Executive Summary

Draft

Environmental Impact Statement/
Environmental Review
and Management Programme

for the Proposed Gorgon Development

September 2005
Disclaimer
This Draft Environmental Impact Statement/Environmental Review and Management Programme (Draft EIS/ERMP) has been prepared by Chevron Australia Pty Ltd on behalf of the Gorgon Joint Venturers. In preparing the Draft EIS/ERMP, Chevron Australia has relied on information provided by specialist consultants, government agencies and other third parties who are identified in the Draft EIS/ERMP. Chevron Australia has not verified the accuracy or completeness of the findings, conclusions and observations of these consultants, government agencies and other third parties, except where expressly acknowledged in the Draft EIS/ERMP.

Note on Name Change
During the production of this Draft EIS/ERMP, ChevronTexaco Corporation changed its name to Chevron Corporation. As a consequence of this, ChevronTexaco Australia Pty Ltd changed its name to Chevron Australia Pty Ltd.

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ISBN 0-9757659-0-6
Title: Draft Environmental Impact Statement/Environment Review and Management Programme for the Proposed Gorgon Development: Executive Summary
The Proposal
The Gorgon Joint Venturers propose to develop the Gorgon gas field that lies approximately 130 km off the north-west coast of Western Australia.

The proposed Gorgon Development is based on the installation of a subsea gathering system and a 70 km subsea pipeline to Barrow Island. The associated gas processing facility will be located at the central-east coast of the island. It is proposed to inject carbon dioxide, which occurs naturally in the reservoir, into deep formations below the island. Liquefied Natural Gas (LNG) will then be transported by ship to international markets. Domestic gas will be delivered to the Western Australian mainland through a subsea pipeline for use in industrial and domestic markets.

Assessment Process
Following referral of the Development in November 2003, the Commonwealth Department of the Environment and Heritage (DEH) and the Western Australian Environmental Protection Authority (EPA) determined that the proposed Gorgon Development should be formally assessed at the Environmental Impact Statement (EIS) and Environmental Review and Management Programme (ERMP) levels, respectively.

The Commonwealth and Western Australian governments have agreed to a coordinated environmental assessment process. A single EIS/ERMP document that satisfies the requirements of each jurisdiction is required under this process. This Executive Summary is available as a separate document.

The Joint Venturers have prepared the Draft EIS/ERMP in accordance with the EPA and DEH requirements as set out in the environmental scoping document and guidelines (ChevronTexaco Australia 2004). This Draft EIS/ERMP is being placed on public exhibition for 10 weeks during which time public submissions will be sought. The DEH and EPA will assess the Draft EIS/ERMP following receipt of public submissions, and the Joint Venturers’ response to those submissions, before reporting to relevant Ministers for a final decision on whether the Development should be approved and if so, under what conditions.

Availability of the Draft EIS/ERMP for Public Comment
This Draft EIS/ERMP is available for public comment from Monday 12 September 2005 until Monday 21 November 2005. It can be viewed at the Gorgon Australian Gas website (www.gorgon.com.au), or at the following locations:

- Department of Environment Library
  Level 8, Westralia Square Building
  141 St Georges Terrace
  Perth WA 6000

- Department of Industry and Resources
  1st Floor, 100 Plain St
  East Perth WA 6000

- Research and Information Centre
  Department of Industry and Resources
  1 Adelaide Terrace
  East Perth WA 6000
This Executive Summary of the Draft EIS/ERMP is available free of charge. The Main Report (Volumes I and II) and the set of Technical Appendices are available at a cost of $10 each. These can be obtained from Chevron Australia by telephoning the Gorgon Health, Environment and Safety Administration Assistant on 08 9216 4000 or emailing your request to gorgon.info@chevron.com.

Submission Process
Individuals and organisations are invited by the EPA and DEH to submit comments on this Draft EIS/ERMP. A submission may include comments, provide information, and/or express opinions about the information presented in the document.

Reasons for conclusions stated in the submission should be stated clearly and supported by relevant data. The source of your information should also be included where applicable. Comments from the public will assist government in making their decision.

All submissions received by the agencies will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the Commonwealth Freedom of Information Act 1982 and the Western Australian Freedom of Information Act 1992. Submissions may be quoted in full or in part of the agencies’ reports.

The closing date for public submissions on this Draft EIS/ERMP is Monday 21 November 2005.

Submissions should be addressed to:
Chairman, Environmental Protection Authority
PO Box K822
Perth WA 6842

AND/OR
First Assistant Secretary Approvals and Wildlife Division
Department of the Environment and Heritage
GPO Box 787
Canberra ACT 2601

Why Write a Submission?
A submission is a way to provide information, express your opinion and put forward your suggested course of action – including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

Why Not Join a Group?
If you prefer not to write your own comments, it may be worthwhile joining with a group interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Submission Checklist
Comments should be in writing and:
• list points so that the issues raised are clear
• refer each point to the appropriate chapter and section in the Draft EIS/ERMP (e.g. Chapter 1, Section 1.1)
• keep the discussion of different sections of the Draft EIS/ERMP distinct and separate
• include relevant, factual and supportive information with details of the source.

Also remember to:
• identify the Development (i.e. the Gorgon Development)
• provide your name, address and date of submission
• identify any special interest you have in the Development (where relevant)
• indicate whether your submission is to be kept confidential.
Foreword

On behalf of the Gorgon Joint Venturers, (Chevron Australia, Texaco Australia, Shell Development Australia and Mobil Australia Resources Company), I am pleased to present this Draft Environmental Impact Statement/Environmental Review and Management Programme for the proposed Gorgon Development. As the Commonwealth and Western Australian governments have agreed to a coordinated environmental assessment process, this document is designed to meet the assessment requirements of both jurisdictions.

The gas fields discovered in the Greater Gorgon area represent Australia's largest undeveloped gas resource. As the custodian of the resource, the Joint Venturers accept responsibility for developing this important national and state asset in a sustainable manner. A successful Development will deliver substantial economic and social benefits to current and future generations of Australians, whilst also protecting the environmental values of the region and delivering net conservation benefits. This Development will be the key to unlocking the vast Greater Gorgon area resources, which are equivalent to 25% of Australia's total known gas resources.

Restricted use of Barrow Island is central to the commercial viability of the development of the Greater Gorgon area gas fields. Exhaustive studies show there are no commercially viable development alternatives to this location. Barrow Island is an internationally significant nature reserve and the site of Australia’s largest onshore operating oilfield. The Joint Venturers recognise the importance of the conservation values of Barrow Island and selected this location only after thoroughly assessing the viability of alternative locations.

The environmental management strategies developed to avoid or mitigate the potential impacts of the Gorgon Development will protect conservation and biodiversity values and enhance Chevron Australia’s successful stewardship of Barrow Island. The Gorgon Development will also deliver a clean fuel that will increase security of gas supply and provide price competition for consumers. The proposed Development will stimulate economic activity and create jobs that will have flow-on social benefits. The potential beneficiaries of the Gorgon Development range from communities in the Pilbara and the state of Western Australia to the whole of the Australian nation and our international customers.

Chevron Australia, operator of the Barrow Island oilfield, has been involved in existing oilfield operations on the island for over 40 years. The management of these operations is widely recognised as a demonstration of the successful co-existence of petroleum operations and the protection and maintenance of conservation values.

Our success in managing oil operations on Barrow Island, as well as our diligence in preparing this plan, demonstrates our commitment to meeting our environmental responsibilities, whilst also meeting national and international clean energy demands.

James W Johnson
Managing Director
Chevron Australia Pty Ltd
1 Introduction

1.1 Proposal Title
This document is the Executive Summary for the Draft Environmental Impact Statement and Environmental Review and Management Programme (Draft EIS/ERMP) for the proposed Gorgon Development. This Executive Summary was prepared by the Gorgon Joint Venturers in accordance with the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the Western Australian Environmental Protection Act 1986 (EP Act).

The title of this proposal is ‘the proposed Gorgon Development’, which comprises a range of offshore and onshore infrastructure components to recover gas.
from the Gorgon gas field (Figure 1-1), and to process this gas at, and ship it from a gas processing facility on Barrow Island. All construction, operation and decommissioning activities associated with this infrastructure are considered as part of the proposed Development.

1.2 Development Proponent

Chevron Australia is the operator and proponent for the proposed Gorgon Development (the key elements of which are outlined in Section 1.3.3) on behalf of the companies listed in Table 1-1. In this document, these companies are referred to together as “the Gorgon Joint Venturers” (or the Joint Venturers).

The Gorgon Joint Venturers are subsidiaries of leading companies in the global oil and gas industry with proven technical and management skills for safe, efficient and environmentally responsible development. These companies have a wealth of international and domestic experience in oil and gas processing and LNG operations covering all aspects of the Development, ranging from drilling to subsea production systems, offshore operations, gas plant operations, and product shipping.

The Joint Venturers also have extensive experience in injection of carbon dioxide (CO₂) into subsurface formations associated with oil recovery operations. This is another key area for the Gorgon Development as discussed in Section 13. The Rangely operation in the United States is one such example. Chevron Australia has also been working closely with the Geodisc program, and its replacement the Cooperative Research Centre for Greenhouse Gas Technologies (CO₂CRC), to widen the knowledge base associated with CO₂ injection.

For over forty years Chevron Australia has been involved in the oilfield operation on Barrow Island and has produced some 300 million barrels of oil. Chevron Australia’s management of oil production activities on Barrow Island is widely recognised as an industry benchmark for co-existence of petroleum development and the protection of conservation values (Box 1-1).

Implementation of conservation best practices underpins the success of the oilfield operations in managing quarantine and protecting the island from unauthorised visits. As a result, Barrow Island is Australia’s largest landmass which has no introduced vertebrate pests such as rats, mice, cats, rabbits and foxes. Without Chevron Australia’s environmental stewardship of the island, the same level of protection of the conservation values would have required a contribution of millions of dollars from the state of Western Australia. Chevron Australia’s success in managing the conservation values of Barrow Island has been formally recognised by the receipt of a number of environmental awards (ChevronTexaco Australia 2003).

Table 1-1:
Addresses of the Gorgon Development Proponent and Joint Venturers

<table>
<thead>
<tr>
<th>Company</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chevron Australia Pty Ltd</td>
<td>Level 24, QV1 Building 250 St Georges Terrace</td>
</tr>
<tr>
<td></td>
<td>Perth, Western Australia, 6000</td>
</tr>
<tr>
<td>Texaco Australia Pty Ltd</td>
<td>Level 24, QV1 Building 250 St Georges Terrace</td>
</tr>
<tr>
<td></td>
<td>Perth, Western Australia, 6000</td>
</tr>
<tr>
<td>Shell Development Australia Pty Ltd</td>
<td>Level 28, QV1 Building 250 St Georges Terrace</td>
</tr>
<tr>
<td></td>
<td>Perth, Western Australia, 6000</td>
</tr>
<tr>
<td>Mobil Australia Resources Company Pty Ltd</td>
<td>12 Riverside Quay, Southbank</td>
</tr>
<tr>
<td></td>
<td>Melbourne, Victoria, 3000</td>
</tr>
</tbody>
</table>

Box 1-1:
Barrow Island – Oilfield and Nature Reserve

Barrow Island is the centre for Chevron Australia’s oil operations in Western Australia. It has been operating as a producing oilfield since 1967. The conservation value of the island has long been recognised and a successful environmental management program has been in place for almost 40 years of the oilfield operation.

Barrow Island is a unique remnant of the natural ecology of the north-west with close affinities to the Cape Range area. In 1910, Barrow Island was proclaimed as a Class A Nature Reserve. The Class A status of the island reflects its importance as a refuge for wildlife species, some of which are endemic to Barrow Island and some of which are extinct, or near extinction, on the mainland.
1.2.1 Environmental Commitment and Responsibility

Developing Gorgon gas in a sustainable manner is a major objective of the Gorgon Joint Venturers. Further, the Joint Venturers are committed to conducting activities associated with the proposed Gorgon Development in an environmentally responsible manner; and aim to implement best practice environmental management as part of a program of continuous improvement. This will be achieved by addressing issues systematically, consistent with internationally accepted standards and the Chevron Operational Excellence Management System which includes the values and goals of the Chevron Health, Environment and Safety Policy (Policy 530). To fulfil its commitment to ensuring the Gorgon gas resource is successfully developed in an environmentally responsible and sustainable manner, the Joint Venturers will draw on their collective experience and the most appropriate technologies available.

During the planning and design of the Gorgon Development, a range of mitigation measures to prevent or minimise adverse environmental impacts have been taken into consideration. For example, the location for the feed gas pipeline shore crossing was moved to avoid sensitive rock wallaby habitat. Further, a range of management measures for identified potential adverse environmental impacts are presented throughout this Draft EIS/ERMP. In many situations, where impacts cannot be avoided, the implementation of these measures will limit the degree or magnitude of the adverse impact; or rehabilitate any impacted sites. In addition, much of the assessment work and many of the proposed management strategies and monitoring programs will contribute significantly to the substantial body of scientific knowledge and understanding of the ecology of the Development area – thus providing benefit as environmental offsets.

The Joint Venturers are proud of their environmental record and, in accordance with the requirements of Schedule 4 of the EPBC Regulations, confirm that none of the Venturers are the subject of any proceedings under a Commonwealth, state or territory law for the protection of the environment or the conservation and sustainable use of natural resources.

1.3 Development Overview

1.3.1 Resource under Consideration for Development

The Greater Gorgon area, situated 130 km off the north-west coast of Western Australia, comprises the largest gas resource discovered to date in Australia (Figure 1-2). The reservoirs of untapped natural gas contain in excess of 1.1 Tera cubic metres (Tm³) (40 Trillion cubic feet (40 Tcf)) of gas which represents some 25% of Australia’s known gas resources. Development of this substantial national asset would secure Australia’s position as a leading gas producer and generate a new source of wealth for Western Australia and Australia.

The Gorgon Joint Venturers are considering developing the Gorgon field, which is located within the Greater Gorgon area (Box 1-2). The field retention lease is held by the Gorgon Joint Venturers and lies in Commonwealth waters approximately 70 km from Barrow Island. Due to development economics, the Jansz field, which is 80 km further north-west of the Gorgon field, will be developed in a similar timeframe. Gas from the Jansz field will also be processed at and shipped from Barrow Island. Mobil Exploration and Production Australia (MEPA) is the operator and proponent of the Jansz field. The Jansz deepwater development and pipeline will be subject to a separate approval process, coordinated by MEPA as operator of the field.

It is the intention of the Joint Venturers that the Gorgon and Jansz fields be developed first due to the economics of field development, which is driven by the following factors:

• resource size, internal structure, and reservoir properties of each field
• amount of information available on each field
• gas composition of each field, including the amount of hydrocarbon liquids (condensate) and inert gases
• distance of each field from land
• water depth at each field.
1.3.2 Scope of the Proposed Development

The Gorgon Joint Venturers propose to develop a 10 million tonne per annum (MTPA) Liquefied Natural Gas (LNG) plant and, if deemed commercially viable, a 300 TJ/day domestic gas plant on Barrow Island that will be supplied from both the Gorgon and Jansz fields. Approximately 2000m³/day (12,000 bbl/day) of hydrocarbon condensate will also be produced.

The scope of this Draft EIS/ERMP, as illustrated in Figure 1-1, covers:

- the Gorgon gas field wells and subsea installation
- a feed gas pipeline from the Gorgon gas field to the gas processing facility on Barrow Island
- an easement along the Gorgon gas field pipeline (onshore Barrow Island and traversing state waters) to accommodate additional feed gas pipelines
- a gas processing facility on Barrow Island (including two LNG trains, domestic gas and condensate facilities)

Box 1-2: Gorgon Gas Resource Base

The gas fields of the Greater Gorgon area contain an estimated gas resource in excess of 1.1 Tm³ (40 Tcf) and include the Gorgon area gas fields in relatively shallow water; and the Jansz field, among others, in deeper water further offshore.

The gas fields of the Gorgon area contain a technically proven and certified recoverable gas resource of 0.37 Tm³ (12.9 Tcf) and includes the Gorgon, West Tryal Rocks, Spar, Chrysaor and Dionysus fields.

The Gorgon gas field is the largest field in the Gorgon area, a technically proven and certified resource of 0.27 Tm³ (9.6 Tcf), and one of the largest fields ever discovered in Australia.
• port/marine facilities at Barrow Island
• water supply and disposal
• the construction village and associated facilities
• a proposal to dispose of reservoir CO₂ by injection into the Dupuy formation
• monitoring of CO₂ movement in the Dupuy formation
• an optical fibre cable connection to the mainland
• a domestic gas pipeline to the mainland.

For the purpose of cumulative impact assessment, this Draft EIS/ERMP addresses the impacts on, and near, Barrow Island associated with the installation of the Jansz feed gas pipeline to process gas from the Jansz field and other potential tieback opportunities associated with the Greater Gorgon area, or other nearby prospects. An easement along the Gorgon gas field pipeline corridor (onshore and traversing state waters) to accommodate the Jansz and additional feed gas pipelines is included in this environmental assessment and approval application with construction subject to conditions set for the Gorgon Development. Onshore and near shore construction of additional feed gas pipelines will be planned concurrently, where possible, to minimise the total environmental impact.

A proposal to dispose of reservoir CO₂ by injection into the Dupuy formation, to mitigate greenhouse gas emissions, is also included in this environmental approval application.

Under the provisions of the Western Australian Barrow Island Act 2003, no more than 300 ha of uncleared land are available for this and other future gas processing proposals on Barrow Island. This is comprised of 150 ha for gas processing purposes, 50 ha for petroleum pipelines and 100 ha for future developments. Future phases of the Development will be subject to separate approval. However, the cumulative impacts of land clearing and habitat modification for the full 300 ha are considered in this Draft EIS/ERMP.

The infrastructure and activities that are beyond the scope of this assessment and will be assessed under separate approval processes are:
• the Jansz field development and pipeline (operated by MEPA)
• subsea installations to develop additional gas fields in the Greater Gorgon area, or other nearby prospects
• feed gas pipelines from additional gas field developments in Commonwealth waters
• offshore seismic marine surveys
• shipping activities outside of the Barrow Island port facility.

1.3.3 Principal Elements of the Proposed Development

Development of the Gorgon field will require a range of infrastructure to extract the gas and transport it to Barrow Island for processing and delivery to market. The principal physical components of the proposed Development are provided in Table 1-2.

The initial Development will consist of subsea infrastructure for the production and transport of gas from the Gorgon gas field to Barrow Island, and a gas processing facility at Town Point. A subsea development concept circumvents the need for an offshore platform as part of the initial development.

Liquefied Natural Gas and condensate produced at the gas processing facility will be shipped from Barrow Island. If commercially viable, gas for domestic use will be exported by a pipeline from Barrow Island to the domestic gas collection and distribution network on the mainland. Associated infrastructure will be required on the island and in the adjacent marine area. This will include administration and accommodation facilities, a materials lay-down area, a materials offloading facility, a CO₂ injection facility and a conventional loading jetty.
<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market objective</td>
<td>First shipment of LNG in mid-2010</td>
</tr>
<tr>
<td>Construction start (site preparation)</td>
<td>Late-2006</td>
</tr>
<tr>
<td>Development life</td>
<td>60 years</td>
</tr>
<tr>
<td>Size of recoverable resource:</td>
<td>• Gorgon field 0.27 Tm³ (9.6 Tcf) (technically proven and certified)</td>
</tr>
<tr>
<td>Leases:</td>
<td>• WA-2-R; WA-3-R</td>
</tr>
<tr>
<td>Typical gas composition:</td>
<td>• Gorgon field CO₂ = 14–15%; N₂ = 2–3%; Hydrocarbon = remainder</td>
</tr>
<tr>
<td>Wells (all subsea):</td>
<td>• Jansz field* CO₂ = &lt; 1%; N₂ = 2%; Hydrocarbon = remainder</td>
</tr>
<tr>
<td>Pipeline lengths:</td>
<td>• Gorgon gas field 18–25</td>
</tr>
<tr>
<td>Gas processing facility:</td>
<td>• Town Point, Barrow Island 2 x 5 MTPA LNG trains 300 TJ/day domestic gas</td>
</tr>
<tr>
<td>Port facility</td>
<td>• Container and shipping facilities with an 800 m causeway 3.1 km jetty</td>
</tr>
<tr>
<td>Other associated facilities</td>
<td>• Mainland supplies optical fibre cable construction village</td>
</tr>
<tr>
<td>Air emissions:</td>
<td>• 4.0 million tonnes of CO₂ equivalents per annum 4430 tonnes per annum</td>
</tr>
<tr>
<td>Dredging:</td>
<td>• MOF channel and turning basin 0.8 Mm³ over – 21 weeks</td>
</tr>
</tbody>
</table>

Table 1-2: Key Elements of the Proposed Gorgon Development
The principal physical elements outlined in this table are described in greater detail in Section 6.

1.3.4 Development Timeline

An indicative schedule for the proposed Development is provided in Figure 1-3 with the first shipment of LNG expected in mid-2010. The production life of the proposed gas processing facility will fall within the lease period of 60 years that is allowed under the State Agreement scheduled to the Barrow Island Act 2003.

1.3.5 Development Area on Barrow Island

If environmental and State Agreement approval for construction of a gas processing facility on Barrow Island is granted, the area allowed for new disturbance will be limited to a total of 300 ha. Of that area, 50 ha have been set aside for petroleum pipeline easements and 150 ha reserved until 31 December 2009 for the Joint Venturers. The remaining 100 ha is reserved for other projects to process or use gas from the Title Areas or the Greater Gorgon area. A lease for gas processing

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**Table 1-2: (continued)**

**Key Elements of the Proposed Gorgon Development**

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping:</td>
<td>– 3 shipments per week</td>
</tr>
<tr>
<td>• LNG export</td>
<td>– 1 shipment per month</td>
</tr>
<tr>
<td>• condensate export</td>
<td></td>
</tr>
<tr>
<td>Total direct employment:</td>
<td>– 3300 people</td>
</tr>
<tr>
<td>• construction (on Barrow Island at peak)</td>
<td>– 600 people:</td>
</tr>
<tr>
<td>• operations:</td>
<td>• 150–200</td>
</tr>
<tr>
<td>• on Barrow Island</td>
<td>• 150–200</td>
</tr>
<tr>
<td>• on rotation (off the island)</td>
<td>• 200–300</td>
</tr>
<tr>
<td>• in Perth office</td>
<td></td>
</tr>
<tr>
<td>Development Investment</td>
<td>– $11 billion</td>
</tr>
</tbody>
</table>

* Composition of Jansz gas included here as the gas processing facility will receive gas from both Gorgon and Jansz fields and as such emissions calculations and modelling have been based on the total incoming gas stream.

** Potential impacts in the easement in state waters associated with construction and operation of the Jansz (or other) feed gas pipelines are considered for cumulative impact assessment purposes.

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**Figure 1-3:**

**Indicative Environmental Approval and Development Schedule**

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would be granted under the *Land Administration Act 1997* for a period of 60 years but this land would remain part of the Class A Nature Reserve. Lease rent and charges would be similar to those paid by other large gas processing projects in the Pilbara region. The lease would be subject to local government (Shire of Ashburton) rates.

### 1.4 Development Objectives

The primary objective of the Gorgon Joint Venturers is to commercialise the proven recoverable gas from the Greater Gorgon area in a sustainable manner. This includes continuing to protect the conservation values of Barrow Island, managing all environmental, health and safety requirements responsibly, and implementing best practices throughout all phases of the Development.

To meet this objective, the Joint Venturers established a set of sustainability principles and assessment criteria for the proposed Development on Barrow Island during the Environmental, Social and Economic (ESE) Review process (ChevronTexaco Australia 2003). These principles and criteria are based on widely accepted sustainability principles and address the key issues, particularly those concerning environmental protection, expressed by stakeholders consulted about the proposed Development. They are also considered to be consistent with the direction of the Western Australian Government. These principles will be applied to all phases of the Development, and provide a framework for the Joint Venturers to sustainably unlock the value of Greater Gorgon area.

### 1.5 Development Rationale

The Western Australian and Commonwealth governments both identify the resource industry as a key to economic growth, so have enacted legislation and developed policy objectives designed to expedite development of Australia’s resources. The retention licences issued to the Joint Venturers obligate them to actively seek development opportunities for these resources.

There is a growing demand for energy in the Asia–Pacific region (Figure 1-5) and the Australian domestic gas market. At the international market level, particularly in the Asia–Pacific region, the Development will supply LNG for the next generation of gas-based industries. At the Australian market level, the proposed Development will double the size of the gas industry in Western Australia at a time when there is a projected shortfall in energy supply. Further, the development of an additional strategic gas supply hub in Western Australia will significantly improve the availability of long-term, competitive supplies of gas to the state, and help build Australia’s standing as a reliable gas supplier.

Development of the Gorgon gas field has the potential to secure Australia’s position as a leading gas producer and provide a large source of additional wealth to Australia and Western Australia (ChevronTexaco Australia 2003).

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**Figure 1-4:**
Asia–Pacific LNG Demand Forecast

![Figure 1-4: Asia–Pacific LNG Demand Forecast](chart.png)

- **Other Asian Countries**
- **China**
- **North America**
- **West Coast**
- **Japan**
- **Taiwan**
- **South Korea**

<table>
<thead>
<tr>
<th>Year</th>
<th>Million tonnes per annum (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 (actual)</td>
<td>74</td>
</tr>
<tr>
<td>2005</td>
<td>102</td>
</tr>
<tr>
<td>2010</td>
<td>156</td>
</tr>
<tr>
<td>2015</td>
<td>208</td>
</tr>
</tbody>
</table>
1.5.1 Consequences of Missing the Current Development Opportunity

If the Development does not proceed, the economic, social and strategic benefits identified and described in the Draft EIS/ERMP will not be realised. Even a short delay to the Gorgon Development could trigger a long delay in capturing and transferring these benefits to Australia, Western Australia and the Pilbara. This is because the market opportunities currently available to the Joint Venturers could be easily won by competing countries such as Indonesia, Malaysia, Russia and Qatar. Future market opportunities may not become available for a considerable period if the current opportunity is lost.

Missing the current market opportunity or not developing the Gorgon gas field also risks not realising the national, state and regional economic benefits from the proposed Development that would increase general economic growth, sustain regional development, and increase competition in domestic gas markets. A substantial increase in government revenues would also be at risk, both through the direct payment of taxes by the Joint Venturers and the workers and businesses associated with the Development. This would deny Australians and Western Australians the associated social benefits such as an increase in community services and highly skilled employment opportunities.

The Pilbara region of Western Australia, in particular, would be at risk of losing the benefits of growth in employment and business opportunities. The ecological values of the proposed Development area on Barrow Island would remain unaffected. Other opportunities to Western Australian businesses at risk from not proceeding with the Development include technology transfer and capacity building from the design, construction and maintenance of the gas processing facility and associated infrastructure – skills that could be applied to other resource and industrial projects in the state.
2 Legislative Background to this Proposal

Before proceeding with the federal and state regulatory environmental approvals processes, the Gorgon Joint Venturers sought from the Government of Western Australia in-principle approval for restricted access to Barrow Island for a foundation development. In a progressive step towards formally assessing the sustainability of the proposed Development, the government in consultation with the Joint Venturers developed an environmental, social and economic review and assessment process (ESE Review process) (Figure 2-1).

The ESE Review process required the Joint Venturers to present a report to the government and public that examined relevant environmental, social, economic and strategic issues, and demonstrated the proposed Development would yield net conservation benefits to the state. The process was a first in Western Australia and one of the few sustainability assessment processes documented internationally for a specific development. A key feature of the ESE Review process was a high level of public consultation to encourage all interested stakeholders to contribute to the government’s decision.

In-principle approval for restricted access to Barrow Island was granted in September 2003. If full federal and state regulatory environmental approval is granted for the proposed Development, the associated terms and conditions will be governed by the Western Australian Barrow Island Act 2003 and the Gorgon Gas Processing and Infrastructure Project Agreement (the State Agreement) that has been signed by the State Government of Western Australia and the Joint Venturers (Plate 2-1).

Plate 2-1: Signing of the State Agreement
Figure 2-1: Summary of the ESE Review Process (source: ChevronTexaco Australia 2003)

SCOPING

- Socio-Economic Study Guidelines
- EIA Administrative Procedures (EPA 2002)

DRAFT ESE REVIEW DOCUMENT

INVESTIGATION

- Investigations
- Expert Panel Review

ESE REVIEW DOCUMENT

ASSESSMENT

- Gorgon Venture Response
- Public Comment (6 weeks)
- MPR Bulletin, EPA Bulletin Conservation Commission advice
- Public Comment (6 weeks)

GOVERNMENT ADVICE

DECISION

- DEVELOPMENT-SPECIFIC APPROVALS INCLUDING ENVIRONMENTAL IMPACT ASSESSMENT

GOVERNMENT DECISION

EP ACT PT IV EPBC ACT ASSESSMENT

- Packaged Bulletins and advice with overarching Summary released through SIAC
3 Development Alternatives

3.1 Regional Development Locations

In the 10-year period before making the decision to seek in-principle approval for restricted access to Barrow Island for a foundation development, a number of alternative locations, within a 200 km radius of the Gorgon gas field, were investigated. Pursuing these concepts required the completion of many engineering, commercialisation, marketing and environmental studies at a cost of almost $1 billion.

A commercialisation attempt on the Burrup Peninsula was terminated in the late 1990s when it became clear that such a development would be internationally uncompetitive. Subsequently, a systematic and stepwise process was used to identify and assess alternative development locations. The alternative locations examined extend from the Burrup Peninsula in the north to Exmouth in the south; together with island locations (refer to Figure 3-1). Candidate locations were assessed against a suite of technical, commercial, social and environmental constraints and requirements.

The results of the assessment led the Joint Venturers to the conclusion that Barrow Island, the closest landfall to the gas field, was the only commercially viable location to develop this important resource. This finding was verified by an independent review (and cost audit) commissioned by the Western Australian Department of Industry and Resources (DoIR).

The naturally high levels of CO₂ in Gorgon gas must be removed in order to produce LNG and meet domestic gas specifications. Barrow Island provides the opportunity to dispose of reservoir carbon dioxide (CO₂) by injection into formations deep beneath the island. The proposed gas processing facility on Barrow Island provides the lowest cost option for CO₂ injection, due to the proximity to a suitable injection site. Injection of reservoir CO₂ would make the Gorgon Development one of the most greenhouse gas efficient LNG projects in the world. Development concepts that involve an alternative gas processing facility location would still require considerable construction activity, operating facilities and a substantial footprint on Barrow Island, associated with injection of CO₂.

An assessment of the regional alternative locations against the controlling provisions of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) showed that all the locations have similar potential for impacts on Commonwealth Marine Areas and only the Exmouth South location has the potential to impact a Commonwealth Marine Protected Area. Similarly, all locations have potential for impacts to species listed as threatened or migratory under the EPBC Act.

Key reasons for rejecting regional alternative locations are summarised below.

Montebello Islands

The Montebello island group was the location of nuclear weapon testing in 1952 and 1956 and elevated radiation levels are still found in some parts of the islands. The Gorgon Joint Venturers are not prepared to expose workers to such risks. The potential for radiation exposure would present serious industrial relations issues as well as create negative public and customer perceptions, adversely impacting the ability to attract and retain customers.
In addition, neither Trimouille nor Hermite Island has sufficient land available to safely accommodate the Gorgon Development; and both would present cost penalties over the Barrow Island development concept (i.e. $300 million for Hermite Island; and $70 million for Trimouille Island).

**Thevenard Island**

The Thevenard Island option is $500 million more expensive than the Barrow Island development concept, as a result of the required ground improvements, additional feed gas pipeline length, levees to protect against storm surge, connection to the CO2 injection site, personnel transport and relocation of the existing airstrip.

Other disadvantages of Thevenard Island are the distance from the Greater Gorgon area reserves, the limited area available for development, and the lack of sufficiently sheltered waters for LNG carrier berthing and loading. It is also considered that operational safety would be compromised due to the need to evacuate personnel by helicopter in the event of a cyclone, and that a development at this location would result in impacts to recreational fishers, boat users and tourists (including the need to acquire the jetty location from Mackeral Island Resort).

**Maitland Estate/West Intercourse Island**

The combined Maitland Estate/West Intercourse Island option is over $1 billion more costly than the Barrow Island development concept. These costs arise from the need for a remote hub platform, an additional 180 km of carbon steel gas pipeline, and additional pipeline and compression for CO2 disposal.

The use of West Intercourse Island for LNG storage and load-out would require a 12 km long interconnecting causeway and a pipeline easement between the gas processing facility and load-out facility. Construction of the LNG storage tanks is likely to result in disturbance to mangroves and a significant number of aboriginal sites. An extensive dredging program would be required to reach the Hamersley Channel, or to create a new channel to avoid congestion or conflicts with shipping traffic.
Holden Point, Burrup Peninsula
The Burrup Peninsula option is over $1 billion more costly than the Barrow Island development concept. Additional costs are related to the need for a remote hub platform, an additional 160 km of carbon steel gas pipeline, and additional pipeline and compression for CO₂ disposal. Failure to secure a customer for a Burrup Peninsula-based development in 1998 supports the conclusion that such a development is not commercially viable.

Cape Preston
An existing mining tenement and proposed iron ore loading facility at Cape Preston are unlikely to be compatible with LNG loading activities, which require intrinsically safe operations to avoid ignition sources. Even if the Joint Venturers were to have exclusive use of Cape Preston, the site offers no significant cost advantage over a Burrup Peninsula location as development would cost $720 million more than a Barrow Island development concept.

3.2 Barrow Island Sites
An assessment of potential sites on Barrow Island led to the selection of Town Point as the preferred location for the gas processing facility (Figure 3-2). Overall, this site presents a low level of environmental impact (relative to the alternative sites) and offers safe and reliable marine operating conditions due to the sheltered nature of the adjacent waters. Other considerations included a range of technical, operational and cost-related issues.

Key reasons for rejecting alternative sites are summarised below.

Latitude Point
A Latitude Point site would require a larger dredging program, with associated impacts to adjacent coral communities, without any obvious technical or environmental benefit over the Town Point site.

Surf Point
Surf Point offers the greatest cost advantage of the alternative sites. Situated at the north-east corner of Barrow Island, it is located close to deep water, but is exposed to strong tidal currents which may adversely affect the safe operation of LNG carriers in the area. Potential development sites at this location are heavily restricted due to the presence of sensitive vegetation associations and sandy, unstable soils. The north of the island is also relatively undisturbed and is the furthest point on the island from the existing oil operations infrastructure. Stakeholder consultation has identified a strong preference for avoiding direct impacts to the less disturbed northern portion of the island.

3.3 Shore Crossing Locations
After investigating alternative shore crossing locations, and the associated onshore feed gas pipeline route, North White’s Beach was selected as the preferred location, with the preferred construction technique being horizontal directional drilling (HDD) (refer to Figure 3-3). Flacourt Bay, to the south of North White’s Beach, is being carried into the next design phase as a fall-back option, pending more detailed geological...
investigations. An onshore pipeline route from North White’s Beach will run along existing roads and other disturbed land as much as possible.

The North White’s Beach/HDD option is preferred as it has a smaller footprint and presents lower risks to rock wallabies, turtle habitat and the Barrow Island Marine Park. It also requires less earthwork, involves a shorter construction period, and involves relatively simple stabilisation techniques. This option offers the lowest construction risk and provides cost-saving opportunities.

Conclusions regarding alternative shore crossing locations are as follows:

- Flacourt Bay is the preferred fall-back option as it provides a pipeline route which is adjacent to existing
oil field operations and infrastructure and provides the shortest pipeline route across the island.

- The geology at Obe’s Beach does not support the HDD technique due to the suspected presence of channelling, and therefore requires more environmentally intrusive and costly construction techniques.

- A marine route to Town Point was rejected as it would require a large dredging campaign (in addition to that required for the materials offloading facility and LNG load-out), and involve high cost and complexity associated with a longer offshore pipeline installation in shallow water.

- Cape Dupuy was ruled-out because of the greater footprint and technical challenges of operating installation vessels in the strong currents around the cape.
The Gorgon Development proposal was referred to the Commonwealth Department of the Environment and Heritage (DEH) and the Western Australian Environmental Protection Authority (EPA) in November 2003. These agencies then determined that the Gorgon Development should be formally assessed at the Environmental Impact Statement (EIS) and Environmental Review and Management Programme (ERMP) levels, respectively. These are detailed levels of assessment that are generally applied to major projects which have significant environmental issues, many of which are complex or of a strategic nature.

The Commonwealth and Western Australian governments agreed to a parallel coordinated environmental assessment process. In accordance with this process, a Draft EIS and an ERMP that satisfies the requirements of each jurisdiction and consolidated as a single document (Draft EIS/ERMP) is required.

The Joint Venturers have prepared this Draft EIS/ERMP document in accordance with the requirements of the ‘Guidelines for an Environmental Impact Statement and Environmental Scoping Document for an Environmental Review and Management Programme’ (the Scoping Document) (ChevronTexaco 2004). The Draft EIS/ERMP is being placed on public exhibition for 10 weeks during which time public submissions will be sought. During this time, a package of additional information will be issued presenting the results of subterranean fauna species identification (refer to Section 10.4), the selected barriers for the three priority quarantine pathways (refer to Section 12.4), and the results of the field validation for the dredge plume modelling (refer to Section 7.8). The Additional Information Package will be available for comment for the last four weeks of the period of public exhibition.

The DEH and EPA will assess the Draft EIS/ERMP following receipt of public submissions, and the Joint Venturers’ response to those submissions. Once the DEH and EPA have accepted that responses to public submissions are adequate, the document will become the Final EIS and ERMP (Final EIS/ERMP). The agencies will then report to relevant Ministers for a final decision on whether the Development should be approved and, if so, under what conditions.
5 Stakeholder Engagement

The Gorgon Joint Venturers are committed to open and accountable processes that encourage stakeholder engagement throughout all stages of the Development. The Venturers have established an extensive and ongoing stakeholder engagement program that builds on the pro-active approach to consultation that commenced in early 2002 during the ESE Review process. Stakeholders consulted include a broad range and diverse cross-section of government, industry and community representatives (Plate 5-1 and Plate 5-2).

Plate 5-1: Media Conference on Barrow Island
Active participation in the carefully designed and implemented stakeholder engagement program has provided opportunities for stakeholders to obtain both technical and environmental information on potential issues and to express their views directly to the Development Team. Input from these stakeholders has provided the Venturers with valuable feedback and has contributed to guiding the assessment and management of the proposed Development. This input will continue to be valuable throughout the ensuing phases of the Development.

Plate 5-2:
EPA Visit to Barrow Island
6 Development Description

As noted in Section 1.3.3, development of the Gorgon field will require a range of infrastructure to extract the gas and transport it to Barrow Island for processing and delivery to market. The principal physical components of the proposed Development provided in Table 1-2 are described in the following sections.

6.1 Offshore Production Wells
The offshore production wells will be drilled using a vessel similar to that commonly used in north-west Australia at similar water depths. Drilling requires approval by the Western Australian Department of Industry and Resources under the Commonwealth Petroleum (Submerged Lands) Act 1967 (P(SL)A). Detailed Environment Plans, Oil Spill Contingency Plans and drilling fluid management procedures will be produced as part of this process.

Corrosion inhibitors and other chemicals may also be injected into the wells and flowlines via the umbilical bundle which will follow the path of the main feed gas pipeline.

An electrohydraulic control system will be adopted to control the valves on the subsea trees. The control fluid will be a water-based fluid (with glycol), which has been designed and selected to be suitable for release to the environment.

To meet government regulations and safety requirements, corridors centred on the offshore pipelines and all subsea infrastructure, will be established in which anchoring by commercial vessels will be prohibited, and access restricted. The corridors, which will extend approximately 500 m on either side of the pipeline, and around subsea equipment, will be gazetted and marked on navigation charts.

6.2 Feed Gas Pipeline
The pipeline between the gas field the onshore gas processing facility (the Gorgon feed gas pipeline) will be corrosion resistant alloy (CRA) clad carbon steel or carbon steel. To support the operation of the wells and manifolds it will be connected to the gas processing facility by an umbilical bundle. The umbilical bundle will include: electrical power and signal lines, control line (water-based control fluid), chemical injection lines and spare lines. Separate injection lines and utility lines and other essential service lines will also be required.

6.3 Shore Crossing
The feed gas pipeline will be installed across the western shore of Barrow Island using HDD technology. This involves drilling a 1100 mm diameter hole from the rear of the beach to the 12 m water depth contour, approximately 1 km from shore. At the subsea exit point, a small amount of jetting or rock dumping will be required to create a gentle transition from the exit angle to the natural seabed contour to prevent a large unsupported pipeline span being generated. Approximately seven holes will be required for two complete feed gas pipeline systems.
6.4 Onshore Feed Gas Pipeline
The onshore section of the pipelines will be supported above ground with sufficient clearance to ensure that fauna can pass freely underneath the pipeline. The pipelines will be buried under roads, with appropriate culvert and right-of-way systems to enable installation of future pipelines. Seasonal water crossings may be traversed or trenched depending on their size, surrounding terrain, geology and other factors.

The feed gas pipeline construction activities will be located within a 30 m easement. As the design develops, endeavours will be made to improve on this to set a new industry benchmark. This width will provide adequate space for short-term stockpiling of vegetation and topsoil where it exists, as well as safe manoeuvrability for construction machinery and associated traffic. Vegetable along the easement will be slashed to prevent outbreak of fire associated with welding; and to promote successful regrowth. The easement will be graded, where necessary, to provide a safe and level working area and to reduce erosion and sediment transport. Easements for smaller lines will be much smaller.

6.5 Gas Processing Facility
A schematic representation of the gas treatment process is shown in Figure 6-1, while a likely layout for the proposed gas processing facility is presented in Figure 6-2.

The acid gas removal units will utilise accelerated-methyldiethanolamine (a-MDEA) in water as the solvent for CO2 and H2S removal.

Ethane and propane will be recovered from the gas for use as refrigerant in the liquefaction process for the LNG system. These hydrocarbons will be stored outside of the process area. Approximately 500 m³ and 1800 m³ of ethane and propane will be stored, respectively. It will be necessary to import ethane and propane to start the LNG process but after a period of time the system will be self-sufficient in these products.

The Joint Venturers will utilise a commercially available and proven liquefaction technology. Approximately 90% of current LNG plants around the world use a variation of the propane pre-cooled liquefaction technology from Air Products and Chemicals, Inc (APCI). This process is based on a mixed refrigerant process that utilises nitrogen, methane, ethane and...
propane as refrigerants. This is the preferred technology and is the basis for assessment in this Draft EIS/ERMP.

For the purposes of this Draft EIS/ERMP, it is assumed that the refrigerant compressors on each LNG train will be driven by two large industrial gas turbines. These turbines will be assisted by electric motor starter/helper drivers that provide mechanical power for starting the turbines, and additional energy for production. Gas turbines will also be used for generation of electrical power. Gas turbine exhaust waste heat recovery units will provide the heat for the hot oil heating medium system and the dehydration regeneration gas.

As part of the ‘flashing process’, some LNG will be turned back to a vapour. This ‘flash gas’ will be relatively rich in nitrogen, allowing the remaining LNG product (mostly methane) to meet the nitrogen sales specification. The nitrogen-rich flash gas will be compressed and used as the main source of fuel gas for the gas processing facilities on Barrow Island.

LNG product from the liquefaction process will be stored in two full containment storage tanks of approximately 135 000 m³–155 000 m³ net each. The tanks are expected to be approximately 35–40 m high and 70–80 m in diameter. The design of LNG tanks is carefully controlled through British Standard EN1473 ‘Installation and Equipment for LNG – Design of Onshore Installations’. The tanks will be designed to withstand cyclonic wind forces and any impact from items caught by cyclonic winds.

The condensate tanks are expected to each have a net capacity of approximately 35 000 m³. The condensate will be loaded onto ships either using the existing Barrow Island oil loading facilities, a subsea line from the LNG jetty, or directly from the LNG Jetty.

Condensate, diesel fuel, a-MDEA and other similar materials will be stored in tanks which are bunded to meet Australian Standards, as a minimum.

6.6 Domestic Gas

Following acid gas removal, the gas destined for the domestic gas market will be dehydrated and the hydrocarbon dew point controlled to meet the domestic gas specification.

It is proposed that the domestic gas pipeline will be routed directly from Town Point to the mainland. The final alignment will be modified to reduce impacts to sensitive habitat as the design develops.
This pipeline will approach the mainland immediately adjacent to the existing Apache Energy Gas Sales Pipelines to reduce environmental impact associated with development of a new shore crossing. The Barrow Island end will be in pre-disturbed land.

6.7 Plant Lighting

Minimising light spill is an important design criterion for the proposed Development due to potential impacts on turtle hatchlings. To minimise the potential impact, a hierarchical lighting strategy has been developed. In general, lighting levels will be reduced to those required for safe working and security.

In areas where colour definition is not required for safety or operational purposes, shielded red or monochromatic lights are proposed. This includes areas such as the MOF causeway, jetty, roads within the gas processing facility and general open areas. In areas where minimal colour definition is required, a reduced spectrum yellow/orange type of shielded light, such as sodium vapour, will be used. These lights will form the primary lighting for the facility.

Areas that require inspection during operator rounds and/or regular maintenance (e.g. filter change outs) will utilise fully shielded full spectrum white lights that are normally off. These lights will be switched on only as required. For an emergency situation, additional lights will be required for safety, including perimeter flood lights.

The lighting regime will continue to be reviewed during the design phase and is subject to confirmation that it is acceptable from a health and safety perspective.

6.8 Flare System

A ‘no routine-flaring policy’ will be adopted for the design of the gas processing facility. This means that during normal day-to-day operation, the flare will not be used for waste gas disposal.

A total of three flares will be required for the safe operation of the gas processing facility. The two main flares will either be located on a flare tower or at ground level. A flare tower may be in the order of 150 m high, located to the west of the facility. These flares would be used during plant emergencies, start-up, shut-down and short-duration upset conditions. Short-term (several hours) flaring can avoid the need for a full plant shut-down which would result in a greater volume of gas flaring.

Alternatives to reduce anticipated flaring loads, and possibly the size of the main flare stacks, will be reviewed during the design phase.

6.9 CO₂ Injection Facilities

Carbon dioxide will be compressed within the gas processing facility and transported via a 250–350 mm diameter above ground pipeline to the injection wellheads. The injection wells will be directionally drilled in clusters of three-four wells, from a small number of drill centres. Careful selection of the bottom-hole locations will be required to achieve the desired injection rates and distribution. This approach will reduce the land required for drilling and well operations.

The CO₂ injection pipeline will follow the most direct path practicable to the injection well locations while preferentially using previously disturbed land. The final alignment will be chosen to protect the safety of personnel in the unlikely event of CO₂ release from the pipeline.

6.10 Drainage and Waste Water System

The waste water system will be managed to maximise the re-use of water, and to protect soils, subterranean fauna, groundwater and the marine environment from contamination. To achieve this, a tiered waste water management approach will be adopted within the gas processing facility, which comprises the following:

- diverting water, which flows naturally onto clean areas of the site during rainfall events, to natural drainage areas
- allowing water from unpaved areas and paved non-process areas (e.g. roads and buildings), where no contamination is likely, to soak naturally into the ground, or directing this water to natural drainage
- directing water in areas that could be contaminated, but are usually considered to be relatively clean, to a holding basin for water quality testing before discharge or disposal. (Uncontaminated water will be discharged back to natural drainage, while contaminated water will be pumped to a treatment system.)
- directing water from areas that are expected to be contaminated (e.g. sumps and areas around pumps and turbines) to an oil recovery system.
The design of this tiered waste water facility will take into account the increased flows associated with severe storm events and potential firewater runoff (the latter of which may be contaminated with hydrocarbons, chemicals and salt).

All process water and potentially contaminated runoff will be treated in an oil recovery system. Recovered hydrocarbons will be recycled (by directing them back into the process, where appropriate), or will be returned to the mainland for recycling or appropriate treatment and disposal.

6.10.1 Sanitary Waste
Sanitary waste water systems will be required to support all phases of island-based work. Treated effluent will be disposed via one (or a combination) of the following systems/methods:
- re-use for construction, hydrotesting and/or land farming
- utilisation of the existing produced water disposal system
- injection to drilled deep wells.

The treated process water and the effluent from the demineralisation plant will be combined with the treated water from the sewerage plant and injected into subsurface formations below Barrow Island. It is anticipated that sludge will be removed from Barrow Island and disposed of on the mainland.

6.10.2 Fresh Water
The most significant single requirement for water will be associated with hydrotesting the feed gas pipelines, domestic gas pipeline and the LNG tanks. This is discussed in the relevant sections for these activities.

Horizontal directional drilling will be used for the pipeline shore crossings. This technique will also require a significant quantity of water (approximately 20,000 m³) which would most likely be salt water, but may need to be fresh water depending upon the selection of drilling fluid.

Three options are currently being considered as the source of water to the water making facilities, namely groundwater, seawater or the Dupuy Formation.

6.11 Materials Offloading Facility (MOF)
Access to the MOF will be provided via an 800 m long causeway from Town Point. The MOF will extend a further 325 m from the offshore end of the causeway. This concept significantly reduces the volume of material to be dredged and associated blasting of the limestone platform that would otherwise be required to provide an access channel to a shore-based facility. Vessels will access the MOF via a dredged channel approximately 1.3 km long, 120 m wide and dredged to 6.5 m relative to chart datum. At this depth, the channel will be tidally restricted for the larger vessels required during construction. A deeper pocket will be dredged against the MOF to enable these larger vessels to be unloaded during all tidal conditions.

The MOF will also incorporate mooring facilities for tug boats and other vessels required to support the LNG carriers and refuelling capabilities for the smaller vessels (such as tugs). The details of the MOF specification will be reviewed with respect to module and equipment sizes determined as the design proceeds; however the basic concept will not change.

6.12 LNG Jetty
A jetty will be built with mooring facilities to receive LNG carriers and possibly condensate tankers. The jetty will be approximately 3.1 km long commencing from the offshore end of the causeway. The approach trestle and loading platform will be constructed with a steel open pile design and the height will be sufficient to avoid wave forces on the underside of the deck.

6.12.1 Jetty Approach Channel
The LNG carriers will require safe access via a shipping channel. The location of the proposed LNG loading berth has been developed in consultation with the Barrow Island shipping pilots, and will be located several kilometres from the existing crude oil loading mooring.

Dredging will be necessary to create a shipping channel and turning basin that is approximately 14 m deep relative to the chart datum to allow access/egress of LNG carriers in any tidal condition. The current estimate of the volume of dredge material produced is approximately 9 million m³. It is proposed that the channel will be dredged by removing unconsolidated material by trailer suction hopper dredge, then using a cutter suction dredge to break the hard material and load into hopper barges moored alongside the vessel.
The approach route will have an alignment as straight as possible with any bends at least 1000 m radius, if bends cannot be avoided. The approach channel will require a minimum width of approximately 300 m. The channel will be equipped with appropriate navigation aids. An exclusion zone will be established around the LNG jetty and channel in accordance with industry guidelines. During the operations phase, the Barrow Island port will be controlled by a Loading Master/Harbour Master who will control all activities within the port limits. During construction, these duties will be assumed by a Marine Operations Manager, or similar role.

During severe adverse weather conditions, LNG ships and condensate ships will be diverted, delayed, or released to avoid being caught in shallow or confined waters. Tugs will also be released to avoid the weather. During severe adverse weather conditions, construction vessels will shelter in the Dampier archipelago, which is common practice in the region.

### 6.13 Administration and Maintenance Facilities

An administration building and maintenance facilities will be constructed either within the gas processing facility site, or in the vicinity. This area will contain offices and workshop facilities for the maintenance of the gas processing facility equipment. Some of these facilities may be shared with the existing oil operations on Barrow Island.

### 6.14 Roads

The construction of the gas processing facility will require the re-alignment and upgrading of several existing roads on Barrow Island. The upgrades will involve widening, grading and sealing to increase safety for both personnel and fauna due to increased visibility. Sealing the main roads will also reduce dust generation. Drivers will operate under strict procedures to reduce environmental impacts.

### 6.15 Interconnections with Existing Operations

There are likely to be a number of interconnections with existing facilities on Barrow Island, such as the condensate loadout, power supply, water injection systems, water supply, communications and gas supply. Where possible, these facilities will be installed along currently disturbed areas (e.g. power lines along existing roads), or along a common corridor, to reduce environmental impact.

### 6.16 Onshore CO2 Injection Wells

The onshore CO2 injection wells will require the following:

- access roads for personnel and equipment
- water and other materials required for the drilling fluid
- a level work site on which to place the drilling rig
- excavated and lined pits or tanks in which to store fluids
- facilities to remove cuttings from the drilling fluid
- systems to manage cuttings disposal
- facilities to enable each well to be cleaned up.

Carbon dioxide resistant cement will be used to fix the casing in place. Use of this cement will also prevent the release of CO2 via the wells.

### 6.17 Pioneer Camp

A pioneer camp will be constructed to accommodate personnel during the initial phase of construction, as the existing oil field operations camp does not have the necessary capacity. The initial phase of work will involve establishing the main construction village. The pioneer camp will accommodate 250 personnel and will require additional amenities such as water treatment, sewage treatment and waste management.

The pioneer camp does not form part of the proposal covered by this Draft EIS/ERMP as it will be constructed during the EIS/ERMP assessment period and will be subject to a separate approval process. The camp has been included here for completeness and to allow consideration of cumulative impacts.

### 6.18 Construction Village

The existing camp on Barrow Island and pioneer facilities will be too small to accommodate the expected number of people required to construct the gas processing facility and associated infrastructure, or to operate the facilities on a long-term basis. Therefore, a new construction village will need to be built. The construction village will cater for a peak workforce of approximately 3300 personnel. A section of the village will be designed as a permanent installation to support large-scale maintenance campaigns, or as an operational village.
The construction village will require a range of facilities and utilities including:

- power supply
- water supply
- waste water management
- sewage treatment (with connection to the water injection system)
- recreational facilities
- mess facilities
- laundry
- bus parking facilities
- waste management facilities, including an incinerator
- medical facilities
- fire station
- telecommunications (including internet and phone).

Various sites have been examined for the location of the construction village and four short-listed sites are currently under consideration. Preliminary assessments have not identified any significant difference in environmental sensitivity between the sites. Further work will be undertaken during the design phase to finalise site selection, such that potential environmental impacts are kept to acceptable levels.

6.19 Airport

Earthworks may be required associated with potential extensions to, and realignment of, the runway and any expansion of the terminal.

6.20 Telecommunications

A communications network will be installed on Barrow Island to support the construction and operational activities. The network will provide for radio, telephone and data links between most facilities on the island. An optical fibre cable will be installed between Barrow Island and the mainland to provide a reliable link to existing communication networks. Onslow and Peedamulla are currently under consideration as tie-in locations to the mainland optical fibre cable network (Figure 6-3). The latter provides a shorter subsea route but a significantly longer terrestrial route.

6.21 Waste Staging Area

Various wastes will be generated through all stages of the Development. The principles of ‘avoid, reduce, re-use, and dispose in an environmentally responsible manner’ will be followed. The focus will be on avoiding waste at source by working with the suppliers in the tendering and contracting processes. Appropriate waste segregation and storage facilities will be provided, such as for food wastes (e.g. covered where possible to keep out fauna), scrap steel (i.e. for recycling), and hazardous wastes (e.g. bunding for liquid wastes in line with relevant Australian Standards). These facilities will be designed in accordance with Australian Standards and incorporate best practice principles. No wastes will be disposed of on Barrow Island, other than those such as waste concrete, which can be utilised by existing oilfield operations.

6.22 Mainland Supply Base(s)

Logistical support facilities will be required to support both offshore and Barrow Island operations. Mainland supply bases will allow for consignment, loading and refuelling of support vessels and subsea construction vessels, storage of construction materials, offloading of materials requiring transport and the return of waste. The preferred concept is to utilise existing facilities that either meet the construction requirements, or that can be upgraded readily. The exact location and nature of the facilities have yet to be decided; however, it is anticipated that existing infrastructure in the King Bay area near Dampier and at the Australian Marine Complex south of Perth may be utilised, with various locations in the Perth metropolitan area. The facilities will incorporate lay-down and storage areas, warehouses, quarantine facilities (such as a wash down bay, fumigation facility, inspection pit, etc), administration and wharf facilities (if adjacent), together with appropriate waste management systems and waste water collection and treatment systems. These facilities will also support the Development quarantine management system, and will have security surveillance.

6.23 Decommissioning

As the life of the proposed Development is expected to be in the order of 60 years, it is reasonable to assume that there will be changes to decommissioning procedures and regulatory requirements that incorporate advances in technology and information. In recognition of these potential changes, the Gorgon Joint Venturers commit to adopting best practices in environmental management at the time of decommissioning. However, the basic principle is that all surface equipment will be removed and the site rehabilitated.
Figure 6-3: Possible Routes for Optical Fibre Communications Link
7 Emissions from the Development

Emissions will occur during the construction, commissioning, operation, maintenance and decommissioning phases of the proposed Gorgon Development.

The predicted emissions are based on current information. Opportunities to further reduce emission levels will be pursued during the detailed design phases of the proposed Development.

The main aspects considered are:
- atmospheric emissions
- light
- noise
- solid non-hazardous wastes
- liquid wastes
- dredging
- accidental releases (i.e. spills).

Greenhouse gas emissions are covered in Section 13.

Predicted emission levels have been compared to legislative standards and guidelines where they exist.

7.1 Atmospheric Dispersion Modelling Methodology

Two different atmospheric dispersion models were used to predict the impact of the proposed gas processing facility on air quality. These models were:
- DISPMOD, the Western Australian coastal model, which was employed to estimate local ground level concentrations of the emissions from various operating scenarios.
- TAPM, the CSIRO’s prognostic meteorological and air pollution model, which was used to address regional air quality impacts and local deposition rates.

Emissions from the existing Barrow Island facilities were also included in order to address the potential cumulative levels.

7.2 Air Quality Criteria

Within Western Australia, the Environmental Protection Authority (EPA) assesses all new projects in terms of air emissions at the stack or vent outlet and the resultant ambient ground level concentrations. For emissions from industrial sources, the EPA requires that ‘all reasonable and practicable means should be used to prevent and minimise the discharge of waste’ (EPA 1999). For new projects, the EPA requires the assessment of best available technologies to reduce waste discharges, and justification for the adopted technology.
Best practice for NO\textsubscript{x} reduction is generally considered to be Selective Catalytic Reduction (SCR), which involves the reaction of NO\textsubscript{x} with ammonia to produce nitrogen and water. It requires the injection of a solution of ammonia (or a solution of urea) into a gas turbine exhaust, and the exhaust gases then passing over a catalyst. This process is not considered best practice for the Gorgon Development as transporting large quantities of ammonia or urea to Barrow Island, and using these materials, introduces additional safety, environmental and quarantine risks.

The EPA has developed a guidance statement for oxides of nitrogen emissions from gas turbines, with limits for emissions following the Australian Environmental Council/Natural Health and Medical Research Council (AEC/NHMRC) National Guidelines. These limits are 0.07 g/m\textsuperscript{3} (Standard Temperature and Pressure, dry and 15% O\textsubscript{2}) for gaseous fuels and 0.15 g/m\textsuperscript{3} for other fuels. Modern natural gas-fired systems, employing NO\textsubscript{x} control technology can be expected to achieve emissions lower than 0.07 g/m\textsuperscript{3}.

Current indications from gas turbines of a similar size are that NO\textsubscript{x} emissions may be half to a third of this concentration; however the assessment conducted for this document is based on the more conservative figure of 0.07 g/m\textsuperscript{3}.

Other standards (such as National Environmental Protection Measure (NEPM), World Health Organisation (WHO) and the USEPA National Ambient Air Quality Standards) have been referenced where necessary.

A summary of the maximum predicted concentrations of the various emissions for normal (routine) operations as well as a range of emission levels during start-up and plant upset conditions are presented in Table 7-1. The results show that the proposed Gorgon Development will measure better than the relevant criteria. For example, the maximum 1-hour NO\textsubscript{2} concentration over the entire modelling grid is 0.06 parts per million (refer to Figure 7-1); this is half the NEPM value.

**Figure 7-1:**
Maximum 1-hour NO\textsubscript{2} Concentration (in ppm)
### Table 7-1:
Comparison of NEPA, USEPA and WHO Ambient Air Quality Standards and Guidelines with Predicted Gorgon Development Emissions

<table>
<thead>
<tr>
<th>Emission</th>
<th>NEPM</th>
<th>USEPA</th>
<th>WHO</th>
<th>Gorgon Development – Model Predictions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Averaging Period</td>
<td>Maximum Concentration</td>
<td>Averaging Period</td>
<td>Maximum Concentration</td>
</tr>
<tr>
<td><strong>Nitrogen dioxide</strong></td>
<td>1 hour</td>
<td>0.12 ppm (246 µg/m³)</td>
<td>1 year</td>
<td>0.03 ppm (62 µg/m³)</td>
</tr>
<tr>
<td></td>
<td>1 year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Photochemical oxidants (as ozone)</strong></td>
<td>1 hour</td>
<td>0.10 ppm (214 µg/m³)</td>
<td>1 hr</td>
<td>0.08 ppm (171 µg/m³)</td>
</tr>
<tr>
<td></td>
<td>4 hours</td>
<td>0.08 ppm (171 µg/m³)</td>
<td>1 hr</td>
<td>0.08 ppm</td>
</tr>
<tr>
<td><strong>Sulphur dioxide</strong></td>
<td>1 hour</td>
<td>0.20 ppm</td>
<td>SO₂ – 3 hr</td>
<td>0.5 ppm (1300 µg/m³)</td>
</tr>
<tr>
<td></td>
<td>1 day</td>
<td>0.08 ppm</td>
<td>SO₂ – 24 hr</td>
<td>0.14 ppm (human)</td>
</tr>
<tr>
<td></td>
<td>1 year</td>
<td>0.02 ppm</td>
<td>SO₂ – Annual</td>
<td>0.03 ppm (human)</td>
</tr>
<tr>
<td><strong>Particles as PM10</strong></td>
<td>1 day</td>
<td>50 µg/m³</td>
<td>24 hr</td>
<td>150 µg/m³ (human)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annual mean</td>
<td></td>
<td>50 µg/m³</td>
</tr>
<tr>
<td><strong>Nitrogen deposition</strong></td>
<td></td>
<td>15–20 kg/ha/yr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7.3 Light
Lighting associated with construction and operation of the Development has the potential to affect marine fauna, notably sea turtles and some seabirds (e.g. shearwaters and gulls). Because there is no single, measurable level of artificial brightness on nesting beaches that is known to be acceptable for sea turtle conservation, the most effective conservation strategy is simply to use ‘best available technology’ to reduce effects from lighting (Witherington and Martin 2000). Best available technology includes many light management options that have been used by lighting engineers for decades and others that are unique to protecting sea turtles. These include: reducing the number and wattage of lights; using longer wavelength (narrow spectrum) lights; positioning lights behind structures; and shielding, redirecting, lowering and/or recessing lights to prevent light spill to the beach.

Preliminary modelling demonstrates that these types of measures will dramatically reduce lighting effects over a conventional lighting regime. For example, Figure 7-2 illustrates the reduction in light spill from a conventional lighting regime (250 watt high pressure sodium) as a result of redirecting lights away from beaches (Case A), reducing the height of lights (Case B), and reducing the wattage (Case C).

As the design progresses, the Gorgon Joint Venturers will continue to apply these principles and include more specific detail to minimise light spill from the onshore and offshore equipment.

7.4 Noise
A preliminary environmental noise assessment of the proposed gas processing facility on Barrow Island was undertaken. An acoustic model was developed using the Environmental Noise Model (ENM) developed by RTA technology. The ENM program calculates sound pressure levels at nominated receiver locations or produces noise contours over a defined area of interest around the noise sources. It was specifically used to generate noise contours for the area surrounding the gas processing facility, and to predict noise levels at the Chevron camp and the proposed Gorgon construction village site. In particular, the acoustic model was used to predict noise levels for normal gas processing facility operation, emergency blow-down of the facility, and the existing Barrow Island power station, respectively.

Figure 7-2:
Isolux Contours – Gas Processing Facility
Noise contours and noise levels were predicted for a range of meteorological conditions, including: calm conditions and worst-case wind conditions for sound propagation in the eight cardinal directions. The effects of temperature inversions on the modelling results were also reviewed.

Barrow Island is a Class A Nature Reserve and a producing oilfield, consequently public access to the island is limited and there are no noise sensitive premises. The Chevron camp site is located approximately 3.5 km to the south-south-east of the proposed gas processing facility site and the proposed Gorgon construction village will be located approximately 400 m south. These are the only facilities located on the island where noise could be considered to have any social impact.

Since these facilities are designed to service industry on the island, they have been classed as industrial premises according to Schedule 1, clauses 7 and 8, of the Environmental Protection (Noise) Regulations 1997. The assigned noise levels are, therefore, 65 dB(A), 80dB(A) and 90 dB(A) for the $L_{A10}$, $L_{A1}$ and $L_{Amax}$ descriptors respectively. The most significant of these descriptors for continuous plant noise is the $L_{A10}$ assigned level of 65 dB(A).

The predicted noise levels for routine gas processing facility operation at the existing Chevron camp site for a range of meteorological conditions ranged from 23 dB(A) to 36 dB(A) with the highest noise levels predicted for northerly wind conditions. This is well below the assigned level of 65 dB(A) and it is likely that noise from the gas processing facility will be inaudible during normal operations. Under the same meteorological conditions, the noise levels at the Gorgon construction village during routine operations will range from 53 dB(A) to 65 dB(A), which is also within the assigned level of 65 dB(A).

7.5 Solid Non Hazardous Wastes

Solid non-hazardous wastes will be generated in varying amounts throughout all phases of the Gorgon Development; however, it is expected that the majority of waste will be generated during the construction phase on Barrow Island. Wherever practical the following wastes will be re-used or recycled:

- vegetation, rock and soil overburden from site levelling, foundation preparation, pipe-laying, and drilling activity
- drilling fluids, cuttings and dredge spoil material
- scrap pipe, metal fabrication, insulation, concrete and general construction materials
- packaging.

Onshore construction and drilling wastes not re-used or recycled will be collected, stored or contained on location at designated collection sites. Wastes generated on Barrow Island will generally be removed from the island for disposal at an approved disposal facility.

Drill cuttings from offshore activity will be separated from drilling fluids and disposed to the marine environment, in accordance with legislative conditions and consistent with standard industry practice. Injection of cuttings into a suitable sub-surface formation is extremely unlikely in a subsea wellhead development program at the water depth (>190 m depth) and receiving environment in the Gorgon area. Drill cuttings and fluids from the onshore HDD associated with the shore approaches for the feed gas pipelines will initially be collected, separated and the fluid re-used in the drilling process. However, once the drill has broken through to the seafloor, some bentonite and drill cuttings will be discharged to the marine environment.

Development wastes will be identified, categorised, handled, stored and managed in accordance with a Development-specific Waste Management Plan to be approved prior to any construction activity. Wastes will be generated during construction/installation of wells, shore crossings, shipping channel, MOF, gas processing facility, and associated pipelines. Waste volumes generated during operations and maintenance of the Gorgon Development will be substantially less.
7.6 Liquid Wastes
A range of liquid wastes will be associated with the proposed Development, including ballast water, drainage water, drilling fluids, produced formation water, hydrostatic test water and subsea control fluids. These are discussed below.

7.6.1 Ballast Water
Currently, all oil tankers visiting the Barrow Island and Thevenard marine terminals have been informed by Chevron (as operator) of the ‘Australian Quarantine and Inspection Service (AQIS) Voluntary Guidelines for the Handling and Treatment of Ballast Water Carried in Ships Entering Australian Waters.’ Since 1993, the source and volume of ballast water discharged from tankers visiting these terminals has been monitored. These requirements and monitoring activities will also be applied to the Gorgon Development.

7.6.2 Drainage
Clean deck drainage water on the drill rig, dredges, tankers and support vessels will be directed overboard. Where drainage contains traces of hydrocarbon, it will be directed to a sump and oil water separator. The discharge of surfactants, dispersants and detergents will be minimised. Detergents or dispersants used for wash-down will be biodegradable and phosphate free. All endeavours will be made to keep detergents out of oily water separation systems as they adversely affect the separation. Onshore, a wastewater system will be designed to protect soils, groundwater and the marine environment from contamination. In order to minimise the discharge of contaminants and nutrients, a multi-tiered waste water management approach has been adopted.

7.6.3 Drilling Fluids
Drilling fluids are likely to be a combination of water-based and non-aqueous drilling fluids. Non-aqueous drilling fluids, such as synthetic based fluids, will be low toxicity, and are commonly used in north-west Australia with regulatory approval. Full details of drilling fluids and alternatives considered will be provided in the Environment Plan, required under the Petroleum (Submerged Lands)(Management of Environment) Regulations.

7.6.4 Produced Formation Water
Produced formation water from the gas fields, along with additives such as monoethylene glycol (MEG) and corrosion inhibitor, will be separated from the incoming gas stream at the gas processing facility. The liquids will then be separated into a water phase and condensate. The water phase will be directed into deep injection wells on Barrow Island.

7.6.5 Hydrostatic Test Water
Where practicable, test water will be re-used to test other components. Following successful testing, the hydrostatic test water will be injected into dedicated disposal wells on Barrow Island. Alternatively, if it meets approved quality standards, it will be disposed of into the marine environment at an approved location and discharge rate. A Hydrostatic Testing Management Plan will be prepared for government approval.

7.6.6 Subsea Control Fluids
Subsea control fluids will be used to operate, protect and maintain the upstream manifolds and wellheads in the offshore field area. These fluids are specifically designed for this purpose and are commonly used in subsea exploration and development wells in north-west Australia, the Gulf of Mexico, North Sea and offshore Brazil. An open loop system for subsea control fluids is planned with small volumes of control fluid released from the valves on the seabed when they are operated. Control fluids will be selected for low toxicity and biodegradability while meeting operational requirements.

7.7 Hazardous Wastes
Hazardous wastes which will be generated include: sand, scales, filters, molecular sieves, and mercury removal adsorbent. All hazardous wastes associated with the Gorgon Development will be managed in accordance with a Development-specific Waste Management Plan. The Plan will include systems and details for tracking wastes from source to disposal to a licensed hazardous waste facility on the mainland.

7.8 Dredging
Dredging on the east coast of Barrow Island is proposed within the existing Barrow Island port boundary and the proposed dredge spoil disposal site is located immediately to the south east (Figure 7-3). Dredge spoil from excavation at the MOF, access channels and turning basin will be disposed of in designated sites pursuant to the terms and conditions of the Commonwealth Sea Dumping Permit (Environment Protection (Sea Dumping) Act 1981) and National Ocean Disposal Guidelines for Dredged Material. Table 7-2 identifies the proposed locations, equipment, volumes and duration for the dredging program.
Table 7-2: Location, Equipment and Estimated Volumes and Duration of Dredging Activity

<table>
<thead>
<tr>
<th>Dredging Location/Activity</th>
<th>Dredger/Equipment Proposed</th>
<th>Volume (Mm³)</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOF Channel and Basin to -6.5 m LAT</td>
<td>Cutter suction dredge Discharge pipeline to MOF causeway for fill</td>
<td>~0.80</td>
<td>~21 weeks</td>
</tr>
<tr>
<td>LNG channel and turning basin to -14 m LAT</td>
<td>Cutter suction dredge and trailer suction hopper dredge and self-propelled hopper barges with bottom dump</td>
<td>~8.0–9.0</td>
<td>~45 weeks</td>
</tr>
<tr>
<td>Disposal of dredged material to proposed 3 x 3 km spoil disposal site taking advantage of local bathymetry</td>
<td>Self propelled hopper barges with bottom dump</td>
<td>Capacity to handle 12.0</td>
<td>≥45 weeks</td>
</tr>
</tbody>
</table>

Figure 7-3: Proposed Location of Marine Facilities and Dredge Spoil Site
The dredging required to create the access channels and berth areas for the Development will result in physical disruption to localised areas of the seabed and the generation of turbidity plumes at both the dredging and disposal sites. To predict and assess the potential impacts on corals and determine the monitoring that will be required, numerical modelling was undertaken using a particle tracking technique. The modelling was carried out in two steps. Firstly, the 3-dimensional ocean circulation of the region from south of Barrow Island to north of the Montebello Islands was predicted for 16 months using the GEMS coastal-ocean model GCOM3D. Then the total dredging program was simulated over 450 days using a sophisticated particle tracking model which simulates the daily behaviour of the dredge(s) based on an estimated dredge log.

Modelling predicted the daily distribution of Total Suspended Solids (TSS) and seabed coverage to be developed over the total dredge program (approximately 450 days). The daily output was analysed to derive periods of continuous exposure to turbidity and/or sedimentation above defined thresholds. The result of this analysis is summarised in maps of exposure zones showing regions affected by turbidity or sedimentation that result in high impact, moderate impact and the extent of sedimentation and the visible turbidity plume (Figure 11-1). Where there was uncertainty in model parameters, conservative values were chosen such that the model would tend to overestimate the extent and magnitude of impact. The model predictions were aligned to the current dredging schedule, which is throughout the year except for the period(s) of coral spawning.

Field validation of the dredge plume model is currently underway (at the time of publication). The results of the field validation work will be included in a package of additional information to the Draft EIS/ERMP (refer to Section 4).

7.9 Accidental Spills to the Marine Environment

The chance of a hydrocarbon release will be remote due to the high standards of design, material selection and construction and operation applied. Such standards are driven, not only by the environmental objective of the Gorgon Joint Venturers, but by the expectations of customers and external stakeholders that drive optimum supply reliability.

The potential hydrocarbon releases that were identified for the Gorgon Development include:

- an onshore release from the feed gas pipeline, condensate from the rupture or leak from a pipeline or tank within the gas processing facility
- a release of condensate and produced water (containing dissolved hydrocarbons and monoethylene glycol (MEG)) from the subsea production equipment, subsea flow lines or the feed gas line running from the supply fields to the western shore of Barrow Island
- a release of processed condensate from either of the subsea condensate off-loading pipelines (existing or new) on the eastern side of Barrow Island
- a release of diesel from shore facilities or small vessels operating around facilities on the east and west coasts of Barrow Island
- a release of condensate, crude oil (from other sources) and bunker fuel oil from tankers brought to the export terminal.

Tank and storage areas were excluded from assessment as they will be provided with appropriate bunding and drainage systems in line with Australian Standards, as a minimum.

For each of the spill scenarios identified above, the risk of the event occurring was identified and trajectory modelling undertaken assuming the event occurred. It must be emphasised that the modelling assumed that there was no intervention, but the Gorgon Joint Venturers will have in place a comprehensive spill contingency plan, and therefore results are extremely conservative.

For example, a complete rupture of the existing condensate offloading pipeline, when pressurised and delivering condensate to a tanker, was identified as a worst-case spill scenario (Figure 7-4). Simulation of this spill scenario predicted that if such a release occurred (joint risk of $4.93 \times 10^{-5}$) a slick of floating condensate would most commonly drift along a north-south axis with the prevailing tidal currents. Depending on climate and metocean conditions, after 96 hours, parts of the slicks were predicted to have a high probability of washing onto shorelines throughout the adjacent islands. During winter, the probability of the Lowendal Island shorelines receiving floating condensate at the concentration of 0.8 g/m² was predicted to be 60% and those at the Montebello Islands was up to 30%.
Dissolved aromatic hydrocarbons within the intertidal and shallow sub-tidal areas along the east coast of Barrow Island were predicted to be in the order of 10–30 ppm, while the average predicted concentrations among simulations were 1–3 ppm. Results of modelling and potential impact to the marine environment are further discussed in Section 11.2.

Figure 7-4: Predicted Release of Condensate from Condensate Offloading Pipeline (2 km from Barrow Island)
8 Existing Environment

8.1 Baseline Studies
A range of environmental studies and field surveys were conducted as part of the preparation of this Draft EIS/ERMP. Field surveys in the terrestrial and marine environment were conducted from 2002 through to 2005 to establish the distribution and abundance of species and communities, both within and outside the Development area, and to assess potential impacts to environmental factors. Field surveys included:

- vegetation surveys covering over 1600 ha within and outside of the Development area
- a year of monthly terrestrial avifauna and shorebird counts
- extensive mammal, reptile and invertebrate trapping
- a comprehensive subterranean fauna sampling program including establishment of 43 subterranean sampling bores
- side-scan sonar, video transect and snorkel surveys of the marine environment

Surveys were undertaken in accordance with EPA Guidance No. 51 (Terrestrial Flora and Vegetation Surveys), EPA Guidance Statement 54 (Subterranean Fauna) and EPA Guidance No. 56 (Terrestrial Fauna Surveys).

8.2 Physical Environment
The proposed Gorgon Development will be located in the tropical waters off Australia’s north-west coast approximately 1200 km north of Perth and approximately 120 km west of Dampier and the Burrup Peninsula. This coastal environment is scattered with numerous small islands. Barrow Island is the largest island in the region, is a Class A Nature Reserve and supports an operating oilfield.

The region is characterised by an arid, sub-tropical climate. Summer is characterised by high temperatures (20–34°C), high humidity and predominantly south-west winds. In contrast, winter is characterised by moderate temperatures (17–26°C), fine weather and predominantly strong east to south-east winds. Tropical cyclone activity occurs from November to April with an average of two cyclones passing through the Barrow Island area per year.

The Gorgon gas field is located approximately 70 km west of Barrow Island in approximately 200 m water depth on the edge of the continental shelf. The majority of the seabed between the edge of the continental shelf and Barrow Island is level with areas of moderate relief comprising rock and reef outcrops. The seabed along the proposed domestic gas pipeline route is also relatively uniform with water depths of about 16 m along most of the route.
The western half of Barrow Island is characterised by steep valleys, escarpments and exposed limestone ridges. The topography along the west coast typically comprises weathered rocky cliffs and headlands interspersed with narrow sandy beaches. The eastern coastline is protected with a slight land gradient to the ocean. This coastline is characterised by vegetated sand dunes and expansive tidal flats.

There are no permanent creeks on Barrow Island. Freshwater seeps provide the only permanent source of surface water. There are two aquifers below Barrow Island: a deep, brackish aquifer and a shallow unconfined aquifer. These aquifers are currently used to supply the oilfield operations.

The mainland section of the domestic gas pipeline crosses the Onslow Coastal Plain which comprises coastal saline flats and extensive sandy plains and dunes.

8.3 Terrestrial Ecology

Flora and Vegetation Communities – The flora of Barrow Island is typical of the arid Pilbara region and has floral affinities with the Cape Range area. A total of 68 families, 180 genera and 406 vascular plant taxa have been recorded on Barrow Island which constitutes approximately 23% of the flora records documented for the Pilbara region. Fourteen introduced vascular plant taxa have been recorded on the island, the majority of which have been recorded in or near previously disturbed sites.

No Declared Rare Flora species, as listed under the Western Australian Wildlife Conservation Act and as listed by CALM, occur on Barrow Island. Two Priority species occur on Barrow Island: Helichrysum oligochaetum (Priority 1); and Corchorus interstans (ms) (Priority 3). Helichrysum oligochaetum was not recorded within the proposed Development areas. Corchorus interstans was recorded within the proposed gas processing facility area and within the proposed North White’s Beach pipeline corridor. Corchorus interstans is widely distributed on the island and occurs on the Pilbara mainland. It recovers well from disturbance and is not considered under threat on Barrow Island.

No vegetation communities listed under the EPBC Act, or Threatened Ecological Communities as listed on the Department of Conservation and Land Management Threatened Ecological Database, have been recorded or are known to occur on Barrow Island.

The mainland section of the proposed domestic gas pipeline corridor will traverse a pastoral lease that has been heavily affected by introduction of weed species and disturbance by domestic stock.

Avifauna – Fifty-one species of terrestrial avifauna have been recorded on Barrow Island; however only 16 of these species are residents or regular migrants to the island. Most species are considered to be vagrants from the adjacent mainland. The most common landbirds on Barrow Island are the spinifexbird, white-winged fairy wren, singing honeyeater, white-breasted wood swallow and the welcome swallow.

The Barrow Island white-winged fairy wren is an endemic subspecies that is abundant and widespread on Barrow Island (Plate 8-1). It is listed under Schedule 1 of the Wildlife Conservation Act and as a threatened species (Vulnerable) under the EPBC Act. The white-winged fairy wren is abundant on Barrow Island.

<table>
<thead>
<tr>
<th>Proposed Development Area</th>
<th>No. Taxa</th>
<th>No. Families</th>
<th>Dominant Families</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed gas processing facility footprint</td>
<td>48</td>
<td>26</td>
<td>Euphorbiaceae (7 taxa), Papilionaceae (4 taxa), Poaceae (3 taxa), Asteraceae (3 taxa)</td>
</tr>
<tr>
<td>Proposed North White’s Beach pipeline route</td>
<td>67</td>
<td>27</td>
<td>Chenopodiaceae (9 taxa), Poaceae (9 taxa) and Asteraceae (7 taxa)</td>
</tr>
<tr>
<td>Proposed alternative Flacourt Bay pipeline route</td>
<td>60</td>
<td>27</td>
<td>Poaceae (12 taxa), Asteraceae (5 taxa) and Papilionaceae (4 taxa)</td>
</tr>
</tbody>
</table>
Five EPBC Act-listed migratory species or their habitats may occur within the vicinity of the mainland domestic gas pipeline corridor. Due to the degraded state of the vegetation communities in this area and the narrow width of the proposed easement, it is unlikely that the domestic gas pipeline corridor contains critical habitat for any listed avifauna.

Mammals – Barrow Island is recognised as an important refuge for native mammal species that have either declined in numbers or become extinct on the mainland. The island supports 13 species of resident terrestrial mammals, with a further two species of bat recorded as vagrants to the island.

All of the terrestrial mammal species of Barrow Island, except bats, were either trapped or observed within the proposed Development area. Bats are likely to forage in the Development area, but have not been recorded. All of these species are widespread on the island, with the exception of the water-rat which is confined to coastal areas. There are no distinctive habitat features within the proposed Development area that are likely to support unusually high population densities of any mammal species.

The small black-flanked rock-wallaby population does not occur within the proposed Development area.

Reptiles and Amphibians – The reptile and amphibian assemblage on Barrow Island is depauperate in comparison with the herpetofauna of the adjacent mainland. Barrow Island is home to 43 species of reptiles comprising dragons, legless lizards, geckoes, skinks, blind snakes, monitors, snakes and one frog species.

Most of these species, or their habitats, are widely distributed on Barrow Island. Twenty-seven species, or more than half of the terrestrial reptiles known to occur on Barrow Island, have been recorded in the vicinity of the Development area.

The reptile assemblage along the proposed domestic gas pipeline route on the mainland is expected to be degraded by feral predators and habitat alteration through livestock grazing. The EPBC Act-listed Pilbara olive python is restricted to rocky habitats in the Pilbara and is not expected to occur in the sandy habitats along the domestic gas pipeline corridor.
Short-range Endemics – The term ‘short-range endemics’ is used to describe invertebrate species such as trapdoor spiders, snails and millipedes, that are restricted in range by poor dispersal ability and are generally endemic to small areas.

Over 40 potential short-range endemic invertebrate taxa were collected on Barrow Island during field surveys. The collection comprised spiders, scorpions, pseudoscorpions, centipedes, millipedes and land snails.

The distribution of similar habitats to those represented with the Development area suggests that invertebrate taxa collected are widely distributed on Barrow Island. None of the invertebrate fauna known from the proposed Development area are listed under the Wildlife Conservation Act or as Priority fauna by CALM. A pseudoscorpion and a single specimen of a large, dark scorpion (*Urodacus* sp.), recently collected within the proposed Development area, appear to be new and undescribed species of conservation significance. Again, these species are expected to occur across Barrow Island in habitats similar to those within the Development area.

Subterranean Fauna – Subterranean fauna sampling program records to date confirm that the habitats under both the proposed gas processing facility and the adjacent parts of the island support stygofauna and troglofauna. However, these assemblages may not be as diverse as those recorded from caves and more developed karstic areas in other parts of Barrow Island.

Baseline surveys for subterranean fauna will continue on Barrow Island until construction of the proposed Development commences. The results of subsequent sampling, concluded prior to construction, will be published separately. This will provide a species level analysis of subterranean fauna distribution, along with a more complete analysis of the physical nature of the subterranean environment.

Marine Ecology

Marine Conservation Areas – The waters surrounding Barrow Island are part of the area covered by the Montebello–Barrow Island marine conservation reserves (Figure 8-1). The majority of the conservation area is zoned as a Marine Management Area, recognised for both commercial and conservation values. The Barrow Island Marine Park and Bandicoot Bay conservation area provide additional protection for Biggada Reef and Bandicoot Bay. A large area off the east coast of Barrow Island is currently a designated port.

Marine Macrophytes – The marine flora comprises vascular flowering plants such as mangroves and seagrasses and plants such as algae.

There are no mangroves in the proposed Development area on Barrow Island. However the proposed domestic gas pipeline will cross a dense and well-developed mangrove community. This community comprises large *Avicennia marina* trees at the seaward edge, backed by tall *Rhizophora stylosa* trees and more *Avicennia* further inland. In total 2.3 ha of mangrove community would be directly affected by the pipeline.

There are no significant seagrass meadows present in the proposed Development area around Barrow Island. All areas with exposed, or seasonally exposed, hard substrate in the shallow waters support macroalgae.
**Marine Mammals** – The Pilbara region supports migratory, transient and resident marine mammals such as whales, dolphins and dugongs.

Humpback whales are likely to be present off the west coast of Barrow Island during the June to October migration period. Most whale species are more abundant in deeper waters and are expected to be rare visitors to the offshore waters close to the western shore of Barrow Island and are unlikely to visit the shallow, turbid inshore waters in the vicinity of the proposed east coast port facilities, domestic gas pipeline or optical fibre cable shore crossings.

Dugongs occur throughout the shallow waters between the Pilbara offshore islands and the mainland. Ephemeral seagrass meadows along the mainland coast in the vicinity of the proposed domestic gas pipeline shore crossing are likely to be feeding areas; however seagrass habitats are very widespread along the Pilbara coast and the area in the vicinity of the mainland shore crossings is not expected to be significant habitat for dugongs.

Bottlenose dolphins, common dolphins and striped dolphins are likely to visit the offshore Development area on the west coast of Barrow Island. Bottlenose dolphins are also likely to be regular visitors to the east coast Development area.

**Marine Avifauna** – Barrow Island’s marine avifauna comprises at least 67 species, including 25 species of migratory shorebirds and 20 resident shorebirds.

Barrow Island is both a staging site and an important non-breeding site for migratory shorebirds. The highest abundances of shorebirds on Barrow Island (over two-thirds of records for most species) are associated with the south-eastern and southern coasts of the island, from the existing Chevron camp to Bandicoot Bay. The Development area does not contain critical shorebird habitat. Despite the presence of broad intertidal reef platforms adjacent to Town Point, only 1% of shorebirds on Barrow Island were observed foraging near the proposed Development area in 2003 and 2004.

**Marine Turtles** – Barrow Island is a regionally important nesting area for green turtles and flatback turtles. Hawksbill turtles nest at low densities around the island and loggerheads have been only occasionally recorded from the island.

Green turtles nest predominantly on the sandy west coast beaches on Barrow Island in spring and summer. Hatchlings emerge from nests through summer and early autumn. While most green turtles migrate away from the area after breeding, some appear to be resident at Barrow Island, remaining near the island during the winter. The area of the proposed feed gas shore crossing at North White’s Beach is not a locally important green turtle nesting site. Flacourt Bay, where the alternative pipeline shore crossing is proposed, is an important green turtle nesting habitat.

Nesting flatback turtles favour mid-east coast beaches on Barrow Island. The beaches either side of the proposed Development area at Town Point are important components of this regionally significant rookery. In the summers of 2003–2004 and 2004–2005, flatback turtle nesting densities were highest on the central east coast adjacent to Town Point (Figure 8-2).

The proposed shore crossing for the domestic gas pipeline is comprised of mangroves and mudflats and is unsuitable for turtle nesting. A flatback turtle rookery has recently been identified at Back Beach, Onslow.
Fish – No areas of regional importance to fish species were identified during seabed surveys of the proposed Development area. Environment Protection and Biodiversity Conservation Act listed pipefish and seahorses are expected to be widespread throughout shallower benthic habitats of the area. Some of the protected species are expected to occur in the vicinity of the proposed pipeline routes and nearshore infrastructure on the east coast of the island and on the mainland coast. Other EPBC Act-listed species, such as the whale shark, grey nurse shark and great white shark, are occasional visitors to the Barrow Island area.

Marine Invertebrates – Invertebrate assemblages of the western and northern shores of Barrow Island are typical of the Pilbara offshore bioregion. Invertebrate assemblages of the eastern and southern shores are more similar to assemblages in the Pilbara nearshore bioregion along the mainland coast. All of the invertebrate assemblages in areas proposed for development are associated with habitats that are widely distributed regionally. None of the invertebrate assemblages are considered to be of high conservation significance.
8.5 Social Environment
The Pilbara resident population is approximately 40 000 people. The vast majority of Pilbara residents are located in the western third of the region, which includes the main townships of Karratha, Port Hedland and South Hedland. A small number of Indigenous communities occur in the eastern portion of the region.

The development of the Pilbara has coincided with the discovery of vast deposits of iron ore and oil and gas resources. Resource projects are the main economic and employment generators in the region and impact on the social profile and communities that support them.

8.6 Cultural Heritage
There are 13 registered archaeological sites on Barrow Island although none are close to the proposed Development area. There are no listed ethnographic sites on Barrow Island. There are two ethnographic sites located close to the proposed domestic gas pipeline route on the mainland and nine identified cultural heritage sites within the vicinity of the pipeline route.

8.7 Native Title
There are no lodged Native Title claims over the Gorgon gas field or Barrow Island. There are currently three registered Native Title claims that may overlap the proposed domestic gas pipeline route.

8.8 Economic Environment
The Pilbara region is one of the most important wealth producing regions in Western Australia. The region is responsible for the production of goods and services worth more than $16 billion per annum. The mining and petroleum industries are the main source of income for the region.

The Western Australian economy is dominated by the resources sector which also contributes largely to the Australian economy. Western Australia is now the major oil and gas producer in Australia, and has more than three-quarters of Australia’s identified natural gas resource within its jurisdiction.
Environmental risk assessments for the proposed Gorgon Development, including definition of consequences and identification of stressors and receptors, were undertaken by technical specialists with recognised expertise in a broad range of environmental fields. This included specialists with a long-standing knowledge and experience of working on Barrow Island.

Environmental risk assessment is a process that evaluates the likelihood and consequence of adverse environmental impacts occurring as a result of exposure to one or more stressors. An advantage of this approach is that it allows potential environmental hazards or threats to be considered on the basis of the level of risk to the environment. This assisted in prioritising the development of management measures to determine whether an overall acceptable level of risk could be achieved.

The risk assessment methodology was developed by risk consultants and ecological specialists working together and in accordance with recognised standards for environmental risk analysis and management (Figure 9-1).

Risk assessments for the proposed Development initially involved identification of stressors (hazards or threats) through a series of hazard identification workshops. Examples of stressors include light, noise, and clearing and earthworks. This was followed by definition of consequence categories for groups of environmental factors (e.g. Table 9-1). The likelihood of a particular impact occurring from an interaction between a stressor and a receptor was also defined based on a nominal Development life of 60 years (Table 9-2).

Prior to risk characterisation, ecological specialists identified groups of receptors (species or communities) which were considered to be sensitive to stressors associated with the Development (e.g. protected fauna, restricted flora and vegetation communities). Within each group of receptors, key receptor species were identified which were considered to be particularly sensitive to stressors and hence protective of a wider biological group. Risk levels (low, medium, high) were then estimated for each stressor and associated key receptors through an assessment of consequences and likelihood (Figure 9-2).
By systematically identifying all of the hazards or threats to conservation values potentially associated with the proposed Development, and engaging ecological specialists to assist in the development of risk-based management strategies, potential impacts will be, or are being, reduced to meet acceptable risk standards. In some cases, potential impacts will be avoided altogether.

A risk is considered acceptable if it falls in the low category without any further mitigation measures, and ‘tolerable’ if it falls in the medium risk category and is managed to reduce the risk to a level ‘as low as reasonably practicable’ (SAA HB 436:2004). Risk reduction measures must be applied to reduce high risks to tolerable levels. Taken together, these risk levels and corresponding requirements for risk treatment are the standards for acceptable risk to flora and fauna.
### Table 9-1: Consequence Definitions for Risk-based Environmental Assessment

<table>
<thead>
<tr>
<th>Consequence Category</th>
<th>Minor</th>
<th>Moderate</th>
<th>Serious</th>
<th>Major</th>
<th>Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protected fauna species (listed/threatened)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Individual level effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local, short-term behavioural impact.</td>
<td>Local, long-term or widespread, short-term behavioural impact.</td>
<td>Widespread, long-term behavioural impact.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Population level effects</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Local, short-term decrease in abundance. No lasting effects on local population.</td>
<td>Local, long-term or widespread, short-term decrease in abundance. Loss of small number of individuals without reduction in local population viability.</td>
<td>Local, long-term or widespread, short-term decrease in abundance. Loss of individuals leads to reduction in viability of local population. No reduction in viability of race on Barrow Island.</td>
<td>Local, long-term or widespread, short-term impact leads to loss of local population/s and reduced viability of the race on Barrow Island.</td>
<td>Widespread, long-term impact on population. Extinction of Barrow Island race.</td>
<td></td>
</tr>
<tr>
<td><strong>General fauna communities and species (not listed/threatened)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Individual effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local, long-term or widespread, short-term behavioural impact.</td>
<td>Widespread, long-term behavioural impact.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Population level effects</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Local, long-term or widespread, short-term decrease in abundance. Loss of small number of individuals without reduction in local population viability.</td>
<td>Local, long-term or widespread, short-term decrease in abundance. Loss of individuals leads to reduction in viability of local population. No reduction in viability on Barrow Island.</td>
<td>Local, long-term or widespread, short-term impact leads to loss of local population/s and reduced viability on Barrow Island.</td>
<td>Widespread, long-term impact on population. Extinction on Barrow Island.</td>
<td>Loss from immediate region.</td>
<td></td>
</tr>
</tbody>
</table>
### Table 9-2: Likelihood Definitions for Risk-based Environmental Assessment

<table>
<thead>
<tr>
<th>Likelihood category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost certain</td>
<td>Very likely to occur on an annual basis. Includes planned activities. Socio-economic description includes the period during construction.</td>
</tr>
<tr>
<td>Likely</td>
<td>Likely to occur more than once during the life of the proposed Development.</td>
</tr>
<tr>
<td>Possible</td>
<td>May occur within the life of the proposed Development.</td>
</tr>
<tr>
<td>Unlikely</td>
<td>Not likely to occur within the life of the proposed Development.</td>
</tr>
<tr>
<td>Remote</td>
<td>Highly unlikely and unheard of in industry, but theoretically possible.</td>
</tr>
</tbody>
</table>

### Figure 9-2: Gorgon Development Environmental Risk Matrix

```
<table>
<thead>
<tr>
<th>Consequence category</th>
<th>Minor</th>
<th>Moderate</th>
<th>Serious</th>
<th>Major</th>
<th>Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost certain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likely</td>
<td></td>
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<td></td>
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<tr>
<td>Possible</td>
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<td></td>
<td></td>
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<tr>
<td>Unlikely</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Remote</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
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Legend: Low Risk, Medium Risk, High Risk
For the purposes of risk assessment, the terrestrial environment was considered as four factors: the physical environment (i.e. soil and landform and water resources); flora and vegetation communities; terrestrial fauna; and subterranean fauna.

The potential stressors and assessed level of residual risk to terrestrial environmental factors are summarised in Table 10-2. The residual risks posed by stressors associated with each phase of the proposed Development were assessed as low to medium for all environmental factors except subterranean fauna. In each of these cases, the potential consequences to the terrestrial ecology of Barrow Island would be greatly reduced by implementing the proposed management measures, pose an overall acceptable level of residual risk to the conservation values of Barrow Island and meet the environmental management objectives for the Development.

The Joint Venturers are committed to adopting all management measures outlined in the Draft EIS/ERMP. The Development is currently in the early design phase with less than 10% of engineering design completed to date. As detailed design of the proposed Development progresses, it may become necessary to modify proposed management strategies, particularly those with an engineering element. If this occurs, alternative management strategies that achieve stated environmental objectives and targets will be developed.

10.1 Physical Environment

10.1.1 Soil and Landform
The main risks to soil and landform from the Development are associated with the following stressors:
- clearing and earthworks
- liquid and solid waste disposal
- leaks or spills.

Potential impacts to soil and landform associated with these stressors include erosion (wind and water) and soil contamination. Each of these stressors poses a medium level of residual risk to the environment during construction and a low level of residual risk during operations. The exception is leaks or spills which was assessed as a medium residual risk stressor during the operations phase.

Management measures have been developed to ensure that the risks of impacts from these stressors are minimised (Table 10-2). With respect to clearing and earthworks, management measures have been developed to ensure that impacts are limited to the specific disturbance required to construct and operate the proposed Development, and are restricted to the allowable footprint area (see Section 1.3.2).
10.1.2 Surface Water and Groundwater Quality

The main risks to surface water and groundwater quality from the Development are associated with the following stressors:

- clearing and earthworks
- physical presence
- liquid and solid waste disposal
- leaks or spills.

Potential impacts associated with these stressors include sedimentation, disturbance to natural drainage patterns, altered water infiltration and recharge rates and contamination. Stressors to surface water and groundwater present a medium level of residual risk during construction, with reduced low to medium risks during the operations phase of the Development.

Management measures have been developed to minimise potential risks associated with environmental stressors (Table 10-2). Erosion and sedimentation control measures will be applied to all clearing and earthworks. Impacts to groundwater recharge will be minimised by constructing a number of separate facilities on hardstand, interspersed with open and unsurfaced areas. The tiered drainage management system (refer to Section 6.10) will be based on hydrogeological data to maximise on-site infiltration of uncontaminated water. To mitigate potential risks associated with liquid and solid waste disposal, comprehensive waste management plans will be developed for all phases of the Gorgon Development. The primary focus of waste management will be minimisation of waste generation based on the principles of eliminate, reduce, reuse, recycle and environmentally responsible disposal.

10.1.3 Air Quality

The main risks to air quality are associated with atmospheric emissions and dust generated by clearing and earthworks. The potential impact of these stressors is a decrease in local and regional air quality. Both stressors present a low risk to local and regional air quality during construction, commissioning and operations (Table 10-2).

10.2 Flora and Vegetation Communities

No high risk stressors to terrestrial flora and vegetation communities were identified through the risk assessment process. Most stressors pose a low risk; however the following two stressors were assessed to present a medium risk:

- clearing and earthworks
- fire.

Clearing and earthworks poses the greatest risk during construction whereas fire is a risk associated with the Development during construction, commissioning and operations. Low risk stressors include atmospheric emissions, light/shading, heat/cold, dust, unpredicted CO₂ migration and leaks or spills. Potential impacts associated with all potential stressors include loss and/or disturbance to flora and vegetation and alteration of vegetation community composition.

Under the provisions of the Barrow Island Act 2003, no more than 300 ha of uncleared land is available for gas processing projects. Should 300 ha, or approximately 1.3% of the island, be cleared for the proposed or future gas developments, this would represent an increase in the area of cumulative disturbance from approximately 5.2% of the island (as currently disturbed) to approximately 6.5% of the island. The Joint Venturers are committed to limiting clearing to that available under the Barrow Island Act, and to avoiding restricted vegetation communities and priority flora.

Due to the presence of a high fuel load on Barrow Island, a fire originating from construction or operations activities could result in a substantial wildfire under certain climatic conditions (e.g. high temperatures, low humidity and strong wind). Examples of ignition sources during construction and operations include hot works (welding and grinding) and vehicle exhausts. The Joint Venturers’ policy will be to control fires that are either caused by construction or operations activities or which pose a risk to Development facilities or personnel. The response to naturally occurring fires that do not pose a threat to Development facilities or personnel will be in accordance with policies and procedures agreed through the Barrow Island Coordination Council with CALM and the Conservation Commission of WA.
10.3 Terrestrial Fauna

No high risk stressors to terrestrial flora and vegetation communities were identified through the risk assessment process (Table 10-2). Medium risk stressors, which are associated primarily with the construction phase of the Development, include:

- clearing and earthworks
- physical interaction
- noise and vibration (operations)
- fire.

Risk assessments indicate that a number of stressors pose a low risk to terrestrial fauna during most phases of the Development, including:

- leaks or spills
- light or shade
- atmospheric emissions
- dust
- unpredicted CO₂ migration or release
- heat and/or cold
- noise and vibration.

The main potential impacts associated with these stressors include direct displacement or loss of fauna, habitat loss or modification, and increased competition between individuals and species.

The proposed location and layout of the gas processing facility and associated infrastructure was selected with reference to the distribution of significant terrestrial fauna species and their habitats. For example, the proposed location of the feed gas pipeline has been realigned to avoid black-flanked rock wallaby habitat. The result is that fauna habitats within all of the areas proposed to be cleared are well represented across Barrow Island and there is no indication that any habitats within the Development footprint are of critical importance to terrestrial fauna. Trapping and spotlighting data, from both CALM monitoring programs and field surveys for the Gorgon Development, indicate similar densities of most mammals across Barrow Island. It is estimated that clearing and earthworks will therefore affect approximately 1.3% of the terrestrial fauna on Barrow Island, should the total area available for the currently proposed and future gas processing developments be cleared (Table 10-1).

Unavoidable habitat loss and displacement of fauna will be mitigated by relocating selected fauna to suitable release sites. A translocation program will be designed in consultation with CALM and DEH to augment existing endangered species relocation programs.

The main impact associated with interaction between the Development and local fauna will be accidental road kill. Lesser impacts include injuries or fatalities in hazardous areas. Although some level of road kill is highly likely when vehicles are regularly travelling through fauna habitat, there are a number of management measures that can be implemented to reduce fatality rates. The Joint Venturers are committed to enforcing speed limits on all roads, reducing vehicle numbers and monitoring the number of road kills to ensure that management is successful and impacts are not greater than predicted.

10.4 Subterranean Fauna

Due to the limited data available on the distribution and diversity of subterranean fauna within the gas processing facility site, risks to subterranean fauna have conservatively been assessed as either medium

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Table 10-1: Estimated Abundance of Terrestrial Fauna Species within the Total Development Area on Barrow Island

<table>
<thead>
<tr>
<th>Species</th>
<th>Estimated abundance (number of individuals) in total proposed Development area (300 ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burrowing bettong</td>
<td>10–15* (one warren)</td>
</tr>
<tr>
<td>Euro</td>
<td>10*–20**</td>
</tr>
<tr>
<td>Golden bandicoot</td>
<td>780–1040**</td>
</tr>
<tr>
<td>Northern brushtail possum</td>
<td>20**</td>
</tr>
<tr>
<td>Spectacled hare wallaby</td>
<td>75*</td>
</tr>
<tr>
<td>White-winged fairy wren</td>
<td>315*</td>
</tr>
</tbody>
</table>

* based on direct estimate from surveys; ** based on 1.3% of estimated total island abundance
or high level. However, it is important to note that this level of risk primarily reflects uncertainty in the absence of final analysis of sampling data. Further information from the ongoing sampling program will provide a clearer model of the wider distribution of the subterranean taxa and is expected to result in a reduction in risk to medium or low levels.

High risk stressors based on the current assessment include:
• clearing and earthworks (construction and commissioning)
• physical presence of gas processing facility (operations).

Medium risk stressors include:
• wastewater discharge (construction and commissioning)
• noise and vibration (construction and commissioning)
• leaks and spills (operations)
• CO₂ leak (operations).

Bores established for subterranean fauna monitoring were first sampled in November 2004 and again in March 2005. This has comprised two rounds of stygofauna sampling and one completed round of troglofauna sampling (a second was underway at the time of printing). Final results, completed to species level, will be published in a package of additional information to the Draft EIS/ERMP (refer to Section 4).
<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objective</th>
<th>Potential Environmental Impact/Consequences</th>
<th>Key Management Measures</th>
<th>Target</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| Soil and Landform      | • To maintain the integrity, ecological functions and environmental values of soil and landform. | • erosion and sedimentation  
• soil compaction  
• soil inversion  
• disturbance to significant geological features (e.g. caves)  
• changes in landform  
• soil contamination. | • limit clearing and earthworks (land use register)  
• reuse topsoil and vegetation  
• install use erosion and sediment control structures  
• suppress dust generation  
• develop a waste management plan  
• avoid disposal of solid wastes to landfill on Barrow Island  
• develop an emergency (spill) response plan  
• design equipment to include built-in safeguards  
• contain and remediate any contaminated soil  
• apply industry standards for storage and handling of fuels and chemicals  
• implement early leak detection and reporting systems. | • no solid waste disposed to landfill on Barrow Island  
• no contaminated soils outside of Development footprint  
• contaminated areas remediated  
• no long-term detectable impact at hydrostatic test disposal site/s  
• no measurable impact on groundwater  
• no contamination of surface water outside of Development area. | Clearing and earthworks.  
Liquid and solid waste disposal.  
Leaks or spills. | Const. and Comm.  
Operations  
Non-routine |
|                        |                                                                           |                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                               | M  
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|                        |                                                                           |                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                               | M  
L  
– |
|                        |                                                                           |                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                               | M  
M  
– |
Executive Summary

Surface Water and Groundwater Quality

To maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem function, are protected.

To minimise the potential for erosion due to stormwater flow.

- sedimentation of natural drainage systems
- disturbance to natural drainage patterns
- change in water infiltration and recharge rates
- increased runoff
- change in groundwater level
- surface water and groundwater contamination.

- avoid natural drainage lines
- implement tiered stormwater drainage management system
- install use erosion and sediment control structures
- implement an approved waste management plan
- avoid disposal of solid wastes to landfill on Barrow Island
- design equipment to include built-in safeguards
- apply industry standards for storage and handling of fuels and chemicals
- develop an emergency (spill) response plan
- contain and remediate any contaminated soil.

- no contamination of surface water outside of Development area
- no measurable impact on groundwater regime (recharge and quality)
- no solid waste disposed to landfill on Barrow Island.

Table 10-2: (continued)
Summary of Risk Assessment for Terrestrial Environmental Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objective</th>
<th>Potential Environmental Impact/Consequences</th>
<th>Key Management Measures</th>
<th>Target</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water and Groundwater Quality</td>
<td>To maintain the quantity and quality of water so that existing and</td>
<td>To minimise the potential for erosion due to stormwater flow.</td>
<td>• sedimentation of natural drainage systems</td>
<td>• no contamination of surface water outside of Development area</td>
<td>M L –</td>
</tr>
<tr>
<td></td>
<td>potential environmental values, including ecosystem function, are</td>
<td></td>
<td>• disturbance to natural drainage patterns</td>
<td>• no measurable impact on groundwater regime (recharge and quality)</td>
<td>M M –</td>
</tr>
<tr>
<td></td>
<td>protected.</td>
<td></td>
<td>• change in water infiltration and recharge rates</td>
<td>• no solid waste disposed to landfill on Barrow Island.</td>
<td>M M –</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• increased runoff</td>
<td></td>
<td>M L –</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• change in groundwater level</td>
<td></td>
<td>M L –</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• surface water and groundwater contamination.</td>
<td></td>
<td>M L –</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- no contamination of surface water outside of Development area
- no measurable impact on groundwater regime (recharge and quality)
- no solid waste disposed to landfill on Barrow Island.

- Clearing and earthworks.
- Physical presence.
- Liquid and solid waste disposal.
- Leaks or spills.
### Table 10-2: (continued)
Summary of Risk Assessment for Terrestrial Environmental Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objective</th>
<th>Potential Environmental Impact/Consequences</th>
<th>Key Management Measures</th>
<th>Target</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| **Air Quality**      | To ensure that atmospheric emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards. To minimise emissions of ozone depleting substances to levels as low as practicable on an ongoing basis. | • decrease in local and regional air quality. | • conduct regular inspection and maintenance of vehicles, plant and equipment  
• avoid ozone depleting substances  
• adopt energy efficient technology and design  
• comply with EPA licence conditions  
• implement greenhouse gas management plan  
• use dry gas seals on compressors  
• design and operate condensate storage tanks to reduce fugitive emissions  
• use high efficiency combustion in flare and fuel users  
• use a-MDEA in CO₂ removal process  
• inject CO₂ removed from feed gas into deep well  
• implement dust suppression measures. | • no breaches of environmental licence conditions  
• dust emissions limited to immediate vicinity of earthworks. | **Stressor** | **Const. and Comm.** | **Operations** | **Non-routine** |
|                      |           |                                             |                         |        | L  | L  | L  | L  |
Residual Risk

### Terrestrial Flora and Vegetation Communities

- To maintain the abundance, diversity, geographic distribution and productivity of flora through the avoidance or management of adverse impacts and improvement in knowledge.

- To protect EPBC Act-listed threatened and migratory species.

- To protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act.

#### Potential Environmental Impact/Consequences

- loss and/or disturbance to flora and vegetation communities
- spread of weeds
- alteration of community composition
- reduced plant growth and productivity.

#### Key Management Measures

- develop flora and vegetation management plan
- develop fire management program
- avoid restricted vegetation communities
- avoid priority flora
- limit clearing and earthworks (land use register)
- rehabilitate cleared areas that are no longer required for operations or future works
- conduct surveys prior to clearing
- prohibit off-road vehicle driving under normal circumstances
- perform audit, inspection and maintenance of fire equipment and fire prevention mechanisms regularly
- implement air emissions management procedures
- suppress dust generation.

- Development footprint limited to that allowed under the Barrow Island Act
- <10% estimated island-wide distribution of any community or taxa impacted
- long-term viability of restricted communities and taxa maintained
- no spread of introduced species
- mainland mangroves rehabilitated
- establishment of fire management program through BICC
- no broad scale fires originating from Development
- no breaches of environmental licence conditions
- no loss of vegetation from emissions
- no spills of stored chemicals contacting receptors outside bunded areas.

### Summary of Risk Assessment for Terrestrial Environmental Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objective</th>
<th>Potential Environmental Impact/Consequences</th>
<th>Key Management Measures</th>
<th>Target</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial Flora and Vegetation Communities</td>
<td>To maintain the abundance, diversity, geographic distribution and productivity of flora through the avoidance or management of adverse impacts and improvement in knowledge. To protect EPBC Act-listed threatened and migratory species. To protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act.</td>
<td>• loss and/or disturbance to flora and vegetation communities • spread of weeds • alteration of community composition • reduced plant growth and productivity.</td>
<td>• develop flora and vegetation management plan • develop fire management program • avoid restricted vegetation communities • avoid priority flora • limit clearing and earthworks (land use register) • rehabilitate cleared areas that are no longer required for operations or future works • conduct surveys prior to clearing • prohibit off-road vehicle driving under normal circumstances • perform audit, inspection and maintenance of fire equipment and fire prevention mechanisms regularly • implement air emissions management procedures • suppress dust generation.</td>
<td>• Development footprint limited to that allowed under the Barrow Island Act • &lt;10% estimated island-wide distribution of any community or taxa impacted • long-term viability of restricted communities and taxa maintained • no spread of introduced species • mainland mangroves rehabilitated • establishment of fire management program through BICC • no broad scale fires originating from Development • no breaches of environmental licence conditions • no loss of vegetation from emissions • no spills of stored chemicals contacting receptors outside bunded areas.</td>
<td>Stressor Const. and Comm. Operations Non-routine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Const. and Comm. Operations Non-routine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearing and earthworks (restricted flora and vegetation communities).</td>
<td>M L –</td>
<td>L L –</td>
</tr>
<tr>
<td>Clearing and earthworks (general flora and vegetation communities).</td>
<td>M M –</td>
<td>L L L</td>
</tr>
<tr>
<td>Fire.</td>
<td>L L –</td>
<td>L L –</td>
</tr>
<tr>
<td>Atmospheric emissions.</td>
<td>L L –</td>
<td>L L –</td>
</tr>
<tr>
<td>Light/ shading/ heat/ cold.</td>
<td>L L –</td>
<td>L L –</td>
</tr>
<tr>
<td>Dust.</td>
<td>– – L</td>
<td>– – L</td>
</tr>
<tr>
<td>Unpredicted CO₂ migration.</td>
<td>L L –</td>
<td>L L –</td>
</tr>
</tbody>
</table>
### Table 10-2: (continued)
Summary of Risk Assessment for Terrestrial Environmental Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objective</th>
<th>Potential Environmental Impact/Consequences</th>
<th>Key Management Measures</th>
<th>Target</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial Fauna</td>
<td>To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystems levels through the avoidance or management of adverse impacts and improvement in knowledge. To protect EPBC Act-listed threatened and migratory species. To protect Specially Protected (Threatened) Fauna, consistent with the provisions of the Wildlife Conservation Act. To protect evolutionary significant units, including genetic races on Barrow Island.</td>
<td>• direct displacement or loss of individuals • increased competition • habitat loss or modification • direct behavioural disturbance • injury or fatality (i.e. road kill).</td>
<td>• avoid critical habitat • minimise clearing or modification of important fauna habitats • translocate selected fauna • identify hazardous areas/activities and prevent fauna mortality or injury • educate workforce and visitors and enforce rules on interaction/interference with fauna • restrict recreation in designated sensitive areas • establish workforce conservation programs • minimise lighting levels to that required for safe working • fence hazardous construction areas within gas processing facility.</td>
<td>• Development footprint limited to that allowed under the Barrow Island Act • &lt;5% estimated island-wide population of any species impacted • long-term viability of listed fauna species maintained • critical/restricted fauna habitats avoided • translocation of listed fauna to suitable recipient sites • fauna prevented from entering spill sites • no contaminated soils outside of Development footprint • no contaminated areas within Development area remediated • compliance with tiered lighting strategy • no listed fauna fatalities within the gas processing facility • adherence to ‘no routine flaring policy’</td>
<td>Stressor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>M</td>
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<td></td>
<td></td>
<td>M</td>
</tr>
</tbody>
</table>
### Table 10-2: (continued)
Summary of Risk Assessment for Terrestrial Environmental Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objective</th>
<th>Potential Environmental Impact/Consequences</th>
<th>Key Management Measures</th>
<th>Target</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial Fauna (continued)</td>
<td></td>
<td></td>
<td>• no breaches of environmental licence requirements</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 10-2: (continued)

Summary of Risk Assessment for Terrestrial Environmental Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objective</th>
<th>Potential Environmental Impact/Consequences</th>
<th>Key Management Measures</th>
<th>Target</th>
<th>Stressor</th>
</tr>
</thead>
</table>
| Subterranean Fauna   | To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. | • direct loss of habitat  
• local loss of troglofauna and stygofauna  
• modification of subterranean habitats (e.g. changes to hydrology, sedimentation, contamination). | • ongoing subterranean fauna sampling and monitoring program  
• limit clearing and ground disturbance  
• install erosion control and flow diversion devices  
• prevent transport of contaminants to the subterranean habitat  
• use drill and blast techniques which reduce zone of effect  
• apply industry standards for storage and handling of fuels and chemicals  
• develop an emergency (spill) response plan  
• implement automatic emergency response engineered systems to reduce release volumes  
• design drainage strategy to maximise on-site infiltration of non-contaminated runoff. | • no loss of restricted subterranean fauna species  
• long-term viability of restricted subterranean fauna species maintained  
• no contamination of subterranean habitats  
• no breaches of environmental licence conditions  
• no CO₂ leak from subsurface formation  
• no measurable impact on groundwater regime (recharge and quality). | Clearing and earthworks.  
Physical presence.  
Wastewater discharge.  
Noise and vibration.  
Leaks or spills.  
Unpredicted CO₂ migration. |
|                      | To protect EPBC Act-listed threatened species.  
To protect Specially Protected (Threatened) Fauna, consistent with the provisions of the Wildlife Conservation Act. | | | | Const. and Comm.  
Operations  
Non-routine |
|                      | • no loss of restricted subterranean fauna species  
• long-term viability of restricted subterranean fauna species maintained  
• no contamination of subterranean habitats  
• no breaches of environmental licence conditions  
• no CO₂ leak from subsurface formation  
• no measurable impact on groundwater regime (recharge and quality). | | | | | |

* Although a worst case risk assessment, based on a precautionary approach, has found there to be some high risk stressors to subterranean fauna it is anticipated that further information from the proposed sampling strategy will provide a clearer model of the wider distribution of the subterranean taxa and result in a reduction in risk to medium to low levels.
A risk-based assessment was undertaken on the stressors associated with each phase of the proposed Development that could impact on various species and communities (receptors) of the marine environment. For the purposes of risk assessment, the marine environment was considered as four factors: physical environment; benthic primary producers; benthic primary producer habitats; and marine fauna.

Table 11-3 provides a summary of potential stressors and assessed level of residual risk to marine environmental factors. The residual risks posed by stressors associated with each phase of the Development were assessed as low to medium for all factors. The potential environmental consequences of the Development are unlikely to have long-term implications for the marine environment surrounding Barrow Island or mainland components of the Development. The overall level of risk to marine conservation values is therefore considered to be acceptable and environmental management objectives for the Development achievable.

### 11.1 Physical Environment

**11.1.1 Seabed Substrates**

Risks from the Development to seabed substrates are associated with the following stressors:

- physical disturbance
- physical presence of infrastructure
- liquid and solid waste disposal
- leaks or spills.

All of these stressors, with the exception of physical disturbance, were assessed as low risk. Physical disturbance to the seabed is predicted to pose a low to medium risk to seabed substrates.

Potential impacts associated with seabed disturbance include:

- change in the seabed profile
- short-term increase in turbidity, elevated suspended sediment levels and sedimentation.

The areas of seabed likely to be disturbed by installing marine infrastructure are provided in Table 11-1.
The physical habitats potentially affected by the proposed Development are widely represented throughout the Montebello/Lowendal/Barrow Islands region. Impacted areas along the pipeline routes and optical fibre cable route will recover from physical disturbance. Seabed substrates impacted by dredging and installation of port facilities off the east coast of Barrow Island will be permanently impacted by the Development; however, affected substrates are widely distributed and losses will be partially offset by creation of new habitat. Management of marine construction activities will be addressed in detailed Environment Plans.

### 11.1.2 Water Quality

The main risks to marine water quality are associated with discharges (e.g., drill cuttings and fluids) and leaks or spills. The potential impact of these stressors is short-term pollution of the water column. Both stressors present a low risk to marine water quality during construction, commissioning, and operations.

### 11.1.3 Foreshore

The main risks to foreshore areas from the Development are associated with physical disturbance during construction and the ongoing physical presence of infrastructure over the life of the Development (Table 11-3).

<table>
<thead>
<tr>
<th>Facility</th>
<th>Approximate Area of Disturbance (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary anchors for drilling and installation activities</td>
<td>Approx. 8–12 anchors, total area of 40 m²</td>
</tr>
<tr>
<td>Subsea trees and manifolds</td>
<td>2.5 (25 wells)</td>
</tr>
<tr>
<td>Flowlines (intrafield flowlines)</td>
<td>15.5</td>
</tr>
<tr>
<td>Feed gas pipelines</td>
<td>200</td>
</tr>
<tr>
<td>Domestic gas pipeline</td>
<td>200</td>
</tr>
<tr>
<td>MOF and access channel (includes causeway)</td>
<td>42</td>
</tr>
<tr>
<td>Jetty</td>
<td>6</td>
</tr>
<tr>
<td>Optical fibre cable</td>
<td>123 (123 km x 10 m)</td>
</tr>
<tr>
<td>Turning basin and shipping channel</td>
<td>144</td>
</tr>
<tr>
<td>Dredge spoil grounds</td>
<td>900</td>
</tr>
</tbody>
</table>

Table 11-1: Proposed Direct Disturbance to Seabed

Potential impacts to foreshore areas associated with these stressors include erosion, soil compaction, changes in longshore coastal processes and altered profile of coastal areas. Physical disturbance during construction poses a medium level of risk to foreshore areas. Both physical disturbance and the ongoing presence of infrastructure were assessed as a low risk during operations.

Management measures have been developed to ensure that the risks of impacts from these stressors are minimised (Table 11-3). Clearing and earthworks will be strictly controlled in foreshore areas (e.g., during construction of pipeline shore crossings) and erosion and sediment control measures will be installed where there is a risk of erosion. All pipeline shore crossings will be reinstated to a level consistent with surrounding terrain.

The construction of a causeway and MOF will impose a physical barrier on the site with a potential to impact on the dynamics of the existing foreshore environment. Field measurements and modelling indicate that beaches in the vicinity of Town Point are low energy zones with limited longshore drift. The alignment of beaches on either side of Town Point will be monitored following construction to confirm that longshore sediment drift will not be affected by the presence of the causeway.
11.2 Benthic Primary Producers (Marine Flora and Corals)

Benthic primary producers (BPP) are photosynthetic organisms that are attached to marine (intertidal and subtidal) substrates and contribute to the productivity of marine ecosystems. The marine macrophyte and coral assemblages in the marine environment surrounding Barrow Island are dominated by tropical species that are widely represented within the Montebello/Lowendal/Barrow Island region and across the Rowley Shelf. Mainland taxa are similarly widespread along the Pilbara coast.

Stressors which pose a potential risk to benthic primary producers include seabed disturbance, leaks and spills, physical presence of Development infrastructure and wastewater and other discharges. Both the physical presence of infrastructure and management of wastewater and other discharges have been assessed as low risk during both construction and operations. Seabed disturbance and leaks and spills are both stressors that pose a medium level of risk during the construction phase. Leaks and spills also present a medium risk during the operational phase of the Development.

The major, long-term impact of seabed disturbance on BPP is associated with direct removal of substrates with attached marine macrophytes and corals, such as excavation of vessel access channels by dredging, and installation of infrastructure on the seabed, such as by construction of the MOF. Construction activities in the marine environment, particularly dredging and drilling, will also temporarily affect benthic primary producers, most notably through increased levels of sedimentation and turbidity.

The likelihood of direct impacts to marine macrophytes (macroalgae and seagrasses) and corals from construction or operation of the feed gas pipeline, causeway, MOF, LNG jetty and access channels is almost certain, because the disturbance is an unavoidable element of the proposal. The consequence of the impacts is considered minor because potential impacts will be limited to a local, long-term impact on the communities and there will be no reduction in community or taxon viability in the local area.

Macroalgal beds and coral communities of the type that are likely to be impacted by the Development are widely distributed throughout the region and no regionally significant coral communities will be directly impacted. There will also be significant regrowth and recolonisation of hard substrates (e.g. jetty piles, spoil disposal ground) in the Development area.

The residual risk of significant adverse impacts to mangroves on the mainland from construction of the domestic gas pipeline is medium. The likelihood of impacts is categorised as almost certain because clearing is unavoidable for construction of the domestic gas pipeline to proceed. The consequence of impacts is considered moderate because the impacts are restricted to a small area of a regionally significant mangrove system that is well represented along the Pilbara coast. The absence of observable edge effects along the existing pipeline easement indicates that the integrity of the local mangrove habitat will not be reduced by the proposed Development.

The spatial extent of potential indirect impacts from sedimentation and turbidity associated with HDD for the feed gas pipeline shore crossing at North White's Beach and the dredging program off the east coast of Barrow Island was predicted using a 3D hydrodynamic model (GCOM3D) and a 3D dredge simulation model (DREDGETRAK). The implications to benthic primary producer communities of increased suspension and deposition of sediments resulting from construction operations will vary considerably depending on the extent and nature of impacts, including the taxa affected. It is anticipated that turbidity and sedimentation will result in a local long-term impact on benthic primary producers adjacent to the Development and short-term impacts in areas which encompasses coral and macroalgal communities along the eastern edge of the Lowendal Shelf and northern coast of Barrow Island (Figure 11-1). The modelling results indicate that there will be no adverse impacts to regionally significant corals on the southern Lowendal Shelf, Dugong Reef or Batman Reef. The consequences of predicted impacts from turbidity and sedimentation will be minor, representing a short to long-term reduction in abundance but no reduction in community/taxon viability in the local area.
Figure 11-1: The Anticipated Area of Impact During the Installation of the Feed Gas Pipelines and Construction of the Causeway, MOF, Jetty and Dredged Channels.
The Joint Venturers will develop and adopt a monitoring and management program designed to restrict the potential effects of HDD, dredging and dredge spoil disposal during the construction phase of the Development to predicted impact zones. The monitoring and management program will be developed in consultation with the Commonwealth and Western Australia state agencies. This will form part of the drilling, dredging and dredge spoil disposal monitoring and management plan for the Development.

The potential for significant impacts to marine benthic primary producers from a leak or spill incident associated with the Development relates primarily to a spill of condensate or liquid hydrocarbons from work vessels, LNG ships and work barges that will have bunkers of diesel and possibly other liquid fuels on board. Unlike other liquid hydrocarbons, LNG is not toxic and produces a buoyant vapour cloud when spilled on to water. As this cloud mixes with air, it warms up and disperses into the atmosphere. The potential for environmental impacts from a release of LNG are therefore considered negligible.

Spilled liquid hydrocarbons can adversely affect marine benthic primary producers if there is direct contact at low tide, through the dispersal of oil droplets into shallow subtidal areas or by dissolution of toxic hydrocarbons into the water column. The extent to which a spill will affect benthic primary producers in any area depends on a complex suite of interacting physical, chemical and biological factors. Within the area potentially at risk from a leak or spill, the intertidal coral communities at Biggada Reef on the west coast of Barrow Island are the most vulnerable benthic primary producer communities with high conservation significance. Significant coral communities on the east coast are mostly subtidal, as are the denser macroalgae and seagrass communities on both coasts. Modelling indicates that a small-volume spill from a refuelling incident on either the west or east coasts of Barrow Island would be unlikely (i.e. 2.43 x 10^-5/yr) to result in significant exposure of benthic primary producers to hydrocarbons. The probability of a large leak or spill is very low (2.76 x 10^-5/yr) and the likelihood of a large spill occurring and affecting benthic primary producers is categorised as remote.

Management of hydrocarbon spills within the offshore petroleum industry is focussed on prevention of incidents, combined with comprehensive contingency response planning, integrated at national, state and local levels. Equipment design, material selection and construction techniques and standards adopted for the Development are based upon proven, robust solutions used extensively in similar environments and applications worldwide.

The offshore Pilbara north-west shelf region is a major petroleum exploration and production province. Detailed contingency planning is in place to reduce the risk of a significant spill and substantial oil spill response capacity is currently maintained at the Port of Dampier and on the islands of the north-west shelf, including Barrow Island, to provide for rapid intervention if an incident occurs.

11.3 Benthic Primary Producer Habitats

Benthic primary producer habitats comprise both benthic primary producer communities and the substrates that support these communities.

The Joint Venturers have adopted the EPA's risk-based approach, as outlined in Guidance Statement No. 29 (EPA 2004), to assess unavoidable cumulative impacts to benthic primary producer habitats within the proposed Development area. As specified by the Guidance Statement, management units were defined in consultation with the Western Australian Department of Environment (DoE) and existing and proposed disturbance to benthic primary producer habitats assessed against relevant cumulative loss thresholds. The recommended size for a management unit to represent an ecological unit is nominally 5 000 ha although larger and smaller units can be established (EPA 2004).

Fourteen management units have been defined to assess impacts to benthic primary producer habitats from the Development. This consists of eleven management units around Barrow Island and three on the mainland coast (Figure 11-2 and Figure 11-3). A summary of results from the assessment of cumulative impacts to benthic primary producer habitats within the proposed Development area using EPA guidelines is shown in Table 11-2.
Figure 11-3:
Mainland Management Units, Benthic Habitats and Proposed Infrastructure
Permanent loss of benthic primary producer habitats are predicted to exceed EPA cumulative loss threshold levels in three of the fourteen management units established in accordance with EPA Guidance Statement No. 29. The proposed dredge spoil area will permanently modify approximately 6% and 14% of the seabed in management units 10 and 11 respectively. While these losses exceed the benthic primary producer habitat cumulative loss threshold levels (2% and 10%), they do not represent a threat to the ecological integrity of the surrounding benthic primary producer habitat or to the conservation values of the Barrow Island Marine Conservation Area. The flat sandy seabed in both of these management units is very well represented in both the local area and the region. It is close to the depth limit for the seagrasses and is likely to be of marginal value in terms of seagrass productivity compared to shallower areas closer to Barrow Island. Similarly benthic primary producer habitats in management unit 8 within the port area are well represented throughout the Montebello/Lowendal/Barrow Islands region and permanent loss of some areas of benthic primary producer habitat (23%) is not predicted to affect ecosystem integrity in the port area or region.

Losses of unconfirmed coral habitat in the two Lowendal Islands management units (2 and 3) also exceed cumulative loss thresholds; however the majority of the assumed distribution of coral habitat in these management units, as identified by the CALM (2004) marine habitat mapping, has not been confirmed by field surveys. It is anticipated that only a small proportion of the areas affected by persistent turbid plumes represent coral habitat and that these coral communities would fully recover from sedimentation and turbidity impacts.

11.4 Marine Fauna

Physical interaction and light emissions were assessed as medium – high risk stressors to marine fauna (Table 11-3). Medium risk stressors, which are associated primarily with the construction phase of the Development, include:

- seabed disturbance
- noise and vibration
- leaks or spills (construction and operations)

Risk assessments indicate that physical presence of infrastructure and wastewater discharges pose a low risk to marine fauna during construction, commissioning and operations phases of the Development.

The main potential impacts associated with marine stressors include loss, injury, or disturbance to marine fauna, and loss or modification of habitat.

Sea turtles are one of the most sensitive receptors that will be affected by physical interaction with Development activities and by light emissions. There is potential for collisions between vessels (e.g. pipelay vessels and dredges) and sea turtles off the east and west coasts of Barrow Island. On the east coast, further surveys will be conducted, prior to construction, to establish the extent to which seabed habitats are utilised by resident and internesting flatback turtles. Results from surveys and satellite tracking studies will establish whether or not flatback turtles are using seabed areas off the east coast of Barrow Island as resting and internesting habitats and if management strategies such as relocation of turtles and modification of dredge specifications (i.e. turtle deflection devices) will be necessary. If dredge areas do not represent important flatback turtle habitat, then it is unlikely that significant numbers of flatback turtles (i.e. 10s) will be directly impacted by dredging.
Elevated light levels on nesting beaches can be detrimental to sea turtles because light may alter critical nocturnal behaviours, namely how sea turtles choose nesting sites, how adult females return to the sea after nesting, and how hatchlings find the sea after emerging from nests. Because there is no single, measurable level of artificial brightness on nesting beaches that is acceptable for sea turtle conservation, the most effective conservation strategy is simply to use "best available technology" to reduce effects from lighting (Witherington and Martin 2000). Best available technology includes many light management options that have been used by lighting engineers for decades and others that are unique to protecting sea turtles. To protect sea turtles, light sources can be minimised in number and wattage, repositioned behind structures, shielded, redirected, lowered, or recessed so that light does not reach the beach. To ensure that lights are on only when needed, timers and motion detector switches can be installed.

The Joint Venturers are committed to adopting a lighting strategy for the gas processing facility and associated infrastructure that will avoid or mitigate impacts to sea turtles caused by artificial light. No permanent 24-hour lighting will be located within 500 m of turtle nesting beaches and light emission modelling and line-of-sight studies will be incorporated into lighting design to eliminate non-essential lighting and reduce essential lighting to lowest practicable levels. The implementation detail for these strategies will be developed, in consultation with CALM, the Department of Environment (DoE) and the Commonwealth Department of the Environment and Heritage (DEH), and submitted for approval as part of the EMP for the Development.

Table 11-2:
Summary of Benthic Primary Producer Habitat Assessment

<table>
<thead>
<tr>
<th>Management Unit</th>
<th>% Benthic Primary Producer Habitat -Permanent Loss*</th>
<th>EPA Cumulative Loss Threshold (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North West Coast MU 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macroalgae dominated intertidal limestone platform</td>
<td>&lt;1</td>
<td>2 (category C)</td>
</tr>
<tr>
<td>Subtidal limestone reef platform with macroalgae and scattered corals</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Lowendal Islands MU 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macroalgae-dominated intertidal limestone platform</td>
<td>0</td>
<td>10 (category E)</td>
</tr>
<tr>
<td>Subtidal limestone reef platform with macroalgae and scattered corals</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Reef platform/sand with scattered seagrass</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Confirmed coral habitat</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Unconfirmed coral habitat</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Lowendal Islands MU 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macroalgae-dominated intertidal limestone platform</td>
<td>0</td>
<td>10 (category E)</td>
</tr>
<tr>
<td>Subtidal limestone reef platform with macroalgae and scattered corals</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Reef platform/sand with scattered seagrass</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Confirmed coral habitat</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Unconfirmed coral habitat</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>Barrow Island Port Area MU4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macroalgae-dominated intertidal limestone platform</td>
<td>&lt;1</td>
<td>10 (category E)</td>
</tr>
<tr>
<td>Subtidal limestone reef platform with macroalgae and scattered corals</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Management Unit</td>
<td>% Benthic Primary Producer Habitat -Permanent Loss*</td>
<td>EPA Cumulative Loss Threshold (%)</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>----------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Barrow Island Port Area MU4 (continued)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reef platform/sand with scattered seagrass</td>
<td>&lt;1</td>
<td>10 (category E)</td>
</tr>
<tr>
<td>Coral habitats</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Barrow Island Port Area MU5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtidal limestone reef platform with macroalgae and scattered corals</td>
<td>0</td>
<td>10 (category E)</td>
</tr>
<tr>
<td>Reef platform/sand with scattered seagrass</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Coral habitats</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Barrow Island Port Area MU6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtidal limestone reef platform with macroalgae and scattered corals</td>
<td>0</td>
<td>10 (category E)</td>
</tr>
<tr>
<td>Reef platform/sand with scattered seagrass</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Coral habitats</td>
<td>5</td>
<td></td>
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<tr>
<td>Barrow Island Port Area MU7</td>
<td></td>
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<tr>
<td>Macroalgae-dominated intertidal limestone platform</td>
<td>0</td>
<td>10 (category E)</td>
</tr>
<tr>
<td>Subtidal limestone reef platform with macroalgae and scattered corals</td>
<td>&lt;1</td>
<td></td>
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<tr>
<td>Reef platform/sand with scattered seagrass</td>
<td>&lt;2</td>
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<tr>
<td>Coral habitats</td>
<td>0</td>
<td></td>
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<tr>
<td>Barrow Island Port Area MU8</td>
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<tr>
<td>Subtidal limestone reef platform with macroalgae and scattered corals</td>
<td>0</td>
<td>10 (category E)</td>
</tr>
<tr>
<td>Reef platform/sand with scattered seagrass</td>
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<tr>
<td>Coral habitats</td>
<td>23</td>
<td></td>
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<tr>
<td>Barrow Island Port Area MU9</td>
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<tr>
<td>Reef platform/sand with scattered seagrass</td>
<td>7</td>
<td>10 (category E)</td>
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<tr>
<td>Dredge Spoil Area MU10</td>
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<tr>
<td>Reef platform/sand with scattered seagrass</td>
<td>6</td>
<td>2 (category C)</td>
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<tr>
<td>Dredge Spoil Area MU11</td>
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<tr>
<td>Reef platform/sand with scattered seagrass</td>
<td>14</td>
<td>5 (category D)</td>
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<tr>
<td>Mainland MU1</td>
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<td></td>
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<tr>
<td>Mangrove habitat</td>
<td>&lt;1</td>
<td>1 (category B)</td>
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<tr>
<td>Mainland MU2</td>
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<tr>
<td>Seagrass habitat</td>
<td>0</td>
<td>5 (category D)</td>
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<tr>
<td>Onlsow MU</td>
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<td></td>
</tr>
<tr>
<td>Macroalgae and seagrass habitat</td>
<td>&lt;1</td>
<td>5 (category D)</td>
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</tbody>
</table>

* Figures for benthic primary producer habitat loss are based on the anticipated impact scenario.
### Table 11-3: Summary of Risk Assessment for Marine Environmental Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objective</th>
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<th>Residual Risk</th>
</tr>
</thead>
</table>
| Seabed Substrates    | To maintain the ecological functions and environmental values of marine benthic habitats and the subtidal and intertidal zones. | • change in seabed profile  
• sedimentation  
• damage to high profile reef structures  
• change in seabed type, e.g. sand to rock  
• smothering of seabed  
• localised change in longshore coastal sediment dynamics  
• localised contamination of marine sediments  
• alteration of sediment characteristics (sediment size and anoxic conditions). | • locate Development infrastructure to avoid sensitive areas  
• undertake dredge spoil disposal in accordance with licence conditions  
• locate and orientate Development infrastructure to minimise impacts to nearshore sediment transport  
• develop Environment Plans for marine activities  
• specify heavy metal limits in drilling chemicals (e.g. barite) if used  
• use HDD in favour of trenching at feed gas pipelines shore crossing  
• develop appropriate erosion control methods for domestic gas pipeline shore crossing  
• develop Waste Management Plan  
• comply with MARPOL 73/78 Annex IV requirements  
• develop an emergency (spill) response plan. | • compliance with EPA guidance statement for BPPH disturbance  
• no detectable long-term change in longshore coastal sediment dynamics  
• no long-term contamination outside of Development area. | Stressor | Const. and Comm. | Operations | Non-routine |
|                      |           |                                           |                         |        | L – M         | L           | –           |
|                      |           |                                           |                         |        | –             | L           | –           |
|                      |           |                                           |                         |        | L             | L           | –           |
|                      |           |                                           |                         |        | L             | L           | –           |

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|                      |           |                                           |                         |        | L – M         | L           | –           |
|                      |           |                                           |                         |        | –             | L           | –           |
|                      |           |                                           |                         |        | L             | L           | –           |
|                      |           |                                           |                         |        | L             | L           | –           |

- Compliance with EPA guidance statement for BPPH disturbance.
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• no long-term contamination outside of Development area. | Stressor | Const. and Comm. | Operations | Non-routine |
|                      |           |                                           |                         |        | L – M         | L           | –           |
|                      |           |                                           |                         |        | –             | L           | –           |
|                      |           |                                           |                         |        | L             | L           | –           |
|                      |           |                                           |                         |        | L             | L           | –           |

- Compliance with EPA guidance statement for BPPH disturbance.
- No detectable long-term change in longshore coastal sediment dynamics.
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</tr>
</thead>
</table>
| Water Quality        | To maintain the quality of water so that existing and potential environmental values, including ecosystem function, are protected. | • localised decline in marine water quality  
• increases in localised turbidity  
• localised copper or tributyltin (TBT) pollution from vessel anti-fouling leachate.  
• localised pollution of the water column from minor spill  
• more widespread pollution from spill >10 m³. | • develop drilling Environment Plan  
• comply with MARPOL 73/78 Annex IV requirements  
• develop Waste Management Plan  
• design equipment to include built-in safeguards  
• develop protocols for transfer of fuel from support vessels  
• apply industry standards for storage and handling of fuels and chemicals (e.g. bunding)  
• develop and implement approved OSCP and emergency response and spill contingency planning. | • no long-term contamination outside of Development area. | Stressor | Const. and Comm. | Operations | Non-routine |
|                      |           |                                            |                         |        | L | L | – | – |
|                      |           |                                            |                         |        | L | L | – | – |
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</tr>
</thead>
</table>
| Foreshore            | To maintain the integrity and stability of beaches.                       | • soil compaction  
• erosion  
• changes in the foreshore profile  
• localised change in seabed profile  
• localised, minor change in longshore coastal sediment dynamics  
• localised surge in water level due to entrapment by causeway.                                                                 | • limit clearing and earthworks  
• install erosion and sediment control structures  
• re-instate pipeline shore crossings to a level consistent with surrounding terrain  
• assess potential for acid sulphate soils on the mainland  
• implement revegetation/rehabilitation plan for shore crossing sites  
• conduct numerical modelling of coastal processes and longshore coastal sediment transport dynamics adjacent to proposed causeway  
• orientate causeway to minimise impact on wave refraction patterns  
• monitoring of beach alignment either side of Town Point.                                                                 | • foreshore profiles re-instated  
• no detectable long-term change in longshore coastal sediment dynamics.                                                                 | • Physical disturbance.  
• Physical presence.                                                                 | Const. and Comm. | Operations | Non-routine |
|                      |                                                                          |                                                                                                                                 |                                                                                                                                                                                                                         |                                                       | M                              | L                          | –                          |
|                      |                                                                          |                                                                                                                                 |                                                                                                                                                                                                                         |                                                       | –                              | L                          | –                          |
### Table 11-3: Summary of Risk Assessment for Marine Environmental Factors

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<tr>
<th>Environmental Factor</th>
<th>Objective</th>
<th>Potential Environmental Impact/Consequences</th>
<th>Key Management Measures</th>
<th>Target</th>
<th>Residual Risk</th>
</tr>
</thead>
</table>
| Benthic Primary Producers (Marine Flora and Corals) and Habitats | To maintain the ecological function, abundance, species diversity and geographic distribution of mangrove, coral, seagrass and other benthic primary producer communities and their habitats. | • loss and/or disturbance to marine flora and coral communities  
• loss on mangroves along domestic pipeline route on mainland  
• enhanced growth of macroalgae and corals on causeway and jetty. | • identify regionally significant marine habitats and communities and avoid  
• reduce dredge requirements to minimum practicable  
• locate marine infrastructure to avoid sensitive habitats  
• conduct benthic primary producer habitat assessment in accordance with EPA guidance 29  
• consult EPA Guidance Statement No.1 for arid zone mangrove protection for mangroves of special significance (EPA 2001)  
• use HDD or tunnelling in favour of trenching at feed gas pipelines shore crossing  
• design and operate of east coast dredging in accordance with requirements of the Environment Protection (Sea Dumping) Act 1981  
• develop and implement Dredging Management and Monitoring Plan  
• develop appropriate erosion control methods for the mainland section of the domestic gas pipeline. | • significant habitats and sensitive areas mapped and avoided.  
• heavy metal limits not exceeded  
• risks associated with trenching eliminated  
• requirements of Environment Protection (Sea Dumping) Act 1981 recorded and met  
• alternative locations within the spoil sites and dredge areas used when trigger values exceeded  
• incidents reduced and/or avoided  
• fuels, chemicals and hazardous materials transported and stored safely  
• spill management efficient and effective  
• corrosion monitored and managed  
• longshore sediment transport processes maintained. | Stressor | Const. and Comm. | Operations | Non-routine |
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</tbody>
</table>
Residual Risk

Marine Fauna To maintain the abundance, species diversity, geographic distribution and ecological functions of marine faunal communities.

To ensure that any impacts on locally significant marine communities are avoided, minimised and/or mitigated.

To protect EPBC Act-listed threatened and migratory species.

To protect Specially Protected (Threatened) Fauna consistent with the provisions of the Wildlife Conservation Act.

- loss of, or disturbance to (e.g. changes in behavioural patterns), marine fauna
- vessel collision with listed marine fauna resulting in injury or mortality
- loss of modification to habitats (e.g. turtle beaches)
- creation of 'artificial' habitat associated with subsea facilities.

- develop Environment Plans for marine activities
- schedule activities to reduce impacts to marine fauna
- educate workforce and visitors and enforce rules on interaction/interference with fauna
- control and restrict access to beaches and intertidal reefs
- restrict vessel speed and access
- use turtle deflection devices on the dredge barge, if required
- relocation of turtles, if required
- set gas processing facility and flare back from coast shielded by coastal dunes
- design gas processing facility so that no permanent 24-hour lighting is located within 500 m of turtle nesting beaches
- design lighting in accordance with tiered lighting strategy
- establish a turtle tagging and monitoring program
- presence of marine monitors during all relevant marine construction activities.

- no long-term impacts to significant marine communities
- long-term viability of listed fauna species maintained
- adherence to Environment Plan
- no breach of environmental licence conditions
- implementation of anchor management plan
- adherence to workforce rules regarding interaction with flora and fauna
- no contamination outside of immediate Development area
- no light sources directly visible from nesting beaches
- no permanent 24-hour gas processing facility lighting located within 500 m of nesting beaches

- Seabed disturbance.
- Physical interaction.
- Physical presence.
- Wastewater discharges.
- Light.
- Noise and vibration.
- Leaks or spills (minor <10 m³).
- Leaks or spills (>10 m³).

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<tr>
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<th>Key Management Measures</th>
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<td>Marine Fauna</td>
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<td>• loss of, or disturbance to (e.g. changes in behavioural patterns), marine fauna • vessel collision with listed marine fauna resulting in injury or mortality • loss of modification to habitats (e.g. turtle beaches) • creation of 'artificial' habitat associated with subsea facilities.</td>
<td>• develop Environment Plans for marine activities • schedule activities to reduce impacts to marine fauna • educate workforce and visitors and enforce rules on interaction/interference with fauna • control and restrict access to beaches and intertidal reefs • restrict vessel speed and access • use turtle deflection devices on the dredge barge, if required • relocation of turtles, if required • set gas processing facility and flare back from coast shielded by coastal dunes • design gas processing facility so that no permanent 24-hour lighting is located within 500 m of turtle nesting beaches • design lighting in accordance with tiered lighting strategy • establish a turtle tagging and monitoring program • presence of marine monitors during all relevant marine construction activities.</td>
<td>• no long-term impacts to significant marine communities • long-term viability of listed fauna species maintained • adherence to Environment Plan • no breach of environmental licence conditions • implementation of anchor management plan • adherence to workforce rules regarding interaction with flora and fauna • no contamination outside of immediate Development area • no light sources directly visible from nesting beaches • no permanent 24-hour gas processing facility lighting located within 500 m of nesting beaches</td>
<td>Stressor</td>
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<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine Fauna (continued)</td>
<td></td>
<td></td>
<td>• compliance with tiered lighting strategy</td>
<td></td>
<td>Non-routine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• adherence to no routine flaring policy</td>
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<td></td>
<td></td>
<td></td>
<td>• no blasting outside of daylight hours.</td>
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<thead>
<tr>
<th>Stressor</th>
<th>Const. and Comm.</th>
<th>Operations</th>
<th>Non-routine</th>
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12 Quarantine – Risks and Management

12.1 Introduction
Quarantine management of Barrow Island has been instrumental in protecting the unique conservation values of the Barrow Island Class A Nature Reserve. It has formed a core component of the environmental management of Barrow Island since oilfield operations began in the 1960s, and has been effective in preventing the establishment of organisms which do not naturally occur on the island.

Quarantine management involves the application of barriers which are designed to prevent the introduction of non-indigenous species beyond a designated border. Such barriers may be applied in sequence over an entire transport pathway, and in the Barrow Island case extend from mainland supply depots, transport containers and vehicles, and ultimately upon arrival at Barrow Island. Quarantine activities also extend beyond the Barrow Island border to include monitoring and response to any non-indigenous species which may potentially breach quarantine barriers.

Quarantine will form a critical component of the environmental protection regime for the proposed Gorgon Development because the construction and operation of a gas processing facility on Barrow Island will result in a substantial increase in activity. Consequently, this will increase the potential for the introduction of non-indigenous species. Such an introduction could lead to irreversible and detrimental impacts to the ecological composition and function of the island’s ecosystem through increased competition for resources, direct predation, or habitat modification.

To protect the conservation values of Barrow Island from the impacts of non-indigenous species, the Joint Venturers have developed a risk-based Quarantine Management System. The primary focus of this system is to prevent the introduction of non-indigenous species to Barrow Island and the surrounding marine environment. Further levels of protection will be provided through detection and response strategies which will prevent the establishment of any non-indigenous species in the native environment.

12.2 Quarantine Management Objectives
The quarantine management objective for the proposed Gorgon Development is to protect the conservation values of the Nature Reserve and simultaneously facilitate the construction and operation of a gas processing facility on Barrow Island. To support this objective, the Joint Venturers have developed a ‘Barrow Island Quarantine Policy’ (Box 12-1).

This policy also forms a core element of the Quarantine Management System (QMS) which is discussed in Section 12.5).

To achieve the quarantine objective, the Joint Venturers have developed a risk-based approach to quarantine management based upon the advice of the Environmental Protection Authority (EPA 2003).
Box 12-1:
Barrow Island Quarantine Policy

Barrow Island Quarantine Policy

Chevron Australia Pty Ltd, the operator of the Barrow Island oilfield and the proposed Gorgon gas facility, is proud of its environmental reputation and performance on Barrow Island. As operator of both oil and gas ventures, Chevron will continue to hold overall management responsibility for operational activities on the island, and for operating in a manner that protects the conservation values of the Barrow Island Nature Reserve and the surrounding waters.

Central to this responsibility is our goal to prevent the establishment of introduced species on Barrow Island and in the surrounding waters. This will be achieved through the implementation of a Quarantine Management System that delivers world class performance and integrates quarantine management into business planning and operational processes.

Chevron will:

- Not compromise quarantine requirements;
- Identify and manage quarantine risks arising from our operation, with the objective of preventing the introduction and establishment of species to Barrow Island;
- Develop and maintain a positive quarantine culture in our staff, contractors and suppliers;
- Engage only contractors and suppliers who have demonstrated a willingness to meet or exceed our quarantine standards;
- Maintain a system of continuous improvement in our management of quarantine;
- Meet or exceed all legal requirements, be a responsible corporate citizen and demonstrate leadership in quarantine management;
- Provide the appropriate training to support the implementation and ongoing operation of the quarantine programmes;
- Set measurable quarantine targets and performance objectives;
- Ensure conformity with this policy by a comprehensive compliance program including audits;
- Have an open and transparent quarantine process that includes stakeholder engagement and reporting;
- Recognise and address government and community concerns on quarantine; and
- Respond quickly and effectively to any quarantine emergency with the potential to impact the biodiversity of the area.

Chevron will commit the necessary resources to ensure the effectiveness of this policy.

This policy, its intent and each person’s responsibility will be communicated to employees, contractors, subcontractors and visitors. All are required to comply with the processes, procedures and systems of work developed in accordance with this policy.

This policy applies to all activities on Barrow Island and in the surrounding waters.

Signed

James W Johnson – Managing Director
Chevron Australia Pty Ltd
August 2005
12.3 Approach to Quarantine Management
The approach adopted by the Joint Venturers is consistent with the advice of the EPA, and specifically includes the establishment of a Quarantine Expert Panel, extensive community involvement, investigation of quarantine best practices, and the development of standards for acceptable risk.

12.3.1 Quarantine Expert Panel
The Joint Venturers established the Quarantine Expert Panel (QEP) to obtain the best possible advice to guide the development of quarantine management for the Gorgon Development. Experts invited to participate represented a broad cross-section of expertise including conservation, ecology, biosecurity and risk management. The QEP was chaired by Bernard Bowen, and its 10 members were affiliated with a range of government departments, scientific institutions, non-government organisations and private consultancies. Advice provided by the QEP guided the development of the Gorgon Risk-Based Method (Section 12.4), and the development of a set of standards for acceptable risk (Section 12.4.1).

12.3.2 Community Involvement
The Joint Venturers initiated extensive community involvement in the development of quarantine management options for Barrow Island. This specifically involved four Community Consultation Meetings and four technical workshops. The technical workshops specifically addressed the development of risk standards, the design of a Quarantine Management System, and the level of detail required in quarantine barrier design. Most importantly, community members were prominent in the development of risk standards. This is reflected in a formal report tabled at the Community Consultation Meeting of 16th June 2004, which was also forwarded to the EPA and the Joint Venturers. In this report the community expressed the view that the risk of establishment of introduced species would be acceptably low if it conforms to the risk standards developed at these workshops (Section 12.4.1).

12.3.3 Best Practice Benchmarking
The Joint Venturers commissioned a study to establish quarantine best practice for the protection of conservation values of nature reserves. The study revealed the existence of few such quarantine programs, and highlighted the relevance of current quarantine practices on Barrow Island which attend to a dual commercial and conservation imperative.

12.3.4 Baseline Data
In order to determine a credible baseline dataset of species presence on Barrow Island, the Joint Venturers have engaged in a number of activities, including preparation of a report into baseline studies and data gaps. On the basis of expert advice, the Joint Venturers have initiated invertebrate baseline field surveys on Barrow Island, a preliminary marine monitoring and detection program, and have initiated further assessment of the extensive array of terrestrial flora and fauna data collected on Barrow Island to date. Baseline information collated as a result of these activities will provide a vital reference dataset which will be used to assess the effectiveness of quarantine efforts associated with the Gorgon Development.

12.4 Quarantine Risk Assessment Method
The centrepiece of the Joint Venturers’ approach to quarantine management is the development of the Gorgon Risk-based Quarantine Assessment Method. This method has been adapted from accepted risk assessment approaches with critical input from the QEP, the community, and independent technical experts. The risk assessment method is a pathway-driven means that requires identification of quarantine threats, and the development of specific quarantine barriers to reduce the likelihood of introduction of non-indigenous species to Barrow Island.

In view of the difficulty of predicting the ecological outcomes of the introduction of any type of non-indigenous species, this risk assessment does not attempt to estimate the likelihood of ecological consequences of an introduction. To that end, the Joint Venturers have adopted a precautionary approach which focuses on the prevention of the introduction of any non-indigenous species in the first instance. Qualitative estimates of quarantine risk are therefore made on the basis of introduction, and to a lesser extent likelihood of survival, detection, and eradication for a range of biological groupings. This is an interactive process that involves input from independent ecological experts in risk assessment workshops. Seventeen such workshops have been conducted to date, and have focused on 3 pathways under priority consideration, those being: i) sand and aggregate, ii) food and perishables, and iii) personnel and accompanying luggage. Assessments of the remaining pathways will be undertaken as the necessary technical advice and design detail becomes available.
12.4.1 Implementation of Risk Standards

The Joint Venturers propose to meet the standards for acceptable risk by implementing selected arrays of quarantine barriers along pathways of entry to Barrow Island. Three priority pathways were chosen to demonstrate the application of such barriers, those pathways being:

1. Sand and aggregate
2. Food and perishables
3. Personnel and accompanying luggage.

These priority pathways are considered to represent the greatest range of threats of introduction of non-indigenous species and are characteristic of early Development activities during site establishment and construction.

Selection of conceptual quarantine barriers for subsequent assessment in Quarantine Hazard (QHAZ) workshops involves consideration of proposed barriers in two phases: i) initial assessment of the feasibility of each barrier, and ii) consideration of...
Health, Environment and Safety (HES) and Human Resource (HR) issues. The outcomes of this process provides detailed quarantine barrier specifications for each pathway which are subject to QHAZ assessment to ensure barrier function is satisfactory and that risk standards can be met. To date, information gathered in risk assessment workshops has enabled the Joint Venturers to demonstrate that the risk standards can be met with a very high level of confidence.

The Joint Venturers have established an ongoing process of analyses of the proposed quarantine barriers, and have committed to publishing the outcomes of QHAZ workshops for the three priority pathways. This will take the form of a package of additional information to this Draft EIS/ERMP (refer to Section 4). This report will provide more detailed information and justification on the barriers selected by the Joint Venturers to reduce the quarantine risks. The Joint Venturers will also conduct a further Barrow Island Quarantine Community Consultation Meeting subsequent to the release of the Additional Information Package.

Prior to completion of the QHAZ step, however, the Joint Venturers have committed to the implementation of a number of quarantine barriers common to all pathways, and some initial barriers specific to the three priority pathways. Additional barriers will be implemented subject to the outcomes of the QHAZ assessment workshops. An outline of barrier commitments to date is provided below.

12.4.2 Systematic Barriers
The Joint Venturers commit to the following systematic quarantine barriers that are common to all pathways:

- Inclusion of quarantine requirements in pre-qualification of suppliers and contractors.
- Inclusion of quarantine requirements in contracts for all contractors and suppliers providing goods and services for Barrow Island.
- Induction of all personnel (staff, contractors, and suppliers) in quarantine management requirements.
- Provision of specific quarantine training to personnel in the procurement and logistics supply chain.
- Inclusion of quarantine responsibilities in the position description for key personnel.
- Development and support of a strong culture of quarantine awareness in the workforce.
- Recording and tracking of quarantine compliance for all personnel and goods going to Barrow Island.
- Conduct of regular quarantine compliance audits and checks throughout the supply chain.

12.4.3 Sand and Aggregate Barriers
The Joint Venturers commit to the following key barriers for the sand and aggregate pathway:

- Implement a Quarry Environmental Management Plan.
- Clean and inspect quarry equipment.
- Cover material in segregated storage.
- Sample material to verify compliance.
- Cover during sea transport.

It can be demonstrated through the application of risk estimates for all barriers at each step in the sand and aggregate pathway that the residual quarantine risk may be reduced to ‘remote, unlikely’. Further development of quarantine measures at the Barrow Island border in the design phase, and post-border monitoring and eradication strategies, will provide additional levels of risk reduction and provide confidence that the standards for acceptable risk will be met.

12.4.4 Food and Perishables Barriers
The Joint Venturers commit to the following key barriers for the food and perishables pathway:

- Manage receipt, screening, consolidation, despatch from a central facility.
- Pre-process fresh food and vegetables prior to despatch.
- Select packaging to allow visual inspection; reduce organic packaging.
- Inspect, seal and tag shipping containers.
- Prohibit nominated food and perishable items from transport to Barrow Island.
- Design kitchen facility with internal quarantine zones and barriers to contain and eradicate non-indigenous species.
- Implement a dedicated food and packaging waste containment and removal program.

It can be demonstrated through the application of risk estimates for all barriers at each step in the food and perishables pathway that the residual quarantine risk may be reduced to ‘remote, unlikely’. Further development of pre-border quarantine barriers, and the design of Barrow Island border protection measures and post-border monitoring and eradication strategies will provide additional levels of risk reduction and provide confidence that the standards for acceptable risk will be met.
12.4.5 Personnel and Accompanying Luggage Barriers

The Joint Venturers commit to the following barriers for the personnel and accompanying luggage pathway:

- Establish pre-employment agreements, including awareness training and inductions to appreciate quarantine risks and barriers which carry personal responsibilities.
- Inspect all luggage via x-ray or visual by trained inspectors.
- Declaration of quarantine compliance for personal luggage.
- Cleaning of aircraft to meet quarantine standards.
- Shipment of toolboxes and work cargoes not accepted as checked luggage and processed through mainland logistics base.
- Confinement of transit passengers, luggage and freight to a secure area at Barrow Island airport.
- Implementation of a management plan for flights departing from locations other than Perth.
- Verification of personnel, luggage and freight on arrival.

It can be demonstrated through the application of risk estimates for all barriers at each step in the personnel and luggage pathway, that the residual quarantine risk may be reduced to ‘extremely, remote, highly unlikely’ which is consistent with the standards for acceptable risk.

An assessment of quarantine threats posed by rodents on marine vessels has also progressed to the pre-QHAZ stage of the risk-based method. Preliminary risk estimates suggest that the application of barriers such as inspection and fumigation of cargoes will reduce the risk of introduction to an acceptable level.

12.5 Quarantine Management System

Quarantine management will be implemented, updated, and monitored through a Quarantine Management System (QMS) which is currently under development. The QMS is modelled upon the principles of AS/NZS ISO 14001:1996, Environmental Management Systems – Specification with Guidance for Use (ISO 14001). The QMS is intended to embed quarantine practices in a consistent and integrated manner into all facets of operations.

The Joint Venturers are confident that implementation of quarantine barriers and practices through the Quarantine Management System will deliver new performance benchmarks for quarantine management, and provide an unprecedented level of quarantine protection for the conservation values of Barrow Island.
The Gorgon Joint Venturers recognise and share the concern of the community, industry and government regarding the potential for global climate change. In response, the Joint Venturers have integrated these concerns into their business decisions. This commitment to responsible management of greenhouse gas emissions is reflected in the adoption of the Gorgon Gas Development Greenhouse Gas Management Strategy. The commitments contained in this Strategy have been used to guide planning for the proposed Development and will continue to provide a framework for future engineering decisions and the ongoing management of greenhouse gas emissions.

Integration of the Gorgon Development Greenhouse Gas Management Strategy into the gas processing facility design has resulted in the adoption of greenhouse gas efficient practices such as waste heat recovery and the proposal to inject the CO₂ contained in the reservoir gas stream. These actions represent a commitment to reduce emissions of greenhouse gases that exceed those of other LNG producers.

13.1 Alternative Greenhouse Gas Abatement Options

The Gorgon Joint Venturers have undertaken a range of studies into potential greenhouse gas reduction or offset opportunities that could be used to reduce the emissions from any proposed development of the Greater Gorgon gas fields. The options assessed include:

- investing in commercial forestry
- assisting in revegetation or land rehabilitation plantings
- facilitating reduced land clearing
- undertaking the disposal of reservoir CO₂ by injection into the subsurface
- assisting other industries to switch to alternative fuels (e.g. from coal to gas)
- facilitating the use of compressed natural gas (CNG) as vehicle fuel
- providing support for renewable energy technologies (wind, solar, biomass)
- promoting the sale of CO₂ as a feed stock to another company or industry
- market-based options.
Based on this analysis, the Gorgon Joint Venturers have elected to reduce the Development’s greenhouse gas emission by the disposal of reservoir CO₂ by injection into the Dupuy Formation, 2000 m below Barrow Island.

13.2 Greenhouse Gas Emissions Efficiency Improvements

Early design concepts for the development of the Gorgon field included a gas processing platform located offshore in proximity to the gas field with an LNG processing facility on the Burrup Peninsula. Subsequent engineering decisions that have resulted in significant improvements in greenhouse gas emissions efficiency compared to this early design include:

- replacement of the offshore gas processing platform with an all subsea development
- changes in LNG process technology
- improved waste heat recovery on the gas turbines resulting in a significant reduction in the use of supplementary boilers and heaters
- significantly reduced greenhouse gas emissions resulting from the injection of reservoir CO₂ into the subsurface.

The contribution to improved greenhouse gas emissions efficiency from each of these areas expressed in tonnes of CO₂e per tonne LNG produced is shown graphically in Figure 13-1.

13.3 Emissions from Operations

The estimated annual greenhouse gas emissions from the proposed Development are 4.0 million tonnes of CO₂e (MTPA CO₂e). Table 13-1 documents the estimated emissions from the LNG and domestic gas components of the facility and the estimated emissions resulting in the provision of support infrastructure and logistics to Barrow Island.

Ongoing engineering and design work and the actions contained in the Greenhouse Gas Management Plan may reduce these estimated greenhouse gas emissions by a further 660 000 MTPA CO₂e.

Figure 13-1: Greenhouse Emissions Efficiency Improvements
13.4 Benchmarked Greenhouse Gas Emissions Performance

Figure 13-2 shows the greenhouse efficiency of the Gorgon Development compared with data from the:

- North West Shelf Project
- Darwin LNG Project (under construction)
- Snohvit – Hammerfest, Norway (under construction)
- Oman LNG – Qalhat, Oman
- Nigeria LNG – Bonny Island, Nigeria
- RasGas – Ras Laffan, Qatar
- Qatargas – Ras Laffan, Qatar
- Atlantic LNG – Point Fortin, Trinidad and Tobago.

This benchmarking analysis shows that the Gorgon Development will be amongst the most greenhouse efficient LNG developments in the world, particularly when emissions related to the initial gas production are considered. Based on this data, only Oman LNG and Snohvit have appreciably better LNG greenhouse gas efficiency. If the data for the proposed Gorgon Development is normalised, taking into account the operating conditions under which Oman and Snohvit operate, the underlying gas processing facility efficiency is similar across the three projects.

Table 13-1: Predicted Annual Greenhouse Gas Emissions from the Gorgon Development

<table>
<thead>
<tr>
<th>Emissions Source</th>
<th>LNG Processing</th>
<th>Domestic Gas Processing</th>
<th>Island Infrastructure Support</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TPA CO₂e</td>
<td>TPA CO₂e</td>
<td>TPA CO₂e</td>
</tr>
<tr>
<td>Gas Turbine – Gas Processing</td>
<td>1 612 000</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Drivers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Turbine – Power Generation</td>
<td>1 287 000</td>
<td>200 000</td>
<td>60 000</td>
</tr>
<tr>
<td>Fired Heaters</td>
<td>71 000</td>
<td>28 000</td>
<td>Nil</td>
</tr>
<tr>
<td>Flare – Events</td>
<td>60 000</td>
<td>Minor</td>
<td>Nil</td>
</tr>
<tr>
<td>Flare – Pilots</td>
<td>2 000</td>
<td>Minor</td>
<td>Nil</td>
</tr>
<tr>
<td>Fugitive Emissions</td>
<td>Less than 1 000</td>
<td>Less than 1 000</td>
<td>Nil</td>
</tr>
<tr>
<td>Transport</td>
<td>Nil</td>
<td>Nil</td>
<td>10 000</td>
</tr>
<tr>
<td>Diesel Engines</td>
<td>Less than 300</td>
<td>Minor</td>
<td>Minor</td>
</tr>
<tr>
<td>Reservoir CO₂ Vented</td>
<td>500 000</td>
<td>180 000</td>
<td>Minor</td>
</tr>
<tr>
<td>Total</td>
<td>3 534 000</td>
<td>409 000</td>
<td>70 000</td>
</tr>
</tbody>
</table>

Reference Case Assumptions:

- LNG production is sourced equally from the Gorgon and Jansz fields.
- Domestic gas production is sourced from the Gorgon Field.
- Based on 8160 hours (340 days) plant operation per year.
- All power generation gas turbines (including spare) are operated at part load, resulting in an additional 65 000 tonnes per year of emissions over case where spare is on cold standby and online turbines are operated at maximum efficiency.
- 20% of reservoir CO₂ (0.68 MTPA) is vented rather than injected into the Dupuy Formation.
- Reservoir CO₂ vented is allocated between LNG and domestic gas production in proportion to throughput from the Gorgon gas field.
- Waste heat recovery is applied to LNG process drive gas turbines and hot oil used as the waste heat recovery medium.
13.5 Disposal of Reservoir Carbon Dioxide by Injection into the Dupuy Formation

A thorough review of potential CO2 injection locations has been conducted and has determined that the Dupuy Formation, accessed from the eastern side of Barrow Island, is the preferred location for this activity. Appropriate monitoring of the injected CO2 is planned to assist with the ongoing management of the CO2 injection operations. The proposed injection of the reservoir CO2 will reduce greenhouse gas emissions attributable to the proposed Development (including domestic gas production) from 6.7 million tonnes per annum of CO2 equivalent (MTPA CO2e) to 4.0 MTPA CO2e.

The opportunity to reduce greenhouse emissions by the subsurface injection of CO2 is relatively new; however the technologies to be applied by the Gorgon Joint Venturers are well established in the oil and gas industry and are being used to inject CO2 in other parts of the world.

Modelling by the Gorgon Joint Venturers shows that during the operational phase, the CO2 will initially move out from the injection well bore as a discrete plume, driven by the injection pressure. As the plume moves further away from the injector well, the injection pressure will dissipate and the rate of migration will slow. At this point, the CO2 plume will migrate under buoyancy forces where the migration path is determined by the dip and heterogeneity of the reservoir. As the CO2 migrates during the injection phase, a portion of the injected CO2 will become trapped in the formation by the solution and residual gas trapping mechanism.

Once injection ceases, the injection pressures will rapidly dissipate and the buoyancy contrast between the CO2 and the formation water will be the driving force for migration of the remaining CO2. As a result, the rate of lateral CO2 migration will dramatically reduce and the CO2 will tend to migrate upwards with vertical movement being restricted by the baffles and barriers in the system. The rate of migration will be determined by the tortuosity of the formation with a large proportion of the CO2 plume anticipated to be trapped by residual gas trapping in the low permeability layers in the upper Dupuy Formation. Figure 13-3 shows the migration of the CO2 plume through the Dupuy Formation over the injection period and for the next 1000 years.
Figure 13-3:
Reservoir Simulation Based on the Preferred Injection Scenario and Showing the Extent of the CO₂ Plume Over 1000 Years
The Gorgon Joint Venturers continue to study the most appropriate techniques to monitor the injected CO₂. It is likely that these activities will evolve as the behaviour of the CO₂ in the subsurface is verified and as existing technologies improve and new technologies become available. Monitoring activities are planned around:

- routine observation and recording of injection rates and surface pressures
- health, environment and safety oriented surveillance to detect surface leaks before they can pose a risk to personnel or the environment
- verification via seismic surveys and/or observation wells of the CO₂ plume migration in the subsurface.

### 13.5.1 Carbon Dioxide Injection Operations Management Plan

Oil and gas field operations are often managed through a Reservoir Management Plan or an Operations Management Plan, which outlines how a field will be developed. The Gorgon Joint Venturers propose to adopt this process to assist in the management of the CO₂ injection operations. The primary objective of the CO₂ Injection Operations Management Plan will be to maximise the volume of reservoir CO₂ injected whilst ensuring that injection does not pose a health or safety risk to people, an environmental risk to the conservation values of Barrow Island, or a risk to other assets such as oil or gas field operations around Barrow Island.

Responses to the unpredicted migration of CO₂, the avoidance of unacceptably high formation pressures, and ensuring that existing well penetrations are appropriately managed, are critical to the overall environmental and safety performance of the CO₂ injection operations. Management actions to ensure effective performance in these areas have been developed.

### 13.5.2 Potential Failure Modes Related to Carbon Dioxide Injection

The Gorgon Joint Venturers have undertaken a study to identify potential risks associated with the proposed injection of CO₂ into the Dupuy Formation. This study commenced with a Failure Mode and Effects Workshop conducted in accordance with the principles and guidelines contained in AS/NZS 4360 (2004) for risk management and AS/NZS 3931 (1998) for risk analysis of technological systems.

The objective of the workshop was to identify credible threats of failure of the proposed injection project, either through a failure in the injection facilities or a failure which might result in the loss of containment in the target reservoirs.

The probability of CO₂ migrating to the surface has been determined to be remote with potential environmental consequences limited to localised impacts on flora and possible detrimental impacts on subterranean fauna.

### 13.6 Greenhouse Gas Management Plan

The Gorgon Joint Venturers have developed a Greenhouse Gas Management Plan as a tool to further reduce greenhouse gas emissions from the proposed Gorgon Development. The Greenhouse Management Plan documents:

- the Gorgon Joint Venturers’ participation in a range of government programs aimed at reducing greenhouse gas emissions, including the reporting of greenhouse gas emissions and reduction efforts under those programs
- performance indicators and the establishment of longer-term performance targets for those indicators
- planned actions to be taken by the Gorgon Joint Venturers to minimise greenhouse gas emissions from the Gorgon Development with the objective of meeting the set performance targets.
Both positive benefits and negative social risks will be created by the Gorgon Development. The Development will generally benefit the livelihoods and lifestyles for the Pilbara community through employment and local business opportunities. There is a strong linkage between the social and economic benefits of the proposed Development. Major benefits include increased employment and training initiatives and opportunities for increased participation by Indigenous people. Potential adverse social risks are mainly associated with cultural heritage, native title issues on the mainland, and workforce and family through implementation of a fly-in fly-out (FIFO) regime.

14.1 Government Policy and Plans
There are a wide range of social and economic plans designed to provide policy and guidance to local, regional, state and federal governments. The Gorgon Development will have implications for a number of these plans.

At the local level, Town Planning Schemes and Structure Plans provide guidance for development on the near and onshore areas of the Australian mainland. The applicability of the Shire of Ashburton Town Planning Scheme No. 7 to the Gorgon Development is currently being determined. The key regional plans for the Pilbara are the Pilbara Land Use Strategy and the Pilbara Regional Priority Plan. The former presents a strategic 25-year plan for the Pilbara and identifies broad objectives for the land use and development.

The key state legislation, policies and plans that have implications for the social impact issues are the Barrow Island Act 2003 and State Agreement (see Section 2), the Western Australian Sustainability Strategy, and the State Planning Strategy and Regional Development Policy.

The potential socio-economic impacts (risks and benefits) of the Gorgon Development to the various federal government policy and plans include: perceived reduction in potential opportunities for industrial development in the Pilbara region as a consequence of development on Barrow Island; use of a FIFO workforce with potential loss of opportunities for local personnel; opportunities for increasing participation of local Indigenous workforce by supplementing education and training; and the transfer of knowledge and technology.

14.2 Local Communities
The Gorgon Development will result in minor population changes in the Pilbara and Western Australia. The most significant changes would occur in Dampier/Karratha area should the Development require the construction of a supply base. The construction workforce of 130–140 workers for a potential new supply base may generate a short-term (40-month) demand for the services such as health, welfare, emergency response, transport and other services.

The significant majority of the Development workforce will be located on Barrow Island and will generate limited demand for social infrastructure in the Pilbara
region or Perth. This situation would be substantially different if the Development were located on the mainland, as demand impacts on social infrastructure would be increased.

During operation, the population increase (if any) will be insignificant, and will have no major or serious impact on the local communities or social infrastructure. The residual risk for local communities is low.

14.3 Livelihoods and Lifestyle
Major resource projects have contributed significantly to the social, economic and cultural setting in the Pilbara region. It is unlikely that the Gorgon Development will change the way of life for a construction workforce which historically is engaged in FIFO employment in the resources sector. While there may be potential impacts, or specific Gorgon Development issues, it is expected that these differences will be managed through employee relations, employment sourcing and workforce health and safety systems. Some of these issues include: employment opportunities of the existing workforce; the staffing levels during construction and operations; the work schedules during construction and operation; recreation facilities and future access to Barrow Island.

A number of plans to identify and enhance the social opportunities are being developed. The Gorgon Development Australian Industry Participation Policy (AIPP) outlines the approach to local content and procurement. This Policy specifies a commitment to provide full, fair and reasonable opportunity for Australian industry to supply goods and services to the Development. In accordance with the Barrow Island Act, a Social Impact Management Plan (SIMP) is being developed in close consultation with Western Australian government agencies to enhance social opportunities. The SIMP is being prepared during the proposal stage of the Development and will be subject to Ministerial approval, but is separate from the EIS/ERMP process. At the local level, the Joint Venturers will continue to work through community groups in the region to ensure potential impacts are identified, managed and activities in the region are coordinated.

14.4 Land and Sea Use and Tenure
The Gorgon Development will not change the Class A Nature Reserve designation and tenure of Barrow Island which will remain with the state.

The water surrounding Barrow Island is part of the area covered by the Montebello–Barrow Islands marine conservation reserves (CALM 2004). The majority of the conservation area is zoned as a Marine Management Area, which is recognised for both commercial and conservation values. The Barrow Island Marine Park and Bandicoot Bay conservation area (benthic fauna/seabird protection) will provide additional protection for Biggada Reef and Bandicoot Bay. A large area off the east coast of Barrow Island is currently a designated port (refer to Figure 8-1).

The existing oil operations on Barrow Island will not be physically impacted by the Development in a substantial way as most of the infrastructure (pipelines) and gas processing is proposed to be located north and east of the existing oil field; and is not competing for similar hydrocarbon resources. It is expected that there will be synergies between the oil operations and the proposed Gorgon Development.

Should the domestic gas pipeline tie-in with the existing Bunbury to Dampier pipeline at Compressor Station 1, an easement over Crown lands located on the Australian mainland will be required. The pipeline will be located on Mardie Station, a rural pastoral lease area.

The waters off the Pilbara Coast are used extensively for oil and gas development with the entire proposed Development area covered by leases/licences granted under the Petroleum (Submerged Lands) Act 1967. The stretch of water between Barrow Island and the mainland contains management areas and leases for other purposes, such as: commercial fisheries zones, native title claim areas (near-shore) and a mangrove management zone.

The Gorgon Development will not change the boundaries or underlying designation of the management areas or zones and the potential impact is considered low.
14.5 Native Title
There are no native title claims over Barrow Island or to north-west of Barrow Island over the Gorgon or Greater Gorgon gas fields. There are currently three registered native title claims that may overlap the proposed domestic gas pipeline route option and associated shore crossing onshore seas approach to the mainland. The Joint Venturers intend to engage in appropriate, good-faith negotiations with the indigenous communities. Constructive and inclusive dialogue will maximise the potential for positive impacts and resolve any potential issues.

14.6 Cultural Heritage
No ethnographic surveys have been undertaken on Barrow Island or the onshore domestic gas pipeline alignment. However, from earlier work conducted by Apache Energy, and their predecessor Hadson Energy Resources Corporation, two ethnographic sites associated with Peters Creek are known to be located adjacent to the Apache Energy export pipeline on the mainland, in the general vicinity of the proposed domestic gas pipeline route. A further detailed survey prior to commencement of construction will confirm whether these sites, or other potential sites, may be affected by the Development.

Only two of the 13 registered indigenous sites on Barrow Island were identified as being close to the Development area. Both of these sites were artefact scatters. Prior to construction, all proposed ground disturbance areas (including the seabed) will be surveyed for indigenous, historical and maritime cultural heritage evidence. Emphasis will be on areas of high site potential such as clay pans, shore lines, freshwater and drainage areas.

A draft Cultural Heritage Management Plan (CHMP) has been developed to assist in avoiding or minimising potential impacts during the construction and operation of the Gorgon Development. This plan will be refined further in the current phase of Development planning. Consultation with Aboriginal groups will continue throughout the Development phases and good-faith negotiations will be undertaken should an easement for the domestic gas pipeline be required.

Overall residual risk for cultural heritage will be low during site selection and design, medium during construction, and low during operations and decommissioning.

14.7 Historical and Maritime Heritage – Terrestrial
One known historical site (a glass artefact scatter) has been located at the alternative feed gas pipeline shore crossing at Flacourt Bay. There is the potential for additional sites to be identified, particularly in the coastal zone of Barrow Island which may include subsurface cultural material buried by cyclone and dune aggradation.

There is one known mainland historical site in the vicinity of the domestic gas pipeline route (the remains of a reported shipwreck close to the Apache pipeline). Potential exists for other similar sites to be present in the vicinity of the domestic gas pipeline route.

Detailed surveys for historical sites will be undertaken following finalisation of the footprint well in advance of any surface disturbance or construction. The residual risk from the Development to historical heritage sites is low to medium with the greatest risk occurring during construction.

14.8 Maritime Heritage – Subsea
No shipwreck sites have been identified or recorded in the immediate area of the proposed Gorgon Development. Review of underwater video surveillance, side-scan sonar and bathymetry surveys of the general pipeline routes, the pipeline shore approaches, materials offloading facility and LNG shipping channel and turning basin has not produced any evidence of maritime heritage sites.
14.9 Landscape and Aesthetics
A visual assessment of the proposed Gorgon Development was undertaken to evaluate the degree to which its components (subsea wells, pipelines, gas processing facility and marine infrastructure) would change the ‘seen’ or visual amenity of the existing landscape (Figure 14-1).

The residual risks during construction are medium and during operation low. The medium risk is derived from the fact that landscape values will definitely be impacted by the proposed Development. Overall, however the number of receptors is very low and the impact is of low consequence. Following decommissioning the site at Barrow Island will be rehabilitated and some of the landscape values can be returned.

14.10 Workforce and Public Health and Safety
Protection of the workforce health and safety during both construction and operations is important to the Joint Venturers. Utilising expert personnel and the Chevron Operational Excellence Management System (OEMS), the potential health and safety hazards and risks to Development personnel will be identified and assessed, then the subject of substantial planning, organisation and procedural/facility development.

Hazard and Operability (HAZOP) studies will be conducted for Development components. Hazard and risk workshops will be held with a wide range of professionals in relation to the construction, commissioning and operation phases of the Development facilities to identify all hazards and risks, assess those hazards and risks identified and develop controls to manage these hazards and risks.

14.11 Public Risk Assessment
The level of risk to the public for the all of the Gorgon Development facilities was determined to be acceptable given the surrounding land use and the number of physical and procedural controls incorporated into the pipeline design, construction and operation complying or exceeding the controls criteria as provided by Australian standards.

Compliance with Australian standards requires that risk from each identified threat be as low as reasonably practicable through all stages of design, construction, operation and decommissioning.

Plate 14-1:
Viewing Simulation Looking North on Ridgeline from Camp (approximately 4 km from gas processing facility site)
The economic benefits resulting from the proposed Gorgon Development will have national, state and regional dimensions. The proposed Development will contribute substantial, positive economic benefits to Australia and Western Australia, derived from the combination of: export income; tax and royalty revenue paid by the Joint Venturers; increased supply and competition in the domestic gas market; businesses and individuals employed; and the amount of money spent in the local economy.

Using two independent economic models, AE-MACRO and MMRF-GREEN, a number of major benefits to Australia and Western Australia’s economies were identified. At the national level some of the key benefits will include: approximately $17 billion in revenue from company tax and Petroleum Resources Rent Tax (PRRT); an increase in Gross Domestic Product (GDP) of approximately $3.6 billion by 2030 (depending on model and scenario used): and an increase of exports in excess of $2 billion per year (at today’s prices) during operation. At the state level, Western Australia’s economic welfare is expected to improve by approximately $4 billion, which is one-sixth of the total Australian economic welfare. Western Australia will also benefit from significant improvements to business investment and Gross State Product (GSP) (Figure 15-1).

In response to increased revenues and economic growth, governments may increase expenditures, and reduce the average personal income tax rate to keep the ratio of public debt to GDP from falling. In turn, such income tax reductions would stimulate further economic growth. This general growth will provide flow-on benefits for business, employment and government revenues. Western Australia and the Pilbara region will benefit from increased demand for goods and services that will further stimulate business development and employment opportunities. The proposed Development is predicted to generate and sustain over 6000 jobs on average through the decades of operation, with 1700 generated in Western Australia (Figure 15-2).

Currently, the regional economy of the Pilbara is not large enough to provide all of the labour, goods and services that will be required by the Development. With increased labour and service demand, there is a risk that regional prices for goods and services will increase. This impact may be compounded by the influence of other large resource project activity scheduled for the area. Both economic models examined the potential for crowding-out investment opportunity and predicted that the proposed Development will have limited impact on this opportunity.
Figure 15-1: Gorgon Development – Contribution to National GDP and Western Australian GSP (Net Present Value in 2002)

Figure 15-2: Gorgon Development – Contribution to National and Western Australian Employment
The Joint Venturers are committed to conducting activities associated with the proposed Gorgon Development in an environmentally responsible manner; and will aim to implement best practice environmental management as part of a program of continuous improvement. To assist in meeting this commitment, a comprehensive Environmental Management System (EMS) will be developed that is consistent with recognised international standards and Chevron’s Operational Excellence Management System. As part of this process an integrated series of Environmental Management Plans (EMPs) will be developed progressively through three related stages.

16.1 Environmental Management System

The Gorgon Joint Venturers will develop a project-specific EMS that is consistent with the recognised international standard AS/NZS ISO 14001:2004, Environmental Management Systems – Specification with Guidance for Use (ISO 14001). This standard has been selected because it is a proven method of establishing effective systems for environmental management generally, and contains all of the elements necessary to manage threats to the important conservation values of the Development area. The system will also be consistent with Chevron’s established Operational Excellence Management System (refer to Box 16-1).

A key purpose of the EMS is to ensure that all environmental management measures presented in the Draft EIS/ERMP, and refined during further planning, design, construction and operation are captured and implemented in an effective manner.

The key elements of the proposed management system are outlined in Table 16-1.

**Box 16-1: Chevron Operational Management System**

Operational Excellence is the systematic management of safety, health, environment, reliability and efficiency to achieve world-class performance. It is a common process applied to Chevron’s operations around the globe in order to:

- achieve an injury-free work place
- eliminate spills and environmental incidents, and identify and mitigate key environmental risks
- promote a healthy workplace and mitigate significant health risks
- operate incident-free with industry leading asset reliability
- maximise the efficient use of resources and assets.

The Operational Excellence Management System consists of three parts:

- Leadership Accountability
- Management System Process
- Operational Excellence Expectations
<table>
<thead>
<tr>
<th>System Element</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy</td>
<td>Chevron Policy 530 Protecting People and the Environment will be adopted.</td>
</tr>
<tr>
<td>Objectives and Targets</td>
<td>Environmental objectives listed in the draft EIS/ERMP and the Gorgon Development sustainability principles will be incorporated into the EMS.</td>
</tr>
<tr>
<td>Leadership and Commitment</td>
<td>The visible commitment of senior management will demonstrate the importance of sound environmental management.</td>
</tr>
<tr>
<td>Organisation Structure and Responsibility</td>
<td>The EMS will clearly define the organisation for the overall management of activities and operations. All personnel associated with the Gorgon Development will be responsible for delivering HES performance.</td>
</tr>
<tr>
<td>Operational Control</td>
<td>An integrated series of Environmental Management Plans (EMPs) will be developed progressively though three related stages: A Framework EMP; the detailed EMP series; and the Contractor EMIPs.</td>
</tr>
<tr>
<td>Documentation and Reporting</td>
<td>All elements of the EMS will be documented and managed through the existing Chevron Australia document control system. Internal and external reporting requirements will be clearly documented, and will include a public reporting process to inform stakeholders of the status and progress of key environmental issues.</td>
</tr>
<tr>
<td>Training, Awareness and Competence</td>
<td>The Joint Venturers will establish and maintain procedures for inducting and training all employees and contractors with regard to their environmental management responsibilities.</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Detailed monitoring programs will be developed, in consultation with the Barrow Island Coordination Council, key regulatory agencies, and the Conservation Commission of Western Australia, to address construction and operational activities which have the potential to adversely impact the environment.</td>
</tr>
<tr>
<td>Auditing</td>
<td>A detailed environmental audit program will be developed in consultation with the Environmental Audit Branch of the Western Australian Department of Environment (DoE).</td>
</tr>
<tr>
<td>Non-Conformance and Corrective Action</td>
<td>Investigation and corrective action procedures will be established to determine the cause of non-conformance; identify and implement corrective action; initiate preventative actions; apply controls to ensure that preventative actions are effective; and record any changes in written procedure resulting from the corrective action.</td>
</tr>
<tr>
<td>Emergency Preparedness and Response</td>
<td>Emergency response procedures will address all credible risks associated with Development activities (such as hydrocarbon or chemical spill, fire, quarantine breach, and fauna injury). Procedures will be implemented through the Barrow Island Coordination Council.</td>
</tr>
<tr>
<td>Incident Reporting</td>
<td>Chevron Australia has a robust and proven incident management and investigation process. The Joint Venturers will revise this process where appropriate.</td>
</tr>
<tr>
<td>System Review</td>
<td>The Joint Venturers will assess the adequacy and effectiveness of the management system annually during construction and the first few years of operation, and address identified deficiencies.</td>
</tr>
</tbody>
</table>
16.2 Environmental Management Plans

Environmental Management Plans will form the cornerstone of the Gorgon Joint Venturers’ EMS as they will document actions and responsibilities for protection of the conservation values of the Development area. The Plans will be developed in three related phases (Figure 16-1).

**Framework EMP**

The Framework EMP compliments the material presented in the main body of the Draft EIS/ERMP as it brings together activity-specific environmental management and protection measures currently under consideration. The document has been structured to address the major Development activities associated with construction and commissioning (e.g. drilling, pipe laying and earthworks) and the major Development components (e.g. offshore wells, feed gas pipeline and gas processing facility). The core of the Framework EMP is a set of environmental protection and management measures to avoid, reduce or mitigate environmental impacts.

The Framework EMP has a specific lifespan in its current form. Its purpose is to provide stakeholders with the opportunity to better understand the management measures proposed for construction and commissioning of the Gorgon Development. Following review of the Draft EIS/ERMP by the public and regulatory agencies, the Framework EMP will be used as a basis for, and be superseded by, the detailed EMP series.

**The Detailed EMP Series**

The detailed EMPs will guide the activities of specific workforce groups working on particular components of the Development (i.e. dredging and spoil disposal, construction of the construction village, onshore feed gas pipeline construction, etc.). They will address normal operations, unplanned incidents and emergency situations.

The Plans will be developed and documented through a systematic and consultative process to address environmental factors and risks identified during the environmental impact assessment phase. The documents will be prepared to the satisfaction of the Commonwealth Department of the Environment and Heritage (DEH) and the Western Australian Environmental Protection Authority (EPA), upon advice from relevant regulatory agencies.

Detailed EMPs will be prepared progressively in the lead-up to the specific activity taking place. That is, some detailed EMPs, such as those for preparation of the Gas Processing Facility site, will need to be prepared in draft form prior to Ministerial approval of the Gorgon Development, as the activities will need to commence shortly after approval. Detailed EMPs for other activities, such as drilling or construction of the domestic gas pipeline, will not need to be prepared until after this time, as the activity may not occur for 12 months or more, and will be more meaningful when a greater level of engineering detail is available.

Operations EMPs will be developed during the late construction phase. Similarly, the Decommissioning EMPs will be prepared at an appropriate stage during the operation phase.

The detailed EMPs will build on the material contained in the Draft EIS/ERMP and include more detailed location-specific engineering and environmental information. In addition, the detailed EMPs will be prepared with input from government agencies and in consideration of public comment; and will incorporate conditions of approval and relevant legislative requirements and industry standards (Figure 16-2).

![Figure 16-1: Phases of EMP Development](image-url)
Figure 16-2:
Inputs to Detailed EMPs

- **Design and Construction Contractor**
  - Technical Input

- **Draft EIS/ERMP**
  - Management commitments
  - Management strategies
  - Stakeholder comment

- **Government Agencies**
  - Comment and advice

- **Conditions of Approval**

- **EMPs**

- **Legislative Requirements, Industry Standards**

Table 16-2:
EMP Structure and Content

<table>
<thead>
<tr>
<th>EMP Component</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development Activity/Issue</td>
<td>The construction or operation activity to be managed (e.g. vegetation clearing at gas processing facility site).</td>
</tr>
<tr>
<td>Relevant Environmental Factor/s</td>
<td>Environmental factor/s that may potentially be affected by construction or operation activity to be managed (e.g. flora, fauna and cultural heritage).</td>
</tr>
<tr>
<td>Environmental Objective/s</td>
<td>The environmental management objective/s that relates to the environmental factor/s potentially affected by proposed construction or operation activity.</td>
</tr>
<tr>
<td>Performance Criteria</td>
<td>Measurable performance criteria for construction and operation activities.</td>
</tr>
<tr>
<td>Implementation Strategy</td>
<td>Detailed strategies and procedures to avoid, mitigate or minimise impacts of tasks or actions that will be implemented to achieve performance criteria.</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Monitoring requirements to measure performance (i.e. specified indicators of change).</td>
</tr>
<tr>
<td>Auditing</td>
<td>Auditing requirements to demonstrate implementation of agreed construction and operation environmental management strategies and compliance with agreed performance criteria.</td>
</tr>
<tr>
<td>Reporting</td>
<td>Format, timing, and responsibility for reporting and auditing of monitoring results.</td>
</tr>
<tr>
<td>Corrective Action/s</td>
<td>Action required when performance requirements are not met and person(s) responsible for undertaking the corrective action.</td>
</tr>
<tr>
<td>Review</td>
<td>Process and timing for review and update of the EMPs.</td>
</tr>
</tbody>
</table>
Detailed EMPs will cover all Development components, with the final structure of construction EMPs determined during the detailed design phase in conjunction with the design and construction contractor, to the satisfaction of the EPA and DEH. Currently, the following EMPs are proposed, with the general structure for each plan as indicated in Table 16-2:

- Upstream Field Infrastructure (Manifolds and Flowlines).
- Offshore Feed Gas Pipeline.
- Onshore Feed Gas Pipeline.
- Gas Processing Facility, Camp and Associated Infrastructure.
- Port Facilities (materials offloading facility and LNG Jetty).
- Dredging and Dredge Spoil Disposal.
- Drilling (Offshore).
- CO₂ Injection System (Pipeline and Wells).
- Domestic Gas Pipeline and Associated Infrastructure.
- Greenhouse Gases.
- Optical Fibre Cable.
- Mainland Supply Base.
- Quarantine Management.
- Waste Management.
- Spill Contingency and Response.
- Cultural Heritage Management.

**Contractor EMIPs**

Environmental Management Implementation Procedures (EMIPs) will be prepared by the design and construction contractors. These internal project documents will build on the environmental protection measures contained in this Framework EMP and the detailed EMPs approved by agencies. The procedures will be finalised and approved by the Gorgon Joint Venturers prior to the construction activity being undertaken.
The Draft EIS/ERMP is the primary source of information for the public and regulatory decision-makers in their assessment of the potential environmental impacts of the proposed Gorgon Development.

During the course of preparing the Draft EIS/ERMP, the Gorgon Joint Venturers have addressed the environmental, social and economic issues associated with the proposed Gorgon Development using a rigorous risk-based assessment approach. These issues are relevant to the Environmental Protection Act 1996 (WA), the Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth) and the Environmental Protection (Sea Dumping) Act 1981 (Commonwealth) and were identified in the Guidelines for an Environmental Impact Statement and Environmental Scoping Document for an Environmental Review and Management Programme (the Scoping Document) (ChevronTexaco Australia 2004).

The major ecological issues investigated during the environmental assessment process, using a risk-based approach, were:

- biodiversity and conservation values of Barrow Island and its surrounding waters
- quarantine management
- disposal of reservoir CO₂ by injection into the Dupuy Formation.

The Gorgon Joint Venturers are committed to adopting specific management measures that will protect the conservation values of Barrow Island and the Development area. The management measures, which are described throughout the Draft EIS/ERMP, particularly in Chapters 10-14, will reduce to acceptable levels the environmental risks associated with the Gorgon Development. To assist regulatory agencies, stakeholders and other interested readers, a consolidated list of commitments is provided (refer Attachment 1). In addition to these specific commitments, the design, construction and operation of the Gorgon Development will be guided by ten principles of conduct as outlined in Table 17-1.

If approval for the proposed Development is granted by the relevant ministers, the Gorgon Joint Venturers will be required to meet a range of commitments and obligations under the State Agreement of the Barrow Island Act 2003. Additional environmental assessment and management requirements would also apply to the Development under state and federal legislation.

The Gorgon Joint Venturers are committed to sustainable development and are committed to meeting each of the ten Gorgon Development sustainability principles by integrating them into its policies, practices and procedures (ChevronTexaco Australia 2003). The Gorgon Venturers’ progress toward sustainability will be assessed through an annual sustainability reporting process which will utilise the sustainability criteria and measurement statements developed during the ESE Review process to measure performance against each of the sustainability principles.
A risk-based approach was applied to identify and assess the most significant risks to Barrow Island’s conservation values, following the recommendation of the EPA to develop a set of standards for acceptable risks to the conservation values of Barrow Island and demonstrate that these standards could be met with a high level of confidence. This process was undertaken in accordance with Australian standards for risk management and widely accepted best practice in environmental risk assessment.

Established risk management practices have been adapted to address potential quarantine threats to the conservation values of Barrow Island. The approach taken is consistent with EPA advice as it has engaged independent technical experts to develop and undertake a risk-based quarantine management process, and has involved the community in a transparent manner in the development of acceptable risk standards. This approach involved establishing an independent Quarantine Expert Panel and a community consultation process.

<table>
<thead>
<tr>
<th>Table 17-1: Principles of Conduct for Sustainable Management of the Gorgon Development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legislative Compliance</strong></td>
</tr>
<tr>
<td><strong>Sustainable Development</strong></td>
</tr>
<tr>
<td><strong>Footprint Compliance</strong></td>
</tr>
<tr>
<td><strong>Biodiversity Protection</strong></td>
</tr>
<tr>
<td><strong>Quarantine Management</strong></td>
</tr>
<tr>
<td><strong>Greenhouse Gas Management</strong></td>
</tr>
<tr>
<td><strong>Cultural Heritage Management</strong></td>
</tr>
<tr>
<td><strong>Management System Implementation</strong></td>
</tr>
<tr>
<td><strong>Stakeholder Engagement</strong></td>
</tr>
<tr>
<td><strong>Transparency</strong></td>
</tr>
</tbody>
</table>
The Gorgon Joint Venturers’ commitment to the responsible management of greenhouse gas emissions is evidenced by the results of benchmarking the anticipated LNG emissions efficiency performance from the Gorgon Development with other LNG facilities. There is currently one operating LNG facility in Australia and another under construction. The expected performance of 0.35 tonnes of CO₂e per tonne LNG to be produced (based on the reference case assumptions) exceeds both these facilities when greenhouse emissions related to gas production are considered.

There is a strong linkage between the social and economic benefits of the proposed Development. The most significant benefits will be economic. In particular, the substantial input into the Australian economy through increased taxation revenues, direct spending, opportunity for local government rating, increased security of supply and availability of natural gas, employment and training initiatives, incremental improvement in the capacity of the economy and the labour force to absorb major oil and gas projects and opportunities for increased participation by indigenous people will be the major Development benefits.

The Gorgon Joint Venturers aim to work with Australian companies who can assist in building and delivering a world-class competitive and safe Development.

The Gorgon Development will also provide the impetus for the expansion of existing services and industries and attract a number of new ones. It will help underpin the development of new technologies and skills, for example in disposal of CO₂ by injection and subsea technology, thereby creating regional capacity for future growth. The proposed Development will also underpin a second major gas supply to the mainland for domestic industry.

17.1 Stakeholder Engagement and Way Forward

Comprehensive and effective community consultation, engagement and participation have been, and remain, key elements of the proposed Gorgon Development. Community involvement will continue throughout all stages of the proposed Development and, where relevant, will be incorporated into the Social Impact Management Plan pursuant to the State Agreement.

The Gorgon Joint Venturers will continue to meet with stakeholders, answer questions and seek feedback throughout the EIS/ERMP process. The federal and state government review of the Draft EIS/ERMP document and the 10-week public comment period will provide stakeholders with further opportunity to provide formal input into the environmental approvals process.

As an integral component of their commitment to transparency, the Joint Venturers will make the results of environmental baseline surveys, environmental assessments and monitoring programs available to government agencies, scientific organisations, academic institutions, industry groups and the public to further the understanding of the ecology of the proposed Development area.

The Joint Venturers recognise that the proposed Development is of national significance and believe that, if the $11 billion proposed Development is granted environmental approval, implementation of the management measures proposed throughout this document will continue to protect the conservation values of Barrow Island and the Development area, whilst contributing $17 billion to government revenue, creating 6000 jobs across Australia and stimulating significant future regional Development.


Key Commitments
– Attachment 1
## Key Commitments

<table>
<thead>
<tr>
<th>Commitment Number</th>
<th>Commitment (Action)</th>
<th>Timing</th>
<th>Advice From*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>The Gorgon Joint Venturers will implement an Environmental Management System (EMS), which is consistent with the recognised international standard AS/NZS ISO 14001:2004, Environmental Management Systems – Specification with Guidance for Use (ISO 14001).</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>A series of Environmental Management Plans (EMPs) will be developed and documented through a systematic and consultative process according to an agreed timetable with the EPA and DEH, taking into consideration comments on the Draft EIS/ERMP and recommendations from relevant agencies.</td>
<td>Prior to construction of the relevant Development component</td>
<td>Various DMAs</td>
</tr>
<tr>
<td>1.3</td>
<td>The Gorgon Joint Venturers will share the use of key infrastructure and services on Barrow Island, whether a part of the existing Barrow Island operation or developed as part of the Gorgon Development in accordance with the Barrow Island State Agreement.</td>
<td>Ongoing</td>
<td></td>
</tr>
</tbody>
</table>
| 1.4               | Further environmental surveys will be undertaken prior to the commencement of construction to finalise selection of alternatives or preferred routes and/or locations and the survey results provided to CALM. These environmental surveys will include:  
  - the flora of the proposed optical fibre cable route  
  - flora and fauna in the CO2 injection seismic monitoring area  
  - vegetation communities containing *Acacia synchronica* to the north of the existing airstrip  
  - avifauna along the proposed domestic gas pipeline route  
  - the distribution of shorebird habitats near the mainland shore crossings  
  - the inter-nesting or hibernating flatback turtles at Town Point. | Prior to construction of the relevant Development component | CALM                              |
| 1.5               | A detailed Decommissioning Assessment and Plan reflecting industry best practice, including completion criteria, will be prepared and submitted 6 months prior to decommissioning to identify the best overall outcome. | At least 6 months prior to decommissioning | Various DMAs                     |
| 1.6               | Once gas processing operations have ended, the facility will be decommissioned and the equipment removed from site; and the land rehabilitated to a condition which is consistent with the surrounding environment. | Decommissioning                  |                                  |

* In addition to DoE and DEH, third parties that have particular expertise and/or statutory responsibility relevant to implementing these commitments are included in the column entitled Advice From.
## Key Commitments

### Clearing & Earthworks

**Environmental Management Objective/s:**

- To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna through the avoidance or management of adverse impacts and improvement in knowledge.
- To protect EPBC Act listed threatened species, migratory species and Threatened Ecological Communities (TECs).
- To protect Specially Protected (Threatened) Fauna consistent with the provisions of the *Wildlife Conservation Act 1950*.
- To protect evolutionary significant units, including genetic races on Barrow Island.

<table>
<thead>
<tr>
<th>Commitment Number</th>
<th>Commitment (Action)</th>
<th>Timing</th>
<th>Advice From*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Gas processing facilities, associated infrastructure and the CO₂ monitoring grid and injection wells will be located to preferentially use previously disturbed areas and limit the disturbance to that required for safe construction and operation.</td>
<td>During design, construction and operations</td>
<td>CALM, DoIR</td>
</tr>
<tr>
<td>2.2</td>
<td>Further survey work during the detailed engineering phase will be undertaken to assist with final alignments of the CO₂ monitoring grid and preparation of Environmental Management Plans, which will be undertaken to the satisfaction of the EPA and DEH.</td>
<td>During design and prior to construction</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Disturbance to important fauna habitats, listed fauna species, restricted flora and vegetation communities will be avoided where practicable.</td>
<td>During design, construction and operations</td>
<td>CALM</td>
</tr>
<tr>
<td>2.4</td>
<td>Significant fauna, such as bettongs, will be translocated from the Development area to alternative locations on Barrow Island in consultation with CALM.</td>
<td>During construction</td>
<td>CALM</td>
</tr>
<tr>
<td>2.5</td>
<td>No new quarries or borrow pits outside of the construction site will be created to support the Development on Barrow Island.</td>
<td>Construction and operations</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Site specific rehabilitation procedures including completion criteria will be developed and implemented in consultation with the relevant authorities for areas that are no longer required for operations or future works.</td>
<td>Prior to rehabilitation</td>
<td>CALM, DoIR</td>
</tr>
<tr>
<td>2.7</td>
<td>Rehabilitation of works sites and access roads will be undertaken to a condition consistent with the surrounding landscape.</td>
<td>Ongoing</td>
<td></td>
</tr>
</tbody>
</table>

* In addition to DoE and DEH, third parties that have particular expertise and/or statutory responsibility relevant to implementing these commitments are included in the column entitled Advice From.
Key Commitments

Fire & Emergency Response

Environmental Management Objectives:

- To ensure that there is no adverse effect on environment values or the health, welfare and amenity of people and land uses.
- To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna through the avoidance or management of adverse impacts and improvement in knowledge.
- To protect EPBC Act listed threatened species, migratory species and Threatened Ecological Communities (TECs).
- To protect Specially Protected (Threatened) Fauna consistent with the provisions of the *Wildlife Conservation Act 1950*.
- To protect evolutionary significant units, including genetic races on Barrow Island.

<table>
<thead>
<tr>
<th>Commitment Number</th>
<th>Commitment (Action)</th>
<th>Timing</th>
<th>Advice From*</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>An Emergency Management Plan that includes integrated safety and emergency response systems will be prepared and implemented in consultation with the relevant authorities and neighbouring industry participants.</td>
<td>Prior to construction of the relevant Development component and then ongoing</td>
<td>FESA, CALM and local Shire</td>
</tr>
<tr>
<td>3.2</td>
<td>In the event that a fire is started as a result of the Development, then immediate corrective action will be taken to extinguish or contain the fire and its occurrence will be reported to relevant authorities.</td>
<td>Ongoing</td>
<td>CALM</td>
</tr>
<tr>
<td>3.3</td>
<td>The Gorgon Joint Venturers will participate in a research program, managed by CALM, on the ecological effects of fire regimes on Barrow Island.</td>
<td>Ongoing</td>
<td>CALM</td>
</tr>
</tbody>
</table>

* In addition to DoE and DEH, third parties that have particular expertise and/or statutory responsibility relevant to implementing these commitments are included in the column entitled Advice From.
**Key Commitments**

**CO2 Injection**

**Environmental Management Objective:**
- To ensure that atmospheric emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

<table>
<thead>
<tr>
<th>Commitment Number</th>
<th>Commitment (Action)</th>
<th>Timing</th>
<th>Advice From*</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>The Gorgon Joint Venturers will significantly reduce Development CO2 emissions by injecting the reservoir CO2 removed during the gas processing operations into the Dupuy Formation, provided it is technically feasible and not cost prohibitive.</td>
<td>During operations</td>
<td>DoIR</td>
</tr>
<tr>
<td>4.2</td>
<td>In the unlikely event that it should prove technically infeasible or cost prohibitive to inject the proposed volume of CO2, the Gorgon Joint Venturers will consult with government with the intent of maximising the injection of CO2 within the commercial constraints of the Gorgon Development.</td>
<td>Ongoing</td>
<td>DoIR</td>
</tr>
<tr>
<td>4.3</td>
<td>A CO2 Injection Operations Management Plan will be prepared with the objective of maximising the volume of reservoir CO2 injected whilst ensuring that the injection does not pose an unacceptable health, safety or environmental risk.</td>
<td>Prior to commissioning and ongoing</td>
<td>DoIR</td>
</tr>
<tr>
<td>4.4</td>
<td>If at any time the Gorgon Joint Venturers consider that the injection of reservoir CO2 represents an unacceptable risk to the environmental values of Barrow Island, or a safety risk, then the CO2 injection operation will be suspended until such time as all risks are addressed.</td>
<td>During operations</td>
<td>DoIR</td>
</tr>
<tr>
<td>4.5</td>
<td>Appropriate arrangements will be made with the Barrow Island Joint Venture to ensure that all wells in the path of the migrating CO2 are assessed and if required, worked over such that they are fit for service in a CO2 environment.</td>
<td>During operations</td>
<td>DoIR</td>
</tr>
<tr>
<td>4.6</td>
<td>A CO2 Monitoring Program will be prepared, implemented and reviewed in consultation with the relevant authorities.</td>
<td>Prior to commissioning and then ongoing</td>
<td>DoIR</td>
</tr>
</tbody>
</table>

* In addition to DoE and DEH, third parties that have particular expertise and/or statutory responsibility relevant to implementing these commitments are included in the column entitled Advice From.
Key Commitments

Atmospheric & Greenhouse Gas Emissions

Environmental Management Objective:
• To ensure that atmospheric emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

<table>
<thead>
<tr>
<th>Commitment Number</th>
<th>Commitment (Action)</th>
<th>Timing</th>
<th>Advice From*</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>The Gorgon Joint Venturers undertake to report on and manage greenhouse gas emissions from the Gorgon Development in accordance with the Gorgon Development Greenhouse Gas Management Plan. This plan includes a series of longer term greenhouse gas emission performance targets to be used to guide the further reduction of greenhouse gas emissions.</td>
<td>During operations</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>The Gorgon Joint Venturers will continue to participate in government programs aimed at the voluntary reduction of greenhouse gas emissions.</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td>5.3</td>
<td>Energy efficiency studies will be undertaken during the detailed engineering and design of the Development.</td>
<td>During design</td>
<td></td>
</tr>
<tr>
<td>5.4</td>
<td>The Development will be designed based on a ‘no routine flaring’ policy and will incorporate a high efficiency flare to reduce the portion of uncombusted hydrocarbon and particulates to as low as reasonably practicable (ALARP). A small flare is required to be in continuous service for safety and maintenance purposes.</td>
<td>During design and operation</td>
<td></td>
</tr>
<tr>
<td>5.6</td>
<td>The Development will be designed and operated to reduce venting of process hydrocarbons.</td>
<td>Operations</td>
<td></td>
</tr>
<tr>
<td>5.7</td>
<td>A monitoring program of key emission sources and types will be developed and implemented in agreement with the DoE.</td>
<td>Prior to commissioning and during operations</td>
<td></td>
</tr>
</tbody>
</table>

* In addition to DoE and DEH, third parties that have particular expertise and/or statutory responsibility relevant to implementing these commitments are included in the column entitled Advice From.
### Key Commitments

**Liquid, Solid & Hazardous Waste**

#### Environmental Management Objectives:
- To ensure that liquid and solid wastes do not adversely affect groundwater or surface water quality or lead to soil contamination.
- To ensure that hazardous materials are handled and stored in a manner that minimises the potential impact on the environment through leaks, spills and emergency situations.
- To ensure that there is no adverse effect on environment values or the health, welfare and amenity of people and land uses.

<table>
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<tbody>
<tr>
<td>6.1</td>
<td>A Waste Management Plan will be prepared and implemented for hazardous and non-hazardous wastes in consultation with the DoE and will include systems and details for individual waste streams and their disposal.</td>
<td>Prior to construction of the relevant Development component and then ongoing</td>
<td>Local Shire, DoIR</td>
</tr>
<tr>
<td>6.2</td>
<td>The Waste Management Plan will be based on the principles of eliminate, reduce, re-use, recycle, treatment and environmentally responsible disposal.</td>
<td>During design, construction and operations</td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>Solid waste will not be disposed of on Barrow Island, with the exception of waste concrete where it may be used by the existing oilfield operation.</td>
<td>Ongoing</td>
<td>CALM</td>
</tr>
<tr>
<td>6.4</td>
<td>A Hydrotest Water Management Plan will be prepared and implemented.</td>
<td>During design and commissioning</td>
<td></td>
</tr>
</tbody>
</table>

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### Key Commitments

#### Leaks & Spills

**Environmental Management Objectives:**
- To ensure that hydrocarbons and hazardous materials are handled and stored in a manner that minimises the potential impact on the environment through leaks, spills and emergency situations.
- To maintain the ecological functions and environmental values of marine benthic habitats and the subtidal and intertidal zones.
- To maintain the ecological function, abundance, species diversity and geographic distribution of mangrove, coral, seagrass and other benthic primary producer communities and their habitats.
- To ensure that any impacts on locally significant marine communities are avoided, minimised and/or mitigated.
- To protect EPBC Act listed threatened, migratory species and Threatened Ecological Communities (TECs).
- To protect Specially Protected (Threatened) Fauna consistent with the provisions of the *Wildlife Conservation Act 1950*.

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<tbody>
<tr>
<td>7.1</td>
<td>Spills and leaks will be contained, recorded and affected sites remediated.</td>
<td>During construction and operation</td>
<td>CALM, DoIR &amp; Dept of Transport</td>
</tr>
<tr>
<td>7.2</td>
<td>Copies of Material Safety Data Sheets (MSDS) for all chemicals will be held on site and all materials managed (handled, stored and disposed of) accordingly.</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td>7.3</td>
<td>An Oil &amp; Chemical Spill Contingency Plan (OCSCP) including emergency response measures will be prepared, implemented and reviewed in consultation with the relevant authorities.</td>
<td>Prior to construction of the relevant Development component and then ongoing</td>
<td>CALM, DoIR &amp; Dept of Transport</td>
</tr>
<tr>
<td>7.4</td>
<td>Spill recovery and cleanup equipment will be provided and maintained at key marine and terrestrial locations as identified in the agreed OCSCP.</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>Navigational exclusion zones will be created around seabed infrastructure to prevent accidental damage to facilities and local pilots will be used to berth ships.</td>
<td>During construction and operations</td>
<td>AMSA, Dept of Transport</td>
</tr>
<tr>
<td>7.6</td>
<td>Installed equipment will be designed and operated to prevent spills and leaks through the provision of in-built safeguards such as relief valves, overflow protection, and automatic and manual shut-down systems.</td>
<td>During design, construction and operations</td>
<td></td>
</tr>
</tbody>
</table>

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### Key Commitments

#### Noise & Vibration

**Environmental Management Objectives:**
- To avoid adverse noise and vibration impacts to fauna.
- To ensure that noise impacts emanating from the proposed gas processing facility comply with statutory requirements specified in the *Environmental Protection (Noise) Regulations 1997.*

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<tbody>
<tr>
<td>8.1</td>
<td>An Environmental Management Plan for CO₂ monitoring with seismic will be prepared to the satisfaction of the EPA and implemented.</td>
<td>Prior to commencing seismic surveys</td>
<td>CALM, DoIR</td>
</tr>
<tr>
<td>8.2</td>
<td>An Environmental Plan for offshore seismic activities will be prepared to the satisfaction of DoIR and implemented.</td>
<td>Prior to commencing offshore seismic surveys</td>
<td>DoIR</td>
</tr>
<tr>
<td>8.3</td>
<td>Blasting will be scheduled for daylight hours to avoid activity peaks of nocturnal mammals.</td>
<td>During construction</td>
<td>CALM</td>
</tr>
</tbody>
</table>

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### Key Commitments

#### Light & Temperature

**Environmental Management Objectives:**
- To avoid or manage potential impacts from light overspill and shade and comply with acceptable standards.
- To maintain the abundance, species diversity, geographic distribution and ecological functions of marine faunal communities.
- To ensure that any impacts on locally significant marine communities are avoided, minimised and/or mitigated.
- To protect EPBC Act listed threatened, migratory species and Threatened Ecological Communities (TECs).
- To protect Specially Protected (Threatened) Fauna consistent with the provisions of the Wildlife Conservation Act 1950.

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</table>
| 9.1               | The following key lighting strategies will be employed:  
- The main gas processing facility shall be designed such that no permanently on-lighting is located within 500 m of turtle nesting beaches.  
- Use red/yellow/orange type of reduced spectrum light, such as sodium vapour as the primary lighting for the facility.  
- Use shielded white type lights in areas that require inspection during operator rounds and/or regular maintenance. These lights will be switched off when not required. | During design, construction and operation | CALM |
| 9.2               | Lighting levels will be reduced to those required for safe working and security; and, in areas where colour definition is not critical for safety or operational purposes, shielded red or mono-chromatic lights will be utilised. | During design, construction and operation |  |
| 9.3               | Areas where land fauna may come into contact with extreme or hazardous temperatures, will be fenced or selectively cleared in consultation with the CALM to provide a suitable buffer. | During construction and operation | CALM |

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### Key Commitments

#### Environmental Management Objectives:
- To protect EPBC Act listed threatened, migratory species and Threatened Ecological Communities (TECs).
- To protect Specially Protected (Threatened) Fauna consistent with the provisions of the *Wildlife Conservation Act 1950*.
- To maintain the abundance, species diversity, geographic distribution and ecological functions of marine faunal communities and ensure that any impacts on locally significant marine communities are avoided, minimised and/or mitigated.
- To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystems levels through the avoidance or management of adverse impacts and improvement in knowledge.
- To protect evolutionary significant units, including genetic races on Barrow Island.

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<tr>
<td>10.1</td>
<td>A Dredging and Spoil Disposal Management Plan (DSDMP) will be prepared in consultation with the relevant authorities to the satisfaction of EPA and DEH, and implemented.</td>
<td>Prior to commencement of dredging and then ongoing</td>
<td>Marine and Harbours</td>
</tr>
<tr>
<td>10.2</td>
<td>To reduce dredge spoil disposal volumes, material will be assessed for use in the construction of the causeway and the MOF.</td>
<td>During construction</td>
<td></td>
</tr>
<tr>
<td>10.3</td>
<td>Shore crossing activities will be managed to reduce impacts during the peak turtle nesting period.</td>
<td>During construction</td>
<td>CALM</td>
</tr>
<tr>
<td>10.4</td>
<td>Shore crossing disturbance areas will be rehabilitated to a condition consistent with the surrounding landscape.</td>
<td>During construction</td>
<td>CALM, DoIR</td>
</tr>
<tr>
<td>10.5</td>
<td>A Marine Anchoring Management Plan will be prepared and implemented in consultation with the relevant authorities.</td>
<td>Prior to construction of the relevant Development component and then ongoing</td>
<td>CALM, DoIR and Dept of Transport</td>
</tr>
<tr>
<td>10.6</td>
<td>Programs will be established to encourage and foster environmental awareness and conservation with the workforce.</td>
<td>Ongoing</td>
<td></td>
</tr>
</tbody>
</table>

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Key Commitments

Environmental Management Objective:
• To prevent the introduction and establishment of non-indigenous species to Barrow Island and its surrounding waters.

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<tbody>
<tr>
<td>11.1</td>
<td>The Gorgon Joint Venturers will develop the Quarantine Management System in consultation with the relevant authorities to the satisfaction of the EPA and DEH, and implement the system.</td>
<td>Prior to construction and then ongoing</td>
<td>CALM</td>
</tr>
<tr>
<td>11.2</td>
<td>The Gorgon Joint Venturers will prepare, implement and periodically review specific quarantine management procedures for all pathways.</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td>11.3</td>
<td>Monitoring and eradication including incident response and reporting will be undertaken in accordance with the agreed Quarantine Management System.</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td>11.4</td>
<td>An expert Quarantine Advisory Group will be established to provide advice on quarantine management.</td>
<td>Prior to construction</td>
<td>CALM</td>
</tr>
<tr>
<td>11.5</td>
<td>Ballast water management practices will be audited by the Gorgon Joint Venturers to verify conformance with domestic and international regulations.</td>
<td>Ongoing</td>
<td>Dept of Transport</td>
</tr>
<tr>
<td>11.6</td>
<td>Targeted flora and fauna surveys will be undertaken to determine baseline data that will be used to judge the effectiveness of quarantine barriers.</td>
<td>Prior to construction</td>
<td>CALM</td>
</tr>
</tbody>
</table>

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## Key Commitments

**Cultural Heritage & Native Title**

### Management Objectives:
- To ensure the cultural and heritage values on and around Barrow Island are not compromised by the Development.
- To ensure that all works are performed in accordance with the *Aboriginal Heritage Act 1972*, *Heritage of Western Australia Act 1990* and *Maritime Archaeology Act 1973*.

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<tbody>
<tr>
<td>12.1</td>
<td>Undertake archaeological and ethnographic surveys within the Development area in consultation with the identified Indigenous communities.</td>
<td>Prior to construction of the relevant Development component</td>
<td>DIA</td>
</tr>
<tr>
<td>12.2</td>
<td>Prior to construction all proposed ground disturbance areas (including the seabed) will be reviewed for indigenous, historical and maritime cultural heritage evidence.</td>
<td>Prior to construction of the relevant Development component</td>
<td>DIA, WA Museum, Maritime Museum, Heritage Council</td>
</tr>
<tr>
<td>12.3</td>
<td>The Development will be managed in accordance with a Cultural Heritage Management Plan, which will be prepared in consultation with the relevant authorities.</td>
<td>Prior to construction of the relevant Development component and during operations</td>
<td>DIA, WA Museum, Maritime Museum, Heritage Council</td>
</tr>
<tr>
<td>12.4</td>
<td>The Joint Venturers will undertake consultation and negotiations with indigenous Native Title claimants in relation to mainland activities such as the domestic gas pipeline and optical fibre cable.</td>
<td>Prior to construction of the relevant Development component</td>
<td>DIA, DoIR and Office of NT</td>
</tr>
<tr>
<td>12.5</td>
<td>If cultural heritage sites cannot be avoided, the relevant authorities will be consulted and management measures agreed.</td>
<td>Prior to construction of the relevant Development component</td>
<td></td>
</tr>
</tbody>
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### Key Commitments

#### Social

**Management Objective:**
- To ensure that there is no adverse effect on the health, welfare and amenity of the workforce or public.

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<tbody>
<tr>
<td>13.1</td>
<td>A Social Impact Management Plan will be prepared in consultation with relevant stakeholders.</td>
<td>Prior to construction</td>
<td>Key stakeholders</td>
</tr>
<tr>
<td>13.2</td>
<td>Where necessary, Traffic Management Plans will be prepared in consultation with the relevant authorities prior to the movement of non-standard construction equipment, machinery or vehicles on public roads.</td>
<td>During construction</td>
<td>MRWA, Police and Local Shires</td>
</tr>
<tr>
<td>13.3</td>
<td>Significant navigational changes or constraints due to construction and operating conditions will be communicated to mariners and commercial fishing operators.</td>
<td>During construction and operations</td>
<td>Dept of Transport</td>
</tr>
</tbody>
</table>

#### Health & Safety

**Management Objective:**
- To ensure that there is no adverse effect on the health, welfare and amenity of the workforce or public.

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</thead>
<tbody>
<tr>
<td>14.1</td>
<td>Comprehensive Safety Management Systems and Plans will be prepared in consultation with the relevant authorities.</td>
<td>Prior to construction of the relevant Development component</td>
<td>DoIR, WorkSafe, and NOPSA</td>
</tr>
<tr>
<td>14.2</td>
<td>Emergency evacuation procedures will be established in consultation with the relevant authorities to remove injured personnel off Barrow Island to suitable medical facility.</td>
<td>Prior to construction of the relevant Development component</td>
<td>FESA and local Shire</td>
</tr>
<tr>
<td>14.3</td>
<td>Medical personnel will be located on Barrow Island throughout construction and operations.</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td>14.4</td>
<td>Regular inspections of the Development by company safety professionals will be conducted throughout construction and operations.</td>
<td>Ongoing</td>
<td>DoIR, WorkSafe, and NOPSA</td>
</tr>
<tr>
<td>14.5</td>
<td>Appropriate recreational opportunities and facilities will be provided within the construction village.</td>
<td>During construction</td>
<td></td>
</tr>
</tbody>
</table>

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## Key Commitments

### Auditing, Monitoring & Reporting

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<tbody>
<tr>
<td>15.1</td>
<td>A comprehensive Environmental Monitoring Program will be established, implemented and periodically reviewed in consultation with the relevant authorities and will be used to guide ongoing management and corrective action. Specific localised monitoring activities will be included within the EMPs.</td>
<td>Ongoing</td>
<td>CCWA, CALM, DoIR, WA Museum, DIA, Health WA</td>
</tr>
<tr>
<td>15.2</td>
<td>An Environmental Audit Program will be established and implemented in consultation with DoE and DEH to determine whether the Development meets environmental objectives, proponent commitments and requirements of the Development's EMS and EMPs. The program will be used to guide ongoing management and corrective action.</td>
<td>Prior to construction of the relevant Development component and then ongoing</td>
<td></td>
</tr>
<tr>
<td>15.3</td>
<td>A Barrow Island land use register will be established and maintained to track all clearing and rehabilitation activities associated with the Development and included in the Annual Environmental Report to authorities.</td>
<td>Prior to construction and then ongoing</td>
<td></td>
</tr>
<tr>
<td>15.4</td>
<td>The status and progress of key environmental issues will be included in the public Annual Environmental Report.</td>
<td>During construction and operations</td>
<td></td>
</tr>
</tbody>
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Disclaimer
This Draft Environmental Impact Statement/Environmental Review and Management Programme (Draft EIS/ERMP) has been prepared by Chevron Australia Pty Ltd on behalf of the Gorgon Joint Venturers. In preparing the Draft EIS/ERMP, Chevron Australia has relied on information provided by specialist consultants, government agencies and other third parties who are identified in the Draft EIS/ERMP. Chevron Australia has not verified the accuracy or completeness of the findings, conclusions and observations of these consultants, government agencies and other third parties, except where expressly acknowledged in the Draft EIS/ERMP.

Note on Name Change
During the production of this Draft EIS/ERMP, ChevronTexaco Corporation changed its name to Chevron Corporation. As a consequence of this, ChevronTexaco Australia Pty Ltd changed its name to Chevron Australia Pty Ltd.

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