marine environment at this site is considered to be moderate to high.

James Price Point is utilized by commercial fishers and is a popular recreational fishing area. It is recognised as a fish aggregation area, dugong feeding area and is part of a migratory pathway for whales.

Terrestrial Environment:

The James Price Point – Flat Rock area is located on an intermediate rainfall area of the extensive Pindan Sandplain surfaces that are characteristic of the Canning Sandplain region. This area features a relatively straight sandy beach coastline anchored by low rock bars of Broome Sandstone at James Price Point and Flat Rock, and some lime indurated beach-rock. North of James Price Point, the beach runs straight up to the base of soft Pindan cliffs. The James Price Point coastline is subject to episodic erosion during extreme meteorological events. The coastal form also indicates this area experiences significant longshore sediment transport which would need to be considered in the design of coastal structures. The landform north of James Price Point to Flat Rock is a very simple environment dominated by Pindan woodland on a very gently sloping surface, with few incised local drainage lines and a narrow strip of coastal heath above the Pindan cliffs that front the beach. The Pindan vegetation at the site has been impacted by excessive burning.

The James Price Point site is assessed as "suitable with reservations" from a visual landscape significance perspective, having landscape quality that is moderate inland to high on the coast, with moderate levels of public concern based on visual values, and a low to moderate visual absorption capability.

Overall, the sensitivity of the terrestrial environments at James Price Point is considered to be low.

James Price Point

James Price Point is a popular recreational area and extensively accessed by the Traditional Owners. There are also pearling leases in the vicinity. Tourism impacts are also anticipated on Broome as a result of its close proximity to this site, including impact on air services, short stay accommodation, potential loss of tourism product and increased pressure on the available workforce. An advantage of this site would be its proximity to existing infrastructure and services, thus reducing the need for additional infrastructure on the peninsula.

Cape Leveque to south of Broome is a continuous “dreaming track” that incorporates the Lurujarri heritage trail and James Price Point. There are numerous registered Aboriginal heritage sites in the vicinity of James Price Point (Walmadan*)* including burial and mythological sites.

See maps 3 and 4 in **Appendix 3**.

7.2.4. North Head

North Head is approximately 26 kilometres north of Beagle Bay. Beagle Bay is accessed by road from Broome (approximately 125 kilometres). There is an unsealed airstrip within 35 kilometres of the site.

The shoreline is a low eroding cliffline of calcareous sandstone of the Bassult Formation that stands to a height of approximately 8 metres above *AHD*. Beyond the cliff top, the ground continues to rise to the south east for a distance in the order of 100 to 200 metres, at which point the ground levels out to a plateau. A 1000 hectare area can be identified. The western boundary of a plant site would be located approximately 2.5 kilometres to the south east from the shoreline. The area has a local high point of RL 30 but is generally level at approximately RL18.

The western edge of the proposed site is likely to be set as close to North Head point as possible, to enable the closest access to deep water and the shortest pipeline distance from the plant to storage tanks and then from storage tanks to jetty loading point.

There is over 950 hectares of relatively level land starting within 1 kilometre of the coast and with sufficient elevation available for the development of a gas processing hub. The soil is generally Pindan and sandy soils with some shallow limestone expected. The closer the site is positioned to North Head point, the narrower is the area of land. The reduced land area close to the coast may make it difficult for multiple operators to equally place infrastructure and access port facilities, particularly if buffer zones are required between facilities. Pipeline access to the site is likely to be good, assuming the pipelines cross the shallow slopes of the Pender Bay beach (pipelines are likely to be buried to reduce their impact) or other beaches. Otherwise, pipelines will need to negotiate the small but rocky cliffs at North Head.

The shoreline faces to the south west and the location does not have any natural protection against predominant wind and waves from the south west and westerlies. A jetty length of 2 kilometres would be required along with a 700 metre diameter turning basin. A short dredged approach channel of 1 kilometre is required with a breakwater of about 2 kilometres to protect the berth.

Charts indicate that access to water depth between 10 and 20 metres is 2 kilometres away and 20 to 50 metres water depth is 4 kilometres directly out from North Head point, which is a reasonable distance to deep water, requiring a medium length jetty and possibly no turning basin or channel.

The site is also exposed to the south west summer swells and is likely to require a breakwater, although there may be some protection from the Lacepede Islands to the south west. Currents are not likely to be a major issue at this site and offshore navigation for LNG tankers is unlikely to be a difficulty.

North Head is 370 kilometres from the Ichthys field and 330 kilometres from Woodside's Browse fields, making it relatively competitively neutral as a destination for the lead proponents. There is no airstrip in the vicinity; therefore it is likely some type of airstrip would require construction as part of any overall development.

Marine Environment:

North Head is a prominent rocky headland at the northern entrance to Beagle Bay. Beagle Bay, as well as Tappers Inlet about 3 kilometres to the north, are located between the two headlands, and are relatively protected and contain highly bioturbated sediments and mangrove communities inshore. The general area is important for shorebirds and mangrove birds and the Lacepede Islands located offshore to the west, have very important seabird rookeries and turtle nesting areas. Seagrass patches can be seasonally present in the bays and offshore, and these are likely to support dugongs in the area. Exposure to wave energy is high on the headlands and west facing shoreline and the offshore waters are characterized by moderate tidal currents and low turbidity. Corals generally occur at sparse to moderate density on reefs to about 10 metres water depth, although areas of moderately dense coral are found inshore from North Head. Offshore, benthic habitats are generally less diverse than offshore from Perpendicular Head immediately north of this site. A wide variety of tropical fin fish species are present and sawfish are likely to occur in more sheltered areas. Turtles are common, although, as with the majority of the peninsula, turtle nesting is understood to be uncommon in the area. The waters off North Head are part of a regionally significant, high density migratory corridor for Humpback whales. The overall sensitivity of the marine environment at this site is considered to be high to very high.

Terrestrial Environment:

The dominant surface type at North Head is the widespread Pindan Sandplain. Low coastal cliffs of calcareous Bossut Formation occur south of Middle Lagoon are the dominant coastal cliff formation in the vicinity of North Head. The site is adjacent to sensitive coastal environments, areas of holocene coastal dunes and mangrove inlets, notably Tappers Lagoon and the drainage lines that drain into the back of it. Significant restricted vegetation types include the mangrove forests and supratidal flats, patches of monsoonal vine thicket (TEC) in sheltered locations behind coastal dunes, seasonal wetlands at the back of mudflats, and coastal karst communities on the calcareous Bossut Formation. The area has one priority flora species and 11 species that represent possible range extensions, two species have unusual characteristics that may need taxonomic consideration.

North Head is assessed as “suitable with some reservations”, having a high coastal landscape character with moderate levels of public concern based on visual values for North Head, and low visual absorption capability and “moderate” visual landscape significance landscape suitability for a hub.

Overall, the sensitivity of the terrestrial environment at North Head is considered to be moderate to high.

Calcareous Sandstone cliffs of the Bossut Formation at North Head

North Head is a significant commercial fishing ground and nursery area for fish and invertebrates. It has also been an important area for wildstock pearl oyster fishing in the vicinity of the Lacepede channel. Tourism impacts are seen as the loss of tourism product and the close proximity of the hub to iconic tourist destinations. North Head is still relatively close to Broome and impacts are likely to include increased demand on air services, reduced availability of short stay accommodation, potential loss of tourism product, and increased pressure on the available workforce. The area also includes a large number of Aboriginal owned eco-tourism businesses.

The site is relatively close to Beagle Bay Aboriginal community and would directly impact on a small number of Aboriginal outstations situated along the north edge of Beagle Bay. North Head has registered Aboriginal heritage sites and the song cycle for the peninsula goes through this area. The area is Aboriginal reserve lands.

7.2.5. Perpendicular Head/Emeriau Point

Perpendicular Head is approximately 28 kilometres north of Beagle Bay. Beagle Bay is accessed by road from Broome (approximately 125 kilometres). There is an unsealed airstrip within 25 kilometres of the site.

Perpendicular Head is to the north east, with the coast line running to the west on the left and to the south on the right. The bay facing north shows significant erosion. This appears to be caused by a combination of drainage gully discharge from the south and the wave action on the soft section of the sandstone cliffs. The bay on the east side of Perpendicular Head (Pender Bay) is sheltered from the prevailing wind and seas.

There is over 950 hectares of land within 1 kilometre of the coast, with some steep slopes and gullies and sufficient elevation available for the development of a gas processing hub. The soil is generally Pindan and sandy soils with some shallow limestone expected. The closer the site is positioned to the peninsula, the narrower is the area of land. The reduced land area close to the coast may make it difficult for multiple operators to equally place infrastructure and access port facilities, particularly if buffer areas between the facilities is required, but the available area is not as constrained as Gourdon Bay and North Head. Pipeline access to the site is likely to be good, assuming the pipelines cross the shallow slopes of the Pender Bay beach (pipelines are likely to be buried to reduce their impact). Otherwise, pipelines will need to negotiate the steep, rocky cliffs at Perpendicular Head.

Charts indicate that access to water depth between 10 and 20 metres is 1 kilometre away and 20 to 50 metres water depth is 2 kilometres directly out from Emeriau Point and Chimney Rocks, which is a short distance to deep water, requiring a medium length jetty and the need for a turning basin or channel is considered unlikely.

The site may be exposed to the south west summer swells and may require a breakwater. However, the Lacepede Islands to the south and the position of the jetty on the peninsula may provide enough protection to avoid the need for a breakwater. Currents are not likely to be a major issue at this site and offshore navigation for LNG tankers is unlikely to be a difficulty.

The site is approximately 370 kilometres from the Ichthys field and 330 kilometres from Woodside's Browse fields and any pipeline is likely to be able to avoid the shallow water bathymetry extending out from the Dampier Peninsula.

Perpendicular Head

Marine Environment:

Perpendicular Head is a prominent rocky headland at the entrance to Pender Bay, which is a typical example of a Canning coast V-shaped bay. The bay, like Tappers Inlet and Beagle Bay to the south, is relatively protected by headlands and contains highly bioturbated sediments and mangrove communities inshore, which are particularly well developed around the creek system in the northern part. Pender Bay has been recommended for consideration as a marine conservation reserve. The area is important for shorebirds and mangrove birds. Dense seagrass patches can be seasonally present in the bays and offshore and these are likely to support significant numbers of dugongs in the area. Exposure to wave energy is high on the headlands and west facing shoreline and the offshore waters are characterized by moderate tidal currents and low turbidity. Corals generally occur at sparse to moderate density on reefs to about 10 metres water depth. Extensive and often very species diverse and abundant, filter-feeding communities are common in deeper waters off the headland and offshore to the north east. Sawfish are likely to occur in sheltered embayments in the area, as well as a wide variety of tropical fin fish species. Turtles are common, although, as with the majority of the Peninsula, turtle nesting is understood to be uncommon in the area. The waters off Perpendicular Head are part of a regionally significant, high density migratory corridor for Humpback whales. Pender Bay is particularly important as a resting and aggregation area for cows and calves before their southward migration. The overall sensitivity of the marine environment at Perpendicular Head is considered to be very high.

Terrestrial Environment:

Perpendicular Head is adjacent and similar to North Head. The dominant surface type is the widespread Pindan Sandplain. Perpendicular Head is a prominent bluff of Emeriau Sandstone. The site is adjacent to sensitive coastal environments, areas of holocene coastal dunes and mangrove inlets, notably Tappers Lagoon and the drainage lines that drain into the back of it. Areas of Pindan cliff are exposed to the east of Perpendicular Head and show evidence of localized episodic erosion during conditions of cyclonic storm surge. Significant restricted vegetation types include the mangrove forests and supratidal flats, patches of monsoonal vine thicket in sheltered locations behind coastal dunes, seasonal wetlands at the back of mudflats, and coastal karst communities on Bossut Formation. Perpendicular Head also features small areas of coastal heath on exposed sandstone headlands and perhaps the largest remaining example on Dampier Peninsula of a mixed shrubland thicket that has been degraded elsewhere by excessively frequent burning. The area has one priority flora species and 11 species that represent possible range extensions, two species have unusual characteristics that may need taxonomic consideration.

Perpendicular Head is assessed as having low “unsuitable” visual landscape suitability for a hub, having high coastal landscape character with high levels of public concern based on visual values and low visual absorption capability. Overall, the sensitivity of the terrestrial environment at Perpendicular Head is considered to be high. Pender Bay is a significant aggregation area for Humpback whale cows and calves, and a nursery area for fish; it is in proximity to wildstock pearl oyster fishing grounds and supports commercial fishing. There is a pearling lease immediately to the north east of Perpendicular Head and an aquaculture lease stretching along the coast between Emeriau Point and Perpendicular Head.

The Beagle Bay to Perpendicular Head area supports a rapidly developing land-based tourism market. A number of Aboriginal owned tourism businesses are to be found along the coast including the iconic Middle lagoon camping area. This market is driven by the landscape qualities of the area, fishing and whale spotting.

There is no native title claim lodged over the area. However, the area forms part of the Lurujarri ‘dreaming track’ and is close to culturally important heritage sites. It also supports a high number of Aboriginal outstations occupied by both Traditional Owners and descendants from people brought to the area from outside of this country. The area is within an Aboriginal Lands Trust reserve. Discussions are currently ongoing regarding the lodging of a native title claim over the area by the Nyul Nyul people.

See maps 5 and 6 in **Appendix 3**.

7.2.6. Packer Island/Black Rod Rock/Lombadina Point

Packer Island/Black Rod Rock/Lombadina Point the northernmost of the Canning Basin Sandplain sites. It is approximately 18 kilometres west of Lombadina/Djarindjin Aboriginal communities by road. Lombadina Point is about 190 kilometres accessed by road from Broome. The foreshore is rocky with mangroves and tidal flats behind. Elevated ground is also set well back from the coast. Packer Island is low lying with ground rising slowly inland. Elevations of more than 20 metres *AHD* are 4 kilometres inland. There is an unsealed airstrip within 15 kilometres of the site.

The western edge of the proposed site is assumed to be adjacent (although set back) from Packer Island, to enable the closest access to deep water and the shortest pipeline distance from the plant to storage tanks and then from storage tanks to jetty loading point as opposed to being located in the shallower bay to the immediate north of Packer Island (which could provide some swell shelter but would likely require a longer jetty, channel and bigger turning basin).

There are no constraints on the position or shape of the site at Packer Island. There is over 950 hectares of relatively level land available, however, land with sufficient elevation available for the development of a gas processing hub is set back at least 2 kilometres from the site (unless fill is used to bring the site forward). The soil is generally Pindan soils and sandy earth which is suitable for construction. Pipeline access to the site is likely to be good, assuming the pipelines cross the shallow slopes of nearby beaches (pipelines are likely to be buried to reduce their impact).

Charts indicate that access to between 10 and 20 metres and 20 to 50 metres water depth are 2 kilometres away, directly out from Packer Island, which is a short distance to deep water, requiring a medium length jetty and the need for a turning basin or channel may not be required.

The site is likely to be exposed to the south west summer swells and require a significant breakwater. Currents are not likely to be a major issue at this site and offshore navigation for LNG tankers is unlikely to be a difficulty.

The site is approximately 310 kilometres from the Ichthys field and 300 kilometres from Woodside's Browse fields and any pipeline is likely to be able to avoid the shallow water bathymetry extending out from the Dampier Peninsula, making the site reasonably competitively neutral and one of the shortest average distances between the lead proponents.

Marine Environment:

Packer Island is located on the northern side of Pender Bay, near the tip of the Dampier Peninsula. It is a barrier island grading to intertidal/subtidal reef oriented parallel to the shore and linked to the mainland by a narrow isthmus. The island acts to form a tombola that links it to the mainland except under spring high tides. The west side of the barrier is exposed to high wave energy. The east side is very sheltered and consists of two generally sandy and shallow lagoonal embayments to the north and south with mangroves in sandy tidal creeks on the isthmus. These areas are important for both shorebirds and mangrove birds. High cover seagrass patches are seasonally present in shallow waters on the west of the barrier amongst algal reefs and pavements.

Unlike the localities further north, there is no biogenic coral reef development but corals occur at sparse to moderate density on reefs to about 10 metres water depth. Patches of filter-feeding communities are common on hard and soft substrates in deeper waters and these can be very species diverse and abundant in places. Sawfish are likely to occur in sheltered embayments within the area and a wide variety of tropical finfish species can be found associated with the diverse range of habitats. Dugongs and turtles are common, although turtle nesting is understood to be uncommon in the area. The waters off Packer Island are part of a regionally significant, high density migratory corridor for Humpback whales. The site is on the northern end of Pender Bay which is particularly important as a resting and aggregation area for cows and calves before their southward migration. The overall sensitivity of the marine environment at this site is considered to be high to very high.

Terrestrial Environment:

Packer Island itself is composed of calcareous sandstone of the Bossut Formation, which is found in patches along the Canning coast. It is connected to the Pindan sandplain soils of the mainland by a narrow intra tidal/supratidal isthmus of mudflat and mangrove swamp sediments in a tombola formation developed behind the shelter of Packer Island. Prominent mobile and vegetated coastal dune fields are evident on the northern and southern flanks of the tombola. There is evidence of cyclonic storm surge overwash of Packer Island. The coastline is considered highly unstable. Tombolas are noted as unstable geomorphological landforms, with potential for extensive coastal change in the event of sea level fluctuations and extreme meteorological events. The diverse topography has produced diverse vegetation communities. Environments of conservation significance include mangrove forests and associated supratidal communities, seasonal wetlands, large, well developed dune swale monsoon vine thickets and karst communities on Packer Island. There are six fauna species of conservation significance. The area is representative of northern high rainfall Pindan communities, which are relatively restricted in area, and not represented in any conservation reserves. Packer Island is part of the proposed Cape Borda Nature Reserve recommended by the EPA and the former Department of Conservation and Land Management (CALM).

In terms of visual landscape significance, Packer Island is assessed as “not suitable” for a hub, having high landscape character significance and low to moderate visual absorption capability.

The overall sensitivity of the terrestrial environment of this site is considered to be very high.

Packer Island

Packer Island does not support any pearling grounds but is a commercial fishing area and an important fishing area for local Aboriginal people and for tourism based recreational fishing. Whist not supporting tourism infrastructure, the area contributes to the diversity of tourism products on the peninsula and the development of a hub at the north end of the peninsula is seen as in conflict with its status as an eco-tourism and Aboriginal culture-based tourism experience. The area is of cultural significance to Indigenous people with a number of heritage registered camp sites, artefact scatters and burials.

The determination of the Bardi Jawi native title claim has granted exclusive rights to the Traditional Owners to control access. The site is 18 kilometres from Lombadina/ Djarindjin, important communities for both Traditional Owners and people brought to the area from outside of this country.

See maps 7 and 8 in **Appendix 3**.

7.2.7. Koolan Island

Koolan Island is representative of the Kimberley Plateau Geological Province and has very different site geological and environmental characteristics from preceding sites. Koolan Island is 130 kilometres north of Derby, located in Yampi Sound in the West Kimberley. There is an existing airport, port and other infrastructure on the island, which currently supports an active mining operation. It is unlikely that the existing port or other facilities, with the exception of the airport, will be able to be utilised for the gas hub and dedicated facilities will need to be developed.

There is only 360 hectares of land potentially available due to the shape of the island and current mining activities. This is insufficient area to support a gas processing hub. The site has sufficient, although probably excessive, elevation. The site is extremely steep, rising to 150 metres in the middle of the island, and is largely formed of hard rock. Pipeline access to the site would be difficult due to the steep, rocky slopes which are likely to also extend offshore.

Charts indicate that access to water depth between 10 and 20 metres in the narrow channel between the island and the mainland is available close to shore (although water depth may be deeper, given the steep sloping nature of the island). This would require a short length jetty and the need for a turning basin or channel will not be required.

The site is likely to be protected and a breakwater not required. Currents are, however, likely to be a significant issue at this site in the narrow channel for LNG tankers. Offshore navigation for LNG tankers may also be difficult due to the presence of currents and offshore islands.

The site is approximately 250 kilometres from the Ichthys field and 310 kilometres from Woodside's Browse fields making the site reasonably competitively neutral and one of the shortest average distances between the lead proponents.

Koolan Island is part of the Buccaneer Archipelago located off the Yampi Peninsula on the southern edge of the Kimberley Plateau region. The Buccaneer Archipelago and Yampi Peninsula is a distinctive region of tightly folded and faulted rock strata that produces an extremely complex coastal environment. The island supports an operating iron ore mine.

Marine Environment:

Koolan Island is one of a chain of relatively narrow and steeply sided islands on the northern side of the Buccaneer Archipelago. The southern side of Koolan Island is protected from swell and separated from the mainland by a relatively deep, narrow channel with moderate to strong tidal currents and moderate turbidity. Exposure to wave energy is moderate to high on the northern shore. There are no important seabird sites on or around the island. As with the Maret Islands and Wilson Point, the steep bathymetry and range of exposure to swell waves and tidal currents provides a range of habitats supporting a high diversity of marine communities. The southern side of the island and the adjacent mainland coast are fringed by mangroves. Well-developed and extensive fringing coral reefs occur along the island shore with high live coral and tropical finfish abundance and diversity. Filter-feeding communities occur on the reef slope and on areas of hard substrate amongst bioturbated sand in deeper water. Although sea turtles occur, there is extremely limited habitat for nesting and the importance for dugong is unknown but not likely to be significant.

Humpback whales with newborn calves use the Buccaneer Archipelago for resting but the significance of the waters inside Yampi Sound and around Koolan Island for Humpback whales is less well understood. The overall sensitivity of the marine environment at this site is considered to be high.

Terrestrial Environment:

Koolan Island is formed on highly folded and faulted Yampi Member Sandstones including hematitic quartz sandstones and iron ore, with minor components of Warton Sandstone and Elgee Siltstone. The hard rock strata are almost vertically dipping and the island terrain is steep-sided and elevated with deeply incised creeks. Very extensive blasting and earth moving would be required to establish a minimal area of level surface for a possible hub. Access to the elevated site and management of drainage from the elevated surface would be challenging. The island supports predominantly eucalyptus woodland vegetation communities, but also 'at risk' *Callitris intratropica* (Cypress Pine) communities along deeply incised drainage lines, and small areas of monsoon vine thicket TEC's and mangrove communities in embayments. The island has been well surveyed and supports a diverse flora, including three priority flora species. Threatened fauna include the endangered Northern Quoll and Gouldian Finch, two vulnerable species and five other specially protected and priority listed species, and short range endemics. Despite the mining history, the island retains high landscape qualities from the side, mostly observed by marine tourists and is adjacent to the route to Horizontal Falls, one of the region's highest profile attractions. The level of public concern based on visual values is expected to be high, with low to moderate visual absorption capability. Overall sensitivity of the terrestrial environment at this site is considered to be high.

Koolan Island

Koolan Island is close to pearl lease grounds and is a commercial mudcrab fishing ground. Though the area is already industrialised, the tourism industry is concerned that an LNG hub would further impact on the area's visual amenity and that exclusion zones and the risk of accidents and spills could impact on the high value boat tourism market.

Koolan Island has significant Aboriginal heritage sites inclusive of rock shelters and paintings and has cultural importance to the Traditional Owners. The island is also currently providing employment opportunities for Aboriginal people in the iron ore industry.

See maps 9 and 10 in **Appendix 3**.

7.2.8. Wilson Point

Wilson Point is located on the southern edge of Camden Sound and is approximately 220 kilometres north of Derby and 355 kilometres north east of Broome. Wilson Point is extremely remote. There is no existing infrastructure or roads close by. It is estimated that over 600 kilometres of sealed road across difficult and remote country would be required to service Wilson Point by road (which may not be required if the site is serviced by sea and air only).

There is over 950 hectares of available land, starting within 1 kilometre of the coast, however, there are steep slopes rising to 50 metres within 500 metres of the shore. The soil is considered rock and stone with possible fault lines, requiring significant earthworks. The closer the site is positioned to the peninsula, the narrower is the area of land available. The reduced land area close to the coast may make it difficult for multiple operators to equally place infrastructure and access port facilities, particularly if buffer areas are required between facilities, similar to Gourdon Bay and North Head. Pipeline access to the site is likely to be reasonable, assuming the pipelines cross the beaches close to the site (pipelines are likely to be buried to reduce their impact), however, they may need to traverse some steep slopes to reach the site. Otherwise, pipelines will need to negotiate the steep, rocky cliffs at Wilson Point.

Charts indicate that access to water depth between 10 and 20 metres is 1 kilometre away and 20 to 50 metre water depth is 2 kilometres away, requiring a medium to short length jetty and the need for a turning basin or channel is considered unlikely.

The site is likely to be protected and a breakwater not required. Currents are not considered to be a significant issue but the presence of small offshore islands nearby may present some minor difficulties for LNG tanker navigation and require further investigation.

The site is approximately 220 kilometres from the Ichthys field and 320 kilometres from Woodside's Browse fields making the site reasonably competitively neutral and one of the shortest average distances between the lead proponents.

Marine Environment:

The potential hub location at Wilson Point is within a relatively sheltered and deep embayment in Camden Sound, protected by the Slate Islands to the west. The coast is mainly rocky and incised, with steep slopes and few sandy beaches. Exposure to wave energy is moderate to high on the seaward side, but generally low within the embayment. Tidal currents are moderate within the embayment and turbidity is relatively low. There are some small patches of mangroves at the base of creek lines and in Deception Bay to the south and in Kuri Bay to the north east. As with the Maret Islands, the steep bathymetry and range of exposure to swell waves and tidal currents provides a range of habitats supporting a high diversity of marine life, including a wide variety of tropical finfish species. Coral reef formations occur inside the bay with extensive and well developed staghorn coral thickets in places. Tabular and massive forms dominate in more exposed areas and diverse filter-feeding communities and soft sediment communities are common in deeper water. The importance for dugong and turtles is unclear but some utilization of beaches by turtles is known to occur. The area is within the central calving grounds for Humpback whales and is of very high significance in that regard. The overall sensitivity of the marine environment at this site is considered to be very high.

Terrestrial Environment:

The Wilson Point site area is relatively rugged terrain located on regionally restricted Buckland member sandstones, confined to a relatively small area of the near coastal Kimberley in this vicinity, with areas of Hart Dolerite, and Cainozoic Sands developed on the sandstone substrate. The area has a predominantly rugged rocky and cliff coastline with some narrow embayments with pocket sand beaches, mangroves and stream environments, and is considered relatively stable. Given the terrain and high rainfall, stormwater management would need careful consideration. Vegetation is diverse, reflecting the diverse substrate and landform types. Significant vegetation includes monsoonal vine thicket (TECs), and 'at risk' *Callitris intratropica* (Cypress Pine) vegetation complex that is regionally threatened by excessively frequent hot fire and wetland stream environments that provide important fauna habitat. The presence of the *Callitris* community confirms satellite imagery indicating that this area has not been burnt very frequently in recent years and may be a fire refuge. Surveys for Woodside have identified the presence of a number of significant flora and fauna species. The area is in the core of the high rainfall north west coastal Kimberley and is expected to retain an intact assemblage of flora and fauna. Wilson Point is part of the remote north west Kimberley coastal wilderness region. Visual landscape significance assessment has classified this site as "unsuitable" for a hub, with distinctive visual character with high levels of public concern based on visual values and a low visual absorption capability. The area is remote from land-based access. Quarantine risks and the potential for impacts arising from possible future decisions to forge land-based infrastructure links would be very significant.

The overall sensitivity of the terrestrial environment at this site is considered to be very high.

Wilson Point

Wilson Point is a significant fish habitat supporting high biodiversity. It is in the centre of the Humpback whale calving grounds and close to iconic pearling activities at Kuri Bay and the islands to the north and east of Camden Sound. It is also a commercial mudcrab fishing ground.

Wilson Point is within a region of outstanding natural, Indigenous and historical values which may potentially include values that may meet criteria for national and possibly international heritage listing. Being remote and inaccessible by land, major development brings the risk of the opening of the region to a range of environmental impacts including introduced pests and weeds, particularly if a road to the hub was constructed.

The Wilson Point area is significant to the Dambimangari people and important rock art sites are located in the immediate region. The area has had only a small number of heritage surveys undertaken and is likely to have more heritage sites than currently registered with the Department of Indigenous Affairs.

See maps 11 and 12 in **Appendix 3**.

7.2.9. Maret Islands

The Maret Islands are located in the remote northern Kimberley area, situated approximately 15 kilometres west-north west of Bigge Island. Maret Island is 355 kilometres north-north east of Derby.

The Maret Islands are well elevated; the northern island is narrow and longer than the southern island. The site is characterised by limited available land (approximately 360 hectares each island). The islands are relatively flat, which means that it is feasible to construct a plant and associated facilities with a lesser need for significant civil works, therefore assisting in minimising the potential impact associated with the construction of the facilities. Soils are thought to comprise a mixture of sandy and laterite soil structure but the presence of clay may present some difficulties which need to be further investigated. Pipeline access to the site is considered good, assuming the pipelines cross the beaches on the islands (pipelines are likely to be buried to reduce their impact), however they may need to traverse some steeper sections to reach the site.

Charts indicate that access to water depth between 10 and 20 metres and 20 to 50 metres is very close, requiring a short jetty and the need for a turning basin or channel will not be required.

The site is likely to be protected and a breakwater not required. Currents and offshore navigation are not considered significant issues at this site.

The site is approximately 200 kilometres from the Ichthys field and 340 kilometres from Woodside's Browse fields making the site reasonably competitively neutral and one of the shortest average distances between the lead proponents.

The Maret Islands limited size is considered to be technically sufficient to accommodate a single operator LNG hub, but could not accommodate a multi operator LNG hub or a gas processing hub due to the constraint of land area. INPEX has suggested a development on Maret Islands could ultimately produce up to 31.8 Mtpa of LNG from a single operator LNG facility. This facility would have an initial LNG production of 8.4 Mtpa and could be expanded to the maximum capacity by adding trains. Constrained size raises the potential for increased difficulties in managing construction and operational impacts on site to satisfactory environmental standards.

The Maret Islands are outliers of the high rainfall (estimated 1000+mm) north west Kimberley Plateau region, being amongst the most north westerly of the mainland islands of the Bonaparte Archipelago off the Kimberley coast. INPEX has undertaken detailed environmental surveys of the islands for environmental assessment purposes but has not been in a position to provide this detailed information to inform the NDT process.

Marine Environment:

The North Maret and South Maret Islands are within an offshore island group on the mid-shelf. These islands are joined at low tide and are characterised by extensive fringing coral reef flats and small sandy beaches backed by steep scree slopes between rocky headlands. These islands are not considered important for seabirds. There are no mangroves but fringing intertidal reef flats can be 100's of metres wide and the coral communities that have built them are very healthy and exceptionally diverse.
The waters surrounding the islands support a wide range of tropical finfish species. Surveys by INPEX have found that filter-feeding communities are common in deeper waters and are very species diverse and abundant in places. This area appears to be towards the northern limit of the Humpback whale calving grounds, but at this stage it is not considered of high significance to the population as a whole. Dugongs occur in the area and most sandy beaches are heavily utilised by sea turtles for nesting. These beaches appear to be regionally important for turtle breeding and the overall sensitivity of the marine environment at this site is considered to be high.

Terrestrial Environment:

The Maret Islands are one of the largest examples of the regionally uncommon basalt (Carson Volcanics) islands, particularly as the dominant landform is a regionally rare flat-topped heavily lateritised island surface with cliffed edges. The palid zone clays underlying the laterite, laterite cliff and boulder scree slopes are exposed along the cliffs that fringe the islands coast and basalt is present in places at near sea level elevations. Sand beaches and vegetated storm-ridges are common between laterite cliffed headlands. The coastal geomorphology is considered relatively stable. The islands support monsoonal vine thicket vegetation on the laterite cliff and boulder scree slopes surrounding the island and better developed examples on the sand swales and sheltered laterite slopes behind storm ridges at the head of some embayments. These communities are supported during the drier months by moisture from wet season rains that has infiltrated the laterite surface and is held in the underlying clays. The laterite surface supports tussock grasslands and herblands on massive laterite and low open woodlands to woodlands where the surface is more fractured, allowing better water and root penetration. The herbfield vegetation on massive laterite is considered likely to be significant as it is regionally uncommon, with potential to support restricted and possible endemic plant species. Survey results from the islands are not available to confirm this, but it is understood from an INPEX presentation that new unnamed plant species have been recorded. The islands do not support terrestrial mammal fauna, but have an intact fauna that is known to include short range endemic species including land snails associated with the vine thickets.

The Maret Islands are part of the remote north west Kimberley coastal wilderness region that has outstanding natural and cultural heritage values. Landscape quality has been assessed as distinctive, with a high level of public concern based on visual values and low visual absorption capability. As one of the largest Kimberley islands with a laterite surface formed over a basalt substrate, it is important as a representation of this environment type and serves as an important refuge. The islands are likely to have national heritage significance for their geoheritage and landscape values. The Maret Islands have been recommended as a Nature Reserve by the EPA (1981) and this recommendation has been reinforced by CALM (1992).

The overall sensitivity of the terrestrial environment of the Maret Islands is considered to be high to very high, because of the remote location, uncommon island environment that it represents the extensive fringing vine thickets and the uncommon herbfield vegetation present on the plateau surface.

Maret Islands

The Maret Islands are close to commercial fishing grounds and are considered to be an important fish habitat supporting high biodiversity.

A development on Maret Islands is seen as a risk to the “wilderness” tourism market including boat tourism and aerial tourism. Risks are seen to be due to a loss of visual amenity, increased boat movements, potential exclusion zones and the risk of accidents and spills. INPEX has stated that these impacts can be avoided, minimised or mitigated.

The Maret Islands lie within a region of outstanding natural, Indigenous and historical values which has potential to include values that may meet criteria for national and possibly international heritage listing. The marine environment includes highly diverse coral reefs.

The Maret Islands are believed to have ceremonial/mythological importance to the Uunguu Traditional Owners.

See maps 13 and 14 in **Appendix 3**.

7.2.10. Cape Voltaire

Cape Voltaire is located in the Northern Kimberley region approximately 300 kilometres west of Wyndham, 375 kilometres north north-east of Derby and 550 kilometres north north-east of Broome. The locality of Cape Voltaire is extremely remote. There is no existing infrastructure or roads close by. It is estimated that over 370 kilometres of sealed road across difficult and remote country would be required to service Cape Voltaire by road (which would not be required if the site is serviced by sea and air only).

The site is likely to be on the south east of Cape Voltaire, set as close as possible to the bay between Nglayu and Kankanmengarri islands, to enable the closest access to protected deep water and the shortest pipeline distance from the plant to storage tanks and then from storage tanks to jetty loading point.

There is over 950 hectares of reasonably flat land available with sufficient elevation within 1 kilometre of the coast, however, the presence of deeply fissured rock mixed with deep sands is likely to mean substantial earthworks would be required. Pipeline access to the site may be difficult due to the absence of appropriate beaches and steep sections to the site.

Charts indicate that access to water depth between 10 and 20 metres is 3 kilometres away and 20 to 50 metres water depth is 4 kilometres away, requiring a medium jetty and the need for a turning basin and /or channel. Further study of the bathymetry in the area is likely to be required.

The site is likely to be protected and a breakwater not required. Currents and the presence of small offshore islands and reefs may present an issue for LNG tanker navigation.

The site is approximately 260 kilometres from the Ichthys field and 410 kilometres from Woodside's Browse fields.

Cape Voltaire could be a technically suitable site. However, further land and marine studies would be required to evaluate site preparation needs and confirm the suitability of its partially surveyed east coast.

The site is located in the remote high rainfall (estimated 1200 mm) north west Kimberley plateau region approximately 60 kilometres north north-west of the Mitchell Plateau. This site has recently been added to the list by the KLC and Traditional Owners and has not yet been surveyed for this review. Assessment is based on limited available information. Surveys are not proposed.

Marine Environment:

The potential hub site is towards the end of a relatively exposed peninsula with some important seabird breeding islands immediately to the north and also in Admiralty Gulf. On the basis of remote sensing imagery, the coast is comprised of extensive mangrove-lined rocky shores with some deeply incised bays and estuaries but few beaches. Well developed fringing coral reefs are evident and tidal currents and turbidity may be significant. It is likely that filter-feeding and soft sediment communities occur in deeper areas and seagrass in the shallows. Dugongs are known to occur in the area and turtles are common. Sawfish are likely to occur, and the area supports a significant variety of tropical finfish species and protected species such as Giant Grouper.

Although the area is near the northern limit of the Humpback whale calving grounds, it is unlikely to be significant for the Humpback whale population as a whole. The significance of the area for other cetaceans such as snubfin dolphins is unclear. The overall sensitivity of the marine environment at this site is considered to be at least as high as that of Anjo Peninsula.

Terrestrial Environment:

The site area is rugged terrain on King Leopold sandstone with areas of Hart Dolerite, and Cainozoic Sands developed on the sandstone substrate. The area has a predominantly rugged rocky and cliff coastline with some narrow embayments with pocket sand beaches and is considered relatively stable.

Vegetation is expected to be more variable than Anjo Peninsula, given the more diverse and rugged site characteristics and geology, including coastal mangrove communities, limited supratidal flats, seasonal stream and wetland environments, Spinifex tussock grasslands and Open Woodland to Woodlands on sandstones, Woodlands and Open Forest on Cainozoic sand surfaces, rock outcrop communities and woodland communities on Hart Dolerite. There are patches of monsoon vine thicket in sheltered sites on the Hart Dolorite substrates. The fauna assemblage is expected to be intact and diverse, given the high rainfall north west Kimberley location, diverse substrate and isolated peninsula location that will give a degree of protection from feral stock. Low fire frequency, indicated by satellite imagery may make the area a significant refuge for fauna and vegetation that are regionally threatened by frequent hot fire, though there is evidence that recent fires have caused significant damage to monsoon vine thickets.

Cape Voltaire is a remote wilderness area that has significant landscape qualities and visibility from a marine tourism perspective.

The overall sensitivity of the site from a terrestrial environment perspective is considered to be high to very high.

Cape Voltaire is close to pearl leases and commercial fishing grounds and is considered to be a significant fish habitat.

A development on Cape Voltaire is seen as a risk to the “wilderness” tourism market inclusive of boat tourism and aerial tourism. It is located directly adjacent to the main boat tourism transit route. Risks include the loss of visual amenity, increased boat movements, potential exclusion zones and the risk of accidents and spills.

Cape Voltaire lies within a region of outstanding natural, Indigenous and historical values which has potential to include values that may meet criteria for national and possibly international heritage listing. As a remote mainland location, the potential for future road access would risk a range of environmental impacts, including pests and weeds with wider regional impacts.

Cape Voltaire has a number of registered Aboriginal heritage sites inclusive of some significant rock art. It is likely that with full heritage surveys, the area will be found to be of national significance.

See maps 15 and 16 in **Appendix 3.**

7.2.11. Anjo Peninsula

Anjo Peninsula is located in the high rainfall (1200 mm) north west Kimberley Plateau region approximately 25 kilometres north west of Kalumburu.

Anjo Peninsula is very remote, being approximately 230 kilometres to Wyndham, 468 kilometres to Derby and 621 kilometres to Broome. There are 200 metre high mountains inland. The Anjo Peninsula has some established transport infrastructure based around the site of the WWII Truscott airbase. There is currently an sealed airstrip, some minor buildings and unsealed road access to West Bay where the site is proposed to be located. It is estimated that over 370 kilometres of sealed road across difficult and remote country would be required to service Anjo Peninsula by road (which would not be required if the site is serviced by sea and air only).

There is over 950 hectares of relatively level land available within 1 kilometre of the coast with sufficient elevation available for the development of a gas processing hub. The soil is generally sandy and stony soils and is considered suitable for construction. Pipeline access to the site is likely to be good, assuming the pipelines cross the nearby beaches (pipelines are likely to be buried to reduce their impact).

Charts indicate that access to water depth between 10 and 20 metres is 5.5 kilometres away and 20 to 50 metres of water depth is 15.5 kilometres away. Further study of the bathymetry in the area is likely to be required. Given the current bathymetric figures, this site is likely to require a long jetty, turning basin and medium length channel.

The site is protected and will not require a breakwater. Currents and the presence of small offshore islands and reefs may present an issue for LNG tanker navigation.

The site is approximately 350 kilometres from the Ichthys field and 500 kilometres from Woodside's Browse fields. The pipeline distance required may mean that a gas compression platform is required if the pipeline distance is more than 500 kilometres.

The Anjo Peninsula is close to pearl lease sites and commercial fishing grounds and given its complex marine system, is likely to be an important fish habitat. It is also popular with wilderness recreational fishing.

A development on the Anjo Peninsula is seen as a risk to the "wilderness" tourism market inclusive of boat and land-based tourism. The proposed site though located some distance from the main boat tourism transit routes would potentially be visible both day and night, impacting on the wilderness experience. Risks are seen to include the loss of visual amenity, increased boat movements, potential exclusion zones and risks from accidents and spills.

This site has recently been added to the list by the KLC and Traditional Owners. Some terrestrial and marine surveys have been completed and the preliminary findings have been used to inform this review. Assessment is based on information available at the time of this review but it is recognised that more information will become available as the data from these recent surveys are analysed more fully.

Marine Environment:

The south eastern side of the peninsula near the potential hub site is relatively indented and sheltered from swell by offshore banks and several islands, some of which in Napier Broome Bay are important for breeding seabirds. Although this area experiences one of the lowest tidal ranges in the Kimberley, tidal currents can be significant with current eddies and moderate to high turbidity evident in satellite images. Two major rivers draining some 24,000 km^2 of catchment discharge water and suspended sediments to Napier Broome Bay. The coastline of the peninsula is characterised by narrow bands of fringing mangroves interspersed with sandy beaches and rocky shores. Patches of dense mangroves are associated with tidal creek mouths and some islands. The shoreline is fringed by a reasonably broad zone comprising intertidal/subtidal algal-dominated reefs including those based on rock substrate and others that appear to be biogenic and built by coral communities. In places, the reef platforms were approximately 1.6 km wide. The biogenic reefs, some with abundant live corals present, are most prevalent on the more exposed northern and western sides of the peninsula. Reefs were generally dominated by algae, but other biota, such as sponges, whips, hard and soft corals and other filter feeders were present in varying amounts. On the east coast of the peninsula, the abundance of live hard-coral colonies tended to increase towards the tip of the peninsula. The deeper areas of Napier Broome Bay are characterised by fine sediment with extensive bioturbation evident at most sites. Filter feeding communities in the deeper areas of the bay were patchily distributed and generally of relatively low density and diversity. The diversity and complexity of habitats in the area is likely to support significant finfish diversity and protected species such as Giant Grouper may occur. Turtles are thought to be most common on the west side of the peninsula and although dugongs are known to occur in the area, especially in the vicinity of Woppinbie Creek, no seagrass was recorded during the August 2008 survey. Sawfish are likely to occur, and although the area is not thought to be significant for Humpback whales, cows and calves were observed offshore from the peninsula during August 2008. The significance of the area for other cetaceans such as snubfin dolphins is unclear. The overall sensitivity of the marine environment to pressures associated with constructing and operating an LNG hub at this site is considered to be moderate to high.

Terrestrial Environment:

The site geology is King Leopold Sandstone with substantial areas of residual Cainozoic Sand surfaces formed on the sandstone, which may show some laterisation. These sandy soils have reasonable capacity to manage stormwater. Coastal geomorphology is varied with sandstone headlands, sandy bays and mangrove creeks that are considered reasonably stable.

Broad vegetation information is available from historical botanical collections and a broader sub-regional mapping program. This information has been updated with new vegetation mapping and dry season flora and fauna surveys. The recent mapping identifies a diverse environment supporting ten vegetation communities within the study area. Upland vegetation on the site are dominated by *Eucalyptus tetradonta / E. miniata* open forest, on well drained deep sandy to sandy loam surfaces, *Acacia* shrublands on rugged outcropping King Leopold Sandstones, *Corymbia bleeseri* open forest communities are associated areas with very shallow skeletal soils and *Corymbia latifolia* woodland with rocky soils over massive sandstone. Understoreys generally include tall annual sorgum grasses with a variable small tree and shrub component.

Areas with seasonal inundation associated with impeded drainage support an open forest of *Corymbia polycarpa* / *Eucalyptus apodophylla*. Ephemeral lake, claypan or stream bed communities are scattered as a mosaic across the study area. They include spring-fed streams that appear to be perennial, seasonal wetlands and streams that dry to pools during the dry season. Riparian vegetation is typically confined to a narrow fringing corridor along creek lines. Vine thickets are limited to small areas scattered on coastal dunes that have been severely impacted by cattle.

Coastal communities include dense stands of *Acacia* dominated shrubland and *Spinifex* grasslands on coastal dunes, Mangrove communities and supratidal mudflats in sheltered embayments, and narrow fringing mangrove stands along sandstone coasts.

These communities are generally widespread in the region. Two communities are of possible conservation significance, small remnant stands of the fire sensitive cypress pine *Callitris columellaris* and the small areas of monsoon vine thicket.

The recent dry season surveys and previous surveys have not recorded EPBC Act listed Endangered or Vulnerable species or Declared Rare Flora listed under the Wildlife Conservation Act, but have identified several priority flora in the study area and surrounding areas. The area is part of the north-west Kimberley region that has generally retained an intact faunal assemblage, however the relatively accessible terrain of Anjo Peninsula may have allowed feral cattle grazing and repeated extensive fire to have an impact on the terrestrial mammal fauna at this location.

Landscape quality has not yet been assessed. The location between Kalumburu and Truscott airbase which has limited vehicle access, reduces potential wilderness values. Potential for upgraded land-based access may still pose significant ecological and quarantine risk. The overall sensitivity of the terrestrial environment to an LNG hub at this site is considered to be high.

Anjo Peninsula lies within a region of outstanding natural, Indigenous and historical values which has potential to include values that may meet criteria for national and possibly international heritage listing.

The Anjo Peninsula has significant heritage sites for Indigenous and non Indigenous cultures. The land area is Aboriginal reserve leased to the Waambaal Aboriginal Corporation. An Aboriginal ranger station has been established on the peninsula. There are also pearling lease and holding sites within Napier Broome Bay.

See maps 17 and 18 in A**ppendix 3**.

8. Site Evaluation

8.1. Objectives and Method

The NDT site evaluation criteria is being applied within the overall framework of the strategic assessment report which in turn responds to the Terms of Reference endorsed by the Commonwealth Environment Minister and the State Environment Minister related to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and *Environmental Protection Act 1986* respectively.

The use of the matrix as a decision making tool is being limited to demonstrating the potential of cumulative impacts across a wide range of criteria and to assist with ranking prospective sites and will be supported by a range of underpinning data, reports and on ground studies.

It is also recognised that not all impacts can be quantified through available data. To overcome this, the environmental and other working groups have developed sub criteria and the use of High, Medium and Low as indicators of potential impact risk to reflect the uncertainty of knowledge implicit in areas of the State that are remote and not fully studied.

The NDT evaluation panel has subjectively assessed for potential advantage or disadvantage based on the available technical data and non technical information provided by the experts and interested parties incorporated within the NDT stakeholder process.

A six point relative scale was applied with three scales for disadvantage, minor, major and significant, neutral and two scales for advantage minor and major. The scoring reflects an assessment against this scale without the application of potential mitigation or management measures.

It is recognised that a significant environmental or heritage value or major technical constraint issue may constitute a fatal flaw for any one site and the application of a fatal flaw evaluation on a critical criterion could potentially eliminate the site from further consideration. The NDT evaluation panel has indicated where a fatal flaw may be evident and this will be confirmed following the public consultation process and further quantitative analysis where there is incomplete information.

8.2. The Site Evaluation Criteria Assessment

The NDT site evaluation panel assessed each of the 11 sites identified in the Interim Report, utilising criteria published in the Strategic Assessment Terms of Reference.

Each criterion related to environmental constraints, technical attributes and socio-economic impacts were rated for advantage or disadvantage.

The NDT also arranged for the environmental criteria to be independently assessed by marine and terrestrial environmental experts.

The comparative assessment is presented in **Appendix 11**.

The independent assessment panel also provided comments on specific criteria. This is presented in **Appendix 12.**

Industry provided an independent assessment of the environmental and technical criteria which was then compared with the NDT Evaluation Panel assessment at the Perth workshop held on 7 August 2008. Industry responses are included in the body of this report.

The KLC participated in the review of the panel assessment and indicated that their assessment of Indigenous heritage and cultural criteria would be submitted to the NDT through the public comment process.

8.3. Outcomes

The prime objective of the this phase of the Browse Basin gas processing options assessment was to determine if there is a site or sites in the Kimberley capable of being developed as a LNG processing hub. This recognises that alternative development options to a Kimberley hub may exist and be less constrained or economically more viable than any of the Kimberley options.

The NDT Evaluation Panel recognised that a site close to the centre of the Browse Basin would make a single gas hub highly attractive to industry. One issue identified, was the relatively unexplored nature of the Browse, Canning and Roebuck Basins and the potential for future gas fields to be discovered both further north of Ichthys and south of Calliance including areas directly west of the Dampier Peninsula.

The current centre of the field favours sites such as the Maret Islands, Wilson Point and Packer Island. As demonstrated in this report, there are a number of significant environmental and heritage constraints at these locations. The NDT recognises in recommending sites further north and south of the more central locations that alternative development options such as Gas to Burrup or Gas to Darwin may prove more viable for industry.

The Woodside Browse Joint Venture indicate that Quondong/James Price Point, North Head/Perpendicular Head and Packer Island are preferred locations for their further evaluation.

The INPEX Browse Joint Venture indicates that the Maret Islands remain their preferred site with possible consideration for the Anjo Peninsula, once additional information becomes available.

8.4. Further Studies

Technical/environmental/heritage

The sites recommended for further consideration in this report will be subjected to geotechnical investigation in both the terrestrial and marine areas and in Aboriginal heritage surveys. WorleyParsons Services Pty Ltd will prepare a design concept for each site cognisant of the environmental and technical constraints identified in this report. The outcome of this process will be an indication of the capacity to design a hub avoiding or minimising environmental, heritage and socio-economic impacts.

The KLC and the NDT will also undertake a program to identify ethno-biological values at each shortlisted site and work to define Indigenous landscape values, a concept yet to be the subject of academic study and hence not subject to specific assessment within the EP Act.

It is anticipated that these studies along with the considered opinion of the Traditional Owners will lead to the identification of a preferred site.

The NDT will be completing marine and terrestrial studies at the Anjo Peninsula, terrestrial studies at James Price Point, metrological ocean studies at shortlisted sites, terrestrial metrological studies and non-invasive geotechnical studies at each site.

Through the WA Marine Science Institution, the NDT has commissioned whale studies to determine the migration patterns of whales and dugongs along the Dampier Peninsula coastline. This will complement previous studies undertaken by INPEX over the past few years.

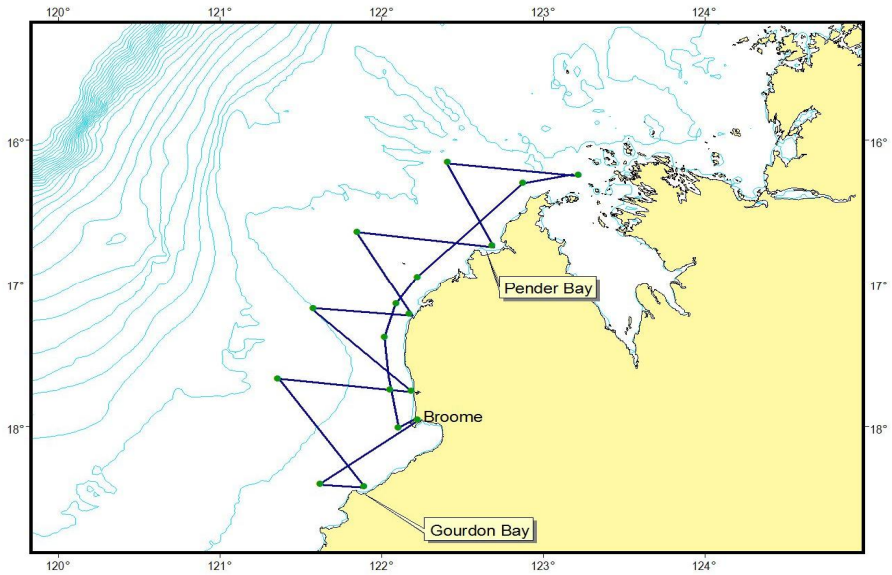

Figure 5 Whale Surveys 2008, (Centre for Whale Research).

Socio-economic studies

The NDT has established a Regional Impacts Group to pursue the evaluation of socio-economic impacts within the strategic assessment process. The objective is to provide management responses that would lead to the avoidance or mitigation of potential negative impacts of a gas hub in the West Kimberley region and maximise flow-on benefits to regional businesses and communities.

Process

Identify, analyse and plan for the management of the positive and negative impacts of the proposed West Kimberley gas processing hub on the local and regional including:

- Communities in existing towns and settlements;
- Existing industries, including tourism, fisheries, construction and mining;
- Physical and social infrastructure;
- Demand for land and housing;
- Demand for services; and
- Employment opportunities.

The region to be considered will include primarily the areas covered by the Shires of Broome and Derby/West Kimberley, but where significant impacts extend to other regions, these will be identified as appropriate.

Outputs

The regional impact studies will deliver the following outcomes:

- A broad social impact assessment utilising internationally accepted methodologies;
- Recommendations for managing identified social impacts;
- Industry impact studies on tourism, fisheries, construction, mining and other industries as appropriate;
- A small business impact assessment;

- A sub-regional land use plan and structure plan, including land use within the buffer area of the selected site(s);
- A land release and housing strategy for Broome and Derby and other settlements within 100 kilometres of the hub site;
- An infrastructure plan to service the hub and increased economic activity and population;
- A demographic model of the direct and indirect population impacts of the proposed development and a government services plan to serve the increased population; and
- An education and training plan to support the provision of suitably qualified local workers and meet the needs of local and regional communities, including a strategy to maximise the employment-readiness of Indigenous people.

See **Table B** below.

Table B. Proposed Studies/Planning Framework

Output	**Lead Agency**
Social impact assessment	DPI
Industry impact studies: Tourism Fisheries Construction Mining	 Tourism WA Fisheries DHW DoIR
Small business impact assessment	SBDC
Regional land use plan and structure plan	DPI
Land release strategy	LandCorp
Housing strategy	DHW
Infrastructure plan	DPI
Education and training plan	DET
Government services plans: Local Government Health Police Welfare Services Regulatory compliance	 DLGRD Health Police WA DfC Fisheries, DPI, others

9. Additional Sources of Information

Australian Bureau of Statistics, *Australian Census of Population and Housing* 2006.

BHP Billiton, *Pilbara LNG Project Site Selection Study,* 2005.

Broome International Airport, *passenger statistics,* 2008.

INPEX Browse, Ltd. *Ichthys Gas Field Development*, 2008.

Kadar Pearson and Partners, *Broome Accommodation Study,* 2006.

Kimberley Development Commission, http://www.kdc.wa.gov.au

Sustainable Tourism CRC, *Tourism and the Kimberley coastal waterways environmental and cultural aspects of expedition cruising*, 2008. http://www.crctourism.com.au

TNS Social Research, *Tourism Management on the Kimberley Coast,* 2006.

Tourism Western Australia, *Kimberley fact sheet,* 2008.

Woodside Energy Ltd, *Browse LNG Development, Site Identification and Assessment* 2006.

List of Appendices

Appendix 1 Gaffney Cline and Associates Reports 1-3.

Appendix 2 Broome workshop presentations.

Appendix 3 Site location maps and GIS attribute data for the site maps.

Appendix 4 Marine studies reports.

Appendix 5 Western Australian Museum, Intertidal study.

Appendix 6 Edith Cowan University, historical datasets of dugong observations in the Kimberley region of Western Australia.

Appendix 7 Damara WA, Coastal Geomorphology report.

Appendix 8 ENV Consultants reports:
8.1 Flora assessment
8.2 Vegetation assessment
8.3 Vertebrate fauna assessment

Appendix 9 Richard Hammond, Visual landscape study:
9.1 Maps of Visual Landscape Character-Significance Ratings
9.2 Key Travel Routes and Use Areas
9.3 Visual Landscape Summary-Site Characteristics and Issues Matrix

Appendix 10 Environmental Experts Working Groups matrix assessments:
10.1 Marine
10.2 Terrestrial

Appendix 11 Site Evaluation criteria matrix.

Appendix 12 Independent Assessment Panel comments.