

Environmental Advice on the Principle of Locating a Gas Processing Complex on Barrow Island Nature Reserve

Gorgon Venture

**Section 16 Report and Recommendations
of the Environmental Protection Authority**

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EXECUTIVE SUMMARY

1.1 Introduction

Barrow Island is a class A Nature Reserve situated about 70 km off the Pilbara coast of Western Australia. The waters around Barrow Island have recently been proposed for reservation as part of a Barrow-Montebello Islands Marine Conservation Reserve.

This report is the environmental contribution to the Government's strategic economic, social and environmental assessment of a proposal to locate a gas processing complex on Barrow Island. Part A provides the EPA's advice on access to Barrow Island for industry. Should Government decide to agree to access, Part B provides the EPA's recommendations on managing the environmental issues that would arise. This strategic level process is designed to guide and assist in the making of an in-principle decision by Government. Formal environmental assessment would still be necessary under the provisions of Section 38 of the *Environmental Protection Act* and the *Commonwealth Environment Protection and Biodiversity Conservation Act*.

PART A

1.2 EPA Advice - Industry on Barrow Island

Barrow Island has been recognized, in statute and by the community, for its high and unique conservation values for over ninety-five years. It is classified as a class A Nature Reserve to reflect its status as a jewel in the crown of the conservation estate and to protect its environmental values.

In 1966 legislation provided for a petroleum lease on Barrow Island and a producing oil field was subsequently established.

The internationally recognized environmental values of Barrow Island are its unique combination of taxa and communities and its island status. Of the known taxa of Barrow Island, there are 24 terrestrial species that occur nowhere else in the world and another 5 that are restricted in their distribution. The high density and diversity of species is largely due to Barrow Island being naturally quarantined from invasive species by its island status and legislatively protected by its statutory status.

<p>Given the very high environmental and unique conservation values of Barrow Island, which are reflected in its status as a class A Nature Reserve, it is the view of the EPA that, as a matter of principle, industry should not be located on a nature reserve and specifically not on Barrow Island.</p>
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1.3 EPA Advice - Alternative Locations

On environmental grounds, there are other preferred options available for the location of the Gorgon gas development.

The developer has considered and, at this stage, dismissed other locations and concluded that Barrow Island is the only commercially feasible location. The developer also considers Barrow Island is environmentally and socially acceptable. The EPA understands that independent analysis indicates that Trimouille Island would be economically competitive with Barrow Island and that Thevenard Island without CO₂ injection could also be economically competitive with Barrow Island with CO₂ injection. The environmental advantages of either of these alternative locations are significant.

DCLM advises that the alternative sites considered have lower environmental and conservation values than Barrow Island, and that its ranking from most to least desired site for the development from an environmental point of view is Cape Preston, Maitland Estate/West Intercourse Island, Thevenard Island and Trimouille Island, if marine values could be adequately protected.

The EPA considers that, from an environmental point of view, alternative sites to Barrow Island could be found acceptable in the sequence (most to least desired location) of brown-fields mainland sites, green-fields mainland sites and Thevenard Island. Trimouille Island could be considered, provided marine values could be adequately protected.

1.4 EPA Advice - Threats to the Environmental and Conservation Values of Barrow Island

The most important potential threats to the unique conservation values of Barrow Island are terrestrial and marine invasive organisms, land clearing and fire. There are, however, many other significant threats associated with siting a gas processing complex on Barrow Island.

The primary potential threat is the introduction of invasive organisms, particularly animal pests and weeds, including disease.

The volume and number of proposed movements (barges, aircraft, personnel, equipment, construction material, food, supplies and stores) represents the single biggest pathway for the potential introduction of pests and diseases to Barrow Island. The ability to eradicate some pests and diseases remains unproven.

The operators of the existing Barrow Island oil field have recorded 27 breaches of quarantine since 1964. To date, potentially invasive animals have either not become

established or have been eradicated. A number of weed invasions have established on Barrow Island and are currently contained, but not eliminated.

At this stage, there is little concrete information on which to base a judgment about the risk to conservation values from quarantine breaches for a proposal of the scale proposed by the Gorgon Venture.

While the current quarantine system on Barrow Island has served the historic level of operations reasonably well, the level of activity projected for the new proposal would require unprecedented levels and types of quarantine effort. Given the yet to be defined and untried nature of the intensity and combinations of controls likely to be required, the EPA's level of confidence in their success is currently low.

In the view of the EPA, a "try it and see" approach is unacceptable in a class A Nature Reserve with high and unique conservation values, given the dire consequences of failure. The EPA strongly recommends a precautionary approach, as advocated in EPA Position Statement No. 7, is most appropriate where the environment and conservation values are so high and unique. This approach requires any decision to proceed with development to be based on solid data, enabling sound judgment. If the project were to proceed, it could only be with a policy of a 'zero tolerance of invasions' target and an associated quarantine regime of sufficient, demonstrated rigor to achieve this.

The waters around Barrow Island have been proposed for reservation as part of a Barrow-Montebello Islands Marine Conservation Reserve. The marine values would be put at risk should marine pests from shipping ballast, hull fouling, dredging activity, oil spills, shipping accidents and industrial discharges become threats to the proposed marine conservation reserve.

The risk of a condensate spill from the gas delivery line, or from tanker operations, requires careful consideration. Similarly the potential for direct impacts or the introduction of exotic marine pests to an area proposed as a marine conservation reserve deserves careful scrutiny.

The clearing of 300ha, specifically for the proposed new facility, is particularly significant for a class A Nature Reserve, and would be cumulative on the impacts caused by previous clearing of over 1000ha. Causes for concern are the proposed clearing of a drainage channel (given their limited extent on the island), sedimentation, run-off of pollutants, groundwater contamination and impacts on stygofauna.

It is the EPA's view that the clearing of 300ha, in addition to the previous clearing of over 1000ha, is inconsistent with the purpose of preserving the natural attributes of a class A Nature Reserve, and would have direct, deleterious impacts on at least some Barrow Island organisms with high biodiversity values.

A major shift in fire frequency or intensity could render a significant change to the environmental and unique conservation values of Barrow Island. Spinifex grasslands dominate large parts of the Barrow Island environment. These grasses are adapted to dry, fire prone, low nutrient environments and ultimately depend on fires to persist against dominance by shrubs. Barrow Island has been subject to a fire suppression regime to protect the oil field assets for over 40 years. Long-term fire suppression poses a credible ecosystem-wide threat to Barrow Island.

The EPA recommends that fire research and trials should commence, and that a plan designed to safely manage extensive fire, consistent with a natural regime, should be developed, regardless of whether or not the Gorgon gas project proceeds. The EPA appreciates that this is a particular challenge in the existing oil field but believes that more can be done in the northern part of the island now and more extensively as techniques consistent with the oil field are developed and as the field is shut down.

The developer proposes to inject 4.2mtpa of reservoir CO₂ into the hyper-saline Dupuy Formation aquifer beneath Barrow Island, at depths below 2700m. Up to 3.3mtpa of CO₂ would still be released. The company's commitment to inject CO₂ is qualified by a proviso that it be technically feasible and not cost-prohibitive.

The EPA is of the view that CO₂ injection is a secondary issue to the conservation values of Barrow Island. In reaching this conclusion, the EPA notes that many of the conservation values occur only on Barrow Island whereas there are other possible locations for CO₂ injection.

CO₂ injection on Barrow Island in isolation from a gas processing plant may be possible without putting the conservation values at undue risk. However, management plans would need to be developed to ensure that the risks from CO₂ injection would not have unacceptable environmental impacts.

The EPA recommends that the risk of carbon dioxide leakage at the point of injection and by leakage from underground storage should be specifically investigated with a view to determining the risks to the natural environment of Barrow Island.

Given adequate plant design, including appropriate stack heights and avoidance of building effects, it is likely that National Environmental Protection Measure values could be met for NO₂ on Barrow Island. No details of the effects of NO_x or other gases on the natural environment of Barrow Island are available. The developer would also need to undertake detailed investigations in order to determine if the long term impacts from the deposition of acid gases and other pollutants on the natural environment would be acceptable.

Should the proposal proceed, the EPA recommends that attention be given to adequate plant design, including appropriate stack heights, avoidance of building effects, and appropriate emission standards, with particular reference to employees and the natural environment of Barrow Island. Dispersion modelling would be required to confirm if near field and regional impacts on health and the environment are likely to be acceptable once details on source parameters are available.

The EPA believes that the proposal to place a large scale gas complex on Barrow Island is fatally flawed because such a complex is inconsistent with the purpose of a class A Nature Reserve, and is likely to significantly increase the risk of invasions by pests and weeds which could put the high and unique conservation values of Barrow Island at serious risk. It is the EPA's judgment that the ability to manage that risk has not, at this stage, been convincingly demonstrated.

Having weighed the environmental values, the limited available data about risks, and the current level of knowledge on their management, the EPA is of the view that the proponent has failed to demonstrate that establishing a gas processing complex on Barrow Island could achieve an acceptably low level of risk to Barrow Island's outstanding environment and unique conservation values.

PART B

1.5 EPA Recommendations – Management Plans to Address the Risks to the Environmental Values of Barrow Island

The EPA strongly recommends that industrial development should not proceed on Barrow Island. Should the Government decide, for economic or industry development reasons, to allow the proposal to proceed on Barrow Island, a package of comprehensive management plans should be required to address the risks posed by the development.

The overarching principles underpinning any development on Barrow Island should be:

- the class A Nature Reserve status of Barrow Island should have primacy; and
- the environmental and conservation values of the island should not be compromised.

The level of performance required to guarantee the maintenance of Barrow Island's conservation values would need to be extremely high (exceeding current standard practice on Barrow Island) to approach an acceptable level of confidence in their success. Such performance would likely set new standards in the oil and gas industry worldwide.

If Government agrees to a gas processing complex on Barrow Island the following non-negotiable environmental requirements should be imposed.

Class A Nature Reserve Status to be Paramount

The EPA recommends that the class A Nature Reserve status of Barrow Island should be superior to any industrial lease and fixed by statute, with the primary purpose being the preservation of environmental and conservation values of the island. Tenure should be vested in the State conservation agency (Conservation Commission), consistent with the primary purpose of nature conservation in such a way that any change which may be contemplated in future requires the agreement of both Houses of Parliament.

Development Envelope to be Strictly Limited

The EPA recommends that the limit of 300ha for new development should be enshrined in statute, in a way that requires the agreement of both Houses of Parliament should any increase be contemplated in future.

Reservoir CO₂ Management – Barrow Specific Requirement

In the event that in-principle access to Barrow Island is agreed, the EPA recommends that it should be on the proviso that sequestration or other appropriate management of the CO₂ must be committed to, either by sub-surface injection as proposed, or by an alternative acceptable to Government, on the advice of the EPA.

The EPA further recommends that standards for the risk of environmental impacts from CO₂ releases would need to be developed and data collected to demonstrate that such risks would be acceptably low.

Government Agency Control and Resources

The EPA recommends that arrangements should be put in place for appropriate powers and adequate resources to be provided to DCLM to ensure it can properly manage the conservation values of Barrow Island for the duration of any approved development.

Independent Expert Advice and Transparent Public Processes to Decide Acceptable Risk to Conservation Values

Should Government agree in-principle to access to Barrow Island for a gas processing complex, the EPA recommends that:

- The proponent be required to engage in the development of a set of standards for acceptable risks to the conservation values of Barrow Island. Such a process should include appropriate technical experts and be structured to ensure a high level of transparency and community involvement.
- The proponent be required to demonstrate to the EPA, on the advice of DCLM and the DoE, that the risk standards can be met, with a very high level of confidence.

Beyond Current Best Practice Environment and Conservation Management

The EPA recommends that the developer be advised that the formal environmental impact assessment process under Part IV of the *Environmental Protection Act* will require clear demonstration of the developer's ability to meet any environmental and conservation risk standards. In so doing, they can expect to set new benchmarks in conservation management performance that go significantly beyond current best practice.

Management

The EPA recommends that a comprehensive plan for the management of environmental and conservation values would need to be developed, to the requirements of the EPA in consultation with DCLM.

Protection

The EPA recommends that specific measures for the protection of the unique conservation values of Barrow Island would need to be developed, in consultation with DCLM, as part of a comprehensive management planning process.

Insurance

The EPA recommends that a substantive research and planning programme be required, in consultation with DCLM, to define the potential for establishing suitable habitat elsewhere and demonstrating successful translocation of species from Barrow Island.

Offsets

The EPA recommends that a suitable offset for any area cleared on Barrow Island should be negotiated to the satisfaction of the EPA, on the advice of DCLM.

Net Conservation Benefits

As required by Government, net conservation benefits (NCBs) should be provided by the project, in addition to the management, protection, insurance and offset actions that directly relate to the impacts or potential impacts of a proposed development.

Recognising the scale of the proposed project and the high and unique conservation values involved, the EPA recommends that an NCB decision of substance is required, which is commensurate with the scale of these factors.

PART A

2 INTRODUCTION

2.1 Preamble

The Western Australian Government has undertaken to consider the use of Barrow Island as the location for processing and exporting natural gas from the Gorgon Gas field. Barrow Island is a class A Nature Reserve situated about 70km off the Pilbara coast of Western Australia. A process has been put in place to provide separate environmental, social, economic and strategic advice to Government to enable an in-principle decision to be made about access to Barrow Island.

This report is the environmental contribution to the Government's strategic economic, social and environmental assessment of the proposal. This report contains the advice and recommendations of the Environmental Protection Authority (EPA) to the Minister for the Environment and Heritage on the strategic environmental considerations relevant to the proposal by Gorgon Australian Gas to develop a gas processing complex on the Barrow Island class A Nature Reserve. The EPA's report is divided into two parts. Part A provides the EPA's advice on the question of whether or not access to Barrow Island should be agreed on environmental grounds. Should Government decide that access should be granted, Part B provides the EPA's recommendations to manage the environmental issues which will arise as a result.

The EPA report presents an overview of the history of the Barrow Island Nature Reserve and the environmental values which make it an area worthy of protection and conservation. It provides advice on alternative sites for the processing section of the Gorgon development and draws attention to impacts of the proposal which may constitute "fatal-flaws" in the plan to use Barrow Island as the location for a gas processing plant. The EPA recognises that the Government may allow the use of Barrow Island on economic grounds and provides advice on impact management and minimisation and net conservation benefits. Further detail on the issues in this report is contained in the attached appendices.

2.2 The Developer

The developer is Gorgon Australian Gas (the Gorgon Venture). ChevronTexaco is the majority partner in the Gorgon gas field operation, in association with joint venture partners Shell and ExxonMobil. Reference to ChevronTexaco in this report should be read as representing the Gorgon Venture.

2.3 The Proposal

Based on information contained in the developer's document (ChevronTexaco 2003a), the major features of the proposal are:

- a 70km natural gas pipeline from the offshore Gorgon area gas fields to Barrow Island;
- an integrated gas processing complex on Barrow Island, occupying an area of 300 hectares;
- a liquefied natural gas (LNG) export capacity of 5 million tonnes per annum (mtpa);
- a 4km jetty and sea terminal to Barrow Island;
- a dredged shipping channel and materials off-loading facility for use in the construction phase;
- CO₂ (waste product) treatment plant and wells for injection into the Dupuy Formation beneath Barrow Island; and
- a projected life of 30 years, based on the Gorgon area gas fields (Figure 1).

Features of possible future expansion of the development include:

- additional 5mtpa LNG trains within the complex;
- a domestic gas plant;
- a gas-to-liquids (GTL) plant;
- a domestic gas pipeline to the mainland; and
- project life extended several decades, depending on the reserves of the Greater Gorgon area (Figure 2).

The proposal is conceptual in nature and includes the developer's preferred site for the processing plant and preliminary process descriptions for the purposes of this strategic assessment.

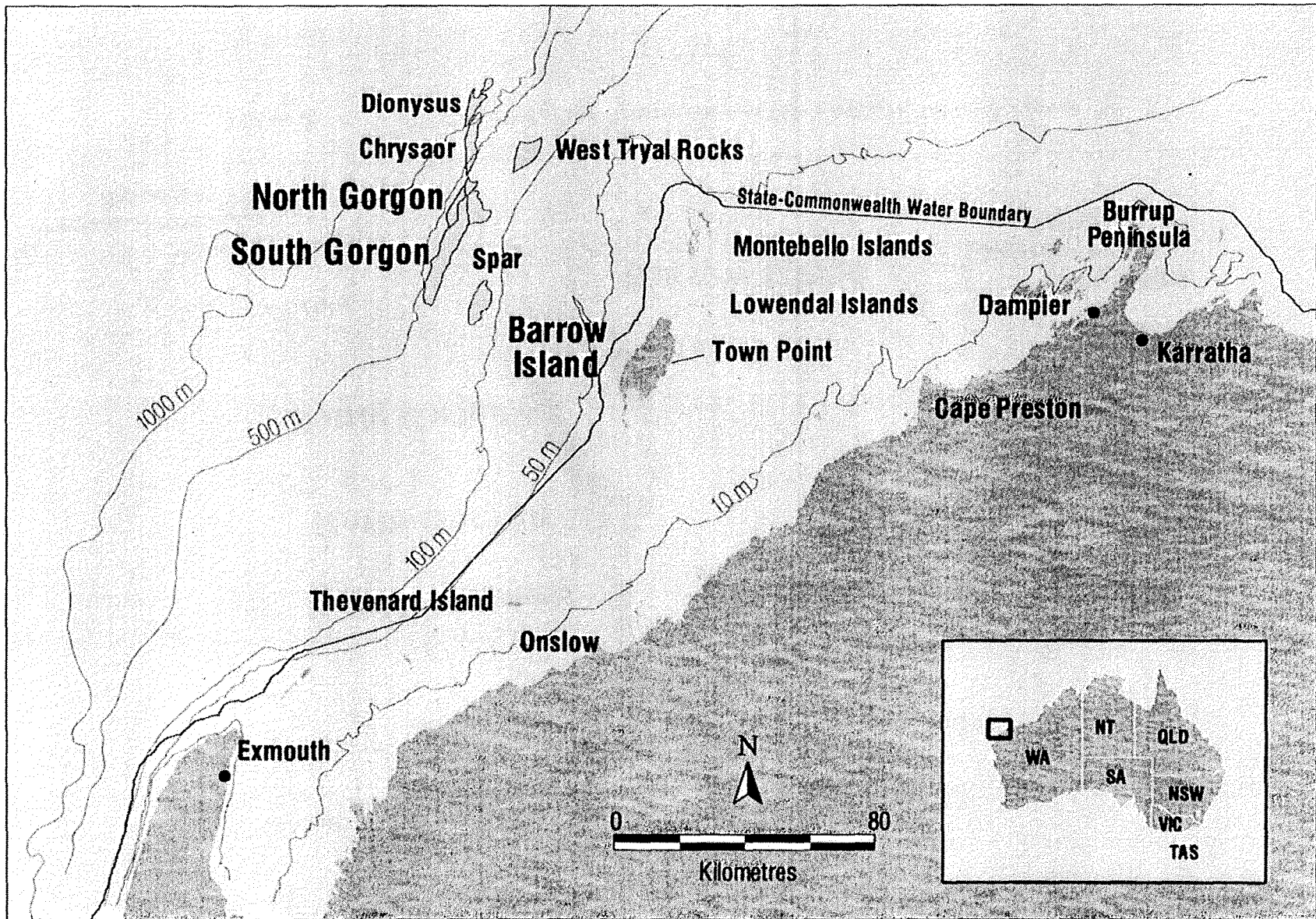


Figure 1: Location of the Gorgon Gas Fields and Alternative Development Sites

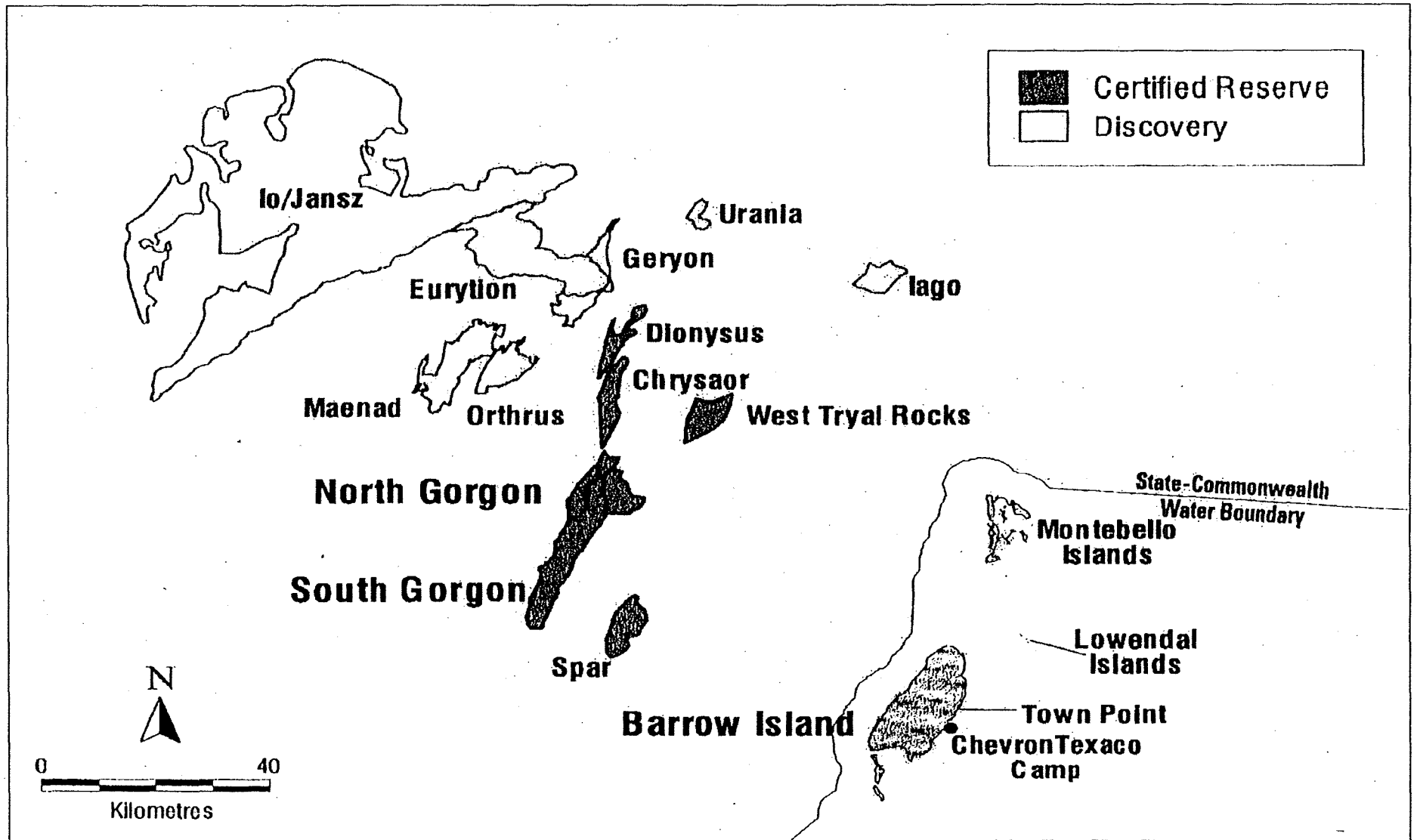


Figure 2: Location of the Greater Gorgon Gas Fields, including Io/Jansz

2.4 The Process

In November 2001 the developer was advised that the WA Government is prepared to consider the restricted use of Barrow Island for the initial development of the Gorgon area gas fields, after all relevant environmental, social, economic and strategic issues had been examined, and provided that the proposed development would yield net benefits for conservation.

A process was put in place to provide separate environmental, social, economic and strategic advice to ensure that Government had the best available information to make an in-principle decision about access to Barrow Island and to ensure that all interested parties have an opportunity to provide input to the Government's deliberations. The process has been overseen by the Standing Inter-agency Committee of CEOs (SIAC).

The EPA was asked to provide advice to Government on the environmental aspects of the proposal, the Conservation Commission was asked to provide advice on nature conservation matters and the Department of Industry and Resources (DoIR) was given responsibility for assessing the strategic, economic and social aspects of the proposal.

In February 2003 the Gorgon Venture released the "Environmental, Social and Economic Review of the Gorgon Gas Development on Barrow Island" (ESE Review) for a six week public submission period.

Public submissions on the environmental aspects of the ESE Review were received by the EPA, on behalf of SIAC. ChevronTexaco responded to the submissions, and the whole of government evaluation phase of the project commenced. A summary of the submissions can be found at www.epa.wa.gov.au and ChevronTexaco's responses can be found at www.gorgon.com.au. A list of submitters names is attached to this report at Appendix 4.

This report contains the Environmental Protection Authority's strategic advice on a conceptual proposal from an environmental perspective and has been prepared under Section 16(e) of the *Environmental Protection Act* (Government of Western Australia, 1986). It should be noted that this strategic level process aims to assist an in-principle decision by Government. An in-principle Government approval would not remove the need for formal environmental impact assessment under Section 38 of the *Environmental Protection Act (1986)* and the Commonwealth *Environment Protection and Biodiversity Conservation Act* (Commonwealth of Australia, 1999). An approval arising out of the current process does not constitute or imply environmental acceptance of the proposal.

This report has been released, together with those by the Department of Industry and Resources and its consultant, Allen Consulting Group (DoIR, 2003; ACG, 2003) and the Conservation Commission (Conservation Commission, 2003), for six weeks, to give the public full access to the environmental, social, economic and strategic advice available to

Government about the Barrow Island proposal. This period provides the opportunity for public comment before Government makes an in-principle decision.

The EPA Services Unit will provide a secretariat to receive any comments or further input which the public may wish to provide ahead of the Government's in-principle decision, which is expected in September 2003. Comments should be forwarded by **12 August 2003** to:

Mr Douglas Betts
Department of Environment
PO Box K 822
PERTH WA 6842.

The Minister for State Development will convene a Ministerial Sub-Committee with the Treasurer/Minister for Energy and the Minister for the Environment and Heritage to coordinate and oversee the finalisation of all matters relevant to the Government's in-principle decision.

3 ENVIRONMENTAL PROTECTION AUTHORITY ADVICE ON ENVIRONMENTAL VALUES OF BARROW ISLAND

3.1 The Question for the EPA

The primary question for the EPA is, whether or not it is environmentally acceptable for the Barrow Island class A Nature Reserve to be used as the location for a gas processing complex, specifically, for the processing of natural gas from the offshore Gorgon area gas fields.

This section presents an overview of the history of the Barrow Island Nature Reserve and the environmental values which make it an area worthy of protection and conservation.

3.2 History and Status of Barrow Island

3.2.1 Barrow Island as a Nature Reserve

Barrow Island has a recognized and time-honoured history as a Nature Reserve of State, national and international importance:

- 5 October 1908 - "The West Australian" carried a letter to the Premier (Mr N. J. Moore) from the President of the Western Australian Natural History Society (Dr Cleland) which said, in part "*...on behalf of all scientific men...throughout the world, and of all lovers of nature, I desire to convey to you our earnest hopes that the Government may see their way to proclaim Barrow Island an absolute fauna and flora reserve for all time.*" He stated that Western Australia should "*do its*

utmost to preserve from absolute extinction some of its many rare and unique animals in suitable localities adequately guarded from the vandal. This is a duty we owe not only to ourselves, but to posterity, for whom we hold in trust the natural resources of our State". At the time, Dr Cleland cited four species as unique to Barrow Island.

- 18 November 1908 - Executive Council set apart Reserve 11648 for the purpose of "Protection of Flora and Fauna".
- 9 February 1910 - Executive Council classified Reserve 11648 as class A under the Permanent Reserves Act.
- 1966 - legislation provided for a petroleum lease on Barrow Island.
- 1979 – Barrow Island was renamed a Nature Reserve.

Nature reserves are created by Parliament for the purpose of preserving their natural values. They are more constrained in their human use than national parks and any change to the purpose requires the agreement of both Houses of Parliament (Section 43, *Land Administration Act (1997)*) (Government of Western Australia, 1997a). Class A nature reserves are the most precious of nature reserves, the jewels in the crown of the conservation estate, set aside for the purpose of protecting their recognized conservation values.

The waters around Barrow Island have been proposed for reservation as part of a Barrow-Montebello Islands Marine Conservation Reserve. The Biggada reef coral community south of Flacourt Bay on the west coast, and the mudflats of Bandicoot Bay on the south coast have regional conservation significance (Marine Parks and Reserves Working Group, 1994). These areas are proposed to be reserved with a high level of protection.

3.2.2 Industry on Barrow Island and Nature Reserves

Barrow Island has supported a producing oil field for nearly 40 years and production is expected to continue for another 15 to 20 years (ChevronTexaco, 2003a). Since the first oil well was drilled on Barrow Island in 1964 (production began in 1967), more than 800 wells have been drilled. There are currently 455 oil-producing wells, serviced by a fly-in fly-out workforce of 150 to 200. The petroleum lease (L-1H) overlies and takes precedence over the class A reserve and currently allows for third party industrial development, by agreement with the State.

Access to Barrow, Varanus, Thevenard and Airlie Islands in the Pilbara has been provided in the past to facilitate development of associated or nearby oil fields. While all these islands are nature reserves, the conservation values of Barrow Island are much greater than those of the other much smaller islands with simpler ecosystems (see Section 3.3 below).

However, there are policy precedents for excluding development in sensitive environments. Oil drilling is banned in the Ningaloo Marine Park and much of Shark Bay has been variously zoned for marine conservation. Access to marine nature reserves

in Shark Bay is prohibited for mining and petroleum drilling and production under the New Horizons policy (Government of Western Australia, 1997b).

In submissions on the ESE, reference was made to the State Labor Party platform prior to the last election. That platform contained a commitment to “prohibit mineral and petroleum exploration and mining in National Parks and nature reserves” (Labor Party, 2003).

3.3 Environmental Values of Barrow Island Nature Reserve and Surrounding Waters

This section provides an outline of the environmental and unique conservation values of Barrow Island. Further detail on these values is contained in Appendix 1 to this report.

Considerable status was ascribed to the biodiversity values of Barrow Island in 1908, when Dr Cleland cited four species as being unique to the island. There are currently 24 taxa known to be unique to Barrow Island and another 5 that are restricted in their distribution. The 1908 values have increased and continue to do so as taxa become extinct on mainland Australia, and as the community increasingly recognises biodiversity as a valuable resource worthy of protection.

Today, 22 taxa of native mammals that existed in Australia at the time of European settlement are extinct. Another 9 taxa could also be extinct, if it were not for island nature reserves, including Barrow Island. About a quarter of the world’s mammals are listed as threatened by the World Conservation Union (IUCN, 2002). For less studied groups such as fish, mussels and crustacea, the proportion of threatened species could be as high as one- to two-thirds (The Royal Society, 2003).

Barrow Island is perhaps unique for its size in the temperate regions of the world for the absence of introduced mice, rats, cats, goats, sheep, rabbits and foxes (Morris and Burbidge, 2002). Barrow Island has never been grazed by introduced stock. The absence of predators, competitors and land use change has left the island’s ecosystems relatively undisturbed and the native mammals have thrived. While native species loss is a feature of the mainland, Barrow Island is a benchmark for biodiversity features of pre-settlement Australia.

Barrow Island has a substantial suite of unique conservation values. Table 1 summarises the key biodiversity values of Barrow Island, indicated by the number of animals found nowhere else and those with restricted distributions outside Barrow Island. Appendix 1 contains more detail on these values.

Table 1. Distribution of terrestrial animals found on Barrow Island.

Group	Found Nowhere Else	Restricted Elsewhere
Mammals	5	1
Fish		1
Birds	1	
Reptiles	2	
Invertebrates	16 ¹	3
Total	24	5

Source: Department of Conservation and Land Management records.

¹These 16 taxa are mainly subterranean fauna from DCLM records. Based on data from the Gorgon ESE, probably 4 new subterranean invertebrate taxa and at least another 7 of uncertain taxonomic status may exist.

Barrow Island supports 14 taxa of **mammals** on an area of about 23,500 hectares. Six of these are listed as endangered and five are unique to Barrow Island. By comparison, Dirk Hartog Island (Western Australia's largest) once supported 15 taxa of mammals on about 62,000 hectares¹. At least 10 of these taxa have now been lost from Dirk Hartog Island due to introduced predators (cats), competitors (rodents) and habitat loss (grazing by introduced sheep and goats).

Eighteen taxa of **reptiles and invertebrates** (mainly stygofauna) are peculiar to Barrow Island. The Barrow Island Blind Snake (*Ramphotyphlops longissimus*) is believed to be the only troglodytic (confined to living in air spaces underground) snake in the world. The island supports 43 reptile taxa, including the Perentie (*Varanus giganteus*) which, at over 2m long, is the world's second biggest lizard and a top (native) predator on Barrow Island.

The island provides habitat for 53 **bird** taxa including the threatened, endemic Barrow Island Black and White Fairy Wren. Barrow Island is seasonally visited by migratory wading birds, listed as protected by international treaties and Commonwealth and State law.

The island is significant on a national and international scale for marine **turtles**, which are specially protected as threatened fauna. Barrow Island is the nesting site for three turtle species. Threatened **whales and sharks** also occur around Barrow Island.

Studies of Barrow Island's **plants** and vegetation communities have identified 350 plant taxa and the assemblage of both taxa and community types is unique. *Chorchorus interstans* is specially protected as a Priority 3 plant species.

Quarantine practiced on Barrow Island since the oil field was established in the 1960s has limited the number and severity of invasions such that they have been either eradicated or

¹ Rottneest supports one terrestrial mammal (the Quokka) and a few bat species, on an area of about 1,900 hectares.

contained. There have been quarantine breakdowns and some weeds have established on Barrow Island. Nevertheless, its important and unique biodiversity values remain.

The combination of these biodiversity values on a single island reserve and the absence of introduced animals significantly increases the island's overall conservation value above the sum of the individual taxa and community values. It is recognized that its island status protects environmental values from introduced predators, competitors, grazers and diseases. These agents, together with inappropriate fire regimes and disease have driven many native animals to extinction on the mainland. The animals most at risk are those in the "critical weight range" between 35g and 5.5kg which are easy prey to foxes and cats and compete directly with rabbits, rats and mice (Burbidge and McKenzie, 1989).

DCLM advises that its island status and environmental values make Barrow Island an important nature conservation asset on an international scale and one of Australia's most significant nature reserves. The combination of taxa and communities on Barrow Island is unique and cannot be re-created as a combination by translocation from Barrow Island.

While other islands off the Pilbara coast have biodiversity value, Barrow Island has the widest range of habitats and the greatest biodiversity. There are over two dozen terrestrial animal taxa (8 vertebrates and at least 16 invertebrates) that exist on Barrow Island and nowhere else.

3.4 EPA's View on Locating Industry on Barrow Island, and in Nature Reserves in General

The EPA is of the view that, as a matter of principle, industry should not be located in nature reserves, particularly class A Nature Reserves. Key EPA statements have been made on the protection of native vegetation in its Position Statement No 2 (EPA, 2000). EPA Position Statement No 7 (EPA, 2002a) enunciates principles for environmental protection, natural resource management and sustainability which encompass the precautionary principle, intergenerational equity, and the conservation of biodiversity and ecological integrity, all of which are consistent with the view that industry should not be located in nature reserves.

Nature reserves are specifically created by Parliament for the purpose of protecting natural values. As such, these values should not be put at risk. It is not possible to place a dollar value on conservation assets. They have an intrinsic value to the community that should not be discounted.

The community's views on the environment and conservation have changed significantly since approval was provided to allow access by WAPET for oil exploration and production on Barrow Island. As a consequence, previous approval should not be seen as

the basis for admitting further industry access or for an automatic extension to the current proposal.

Expectations of corporate governance and corporate stewardship have also risen since the time that the Barrow Island oil field was approved in the 1960s. Sustainable business now involves setting and reporting against social and environmental goals as well as traditional economic indicators, thereby creating obligations on company directors to meet sustainable environmental objectives as well as economic targets.

Given the very high environmental and unique conservation values of Barrow Island, which are reflected in its status as a class A Nature Reserve, it is the view of the EPA that, as a matter of principle, industry should not be located on a nature reserve and specifically not on Barrow Island.

4 LOCATION/SITE OPTIONS FOR THE PROPOSED GAS PROCESSING PLANT

It is the view of the EPA that Barrow Island is an inappropriate location for the gas processing plant. On environmental grounds there are preferred options for the location of the Gorgon gas development. Advice from DCLM indicates that alternative sites have lower environmental and conservation values than Barrow Island. An outline of environmental issues associated with alternatives to Barrow Island is set out below. Additional information is contained in Appendix 2.

4.1 Options Considered by the Developer

The Gorgon Venture (ChevronTexaco, 2003a) has considered other locations, including the Burrup Peninsula (Holden Point), Maitland Estate/West Intercourse Island, Cape Preston, Thevenard Island, and the Montebello Islands, but concluded that Barrow Island is the only commercially feasible location, as well as being environmentally and socially acceptable. The developer does not present an alternative in the event that Government finds Barrow Island unacceptable.

DCLM advice indicates that the conservation values of all other suggested sites are lower than those of Barrow Island. The DCLM is of the view that *“While ChevronTexaco attempted to do [so] to some degree, it has failed in the ESE Review to provide adequate environmental and social reasoning, supported by reliable data, for the selection of Barrow Island for the gas processing project over the alternative locations.”* *“...the ‘combined’ level of constraint for each site provides a means to ‘offset’ high environmental constraints with low economic constraints, in order to provide an overall moderate level of constraint for sites. This is inappropriate.”* (DCLM, 2003)

4.2 DCLM Advice on Alternatives to Barrow Island

DCLM has provided preliminary data on the environmental values of some of the alternatives to Barrow Island. These data are summarised in Table 2 below.

Table 2. Some environmental values of alternative sites to Barrow Island.

Attribute	Cape Preston¹	Thevenard Island	Trimouille Island	Barrow Island
Land Tenure	-No terrestrial conservation reserves	-Class C nature reserve	-Class A conservation park	-Class A nature reserve
Fauna	-None threatened -Several priority sps.	-One priority mammal	-One threatened mammal (Mala)	-Six threatened mammals -One threatened bird -Endemic reptiles and stygofauna
Flora and Vegetation	-No DRF ² -Five P3 sps.	-No DRF noted	-No DRF noted	-No DRF -One P3 ³ sp.
Introduced Species	-Several introduced mammals -1 declared weed -13 other weeds	-Dense population of house mice -Weeds present	-Feral cats and black rats recently eradicated -Severe weed infestation	-No introduced mammals -Four contained weed species
Marine Values	-Proposed marine conservation reserve	-No marine reserves proposed	-Proposed marine conservation reserve	-Proposed marine conservation reserve

Source: DCLM Submission.

¹Other mainland sites generally have similar, although not identical, values to Cape Preston, according to the DCLM submission.

²Declared Rare Flora (DRF)

³Priority 3 Species

The DCLM order of preference for sites is Cape Preston, Maitland Estate, Thevenard Island, then Montebello Islands (provided marine values could be adequately protected).

The EPA commissioned a review by Murdoch University of the site selection report produced for ChevronTexaco. This review (Annandale and Lanske, 2003) concluded that the analysis performed for ChevronTexaco contained methodological flaws.

4.3 EPA Conclusion and Advice on Alternative Sites

Noting the DCLM advice and the advice from Murdoch University, together with information on the values of Barrow Island (section 3 above) and the risks to those values associated with locating the project on Barrow Island (section 5 below), the EPA does not agree with ChevronTexaco's view that Barrow Island is an acceptable location from an environmental impact point of view. On the basis of the information available, all the alternatives described above would have less environmental constraints than Barrow Island.

The EPA understands that Trimouille Island in the Montebello's group is economically competitive with Barrow Island (ACG, 2003). The developer, however, asserts that the commercial and legal (as distinct from economic) risks on the Montebello Islands group (of which Trimouille is a part) are too great because of elevated radiation levels on some parts and the lack of useable land.

The EPA considers that, from an environmental point of view, alternative sites to Barrow Island could be found acceptable in the sequence (most to least desired location) of brown-fields mainland sites, green-fields mainland sites and Thevenard Island. Trimouille Island could be considered, provided marine values could be adequately protected.

It is possible that CO₂ injection on Barrow Island in isolation from a gas processing plant may be possible without putting the conservation values at risk because of the reduced footprint and activity involved. However, management plans would need to be developed to ensure that the risks from CO₂ injection would not have unacceptable environmental impacts.

The EPA considers that more attention could be given to the possibility of locating only a CO₂ injection plant on Barrow Island with the bulk of the facilities elsewhere.

5 THREATS TO THE ENVIRONMENTAL AND CONSERVATION VALUES OF BARROW ISLAND

If the Government decides, on economic grounds, to allow the location of the gas processing complex on Barrow Island, the EPA recommends that detailed attention should be given to risks posed to the considerable environmental values of Barrow Island. This section of the EPA report is relevant if Government decides to allow the project to be located on Barrow Island. Nevertheless, the conclusion that the level of risk of plant and animal invasions is “virtually certain” (see 5.1 below), supports the EPA view that Barrow Island is not an appropriate site for the gas processing complex. Further detail on the risks associated with invasion by terrestrial organisms is contained in Appendix 3.

The values of Barrow Island are set out in Section 3 above. The combination of early reservation of the land as a nature reserve, its island status and generally effective quarantine so far (associated with limited access) has allowed those values to be retained. This section sets out the risks to the values of Barrow Island, explored by identifying the potential threats posed by industrial development, the likelihood of a threatening event occurring, and the consequences of the event for the values of Barrow Island.

The discussion focuses on the primary threats which may represent “fatal flaws” to industrial development on Barrow Island. Primary threats are those which could result in large scale ecological changes. The primary threats which could credibly be initiated by industrial development are the introduction of invasive organisms (including disease), impacts on the marine environment, clearing of native vegetation, changes to the natural fire regime and industrial discharges. Secondary threats, such as animal deaths due to habitat loss or increased road traffic, are not examined in detail here and would need to be addressed at the time any formal environmental impact assessment is undertaken.

5.1 Terrestrial Invasive Organisms

The most significant potential threat from industrial development to the environmental values of Barrow Island is introduced invasive organisms, particularly animal pests and weeds. Data from the ESE Review (ChevronTexaco, 2003a) and a Quarantine Risk Assessment (QRA) (ChevronTexaco, 2003b), produced in association with the ESE process, illustrate the scale and nature of the increases in proposed movements (barges, aircraft, personnel, equipment, construction material, food, supplies and stores) to Barrow Island, if development of a gas processing complex proceeds:

- at the peak of oil production, up to 50 tankers per year visited Barrow Island; tanker movements are projected to increase from the current 12 per year to up to 160 per year (ChevronTexaco, 2003a);
- the number of people on the island would rise from approximately 150 - 200 to 2200 at the peak of construction;

- the proposal envisages a construction period of 39 months with up to a 10 times increase over current levels in barge movements per week to the island at the height of construction (ChevronTexaco, 2003a, 2003b).

The volume and number of these movements represent the single biggest pathway for the potential introduction of pests and diseases to Barrow Island.

The operators of the existing Barrow Island oil field have recorded 27 breaches of quarantine since 1964. To date, potentially invasive animals have either not become established or have been eradicated. A number of weed invasions have established on Barrow Island and are currently contained, but not eliminated.

The QRA concluded that “*The likelihood of an invasive species introduction ...over the life of the Gorgon development has been classified as ‘likely’ but uncontrolled successful establishment is considered unlikely*”, and that “*The risk of an invasive species introduction to Barrow Island has been determined as moderate.*”

Using data from the ESE and the QRA, projected future quarantine breaches have been calculated, assuming only the current level of control. Given the totals of 51 projected future breaches from barge landings and 31 breaches from personnel landings (see Appendix 3) over the 30 year life of the gas field, a breach would be described as “*virtually certain*” using the descriptors set out by ChevronTexaco.

The real question is, what likelihood of a breach is acceptable? There are no hard and fast rules for this and we were not able to find any comparable precedents. It is a matter for judgment which is addressed further in Appendix 3.

Assuming a level of control consistent with past performance, the likelihood of quarantine breaches would increase significantly with the increased level of traffic to Barrow Island. While the Gorgon Venture has committed to increase the level of control, the significant increase in frequency and volume of movements and the change from a small, long term operations workforce to a large, casual construction workforce introduces significantly greater complexity to the issue of quarantine control. New invasion pathways would also open up, particularly during construction, as materials are secured from new sources via new supply lines (Hayes, 2003). The attendant increase in disturbance (up to 300ha) would also compound the likelihood of invasive weeds establishing and spreading.

Control of the consequent impacts of a quarantine breach on the values of Barrow Island would be heavily dependent on the barriers to invasion that can be created, the controls that can be placed on establishment and the success of eradication plans if establishment does occur. At this stage, there are few hard data or precedents available at the scale contemplated on which to make a judgment about the acceptability of the increased likelihood of invasion and the subsequent risk of impact on the very important environmental and conservation values of Barrow Island. Eradication measures themselves can pose risks to the native animals. Previous rat eradication on Barrow

Island resulted in many native animal deaths because they could not be excluded from the poison bait stations.

The QRA concluded that *“The level of ‘moderate’ risk ...implies that the Gorgon gas development is likely to lead to the introduction of invasive species on Barrow Island if quarantine effort is proportionate to current quarantine procedures. This is not compatible with the Gorgon Venture quarantine objective. To achieve the objective of zero invasive species introductions, a Gorgon-sponsored enhanced quarantine system will need to be developed and implemented.”* The QRA goes on to say *“The Gorgon Venture would undertake ongoing development of an enhanced quarantine system in order to reduce any residual level of quarantine risk in order (sic) achieve the quarantine objective of zero introductions of native species.”*

There is on average a six-fold increase in the likelihood of a breach of quarantine during construction, if the level of control remains the same as in the past (see Appendix 3). This is an important assumption as the level of control could change either way. On the one hand, more controls can be introduced. On the other, it seems unlikely that a contracted workforce, working to construction deadlines, would reach the same levels of training, awareness and control of quarantine issues that a dedicated, stable workforce has attained (i.e.. the oil field workforce).

The Gorgon Venture (ChevronTexaco, 2003b) has proposed a list of control actions to enhance the quarantine system, but little concrete data or evidence has been presented to show that the objective of achieving zero introductions can be met at the scale of operations contemplated. Additional, careful analysis of future invasion pathways, event trees and intervention options would assist in forming a view. This information is not yet available as details such as the sources of construction materials and hence, potential new invasion pathways, are not yet decided by the developer. Even with these data, outcomes would not be certain without some real experience of the new, increased level of activity. Only actual implementation would provide certain information about the outcomes.

Ultimately, the consequences of an invasion are of most concern. Given that a number of animals occur on Barrow Island and nowhere else, the potential consequences of the loss of one or more species are very significant. At this stage, much more work would need to be done to establish the links between invasions and their ultimate consequences.

At this stage, there is little concrete information on which to base a judgment about the risk to conservation values from quarantine breaches for a proposal of the scale proposed by the Gorgon Venture.

While the current quarantine system on Barrow Island has served the historic level of operations reasonably well, the level of activity projected for the new proposal would require unprecedented levels and types of quarantine effort. Given the yet to be defined and untried nature of the intensity and combinations of controls likely to be required, the EPA's level of confidence in their success is currently low.

In the view of the EPA, a "try it and see" approach is unacceptable in a class A Nature Reserve with high and unique conservation values, given the dire consequences of failure. The EPA strongly recommends a precautionary approach, as advocated in EPA Position Statement No. 7, is most appropriate where the environment and conservation values are so high and unique. This approach requires any decision to proceed with development to be based on solid data, enabling sound judgment. If the project were to proceed, it could only be with a policy of a 'zero tolerance of invasions' target and an associated quarantine regime of sufficient, demonstrated rigor to achieve this.

5.2 Threats to Marine Values

Direct removal of marine habitat would occur due to trenching and blasting associated with the laying of gas pipelines, construction of the MOF and piled jetty and the dredging of shipping channels. The risk of marine pest species introductions discharged in ships' ballast water or from hull fouling organisms would increase significantly because of the greater intensity of ship, barge, dredge and work boat activities associated with the project.

Potential disruption to the nesting and breeding patterns for turtles and migration paths for whales and other marine mammals may occur due to noise and disturbance associated with trenching, blasting and dredging activities during the construction phase. Light spill during construction activities, and from the plant, flare, jetty and load out facilities during the operational phase could also pose a significant threat to the nesting and breeding patterns of turtles. The health, abundance and diversity of benthic marine communities may be impacted by turbidity plumes and smothering of marine organisms with sediment, linked to dredging, dredge spoil disposal and re-suspension, reclamation, shipping activities and runoff and erosion from cleared areas of the island. The disposal of 5-10 million cubic metres of dredge spoil has the potential to impact significant marine communities over relatively large time and space scales unless the location of the spoil ground is very carefully chosen.

Contamination of marine life may occur due to routine discharges, leaching of anti-fouling paints, accidental spills or shipping accidents. Thermal loads (cooling water discharge) to marine environment should be discouraged, particularly in summer and

early autumn when the corals are near or at the limits of their thermal tolerance and approaching the peak of their reproductive cycle. The presence of a large construction work force could place increased pressure on the marine and coastal resources of the island, particularly the turtle populations, the inter-tidal communities and the territorial demersal fish resources.

There is currently no information on the presence or otherwise of marine pests in the surrounding waters. No estimate is provided in the ESE of the total area of direct disturbance likely in the marine environment. Given the scale of the proposal and the proposed marine conservation status for the waters around Barrow Island, this disturbance can not be considered trivial. Considerable dredging would be required to provide a channel to the proposed marine offloading facility, a 4km jetty is proposed and the gas supply pipeline would require trenching or other bottom disturbance during installation. An area at Biggada Reef has regional conservation significance (Marine Parks and Reserves Working Group, 1994) and has been proposed as a marine nature reserve. The gas supply pipeline to the Flacourt Bay shore crossing passes within about 150m of the proposed boundary of the reserve. The gas pipeline would also carry some liquid hydrocarbons.

The risk of a condensate spill from the gas delivery line, or from tanker operations, requires careful consideration. Similarly the potential for direct impacts or the introduction of exotic marine pests to an area proposed as a marine conservation reserve deserves careful scrutiny.

5.3 Clearing and Other Direct Impact Threats

The clearing of 300ha is significant in any context and particularly so for a class A Nature Reserve. Many nature reserves are significantly smaller than this. A more or less contiguous area of this extent can be expected to support a meaningful array of biodiversity in its own right. Further, the location at Town Point preferred by the developer is closely associated with a number of Boodie (*Bettongia lesueur*) warrens which would be expected to be at risk from blasting, noise, dust and other disturbance, if not by direct clearing. Clearing of the additional 300ha would be cumulative on the impacts caused by previous clearing totaling over 1000ha (ChevronTexaco, 2003a) on Barrow Island.

The clearing of a drainage channel through the preferred location is a particular issue of concern, given the limited extent of these areas on the island, their preferential targeting for gravel extraction in the past and the possibility that they may support plant taxa that are not well represented elsewhere on the island (Trudgen, 1989). Even if the drainage channel were not cleared, the potential for excessive sedimentation and run-on of pollutants from a complex processing liquid hydrocarbons and other process agents would be cause for concern.

Run-off and subsequent groundwater pollution is of particular concern for its potential to affect stygofauna which inhabit the narrow lens of fresh water beneath and adjacent to the proposed plant site. Clearing of the plant site is also likely to disrupt stygofauna locally through increased sedimentation and disruption of the natural input of nutrients to the groundwater.

It is the EPA's view that the clearing of 300ha, in addition to the previous clearing of over 1000ha, is inconsistent with the purpose of preserving the natural attributes of a class A nature Reserve, and would have direct, deleterious impacts on at least some Barrow Island organisms with high biodiversity values.

5.4 Fire Threat

Another major ecosystem level process that could render a significant change to the environmental and conservation values of Barrow Island is a major shift in fire frequency. Barrow Island consists of a mosaic of vegetation complexes which are more or less adapted to tolerate, benefit from, and even depend on fire for their survival. Spinifex grasslands dominate large parts of the Barrow Island environment. These grasses are adapted to dry, fire prone, low nutrient environments and ultimately depend on fires to persist against dominance by shrubs. At the same time, fire which is more frequent than the seed generation cycle is also likely to threaten the survival of this vegetation type, particularly on an island where re-invasion from outside is severely hampered (Ecaus, 2003).

Between 1956 and 1962, before the oil field was established, some 90% of Barrow Island was burnt. Since then, it has been subject to a fire suppression regime to protect the oil field assets. Five lightning induced fires in the 1990s are understood to have been localised and largely suppressed. Other very small fires caused by human activities (e.g. welding sparks) are unlikely to have had any significant eco-system level influence on the vegetation. Hence Barrow Island has largely been kept free of significant fires for about 40 years. Observations indicate that Spinifex grasslands on Barrow Island have now developed a significant level of ground cover with large, robust clumps which may be at the height of their biomass and size. In the continued absence of fire, these clumps can be expected to gradually senesce and degenerate into the rings and crescents typically seen in long un-burnt country. The time needed for this to occur is not known with certainty. Ecaus (2003) estimates a time period of from 40 to 50 years.

If a gas complex is constructed on Barrow Island, it is the developer's stated intention to "*extend the suppressed fire regime...for reasons of safety of personnel and risk to infrastructure*" (ChevronTexaco, 2003a). Suppression for the 30-year life of the proposed project, and probably for some decades more given the extent of other gas resources in the Greater Gorgon area, in addition to the previous 40 years of fire suppression, could have eco-system level effects of uncertain consequence. For example, Spinifex may senesce and be replaced by shrubs like *Acacia* sp. and *Melaleuca* sp. As a number of the

animals endemic to Barrow Island rely on Spinifex habitat for forage, shade and cover from predators, wholesale changes to the extent or structure of Spinifex grasslands could also have compounding impacts on the other conservation values of Barrow Island. At the least, the present character of the island would change.

Alternatively, overly frequent fire could also alter eco-system dynamics. Spinifex regeneration could be suppressed if plants were burnt too frequently, before they set significant seed stores. Infrequent but intense fire would be likely to damage intolerant vegetation such as figs (*Ficus* spp.) which occupy refuges from moderate fires, such as rocky outcrops (Ecaus, 2003).

While fire at intervals or intensities outside the normal range may affect the vegetation (and hence overall environmental and conservation values) of Barrow Island, it is the deliberate, long-term and island-wide suppression of fire that probably poses the most credible, ecosystem wide threat.

The EPA recommends that fire research and trials should commence, and that a plan designed to safely manage extensive fire, consistent with a natural regime, should be developed, regardless of whether or not the Gorgon gas project proceeds. The EPA appreciates that this is a particular challenge in the existing oil field but believes that more can be done in the northern part of the island now and more extensively as techniques consistent with the oil field are developed and as the field is shut down.

5.5 Sequestration of Carbon Dioxide

The combustion of fossil fuels releases greenhouse gases, principally carbon dioxide (CO₂), methane and nitrous oxide. Carbon dioxide and methane from the produced gas is released from LNG operations in significant quantities. Atmospheric concentrations of these gases have increased substantially in the last 200 years. These increases have raised concerns that the related global warming effects will melt polar ice and raise sea levels, change weather patterns and climatic zones, and consequently modify ecosystems. In response, some nations have agreed to limit their greenhouse gas emissions. Australia has negotiated to limit its increase in emissions from 1990 to 2010 to 8% of its total 1990 emission figure.

It is within this context that ChevronTexaco proposes to inject its reservoir CO₂ into the hyper-saline Dupuy Formation aquifer beneath Barrow Island, at depths below 2700m beneath the surface. The company's commitment to inject CO₂ is qualified by a proviso that it is technically feasible and not cost-prohibitive. Should this not be achievable, there are some contingencies discussed in the ESE review for partial offsetting of CO₂ in a future Greenhouse Gas Management Strategy document but no firm commitment to offset the full quantity of reservoir CO₂. Advice from ChevronTexaco indicates that it considers injection beneath Barrow Island to be a unique opportunity. While ChevronTexaco intends to investigate alternative injection locations and other offset

mechanisms, none is considered to be viable at this stage. The ESE Review finds that Barrow Island and the Dupuy Formation offer the highest degree of maturity, or confidence, on a combination of economic and geologic factors.

Injection would avoid the emission of 4.2 million tonnes of CO₂ annually from two trains of LNG each rated at 5mtpa but it would not offset all the emissions from the project. The quantity proposed for injection amounts to approximately 13% of the life-cycle CO₂ emissions from the production and use of LNG or 57% of the emissions from the production process. The project would still emit 3.2mtpa, mainly as exhaust gases, from the LNG process plant and power station complex. Injection is thus a partial mitigation of an environmental impact which would otherwise ensue. If gas were to be piped to the mainland at the rate of 300 terajoules per day for domestic consumption the compressors required would add 0.1mtpa of CO₂ to the emissions, for a total CO₂ output of 3.3mtpa from the process plant. Power generated for the project would be by gas turbines using co-generation technology to maximise efficiency and minimise these emissions, but they would not be captured or returned to the ground.

The EPA recognises that there is a strategic value to a company in establishing on Barrow Island a central repository for subsurface disposal of CO₂, not only for its own gas reserves, but possibly for other developers in the region with unwanted carbon dioxide. This is particularly so if Governments should in the future decide to impose a more restrictive greenhouse gas management regime on industry. The EPA notes, however, that there is currently no legal or policy requirement to do so at either Federal or State government level.

The EPA believes it is highly desirable for developers to consider innovative means for managing the carbon dioxide generated by industrial developments and encourages the pursuit of sequestration options. In the event that geological sequestration is not technically feasible or is cost prohibitive, then the EPA recommends that other appropriate mechanisms to sequester or otherwise manage an equivalent amount of CO₂ should be required.

The EPA notes, however, that there are potential locations for CO₂ injection other than Barrow Island (APCRC, 2003). Even if CO₂ could only be injected on Barrow Island and nowhere else, an injection facility could conceivably be established there with the rest of the gas complex being located elsewhere. While such a scenario would require careful assessment, the reduced infrastructure required would reduce the potential threat to Barrow Island from additional development.

A key issue for the EPA is the tension between the potential risks to the high conservation values of Barrow Island and the benefits from CO₂ injection. The EPA considers that the CO₂ benefits remain uncertain, because there is as yet no unqualified commitment from the developer to inject CO₂. The EPA is also aware that CO₂ injection is not necessarily dependent on Barrow Island. Potential reservoirs exist elsewhere in the general area, possibly at increased cost (APCRC, 2003). The developer regards these alternatives as less 'mature', meaning there is presently a lower level of certainty that

they would be suitable or reliable because they have been subjected to less study. Given the known and unique conservation values of Barrow Island and the uncertain benefits of injection, the EPA considers that potential CO₂ injection benefits are secondary to the risk to the conservation values of Barrow Island in terms of its assessment of relative environmental importance.

The EPA is of the view that CO₂ injection is a secondary issue to the conservation values of Barrow Island. In reaching this conclusion, the EPA notes that many of the conservation values occur only on Barrow Island, whereas there are other possible locations for CO₂ injection.

One issue of particular environmental relevance is the impacts of leakage of CO₂ back to the surface. Carbon dioxide is invisible, odourless and heavier than air, therefore it tends to collect in depressions. Too much CO₂ is harmful to life-forms which use oxygen to exist. Plant roots need oxygen in the soil; CO₂ normally comprises up to 1% of the gas in soils. If the oxygen is replaced by CO₂ seeping upwards the plants will become stressed and may die, as in the case at Mammoth Mountain in California, where it has created dead patches totalling 100 acres in former forest (USGS, 2000). In extreme cases it may be lethal to fauna and people. For example, at Lake Nyos in West Africa, at least 1700 people were killed by asphyxiation in August 1986 as a result of a sudden natural CO₂ release (USGS, 1997).

The EPA recommends that the risk of carbon dioxide leakage at the point of injection and by leakage from underground storage should be specifically investigated with a view to determining the risks to the natural environment of Barrow Island.

5.6 Other Issues

When providing guidance to the Gorgon Venture on the high level, strategic issues to be covered in the ESE, government agencies agreed that other issues, including emissions to air, land and water, could be managed via a formal assessment by the EPA under Section 38 of the *Environmental Protection Act*. Accordingly, these issues were not required to be dealt with in the ESE. Recognising, however, that discharges to air land and water may be important issues for a large gas complex, the EPA provides the following advice on the nature of some likely issues and the attention they would require during formal assessment.

The following analysis is based on two trains producing 10mtpa of LNG. The main gaseous emissions from the proposed LNG plant would be oxides of nitrogen (NOx) from combustion sources and hydrocarbons (largely methane) mainly from fugitive sources.

The NOx emissions would primarily be generated from gas turbines and to a lesser extent from flaring. The developer has advised that low-NOx burners would be installed in all gas turbines in order to minimise NOx emissions. NOx emissions may potentially result in impacts on human health by the formation of nitrogen dioxide (NO₂) and smog (characterised by ozone) which is formed by complex secondary reactions with reactive organic compounds. However, impacts on community health are not expected to be significant given that the proposed site is approximately 100km from the nearest town (Onslow) and approximately 150km from Karratha. Employees would, however, be housed on Barrow Island. Based on NOx emission estimates for the Woodside Expansion (Trains 4 and 5) and given adequate plant design, including appropriate stack heights and avoidance of building effects, it is likely that NEPM values could be met for NO₂ on Barrow Island. Dispersion modelling would be required to confirm if near field and regional impacts on health are likely to be acceptable once details on source parameters are available.

The other emissions from combustion processes includes sulphur dioxide (SO₂), carbon monoxide (CO), volatile organic compounds (VOC's) and particulates. Sulphur dioxide emissions are expected to be relatively low given that the level of sulphur in the raw feed gas is expected to be low and that the developer estimates that 75% of the fuel gas would be treated and therefore contain negligible quantities of sulphur.

No details of the effects of NOx or other air pollutants on the natural environment of Barrow Island are available. The developer would also need to undertake detailed investigations in order to determine if the long term impacts from the deposition of acid gases or other pollutants on the natural environment would be acceptable.

The LNG plant has the potential to emit odorous pollutants including mercaptans, carbonyl sulphide and hydrogen sulphide, as well as, other hazardous pollutants such as benzene, toluene, ethyl benzene and xylene (BTEX). The odorous/hazardous pollutants can potentially be stripped from the feed gas along with the CO₂ in the "acid gas" removal process. The pollutants can be re-injected with CO₂ into the deep saline reservoir.

However, should the re-injection option not be adopted the hazardous pollutants may potentially be released to the environment. The quantity of BTEX captured along with the CO₂ is related to the concentration of BTEX in the feed gas and the type of solvent used in the Acid Gas Removal Unit. The potential BTEX emission would require assessment under Part IV of the *Environmental Protection Act 1986* as abatement measures, such as recovery or thermal destruction of the BTEX, may be required to ensure that impacts on the environment would be acceptable.

Should the proposal proceed, the EPA recommends that attention be given to adequate plant design, including appropriate stack heights, avoidance of building effects, and appropriate emission standards, with particular reference to employees and the natural environment of Barrow Island. Dispersion modelling would be required to confirm if near field and regional impacts on health and the environment are likely to be acceptable once details on source parameters are available.

5.7 Conclusions on the EPA's Assessment of the Acceptability of the Risks to the Environmental Values of Barrow Island

Barrow Island has a substantial suite of unique conservation values. Development of a gas processing complex would significantly increase the likelihood of invasive organisms reaching Barrow Island. Knowledge about the ability to manage the risk from invasive organisms at the scale of development proposed is presently limited. Such limited knowledge is not commensurate with the high level of confidence required to make decisions appropriate to the protection of a unique set of conservation values in a class A Nature Reserve. The EPA has not been convinced that the environmental and conservation values of Barrow Island can be adequately protected in the face of a large, long-term industrial development such as that outlined by the Gorgon Venture.

The EPA considers that the proposal to place a large scale gas complex on Barrow Island is fatally flawed. Such a complex is inconsistent with the purpose of a class A Nature Reserve. The ability to reduce the risk posed by the development to the island's unique conservation values to an acceptably low level has not been demonstrated.

There has been little definitive, public work done on acceptable risk to conservation values and no clear evidence presented that the scale of project proposed could be managed to ensure that invasive organisms are not introduced to Barrow Island. More environmentally acceptable alternatives to Barrow Island exist, including island locations that independent analysis indicates could be economically competitive with Barrow Island. Finally, the potential benefits of carbon dioxide injection are still not certain to be delivered and alternative locations for injection are possible. The uncertain benefit of carbon dioxide injection is considered to be secondary to the certainty that Barrow Island has very important conservation values which occur nowhere else.

Having weighed the environmental values, the limited available data about risks, and the current level of knowledge on their management, the EPA is of the view that the proponent has failed to demonstrate that establishing a gas processing complex on Barrow Island could achieve an acceptably low level of risk to Barrow Island's outstanding environment and unique conservation values.

PART B

6 MANAGEMENT PLANS TO ADDRESS RISKS TO THE ENVIRONMENTAL VALUES OF BARROW ISLAND

6.1 Introduction

The EPA has recommended that industrial development should not proceed on Barrow Island. Should the Government decide, on economic grounds, to allow the proposal to proceed on Barrow Island, a package of comprehensive management plans should be required to address the risks posed by the development. The EPA's recommendations in this regard are set out below. A series of principles and performance levels should be set, together with a number of non-negotiable actions to deliver environmental outcomes. These principles, performance levels and outcomes are set out below. The issues below should be included in any proposal referred to the EPA for environmental impact assessment under section 38 of the *Environmental Protection Act (1986)*.

6.2 Principles and Levels of Performance to be Met

The overarching principles underpinning any development on Barrow Island should be:

- the class A Nature Reserve status of Barrow Island should have primacy; and
- the environmental and conservation values of the island should not be significantly compromised.

The EPA is unaware of any other industrial facility of this magnitude operating inside a class A island nature reserve. It is recognised that quarantine has been performed on Barrow Island for the past 40 years. However, given the quantum increase in the scale and intensity of activity proposed, threats to the environment and conservation values are likely to increase many fold. Future practices would therefore need to develop new approaches, commit a significantly higher order of resources and set new benchmarks in performance. The level of performance required to guarantee the maintenance of Barrow Island's conservation values would need to be extremely high to approach an acceptable level of confidence in their success. The EPA considers that this level of performance would need to exceed what is currently standard practice at Barrow Island and what is current world's best practice.

The key aim is to prevent any significant loss of environmental and conservation values. Indicators should be:

- no significant threat to the maintenance of enduring, viable populations of endemic species on Barrow Island nor any significant threat to the habitats and resources on which they depend; and
- no significant loss of biodiversity at the species, genetic or ecosystem level.

6.3 Non-negotiable Environmental Requirements

If Government agrees to a gas processing complex on Barrow Island, it is the EPA's understanding that the developers and operators, Australia and, to a lesser extent, Western Australia would receive significant economic benefits. It is understood that strategic benefits would accrue to the operators and the State and social benefits would flow to the community.

These benefits should not accrue at the expense of the environment or the conservation values of Barrow Island. If the economic, strategic and social values are judged by Government to justify the risks to the environment and conservation values, then substantial steps should be taken to insure that the risks are kept to an absolute minimum and that the proposal yields net benefits to conservation, as stipulated by the Government in its Cabinet decision of 15 October 2001.

As Barrow Island is a unique and irreplaceable ecosystem, net conservation benefits cannot be achieved if the current ecosystem is lost.

The substantial risk minimization and net conservation benefits should be non-negotiable and statutorily linked to any in-principle approval on access. These non-negotiable items are set out below.

6.3.1 Class A Nature Reserve Status to be Paramount

The EPA recommends that the class A Nature Reserve status of Barrow Island should be superior to any industrial lease and fixed by statute, with the primary purpose being the preservation of environmental and conservation values of the island. Tenure should be vested in the State conservation agency (Conservation Commission), consistent with the primary purpose of nature conservation in such a way that any change which may be contemplated in future requires the agreement of both Houses of Parliament.

6.3.2 Development Envelope to be Strictly Limited

The ESE Review envisages a maximum disturbance area of 300 hectares.

The EPA recommends that the limit of 300ha for new development should be enshrined in statute, in a way that requires the agreement of both Houses of Parliament should any increase be contemplated in future.

6.3.3 Reservoir CO₂ Management – Barrow Specific Requirement

The Gorgon Joint Venture, in the ESE Review, made a qualified commitment to inject reservoir carbon dioxide back into the ground to effect geo-sequestration beneath Barrow

Island. This commitment to reduce environmental impact, or an acceptable equivalent alternative, should be enforced by statute if access to Barrow Island is agreed. Carbon dioxide should be managed so as to successfully achieve effective sequestration for a period in the order of thousands of years.

Given that the Gorgon Venture commitment was qualified (in that reservoir carbon dioxide injection needed to be technically feasible and not cost prohibitive), an obligation should be placed on the developers to identify a plausible, practicable alternative to injection if the project is placed on Barrow Island and carbon dioxide cannot be injected into the ground. If such an alternative obligation is not placed on the developers, then the partial environmental offset for permitting access to Barrow Island may not be realised. The economic and strategic benefits would be achieved without reducing the environmental impacts from reservoir CO₂.

Standards would need to be agreed and reservoir studies carried out to examine the probability of adverse environmental impacts from carbon dioxide (and other entrained fluids) releases. The data would need to demonstrate that catastrophic events would be extremely unlikely to happen and the likelihood of occurrence of lesser seeps and their impacts would be manageable and unlikely to have serious consequences.

In the event that in-principle access to Barrow Island is agreed, the EPA recommends that it should be on the proviso that sequestration or other appropriate management of CO₂ must be committed to, either by sub-surface injection as proposed, or by an alternative acceptable to Government, on the advice of the EPA.

The EPA further recommends that standards for the risk of environmental impacts from CO₂ releases would need to be developed and data collected to demonstrate that such risks would be acceptably low.

6.3.4 Government Agency Control and Resources

Effective environmental and conservation control and oversight of Barrow Island should rest with the Department of Conservation and Land Management (DCLM). To date, oil field operations on Barrow Island have been conducted with limited ability for effective audit or supervision by the agency charged with managing the conservation estate and assets of the State.

To achieve the appropriate level of control, supervision and audit, there should be certainty that any arrangements for access to Barrow Island for development provide the Department of Conservation and Land Management with the necessary level of statutory power and adequate resources to ensure that it can perform the necessary functions.

The EPA recommends that arrangements should be put in place for appropriate powers and adequate resources to be provided to DCLM to ensure it can properly manage the conservation values of Barrow Island for the duration of any approved development.

6.3.5 Independent Expert Advice and Transparent Public Processes to Decide Acceptable Risk to Conservation Values

A key question bearing on agreement to access Barrow Island concerns the acceptable level of risk to the environmental and conservation values of a class A Nature Reserve. What level of risk is acceptable for the extinction of a species endemic to Barrow Island, or the compromising of an environmental or conservation value?

There are no accepted standards or clear precedents for an acceptable level of risk to conservation values. A discussion of the issues surrounding the selection of an appropriate standard for risk to conservation values appears in Appendix 3. A level of one in a million per year is regarded as acceptable for the risk of death posed to members of the public by an industrial development (EPA, 2000b). To develop a comparable standard for conservation values would require expert input, within a process transparent to the public.

If access to Barrow Island is agreed, the prospective developers should be required to engage earnestly in a rigorous and public process, involving appropriate technical expertise, to set an acceptable risk limit.

Should the Government agree in-principle to access to Barrow Island for a gas processing complex, the EPA recommends that:

- The proponent be required to engage in the development of a set of standards for acceptable risks to the conservation values of Barrow Island. Such a process should include appropriate technical experts and be structured to ensure a high level of transparency and community involvement;
- The proponent be required to demonstrate to the EPA, on the advice of DCLM and the DoE, that the risk standards can be met, with a very high level of confidence.

6.3.6 Beyond Current Best Practice Environment and Conservation Management

Having determined, through an expert and publicly transparent process, an acceptable level of risk to the environmental and conservation values of Barrow Island, it will be of paramount importance for the developers to be able to demonstrate before construction commences that there is a very high degree of confidence that this standard can be met. Quarantine will be the most important factor in controlling this risk. Such a demonstration would almost certainly rely on the development of new approaches, the deployment of significantly more resources and set new benchmarks for performance.

The EPA recommends that the developer be advised that the formal environmental impact assessment process under Part IV of the *Environmental Protection Act* will require clear demonstration of the developer's ability to meet any environmental and conservation risk standards. In so doing, they can expect to set new benchmarks in conservation management performance that go significantly beyond current best practice.

6.3.7 Management, Protection, Insurance and Offsets

The developers should be clearly advised that they would be required to take all necessary management, protection, insurance and offset measures as are required to deal with the known, anticipated or in some cases worst case impacts of the development on the environmental and conservation values of Barrow Island. All four of these undertakings may be required as part of the routine implementation of a development. They are distinct from net conservation benefits.

Management

Management includes all the day to day activities required to prevent industrial and support operations from having a significant impact on the environment or conservation values of Barrow Island.

The EPA recommends that a comprehensive plan for the management of environmental and conservation values would need to be developed, to the requirements of the EPA in consultation with DCLM.

Protection

Protection requires the taking of positive actions to protect the environment, but in this case more specifically relates to the measures to be taken to protect the conservation assets on Barrow Island.

The EPA recommends that specific measures for the protection of the unique conservation values of Barrow Island would need to be developed, to the requirements of the EPA, in consultation with DCLM, as part of a comprehensive management planning process.

Insurance

Insurance describes the measures that are put in place in case the management and protection measures on Barrow Island fail. It relates to actions to be taken to ensure, to the extent possible, the conservation of Barrow Island values elsewhere, so that they may be at least partially preserved if a catastrophic failure were to occur on Barrow Island. Translocation to sites elsewhere would have a number of limitations and require consideration of a wide range of ecological factors, including suitability of the receptor habitat, competitive effects with resident organisms, removal of introduced organisms and appropriate quarantine.

The EPA recommends that a substantive research and planning programme be required, in consultation with DCLM, to define the potential for establishing suitable habitat elsewhere and demonstrating successful translocation of species from Barrow Island.

Offsets

Offsets are actions taken to compensate for an unavoidable loss, such as the permanent clearing of a sizable area of native habitat. They often involve the secure substitution of another piece of habitat for that which is cleared but may extend to monetary compensation to provide for ongoing management or other actions.

The EPA recommends that a suitable offset for any area cleared on Barrow Island should be negotiated to the satisfaction of the EPA, on the advice of DCLM.

7 NET CONSERVATION BENEFITS

Net conservation benefits (NCBs) should be provided by the project, in addition to the management, protection, insurance and offset actions that directly relate to the impacts or potential impacts of a proposed development. NCBs are net of the actions needed to deal with impacts and potential impacts, and are actions outside of what is required for good operational practice.

What constitutes a NCB and what values to place on an environmental cost and a NCB are defined by the circumstances of each case. The conservation values of Barrow Island are high. Consequently NCB's should be of high value. For example, the determination of appropriate NCBs would have to include an evaluation of adequate compensation for the loss of a species.

Benefits may be seen as reasonable to the community if they meet all of their costs (including environmental and conservation costs) and then provide an appropriate return to the State. To be seen as reasonable, the benefit must be substantial and readily visible. NCBs need not be simply a dollar amount, but, to be realised, demonstrable, substantial and enduring conservation outcomes may require the input of resources.

The EPA does not have a precise view on what quantum of net conservation benefits should attach to the proposal to develop a gas processing complex on Barrow Island. The EPA is mindful of the scale of the project, the capital expenditure involved, the very large economic returns to the Commonwealth and to a lesser extent to the State and particularly the irreplaceable conservation values of Barrow Island.

Recognising the scale of the proposed project and the high and unique conservation values involved, the EPA recommends that a NCB decision of substance is required, which is commensurate with the scale of these factors.

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APPENDICES

Appendix 1 - Supporting Data on Conservation Values of Barrow Island

Introduction

The following data augments that contained in Section 3.3 of the main text of this report.

Mammals

Table A1-1 below lists the distribution of mammals found on Barrow Island. More than one third are found nowhere else, that is, they are endemic to Barrow Island.

Table A1-1. Distribution of terrestrial mammals found on Barrow Island.

Where Found*	Number of Taxa
Nowhere else	5
Restricted	1
Not Common	4
Widespread	4
Total	14

Source: DCLM records.

*A listing of the taxa and their distribution is contained in Appendix 1a, together with an explanation of the terms used in Table A1-1 above.

Other Terrestrial Animals

Table A1-2 below lists other terrestrial animals found only on Barrow Island or with restricted distributions elsewhere. There are of course many species of birds, reptiles and invertebrates with widespread distributions elsewhere.

Table A1-2. Distribution of terrestrial animals, other than mammals, found on Barrow Island.

Group	Found Nowhere Else	Restricted Elsewhere
Fish		1
Birds	1	
Reptiles	2	
Invertebrates	16*	3
Total	19	4

Source: DCLM records.

*These 16 taxa are mainly subterranean fauna from DCLM records. Based on data from the Gorgon ESE, probably 4 new subterranean invertebrate taxa and at least another 7 of uncertain taxonomic status may exist.

Appendix 1b lists the taxonomic names of the animals that are contained in Table A1-2 above.

Marine Animals

Data for marine vertebrates listed as threatened are summarised in Table A1-3 below. These data are for taxa formally listed by Environment Australia as threatened and known in the vicinity of Barrow Island. This table contains only those animals formally recognised as threatened on Commonwealth lists. No data appear for marine fish or other groups.

Table A1-3. Threatened marine vertebrates found in the vicinity of Barrow Island.

Group	Endangered*	Vulnerable*
Turtles	1	4
Whales	1	1
Sharks		2
Total	2	7

Source: Environment Australia.

* Classifications as per Environment Australia criteria.

Appendix 1c contains the taxonomic names of the animals listed in Table A1-3.

At least one report (Trudgen, 1989) asserts that there may be undiscovered endemic plant species on Barrow Island or that species previously confined to stream zones may have been lost due to gravel extraction. What is known is that the vegetation of Barrow Island is a unique combination of Indo-Malay, Kimberley and arid interior elements, probably due to the diverse array of habitats and maritime influence on the island.

Reference

Trudgen, M., 1989. A Report on the Progress of the regeneration of vegetation on areas disturbed during oil production on Barrow Island. Report prepared for West Australian Petroleum Pty Ltd., Perth.

Appendix 1a - Terrestrial mammals found on Barrow Island, their distribution and an explanation of terms used

Category	Common Name	Latin Name
Mammals found nowhere else (ie. endemic to Barrow Island)	Barrow Island Spectacled Hare-wallaby Barrow Island Euro Barrow Island Mouse Barrow Island Golden Bandicoot Barrow Island Boodie	Lagorchestes conspicillatus conspicillatus Macropus robustus isabellinus Pseudomys nanus ferculinus Isoodon auratus barrowensis Bettongia lesueur
Mammals with restricted distributions elsewhere	Black flanked rock wallaby	Petrogale lateralis lateralis
Mammals which are not common elsewhere	Unnamed Planigale Tan Antechinus Northern Brushtail Possum Rakali (Water Rat)	Planigale 'species 1' Pseudantechinus roryi Trichosurus vulpecula Hydromys chrysogaster
Mammals which are widespread elsewhere	White-striped Mastiff Bat Common Sheath-tail Bat Finlayson's Cave Bat Djoorri (Common Rock Rat)	Tadarida australis Taphozous georgianus Vespedalus sp? Zyzomys argurus

Definitions of distribution terms used:-

- Endemic - taxon occurs only on Barrow Island
 Restricted - scattered remnant populations occur in limited range of habitats
 Not common - occurs in other areas but not widespread or populations limited
 Widespread - common or widespread in Australia

Appendix 1b - Animals other than mammals found only on Barrow Island or with restricted known distributions elsewhere

Group	Common Name	Latin Name
Fish	Blind Gudgeon	<i>Milyeringa veritas</i>
Birds	Black and White Fairy Wren	<i>Malurus leucopterus edouardi</i>
Reptiles	Barrow Island Ctenotus Skink Barrow Island Blind Snake	<i>Ctenotus pantherinus acripes</i> <i>Ramphotyphlops longissimus</i>
Invertebrates ¹	Barrow Island Millipede Barrow Island Scorpion Barrow Island Nocticola Barrow Island Brogidomma Barrow Island Liagoceradocus Barrow Island amphipod Barrow Island amphipod Barrow Island amphipod Barrow Island amphipod Barrow Island amphipod Barrow Island amphipod Barrow Island amphipod Barrow Island amphipod Barrow Island amphipod Barrow Island amphipod Barrow Island isopod Barrow Island isopod Barrow Island isopod Barrow Island Draculoides Barrow Island Qistrachia	<i>Speleostrophus nesiotus</i> Unnamed new genus Unnamed troglobitic invertebrate <i>Bogidomma australis</i> <i>Liagocerdocus subthalissicus</i> <i>Nedsia fragilis</i> <i>Nedsia humphreysi</i> <i>Nedsia hurlberti</i> <i>Nedsia macrosculptilis</i> <i>Nedsia sculptilis</i> <i>Nedsia straskraba</i> <i>Nedsia urifimbriata</i> <i>Nedsia chevronia</i> <i>Haptolana pholeta</i> <i>Oniscidea (Isopoda) sp. nov.</i> <i>Oniscidea (Isopoda) sp. indet.</i> <i>Draculoides bramstokeri</i> ² <i>Stygiocaris stylifera</i> ² <i>Qistrachia barrowensis</i> ³

¹ Preferential, but limited, survey for subterranean invertebrates has been carried out. Probably four additional, new subterranean invertebrate taxa and at least another seven of uncertain taxonomic status exist as a result of recent work performed in the course of the ESE.

² Also found on North West Cape

³ Also found on island nearby Barrow Is

Appendix 1c - Threatened marine vertebrates found in the vicinity of Barrow Island

Group	Common Name	Latin Name
Turtles	Green Turtle ¹ Hawksbill Turtle ¹ Flatback Turtle ¹ Leathery Turtle Loggerhead Turtle	Chelonia mydas Eretmochelys imbricata Natador depressus Dermochelys coriacea Caretta caretta
Whales	Blue Whale Humpback Whale	Balaenoptera musculus Megaptera novaeangliae
Sharks	Whale Shark Great White Shark	Rhincodon typus Carcharodon carcharias

¹Nests on Barrow Island

Appendix 2 - Additional Analysis of Alternatives to Barrow Island

Alternatives to Barrow Island

There are alternatives to Barrow Island for the location of the Gorgon gas development. The advice of DCLM that alternative sites have lower environmental and conservation values than Barrow Island should be noted.

Considerable additional work on the environmental and conservation values of those alternatives would be required to make a proper comparison of their relative values.

Many submissions also commented on the choice of location, with comments falling into two main categories. Those from industry groups generally supported the proposal. Strategic, social and economic/ engineering aspects were frequently given as the justification for the proposal, although not specifically for the use of Barrow Island. These submissions often cited the 's widely perceived good environmental stewardship over 40 years on Barrow Island as reason for confidence in the environmental acceptability of locating the project there.

Other submitters argued against Barrow Island because of the perceived risks to the island's conservation values. The conservation values of Barrow Island were too important and the proposal too threatening to those values for this to be a sensible choice in a class A reserve. Many species remained to be adequately described and the status of the island's flora and fauna has been undersold. Some questioned whether with today's attitudes to conservation (which are reflected in the current Labor Party platform), the Barrow Island oil field would have been approved at all and could see no reason for its presence to be used as a justification for another development on the island. They suggested several alternatives including the proposed Maitland Industrial Estate and West Intercourse Island; Cape Preston; and Thevenard Island.

The EPA understands that Trimouille Island is economically competitive with Barrow Island (ACG, 2003). The developer, however, asserts that the commercial and legal (as distinct from the economic) risks on the Montebello islands are too great because of elevated radiation levels on some parts and the lack of useable land.

Data on residual radiation levels are contained in Manning et al (2002) and Cooper et al (1990). These reports indicate the area with elevated gamma radiation levels is limited (conservatively estimated at 50ha) and that there would appear to be scope for the 300ha required for a gas complex to be found on Trimouille Island.

The report by Manning et al concludes that the "*gamma radiation levels have now dropped to an almost insignificant level as far as likely health effects are concerned*" (Manning et al, 2002). A detailed report by the Australian Radiation Laboratory (Cooper et al, 1990) notes that most of the land mass of the islands is uncontaminated. Cooper et al state "*The only potential hazards to health from residual radioactive contamination on*

the Monte Bello Islands are due to the inhalation of actinides... and from the external gamma-radiation field. Only one area in the fallout plume of Hurricane [the offshore test] to the north-west of Main Beach, is a potential inhalation hazard." These findings were for the conditions at the time of the studies. Radiation levels will continue to fall naturally and no account had been taken of the potential for site decontamination to further improve these sites. These reports have not been acknowledged in the ESE.

While the developer contends that Trimouille Island has a useable area of less than 100ha, this conclusion is not supported by a convincing case. The island is 522ha in area and comprises sand over a limestone base. Given that earthworks for the existing North West Shelf LNG plant required the blasting and leveling of hard, igneous rock, leveling of sufficient area on Trimouille Island would seem to present less of a challenge. Trimouille Island is a conservation park which is a lower level of reservation than a nature reserve. It has significantly reduced biodiversity values due to previous invasion by weeds and pest animals. Consequently, it has significantly lower terrestrial conservation value than Barrow Island. The surrounding marine environment has been proposed to be part of a marine conservation reserve embracing the Montebello and Barrow Islands. The marine environment has high conservation values and would require careful evaluation.

If Barrow Island were not the location of the process plant, the extra costs of CO₂ sequestration may be favourably altered by moving the injection site closer to the location of the process plant. CO₂ injection may be possible at a number of other locations in the general vicinity, but these would first need to be carefully tested (APCRC, 2003).

Thevenard Island could be expected to rank closer economically to Barrow Island if CO₂ was vented rather than piped back to Barrow Island for injection. Thevenard Island is 589ha in area, supports existing oil field infrastructure, a recreational fishing base and a class C Nature Reserve. Thevenard Island supports one endemic native mouse species, but DCLM advice is that its conservation values are lower than those of Barrow Island. There are also depleted oilfields nearby (a number of which are managed by interests associated with the developer) that may offer storage opportunities for injected CO₂.

While considerable additional work on alternative sites would be required to make a proper comparison of their relative environmental and conservation values, all alternatives described above would have less environmental constraints than Barrow Island.

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Appendix 3 - Invasive Organisms Threat to Terrestrial Values of Barrow Island and Acceptable Risk

Introduction

The following discussion considers available data on the threats presented to the terrestrial values of Barrow Island from invasion by plants and animals which are not native to Barrow Island. No data are available on the likelihood of invasions by marine pests but this issue is of concern because the waters around Barrow Island have been proposed as a marine conservation reserve.

Invasive Organisms Threat to Terrestrial Values

The most significant, credible threat from industrial development to the terrestrial environment and conservation values of Barrow Island is the large increase in the potential for introducing invasive organisms, particularly animal pests and weeds. The proposed development would require orders of magnitude increases in the number of barge and aircraft landings and personnel, equipment, construction material, food, supplies and stores movements to the island. While up to 50 tankers per year visited Barrow Island at the peak of oil production, tanker movements are projected to increase from the current 12 per year to up to 160 per year (ChevronTexaco, 2003a). The number of people on the island would rise from approximately 150 - 200 now to 2200 at the peak of construction (ChevronTexaco, 2003a). The proposal envisages a construction period of 39 months with a peak construction workforce of 2200 personnel and up to a 10 times increase over current levels in barge movements per week to the island at the height of construction (ChevronTexaco, 2003a, 2003b). The volume and number of these movements represents the single biggest pathway for the potential introduction of pests and diseases to Barrow Island.

Data from the ESE Review (ChevronTexaco, 2003a) and a Quarantine Risk Assessment (QRA), produced in association with the ESE process (ChevronTexaco, 2003b), illustrate the scale and nature of the increases in proposed movements to Barrow Island if development of a gas processing complex goes ahead. The QRA was produced on behalf of the Gorgon Venture using data held by the partners. A review of the analysis performed in the QRA was conducted by Dr Keith Hayes of the CSIRO Centre for Research on Introduced Marine Pests in Hobart (Hayes, 2003).

The operators of the existing Barrow Island oil field have recorded 27 breaches of quarantine since 1964. While breaches of quarantine or invasions are to be treated seriously, it is the successful establishment of these invaders that has potentially serious environmental consequences. Animal breaches so far have either not established or been eradicated. A number of weed invasions have established on Barrow Island. These are currently contained, although they have not been eliminated.

Under the assumptions used for the development of a gas processing complex, the QRA conducted for ChevronTexaco on behalf of the Gorgon Venture concluded that "*The*

likelihood of an invasive species introduction ...over the life of the Gorgon development has been classified as 'likely' but uncontrolled successful establishment is considered unlikely". The QRA found that "The risk of an invasive species introduction to Barrow Island has been determined as moderate."

These conclusions were based on historic records of breaches of quarantine and movements to the island, summarised in Table A3-1 below, and data on projected future movements and frequency of breaches shown in the subsequent tables.

Table A3-1. Estimated historic movements to Barrow Island and quarantine breaches

Pathway	Annual Movements	Total Recorded Quarantine Breaches (since 1964)
Barges	150	27
Personnel Movements	10,191	

Source: Gorgon Development Draft Quarantine Risk Assessment. ChevronTexaco 2003b.

Based on records of landings and actual recorded breaches of quarantine since 1997, which ChevronTexaco regards as the most reliable data available, ChevronTexaco calculated an actual frequency of breaches of 0.0044 per barge landing. The frequency of breaches from personnel landings was calculated as 0.000063 per landing. These data assume the same level of quarantine control as is routinely practiced today. In Table A3-2 below the actual frequency is multiplied by the projected number of landings in future to generate an estimate of the potential number of breaches over the future life of the gas field (at least 30 years) and the remaining life of the oil field (assumed as 20 years). Note that the ChevronTexaco analysis only considered breaches attributable to the development and operation of the gas processing complex. Data for the continuing operation of the existing oil field have been added in the tables below.

Table A3-2. Projected future barge landings and quarantine breaches.

Stage	Future Barge Landings	Future Personnel Landings	Future Breaches from Barge Landings ³	Future Breaches from Personnel Landings ³
Gas field Construction	2,800	170,000	12	11
Gas field Operations	6,000	110,000	26	7
Oil field Operations	3,000 ¹	203,820 ²	13	13
Total	11,800	483,820	51	31

Source: Gorgon Development Draft Quarantine Risk Assessment. ChevronTexaco 2003b.

¹Assumes current rate of 150 barges per year continues for projected 20 year oil field life

²Assumes current rate of 10,191 landings per year continues for projected 20 year life.

³Assumes current standard of quarantine only.

Table 5-1 shown in the QRA document (ChevronTexaco, 2003b), sets out the likelihood of quarantine breaches occurring, together with a qualitative description of occurrence. This Table refers to a “*virtually certain*” event being one which “*can be expected to occur more than once a year*”. Using data from the ESE and the QRA, projected future quarantine breaches have been calculated, assuming the same level of control as occurs now. Given the totals of 51 projected future breaches from barge landings and 31 breaches from personnel landings shown in Table A3-2 above, over the 30 year life of the gas field, a breach would be described as “*virtually certain*” using the descriptors set out by ChevronTexaco. This contrasts with the conclusion in the QRA of breaches being “*likely*”.

Table 5-4 in the QRA adds another column to Table 5-1 which includes assumed levels of projected probability of an occurrence. In Table 5-4, the descriptors of “*virtually certain*” and “*can be expected to occur more than once a year*” are retained but an assumed probability of “*once in less than 100 barge landings*” is added. Given that the level of barge landings during construction is over 1000 a year and the number of projected breaches is over 4 per 1000 barge landings, the likelihood of invasion should be described as “*virtually certain*”.

In Table 5-4 in the QRA, the scale of projected probabilities is compressed. From the top, the scale decreases by one order of magnitude for each likelihood of occurrence descriptor until it moves from the “*likely*” to the “*virtually certain*” category. At that point the probability scale jumps by two orders of magnitude. To keep the probability scale uniform would require the insertion of another likelihood category, for example ‘highly likely’. If such a category were added, then the conclusion of the QRA report would be that the likelihood of a quarantine breach would be ‘highly likely’. This would still be at odds with the qualitative description of “*virtually certain*” which applies to a breach occurring more than once a year.

The real question is, what likelihood of a breach is acceptable? There are no hard and fast rules for this and we were not able to find any comparable precedents. It is a matter for judgment which is addressed further below.

The QRA provides further data on the projected numbers of personnel required to construct and subsequently operate a gas complex, the number of personnel movements by aircraft to rotate them on and off the island, and the quantities of soil and rock to be imported to provide fill and aggregate for concrete (ChevronTexaco, 2003b). These data are presented in Table A3-3 below to indicate the magnitude of increases in activity from that historically associated with the existing oil field.

Table A3-3. Historic and projected movements to Barrow Island

Operation	Historic Level	Projected Level	Average Increase
Barge Landings	150 pa	861 pa construction ² 150 pa oil operation 200 pa gas operation	6.7 x in construction 2.3 x in operation
Soil and Rock Volume	750 m ³ ¹	80,000 m ³ ³	170 x
Personnel Movements	10,191 pa	52,307 pa constr. ² 10,191 pa oil ops. 3,900 pa gas ops.	6.1 x in construction 1.4 x in operation

Source: Gorgon Development Draft Quarantine Risk Assessment. ChevronTexaco 2003b.

¹ Known data available for 1998 and 2001 airport upgrades only. Soil and rock sources for original oil field construction not included.

² ChevronTexaco assumes gas complex construction takes 39 months.

³ ChevronTexaco has indicated this may be significantly reduced.

When reading Table A3-3, it should be noted that oil field operation is assumed to continue at the existing level while construction of the gas complex occurs and that the oil field then continues to operate at the same level when the gas complex moves into production.

On this basis, an average of 1011 barges per annum (861 gas construction + 150 oil field operations) would land on the island during the construction period. At a projected quarantine breach frequency of 0.0044 per landing this foreshadows 4.4 breaches per annum during construction. During operations 350 barges would land per annum (150 oil field operations + 200 gas plant operations) which equates to 1.5 breaches per annum. Both these figures are above the “virtually certain” level of one breach per year. Personnel landings would add further to this probability of a breach.

Assuming only a level of control consistent with past performance, the likelihood of quarantine breaches would increase significantly with the increased level of traffic to Barrow Island. While the Gorgon Venture has committed to increase the level of control, the significant increase in frequency and volume of movements and the change from a small, long term operations workforce to a large, casual construction workforce introduces a significantly greater complexity to the issue of quarantine control. New invasion pathways would also open up, particularly during construction, as materials are secured from new sources via new supply lines (Hayes, 2003). The attendant increase in disturbance (up to 300ha) would also compound the likelihood of invasive weeds establishing and spreading. Control of the consequent impacts of a quarantine breach on the values of Barrow Island would be heavily dependent on the barriers to invasion that can be created, the controls that can be placed on establishment and the success of eradication plans if establishment does occur. At this stage, there are few hard data or precedents available on which to make a judgment about the acceptability of the increased likelihood of invasion and the subsequent risk of impact on the very important environmental and conservation values of Barrow Island.

The QRA concluded that *“The level of ‘moderate’ risk ...implies that the Gorgon gas development is likely to lead to the introduction of invasive species on Barrow Island if quarantine effort is proportionate to current quarantine procedures. This is not compatible with the Gorgon Venture quarantine objective. To achieve the objective of zero invasive species introductions, a Gorgon-sponsored enhanced quarantine system will need to be developed and implemented.”* The QRA goes on to say *“The Gorgon Venture would undertake ongoing development of an enhanced quarantine system in order to reduce any residual level of quarantine risk in order (sic) achieve the quarantine objective of zero introductions of native species.”*

Table A3-3 indicates that there is on average a six-fold increase in the likelihood of a breach of quarantine during construction, if the level of control remains the same as in the past. This is an important assumption as the level of control could change either way. On the one hand, more controls can be introduced. On the other, it seems unlikely that a contracted workforce, working to construction deadlines, would reach the same levels of training, awareness and control of quarantine issues that a dedicated, stable workforce like that on the oil field has attained. ChevronTexaco has stated that the planned means to control the increased risk is to enhance the quarantine system, including confining the construction workforce to the site.

A key question then becomes ‘is the level of quarantine effort required to manage a six-fold increase in likelihood of invasions, particularly with a temporary construction workforce, realistically likely to be effective at controlling the increased risk of impacts from invasive organisms?’ At present, while a list of control actions has been proposed by the Gorgon Venture (ChevronTexaco, 2003b) no data or evidence has been presented to show that the laudable objective of achieving zero introductions can be met. Additional, careful analysis of future invasion pathways, event trees and intervention options would of course assist in forming a view. This information is not yet available as details of the sources of construction materials and hence, potential new invasion pathways, are not yet decided. Even with these data, outcomes would not be certain without some real experience of the new, increased level of activity. Only actual implementation would provide certain information about the outcomes.

While the current quarantine system on Barrow Island has served the historic level of operations well, the level of activity projected for the new proposal would require an unprecedented level of quarantine effort. Given the untried nature of the intensity and combinations of controls likely to be required, the level of confidence in their success could currently be assessed as low.

A “try it and see” approach is unacceptable in a class A Nature Reserve with such high conservation values, given the consequences of failure. A precautionary approach, as advocated in EPA Position Statement No. 7, is most appropriate where the environmental and conservation values are so high and unique (EPA, 2002). If the project were to proceed it could only be with a policy of a ‘zero tolerance of invasions’ target and an associated quarantine regime of sufficient demonstrated rigor to achieve this.

Acceptable Risk

The Gorgon Venture (ChevronTexaco, 2003b) sets out a clear quarantine objective of zero invasive species introductions; management action, however, needs to be based on a performance standard, rather than an aspirational goal. While it can be argued, based on the information presented above, that no risk to the conservation values of Barrow Island is acceptable, we are unaware of precedents where standards for acceptable risk to conservation values have been published. The issue of 'acceptable risk' therefore bears some discussion.

What is Acceptable Risk?

In deciding what level of risk to the conservation values of Barrow Island is acceptable, the paramount point is that a suite of species occurs there and nowhere else. If they are lost from Barrow Island, they are lost altogether and forever. Since nothing is risk free, even no action, we need to determine the acceptable level of risk to these conservation values by specifying the conservation objectives against which the consequences of risky action will be measured (Fischhoff et al, 1981).

The desirability of the consequences on the conservation objectives can be regarded as the standard by which the risk will be judged. A robust standard requires the decision-making process to be comprehensive and defensible (Fischhoff et al, 1981). The standard to be set needs to be agreed in the face of the circumstances of the Barrow Island case, the conservation assets that it has and the values that various interest holders bring to assessing the worth of those assets. Comparing the value of a species existence to the value of economic development is not a simple problem. To be comprehensive and defensible such a comparison must have at least three attributes. It must take into account all salient factors, rely on the best available expert knowledge and it must be open to the scrutiny of all interest holders (Fischhoff et al, 1981).

No acceptable risk standards for the protection of conservation assets are known to exist. Not only do we not have a standard for the Barrow Island case but no readily available precedents are known. This means that we would need to decide what standard is appropriate in this case. As outlined above, the process to do this would need to be comprehensive and defensible by involving appropriate expert knowledge in a process which is transparent to all the interest holders.

This is broadly the process that the EPA followed in setting the acceptable levels of fatality risk to individuals from industrial development in its Guidance Statement No. 2. (EPA, 2000). A body of expert opinion and experience was debated with stakeholders, subject to public scrutiny and finally agreed and published by the EPA. A similar process could be undertaken to define a robust standard for future quarantine performance on Barrow Island.

Once an acceptable standard is decided, it would be necessary to demonstrate that it can be met. Given that the proposed gas development is a new and complex undertaking, in a sensitive environment, we will require a high level of confidence that the standard can be

met. This demonstration will require a process that infers, rather than absolutely demonstrates the level of success, because it has not been done in this situation before.

What Level of Risk is Acceptable on Barrow Island?

Only a properly constituted process can produce a robust standard on the acceptable level of risk to the conservation values of Barrow Island. In the absence of such a standard, what precedents or surrogates might exist? We are unaware of any standards for acceptable risk to conservation values.

The EPA is, however, experienced at carrying out a process to agree a level of risk of fatalities to humans. The EPA found (EPA, 2000) that the risk from industry of a human fatality, in off-site residential areas, of one in a million per year or less is so small as to be acceptable. In the absence of any process to decide the acceptable level of risk to conservation values in a nature reserve, this standard could be used as a starting point for consideration.

In a draft Quarantine Risk Assessment ChevronTexaco, on behalf of the Gorgon Venture (ChevronTexaco, 2003b), determined that the risk of an invasive species introduction to Barrow Island was “*moderate*”, based on the likelihood and consequence of an invasive species breaching the current quarantine system for the current operations. While there can be some debate about whether or not this level of risk has been properly determined or is at the right level, the Gorgon Venture regards even this level of risk as incompatible with their stated objective of zero invasive species introductions to Barrow Island.

On that basis, the Gorgon Venture has “*committed to developing and implementing a more rigorous quarantine system including the development of innovative invasive species detection, eradication and control techniques. In this manner, quarantine risk may be reduced to a level compatible with [emphasis added] the Gorgon Venture quarantine objective.*” While this is an objective, it is not an absolute standard. It expresses a desire to achieve success. The Gorgon Venture objective is a clear recognition that the current level of risk is not acceptable and a new, higher standard of performance would be required. The Gorgon Venture stance on this issue should be acknowledged. There is, however, still a requirement for a standard against which actual performance would be judged.

The Gorgon Venture has made it clear that the draft QRA is a work in progress and that it is prepared to do much more work on the detail of quarantine management. The issue now is, what level of certainty can the EPA have today that a standard, once set, can confidently be met? Much more work on the actual invasion pathways and whether or not they can be effectively managed to a standard that is compatible with the nature conservation values of Barrow Island would be required and the Gorgon Venture acknowledges this. These pathways would not, however, be known until actual fabrication contracts are let. For example, it will not be known if large modules of equipment would come from Taiwan or Rockingham, if indeed they would be brought in as modules at all, until some time after financial closure on the project. Hence the best

that can be done now, is to set up an agreed and mandated process with an appropriate test to demonstrate whether or not the proposal can meet the standards that are decided.

The standard set would be a tight one, given the high conservation values of Barrow Island. Effectively meeting a tight standard may not be a certain or readily affordable matter operationally. As such, it should be noted that this may be a fatal flaw to establishing a gas processing complex on Barrow Island and that other alternatives such as the mainland, Thevenard Island or Trimouille Island may warrant closer scrutiny.

Should Government agree in-principle to access to Barrow Island for a gas processing complex, it is recommended that:

- A process is mandated which requires the developer to engage in the development of a set of standards for acceptable risks from invasive organisms on the conservation values of Barrow Island. Such a process should include appropriate technical experts and be structured to ensure an appropriate level of community transparency and involvement.
- A subsequent process is mandated requiring the developer to demonstrate to the EPA, on the advice of DCLM, that the risk standards can be met, with a high level of confidence.

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Appendix 4 - List of Submitters to the ESE

SUBMITTERS

ISO Western Australia	Samuel Witton
Ian Crawford	Dr Dorian Moro
Friends of the Burrup	Department of Industry and Resources
Marine Parks and Reserves Authority	Brunel Energy
Chamber of Commerce and Industry WA	Western Australian Museum
Dare Contract Services	Australian Petroleum Cooperative Research Centre
Australian Petroleum Production and Exploration Association Ltd	Intec Engineering
Apache Energy Ltd	Alcoa World Alumina Australia
Heritage Council of Western Australia	Japan DME Ltd
Karratha and Districts Chamber of Commerce and Industry	Confidential submission
Western Power Corporation	CBI Constructors P/L
Datascience	Wildflower Society of Western Australia (Inc.)
WMC Resources Ltd	Western Australian Speleological Group Inc.
Frontier Engineering Solutions (Asia Pacific) P/L	Greenpeace Australia Pacific
Climate Action Network Australia	The Chamber of Minerals and Energy of WA Inc.
Australian Pipeline Industry Association Inc.	Granherne P/L
Dr Chris Surman	Australian Speleological Federation
Department of Fisheries	Kellogg Brown and Root P/L
MT Bennett	Robin Chapple MLC
Department of Conservation and Land Management	The Australian Gas Association
Conservation Council of WA	WWF Australia
Environment Australia	Office of Energy (WA)
IGL Oil and Gas Consultants	Department of Indigenous Affairs