



GORGON
AUSTRALIAN GAS

ENVIRONMENTAL, SOCIAL AND ECONOMIC REVIEW of
THE GORGON GAS DEVELOPMENT
on BARROW ISLAND
RESPONSE TO SUBMISSIONS
(PREPARED FOR THE ENVIRONMENTAL PROTECTION AUTHORITY)

APRIL 2003

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1 Summary

In response to the Gorgon Venture's approach for in-principle approval of the restricted use of Barrow Island for the development of Gorgon gas, the Western Australian Government requested that all relevant information on the environmental, social, economic and strategic ramifications of the proposed development be presented in the form of an Environmental, Social and Economic Review (ESE Review). The release of the Gorgon Venture's ESE Review on 10th February 2003 was followed by a six-week public comment period.

Public submissions have been received and this document provides an overview of those submissions.

Submissions

A total of 44 submissions were received. While the process is not intended as a statistical exercise, it is worth noting that the number of submissions supporting the development proposal approximated those raising issues and requesting further information.

The Gorgon Venture welcomes the public submissions which will assist the Venture and the Government to better address issues, should in-principle approval to Barrow Island be granted.

Since the release of the ESE Review, the Gorgon Venture has continued to provide information and respond to a number of State and federal government agencies, the WA Government's independent consultant assessing the strategic, economic and social aspects of the development proposal and a number of interested stakeholders.

From the public submissions, the **Environmental Protection Authority** (EPA) prepared a list of environmental questions raised by stakeholders. Likewise, the **Department of Industry and Resources** (DoIR) prepared a list of strategic, economic and social questions.

The Gorgon Venture has provided responses to all the questions and issues identified by the two Agencies. These are presented in two separate documents – EPA responses and DoIR responses.

In general, the submissions focussed on five areas. They are:

- Why the development needs to be on Barrow Island
- Protection of biodiversity on Barrow Island
- Greenhouse gas management
- The level of detail in the ESE Review
- Industry and customer support for the development.

Why the development needs to be on Barrow Island

In the ESE Review, we provided comparative cost information for other locations to underpin our conclusion that we could only be commercially viable on Barrow Island.

Many of the submissions received requested additional information on alternative development locations. We have responded to those questions with additional information. We have also provided commercially sensitive cost information to the Government's independent consultants under a Confidentiality Agreement.

The Gorgon Venture recognises the sensitivity of Barrow Island and understands the reasons for the questions. The decision to seek the restricted use of Barrow Island has been made only after exhausting all other development alternatives.

In addition, Barrow Island offers a unique opportunity to sequester reservoir CO₂ providing greenhouse gas reduction benefits at a cost that does not threaten the international competitiveness of the development.

Protection of biodiversity on Barrow Island

We have received a number of questions relating to the past history and future plans for biodiversity protection on the island. The protection of biodiversity through quarantine is a critical issue in the consideration of the use of Barrow Island for a Gorgon gas development.

There is a desire to see increased quarantine effectiveness, supported by a risk-based assessment, to reflect the increased scale of activity, especially during the construction phase.

The Gorgon Venture has identified a number of enhancements to the existing quarantine procedures if the Gorgon development proceeds on Barrow Island. In addition, we are undertaking a quantified quarantine risk assessment specific to the Barrow Island proposal. We will draw on our 40 years of operating experience, and consult with industry and government experts, to quantify and mitigate the risks associated with the proposed development.

A number of public submissions support the view that the history of operations on Barrow Island over the past four decades demonstrate that it is possible to develop and operate hydrocarbon facilities while protecting the conservation values of the Island.

Greenhouse gas management

A number of questions have been received on the plans for reinjection of reservoir CO₂, which is the cornerstone of the Gorgon Venture's greenhouse gas strategy. Reinjection of reservoir CO₂ would make the development one of the most greenhouse gas efficient projects of its type in the world and would help Australia become a world leader in carbon sequestration.

As the Gorgon gas development would be the largest sequestration project ever undertaken, some public submissions have raised questions about the level of certainty that it can be done. Others expressed confidence in the Gorgon Venture's proposed strategies for managing greenhouse gas emissions, including plans to re-inject CO₂.

The Gorgon Venture has very high confidence in the technical feasibility of re-injection. The technology to separate the carbon dioxide, compress it, transport and re-inject it into subsurface reservoirs has become standard practice and utilised by ChevronTexaco and many other energy companies around the world.

The uncertainty that exists relates to the long-term behaviour of the CO₂ in the reservoir. All of the studies that ChevronTexaco has completed to date supports the view that CO₂ will be safely sequestered over a very long period of time. Final plans are subject to a detailed work program. This work program includes cooperation with other Operators, the Petroleum Division of DoIR and research bodies such as GEODISC and the CO₂CRC.

The Australian Petroleum Cooperative Research Centre is supportive of the CO₂ re-injection strategy, which it describes as technically credible and appropriately cautious. All the information available to the Centre strongly suggests geo-sequestration can be an effective and appropriate way of making significant reductions in CO₂ emissions into the atmosphere. There is benefit in having the nation's first geo-sequestration project at a well understood and accessible location to ensure effective research, surveying and monitoring of the site.

The level of detail in the ESE Review

A number of submissions indicated a desire for additional detail, in some cases approaching the level of detail normally contained in an Environmental Impact Assessment (EIA) process.

The ESE Review process was intended to demonstrate at a strategic level that the proposed Gorgon gas development can generate economic and social benefits, provide net conservation benefits and mitigate potential on-site environmental impacts. If in-principle approval is granted a full EIA would still be required before final approval for a specific project could be considered.

The Gorgon Venture has responded to each question based on the current level of project definition.

Further appropriately detailed investigations would be undertaken to guide design, management and monitoring of the development to ensure environmental impacts are kept to an acceptable level. These investigations would be subject to public and stakeholder review and assessment by environmental agencies during the EIA process.

Industry and customer support for the development

Many of the submissions were from industry bodies and potential customers strongly supportive of the economic benefits that would result from development of another major energy source in Western Australia. These submissions form an integral part of the public comment and information received on the development, which will assist the government in its consideration of the proposal.

It was pointed out that it is strategically desirable to secure an alternative major long term supply of gas for the State's industrial and residential customers - both in terms of improving security of supply and increasing availability in the domestic market.

The substantial reserves of the Greater Gorgon area (in excess of 40 trillion cubic feet) were identified as important for long term state and national energy supplies. Another major supply of gas to the Western Australian marketplace would increase competition. As the submissions indicate, there are growing markets for natural gas for industrial projects, clean power generation and domestic and commercial applications. It is essential these markets are serviced by plentiful supplies of competitively priced gas.

According to another submission, as only ten per cent of Western Australia's gas reserves were being commercialised, it was in the State's interests to support the development of Gorgon and "put Western Australia on the map, from a worldwide perspective in being the LNG producer of choice". As identified in the submissions from global resource companies, the combination of internationally competitive gas and low sovereign risk provides the right environment to encourage world scale projects to the State.

One submission cited a study which concluded that each additional \$1 million of Gorgon development work placed with Australian manufacturers would create flow through effects as follows:

- 18 full time jobs
- \$317,900 tax revenue
- \$1,262,000 worth of value adding
- \$211,700 in saved welfare benefits

The vital importance of the opportunities the development would create in employment, training and technology transfer is also addressed in submissions. Involvement in large resource projects result in a highly trained local construction and operations workforce, which becomes a very valuable community resource.

Technology transfer and development of skills and trades was a key benefit of the proposal identified in a number of submissions. Creating a technologically advanced, skilled

workforce able to compete on a global scale is an advantage that should not be underestimated as a potential export trade earner.

A skilled workforce also results in lower construction costs and ensures a significant proportion of the money spent on construction of projects is retained in the local community. The development of a project the size of Gorgon would help provide continuity of employment thereby retaining skills and building confidence in the future of a range of Western Australian industries.

2 Response to the Environmental Protection Authority

The Gorgon Venture released the *Environmental, Social and Economic Review of the Gorgon Gas Development on Barrow Island* (the ESE Review) for public comment on 10 February 2003. Following the 6-week comment period the Environmental Protection Agency (EPA) received 44 submissions from government agencies, public and private organisations, companies and individuals.

The Environmental Protection Authority and the Department of Industry and Resources separately reviewed the submissions and formulated questions that they in-turn posed to the Gorgon Venture.

There was significant overlap between, and duplication of, questions received from the organisations. The Gorgon Venture has, at the request of the organisations, prepared separate stand-alone responses for each organisation. However, in an attempt to make the document more digestible, has grouped similar questions rather than repeat answers within each document.

This document presents the Gorgon Venture's response to questions posed by EPA. These have been prepared to address stakeholder issues and assist government to make an in-principle decision regarding the acceptability of establishing a gas processing facility on Barrow Island.

3 General

EP248 Does the proponent intend to enter into negotiations with other lease holders over the locations of jetties and shipping channels, given that several of these as proposed lie within other permits?

The reference case shows a channel and a shipping route that is located in adjoining permit areas. The Gorgon Venture recognises that if the proposed development proceeds, consultation with regional operators would be required to ensure that their activities and those of proposed development would not conflict.

In accordance with Commitment 15 (Chapter 15 of the ESE Review) on stakeholder engagement, the Gorgon Venture undertakes to involve regional operators fully in any proposed development arising out of an "in principle" approval for a gas processing facility on Barrow Island.

It should also be noted that the existing crude oil loading line and berth has also coexisted in adjoining permit areas since the 1960s.

4 Development Alternatives

4.1 Requests for More Cost Detail

- EP2 Why has the proponent not provided maps, data, detailed cost breakdowns for the alternative locations to Barrow Island that were considered?*
- EP4 Has the proponent considered the relative construction costs for alternative locations, and the difference between the mainland versus island locations?*
- EP44 Can the proponent provide detailed and reliable qualitative and quantitative data for each alternative site to support its site selection case, including the costs of construction and operation, and the costs associated with quarantine management, rental and environmental management, and in meeting net conservation benefit outcomes for each site?*
- EP56 Why is the detailed information presented in Sections 6.3 and 6.5 of Appendix C, relating to the Stage 2 site comparison, not included in Chapter 4 of the ESE Review document (only outcomes of the analysis are presented as Table 4.3)?*
- EP70 Why has the claim that Barrow Island is the only economically viable location not been supported by a sensitivity analysis that shows the cost of various development options relative to variations in the price of the proponent's product?*
- EP71 Surely there is a breakeven point where development of a gas processing facility on the mainland would be viable. Why have breakeven analysis figures not been presented?*

The alternative locations for a gas processing facility were discussed in Chapter 4 of the ESE Review. The selection process shown in Figure 4.4 started with a regional GIS based evaluation by URS (ESE Review, Technical Appendix C), that produced a shortlist of possible locations. This was followed by a more detailed civil engineering study by the Gorgon Venture for these short-listed locations. The latter study quantified the cost differentials which are summarised in Table 4.3 of the ESE Review. There is an allocation to address native title costs, quarantine, environmental management, and net conservation benefits as they apply to different sites.

In general terms the differentiating engineering factors between sites are:

- distance from the gas field to the gas processing facility
- site characteristics such as proximity to coastline, distance to deep water, site topography, soil types (for both plant and dredging)
- distance for CO₂ reinjection
- distance for domestic gas supply to customers
- capital expenditure allowance for quarantine facilities.

The final comparison was between:

- Barrow Island
- Thevenard Island
- Burrup Peninsula
- Maitland Estate and
- two sites on the Montebellos (added by request).

It included qualitative factors such as safety, marine operability, technical risk and environment as well as cost differences. The overall results of this work showed that Barrow Island met all project criteria at the lowest cost.

The Gorgon Venture has not shared more detailed information (such as detailed relative costs of gas supply, breakeven gas price analysis) in the ESE Review as that would expose

commercially sensitive information in a public document to potential customers and competitors. However, the Government has appointed independent experts that have reviewed Gorgon Venture cost data and competitive assessments under a confidentiality agreement.

4.1.1 Maitland Estate

- EP3 Can the proponent provide more detailed analysis of the Maitland Estate option, specifically why it has been rejected as a viable alternative to Barrow Island?*
- EP11 Despite claims in the Executive Summary that the proponent is seeking restricted use of Barrow Island "after exhausting all other development alternatives", there is no evidence that an exhaustive assessment of all other alternatives has been conducted, and in fact this is acknowledged on p48 of Appendix C. Given that Maitland Estate has been identified as the best location from an "assessment of environmental, social and economic/engineering constraints" (p39 and p47 Appendix C), why has a detailed analysis not been conducted for Maitland Estate?*
- EP14 What is the basis of the claimed \$1100 million relative cost to the base case attributed to Maitland Estate (p14 of Executive Summary)?*
- EP21 Does the proponent intend to undertake (or make available if already completed) detailed economic and engineering feasibilities of both the Barrow and Maitland options?*
- EP23 Has the proponent taken into consideration the likelihood of the State and Commonwealth assisting in the development of the common use infrastructure (including port facilities) at Maitland and West Intercourse?*

The report by URS "Identification of Suitable Locations for a Land-based Gas Processing Facility linked to the Gorgon Gas Field" (attached to the ESE as Technical Appendix C) acknowledged that Maitland Estate would score highly with least constraints on environmental and socio-economic factors. However, it went on to say that the requirement to use West Intercourse Island for access to LNG shipping reduced this advantage. Furthermore, the distance from the Gorgon gas field adds considerable cost penalties to this location. The report nevertheless identified Maitland Estate/West Intercourse Island as a short-listed site worthy of further investigation by the Gorgon Venture and it was included in the next phase of detailed engineering evaluation (see Figure 4.4 for Location Selection Process).

As shown in Table 4.3, the subsequent engineering evaluation resulted in an \$1100 million cost differential with the Barrow Island location. This renders the site commercially non-viable. This cost differential is driven by the distance from the gas field, the distance between the LNG plant and the LNG loading facilities, and the distance back to a suitable CO₂ reinjection site.

The Gorgon Venture did not include any allowance for possible State or Commonwealth assistance with infrastructure development for any of the locations considered.

4.1.2 Cape Preston

- EP46 Why has Cape Preston been excluded, given that: third party access to the area is allowed under the Iron Ore Processing (Mineralogy) Agreement Act 2002; Cape Preston is closer to deep water than Barrow Island (Figure 4.3) and furthermore is completely surrounded by a "sheltered coastline"; Figure 4.7 shows that Cape Preston has the lowest overall constraints; and figures 4.3 and 4.7 demonstrate that Cape Preston meets requirements with respect to distance to deep (sheltered) water, contrary to claims made on p27?*

EP47 *Does the proponent intend to conduct a thorough qualitative and quantitative analysis of the environmental, social and economic implications of locating the development at Cape Preston?*

This site was eliminated by the initial screening, (ESE Review, Technical Appendix C), principally because of a perceived conflict with an existing mining tenement and the proposal to load treated iron ore from Cape Preston. A confidential study of Cape Preston conducted in 1997 showed limited useable space for a gas processing facility.

Any multiple use of Cape Preston would compete for this limited space, especially for ship-loading activity. LNG loading requires intrinsically safe operations to avoid a source of ignition and cannot co-exist alongside iron ore operations.

In response to this query, a civil engineering study has been conducted specifically for Cape Preston using the same criteria applied to the other locations assuming that the Gorgon Venture had exclusive use of Cape Preston. The results of this study are shown in an additional column for Table 4.3 as shown below. This shows that Cape Preston is \$720M more costly to develop than Barrow Island.

Key Cost Attributes	New Request
	Cape Preston
Gas Pipeline Length	175 km
Offshore Platform	Required
Jetty Length	1.9 km
Distance from Coast	3.4 km
Volume of Dredging	3.25 million m ³ soft soils / sand
Extent of earthworks	3.0 million m ³ soft soils / sand
CO ₂ Pipeline Length	95 km
Relative Cost, Millions	+\$720
Useable Land (300 ha available)	Yes

4.2 Civil Engineering Detail

4.2.1 Barrow Island

EP17 *What is the basis of the proponent's claim that the 6.9 million cubic metres to be dredged at Barrow is soft sand, when in fact it is hard limestone?*

Existing geophysical information at the Barrow Island site indicates that potential exists for variable quantities of sand overlying a calcarenite limestone structure up to 10 m thick.

Whilst recognising that the potential for overlying soft sand exists, the Gorgon Venture has costed and assessed the difficulty of dredging for the Barrow Island site on the basis of a calcarenite outcome, assuming all dredging is hard limestone.

The Gorgon Venture does note however that even with harder rock (limestone), the lack of any bedrock (Igneous Structures), offers a much less complicated dredging than other sites where bedrock exists within the dredge horizon.

EP18 What is the basis of the proponent's claim that the surface of Barrow at the proposed development site comprises soft soils and sand, when in fact it consists of limestone with skeletal soils?

The site conditions at the location shown in the ESE Review comprise a mixture of exposed limestone rock and limestone rock covered by deeper soils. The conditions for the site on Barrow Island are regarded as suitable for locating a gas processing facility satisfying all of the engineering requirements in an efficient manner. The limestone cap rock does not present a problem.

A balance between the cost of earth-working soft soils and requirement for ground improvement; foundation piling; drainage issues and corridor designs for heavy module transport are the basis of civil site assessments.

4.2.2 Maitland Estate

EP8 Will the proponent review the October 2002 report by the Shire of Roebourne, indicating that only 1 million cubic metres of material requires dredging at Maitland Estate, compared with the 6.7 million cubic metres claimed in Table 4.3?

The Gorgon Venture has reviewed the referenced report by Astron Environmental on behalf of Shire of Roebourne – “The Maitland Heavy Industrial Estate – Assessment and Comparison with Burrup Peninsula Industrial Estate”, October 2002. It is noted that the assumptions used in this report are inappropriate for an LNG development. The estimate of civil costs for development of a port facility from the north end of West Intercourse Island are based upon a Panamax type vessel with a water depth requirement of 15.0 m and a channel width of just 150 m. Accordingly, dredging is limited to 11.8 m below chart datum, with associated reduction in dredging quantities and cost. This means that vessel departures can only occur on high tides.

For LNG ports, tidal restrictions are unacceptable in case the vessel must urgently depart the berth such as under cyclonic conditions and is the case with all existing LNG port facilities. The channel basin and berthing pocket must all therefore be dredged to 13.0 m below chart datum. The cost of jetty versus dredging for an LNG berth must also be optimised in view of the high cost per kilometre of cryogenic loading pipelines and suitable jetty supports. Together with dredge depth, length (5.7 km) and suitable width (250 m) for safety against grounding in these high current conditions, a quantity of dredging of 6.2 million m³ results.

Additional dredging of 0.5 million m³ is also required for a channel 600 m long by 100 m wide to a depth of 6.0 m below chart datum to allow barge access to a Material Offloading Facility at the northern tip of West Intercourse Island, so that heavy process equipment for the LNG Plant can be offloaded.

These criteria for LNG ship-loading have been consistently applied to all the alternative locations that were short-listed by the URS Report (Technical Appendix C) and subsequently evaluated in detail for engineering, operational and cost differences. Table 4.3 summarises the overall outcome of this detailed evaluation in terms of major cost drivers and capital cost difference.

EP12 Why is the use of West Intercourse as a port seen as a substantial negative (p39)?

The reason why the requirement to use West Intercourse Island for LNG storage and load out was seen as a “substantial negative” was that this requires a 12 km long interconnecting causeway and pipeline easement for LNG rundown, construction of LNG storage tanks on a rocky environment at West Intercourse Island, disturbance to a significant number of aboriginal sites, mangroves and significant dredging to reach the Hamersley Channel.

EP13 Which report on the Maitland Industrial Estate was used as the basis for the proponent's analysis: the DRD Maitland proposal (as given on the Public Environmental Review for the estate) or the October 2002 Shire of Roebourne Report entitled "Maitland Industrial Estate - A Comparison with the Burrup Peninsular", which indicates far fewer impacts than the former document?

Both of the referenced reports were reviewed. Neither the DRD Maitland proposal (as given on the Public Environmental Review for the estate), or the Astron Environmental (October 2002) report "The Maitland Heavy Industrial Estate – Assessment and Comparison with Burrup Peninsula Industrial Estate" was used as the basis of the analysis. The Gorgon Venture undertook their own detailed civil engineering studies to determine the impacts and cost for a gas processing facility at Maitland Estate with loading facilities from West Intercourse Island.

EP15 Why is the proponent claiming that 6.7 million cubic metres of hard rock dredging would be required for the Maitland Estate option, when the existing Hamersley Iron channel has adequate capacity to handle Gorgon shipping?

IR: The Astron Environmental report, titled "The Maitland Heavy Industrial Estate – Assessment and Comparison with Burrup Peninsula Industrial Estate", October 2002, quotes that a lack of borehole data in this region means that the physical environment of the Maitland Heavy Industry Estate in particular is not well known. The authors assumed that visual similarity between West Intercourse Island and the Burrup Peninsula would mean that West Intercourse Island would be expected to follow similar patterns for its geology and oceanography.

This appears reasonable, however it should also be noted that the geology of the near shore region of the Burrup Peninsula is very complex, with basement (Granophyre) rock overlain by calcarenite forming a complex conglomerate and this having Granite and Basalt intrusions. This geology has resulted in some of the most complex and litigious dredging contracts in Western Australia. It is a high risk aspect of the infrastructure associated with this site and treated accordingly in these estimates. The need to have a deeper channel for LNG shipping that is not tidally constrained also leads to a higher risk of encountering the bed rock structure.

The region adjacent to West Intercourse Island is also a region of high currents and sediment mobility. Again, without detailed geotechnical information, the quantity of sediments and soft dredging has been assumed to be minimal.

A risk-based approach to the dredging estimates with this lack of available data results in the conclusion that the effective dredging costs will be significantly greater than those quoted in the Astron Environmental report (referred to above). This will be particularly so in view of the deeper dredging as required for an unconstrained channel.

It should be noted that a conservative assumption on geology has been applied at all of the regional sites assessed by the Gorgon Venture, however in Mermaid Sound, it is the igneous basement rock, associated intrusions and caprock structure which add greater risk and hence cost.

The Astron Environmental report also warns that congestion of the Hamersley channel could be an issue and that an additional parallel channel may need to be dredged to avoid conflicts with large iron ore carriers (which are said to have priority over other vessels). Recent studies by Hamersley Iron were instigated to investigate additional capacity in view of existing constraints to Hamersley Iron themselves with just the current users entering the channel. Should an additional channel or widening of the Hamersley channel be required, such a channel would be approximately 10 to 15 km long and require in the order of an additional 6.0 million m³ of dredging. This introduces an extra cost risk not covered in the ESE Review and may even force consideration of a channel to the west from West Intercourse Island (a far longer and more expensive option).

4.2.3 Thevenard Island

- EP33 Why has the proponent described Thevenard and Trimouille Islands as having limited area available for development when they have several hundreds ha more than the 300ha which is required for the proposed LNG plant and related facilities. Table 4.2 describes Thevenard Is (612ha) as having limited space and Trimouille Is, (~500ha) as extremely restricted, with a useable area of only 100ha?*
- EP48 Why has the proponent rejected Thevenard Island, when it has an area of 589 ha above the high water mark, which is more than adequate; recreational activity is limited to fishing charters which already coexist with industrial operations on the island; and in existing operations the lack of sheltered waters is overcome by exporting oil via a subsea pipeline and offshore tanker loading facility?*

The most significant reason against the use of Thevenard Island is the \$500 million extra cost.

It is possible to fit a 300 ha development onto Thevenard Island since, despite its relatively small size, it is almost rectangular in shape. Ground improvement to prevent liquefaction during a seismic event and levees to protect against storm surge associated with cyclones would be required.

The area currently used by Mackerel Islands Resort would be required by a gas processing facility as the only feasible jetty location is on the south-east end of the island. The existing airstrip would also have to be removed as fixed wing aircraft movements are incompatible with a gas processing facility in such a limited area. The existing accommodation is too small for use.

The metocean criteria for ChevronTexaco's current mooring system are less restricted than for an LNG Carrier alongside a berth. The lack of sheltered waters is a safety concern that would require considerable engineering attention to design.

See response to question "EP 50" in regard to Trimouille Island.

4.2.4 Montebello Islands

- EP50 Why has the proponent rejected the Montebello Islands on the bases of limited land availability, limited sheltered waters and their history as a nuclear test site, when: there is sufficient land available on both Trimouille Island (outside elevated radiation zones) and the southern end of Hermite Island; sheltered waters are available to the east of Trimouille Island and only two small areas of Trimouille Island have very slightly elevated radiation levels?*

The Montebello Islands were rejected primarily on Health Safety and Environment (HSE), industrial relations and market acceptability issues associated with its background as a previous nuclear bomb test site.

The detailed contour and bathymetry information that the Gorgon Venture has for both Trimouille Island and Hermite Island shows that the area available for a gas processing facility is extremely limited.

Hermite Island would be \$300 million more costly than Barrow Island and would involve significant site earthworks to yield a limited plant site area only marginally greater than the minimum five metre elevation requirement. It would also involve dredging a channel directly through a proposed marine sanctuary zone.

Trimouille Island has a lower cost penalty due to its proximity to deep water, but has significant site earthworks required compared to Barrow Island (now estimated at 3.9 million m³). Also, the waters on the east coast of Trimouille Island are not at all sheltered, being exposed to swells from all quadrants to the north and east. The proposed site at

Barrow Island is in the lee of the Lowendal Islands. From experience of crude oil loading east of Barrow Island (about 10 km offshore and not as protected as the proposed LNG Berth for Town Point), it could be expected that a fixed berth east of Trimouille Island would have significant weather disruption.

EP51 Why has the proponent not included any data on radiation levels in its analysis of Trimouille Island? What is assumed to be the area of Trimouille Is which has "elevated radiation levels" above background?

EP52 Given that the radiation levels on Trimouille Island pose no health threats, has the proponent considered that the perception issue could be effectively managed by an education programme for prospective customers and staff?

The Gorgon Venture has reviewed the literature and available studies concerning the radiation hazards on the Montebello Islands. The report by Western Radiation Services prepared for CALM in 1993 assessed the radiological hazard for personnel working on the Montebello Islands for four two-week periods a year. It identified a Radiation Hazard Area covering two-thirds of Trimouille Island, north from Main Beach, and recommended that "no works involving digging and/or excessive dust movement be carried out in contaminated areas". The report also concluded that "A worker could reach the limit of 1 mSv exposure from Gamma and inhaled dust on Trimouille Island after five hours exposure". Although they conceded that "gamma radiation will continue to decrease significantly in the short-term (tens of years)", they went on to say that "the inhalation hazard from Alpha emitting radionuclides will not change appreciably over several hundreds of years".

This shows that construction activities on Trimouille Island, which would disturb the soil and create dust, could seriously affect the health of a construction workforce and the Gorgon Venture does not intend to expose a workforce to this health risk.

The same report stated that "no trace of activity above normal background levels" could be found in soil samples from Hermite Island. However, data on re-suspension and deposition was unavailable and a thorough survey would be required before the site could be considered. This is reinforced by a submission from the Health Department of Western Australia to the Gorgon Venture that states "before any industry is introduced if at all (to the Montebello Islands), a radiological impact study of the area to be used will need to be conducted, and a radiation management plan produced. This plan should evaluate and show that there will be no significant exposure pathways."

The Gorgon Venture is not prepared to subject a workforce to potential long-term exposure to radiation and to expose the development to the related commercial and legal risks.

4.3 Regional GIS Screening Model (URS's Appendix C)

EP10 Why has the proponent not considered locating the Gorgon Gas Development on Varanus Island, potentially making use of existing gas processing facilities and depleted oil fields (with well-understood reservoir parameters) in the vicinity which could be used for injection of waste gases?

There is insufficient land area for a Gorgon gas processing facility on Varanus Island. The majority of the useable space on the island is already occupied by the existing facilities operated by Apache.

EP24 How were the environmental, social and broad technical/cost constraints (see Table 4.1 and Figure 4.4) identified by the proponent?

The constraints in Table 4.1 resulted from detailed discussions between URS and the Gorgon Venture engineering staff. They were based upon the experience of both parties regarding civil engineering requirements (or desirable attributes of a site) and implications for the environmental impact of a site.

EP25 Given the proponent's statement in the summary to the effect that Barrow Island has been a Class A Nature Reserve since 1910 and is one of the most important wildlife refuges in Australia, why was Barrow Island not eliminated from consideration as unsuitable for development on this basis alone, particularly as other sites have apparently been rejected due to their "significant environmental values" (p40)?

EP27 Why does the proponent express so much concern for the Pilbara coastline in deeming these areas unsuitable for development due to their environmental values (when Barrow Island was not eliminated for these reasons)?

The Gorgon Venture recognises the importance of the conservation values of Barrow Island to the community and has only selected this location after an exhaustive study showed there are no economically viable and environmentally acceptable alternatives. ChevronTexaco has considerable experience in successfully managing oil operations on the Class A Nature Reserve which provides the confidence that the proposed development can be undertaken while continuing to protect the conservation values of the island.

Given that the purpose of the ESE Review process is to gain in-principle approval for restricted use of Barrow Island, the island was not eliminated as a location for evaluation at the outset.

The extensive area of coastline between Onslow and Maitland Estate was not rejected solely on environmental grounds – they were also unsuitable based on engineering criteria and hence cost. Areas such as very shallow water, mangroves, and salt flats are very difficult locations on which to establish a gas processing facility.

EP26 Why couldn't national and Marine Parks and Conservation Reserves be avoided altogether, and not just "where practicable" (as stated on p38)?

A principle adopted in addressing regional level planning analyses to identify practical locations for a major development is that some infrastructure associated with a major development may be required to impinge upon, or traverse, certain conservation reserves within the overall region. While the preference is to avoid reserves/conservation estate, some flexibility is required in order to accommodate major developments, particularly developments that require large sites, long linear infrastructure (e.g., pipelines), and major transportation access and facilities.

Some existing reserves do accommodate such infrastructure or industry, for example Barrow Island itself has been an active oilfield for the last 40 years. Hence it is a reasonable intent that National Park, Marine Parks and other conservation reserves are "to be avoided where practicable".

The Gorgon Venture has tried for a number of years to develop a project avoiding Barrow Island without success. The Gorgon Venture recognises the importance of the conservation values of Barrow Island to the community and has only selected this location after an exhaustive study showed there are no economically viable and environmentally acceptable alternatives.

EP28 Does the discussion on p43 imply that in the proponent's view flora has to be "declared rare" in order to be significant?

The ESE Review presents data on a range of criteria relevant to the comparison of "Key Attributes for Possible Locations" (ESE Review, Table 4-2). "Declared rare flora" is listed as one of these key attributes. In the context of an overview discussion of key issues, such as that presented in Table 4-2, "Declared rare flora" is presented as an issue of primary importance. This is not intended to imply that flora, other than that "declared rare", is not significant.

EP32 Why has the proponent treated the Montebello Islands as having environmental constraints on a par with those of Barrow Island (Table 4.3), even though Barrow is a Class A nature reserve and the Montebellos do not

have such a high formally recognised conservation status, particularly as the Montebellos have been degraded through their use as a nuclear test site, are severely infested with weeds and introduced species and have lost at least four species of vertebrate animals?

EP63 How were the values in Figure 6.4 of Appendix C developed, and do they include both construction and operation constraints?

Figure 4.3 combines a variety of environmental criteria, and those that make up the score for Barrow Island versus the Montebello Islands vary. Hence, the final outcome considers not only terrestrial ecosystem values, but also marine environment values that are considered high for the Montebello Islands.

Figure 4.3 of the ESE Review (Figure 6.4 in Technical Appendix C) was included bearing in mind that the document was intended for an extremely wide audience. It was considered necessary to include some content, particularly graphic content, which summarised a very complex process of assessment into a short summary.

Figure 4.3 therefore only indicates a much generalized outcome of the process as used for screening of the region to create a shortlist of sites, rather than eliminate all but a single site. A larger variation of circle sizes or other graphic symbols could have been used (and was considered) to allow 'more accurate differentiation' of the relative rating of the different alternative sites, but the intent was to have simple easy to read summary of the various location constraints.

EP34 Please comment on the suggestion that small changes in key assumptions (such as degree and acceptability of risk associated with quarantine breaches, the valuation calculations of conservation offsets, or the basis for future comparative greenhouse gas savings) could significantly alter the conclusions drawn from the analysis of alternative locations.

The regional assessment of development requirements and constraints identified a short-list of possible development locations using multi-criteria analysis. It was necessarily a very broad 'coarse' level of assessment to determine locations in a very large region that could provide suitable sites for further detailed investigation. The criteria devised were to meet the requirements for development of a generalized 'gas process facility' using feedstock from the Gorgon gas field. The intent was to be unbiased and transparent as possible in the selection process and not skew it towards either a specific site or specific installation or processing technology.

Small changes in these criteria would have been unlikely to have altered the outcome of identified locations. The Gorgon Venture recognises the importance of the conservation values of Barrow Island to the community and has only selected this location after an exhaustive study showed there are no economically viable and environmentally acceptable alternatives.

EP37 Please comment on the suggestion that in its comparison of alternative locations, the proponent has significantly understated the biodiversity values of Barrow Island and has undervalued these in comparison with economic values, thus effectively selecting Barrow Island on economic grounds alone.

The judgement of the correct balance between biodiversity values and economic values is a key differentiator across the community and the reason that the ESE process is so important and must continue to involve all stakeholders.

The Gorgon Venture has never overlooked the biodiversity values of Barrow Island, or the international conservation reputation of the island. This is indeed the key reason why so much effort has been expended on addressing alternative location options, and a reason why the ESE process has been required. However, economic values play a significant part in site selection as a project cannot proceed unless it is commercially viable.

The proposed Barrow Island development is sustainable and can be developed in an environmentally acceptable manner. Barrow Island is the only acceptable location where the development can be commercially competitive.

EP38 In its alternative sites analysis, why has the proponent combined the "levels of constraint", inappropriately allowing high environmental constraints to be offset by low economic constraints?

The Gorgon Venture does not agree that high environmental constraints were 'inappropriately' allowed to offset low economic constraints. The study found that environmental constraints are relatively high throughout the region, and hence economic advantage does become pivotal in both terms of feasibility and comparative advantage of sites.

In the Constraints and Opportunity Assessment undertaken, each of the Environmental, Social, and Economic/Engineering assessments were both undertaken and illustrated separately (see Figures 4.4, 4.5 and 4.6 in Technical Appendix C). This enabled the reader to readily see the outcome of each. Combining all constraints in a composite 'overlay' form without weighting was a 'base case' approach, and was an attempt to assist the reader (See Figure 4.7 in Technical Appendix C).

To include weightings as a means to differentiate between economic and environmental constraints would have introduced a significant level of additional complexity and another level of subjectivity that was not appropriate or practical in this study.

EP39 In the site selection criteria in Appendix C, why has the proponent selected criteria that imply that potential impacts on a large island are likely to be less than those on a small island, when larger islands are more likely to have populations of threatened species and are therefore exposed to more significant risk?

The location assessment was conducted at a very large regional scale and explicitly a coarse level of assessment. While the comment is well received, island size much less than 1000 ha can also become problematic from a variety of engineering, environmental and development points of view. For example, small islands with a large proportion disturbed would be significantly harder to rehabilitate than large islands with a small developed area.

The Gorgon Venture site of 300 ha would have a smaller relative impact on a larger island than it would on a smaller island.

EP40 In the site selection criteria in Appendix C, why is it not recognised that Barrow Island hosts diverse mammal fauna, including six threatened species?

On page 22 of Technical Appendix C, it states that Barrow Island was assigned a higher constraint than other large islands due to "... absence of introduced species (with corresponding high habitat value for rare native fauna)".

EP41 In the site selection criteria in Appendix C, why have conservation reserves been allocated a lower rating than national parks and marine parks, when Barrow Island has extremely significant conservation values by virtue of the fact that its ecosystems have been largely protected?

EP59 Why does the scoring process in Table 4.1 of Appendix C give a constraint factor of 5 for "proximity to nature reserves" but excludes national parks altogether with a constraining factor of 999, when A Class nature reserves and national parks are hierarchically equal in law?

The submission is correct. National Parks and Marine Parks should have been rated the same as conservation reserves and not been given an exclusion rating. This change would not affect the analysis.

EP42 In Table 6.6, why do Maitland and West intercourse rate differently in terms of infrastructure, when in both cases the infrastructure base would be Karratha? Why are these sites allocated a higher degree of constraint than Barrow Island, where new housing would need to be constructed?

While the urban infrastructure base would be Karratha, Appendix C (in Technical Appendix C of the ESE Review) actually provides a broader definition of infrastructure, including on-site and to-site infrastructure. This differentiates Maitland and West Intercourse locations.

The proposed gas processing facility on Barrow Island would not result in “substantial new housing”. The operating personnel of the LNG Plant could be accommodated within the spare capacity of the existing camp. All employees would be based off the island and fly in/fly out arrangements as currently practised would be used. Conversely, in the Karratha region extensive new housing would need to be constructed.

EP43 In Table 6.6, why is Barrow Island seen as having no constraints on recreation/tourism, when existing petroleum leases have been used to exclude others from the island for purposes such as tourism, and therefore such leases are clearly a constraint to tourism? In Technical Appendix C why do the presence of low levels of recreational fishing and diving on the Montebellos prevent the development?

Table 6.6 highlights constraint on building a gas processing facility at various locations against specific criteria such as recreation/tourism. It was not meant to show the potential for tourism at the various locations. Barrow Island scores a low level of constraint for tourism (zero) as there is limited potential for conflicts given no tourism occurs on the island.

EP49 Fig. 4-3. Why is the level of social constraint on the Montebellos assumed to be so much higher than Barrow? Why is it equivalent to Exmouth and the Burrup, where there are many more people present and more constraining land uses, than at the Montebellos?

The social constraint level is higher for the Montebello Islands than for Barrow Island. Compared to Barrow Island, there is more divergent (and conflicting), ‘social’ activity at the Montebello Islands, both currently and anticipated in the future. The Montebello Islands include pearling, commercial and recreational fishing visits, yachting visits, and tourist diving. Barrow Island has none of these activities. The Montebello Islands have far higher ‘seascape’ value and are likely to experience increasing boating tourism/recreational visitations and use in the future.

For different reasons, (such as population, archaeology, and marine based recreation) the overall social constraint level for the Montebello Islands, Burrup Peninsula and Exmouth end up as the same value. This outcome is presented in Table 6.6 in Technical Appendix C of the ESE Review.

EP53 Can the proponent explain the discrepancy between Table 4.2, where the Montebellos do not appear to have been identified as having high environmental constraints (other than being a conservation park), and Table 4.3 which allocates them a high level of environmental constraint?

Table 4.2 lists that Trimouille Island in the Montebello Islands is part of an A Class Conservation Park with surrounding waters being considered for a Marine Park. It also has high marine environmental and habitat values. The environmental constraint criteria applied in Figure 4.3 is consistent with this.

EP57 Why was no economic cost data used in the Stage 2 site comparison analysis on Sections 6.4 and 6.5 of Appendix C, and therefore where did the “key cost driver components” presented in Table 4.3 come from?

The URS study (ESE Review, Technical Appendix C) was based on a ‘regional planning’ coarse level of assessment, which is not a quantified assessment. The study identified

prospective locations for further detailed site assessment, and provided a broad and largely subjective comparison of the relative merits of the various sites.

It was not meant to undertake detailed cost comparisons, but instead to short-list sites for further evaluation. The summary in Table 4.3 of the ESE Review of key cost drivers and the relative costs between the locations were derived from detailed studies by the Gorgon Venture.

The Gorgon Venture has not shared more detailed information (such as detailed relative costs of gas supply, breakeven gas price analysis) in the ESE Review as that would expose commercially sensitive information in a public document to potential customers and competitors. However, the Government has appointed independent experts that have reviewed Gorgon Venture cost data and competitive assessments under a confidentiality agreement.

EP58 Please comment on the suggestion that the late "adding in" of economic data into the site analysis has resulted in artificially high weightings being given to economic criteria.

The Gorgon Venture used a screening process that deliberately avoided bringing detailed economic criteria into the analysis until after a short-list of locations had been created based upon the environmental, technical and social criteria (as explained in Technical Appendix C). This reduced the risk of bias affecting the outcome and also allowed the next phase of evaluation to concentrate on fewer locations.

Figure 4.4 of the main text shows the process used for firstly screening on a regional basis for a short list of locations which were then evaluated in detail to derive the cost of development at that location. Economic viability is fundamental for any development project and the Gorgon Venture does not consider that economic data has been weighted artificially high.

EP60 Why does the scoring process in Table 4.1 of Appendix C give a constraint factor of 5 for "proximity to nature reserves" and 10 for "mangroves"?

The constraint of 10 for Mangrove buffer zones is for a relatively short buffer distance of 200 metres. In a practical sense, this is a very minor additional buffer constraint, especially given the size of the region under investigation. On the other hand, taking Barrow Island as an example, the total area of the island is considerable, and the prospects for identifying quite large sites previously disturbed or modified (i.e., industry related) was considered good, and hence an 'overall' constraint level of five was, on balance, both realistic and fair.

EP61 Why did the proponent not engage with stakeholders in the processes of listing comparison criteria and providing weightings for each criteria, which would have increased the robustness and legitimacy of the process, particularly by using a larger group to determine scores where these cannot be obtained by "scientific" means?

Since 1995 the Gorgon Venture and URS has undertaken considerable field work and community engagement at many locations within the study area including all short-listed locations: Exmouth, Onslow and Cape Preston. This has allowed a unique insight into community values and concerns. This understanding influenced the multi-criteria analysis and the rating process. There was also consideration of stakeholder issues as derived from secondary sources (e.g., reports and literature cited), and from a separate and ongoing stakeholder assessment program undertaken in parallel by the Gorgon Venture. These judgements were also influenced and supported by the professional experience of URS including their own peer review panel.

EP62 Why have the ordinal scores contained in Tables 6.5 and 6.6 of Appendix C (presented on a scale of -2 to +2), been added together, when no mathematical operators can be applied to ordinal scores, since the degree of difference between scores is not known?

The planning discipline has been using qualitative multi-criteria assessments, a variant of 'planning balance sheet' techniques, for decades. When undertaking very broad regional assessments, planners have to take account of extremely disparate and more often than not, unquantifiable or intangible aspects. Planning pedagogy has long accommodated the operational reality that decisions still have to be made in the context of both uncertainty and imperfect information. The Gorgon Venture, supported by URS, therefore believes that this coarse level regional assessment is highly appropriate and valid, as applied.

There are no quantified values expressed in Tables 6.5 and 6.6. No value expressed in the numbers used in anyway relates to a calibrated measurement.

Serious consideration was given to using symbols rather than numbers (e.g., smiling faces, neutral faces and frowning faces, or stars, etc). The intent was to indicate a value judgement in each case of positive versus negative impact/implication, and to provide an illustration of the degree of positive or negative (slight, or very positive/negative). This is a value laden multi-criteria analysis, and is predominantly subjective. This does not mean the attempt to show the implications and differences of each site were invalid.

EP64 Have the impacts of over-land pipelines for gas and CO2 been considered in the site comparison analysis?

The cost comparisons included all pipe requirements including overland pipelines. However, the environmental analysis did not specifically evaluate differences for this factor for each site. This is a very specific level of detail that would be considered more appropriately during the environmental impact assessment phase that would proceed if in-principle approval is granted for the proposed development on Barrow Island.

EP65 Why were "local employment" and "commercial fisheries" not included as social criteria in Table 6.1 of Appendix C?

Table 6.1 is a summary only. Table 6.6 does consider commercial fishing and employment.

EP66 Why has Onslow North been excluded (p 27 Appendix C), when the presence of a small 10m deep basin would surely reduce dredging costs and therefore be an advantage?

The report (Appendix C) should have indicated more clearly that the small deep basin, at the scale of the original data used, falsely suggested that the deep water isobath extended closer to the shoreline than was the case. Hence, during the subsequent engineering evaluation by the Gorgon Venture, further examination at a larger scale revealed that extensive and prohibitively expensive dredging would have been required.

The basin represents an insignificant saving relative to the cost of 19.5 million m³ of dredging required for the access channel.

EP67 How does the mitigating factor that Onslow North "is not connected to the mainland" differ from a similar limitation for island sites (Section 6.2.3 of Appendix C)?

The Gorgon Venture believes that the subject of the question is West Intercourse Island and not Onslow North. In the case of West Intercourse Island, the 'not connected to the mainland' is relevant, because development of a facility would require that there be a connection (bridge, causeway, etc) with the additional impacts and costs that this would involve. Island locations remote from the mainland are entirely different as they need their own infrastructure either in place, as is the case on Barrow Island, or to be constructed for other Islands.

4.4 Need for Better Understanding

EP1 Minister Brown's letter of 20 November 2001 (Appendix 1) anticipates that "...reports...would include comparisons with outcomes that would occur if alternative locations were used for the project." Table 4-2 lists only the constraints on alternative locations, not alternative outcomes. Why are alternative outcomes not presented in the ESE Review?

EP55 Why has the proponent limited its site comparison to a superficial comparison of costs, and not provided a comparison of the potential outcomes that would occur if different locations were chosen, as required by the Minister's letter (Appendix 1)? Can the proponent provide a comparison of outcomes?

The Gorgon Venture believes that it has met the requirements of Minister Brown's letter and completed the ESE Review work based on the agreed scoping document. This has been ratified by the Expert Panel. The studies identified Barrow Island as the only location that meets the environmental, social and economic development criteria and provides a commercially competitive development.

EP6 Why are offshore platforms required for some alternative site options and not others? Would the cost of the platform apparently required for the Maitland option be offset by the lower cost of construction of an onshore LNG plant?

EP7 Under what conditions is corrosion resistant pipe required?

The wellstream fluids directly from the Gorgon reservoir contain water and 13.5 mol% CO₂. This makes it essential to use corrosion resistant alloy (CRA) lined pipeline from the wellhead to the point of first gas treatment to ensure pipeline integrity. However, this pipe material is expensive and beyond about 100 km distance it becomes more economic to install an unmanned offshore platform with simple water removal facilities so that (with the aid of continuous corrosion inhibitor injection) a Carbon Steel (CS) pipeline can be used to continue to the gas processing facility.

Barrow Island is close enough to use a CRA pipeline all the way to landfall without the need for a platform. Locations such as the Burrup Peninsula and Thevenard Island could also use a CRA pipeline, but the platform with CS pipeline is more cost effective. This however still remains far more expensive than the Barrow Island option.

EP9 Why does Table 4.3 show a shorter pipeline length from Gorgon to Hermite Island than to Trimouille Island, when Trimouille is closer to the Gorgon gasfields?

Table 4.3 shows Trimouille Island requires a 93 km feed gas pipeline and Hermite Island a 115 km feed gas pipeline. This is dictated by the pipeline route which must firstly pass to the north of the Montebello Islands to avoid a significant length of very shallow water and then approach the islands from the east.

EP19 Would the contract industries servicing the project be located on Barrow, and what would the environmental and economic impact be?

The contract industries servicing the proposed development would most likely be located in Karratha and Perth. The philosophy for such an island location is based on "change out" maintenance to minimise repair activity on Barrow Island. For example, the use of aero-derivative gas turbines, instead of industrial gas turbines, would allow the complete gas turbine to be sent back onshore for an overhaul whilst a spare replaces it.

EP31 In stating that "the alternative exists to defer or not develop Gorgon area gas" and that "approval...is dependent on successfully securing a market", is the proponent referring to an internal ChevronTexaco decision-making process?

The statement that "the alternative exists to defer or not develop Gorgon area gas" is a decision that can be made by either the Government or the Gorgon Venture since the

approval of both is required to develop. The statement that "approval...is dependent on successfully securing a market" refers to investment decisions by the Gorgon Venture, which are based upon successful market capture and a sound business case before investment is made.

EP54 Has the proponent considered the possibility of locating part of the gas processing facility offshore, thus obviating the need for a tanker-loading jetty?

The ESE Review has a base case of convention technology. All locations evaluated used a conventional jetty and loading berth for LNG load-out as their basis. Studies are underway to investigate the technical viability of using a sub-sea cryogenic pipeline for loading LNG via an offshore loading platform, thereby avoiding the need for a jetty. This would also allow loading in deeper water and avoid the need for dredging. However, at this time, the Gorgon Venture is unable to predict the outcome of these studies and cannot yet build them into the base case. If this system could be used, it would be a world first.

4.5 Domestic gas to Mainland

EP5 Does the cost analysis include the cost of a pipeline to shore? If not, what impact would the inclusion of this cost have on the relative ranking of alternative sites?

EP16 If the cost of product pipeline to the shore has not been included in the cost analysis, why has this been omitted (causing the mainland options to appear more expensive)?

EP22 Has the proponent considered the benefits of accessibility to the DBNG pipeline in the Maitland option (pipeline runs through the estate)?

EP68 Why has proximity to the DBNG pipeline not been included as a constraint factor in the site comparison analysis?

The proposal in the ESE Review is based on establishing a foundation gas processing plant on Barrow Island for LNG or other industrial gas products such as GTL. Such a development will underpin the economics of bringing gas to the domestic market on the mainland.

The pipeline to transport domestic gas to a customer has not been included in the comparison of costs in Table 4.3 of the ESE Review. The inclusion of a domestic gas sales pipeline would affect the relative costs however, the ranking stays the same, with Barrow Island still clearly the only location for a commercially competitive development.

Furthermore, from Barrow Island there is the possibility to utilise any ullage (spare capacity) available in the existing pipeline from Varanus to Compressor Station 1, reducing the capital expenditure for a sales gas pipeline.

4.6 GHG Management

EP29 Why does the proponent conclude that the Dupuy reservoir is the only feasible site for injection of CO₂ when it is claimed on p164 that West Tryal Rocks and the Gorgon gas reservoirs also "offer the best opportunities to re-inject reservoir CO₂?"

The ESE Review concluded that: "The review of sites concluded that the Barrow Island – Dupuy saline reservoir, West Tryal Rocks and the Gorgon gas reservoirs offer the best opportunities to re-inject reservoir CO₂.

"Among those sites, the Barrow Island – Dupuy saline reservoir was identified as the best reservoir for CO₂ re-injection as it would be available when production from Gorgon gas fields commence."

As stated in the ESE Review (p. 164-165) the Dupuy was selected as the best re-injection location because:

- *The depth and “thinning up-dip” provide the most favourable technical conditions for re-injection (see Figure 8-2 and 8-9).*
- *There is little or no potential to jeopardise current or future production of hydrocarbons.*
- *Re-injection wells that penetrate into the Dupuy reservoir would allow access to other saline reservoirs (Flacourt and Malouet) as mitigation/upside options.*
- *The reservoir would be available for re-injection when gas production commences.*
- *The reservoir is large and deep enough to accept the proposed CO₂ volumes.*
- *The Dupuy saline reservoir is accessible from Barrow Island – removing the need for sub-sea wells and offshore platforms, reducing the risk and cost, and making re-injection more practicable.*
- *The location under a land mass (Barrow Island) and the existing oilfield provides increased geological data and monitoring opportunities to improve knowledge of the behaviour of re-injected CO₂.*

EP30 *Why have the costs of the other options been artificially boosted by assuming CO₂ injection can only occur at Barrow Island?*

As stated in Chapter 4 of the ESE Review, sequestration of reservoir CO₂ is seen as a critical issue for a number of stakeholders. Chapter 8 explains that after conducting a regional assessment, the Barrow Island – Dupuy saline reservoir was identified as the best reservoir for CO₂ sequestration. Chapter 15 goes on to make a commitment to plan for re-injection of reservoir CO₂.

It is therefore consistent that this greenhouse gas management strategy be applied to all alternative locations considered. This then requires that a return line and booster compression for transporting the CO₂ to the injection site on Barrow Island be included in the comparative cost estimates.

EP35 *Why have the opportunities for reinjection of CO₂ at locations other than Barrow Island not been investigated further?*

Opportunities for re-injecting CO₂ at locations other than Barrow Island were extensively investigated. A summary of the work undertaken to select a suitable re-injection formation is presented in section 8.8.3 (p. 163-167, ESE Review). Figure 8-6 outlined the area reviewed for potential sites with Figure 8-7 and Table 8-5 outlining nine sites that were selected for further investigation as potential re-injection sites.

EP36 *When are the opportunities associated with “maturing alternative reinjection sites” (Box 8-6) likely to be firmed up, recognising that this could have a significant bearing on the alternative sites analysis?*

The availability of depleted gas reservoirs would depend on the economic life and remaining reserves in formations suitable for large scale reservoir CO₂ re-injection. The exact time frame cannot be defined at this time without further study. Prior work suggested that it would require over 10 years to deplete sections of the Gorgon gas field.

The Gorgon Venture did review a number of the surrounding fields that have the potential to be depleted in the next 5-10 years. This included the Saladin, Spar and the Harriet - Campbell fields (See Figure 8-7 and Table 8-5 in the ESE Review). None of these individual fields have the capacity to accept the CO₂ volumes from Gorgon gas. To meet the volume requirements a network of pipelines and subsea wells or platforms would need to be utilised. This would significantly increase the cost of CO₂ re-injection, potentially making it a cost prohibitive option. However the ‘conversion of nearby oil and gas reservoirs to re-injection as they reach the end of their production lives’ (p. 174, ESE Review) will be considered as part of the contingency plan.

EP69 With reference to the discussion on p 173, does the proponent agree that while locating the gas processing facility elsewhere than on Barrow Island may change the economic equation, it has nothing to do with the practicality of reservoir CO₂ reinjection?

Any given practicable solution to a problem is based on its technical feasibility (i.e., will it work?) and its economic cost (is it affordable). If the cost of re-injection becomes prohibitive, it is no longer a practicable solution.

4.7 Split CO₂ Removal Concept

EP20 Has the proponent considered the two possible options for development at the Maitland Estate: offshore platform and LNG plant at Maitland with small pipeline taking CO₂ back to Barrow, or no offshore platform, but with a CO₂ stripping plant on Barrow with LNG plant at Maitland?

EP45 In its alternative sites analysis, has the proponent considered alternative development concepts, such as initial stripping of the CO₂ on a platform, or at Barrow Island, allowing pipeline transfer of the stripped gas to the mainland for further processing?

The first option was the basis of our evaluation of the Maitland Estate/West Intercourse Island site alternative. The offshore platform is only included to enable water removal and subsequent use of a Carbon Steel pipeline rather than the more expensive option of a 250 km subsea tie-back with a Corrosion Resistant Alloy lined pipeline. The result was that Maitland was \$1100 million more expensive than Barrow Island.

The second option has been studied previously and found to be more expensive and less environmentally acceptable than any of the alternatives described in the ESE Review and would still require approval for use of Barrow Island to locate a gas processing facility (which is what the CO₂ removal requires).

It requires two separate CO₂ removal plants – a bulk removal on Barrow Island and final removal at the LNG Plant.

The Bulk Removal Plant would reduce the CO₂ content of the gas from 13.5 mol% to 2 mol% (to meet domestic gas quality needs). It would be a significant gas processing facility in its own right to handle 1300 MMscfd and would occupy about one-third of the plant area required for an LNG Plant.

It would require:

- Feed gas receival facilities - slugcatcher, filter separators, metering.
- Condensate handling - stabilisation, storage and export facilities.
- CO₂ removal - Absorber Column 6 m in diameter, 40 m high (weighing 800 tonnes), amine regeneration system with 100MW heat duty, amine storage.
- Utility systems – furnaces for regeneration heat (requires 25 MMscfd fuel gas), electricity (50MW), N₂, demineralised water from a desalination plant, flare.
- Infrastructure – construction camp, Material Offloading Facility (MOF), dredged channel for access to MOF, laydown area, operations support, maintenance staff.
- CO₂ reinjection – compression facilities, dehydration, CO₂ pipeline and injection wells.
- Gas dehydration and compression.

The 1150 MMscfd of treated gas could then be piped to a mainland location using a Carbon Steel pipeline. This pipeline has cheaper material but would still require expensive stabilisation due to greater than 60 km of shallow water to be crossed. The final CO₂ removal plant would be similar in scale to the bulk plant since it would still need 100MW heat duty to remove the final 2 mol%. The difference is that its heat could be supplied from waste heat recovery from the LNG Plant's gas turbine exhausts. Also, the final CO₂ removed would be vented to atmosphere rather than be reinjected.

The proposal in the ESE Review is to build an LNG Plant on Barrow Island providing a single site for operations and maintenance, allowing full heat integration with the 200 MW heat duty provided from gas turbine exhaust heat recovery and reinjecting all the CO₂ removed from the gas stream. The Carbon Steel pipeline to the mainland needs only to be sized for domestic gas demand of 300 MMscfd.

The relative cost comparison shows that a Split CO₂ Removal proposal with bulk removal on Barrow Island and final removal together with an LNG Plant at the Burrup Peninsula would cost \$1050 Million more than the reference case on Barrow Island and is hence commercially unviable.

In summary, for a Split CO₂ Removal Concept relative to the ESE proposal:

- It is far more expensive.
- It is less thermally efficient.
- It results in more greenhouse gas emissions (from the 2 mol% vented and from increased fuel gas consumption).
- It still requires approval to build a significant gas processing facility on Barrow Island.

5 Development Concept

EP72 If an initial development is permitted on Barrow Island then there may be increased pressure for future developments on the island, resulting in cumulative environmental effects. What guarantees can the proponent provide to address this concern, to be consistent with the concepts and definitions of sustainability and "net conservation benefit"?

The ESE Review contains a commitment from the Gorgon Venture not to exceed a 300 ha footprint on Barrow Island for all gas developments (See Chapter 15, Commitment 1). If the proposed development proceeds, the Gorgon Venture will not be asking for any additional land area.

Any specific project on Barrow Island would have to fit within that 300 ha and would be subject to the more detailed environmental impact assessment process.

EP73 Why have alternative development options not been considered in this Review?

EP74 Why has the proponent not included information relating to the siting of potential foundation customers on Barrow Island, given that the lack of this information makes an assessment of the full impacts of the proposal impossible?

EP75 Please comment on the proposed Gorgon project's capacity to support a GTL plant?

EP76 Has the proponent made provision for alternative and additional technologies in the 300ha of land proposed for the development?

EP77 Given that the Government's guidelines for the ESE Review call for a description of the "full range of proposed technologies" which may be incorporated into a "gas processing complex" on Barrow Island, why has a potential GTL plant not been included in the proponent's development concept?

EP78 In stating in the Executive Summary that while LNG has been modelled as a reference case, but that different opportunities such as GTL could emerge, is the proponent referring to GTL instead of LNG, or as well as LNG?

The Gorgon Venture has pursued a range of development and marketing options in an effort to secure an initial development, including extensive development and marketing assessments for a variety of locations on the mainland, from the Burrup Peninsula to Exmouth, as well as offshore (FLNG) and island-based concepts. In addition, the previous 1998 concept, based on the Burrup Peninsula, attempted to optimise economies of scale and exploit cooperative synergies with adjacent NorthWest Shelf Project infrastructure on the Burrup Peninsula.

The ESE Review process is seeking "in-principle" approval for restricted use of Barrow Island for a generic gas processing facility rather than a specific development option. This is because the Gorgon Venture has yet to secure a gas customer so is unable to be definitive about the specific outcome.

As explained in Chapter 1 of the ESE Review, the Gorgon Venture has used a reference case of an LNG development since this is viewed as the most likely customer upon obtaining approval for restricted use of Barrow Island. However, it is also stressed that this does not preclude the possibility that a different development option might eventuate on Barrow Island as the foundation customer for Gorgon gas. An obvious example would be a GTL Plant.

The Gorgon Venture used an LNG Plant to explain the foreseen implications of a gas processing facility on the island. It is representative of the impacts such a facility would have on the island and is appropriate for a strategic assessment. The detailed description

of a specific plant would normally be provided as part of the environmental impact assessment approval process.

It is possible also that both an LNG plant and a GTL plant could be integrated on the site. In any case the development option will be restricted to the 300 ha total disturbance limitation as committed by the Gorgon Venture in the ESE Review.

EP79 What is the maximum footprint size that may be justified using the possible in-principle approval resulting from this ESE Review?

The Gorgon Venture has committed that the total disturbance area on Barrow Island from a gas processing facility would not exceed 300 ha – regardless of which foundation customer is eventually secured. This area includes the gas plant, construction camp, quarantine area, pipeline corridors and ancillary disturbance such as widening roads or extending the runway.

EP 334 Has the proponent taken into account in this design the existing East Spar-to-coast pipeline that passes by the north end of Barrow Island?

The Gorgon Venture is well aware of the sub-sea pipeline between the East Spar field and Varanus Island, and will consult with its Operator, Apache and take this into account in the detailed design and construction plan for the Gorgon gas development. Note that this pipeline will not be affected by the plan to re-inject reservoir CO₂.

6 Environmental

6.1 Environmental Impacts

EP95 How would the proponent monitor impacts on the ecosystem of Barrow Island over the life of the development?

Appropriately detailed programs to monitor the potential impacts of the development on the ecosystem of Barrow Island, over the life of the development, would be formulated, if the proposal is granted in-principle approval for the restricted use of Barrow Island. These would be subject to public/stakeholder review and assessment by environmental agencies during the formal environmental impact assessment process.

The purpose of the ESE Review process is to identify factors that are critical to the question of whether or not restricted use of Barrow Island is acceptable. The Gorgon Venture considers such factors to be those that cannot be managed through environmental impact mitigation or minimisation practices and which have a level of risk that would be beyond the Gorgon Venture's control. The level of investigation, assessment and planning undertaken to date is in keeping with the strategic nature of the ESE Review.

The final scope and nature of the detailed management strategies, including monitoring programs, to meet the regulatory requirements of the Western Australian and Commonwealth Governments, would be developed at the time of a formal environmental assessment in consultation with relevant agencies and stakeholders.

EP101 Reference is made in paragraph 4, p122 to qualitative risk assessment of ecological impacts. Where are these data to be found please? Have they been subjected to independent peer review?

A qualitative risk assessment of ecological impacts was prepared by specialist consultants Bowman Bishaw Gorham as an internal document to assist their assessment for the ESE Review. The document was not subject to independent peer review.

EP97 Would the quantity of brine to be discharged from a desalination plant be likely to have significant environmental impacts and why?

Brine from the desalination plant is unlikely to have significant environmental impacts provided it is appropriately managed. Wastewater (including brine from the desalination plant) would not be discharged to the marine environment or to the shallow groundwater aquifer (ESE Review, p. 118). The disposal method for wastewater has yet to be determined. However, it is likely that it would be collected, treated and then disposed via the oilfield's existing deep well (>1000 m) re-injection waste streams. Approximately 750 KL per day of produced formation water is currently re-injected to the geologically isolated Flacourt Formation and the volumes of brine associated with the proposed Gorgon gas development that would be added to this waste stream are negligible.

EP133 Please comment on the DEP's previously cited concerns relating to waste disposal on the island, particularly the use of incised valleys for waste landfill with significant detrimental consequences for associated groundwater bodies.

EP206 Does the proponent intend to clean up contamination which has already occurred on Barrow Island, as well as any future contamination resulting from the proposed development?

Since the development of the oil field on Barrow Island, some areas of groundwater have been contaminated with hydrocarbons. To address this problem, ChevronTexaco has established a remediation plan to recover hydrocarbons and implement procedures to avoid further contamination occurring. The plan and procedures were developed in consultation with the Department of Environmental Protection.

Specialist consultants undertake a routine and comprehensive groundwater monitoring and remediation program on Barrow Island on behalf of ChevronTexaco. The program is designed to detect and, where feasible, remediate any potential effects on the groundwater from oilfield operations. The program is conducted in accordance with ChevronTexaco's DEP Licence 4467 and a number of Action and Management Plans that have been agreed with the Western Australian Government.

ChevronTexaco also undertakes routine groundwater monitoring to assess the impact of oilfield operations on the superficial aquifer under Barrow Island. Currently a minimum of 22 sampling locations are routinely monitored in accordance with Department of Environmental Protection's licence conditions. This program is currently under review for improvement so amendments to associated licence conditions could occur during 2003.

EP209 How will contaminated water be prevented from entering the groundwater system, particularly given that rainfall is irregular and therefore contaminants may build up over a significant period, how will it be treated, and where will the sink for the treated water be?

EP210 What level of contaminants could potentially enter the groundwater system and what would the impacts on stygofauna be?

The Gorgon Venture agrees that contaminated stormwater must be managed to avoid contact with, and contamination of, groundwater. Appropriate mitigation and management measures would be accommodated in detailed engineering and design of the gas processing facility. All necessary measures would be incorporated into the plant design to avoid contamination of groundwater.

Areas on the plant where liquid hydrocarbons are processed or stored would have impermeable hardstand, closed drainage systems and bunded areas (ESE Review, p. 121).

EP238 The proponent states its intent of "minimising discharges to the environment". Why, with a facility sited in an A Class nature reserve can we not be aiming for no discharges to the environment? What types of discharge are considered acceptable to "minimise" rather than prohibit?

The Gorgon Venture has committed to minimising discharges to the environment. For example no process water or domestic effluents will be discharged to the sea. The management of discharges is based on the level of risk it poses to the environment. Unfortunately, some emissions are not realistically avoidable, such as the atmospheric emissions from the gas turbines. However, it is possible to minimise emissions of nitrous oxide and sulphur dioxide from the turbines.

In cases where elimination is not possible, discharges would be minimised. If any discharges are found to cause a significant environmental impact, appropriate mitigation and environmental management measures would be implemented.

EP241 The ecology of the Barrow Is. fauna is poorly known. Virtually nothing is known about the terrestrial invertebrates, much of which is likely to be endemic species, with many unnamed. No mention is made of invertebrate fauna apart from molluscs. The interdependence of these fauna with the island's plants is virtually unknown, as are the processes and functions of the different island ecosystems. Given this lack of knowledge, how would the proponent know what effects on ecosystems, plants and fauna are likely, given that baseline studies have not been carried out?

If the proposed gas development proceeds, invertebrate baseline studies would be conducted as part of an ongoing assessment of the Barrow Island environment.

EP242 As the pipeline, together with its access road, is proposed to cross Barrow Island from west to east and thereby cut across different ecosystems, how will the proponent minimise impacts?

The site selection process for the Gorgon gas development, including the pipeline route, has incorporated measures to reduce the level of environmental disturbance. The proposed route for the east-west gas delivery line generally follows existing roads and seismic tracks.

The specific final alignment of the pipeline will be selected following further environmental studies, including detailed botanical and fauna habitat surveys of the proposed pipeline corridor, to ensure that no significant vegetation or fauna habitat is adversely impacted. Strategies to ensure potential impacts from construction and the ongoing presence of the pipeline are mitigated or minimized, including strict restrictions on the width of disturbance for the pipeline easement, will be developed and presented for review by the public and relevant environmental agencies and stakeholders during a formal environmental assessment process, if the proposed development proceeds to detailed planning.

EP245 Even low levels of gas emissions from the process plant could have significant long term cumulative impacts on plant species that naturally require low levels of nitrogen. It is possible that some species could be disadvantaged and others advantaged, thereby leading to significant ecosystem changes over time. How will this possibility be addressed?

The Gorgon Venture's commitment to incorporating best practice and "best available technology" into the design and operation of the gas processing facility is described in the ESE Review. With these management strategies, the probability that emissions from the plant would alter ambient atmospheric concentrations of any gas to an extent that would provide a competitive advantage or disadvantage to any plant species is extremely low.

A thorough assessment of the potential environmental effects of emissions, and all other aspects of the proposal, would be completed if in-principle approval is granted and the proposed development progresses to detailed design and the formal environmental impact assessment process. The purpose of the ESE Review process was to identify factors that are critical to the question of whether or not the restricted use of Barrow Island is acceptable. The Gorgon Venture considers such factors to be those that cannot be managed through environmental impact mitigation or minimisation practices and which have a level of risk that would be beyond the Gorgon Venture's control.

Based on the ESE Review, the Gorgon Venture is confident that, if the proposed development proceeds, loss of biodiversity of species or communities would not occur. It is therefore considered that the risks from gaseous emissions are sufficiently understood for it to be reasonable to expect that appropriate management strategies could be effectively implemented.

EP 371 What is the projected extra number of transportation movements required to move 2200 construction workers to and from the airport as they rotate rosters? How does this compare with the current level of movements on the island and what is the likely impact on wildlife, particularly road kills? Please provide a comparison with the current level of road kills with the current level of oil field traffic.

The Gorgon Venture acknowledges the potential for increased numbers of transportation movements with development-related activity on Barrow Island. The ESE Review outlines strategies to reduce risk including use of buses and coaches, speed restrictions, control of vehicle movements at high risk times of the day (e.g., dawn and dusk), driver education and prohibition of off-road vehicle movements. While the peak of the construction workforce would be ten times the number of the existing workforce, the construction period is unlikely to incur ten times the road kill.

It is important to note that the workforce employed on construction of the gas processing facilities would be accommodated within the proposed site area at Town Point. The

accommodation facilities are adjacent to the construction site. Movements beyond this area would be restricted to crew change activities which would only involve transporting personnel by bus to and from the airport.

In 2002, there were nine animal casualties as a result of road traffic.

EP99 There are claims that Barrow Island has not been well looked after by industrial operators in the past, citing as examples: weeds at the airport; large numbers of tracks, seismic lines, production areas and infrastructure which have not been rehabilitated; groundwater contamination by hydrocarbons and other contaminants, which has the potential to impact detrimentally on subterranean fauna. What is the proponent's response to these claims?

ChevronTexaco is proud of its environmental performance on Barrow Island. The management of the island oilfield is widely recognised as an industry benchmark for the coexistence of petroleum development and biodiversity protection. The operator has received numerous state, national and international awards in recognition of its environmental performance.

Isolated outbreaks of weeds with highly restricted distributions have occurred on the island in the past, but wherever weeds are detected they are subject to eradication and monitoring. In addition to eradication operations, ChevronTexaco's commitment to weed management includes a policy and practice of rehabilitating disturbed sites. During 2002, the existing program of integrated weed control, including prevention and eradication strategies, was developed further and formalised into a Weed Management Plan (WMP) in consultation with Astron Environmental and the Department of Conservation and Land Management (CALM).

Weed control efforts are prioritized through a risk assessment in accordance with the criteria outlined in the *Environmental Weed Strategy for Western Australia* (CALM 1999). As part of that Plan, ChevronTexaco is actively striving to eradicate the weed, known as buffel grass, at the airport on Barrow Island. While this effort continues the weed has been contained and is regularly monitored.

ChevronTexaco also implements stringent quarantine procedures and has outlined policies to minimise the occurrence of disturbance to naturally vegetated areas outside established access ways and hardstand areas (Astron Environmental 2001).

On behalf of ChevronTexaco, IT Environmental undertake a routine and comprehensive groundwater monitoring and remediation program on Barrow Island. The program is designed to detect and, where feasible, remediate any potential effects on the groundwater from oilfield operations. The program is conducted in accordance with ChevronTexaco's DEP Licence 4467.

EP147 Does the proponent intend to introduce specific performance standards and completion criteria for environmental management, incorporating monitoring procedures and providing a basis for decision-making?

Throughout the ESE Review, the Gorgon Venture clearly demonstrates its willingness and commitment to implement effective management actions and best practice environmental measures that would be developed in consultation with relevant stakeholders – including regulatory agencies. These management actions and measures would also be guided by the findings of studies conducted under a formal Environmental Impact Assessment process.

Oil operations on Barrow Island are already managed within the framework of an Environmental, Health and Safety (EH&S) management system. This system is subject to continual improvement measures (i.e., review, audit and improvement) so is currently being upgraded. For example, ChevronTexaco is currently developing completion criteria and monitoring techniques for Barrow Island that will quantitatively demonstrate rehabilitation progress.

Worldwide, ChevronTexaco is implementing a system of operational excellence that includes an Environment, Health and Safety (EH&S) system that includes modern standards. If the proposed development for Gorgon gas proceeds on Barrow Island, a modern EH&S management system would be developed based on the existing system and would include specific performance standards and completion criteria for environmental management. It would also incorporate monitoring procedures that would provide a basis for ongoing decision-making.

EP221 Why has there been no discussion on the biodiversity values lost already through infrastructure development of Barrow Island (including the possible loss of some 30 flora species)?

ChevronTexaco has conducted, sponsored or supported, numerous environmental research efforts (including flora, vegetation and fauna surveys) on Barrow Island since petroleum operations began in 1967. The company is unaware of any species that has been confirmed "lost" from the island during this period, and would be interested to discuss this with the submitter.

EP231 Why is it apparently considered reasonable to destroy, or risk destroying, the habitat of species that are on an A Class nature reserve and are also protected by international agreements?

The Gorgon Venture is committed to complying with all legislation relevant to the proposed gas development on Barrow Island – including regulations that capture the requirements of international agreements designed to protect habitat and wildlife.

The Gorgon Venture is also committed to implementing the "Gorgon Gas Development Sustainability Principles" (ESE Review, p. 010 and 263). Principle 3, "Biodiversity and Ecological Integrity Protection", states specifically that "The Gorgon gas development will not disrupt ecological structure and function, nor will it result in a loss of biological diversity on Barrow Island."

6.2 General

EP93 What are the risks to flora and fauna in event of a pipeline leak, including in the event that a gas leak ignites?

The risks to flora and fauna from a pipeline failure are extremely low. It is widely acknowledged that modern, high pressure gas pipelines maintain an excellent operating record. It is reasonable to expect that the Gorgon feed gas pipeline would have an even lower chance of failure than other similar pipelines, because third party damage – the highest threat under normal circumstances – is not likely on Barrow Island. This is because private landowners and members of the public would not have access to the pipeline.

It is to be noted that the ESE Review is a strategic assessment and, as such, a detailed risk assessment was neither required nor undertaken. Such an assessment will be conducted when design and engineering details are available, in line with accepted industry practice.

In the extremely unlikely event that a pipeline leak occurs, the valves at either end of the pipeline would automatically shut-in, limiting the amount of gas released to the environment. The released gas would rapidly dissipate thereby limiting the effects on flora and fauna. In the unlikely event of the gas igniting, the surrounding vegetation could catch fire. Response to the fire would be rapid, given that operations personnel would receive immediate warning of pipeline failure. (See also response to EP100, regarding the management and response to fire).

EP98 Edith Cowan University (ECU) was not consulted during the process of identifying potential options to engage in research and development programs in the oil and gas industry (Section 13.2.16). Does the proponent intend to conduct further consultation in this area, and if so, does it plan to include ECU, particularly the Centre for Ecosystem Management, in these discussions?

There was no intentional bias by the Gorgon Venture in meeting only with Murdoch, Curtin and University of Western Australia representatives. The Gorgon Venture recognises the value that other institutions such as Edith Cowan University, University of Notre Dame, the various TAFE and many others could make contributions to the development. If the proposed development proceeds, the Venture will consult individually with many of these organisations, in addition to investigating opportunities collectively through government departments such as the Department of Education and Training.

EP96 What evidence is there for the expectation that animals will readily acclimatise to the increased noise levels, noting that they will have different tonal qualities to those of the oil field operations, that are likely from the proposal?

Existing oilfield operations comprise a wide range of activities with a corresponding variety of noise sources, levels and characteristics. Observations of fauna in the oilfield suggest that they rapidly acclimatize to ongoing sources of low-level noise and there is no indication that this is related to any particular activity and/or sound characteristics (including tonal).

Noise emissions from the proposed facility are expected to be low, although they are likely to be greater than existing oilfield operations, as was noted in the ESE Review. In-depth analysis of the potential effects of the proposed facility on fauna, including those associated with noise emissions, would be undertaken at a time when engineering details of the gas processing facility are known. This analysis would occur as part of a detailed environmental impact assessment, if in-principle approval for restricted use of Barrow Island is granted. Data from this assessment would be used to design and manage the facility and its operations to ensure that noise impacts are kept to an acceptable level.

EP128 How does the proponent intend to minimise impacts on trawl grounds in the Onslow/Nickol Bay Prawn Managed Fishery arising from the proposed pipeline from Barrow Island to the mainland?

The Gorgon Venture consulted the Department of Fisheries during the preparation of the ESE Review to provide an understanding of the development concept and receive feedback on the proposal. The ESE Review focuses on the use of Barrow Island and the surrounding water. Pipeline alignment between Barrow Island and the mainland were not considered in detail as part of the ESE Review. More detailed discussions on a specific project, including pipeline routes, would be held with the fishing industry and the department during the EIA process with a view to enlisting their help to minimise impact.

EP129 What commitment could be given that there would not be future pressure to locate offshore work vessels and their crews on Barrow to minimise travel time to the sub-sea field?

The need for subsea maintenance will be infrequent and is likely to be serviced from specialists out of Dampier.

EP131 Noting the need to manage entrained salt, could dredge spoil be used as fill, to minimise the risk of weed invasion as a result of importing fill from another terrestrial source?

The ESE Review indicated that a limited amount of dredge spoil may be used as fill during the construction phase. Issues relating to the source of all fill, including that of entrained salt, would be considered at a later stage of any development approval process.

EP148 What mammal conservation work does the proponent intend to conduct, and how is this to be linked with mammal conservation undertaken across the State?

EP149 Does the proponent intend to conduct research and monitoring programmes for marine mammals, turtles, seabirds and shorebirds, since Barrow Island and the Gorgon gasfield are located in a marine environment that is a vital link in migration corridors?

The Gorgon Venture would expect to undertake conservation work and monitoring in conjunction with CALM on Barrow Island and in the surrounding waters, particularly as it relates to impacts from the proposed development. Results of this monitoring and conservation work would be included in annual reports. If the development proceeds, the Gorgon Venture would also seek to enter into a formal Conservation Agreement with CALM. The Agreement would provide the framework for management decisions concerning the environment of Barrow Island including fauna conservation (ESE Review, p. 122, p. 272).

The Gorgon Venture is committed to establishing and funding the "Gorgon Environment Foundation" to develop and employ a range of strategies and projects intended to deliver net conservation benefits to Western Australia. Those net conservation benefits would reflect the key conservation values of Barrow Island, including its status as an island which supports many unique fauna species and a high level of biodiversity (ESE Review, p. 177, p. 272).

EP150 Please provide time frames for development activities such as the construction and placement of feed gas pipelines from the gas field to Flacourt Bay, which may impact breeding and nesting activities of listed species

The ESE Review outlines the strategic nature of construction timeframes that will account for the breeding and nesting activities of listed species in order to minimise any potential impacts to fauna populations. The Gorgon Venture is including the need to minimise disturbance during these breeding and nesting seasons in its engineering considerations.

EP208 Will first flush water be separated from following water?

As stated on page 120 of the ESE Review, stormwater run-off from hard-stand and plant areas would be collected and treated prior to disposal. It is anticipated that such stormwater would be discharged to the existing natural drainage system following the collection and treatment of 'first flush' water associated with rainfall events.

EP211 Will hydrocarbon storage facilities be above ground to enable detection of leaks?

It is not anticipated that there will be any underground storage of hydrocarbons.

EP 218 Does the proponent see a role for multinational corporations in engaging with Government in the development of environmental policy?

EP 219 Has the proponent, or any of the individual joint venture partners, ever lobbied against proposed environmental policies or new laws?

The Gorgon Venture believes there is a valid role for all stakeholders, including multinational corporations and environmental organisations, to engage with governments in the development of environmental policy. All of the Gorgon Venture participants have engaged various governments on environmental policies and laws as stakeholders in the related issues. This is an integral part of open and democratic processes. Governments regularly encourage comments on various policies and laws by requesting public submissions, including those from companies such as ChevronTexaco, ExxonMobil and Shell.

EP212 Why does the proponent claim that Barrow Island has maintained its biodiversity values only because of the company's management, when other

valuable islands (e.g. Bernier and Dorre) have maintained their values in the absence of such a presence?

EP220 The Executive Summary states that without the stewardship provided through the oilfield operation, Western Australia would have needed to contribute millions of dollars to provide the same level of protection to the island. On what basis could a lack of people be likely to result in a more degraded environment than what WAPET has left?

ChevronTexaco (formerly WAPET), the operator of both the oilfield and the proposed Gorgon gas development, is proud of its environmental reputation and performance on Barrow Island. The management of the island oilfield is widely recognised as an industry benchmark for the coexistence of petroleum development and biodiversity protection.

ChevronTexaco has been actively involved with oilfield operations on Barrow Island for over 40 years. Due to the presence of those operations, access to Barrow Island is restricted and stringent quarantine measures are implemented. Without these measures Barrow Island would be subject to frequent and unchecked visits by tourists, fishers and others – particularly as Barrow Island is a convenient location for stopovers en route to other popular recreational areas such as the Montebello Islands. These visits would make enforcement of quarantine requirements difficult.

The success of Barrow Island's quarantine program and implementation of restrictions to casual visits is evident in that the island remains an important refuge for rare wildlife species and is free of introduced animals. This point is highlighted by other islands in the region that are as convenient as Barrow Island to visit in terms of proximity to other recreational areas, but suffer from introductions of feral animals.

EP236 Please provide information regarding the seabed environment along the pathway of the pipeline from the mainland to the east coast of Barrow Island and from the west coast of Barrow Island to the sub-sea production facilities at the Gorgon gas field, or where these production facilities are to be placed.

The proposed pipeline routes along the 60 km distance from the mainland to the east coast of Barrow Island, and along the 70 km from the west coast of Barrow Island to the Gorgon gas field, are not addressed in the ESE Review as they involve issues that are essentially common to any petroleum industry development in the region. Further, they are not directly related to the use of Barrow Island to site a gas processing facility. As described in Section 2.3 of the ESE Review, the Gorgon Venture considers that issues critical to the ESE Review are those that "directly relate to the restricted use of Barrow Island to site a gas processing facility". However the seabed environment adjacent to and out for several kilometres has been surveyed by marine environmental specialists. That information is included in the ESE Review (p. 81– 85).

Pipeline route selection studies and an assessment of the impacts of pipeline installations would be appropriately considered in the detailed environmental planning and assessment if the restricted use of Barrow Island is granted in-principle approval.

EP239 Given that further development on Barrow Island is inconsistent with the ALP's 2001 election promise to prohibit mining in national parks and nature reserves, is the proponent seeking to ask the Government to break an election promise?

The Gorgon Venture has prepared this ESE Review in accordance with directions from the Government.

EP246 There is no detailed risk assessment in the ESE. Risks should be compared between Barrow and other sites with respect to a potential catastrophic event (on land and in the sea) and its consequences. What are the risks of a terrorist attack?

At this early stage of the development, the level of engineering detail required to prepare a meaningful risk assessment is not available. If the proposed gas development proceeds, a broad ranging assessment of associated risks would be prepared at a more appropriate period in the development process.

EP167 Is the proponent able to commit to regular audits conducted by a dedicated environmental specialist reporting to CALM and DEP, as well as regular inspections by CALM personnel, to ensure compliance with the commitments made on p94?

If the proposed development of a gas processing facility on Barrow Island proceeds, ChevronTexaco would commit to complying with all audits required under regulatory requirements – as it is with existing oil operations and activities. In 2002 for example, approximately 20 audits were conducted for Barrow and Thevenard Islands. The number and diversity of those audits demonstrate a commitment to the environmental audit process as a means of assessing best practice. A similar range of robust audits is envisaged for any further development on Barrow Island. The range of audits would continue to include representatives from government agencies such as the Department of Environmental Protection (DEP) and Department of Conservation and Land Management (CALM).

Acknowledgement by the Gorgon Venture of CALM's importance in the ongoing role of management of Barrow Island's conservation values is noted on page 122 of the ESE Review. The Gorgon Venture has also proposed that they enter into a formal Conservation Agreement with CALM if the proposed development proceeds. That agreement would provide a framework for management decisions concerning the Barrow Island environment, provide a mechanism for adequate resources of CALM activities on the island, and provide an ongoing vehicle to undertake research on the island.

EP112 How many Environmental Officers currently have responsibility for ChevronTexaco's north-west operations?

After restructuring in 1997, ChevronTexaco made the shift from employing several in-house environmental specialists toward the use of external specialist consultants managed by an in-house Environmental Coordinator. In early 2003, the Environmental Team was expanded through the employment of a field-based Environmental Specialist as well as designating two Environmental Technicians within the field Maintenance Services workforce.

Management of the specialist consultants undertaking established environmental projects, such as monitoring, will be transferred in 2003 to Bowman Bishaw Gorham as part of an overarching environmental services contract for the WA Oil Asset under the direction of the Environmental Coordinator. Bowman Bishaw Gorham has been advisors to ChevronTexaco on environmental matters for over 10 years.

In addition, the Gorgon environmental group has five full-time environmental professional staff, two part-time staff and a large number of consultants, many of whom have provided long-term environmental services to the company on Barrow Island environmental management matters. Environmental staff of ChevronTexaco associated with the proposed Gorgon gas development has worked on Barrow Island for more than 20 years.

6.3 Terrestrial Issues

EP94 The ESE Review document does not appear to recognise the potential significance of road kills of threatened mammal species. How does the proponent intend to minimise and monitor road kills?

The Gorgon Venture acknowledges the potential for increased numbers of transportation movements with development-related activity on Barrow Island. The ESE Review outlines strategies to reduce risk including use of buses and coaches, speed restrictions, control of vehicle movements at high risk times of the day (e.g., dawn and dusk), driver education and prohibition of off-road vehicle movements. While the peak of the construction

workforce would be ten times the number of the existing workforce, the construction period is unlikely to incur ten times the road kill. It is important to note that the workforce employed on construction of the gas processing facilities would be accommodated within the proposed site area at Town Point. The accommodation facilities are adjacent to the construction site. Movements beyond this area would be restricted to crew change activities which would only involve transporting personnel by bus to and from the airport.

In 2002, there were nine animal casualties as a result of road traffic.

EP100 What is the risk and what would be the consequences to conservation values of an uncontrolled, catastrophic fire at the gas plant spreading to a significant fraction of the island?

EP132 Has the proponent considered the potential impacts of bushfires caused by slugs of incandescent carbon, as has occurred on the Burrup?

EP217 Given that suppression of fire for the foreseeable future while the project is in operation could have unknown long term consequences on the island's flora and fauna, how would the proponent address fire management and suppression issues?

Fire is acknowledged as an element of the terrestrial ecology of Barrow Island. The natural fire regime of the island has been suppressed over the last 40 years of oilfield operations and the Gorgon Venture would control fire in its operational areas for reasons of personnel safety and risk to infrastructure (ESE Review, p. 122).

The gas processing facility would be subject to stringent systems and controls aimed at preventing fires and a comprehensive emergency management and response system. The flare system will be designed to minimise the likelihood of causing spot fires. A buffer zone would be in place around the base of the flare. It is therefore considered that there is a very low residual risk of an uncontrolled, catastrophic fire spreading from the gas plant.

The last extensive fire on Barrow Island occurred in 1961 when about 90 per cent of the island burned. The ecology of the island has since recovered and the conservation values of the island remain. Evidence suggests that Barrow Island did burn extensively, but infrequently, in the past.

Fire risk would be managed within the context of a broader fire management plan that would be developed in consultation with stakeholders, particularly the Department of Conservation and Land Management within the framework of a formal Conservation Agreement.

EP102 The conclusion that the project area is not extensively karstic cannot be drawn from the limited evidence presented in the ESE Review. Does the proponent intend to conduct further investigations into the karstic nature of the project area, including caves and fissures?

EP121 The statements at the end of the second paragraph of p111 indicating the absence of karst or fissures seem to be at odds with the statements at the foot of p111 about the "apparent lack of geological isolation in the karst at the site..." They also appear to conflict with paragraph 4 on p121. Please clarify.

Use of the word "extensive" in paragraph 2, p. 111 of the ESE Review was intended to mean that karst in the Town Point proposed development area is not considered to be well developed (i.e., no caves or fissures) or vertically extensive through the geological profile. Karst is however considered to be spatially wide-spread across the island. The Gorgon Venture acknowledges that the use of the word extensive in both contexts is confusing.

The term 'karstic' can have broad application and the proposed development area clearly falls within the scope of the term given the nature of the geology and geomorphology at the Town Point site. Caves and underground caverns are typically considered the most developed karst features. No caves have been recorded in the proposed development area

and field investigations suggest an absence of major fissures or other surface expressions of cavernous formations. This field data, combined with geotechnical data and the results of seismic work conducted over the area, suggest that the area may not be massively or extensively karstic.

Based on the ESE Review, the Gorgon Venture is confident that, if the proposed development proceeds, loss of biodiversity of species or communities on Barrow Island would not occur. It is considered that the risks to subterranean fauna are sufficiently understood for it to be reasonable to expect that appropriate management strategies could be effectively implemented.

A more comprehensive assessment of the karst terrain will be completed if in-principle approval for restricted use of Barrow Island is granted and the proposed development progresses to the detailed stages of a formal environmental impact assessment process. This is likely to include more a detailed geotechnical study, as well as further stygofauna and troglofauna investigations. Scoping of further assessment and survey work will be undertaken in consultation with relevant stakeholders.

EP115 What is the minimum practical working width for an on-shore gas pipeline easement, noting reference in the ESE to "maximum easement of 30m width" and that other lines have been constructed on the mainland where the majority of the working easement is considerably less than 30m?

The Gorgon Venture is committed to minimising environmental impacts associated with the proposed development. Adopting the most appropriate pipeline construction right-of-way width is one means of reducing such impact. However, narrower is not always better. The width required for a pipeline construction right-of-way is influenced by a number of factors including pipeline diameter and design, the nature of the terrain, surface soils and geology, and type of equipment used. In particular, the right-of-way needs to be of sufficient width to ensure valuable topsoil is able to be kept separate from other material and that construction equipment and personnel can move and work safely in a clearly defined and designated area.

The Gorgon Venture would employ best practice to protect both environmental values and workforce safety. As a result, if the pipeline is buried across the relatively flat terrain of the eastern part of the island, the right-of-way may be as narrow as 20 m. However, through the steeper, more rugged terrain of the western section, a greater width, possibly up to 30 m, may be required. In keeping with the strategic nature of the ESE Review, the worst case width of 30 m was used as a basis of the assessment.

EP122 Does the proponent intend to utilise other methods to locate further subterranean voids (caves and fissures) beneath the project site (e.g. airborne and surface geophysical methods for fracture and cavity assessment, ground-penetrating radar, deflections of the geothermal gradient, very low frequency electrometers and seismic reflection profiles)?

EP123 Does the proponent intend to utilise experienced speleologists or cave/karst management consultants in future assessments of karst areas?

EP127 Does the proponent intend to conduct ground probing radar work to look for shallow caverns beneath the main building where the power generation plant is to be located?

If the restricted use of Barrow Island receives in-principle approval, thorough studies of the subterranean fauna values of the site would be undertaken to provide the level of information necessary to conduct detailed impact assessment and support associated management decisions. Further research may include ground probing radar work and contracting of karst management specialists to obtain an inventory of karst features, or other approaches as appropriate. More comprehensive survey of the subterranean fauna that may occur in the area will also be carried out in association with this work.

The detailed scope and nature of the field surveys necessary for such an investigation would be agreed with the DEP and other agencies and stakeholders of relevant expertise prior to preparation of an environmental impact assessment.

EP140 Recognising that fire has been suppressed on Barrow Island for the life of the existing oil field, what is expected to be the impact on the vegetation and flora, and hence animal habitat, if fire is suppressed for the life of the proposed project, and beyond, recognising the likely extended duration of a gas complex on Barrow Is?

EP141 Have any studies been undertaken to indicate what the impacts of fire exclusion have been over the last forty years?

The Gorgon Venture acknowledges fire as a legitimate element in the terrestrial ecology of Barrow Island. However, fire presents an element of substantial risk to the oil and potential gas facilities on the Island. The Gorgon Venture would therefore seek the input of relevant agencies in the development of fire management options for Barrow Island, such that the right balance between conservation values and risk to personnel and infrastructure is achieved.

The Gorgon Venture is not aware of any specific studies with regard to the impacts of fire exclusion on Barrow Island.

It is envisaged that fire management issues would be captured within the proposed Conservation Agreement with CALM if the proposed development for the Gorgon gas field proceeds.

*EP184 Why has the proponent not identified significant mammal species found on Barrow island, in addition to the six threatened species, such as the spectacled hare-wallaby *Lagorchestes conspicillatus conspicillatus* (endemic to Barrow Island), *Planigale species 1*, *Pseudantechinus roryi* and *Zyomys argurus*?*

EP185 Why does the proponent claim that "all of the fauna species recorded at the proposed development site have widespread distributions across Barrow Island" when the survey did not include any trapping, and for example, only 7 of the 43 reptile species were recorded in the study area?

*EP193 Why was no trapping undertaken to detect the presence of the endemic reptile taxa *Ctenotus pantherinus acripes*?*

A report by Bamford Consulting Ecologists 2002 on the fauna of Barrow Island and its conservation significance, as pertinent to the proposed development, was provided in Technical Appendix G of the ESE Review. This report identified all of the species listed in the submission, and their distributions and habitat requirements were considered in the assessment of the potential impacts of the development.

Overviews of the key findings of the technical report were presented in the main body of the ESE Review. The purpose of the ESE Review process is to identify factors that are critical to the question of whether or not restricted use of Barrow Island is acceptable. Accordingly, the main body of the ESE Review concentrated on species of recognized conservation significance, notably those that have been identified as threatened or requiring special protection under either State or Commonwealth environmental legislation. Of the species listed in the submission, only the Spectacled Hare-Wallaby *Lagorchestes conspicillatus conspicillatus* is formally listed and this species was included in the discussion of fauna in the main body of the ESE Review. The remaining mammal species mentioned in the submission do not have formal conservation listings. However, the possible importance of the proposed development area for these species is described in Technical Appendix G of the ESE Review.

The Gorgon Venture believes that the level of investigation and assessment undertaken to date is in keeping with the strategic nature of the ESE Review. The specialist fauna report discusses what is known about patterns of distribution of fauna across Barrow Island and

looks at the significance of the proposed development area with reference to these patterns. There is a considerable body of information available on habitat preferences of fauna on the island, so this made it possible to do the fauna assessment by examining habitats. The significance of all island populations of fauna species, even those that are widespread on the mainland, is recognised by the Gorgon Venture. Further fauna surveys, including trapping, would be undertaken if the project proceeds to detailed environmental assessment.

EP186 Why has the proponent chosen to reference unpublished reports relating to the abundance of mammal species on Barrow Island when published journal articles are available in many cases, often citing very different population figures?

EP187 There are a number of inaccuracies, including incorrect referencing, in the information provided by the proponent with respect to terrestrial mammal populations. Can the proponent provide a reliable analysis of the conservation value of all the terrestrial mammals inhabiting Barrow Island (not just threatened taxa), based on accurate and reliable data?

The Gorgon Venture apologises for any typographical mistakes or other editorial errors, including isolated instances of incorrect referencing.

The ESE Review sourced all available previous information, published or unpublished, as well as undertaking a field survey of the areas that could be affected by the proposed development. The field survey and assessment of the terrestrial fauna values of the development areas was undertaken by experienced zoological specialists Bamford Consulting Ecologists and built on many other surveys conducted over the years either by the operator, CALM, research institutions or independent third parties.

A significant proportion of the scientific research that has been conducted on Barrow Island has been commissioned or supported by the oilfield operators and remains unpublished. It would have been a shortcoming of the ESE Review if this substantial body of information specific to Barrow Island was ignored. Wherever discrepancies were apparent between different sources of information, the data was interpreted on the basis of its recency and robustness; and a conservative approach was generally applied to citing data.

The fauna report (Bamford Consulting Ecologists 2002), provided in Technical Appendix G of the ESE Review, provided a description of the fauna values of the development areas, and relative local and broader conservation implications that was not restricted to threatened fauna.

EP188 A population of 125-160 rock wallabies may well be at or below the critical threshold whereby stochastic events and random genetic drift could threaten the survival of the population. What evidence exists to indicate the likely impact of a loss of a relatively small number of individuals, or of breeding disruption as a result of intensive construction and ongoing operation of a gas line coming ashore at Flacourt Bay, one kilometer from rock wallaby habitat?

EP189 Why does the proponent state that "terrestrial fauna in the areas subject to disturbance are abundant on Barrow Island and breed throughout the year" (p 117), when rock wallabies are likely to be subject to the greatest impacts as they are the least abundant and are dependent upon adequate day time refuges for survival, and they do not breed throughout the year?

EP243 Paragraph 4, p116 states that "affect from construction of the pipeline would involve less than 0.2% of the rock-wallaby habitat on the island" but what fraction of the occupied habitat does this site represent? Presumably 125-160 animals only use a small part of the total potential habitat but what evidence is there that the animals will simply move, without ill effect, if they are disrupted at this site?

The Gorgon Venture acknowledges the high conservation value of the Barrow Island rock-wallaby population; and ChevronTexaco, as operator of the oilfield, has supported research into this population. The relatively small population size of the rock-wallabies on Barrow Island, the restricted extent of their habitat and the associated implications for conservation and vulnerability to disturbance were described in the ESE Review. The need for specific management measures to ensure that any potential impacts to this species are avoided or minimized was also discussed.

The proposed site for the gas processing facility on Barrow Island is located approximately 8 km from rock-wallaby habitat and is extremely unlikely to have any impact on the species. The only aspect of the development that has the potential for effects on rock-wallabies is the western-most section (approximately one km) of the pipeline that would traverse areas that comprise rock-wallaby habitat. The ESE Review highlighted the Gorgon Venture's appreciation that this may require innovative construction approaches that go beyond established environmental best practice. The precise pipeline alignment and method of construction would be developed following thorough investigations of the habitat values of the area to ensure that no caves or other features of particular significance to rock-wallabies are impacted.

Petroleum exploration and production activity has previously occurred in the area without any apparent adverse impact on the rock-wallaby population; and there are a number of existing roads, pipelines and production wells established within it. To the extent possible, the pipeline would optimize the use of areas of previous disturbance.

EP190 Would the proponent commit to undertaking a detailed analysis of areas of fauna habitat in the subject area, including proposed pipeline easements and gas processing facility footprint, and avoiding any disturbance to all sensitive areas of fauna habitat on the island?

If in-principle approval for restricted use of Barrow Island is granted, the Gorgon Venture will commit to further assessment of relevant environmental aspects associated with the proposed development. It is envisaged such assessment would form part of any subsequent approval process.

EP191 What is the potential impact of the proposed development on boodie warrens?

EP192 What evidence is there for the likely effect of blasting operations on nearby boodie warrens or the animals themselves? What proportion of the animals on the island are likely to be affected?

The site selection process for the proposed development was designed to avoid Boodie warrens. The detailed, final layout of plant facilities within the proposed development area would take all warrens into account. The Gorgon Venture is discussing with CALM and the University of Western Australia an opportunity to undertake research into the bettong warrens near the proposed development area.

The specialist fauna assessment of the development area indicates that about one per cent of Barrow Island's Boodies occur in the vicinity of the proposed development. Buffer distances to Boodie warrens that would be incorporated into the detailed design and layout of the facilities would ensure that no direct physiological impacts from blasting occur to Boodies. It would also help to reduce indirect effects. Specific management strategies for blasting would be developed as part of an environmental impact assessment if the proposed development proceeds. Boodies on Barrow Island have persisted close to roads, wells and other areas of previous oilfield construction activity.

*EP194 Why is the significance of the Barrow Island population of the perentie *Varanus giganteus* not mentioned, when it is the only island population of Australia's largest goanna and is vulnerable to roadkill?*

The Perentie, *Varanus giganteus*, is not of listed conservation significance but the importance of a large, island population is acknowledged in the ESE Review. Refer also to the response to EP184.

EP195 Does the proponent intend to undertake a more detailed survey of reptiles and amphibians in the area?

If in-principle approval for restricted use of Barrow Island is granted, the Gorgon Venture will commit to further assessment of relevant environmental aspects associated with the development. Such an assessment may include more detailed survey of reptiles and amphibians if it is considered a necessary component of a subsequent approvals process.

EP235 What is the likely level of construction and operational noise from the sub-sea installations and what are the likely impacts of such noise on Humpback whales?

Noise emissions from the sub-sea installations at the Gorgon gas field, 70 km northwest of Barrow Island, would be similar to those at numerous similar installations in the region and are not anticipated to cause adverse effects on humpback whales. This issue is not addressed in the ESE Review as it is not related directly to the use of Barrow Island to site a gas processing facility. As described in Section 2.3 of the ESE Review, the Gorgon Venture considers that issues critical to the ESE Review are those that "directly relate to the restricted use of Barrow Island to site a gas processing facility".

An assessment of noise from the sub-sea installations and the likely impacts of such noise on humpback whales would be appropriately considered in a detailed environmental assessment if the proposed development proceeds to a formal approval process.

6.4 Marine Issues

EP130 While the proponent has recognised the potential impact from turbidity due to dredging and trenching, have the potential impacts (particularly to coral) from dredging underlying limestone rock also been considered (given there are indications that the resulting turbidity could be significant)?

Detailed geophysical investigations of the seabed would be conducted prior to any dredging operations associated with the proposed development at Barrow Island. These investigations would include refractive seismic surveys, and possibly coring, to characterise the nature of underlying limestone rock. The Gorgon Venture would use the information, as well as the results of ecological and biological studies, to design a dredging program such that risks to the marine environment are acceptably low.

Stabilisation of the pipeline into Flacourt Bay may involve trenching to bury the pipeline. This would be a very discrete operation requiring a shallow, narrow trench and subsequent backfill. The associated plume would be minor, of short duration, and cause minimal effects to the marine environment.

Previous experience with dredging and trenching operations on the North West Shelf provides further confidence that these operations can be acceptably managed.

EP151 Has the proponent considered the potential environmental impacts of dredging during the construction of the jetty; the potential impacts of boat strikes resulting from increased vessel movement in the area; discharge of wastewater and accidental oil spills and/or refuelling incidents?

Vessel-fauna collisions are possible, but very unlikely given the large size and slow speeds of the work vessels, barges and tankers that would be used during construction and operation of the development.

The discharge of wastewater is regulated under State, Commonwealth and international laws. The Gorgon Venture would conduct its marine operations in accordance with "industry best practice" and in compliance with relevant guidelines, including:

- Code of Environmental Practice (APPEA, 1996)
- The IMO's International Convention for the Prevention of Pollution from Ships 1973/78/92, known as "MARPOL 73/78".

ChevronTexaco currently implements detailed and rigorous procedures and systems to manage all offshore refuelling and hydrocarbon offloading operations. These are designed to minimize both the risk of spills and the amount of fuel that could be lost in the unlikely event of a spill incident.

There is no regionally significant habitat in the marine and intertidal environment adjacent to the proposed development. Seagrasses that do occur mainly comprise *Halophila sp.* scattered with much more abundant macroalgae. The jetty was moved to avoid impacts to corals. Significant smothering of seagrass and corals following dredging is considered to be highly unlikely.

EP152 The risk of a worst case oil spill scenario is considered to be "extremely low" (p97). How is this conclusion reached for a spill on the east coast of Barrow which would limit the opportunity for the spill to be dispersed in to the open ocean?

EP153 What is the potential impact of an oil spill occurring co-incident with turtle aggregation/ nesting or hatchling dispersal?

The east coast oil load-out record for the existing Barrow Island oilfield is extremely good. Over 1000 tankers have been loaded from the Barrow terminal without significant environmental incidents. There are limited volumes of condensate produced with LNG; and tanker frequency to load this condensate is not expected to be lower than historical levels. The chance of an incident occurring simultaneously within the limited times of critical turtle behaviour is also very low. Hence the risk may be considered to be extremely low.

EP175 Is the proponent able to commit to the shut-down of construction activities if large marine fauna such as whales and dugongs are detected in the vicinity?

In some areas of the channel offshore from Town Point, underwater blasting may be required. The shock-wave associated with underwater blasting as well as the noise generated by vessels and dredges have the potential to locally impact upon fauna during construction (ESE Review, p. 93). This area does not comprise important habitat to whales, dugongs or other species of conservation significance (ESE Review, p. 93).

Implementation of routine management measures, including the use of warning shots, marine fauna watches and standby vessels to "shepherd" fauna away from the affected area, would be implemented to reduce the risk of significant impacts from blasting. If the proposed development proceeds, it is expected that this would be addressed in detail in an environmental impact assessment and a dredging management plan.

EP180 Does the proponent intend to undertake more detailed mapping of the marine and intertidal benthic habitats along the proposed pipeline corridor and areas adjacent to the development?

Yes. It is acknowledged that further surveys (and mapping) of the marine and intertidal benthic habitats would be required along the pipeline corridor and areas adjacent to other coastal or marine components of the development. These would be completed in an environmental impact assessment, if in-principle approval for restricted use of Barrow Island is granted.

EP181 Would the proponent agree to the involvement of appropriate Government agencies in the specification of a detailed mapping programme of the marine and intertidal habitats, and the design and implementation of any monitoring and research programmes for marine habitats and marine species impacted by the proposal?

The Gorgon Venture has already coordinated its two recent marine habitat surveys with input from the Marine Branch of CALM. Data acquired by the Gorgon Venture has been copied in GIS format to CALM for inclusion in their database. ChevronTexaco is also an active contributor to the collection of information for the proposed marine conservation

reserve being considered for the area. The Gorgon Venture anticipates this cooperation would continue.

EP237 Please provide information regarding the location and depth of the proposed dumping place of the majority of spoil, apparently close to macroalgal habitat.

At this early stage of a development proposal, the Gorgon Venture is not in a position to provide exact details regarding the location and depth of the proposed spoil disposal area. If the development proceeds, the Gorgon Venture would fully comply with the conditions of the *Environment Protection (Sea Dumping) Act 1981* which requires *inter alia*, investigations of the physical and biological characteristics of the spoil ground.

EP244 Is it possible for an oil spill to occur as a result of a condensate leak from the gas delivery line? What is the likely risk to the environment if such a leak occurred in the vicinity of Biggada Reef or turtle nesting areas in Flacourt Bay?

It is possible, but extremely unlikely, for an oil spill to occur as a result of a condensate leak given the design (and potential future construction) of the feed gas pipeline. The ESE review indicates that the integrity and safe operation of the feed gas pipeline would be assured by compliance with Australian Standard AS 2885.4 and a rigorous program of inspections of the operating pipeline to verify any deviation from the design parameters.

In addition, both internal and external corrosion of the pipeline would be minimised and managed by a combination of design, anti-corrosion coatings and materials such that the integrity is not at risk.

In the very unlikely event of failure in the pipeline in the vicinity of Biggada Reef or Flacourt Bay, the release would comprise primarily gas and only relatively low volumes of condensate would be released before detection. Condensate is very light oil and in the warm air and water conditions that prevail at Barrow Island would be subject to very rapid rates of evaporation. The risk of significant effects to Biggada Reef or to turtle nesting at Flacourt Bay is considered to be very low.

6.5 Turtles

EP154 Why does the proponent suggest that the turtle nesting rookery on Barrow Island has only "regional significance", when it is significant for the survival of the overall population of the North West Shelf sea turtle stock, considered to be under threat?

The status of sea turtle nesting in Western Australia has been summarized in Prince (1990). The potential implications of the proposed Gorgon gas development on marine turtles was assessed by K. Pendoley, a marine scientist who has worked on marine turtles in the North West Shelf for many years.

As discussed in the ESE Review, the three species of marine turtles routinely found nesting on Barrow Island include green, flatback and hawksbill turtles. The relative nesting effort of these three species is discussed below on a regional and local scale.

Green turtles are recognized as the most abundant turtle species in northern WA waters. Major Pilbara nesting sites occur at North West Cape, Muiron Islands, Serurier Island, west coast of Barrow Island and the Dampier Archipelago. The largest Green turtle rookeries in Western Australia are found hundreds of kilometres to the north east at the Lacepede Islands in the Kimberley.

The west coast Barrow Island rookery is regionally important (Pilbara) but appears to be smaller than the Lacepede Island rookery where nightly nesting effort numbers in the thousands. In good nesting years, nightly nesting effort of Green turtles on the west coast of Barrow Island can number in the hundreds. In poor years, these numbers can fall to less than ten animals per night per beach. Green turtle use of east coast beaches is significantly lower and for years when hundreds of turtles nest on the west coast beaches

only 10-20. Green turtles per night might use the east coast beaches (K Pendoley, field data 2000).

After green turtles, flatback turtles appear to be the next most abundant species in northern Australian waters. Important Pilbara rookeries used by flatbacks include the east coast of Barrow Island, and Munda Station, Cape Thouin and Port Hedland on the mainland. Flatbacks are commonly found nesting on islands in the Montebello and Lowendal Island groups (K Pendoley, field data 1998-2002). Accordingly, the ESE Review describes flatback nesting on the east coast of Barrow as regionally significant.

The most significant hawksbill rookery occurs at Rosemary Island in the Dampier Archipelago. Nesting numbers on this beach exceed documented nesting efforts at all other Western Australian rookeries. Low level nesting occurs within the Barrow, Lowendal and Montebello Island groups. The number of hawksbills nesting on the offshore Pilbara islands is an order of magnitude lower than the flatback nesting effort.

Only low numbers of hawksbills use the beaches of Barrow Island. Nests have been found at Surf Point and John Wayne Beach (K Pendoley, field data 1999) however the number of hawksbill tracks on both east and west coast beaches suggest less than one animal per week might nest on individual east and west coast beaches.

EP155 Noting the statement on p93 about areas adjacent to marine infrastructure not comprising important habitat to whales, dugongs or other species of conservation significance, how does this relate to turtles passing through the area on the way to aggregate and nest?

As discussed in the ESE Review on p. 89 and p. 90 of the ESE Review, aggregations of green turtles have been reported from the shallow areas along the west coast of Barrow Island, and also around Dugong Reef and the Barrow Shoals to the south. The habitat types present in the area off the east coast of Barrow Island, which could be affected by the proposed development, suggest that it is unlikely to have any particular importance for feeding by turtles. No aggregations of turtles have been reported from this area.

Migrating turtles cover extensive distances. The infrastructure proposed for the development would not obstruct or hinder turtle movements through the areas. There are no restricted passageways or channels at the locations proposed and the temporary and localized disturbance associated with construction of the marine facilities would pose very little risk of significantly affecting turtle movements.

EP247 What method would be used to get a gas feeder pipeline ashore through shallow coastal waters onto the mainland? Dredging ship access at a 'greenfields' site should be avoided.

There are well established techniques for installing pipelines in shallow coastal waters. The ESE Review focuses on the use of Barrow Island and the surrounding water. Pipeline routing between Barrow Island and the mainland was not considered in detail as part of the ESE Review. More detailed discussions on a specific project, including pipeline routes and potential installation methods would be considered in the next phase, if in-principle approval to access Barrow Island is granted.

EP156 Noting the statements in the ESE (p89) that Flacourt Bay represents one per cent of the potential turtle nesting habitat on the Barrow Island west coast, is there any evidence to indicate what percentage of the actual turtle nesting occurs at Flacourt Bay? ie. are all beaches equally important or is Flacourt Bay especially important? cf. information in the next paragraph on relative nesting effort for Flatbacks on the east coast which indicates that not all beaches are equally important.

EP157 How did the proponent arrive at the conclusion that turtle nesting activity on Flacourt Bay ranges from one to fifty nesting attempts per night?

EP158 Assuming that the proponent's unsubstantiated data on turtle nesting is correct, does the proponent not consider that 50 nesting attempts per night,

translating to approximately 700 nesting attempts over a 14-night inter-nesting period, is significant?

Historically, John Wayne Beach, which is two beaches to the south of Flacourt Beach, has had the higher densities on Barrow Island and has been the preferred beach for the voluntary turtle tagging programme run by the Barrow Island staff.

While no quantitative data is available for nesting activity on Flacourt Beach, opportunistic observations of this beach by K. Pendoley suggest it has similar nesting densities to other west coast beaches. In good nesting years, the females are digging up each other's nests; in poor nesting years there may only be two or three nesting attempts per night.

The west coast beaches where data are available show varying, but essentially similar, usage by green turtles. In January 2000, beach surveys of green turtle nesting numbers on Tortuga Beach (immediately south of Cape Dupuy) indicated there were at least 53 animals overnight versus a minimum of 77 animals two days earlier on John Wayne Beach. This equates to a nesting density of 132 animals/km versus 102 animals/km and suggests that the beaches of the area have similar nesting effort.

The Gorgon Venture acknowledges that the nesting activity of Green turtles at Flacourt Bay is important and, as noted in the ESE Review, would carefully manage its operations to avoid unacceptable impacts on them.

EP159 Why does the proponent suggest that Flacourt Bay, at 300m long, represents one percent of the total nesting beaches on the island, implying that there are 30km of nesting beaches along the west side of the island, when the island is only 23 km long and the more southern beaches consist of coarser sand and do not support large numbers of nesting turtles?

Although Barrow Island may only measure 23 km from tip to tip, its shape and the generally cusped shape of its beaches results in a greater length of beach around the perimeter of the island.

Measurement of the lineal extent of the beaches on the west coast of Barrow Island was undertaken for the ESE Review using rectified aerial photography contained in the ChevronTexaco Geographic Information System, at a scale of 1:5000. The total length of beach along the west coast, not including the section of Barrow Island known as "South End", is 26 360 m. The 300 m beach at Flacourt Bay corresponds to 1.1 per cent of this figure, or the "approximately one per cent" described in the ESE Review.

EP160 Why has the proponent not provided data on suitable turtle nesting beaches on Barrow Island other than Flacourt bay, particularly Terminal Beach on the east side which could support as many as 640 turtles in a breeding season?

The ESE Review is of a strategic nature and addresses environmental, social, economic and strategic issues associated with the proposed development of a gas processing facility on Barrow Island. It was not a detailed inventory of all existing information pertaining to Barrow Island, but more a summary and consideration of the effects that the proposed development could have on its conservation values. Nevertheless, the ESE Review is firmly based on the considerable knowledge, data and experience accumulated over some 40 years of experience on the island.

Two east coast beaches have been studied since 1998 by K. Pendoley as part of a PhD project on sea turtles, supported by ChevronTexaco and other local hydrocarbon companies. These beaches are Yacht Club Beach, a narrow 2 km long beach stretching north from the camp and Terminal Beach, a 0.5 km long beach located immediately south of Terminal Point and adjacent to the proposed gas processing facility location. It is slightly south of the Terminal Tanks and is crossed by the tanker load out pipeline. The supratidal zone on both beaches is relatively narrow and flat. The intertidal zone is flat and very broad (100-200 m wide).

Some data for the flatback nesting effort from Yacht Club Beach and Terminal Beach is shown in the table below. The data is of the number of animals, as represented by track

counts, that have crawled up the beach overnight. The data is taken from 10 different field surveys over the four summer seasons between 1998/99 and 2001/02. The data has not been fully analysed and are used for preliminary assessment purposes only. The results suggest the species use of both beaches is similar; primarily flatbacks with mixed nesting of very low numbers of greens and hawksbills.

Flatback turtle nesting effort Yacht Club and Terminal Beaches

Month	No of survey nights	Yacht Club Beach			Terminal Beach		
		Flatback	Hawksbill	Green	Flatback	Hawksbill	Green
October	1	0	2	0	N/S	N/S	N/S
November	5	20+	0	0	3	1	0
December	5	1-59	0	0	6-9	0	0
January	24	1-102	0	1	1-37	1	0
February	2	1	0	0	2	0	1

*N/S=Not Surveyed

The nesting effort on the two beaches can be compared by calculating the density of the tracks on each beach. Using the maximum overnight animals for each month and the length of each beach shows the beaches have attempted nesting effort of the same order of magnitude.

Month	Yacht Club Beach	Terminal Beach
	Number of animals/km/night	
October	0	0
November	9	5
December	26	16
January	45	67
February	0.4	4

EP161 On what basis does the proponent claim that the proposed development would represent a "low risk" (p 90) to the east coast flatback turtle rookeries on Barrow Island, when it is possible that up to 4000 flatbacks may nest on Barrow Island (based upon the likelihood of there being 6 suitable beaches each supporting similar numbers of nesting turtles to Terminal Beach)?

The Gorgon Venture recognises the importance of Terminal Beach, along with other beaches of the east coast of Barrow Island, as nesting habitat for turtles. This was identified in the ESE Review along with an acknowledgement that the construction and operation of the proposed development would need to incorporate specific measures to ensure potential effects on nesting turtles are avoided or minimised.

As described in the ESE Review, turtle nesting on the east coast Barrow Island beaches is predominantly by flatback turtles. Research data collected from 1998 to 2002 (Pendoley unpubl.) at Terminal Beach, which extends approximately 550 m between Latitude Point and Town Point, has recorded flatback turtle nesting activity ranging from one to forty nesting attempts per night. This is similar to the level of nesting activity recorded on beaches immediately south.

Pendoley (pers. comm.) considers that nesting effort may increase on beaches further north along the east coast. However, in the high level, strategic assessment in the ESE

Review, turtle nesting occurring in the vicinity of the proposed development was considered likely to be generally representative of the nesting effort that occurs along the beaches of this coast. The total length of beach along the east coast is approximately 23 km. The 550 m long Terminal Beach near to the proposed development is equivalent to approximately 2.4 per cent of this length of similar habitat.

EP162 [How] does the proponent mean by "peak nesting times" for turtles, with respect to its commitment to reducing disturbance during this period?

To avoid unacceptable impacts to marine turtles, the Gorgon Venture proposed in the ESE Review that management of construction operations would schedule potentially disruptive activities such that they avoid peak nesting seasons. The peak nesting period, as specified in the ESE Review, occurs between late November and January, with hatchling emergence six to eight weeks later.

The Gorgon Venture recognises the imperative to protect marine turtle populations and anticipates that, with appropriate management, this can be achieved. More detailed management prescriptions to achieve this requirement would be described in an environmental impact assessment if the Western Australian Government grants in principle approval for restricted use of Barrow Island.

EP163 Please comment on the suggestion that the proponent has underestimated the value of Barrow Island for sea turtle nesting activities.

The ESE Review appropriately acknowledges the high value of Barrow Island for marine turtles nesting. As stated, three of the four species of marine turtle found in the Pilbara (green, flatback and hawksbill turtles) are known to nest on Barrow Island. All are listed as threatened and/or migratory species under State and Commonwealth legislation. The Review also identifies that Barrow Island beaches are used by large numbers of green turtles and provide important flatback turtle nesting sites. Although only low numbers of hawksbill turtles are known to nest on Barrow Island, all nesting is considered significant. Barrow Island is considered an important nesting site for sea turtles in Western Australia.

EP164 Noting the statement on (p94) that some night time operations are unavoidable, what might be the extent of a worst case impact on turtle nesting or hatchling loss? What would be the effect of losing, say, two consecutive breeding seasons of hatchlings? How likely is such an event?

EP165 Given that sea turtles (both nesting adults and hatchlings) are known to be disturbed by light and that the only acceptable outcome to maintain turtle nesting habitats is zero net ambient light increase during the nesting season, how does the proponent intend to adequately protect turtles from light, when the east coast of Barrow Island would be inundated with massive light pollution from the proposed facility, the flare and load-out facilities and low pressure sodium lights are not an appropriate solution, as they are disruptive to green and flatback turtles (the main species on Barrow island)?

EP168 Is the proponent able to commit to no night time operations on the jetty, or in situations where this is considered unavoidable, to quantify the worst-case turtle hatchling kill for the jetty (recognising that hatchlings will be attracted to the light and are therefore likely to be killed by predators beneath the jetty) and meet any requirements for permits under the Wildlife Conservation Act 1950 to take that number of turtles?

EP178 How would the proponent deal with the problem of the impacts of light and flaring on seabirds, when experience on the North-West shelf suggests that increased gull populations are likely due to the trapping of marine fauna beneath the lights, with resultant impacts on other species?

The Gorgon Venture recognises the importance of limiting the effects of light sources on nesting and hatchling turtles, seabirds and other marine fauna. The ESE Review states that

specific management measures would be implemented to mitigate any effects from lighting, including no flaring during normal plant operations.

Based on the ESE Review, the Gorgon Venture is confident that, if the proposed development proceeds, the risks to marine fauna from lighting are sufficiently understood for appropriate management strategies to be effectively implemented. Examples of the kinds of broad strategies that could be applied to manage the potential effects of lighting were outlined in the ESE Review.

If approval in-principle approval for the restricted use of Barrow Island is granted, a formal environmental impact assessment for the development would include further studies of fauna that could be affected by light spill from the proposed facilities. Those findings would guide the associated design considerations and construction/operational measures that would be applied to achieve best practice environmental management for the protection of marine fauna.

EP169 Is the proponent able to commit to restricting inshore vessel movements and operations during the pre-nesting aggregation phase for turtles at both eastern and western nesting areas, with appropriate supervision to ensure compliance?

Vessel-fauna collisions are possible, but very unlikely given the large nature and slow speeds of the work vessels, barges and tankers that would be used during construction and operation of the proposed development.

EP166 Is the proponent able to commit to undertaking no construction activities on turtle nesting beaches at night during any period when turtles use the beach (adult or hatchling), and the appointment of an environmental specialist to oversee any operations during the breeding period (September to April inclusive) to ensure compliance with this commitment?

EP174 Given that ruts formed by vehicle wheels on the beach are known to cause problems for hatchling turtles, and that these ruts can persist long after their formation, is the proponent able to commit to the restriction of all vehicle and machinery activity along the beach to areas within the pipeline access easement at all times?

The ESE Review states that during peak turtle nesting periods, no vehicle and machinery access to beaches would be permitted by the Gorgon Venture (p. 93). Further, any construction operations during the peak nesting season that would require lighting levels likely to affect turtles on adjacent beaches would be restricted to daylight hours only (p. 93). This would also apply to the turtle hatchling period.

If in-principle approval for restricted use of Barrow Island is granted, development of environmental mitigation and management practices would be guided by further assessment of the development and consultation with stakeholders. Monitoring and compliance of environmental management procedures would be outlined in a project-specific Environmental Management Plan which would be overseen by Gorgon Venture environmental personnel.

EP170 With respect to the turtle protection strategies on p94, how does the proponent intend to shield the pilot flare, which will burn continuously?

The Gorgon Venture acknowledges that the pilot flame will operate continuously. The pilot flame is required to ensure the safe operation of the emergency flare. The pilot flame itself is a relatively low intensity light source, however the Gorgon Venture will continue to assess options to minimise light spill from the pilot flame.

EP171 With respect to the turtle protection strategies on p94, at what height would lights on the proposed plant be, and how would light-fall and reflection from the plant be minimised?

EP172 Is the proponent able to commit to the installation of fully shielded lights, time switches or motion detectors, low intensity lighting, lights installed at a low height, physical barriers around lit areas, and a lighting system design that minimises all irradiance on the beach (i.e. will not reflect off large areas towards the beach thus escaping directional shielding)?

EP173 In order to prevent any impacts of flaring activities on hatchling turtles, is the proponent able to commit to eliminating the need to conduct flaring on Barrow Island, or fully shielding the flare?

Detailed engineering and design of the proposed gas processing facility has not been undertaken. The Gorgon Venture acknowledges the importance of light-spill and would ensure that the design of the facility will incorporate appropriate measures to reduce the effect of lighting during detailed engineering design and ongoing environmental assessment of the proposed development.

The ESE Review states that during peak turtle nesting periods, no vehicle and machinery access to beaches would be permitted by the Gorgon Venture (ESE Review, p. 93). Further, any construction operations during the peak nesting season, which would require lighting levels likely to affect turtles on adjacent beaches, would be restricted to daylight hours only (ESE Review, p. 93).

EP182 Would the proponent conduct a quantitative risk assessment of the potential for a marine oil spill?

The Gorgon Venture would build upon the experience gained by the current Barrow Island oil field operator in terms of the management of spill risk. It is envisaged a marine oil spill risk assessment specific to the proposed Gorgon development, would be undertaken as part of any subsequent development process.

6.6 Seabirds

EP124 Please confirm when the proponent's survey for seabirds, waders and shorebirds was conducted, and comment on the suggestion that it may have been undertaken at an inappropriate time of the year (August), and that therefore the significance of Barrow Island as wader habitat has been underestimated.

EP125 Does the proponent intend to conduct further surveys to identify the seasonal movement of migratory seabirds and waders across the east coast of Barrow Island, as recommended in the avifauna technical report? Why has this not already been done?

EP176 What does the proponent consider to be the "peak seabird breeding period" when vehicle and machinery operation would be restricted on beaches?

The seabird surveys were conducted in August 2002. August is an important breeding time for seabirds and non-migratory waders that are more likely to be site dependent, such as osprey, sooty oyster catchers and pied oyster catchers.

It is recognised in the ESE Review that migratory waders and seabirds would have been underestimated by surveying in August and there was no attempt in the ESE Review to apply the bird counts at the proposed development site to determine the relative importance of the area to these species. Abundances will be higher in spring and summer. In the Kimberley and Pilbara regions, migratory shorebird abundances are known to increase in late August and peak in September and October.

The seabird survey conducted for the ESE Review identified areas of suitable wader habitat within the proposed development area, with recognition that these areas would be popularly used on a seasonal basis. If the restricted use of Barrow Island receives in-principle approval, it is acknowledged that additional surveys of seabirds would be required for preparation of a detailed environmental impact assessment. However, such detailed

surveys are not required at the strategic-level of the ESE Review. Seasonal changes in seabird abundance are expected in any area and further sampling is anticipated to elucidate temporal patterns of usage of the east coast habitats.

Technical Appendix E of the ESE Review specifically highlights the requirement for additional surveys in October to coincide with the expected peak in migratory wader abundance.

EP126 Does the proponent intend to conduct a survey to compare the relative significance of different bays to waders, including a direct comparison between the east coast of Barrow Island and Bandicoot Bay (see p90)?

The Gorgon Venture acknowledges that additional surveys of migratory waders and seabirds would be required for preparation of a detailed environmental impact assessment if the restricted use of Barrow Island receives in-principle approval. Subsequent surveys would assist in confirming the relative importance of the proposed development site in comparison with other areas of the east coast of Barrow Island. Seasonal changes in seabird abundance are also expected in any area and further sampling will also be undertaken to elucidate temporal patterns of usage of the east coast habitats.

The seabird surveys described in the ESE Review were conducted in August 2002. It is recognised in the ESE Review that migratory waders would have been underestimated by surveying at this time of year and there was no attempt in the ESE Review to apply the bird counts at the site to determine the relative importance of the area to these species. Abundances of migratory waders will be higher in spring and summer. In the both the Kimberley and Pilbara regions, migratory shorebird abundances increase in late August and peak in September and October.

August is an important breeding time for seabirds and non-migratory waders that are more likely to be site dependent, such as osprey, sooty oyster catchers and pied oyster catchers.

The seabird survey conducted for the ESE Review identified areas of suitable wader habitat within the proposed development area, with recognition that these areas would be popularly used on a seasonal basis. Bandicoot Bay was specifically referred to on page 90 of the ESE Review because it provides a range of intertidal habitats used by waders, including vast expanses of sand flats that do not occur in the proposed development area. Bandicoot Bay has long been known to be a significant site for waders (Sedgwick 1978).

A subset of the habitats within Bandicoot Bay is present in the proposed east coast development site. The other bays along the east coast of the island provide similar habitats for waders to those found in the proposed development site and are expected to provide alternative foraging areas for waders.

The implication is that the small area within the proposed development footprint probably does not constitute regionally significant wader habitat. It is acknowledged that this needs to be confirmed through direct survey.

EP177 Why does the proponent fail to mention Barrow Island's importance as a nesting site for large birds of prey (e.g. Osprey, White-bellied Sea-eagle), terns and gulls?

Ospreys, white-bellied sea-eagles, terns and gulls are described and assessed in the assessment of seabirds, provided as Technical Appendix E of the ESE Review. Some additional information is provided in Technical Appendix G of the ESE Review. Between these two assessments, all avifauna that occur on Barrow Island were identified and their distributions and habitat requirements were considered in the assessment of the potential impacts of the development.

Overviews of the key findings of the technical report were presented in the main body of the ESE Review. The purpose of the ESE Review process is to identify factors that are critical to the question of whether or not restricted use of Barrow Island is acceptable. Accordingly, the main body of the ESE Review concentrated on species of recognised conservation significance, notably those that have been identified as threatened or

requiring special protection under either State or Commonwealth environmental legislation. Ospreys and white-bellied sea-eagles are among 21 migratory waders and eleven seabirds that are covered by international agreements and therefore recorded on the migratory species lists under the EPBC Act, as discussed in the main body of the ESE Review. None of these birds is threatened or restricted to Barrow Island. The possible importance of the proposed development area for these species is described in the report in Technical Appendices E and G. The Gorgon Venture believes that the level of investigation and assessment undertaken to date is in keeping with the strategic nature of the ESE Review.

EP179 Would the proponent commit to discouraging seabirds from nesting on constructed facilities, by means including the placement of sufficient nesting structures nearby?

Seabird raptors such as Ospreys tend to nest on elevated structures and may nest on constructed facilities. Nesting platforms have been successfully installed and used by breeding raptors in other parts of Barrow Island.

Specific management measures for protecting local raptor populations would be addressed in more detail in an environmental impact assessment if the proposed development proceeds.

EP229 What surveys were done of seabird populations?

Field surveys of seabirds and shorebirds were conducted in mid-August 2002 and each beach was surveyed once. A continuous 12 hour watch was conducted over the beach and intertidal flats at Latitude Point from a bird hide. The methods are described in Technical Appendix E of the ESE Review. The field surveys augmented the review of pre-existing information describing the local and regional importance of the area for seabirds.

EP230 Is the reference to Bandicoot Bay on p90 meant to suggest that Bandicoot Bay provides habitat for wader species that replicates the Town Point Site?

Bandicoot Bay has long been known to be a significant site for waders (Sedgwick 1978) and has vast expanses of sand flats that do not occur in the proposed development area. The implication is that the small area within the proposed development footprint probably does not constitute regionally significant wader habitat.

Bandicoot Bay provides a range of intertidal habitats used by waders. A subset of these habitats is present in the proposed east coast development site. The other bays along the east coast of the island provide similar habitats for waders to those found in the proposed development site and are expected to provide alternative foraging areas for waders.

EP232 What is known of the very significant populations of waders and terns in the bays of the east coast of Barrow Island?

Although little is known of their population dynamics, the east coast bays are recognised as important for waders and seabirds. Seabirds and waders are expected to occur in high densities and to breed in some areas along the east coast. There are probably 'hot spots', such as the offshore islands, for seabird and wader activity. Further data would be gathered as part of a more detailed environmental assessment if the proposed development proceeds.

The seabird survey conducted for the ESE Review was directed towards identifying areas of suitable seabird habitat within the proposed development area, with recognition that use of these areas would vary on a seasonal basis. Seasonal changes in seabird abundance are expected in any area and further sampling is anticipated to elucidate temporal patterns of usage of the east coast habitats.

EP233 What is known of the bird populations that are summer over feeding?

There is presently little quantitative data on seabirds that visit the area over summer. This would be addressed as part of a more detailed environmental assessment if the proposed development proceeds.

EP234 What is known of the bird colonies that are consistently using the east coast bays as permanent habitat areas, and not just as migratory staging points?

Resident birds that are dependent on the proposed development area would have been observed during the August survey. Further data on these birds would be gathered as part of a more detailed environmental assessment if the proposed development proceeds. However, based on the information derived from the seabird survey described in the ESE Review, supported by the biological consultants' knowledge of seabird ecology in the region, there is reasonable confidence that seabird populations would not be significantly impacted by the project.

6.7 Stygofauna

EP103 The limited number of stygofauna found in the area is probably due to the sampling locations selected (existing groundwater bores) and the design of the sampling programme. Furthermore, the fact that three additional undescribed stygofauna were discovered during the sampling programme indicates that the whole subterranean fauna of the area is very poorly understood. Given the high degree of endemism of fauna, does the proponent intend to conduct further investigations into the presence of subterranean fauna in the project area, including in caves, organic soils, mud banks, pool surfaces, soil cones, freshwater streams, root mats and tree roots, fissures and cracks in the limestone?

EP105 The limited number of cavefish found in the area is probably due to the sampling techniques selected. Does the proponent intend to conduct further investigations into the presence of cavefish in the project area?

EP106 Previous research suggests that the troglobitic fauna found on Barrow Island is largely endemic to the Island, and may be even richer than the stygobitic fauna, yet there is little information relating to troglobitic fauna in the ESE Review. Does the proponent intend to conduct further investigations into troglobitic fauna on Barrow Island?

EP117 How does the proponent intend to ensure the protection of the Barrow Island karst system (including caves and other karst features) and the subterranean biodiversity?

EP119 Has any terrestrial subterranean fauna been examined in the project area, and if not, does the proponent intend to conduct such an investigation?

The Gorgon Venture acknowledges that the results of the stygofauna study were limited by the restricted spatial coverage of sampling within the development area (ESE Review, Appendix I). This limitation was taken into consideration when interpreting sampling results. The inherent difficulties in investigating subterranean habitats and fauna were also acknowledged in the ESE Review.

As described in the ESE Review, there are no known caves located within the proposed development area, nor any other obvious surface expressions of substantial karst development. Sampling for troglobitic fauna was therefore limited to four drill holes located within the proposed development area. The assessment of troglobitic fauna included an appraisal of the habitat of the area; and a review of known records from previous work on the island – including the Western Australian Museum's database, which holds 324 records of terrestrial invertebrate taxa collected from caves or other subterranean environments on Barrow Island.

The Gorgon Venture believes that the level of investigation and assessment undertaken to date is in keeping with the strategic nature of the ESE Review. The purpose of the ESE Review process is to identify factors that are critical to the question of whether or not restricted use of Barrow Island is acceptable. The Gorgon Venture considers such factors to be those that cannot be managed through environmental impact mitigation or minimisation practices and have a level of risk that would be beyond the Gorgon Venture's control.

In addressing these factors, the Gorgon Venture Participants applied knowledge and experience accumulated from years of field operations and management on Barrow Island. Similarly, specialist consultants based their assessments on field survey work conducted specifically for the ESE Review. They also applied their expert knowledge of the issue and/or Barrow Island to consider the potential implications of the development.

Based on the ESE Review, the Gorgon Venture is confident that, if the proposed development proceeds, the risks to subterranean fauna are sufficiently understood for it to be reasonable to expect that appropriate management strategies could be effectively implemented. The Gorgon Venture recognises the importance of developing appropriate environmental mitigation and management strategies for subterranean fauna. If in-principle approval for the restricted use of Barrow Island is granted, development of environmental mitigation and management practices will be guided by additional survey work in consultation with stakeholders.

EP104 Given the failure so far to detect four subterranean taxa elsewhere on Barrow (see p111), what support is there for the statement in paragraph two on p121 regarding likely representation elsewhere?

The majority of the species collected during the sampling undertaken for the ESE Review were found both within and outside the proposed development area. It is possible that two of the three undescribed subterranean fauna taxa that were found in the development area during that sampling, but not outside the development area, have been previously recorded elsewhere on Barrow Island (ESE Review, Appendix I).

The available information suggests that the saturated karstic formations that occur in the development area are not geologically isolated; and that the area does not contain the massive or extensive karstic features that are known to occur at certain locations elsewhere on Barrow Island. The site does not appear to have any particular subterranean habitat values relative to other sites on the island.

It is recognised that the results of the stygofauna study are limited by the restricted spatial coverage of sampling undertaken, and that thorough investigations will be required to be conducted during the environmental assessment process to help guide facility design and management, if restricted use of Barrow Island for a gas processing facility is given in-principle approval (also see response EP103). However, the available information suggests that the karst at the site is not geologically isolated and the area does not appear to contain subterranean habitat of particular value. The results of the sampling undertaken to date support these observations.

EP107 Sealing the surface is known to have detrimental impacts on subterranean fauna, which depend on infiltration of organic matter. How does the proponent intend to manage the potentially harmful effects of surface sealing and other activities within the project area?

EP202 What is the likely impact on subterranean fauna of the "effective closure of surface drainage inputs over an area of approximately 300 ha" (Appendix I)?

Changes to surface hydrology can potentially block any areas of groundwater recharge and remove water and nutrient inputs to underlying subterranean systems. The potential for plant infrastructure to alter surface drainage and nutrient inputs was identified and evaluated in the ESE Review. It was concluded that the characteristics of the proposed development make it unlikely that significant effects on local hydrology, groundwater recharge and nutrient flux would result from development at the site, provided that

appropriate drainage management was incorporated into the design. As stated on page 120 of the ESE Review, the plant would not involve a single area of disturbance: it would consist of a number of separate facilities, interspersed with open and unsurfaced areas. Therefore, changes to recharge patterns are likely to be localised and could be mitigated through appropriate plant design and stormwater management strategies.

The Gorgon Venture recognises the importance of effectively managing surface hydrology issues. It would therefore address each of these issues, and all other environmental management issues, in a comprehensive, project-specific Environmental Management Plan that would account for all known and potential ecological impacts. It would also outline management options to mitigate risk (ESE Review, p. 272). Development of an Environmental Management Plan would be guided by additional ecological assessments, survey work and consultation with stakeholders including government agencies.

EP108 What evidence is there to support the statement at the foot of p121 regarding the risk of spills to subterranean habitat, given that there have been numerous spills from oil field flow lines, for example, in the past?

The proposed gas facility would be a modern, purpose-built facility incorporating the latest technology, including best practice environmental management. It would be concentrated within a relatively small area. This contrasts with the existing oilfield, which is dispersed over a much wider area with infrastructure of varying ages installed at different times since the oilfield was first developed in the 1960s.

Areas on the proposed Gorgon gas plant where liquid hydrocarbons were processed or stored would have impermeable hardstand, closed drainage systems and appropriate bunding.

The final design of the plant would be subject to environmental assessment and management measures, including monitoring and response procedures to ensure the risk of leaks or spills affecting the environment are minimised. These procedures and protection measures would require regulatory approval.

EP109 How is it intended to render hardstand areas impermeable, recognising the likely sensitivity of subterranean fauna to pollutant inputs and that concrete is not impermeable?

The Gorgon Venture recognises that contaminated stormwater must be managed to avoid contact with, and contamination of, groundwater. There are numerous available and proven methods for making hardstand impermeable. Appropriate mitigation and management measures would be accommodated in detailed engineering and design of the gas processing facility. If the restricted use of Barrow Island is granted in-principle approval, proposed procedures and protection measures would require regulatory approval.

EP110 The suggested evidence of chemoautotrophic energy production within the subterranean system is specifically associated with the Barrow Island Fault, far removed from the proposed site, making the suggestion irrelevant. What impact does this have on the proponent's analysis of the subterranean system?

It is acknowledged that the existing evidence for chemoautotrophy in Barrow Island subterranean fauna relates to the Barrow Island Fault. However, there are a number of other minor faults on Barrow Island and there is evidence of naturally occurring hydrocarbons in the groundwater at many other locations on Barrow Island. There is also evidence that potentially chemotrophic species are not restricted to the Barrow Island Fault.

If this process is occurring in subterranean ecosystems on Barrow Island near the Barrow Island Fault (and the possibility was raised only peripherally in the discussion in the ESE Review), it is reasonable to assume that it may also occur at other locations, particularly given the evidence suggesting that the species involved may be "opportunistic" using chemoautotrophic energy sources.

The presence of such a system is not pivotal to the assessment of potential impacts from the proposed development on subterranean fauna. Further, evidence that it did not occur would not affect the conclusions of the ESE Review: namely that the potential for the development to have significant adverse effects on subterranean fauna, via changes to local groundwater recharge or nutrient fluxes, is very low (see also ESE Review, p.107).

EP111 If subterranean systems on the island are driven by chemotrophic rather than surface energy, would this not make them particularly vulnerable to pollutant inputs? What is the likely scale of impact and how would this be managed?

The Gorgon Venture considers that the subterranean ecosystem of Barrow Island requires protection regardless of whether it is driven by chemoautotrophic or surface energy inputs. If in-principle approval for restricted use of Barrow Island is granted, the gas plant would be designed and managed to ensure that the risk of leaks or spills is minimised. The detailed strategies developed to achieve this would also be subject to assessment by the relevant environmental agencies as part of the formal environmental assessment process (see also ESE Review, p. 108, p. 109).

It is uncertain whether a subterranean ecosystem driven by chemoautotrophic rather than surface energy would be more vulnerable to pollutant inputs, and the answer may be expected to depend largely on the type of pollutant. It seems possible that a system utilizing natural sources of petroleum hydrocarbons as an energy source would be unlikely to be adversely affected by the input of the same hydrocarbons.

EP118 Why were the findings and recommendations of the report titled "Barrow Island Gorgon Gas Development Subterranean Fauna Survey" (listed in Appendix I) not included in the body of the ESE Review Document?

The ESE Review provided a summary and overview of the findings and recommendations of the technical studies specifically commissioned to assist the ESE Review process. To the extent necessary, it also includes information provided from other sources that address the factors critical to the question of whether or not restricted use of Barrow Island is acceptable. The Gorgon Venture considers such factors to be those that cannot be managed through environmental impact mitigation or minimisation practices and which have a level of risk that would be beyond the Gorgon Venture's control.

The technical reports conducted for the ESE Review process were provided in full as appendices to the main report as consistent with standard practice in the production of environmental review documents.

EP120 Page 111, third dot point refers to eight of twelve taxa of subterranean fauna being recorded in other areas. Do the available data indicate that the other four taxa are confined to the plant site?

Three undescribed taxa and the copepod *Phyllopodopsyllus wellsii* were collected from bores in the development area and not in the sampling undertaken outside the development area. It was speculated (ESE Review, Technical Appendix I) that the two undescribed copepods may correspond to the 'Copepoda: indet.' that have been reported from previous sampling on the island. The oniscoid Isopod specimen appears to be the first representative of this family known from Barrow Island. *Phyllopodopsyllus wellsii* is also known from Cape Range, but has not been recorded previously on Barrow Island.

As was noted in the discussion of subterranean fauna in the ESE Review, the distributions of subterranean species on the island have not been definitively established. Further, future sampling outside of the proposed development area may establish broader distributions for the taxa recovered by the sampling for the ESE Review, particularly given the indications that the karst in the area is not geologically isolated or especially prospective for stygofauna. Such work would be used to guide design and management to minimise and mitigate potential adverse impacts to subterranean fauna (see also ESE Review, p. 103, p. 104).

EP198 Why has the proponent not recognised the fact that Ramphotyphlops logissimus, the world's only known troglobitic reptile, was discovered on Barrow Island, and why has no follow-up of this discovery been undertaken by the proponent?

ChevronTexaco has sought advice regarding the sampling requirements and cost of undertaking a comprehensive survey for *Ramphotyphlops longissimus* on Barrow Island. Due to sampling design requirements, including the need to sample extensively throughout Barrow Island, the estimated cost of the survey work was too high for ChevronTexaco to support alone.

ChevronTexaco has supported other subterranean research work on the island over the past decade and spent \$11 million in 1996 on changes to the produced water disposal system to reduce any possible risk to stygofauna from this system. Since subterranean fauna were first documented on Barrow Island in 1991, ChevronTexaco (formerly WAPET) has provided direct financial support and in-kind assistance to every subterranean fauna sampling program that has been undertaken on Barrow Island. As stated in the ESE Review, this has included more than seven sampling trips by the WA Museum over past decade.

EP199 Why does the section of the proponent's document describing an apparent absence of caves not reflect the fact that troglobitic fauna are very small and that tiny voids will provide suitable habitat?

The ESE review indicates four species of troglobitic (cave dwelling) fauna have been described from Barrow Island to date. Initial investigations in the proposed gas processing facility area indicate an absence of caves, apparent fissures or other surface expressions of cavernous formations that would provide habitat for troglobitic fauna.

The Gorgon Venture acknowledges that the site specific investigations of subterranean fauna undertaken to date are limited by the restricted spatial coverage of sampling within the development area. However, this limitation was taken into consideration during the interpretation of sampling results and the level of investigation and assessment undertaken to date is in keeping with the strategic nature of the ESE Review.

A thorough investigation of subterranean ecosystems in the proposed development area, including a more detailed assessment of potential troglobitic habitat, would be required if in-principle approval for restricted use of Barrow Island is granted and the environmental approval process proceeds. The scope and nature of the sampling program necessary for such an investigation would be agreed with the DEP and other agencies/groups of relevant expertise prior to preparation of an EIA for the development.

EP200 While the proponent acknowledges that the sampling for terrestrial troglobitic fauna has not yet been completed, why is no timetable for the completion of this work presented?

EP201 Given that the report in Appendix I acknowledges the limitations of the subterranean fauna sampling undertaken, does the proponent intend to conduct a comprehensive survey with a dedicated drilling programme, incorporating the full suite of appropriate techniques, in conjunction with appropriate specialists in order to allow a proper assessment of this proposal?

The inherent difficulties in investigating subterranean habitats and fauna were acknowledged in the ESE Review and the limitations of the sampling work were clearly recognised in the technical assessment of this issue in the technical appendices (Technical Appendix I). However, the assessment of the karstic nature of the area and its relative prospectivity as subterranean fauna habitat was not based solely on the sampling program.

A more comprehensive assessment of the karst terrain will be completed if the proposed development progresses to the more detailed stages of the formal environmental assessment process. This would include a more detailed geotechnical study as well as further stygofauna and troglofauna investigations.

The Gorgon Venture recognises the importance of developing appropriate environment mitigation and management strategies for subterranean fauna. It is considered that the risks to subterranean fauna are sufficiently understood for it to be reasonable to expect that appropriate management strategies could be effectively implemented.

EP203 What degree of impact is blasting during construction likely to have on subterranean environments and fauna?

The ESE Review includes an evaluation of the likely scale of impact of blasting on subterranean fauna and concludes that the risk of significant impacts to Barrow Island's subterranean environment and fauna populations would be low. Further investigation of the specific subterranean fauna values of the development site and the potential effects of construction, including blasting, on such values would be undertaken as part of a detailed environmental impact assessment that will be required if the restricted use of Barrow Island is granted in-principle approval. These investigations would guide the design and management of the gas facility to ensure that impacts to subterranean environments and fauna are minimised.

EP204 Why does the proponent claim that threatened species "readily acclimatised to oilfield operations", when it is possible that many species of subterranean fauna have disappeared as a result of the oil contamination of shallow groundwater as a result of existing operations?

The reference to acclimatization of fauna to oilfield operations was made within the context of terrestrial fauna and the potential for effects from noise emissions.

EP205 Can hardstand areas, closed drainage systems and bunds be made impermeable to hydrocarbons, to prevent further groundwater contamination? How does the proponent intend to ensure that they remain impermeable for the duration of the project life?

The Gorgon Venture recognises that contaminated stormwater must be managed to avoid contact with, and contamination of, groundwater. Appropriate mitigation and management measures would be accommodated in detailed engineering and design of the proposed gas processing facility. All necessary measures would be incorporated into the plant design to avoid contamination of groundwater.

EP207 What is the likely impact of groundwater extraction on stygofauna that depend upon the limited fresh groundwater on the island, and how will this be monitored?

No groundwater extraction would be conducted as part of the proposed development (ESE Review pg. 120).

EP240 What effect could injection of CO₂ have on underground fauna? What effects could there be if there were leaks of the CO₂ back to near surface?

The re-injection of CO₂, if found to be technically feasible, would occur to a very deep (>2000 m) saline reservoir that is geologically isolated. The subterranean fauna of Barrow Island are restricted to much shallower depths (<150 m) and would not be affected by re-injection of CO₂ to geologically isolated formations at the very great depths proposed.

6.8 Molluscs

EP196 Given that the survey of land snail populations on Barrow Island by the WA Museum found a species of cameanid that may be endemic to the island, and that the proponent's own consultants have recommended that a more comprehensive survey is required, does the proponent intend to examine further the distribution of cameanid species? Why has this not already been done?

This is recognised in Technical Appendix H (Section 5.1) and further data would be gathered as part of the more detailed environmental impact assessment process if the proposed development proceeds. The Gorgon Venture believes that the level of investigation and assessment undertaken to date is in keeping with strategic nature of the ESE Review. The purpose of the ESE Review process is to identify factors that are critical to the question of whether or not restricted use of Barrow Island is acceptable. In addressing the distribution of the cameanid species, the Gorgon Venture engaged specialist consultants who based their assessments on field survey work conducted specifically for the ESE Review, and applied their expert knowledge to consider the implications of the proposed development.

As described in Technical Appendix H of the ESE Review, there is reasonable confidence that, if the proposed development proceeds, loss of biodiversity of species or communities of cameanid species would not occur. It is considered that the risks to cameanid species are sufficiently understood for it to be reasonable to expect that appropriate management strategies could be effectively implemented. The Gorgon Venture recognises the importance of developing appropriate environment mitigation and management strategies for all fauna, including cameanids. If in-principle approval for the restricted use of Barrow Island is granted, development of environmental mitigation and management practices would be guided by additional survey work and consultation with stakeholders.

EP197 How well represented elsewhere are the native molluscs recorded from the plant site?

All of the native molluscs recorded at the proposed development site are represented elsewhere on Barrow Island. Snails from two families (Camaenidae and Pupilladae) were found in the development area. Two species from the Camaenidae were recorded in the proposed development area, as well as in adjacent areas: *Quistrachia barrowensis*, which is endemic to Barrow Island and some of the islands nearby, and *Rhagada* sp, which may also be endemic to Barrow Island, although its shell characteristics indicate similarities to *R. capensis* which also occurs on the Cape Range Peninsula. The three species from the family Pupilladae found in the development area have widespread mainland distributions.

A detailed description of the native mollusc taxa found within the proposed development areas and their broader distributions is provided in the report prepared by the Western Australian Museum that is included as Technical Appendix H to the ESE Review.

6.9 Vegetation

EP113 Does the proponent intend to conduct further investigations of the flora on Barrow Island, given that: Barrow Island flora is currently poorly described; the distribution of vegetation associations is poorly understood; the Astron study was time constrained and therefore limited; little is known about the taxonomy and level of endemism of the island flora, which is likely to be high given the long period of time the island has been separated from the mainland? If so, when will this investigation be undertaken?

The Gorgon Venture believes that the level of investigation and assessment undertaken to date is in keeping with the strategic nature of the ESE Review. The purpose of the ESE Review process is to identify factors that are critical to the question of whether or not restricted use of Barrow Island is acceptable. The Gorgon Venture considers such factors to be those that cannot be managed through environmental impact mitigation or minimisation practices and which have a level of risk that would be beyond the Gorgon Venture's control.

In addressing these factors, the Gorgon Venture applied knowledge and experience accumulated from years of field operations and management on Barrow Island. Similarly, specialist flora consultants based their assessments on field survey work conducted specifically for the ESE Review, and applied their expert knowledge of Barrow Island to consider the implications of the development.

If in-principle approval for restricted use of Barrow Island is granted, further vegetation surveys would be conducted. These surveys would: further the understanding of broader island distributions of vegetation that occurs at the proposed development site; confirm that any species of potentially restricted distributions that occur in the development area are represented in secure populations outside that area and; guide the project design to minimise impacts on restricted flora.

Based on the ESE Review and a commitment to an appropriate work program, the Gorgon Venture is confident that there would be no loss in biodiversity of species or communities.

The precise scope and nature of the investigations required to support a detailed environmental assessment process would be agreed with the DEP and other agencies/groups of relevant expertise prior to the preparation of an environmental impact assessment for the proposed development.

EP114 Has the proponent made any attempt to assess the impact on vegetation types and flora populations of past industrial activity on the island, given that the quoted 4.5% land cleared represents a significant proportion of an A Class Nature Reserve?

The level of disturbance from previous oilfield operations to the vegetation types on Barrow Island has been quantified for each of the vegetation formations on the island identified by Mattiske Consulting (1993) and was shown in Table 6-2 of the ESE Review.

Consideration of the level of previous disturbance, along with other factors, was incorporated by the Gorgon Venture into both the site selection process on Barrow Island and the review of potential effects to vegetation from developing a facility at the Town Point site.

If in-principle approval for the restricted use of Barrow Island is granted, further assessment of the cumulative effects of the proposed development on the vegetation of Barrow Island would be included in a detailed design and layout planning, as well as in preparation of an environmental impact assessment for the development.

EP116 Given the lack of detailed knowledge of the flora of Barrow Island, how can the proponent be confident that significant flora will not be impacted by the proposal and that it can comply with its commitment that "no new development should be established on Barrow Island unless it can be demonstrated that it will be sustainable and continue to preserve the island's conservation values"?

The ESE Review shows that potential disturbance at the site proposed for the Gorgon gas development would not significantly affect the distribution or viability of significant flora on Barrow Island. The Gorgon Venture therefore believes the ESE Review demonstrates that the proposed development would not adversely impact on the conservation values and biodiversity of Barrow Island.

If in-principle approval for the restricted use of Barrow Island is granted, a range of government approvals would be further required as part of the formal development process. Such approvals would require additional vegetation studies to provide the level of information required to satisfy approval-level standards. These vegetation studies would address the concerns with the proposed development regarding the level of understanding of the flora of Barrow Island.

EP134 The ESE Review lists 250 species of plants on Barrow Island (p101), Mattiske cites about 300 and Astron about 350. Which is the correct figure?

As part of the preparation of the ESE Review vegetation report (Technical Appendix F), Astron Environmental found that 350 plant species had been recorded on Barrow Island to date. The work conducted by Mattiske and Associates (1993), which was quoted as saying "in the vicinity of 300", was conducted almost a decade earlier. Thus further species were identified in the period between the reports. Therefore, the 350 species cited in the

vegetation report of Appendix F of the ESE Review is considered correct. The reference to this figure in the text on page 101 of the ESE Review is a typographical error, which is regretted by the Gorgon Venture. However, this error was not carried over into the discussion of the conservation values of Barrow Island, nor into the review of the potential impacts of the proposed development or the conclusions reached from this review.

EP135 Why does the proponent suggest that the flora of Barrow Island is typical of the arid Pilbara Region, when it is in fact more closely aligned to the Cape Range-Rough Range area (Carnarvon Bioregion), and also has unique vegetation and flora that is not represented on any other island off the Pilbara coast (perhaps due to its size and geology).

It is correct that the Barrow Island flora has affinities to that of the Cape Range peninsula, despite its location within the Pilbara Bioregion, as was highlighted on page 97 of the ESE Review. This relationship to the Cape Range was also described on several occasions elsewhere in the ESE Review, including the second half of the sentence on page 101 that is cited in the submission.

The first half of this sentence referred to the vegetation mapping of the Pilbara region, and more specifically the Eremaean Botanical Province, of Beard (1980), rather than to the Pilbara Bioregion. This was referenced in the text. The dominant floristic components of the vegetation on Barrow Island, namely *Triodia* and *Acacia*, are typically Eremaean. A detailed technical description of the more complex affinities and classifications of the Barrow Island vegetation and flora was provided in the vegetation report included in Appendix F of the ESE Review.

EP136 Does the proponent intend to conduct more intensive (smaller scale) vegetation mapping over the whole island (similar to the community scale vegetation description and mapping undertaken by Astron), to allow valid comparisons to be made with respect to the representativeness of the flora and vegetation types across the island and determine the likely impacts that this project would have on botanical values?

The vegetation of Barrow Island has been relatively well documented, with the entire island mapped by Matiske and Associates in 1993 and complemented by more detailed studies undertaken subsequently at numerous specific locations.

The information provided by the vegetation surveys undertaken on Barrow Island to date, including the island-wide study by Matiske and Associates in 1993 and the study of the development area by Astron Environmental in 2002 (ESE Review, Appendix F), provides the level of information required to support the conclusions reached in the ESE Review. It is understood, and explicitly acknowledged in the ESE Review, that more detailed vegetation studies would be required in a formal environmental impact assessment that would be undertaken if in-principle approval for the restricted use of Barrow Island is granted.

EP137 If all previously cleared areas excluding seismic lines are included in the total, what is the percentage of Barrow Island that would have been disturbed in total, including the current proposal?

The current area of cleared land on Barrow is 657 hectares (current at end of 2001; ESE Review, p. 100). Previously cleared areas which have now been rehabilitated, or are in the process of being rehabilitated, total approximately 410 hectares (ESE Review, p. 100). When added to the proposed area of the Gorgon gas development (300 hectares; ESE Review, p. 61) the percentage of Barrow Island that would have been cleared in total equates to approximately 5.8 per cent of the total area of the island (total area is 23 567 hectares; ESE Review p. 100).

EP138 The figures presented in Table 6.1 on disturbed areas are misleading, as they cover only cleared land and not land which has been subject to other disturbance, such as seismic activities. Furthermore, estimates of land cleared for roads, well-heads and gravel pits appear to have been significantly

underestimated. What is the precise area of disturbance (considering rehabilitated areas as disturbed or cleared), including the area cleared for roads, gravel pits, seismic operations, well-heads and bores and the areas disturbed due to production and salt water flow-line failures?

EP139 What is the precise area of the gravel pits on the island, extinct and active?

Table 6.1 of the ESE Review provides a breakdown of the areas that were cleared as of 2001. This is summarised below:

Description of Area	Cleared Area (Ha)
Roads	284
Wells	220
Gravel pits	5
Infrastructure (buildings, pipelines, etc)	139
Area cleared between 1998 and 2001	9
Total (current utilisation 2001)	657

These areas were calculated utilising a Geographic Information Systems (GIS) based on high resolution photography from 1998 and earlier drawings of the various infrastructures. This work was supported with input from the field to check the quality of the data.

A total area of approximately 410 ha has either been rehabilitated or is in the process of being rehabilitated. This area includes rehabilitated gravel pits, roads, well heads and other areas no longer required for operations.

The total combined area, including rehabilitated areas is 1067 ha or 4.5 per cent of the island.

The area related to seismic lines has not been included for several reasons. Firstly, when the seismic lines are created the root stock is left in place. This allows for the quick regrowth of the pre-existing species. Secondly the areas that were previously used for seismic lines are nearly impossible to identify from the ground due to the successful regrowth from rootstock and seeding from the edge. Finally as the seismic lines were only created temporarily and are relatively narrow the total cumulative long-term impact is negligible.

EP142 Can the proponent demonstrate that an area can be rehabilitated back to its predisturbance state, in terms of correct species mix, and full functionality of the communities? How long does such a process take?

EP144 How does the proponent intend to prepare for the future decommissioning of the plant and associated rehabilitation, with respect to seed collection and storage and propagation of the indigenous species, recognising that such a large rehabilitation has never been attempted before on the islands off the Pilbara coast, and the storage and germination requirements for some species are unknown?

EP216 Given that there is currently no information available to measure the proponent's past rehabilitation performance on Barrow Island against industry best practice benchmarks, does the proponent intend to develop a programme

to meet best practice standards for rehabilitation of disturbed areas?

ChevronTexaco is confident that disturbed land can be rehabilitated to meet "completion criteria" that are commensurate with the environmental and social values of Barrow Island. ChevronTexaco is presently developing completion criteria and suitable monitoring techniques that will demonstrate rehabilitation progress, in a quantitative manner. In the longer term, this would provide assurance to regulators that rehabilitation is satisfactory for a given site. This work is being done with the involvement of the appropriate regulators (CALM and DoIR) and qualified peers. The concept of developing stakeholder-endorsed completion criteria and defining a process to achieve regulator "signoff" is relatively new and has possibly not yet been fully achieved for any industrial operation in Western Australia. ChevronTexaco is confident that it can work with the authorities to successfully establish these criteria for Barrow Island.

Notwithstanding the above, ChevronTexaco has, in the past, conducted monitoring programs and sought opinions of a more qualitative nature that have indicated that rehabilitation has generally been successful. However, it is difficult to substantiate these findings in the absence of appropriate stakeholder-endorsed criteria and supportive data.

As stated on page 120 of the ESE Review, the plant would not involve a single area of disturbance, but would consist of a number of separate facilities, interspersed with some open and uncleared areas. With the expected decline of the oilfield and its progressive rehabilitation over the next 20 - 30 years, there would be ample opportunity for future research to develop techniques for the rehabilitation of large areas on Barrow Island. If the proposed development proceeds on Barrow Island, the Gorgon Venture would apply those research findings to disturbed areas.

EP146 Does the proponent intend to conduct an extensive research and monitoring programme linked to protection and restoration activities, to underpin management decisions (for example to investigate the impacts of fragmentation and alteration of micro-topography and surface water movement)?

The Gorgon Venture considers long-term, annual monitoring of sites to be a key element of best practice environmental management and would commit to undertaking an agreed monitoring programme as part of a comprehensive Environmental Management Plan for the development.

EP183 Can the proponent provide information on the areas of vegetation units that have been disturbed on the island as a result of the existing petroleum operations (particularly the areas from which gravel has been mined) so that a total view of the disturbance of vegetation units can be developed?

EP214 Does the proponent intend to conduct an investigation to determine the spatial distribution of cleared areas on Barrow Island (historically) in accordance with vegetation type, in order to estimate the impacts of clearing on the conservation value of creekline habitats and alluvial flats on the island?

An overview of the vegetation units on Barrow Island is presented in Figure 6-5 on pages 104-105 of the ESE Review. This overview is based on vegetation data stored in the ChevronTexaco Geographic Information System (GIS). The level of disturbance to each of the vegetation formations on Barrow Island from existing and past development was described quantitatively in the ESE Review (Table 6-2).

"Creeklines" on the island have been a source of gravel for oilfield operations and the associated level of disturbance (approx. 21 per cent) to the creekline vegetation, which is dominated by *Triodia angusta* (Mattiske vegetation type D2), is higher than the generally very low levels of disturbance to most vegetation types on the island. However, this vegetation type is also known to regenerate well following rehabilitation of disturbed areas including roads and well pads. The area of this vegetation type that would be potentially affected by the proposed Town Point development site (Table 6-3 in the ESE Review) is

limited (<2 per cent) and includes areas that have been previously disturbed, as was noted in the Astron vegetation survey of the site (Technical Appendix F).

EP223 It is not clear what the headings in the last two columns of Table 6-3 mean. Vegetation unit D2 is listed as occupying 17.7 ha which seems to be represented as 1.6% of the Town Point area, while L3 occupies 21.5 ha for 0.8%? Please clarify.

Column 5 of Table 6-3 of the ESE Review represents the percent of each vegetation unit found at Town Point site as a proportion of its total distribution on Barrow Island. Column 4 is the number of hectares of that particular vegetative unit at the Town Point site.

EP225 What was the nature of the Mattiske (1993) vegetation mapping, and was it uniformly broad scale?

EP226 How do the vegetation systems used by Mattiske and Astron relate to each other?

EP227 What photo interpretation has been done of the Mattiske mapping - has this information been thoroughly checked?

The vegetation mapping performed by Mattiske and Associates (1993) provides descriptions of the prevailing vegetation types to a level of detail commonly referred to as formation level (Groups describing vegetation structure).

Further refined levels of classification are present within these broadscale descriptions, such as vegetation associations (Groups of plants with similar structure and dominance) and plant communities (Groups of plants with constant structure, species dominance and floristic composition).

Astron assessed the distribution of vegetation on Barrow Island at the association level. This system produces association level subunits within the broad scale formation level mapping units used by Mattiske and Associates (1993).

The Mattiske mapping was performed largely through interpretation of aerial photography supported by field surveys to inform and "ground truth" this interpretation. The mapping describes the vegetation in units based on landform/soil types and dominant flora. The entire island was mapped at this level, as shown in Figure 6-5 of the ESE Review.

*EP228 Why is a reference made on p115 to the priority species *Corchorus interstans*, suggesting that it is widely found across the island, whereas the reference given relates to the Burrup Peninsula[r], where it does not occur?*

The Astron Environmental (2002) report that was included in Technical Appendix F of the ESE Review noted that this species has "widespread representation on Barrow Island". The reference on page 115 should have been to the Astron Environmental (2002) report that was included in Technical Appendix F, rather than the Astron Environmental (2002) report for the Burrup Peninsula that was included in the reference list of the ESE Review.

EP143 Does the proponent have a weed management strategy in place that includes the immediate removal of new weeds as soon as they are detected? If so, why have weeds such as buffel grass, kapok, sow thistle, spiked malvastrum and black berry nightshade not been eradicated?

ChevronTexaco has a management plan and response procedures to deal with the introduction and eradication of weeds. Initial detection of a new weed is treated as an incident that is immediately reported and investigated so that suitable corrective actions (control and monitoring) can be effected. Opportunities to detect weeds are many and include:

- regular, dedicated formal weed inspections of appropriate areas by qualified consultants/contractors (3-6 times per annum)

- inspections during general environmental audits by a qualified consultant (every eight months)
- informal inspections by environmental field staff (environmental specialist and technician) (bi-monthly)
- opportunistic sightings by visiting government environmental regulators, ChevronTexaco Perth-based environmental staff, environmental consultants (several times per annum)
- opportunistic sightings by permanent field personnel.

The program of integrated weed control, which includes prevention and eradication strategies, was recently developed further and formalised into a Weed Management Plan (WMP) in consultation with and the endorsement of the Department of Conservation and Land Management (CALM). The plan was prepared by suitably qualified, independent environmental consultants and prescribes a program for the early detection of new weed species; and for the control and monitoring of existing populations. Weed control efforts are prioritized through a risk assessment in accordance with the criteria outlined in the *Environmental Weed Strategy for Western Australia* (CALM 1999).

The existing populations of weeds on Barrow Island are known to be very restricted and are considered to be manageable to the extent that they are likely to be eradicated over the longer term. Persistent species such as buffel grass, sow thistle, spiked malvastrum and black berry have persisted as restricted infestations because of individual characteristics such as quantity and longevity of seed stock and artificial moisture sources. The weed management plan aims to improve knowledge about these characteristics so that control methods can be modified in a way that will achieve eradication at the earliest possible time.

Kapok was officially recorded on Barrow Island for the first time during 2002 as single plants on two separate occasions. In both cases, the plants were removed and destroyed. All seed stock was also collected and destroyed. Monitoring of both locations and adjacent drainage will continue over the next few years until there is complete confidence that it will not re-emerge.

EP224 Please provide information on the methodology used for monitoring the success (or otherwise) of vegetation rehabilitation, and the criteria used to determine the success of rehabilitation.

As part of its ongoing commitment to responsible environmental management of Barrow Island, ChevronTexaco is developing a Rehabilitation Management System. The "completion criteria", or success measures, of the system are being developed in consultation with the Department of Conservation and Land Management (CALM), Department of Industry and Resources (DoIR) and other qualified peers. The management system is comprised of site specific plans rather than generic rehabilitation plans. In mid-2002, a monitoring program was implemented to determine the progress of the rehabilitation of gravel pit sites on Barrow Island.

EP222 Why have the latest reports on vegetation rehabilitation not been presented? Why has annual or quarterly vegetation monitoring not been presented? What vegetation monitoring has been done?

Details of vegetation and flora surveys relevant to the proposed development of a gas processing facility on Barrow Island are presented in Technical Appendix F of the ESE Review.

Monitoring programs and expert opinion sought from experienced botanists about vegetation on Barrow Island indicate that rehabilitation has generally been successful. The botanists involved include Trudgen, Mattiske and Long. ChevronTexaco is also developing "completion criteria", which are commensurate with the environmental and social values of Barrow Island, and monitoring techniques that will quantitatively demonstrate rehabilitation progress. This work is being conducted with the involvement of the appropriate regulators (CALM and DoIR) and qualified peers.

Monitoring of rehabilitated land disturbed by ChevronTexaco (previously West Australia Petroleum) on Barrow Island has been carried out on a periodic basis since 1994. In 1994 and 1997, Mattiske Consulting Pty Ltd completed monitoring of seismic lines established in 1963, 1974, 1981, 1987, 1989 and 1994, while monitoring of gravel pits and other rehabilitated areas, such as gravel pits and landfills was first systematically carried out by Trudgen in 1989.

EP215 As the proponent has cited the 1989 Trudgeon report on its rehabilitation efforts on Barrow Island, does the proponent intend to make this report public? Why is this report not presented in the appendices to the ESE Review?

The report by Trudgen (1989) has been made available to all parties who requested it. This report is listed in the References section of the ESE Review (p. 296) along with all other cited references. The appendices of the ESE Review present study reports that were specifically commissioned under the ESE Review process.

7 Quarantine

7.1 Risk Assessment

EP367 The core question for quarantine is 'will best practice be good enough?' A quantitative analysis of the increased level of risk posed by the increased level of activity is required so that a judgment can be made on the acceptability of that level of risk, given the potentially extreme consequences for conservation. Recognising the increased scale and duration of the proposal, please can you supply an assessment, preferably using Quantitative Risk Assessment, or otherwise Qualitative Risk Assessment, or another appropriate methodology, of the risk of invasive species introduction, over the life of the project and the reasonable estimate of the extended duration of gas processing operations on Barrow? This should be based on know data about the quarantine breakdowns in the past with the existing level of oil field operations or using other relevant data. Any assumptions about the scale and effectiveness of quarantine measures that would be adopted should be clearly stated. The QRA should include the involvement of appropriate agencies and be subject to peer review.

The Gorgon Venture acknowledges the potential quarantine risk associated with the increased scale of activity associated with the proposed Gorgon gas development.

A quarantine program was first introduced on Barrow Island in the mid-1960s in acknowledgement of the world-class conservation values of the island. This quarantine program has set the benchmark for offshore island petroleum operations in Australia and overseas, and is recognised for its excellence in environmental management.

As operator of the existing oilfield and the proposed Gorgon gas development, ChevronTexaco views quarantine as paramount to the protection of Barrow Island's conservation values. The applied quarantine management, procedures, and restricted access have effectively prevented the establishment of invasive species on Barrow Island.

In order to maintain this quarantine record in the event the Gorgon gas development proceeds on Barrow Island, the Gorgon Venture would expand and enhance existing quarantine management procedures in order to control any increase in quarantine risk associated with the development.

ChevronTexaco, in its role as operator of both the Barrow Island oilfield and Gorgon gas development, would continue to provide overall management responsibility for operational activities on the island. This would include coordinating between the ventures on an enhanced quarantine program.

Ongoing success in quarantine management will require the continuous pursuit of improvements in reducing point of source risks, in increasing detection and eradication success and in integrating quarantine into every aspect of the proposed gas development.

The Gorgon Venture has prepared a preliminary qualitative and quantitative quarantine risk assessment specific to the Barrow Island proposal. This will be discussed with the appropriate government agencies.

7.2 Procedures

EP368 How will quarantine practice and enforcement be achieved on non-dedicated tankers? What fraction of the fleet, and hence what component of the risk, will be non-dedicated tankers?

The Gorgon Venture is not in a position to comment on the composition of the tanker fleet at this stage of the proposed development. Current LNG experience has shown that LNG tankers are predominately dedicated vessels that carry cargo between the loading terminal and the receipt terminal. Specific details on how non-dedicated tankers would be managed to meet the Gorgon quarantine objectives would be provided in a formal

environmental impact assessment process if in-principle approval is granted for the proposed development on Barrow Island.

EP369 How would the proponent ensure that quarantine is not breached through recontamination of a vessel following inspection/fumigation?

The potential for recontamination of vessels and equipment after inspection would be considered in the project execution plan. All vessels arriving from overseas would need to meet Australian and Barrow Island quarantine requirements before unloading any material at the island. All material coming to Barrow Island would be checked before landing on the island and if not clear, would be returned for treatment.

The ESE Review outlined current quarantine procedures implemented at Barrow Island. This was supported by Technical Appendix J "Barrow Island Environmental Quarantine Procedures", which detailed multi-stage interventions in the quarantine chain. This involves quarantine checks for goods initially on the mainland, in transit, and prior to set-down on Barrow Island. Part of the procedure is reinspection.

EP374 What level of containment and isolation of landings and operational areas is contemplated to provide a secure quarantine environment? What sort of barriers/ containment procedures are contemplated at high risk sites?

EP377 The dot point list of procedures at p130 appears to apply mainly to equipment and stores. How practical and effective would these or other measures be for ensuring the cleanliness of individuals, bulk fill and major prefabricated plant components for example?

The ESE Review provides an overview of the Barrow Island quarantine procedures associated with current oilfield operations. This is supported by Technical Appendix J "Barrow Island Environmental Quarantine Procedures", which includes details of containment and isolation practice.

The ESE Review provides strategic-level detail of proposed containment protocol at Barrow Island including double fencing of a sterile area (p.137), illustrated in the conceptual facility layout (Figure 5-2).

If the Gorgon gas development proceeds, an enhanced quarantine protocol, including specific containment and isolation practices, would be developed in collaboration with relevant stakeholders.

EP375 Does the proponent accept that it will be impossible to avoid environmental damage to Barrow Island with a peak workforce of 2200, no matter how stringent the quarantine regime may be?

EP376 Reference is made to "quarantine procedures... at the smallest practicable scale" at paragraph one, p128. Recognising that personnel movements represent a vast increase in vector movements over current operations, especially during construction and regular maintenance campaigns, how will this issue be effectively managed?

It has been demonstrated that it is possible to operate the largest onshore oilfield in Australia for the past 40 years while maintaining the conservation values of the island.

As demonstrated throughout the ESE Review, the Gorgon Venture is committed to maintaining the conservation values and biodiversity of Barrow Island. In keeping with this position, the ESE Review demonstrates at a strategic level that any environmental impacts associated with the proposed Gorgon gas development can be managed in a manner that does not compromise the conservation or biodiversity values of the island.

The Gorgon Venture recognises the potential quarantine risk associated with the scale of activity that would result from the proposed development. The Gorgon Venture has prepared a preliminary qualitative and quantitative quarantine risk assessment specific to

the Barrow Island proposal. This will be discussed with the appropriate government agencies. The outcomes of this risk assessment are intended to assist in the design of a Gorgon-sponsored quarantine program, which would be prepared in consultation with relevant stakeholders.

EP381 Has the proponent incorporated its quarantine objectives into specific performance targets and procedures that ensure early detection, identification and control of the invasives that have some risk of entry to the island?

As operator of the existing Barrow Island oilfield, ChevronTexaco maintains an effective level of quarantine protection by focusing quarantine efforts on managing pathways of introduction. Such methods include the early detection and control of potentially invasive species at points of entry.

If the proposed Gorgon gas development proceeds, the Gorgon Venture would develop an enhanced quarantine program that builds upon the existing ChevronTexaco quarantine practices and include specific performance targets and procedures to ensure early detection identification and control of invasive species.

EP383 Would the proponent commit to the development of a protocol for the monitoring of particular marine habitats and species at risk of marine pest incursions, together with contingency guidelines, in conjunction with appropriate Government agencies?

The Gorgon Venture would commit to the development of protocol for the monitoring of particular marine habitats and species at risk of marine pest incursions, together with contingency guidelines. These measures would be developed in consultation with appropriate government agencies.

EP384 Would the proponent adhere to the AQIS guidelines during both the construction and operational phases of the proposed development?

The Gorgon Venture would fully comply with AQIS guidelines during the construction and operation phases of the proposed development of a gas processing facility on Barrow Island.

EP387 Does the proponent have a programme in place to monitor for rats and mice, given that these have been unintentionally introduced to Barrow Island in the past?

The ESE Review outlined details of current quarantine procedures relevant to Barrow Island. This was supported by Technical Appendix J "Barrow Island Environmental Quarantine Procedures". This involves a monitoring program which is subject to regular audit and review. In recent years, the presence of rats or mice on Barrow Island has not been detected.

EP388 How would the proponent prevent mice moving onto barges at Thevenard Island and reaching Barrow Island?

No barges travel directly from Thevenard Island to Barrow Island. All material for Barrow Island must clear quarantine in Dampier before transport to the island. Barges are checked for vermin before leaving for Barrow Island.

EP389 How are major quarantine issues such as the massive import of fill and construction materials, or modules from overseas, to be managed, since the proposed quarantine management plan is an expansion of procedures already in place which do not address these issues?

The Gorgon Venture acknowledges the potential challenge to quarantine integrity associated with the increased activity and change in nature of activities, although not to potential introduction pathways, on Barrow Island if the development proceeds. In response to this matter, the ESE Review lists a number of additional quarantine procedures

that have been earmarked for implementation. It is envisaged that these and other procedures would be captured in the context of a Gorgon-sponsored quarantine protocol, which would improve quarantine scope and reduce the level of quarantine risk.

In the past, fill and large amounts of construction material have been brought onto Barrow Island under the ChevronTexaco quarantine plan without incident.

EP390 Please comment on the likely effectiveness of the proposed fencing as a quarantine procedure, given that the site is subject to large tides and cyclonic winds, and that fencing cannot prevent some species (e.g. ants) from spreading.

The ESE Review provides strategic-level detail of the proposed quarantine area at Barrow Island. This includes the proximate layout (Figure 5-2), and description of a double-fenced sterile area (p. 137). This was anticipated to provide a sterile area near the MOF that final checks could be made before release onto the site.

More detailed design issues, such as fencing type, strength and durability, and species containment features, would be developed in consultation with the relevant experts at a more appropriate stage in the development process.

EP391 Why has the proposal in Section 5, p 65 to establish a quarantine area on Barrow Island not been discussed further in Section 7: Quarantine Management?

The proposed Barrow Island quarantine area is discussed in Section 5 of the ESE Review, and referred to in Section 7 as a double-fenced sterile area designated as a "quarantine area" (p. 137, 7th dot point in the right-hand column).

EP392 Please comment on the suggestion that a quarantine area on the island would be inappropriate, since quarantine management procedures must ensure that all material is "clean" before arrival on the island. How would the proponent achieve this?

All quarantine control is performed prior to goods arriving on Barrow Island. The Gorgon Venture is not proposing that Barrow Island be the primary quarantine control location for the proposed development for Gorgon gas.

The proposed quarantine area on Barrow Island forms an additional level of protection and checking location. It is one component of a multi-faceted quarantine chain. This includes quarantine interventions at the source, departure point, in transit, and checking at the Barrow Island access point (Figure 7-2, p. 129). This is deliberately intended to provide an unsurpassed level of quarantine protection and minimise any residual quarantine risk.

EP393 Why has the requirement for the involvement of AQIS in the inspection of cargoes arriving directly from overseas ports not been mentioned?

If the proposed development on Barrow Island proceeds, the Gorgon Venture would work with the Australian Quarantine Inspection Service (AQIS) and other relevant agencies to assess and manage the specific risks associated with internationally-sourced cargoes to ensure that the level of quarantine protection is not compromised. The Gorgon Venture would fully comply with the requirements of AQIS in such matters.

EP394 Would the proponent engage an independent team of dedicated staff to audit and monitor the quarantine management plan in a transparent and consultative fashion, which is empowered to stop any operation when the risk of quarantine breach is high, and which is highly trained in all aspects of quarantine management?

The ESE Review provides a strategic level overview of quarantine management and potential elements of an enhanced quarantine protocol that would be implemented if the proposed Gorgon gas development proceeds.

Allocation of responsibilities, resources, training and system audits form core components of the current ChevronTexaco quarantine program. Such practices would be carried over to any Gorgon-sponsored quarantine program. The exact nature and design of such a quarantine protocol and the resources required for its successful implementation would be determined in consultation with various agencies at a later stage of any development process.

EP395 Does the proponent intend to develop a new quarantine management plan appropriate to the proposed activities, and which is based upon the results of a quantitative quarantine risk assessment, rather than being an extension of previous plans?

ChevronTexaco, the operator of both the Gorgon Venture and the Barrow Island oilfield would utilise the years of quarantine experience accumulated as the basis of the future quarantine plan. The experience spans some three decades. In addition the operator would utilise the results of the quantitative and qualitative quarantine risk assessment to enhance the existing procedures as part of the new quarantine management plan.

EP399 Why has there been no presentation of the measures that would be put in place to ensure that the construction workforce is fully aware of Barrow Island's quarantine procedures?

EP400 Has the proponent developed a programme for the long-term training of the construction workforce?

The ESE Review provides a strategic overview of additional quarantine practices that could be adopted for the proposed development of a gas processing facility on Barrow Island. ChevronTexaco currently requires all staff and contractors travelling to Barrow Island to undertake an induction program that includes quarantine-specific training. If the proposed development proceeds, appropriate, detailed education and induction programmes would be developed.

The Gorgon Venture recognises the need for ongoing education in the workplace. In addition to proposed induction training specific to Barrow Island, the Gorgon Venture would require all staff and contractors to maintain appropriate levels of awareness and competency facilitated through routine re-training.

EP401 On the issue of invasive species being translocated in ballast water, are there any examples of stringent control (best practice) which have effectively prevented any introductions over an extended period at the level of shipping tonnages contemplated for this project?

If the proposed development on Barrow Island proceeds, the Gorgon Venture intends to fully comply with AQIS guidelines during the construction and operation phases of the development. Furthermore, the Gorgon Venture would aim to apply international best practice and, where appropriate, exceed AQIS requirements in order to ensure a higher level of marine protection at and near Barrow Island – particularly with regard to ballast water management.

The ESE Review provides an overview of the proposed management of ballast water at the strategic level. Specific details with regards to ballast water management and expected levels of shipping tonnages can only be provided at a more advanced stage of any approval or development process.

EP402 What are the realistic prospects of managing an invasive marine species, should one be introduced? Do examples of such management exist in an open water environment similar to that at Barrow Island?

Australian authorities, including AQIS, have experience in the control of invasive marine species. The Gorgon Venture would work with them to develop contingency plans in the unlikely event of such an introduction.

7.3 Invasive Species

EP373 What evidence was used to support the statement in the third paragraph on p113 that the risk of invasive species introduction "is manageable" recognising the much increased scale of construction, routine operations, regular campaign maintenance and ongoing construction (over up to 15 years) of the current proposal and the reasonable estimate of the extended duration of gas processing on Barrow?

EP382 Upon what is the proponent basing the claim that the risk from invasive species is manageable, apart from the good record of much smaller operations on Barrow Island to date?

The Gorgon Venture acknowledges the potential for an increase in quarantine risk associated with the increased scale of activity associated with the proposed Gorgon gas development. ChevronTexaco believes that this risk is manageable based on some 40 years experience of successfully managing these risks, recognition at all levels of management that quarantine is a critical issue, and the commitment to assigning the necessary responsibility and resources to ensure the quarantine objectives are met.

EP378 It is noted that weeds have established on Barrow (and elsewhere on offshore Pilbara islands), and have not been eradicated, despite past quarantine measures. What level of risk is assumed for the further introduction or increased spread of existing infestations of eg. Buffel Grass given the scale of disturbance and importation of fill contemplated for this proposal? How was this calculated?

EP385 How would the proponent control the potential introduction of weeds to Barrow Island through the importation of fill and other activities?

The ESE Review acknowledges breaches of quarantine have occurred over the 40-year period of oil operations on Barrow Island. This is referenced by the recorded presence of specific weeds on the island. However, current quarantine procedures such as monitoring and eradication have successfully contained the presence and distribution of such weeds to very restricted locations in disturbed areas on the island.

The risk of weed introduction has been assessed. In recognition of the increased weed risk on Barrow Island associated with the proposed development, the Gorgon Venture would expand the prevention, monitoring and eradication programs on Barrow Island to facilitate control of any increased weed presence.

EP379 How extensive and where are existing infestations of the environmental weeds listed in Box 7-1? What is the risk that these could be disturbed and further spread by activities associated with the proposal?

The ESE Review specifically acknowledges the recorded presence of twelve weed species on Barrow Island over the 40-year period of oilfield operations. These twelve species comprise four deliberately introduced (with permission) and eight environmental weed species. The eight environmental weed species have highly restricted distributions on the island, often consisting of only a small number of plants. Each of these species is subject to an intensive monitoring and eradication program.

EP380 How can the proponent support its claim that, based on Wapet's record to date, quarantine can be effectively managed without breaches when the proposed development will be significantly larger than the existing operations and Wapet's record has been less than perfect in any case, as evidenced by the outbreak of buffel grass on the south end of Barrow Island and the presence of other weeds such as kapok, sow thistle, spiked malvastrum and black berry nightshade?

The ESE Review acknowledges a small number of breaches of quarantine over the 40-year period of oil operations on Barrow Island. This is referenced by the recorded presence of

specific weeds and the isolated detection of invasive fauna (that have been eradicated) on the island.

During 2001 a Weed Management Plan (WMP) was developed to formalise and improve management measures previously adopted by ChevronTexaco, in consultation and with the endorsement of CALM. The plan was prepared by suitably qualified independent environmental consultants and prescribes a program for the early detection of any new weed species; and for the control and monitoring of existing populations, using a risk-based approach. The existing populations are known to be very restricted and are considered to be manageable to the extent that they are likely to be eradicated over the longer term.

The success of control efforts has been variable and is expected to improve. There is at least one example of a newly detected species (double gee) that was successfully controlled within hours and this has been confirmed by monitoring over subsequent years. Other species, such as those mentioned (with the exception of kapok), have persisted as restricted (mostly extremely-so) infestations because of individual characteristics that support this, such as quantity and longevity of seed stock and artificial moisture sources. The weed management plan aims to improve the knowledge of these characteristics so that control methods can be modified accordingly in order to achieve eradication at the earliest possible time.

Kapok was officially recorded on Barrow Island for the first time during 2002 as single plants on two separate occasions. In both cases the plants were removed, destroyed and all seed stock collected and destroyed also. Monitoring of both locations and adjacent drainage will continue over the next few years until there is complete confidence that it will not re-emerge.

EP386 Why have no surveys of Barrow Island for the invasion of ants been conducted, when ants have caused significant environmental impacts where they have been introduced (eg Christmas Island), and there is a real threat that invasive invertebrate species that are difficult to detect could become introduced to Barrow Island and become established?

Dr CN Smithers conducted an insect inventory on Barrow Island and nearby islands in 1982. Since that time, the presence of invasive ants has not been recorded to date either in anecdotal or actual records.

The threat of incursion by invertebrate species on Barrow Island is acknowledged at the strategic level within the ESE Review. If the Gorgon gas development proceeds, a more comprehensive invertebrate inventory would be compiled, and an enhanced quarantine monitoring protocol would be implemented at all stages of the development to include detection of invertebrates as an invasive species.

7.4 Diseases

EP370 Does a list of invasive species with risk potential exist for Barrow Island?

The existing oil operation on Barrow Island has focused its quarantine efforts on identifying pathways for invasive species to get to Barrow Island. A list of invasive species with risk potential specific to the island would be useful, but the objective of current quarantine procedures is to prevent accidental introductions to the island of all non-native flora and fauna species. A list of species with invasive and colonisation potential for Barrow Island would be prepared if the proposed development for Gorgon gas proceeds. This list would contribute to an enhanced quarantine protocol.

EP372 How can it be demonstrated that the routine quarantine procedures developed to deal with normal oil field operations will cope with the scale, pressure, urgency, and diversity of contractors encountered during construction and repeated, large scale maintenance campaigns?

The Gorgon Venture acknowledges the potential for increased quarantine risk associated with the increased scale of activity associated with the proposed Gorgon gas development. If the development proceeds, the Gorgon Venture would develop a significantly enhanced quarantine program in consultation with all relevant stakeholders.

The ESE Review provides a strategic overview of additional quarantine practices that could be adopted for the Gorgon gas development. These include quarantine positions in construction organisations, and quarantine-related contractual requirements which may be linked to overall performance within workforce contracts.

The Gorgon Venture also recognises the unique risk to quarantine standards presented by the itinerant nature of a contractor workforce. To address this matter, rigorous quarantine education and performance standards will be tailored to align demands characteristic of such a workforce.

EP396 What ongoing research is being undertaken to examine how mainland diseases can be prevented from arriving on the island?

The Gorgon Venture intends to manage quarantine primarily through the stringent control of entry pathways to Barrow Island which would mitigate the risk of entry of any animal or vegetative matter, and by extension, any associated disease or pathogen.

If the proposed development for Barrow Island receives in-principle approval, the Gorgon Venture would design an enhanced quarantine protocol which would address issues related to the risk of introduction of mainland diseases. Such a protocol would be prepared in consultation with relevant stakeholders, and would reference necessary research regarding mainland diseases.

EP397 What recent improvements have been made to quarantine procedures on Barrow Island to ensure that diseases prevalent on the mainland do not arrive on the island?

Recent improvement to quarantine procedures aimed at preventing the introduction of disease onto the island include the prevention of any animal or plants being returned to the island (for example an injured euro or herbarium specimens from the mainland), or animal traps used in monitoring or research programmes.

EP398 Why has the proponent failed to quantify the risk of disease?

The Gorgon Venture has not specifically quantified the risk of disease although it has been considered in the existing quarantine plan. If the proposed development proceeds, the Gorgon Venture intends to manage quarantine primarily through the stringent control of entry pathways to Barrow Island which would mitigate the risk of entry of any animal or vegetative matter, and by extension, any associated disease or pathogen. The Gorgon Venture has prepared a preliminary qualitative and quantitative quarantine risk assessment specific to the Barrow Island proposal. This will be discussed with the appropriate government agencies.

8 Greenhouse

8.1 Gorgon Venture Response to Climate Change

EP305 Does the proponent consider that the widespread application of CO₂ sequestration will inhibit investments in renewable energy technologies? Please comment on the suggestion that any research and development spending on geosequestration should be matched by equivalent spending on renewable energy systems.

Fossil fuels continue to be the prime source of energy for the growing population and growing energy needs of the world. Renewable energy currently provides about eight percent of global energy needs, and most of this is hydroelectric power. As a company dedicated to supplying the world's current and future energy needs, ChevronTexaco see the ongoing need to continue to produce fossil fuels in an economical and environmentally and socially responsible manner.

At the same time, ChevronTexaco has made well over \$170 million in long-term, strategic investments in the development of renewable energy and other advanced energy technologies to further commercialise many of these technologies. Technologies that have been invested in include advanced battery manufacturing for hybrid gasoline-electric vehicles, solid hydrogen storage development, fuel cell commercialisation, flexible panel photovoltaic commercialisation, and the further commercialisation of wind power.

ChevronTexaco's vision in pursuing CO₂ sequestration in geologic formations together with other advanced energy technologies that are being developed and commercialised to ensure that a portfolio of energy sources will be developed for the future. An important component of this portfolio will be to demonstrate yet another way that fossil fuels can continue to serve an important role to supply the energy that the world needs while emissions of associated greenhouse gases are significantly reduced.

EP310 Why has the proponent not addressed the strategic implications of Western Australia hosting yet another massive greenhouse point source in an age of climate change, carbon taxation and potential economic sanctions?

EP341 It is suggested that increases of 0.7% (Australia with re-injection), 1.6% (Australia without re-injection), 7.7% (WA with re-injection) and 19% (WA without re-injection) cannot be sustained in the face of a world trying to cope with global climate change and a country that will eventually have to sign up to the Kyoto Agreement? Please comment.

EP346 Does the proponent agree that Figure 8-4 makes an excellent case for not proceeding with the development since improvements in greenhouse gas reductions are at about 10% per year and these technical improvements are difficult to incorporate - according to the proponent's document - into existing plant?

EP347 Does the proponent agree that not implementing the project at all would potentially avoid over eight million tonnes of CO₂ emissions per annum?

The Gorgon Venture recognises the concerns about climate change and the impact of increasing greenhouse gas emissions and has committed to implement measures which go beyond those of similar projects to reduce its greenhouse emissions, such as reservoir CO₂ re-injection. As a result, the Gorgon development is estimated to emit only 3.3 million tonnes of CO₂ emissions per annum, not over eight million tonnes of CO₂ emissions per annum as suggested above.

World demand for energy continues to increase and this needs to be met. CSIRO studies have shown that development of Gorgon gas can help meet these energy needs while producing a significant reduction in global greenhouse emissions, based on a full life cycle analysis of electric power generation. (ESE Figure 8-1, p150),

The Gorgon Venture believes that the use of natural gas as an energy source is the best current solution to provide a large scale source of energy. Natural gas is relatively clean burning and has the lowest life-cycle greenhouse gas emissions of any fossil fuel. It facilitates the use of more energy efficiency power generation systems such as fuel cells.

The Western Australian government has acknowledged the greenhouse benefits of natural gas as demonstrated in the *Western Australia and Greenhouse Issue Paper* (2002):

Strategically, Western Australia should expand the use of its natural gas resources and make them available to the rest of the world, while still meeting our greenhouse gas responsibilities. If we are able to do this we will be able to contribute to lower global greenhouse gas emissions by:

- *displacing other more greenhouse intensive fuels, such as coal or petroleum, in Australia and overseas countries; and*
- *using the resources in Western Australia to produce goods or materials using cleaner and more environmentally friendly technologies that are used overseas.*

If the Gorgon gas development does not proceed, Australia would lose the substantial economic benefits that would be gained from development of its abundant gas reserves for local industry and the export of LNG. However as the requirement for energy would still exist, either another LNG facility would be constructed elsewhere (most likely in Asia in a country without any greenhouse gas emission targets) or alternatively the energy would be sourced from either coal or oil. It is likely that if the Gorgon development did not proceed, global greenhouse emissions would be larger than if the development proceeds as described in the ESE Review.

EP311 How would the project economics survive a Kyoto carbon trading regime and/or a range of potential carbon tax models?

Due to the emphasis placed on process efficiency and greenhouse gas emission abatement, the development is likely to be in a better position than many gas projects in the world if some form of carbon tax was applied consistently. Currently, no carbon tax has been contemplated by the Gorgon Venture. Such a carbon tax could make the development uncompetitive with energy suppliers from countries without Kyoto commitments, without special consideration from government.

EP313 What is the proponent's position with respect to the Kyoto Protocol?

EP326 Why is there no discussion on the implications of the project in the context of the potential implications of the Kyoto protocol?

EP327 In indicating its support for "the development and use of international mechanisms such as Emissions Trading", why does the proponent not extend this to identify the existing international protocols that enable emissions trading, specifically the Kyoto Protocol?

ChevronTexaco recognise the increasing public and government concerns about global climate change and integrates these concerns into business decisions. ChevronTexaco support flexible and economically sound policies and mechanisms that protect the environment such as Emissions Trading, Clean Development Mechanism and Joint Implementation, which provide flexible, market-based, economically sound means to reduce emissions.

The Gorgon Venture recognises Australia's commitments to honour its international greenhouse obligations and fully supports the joint measures identified in the LNG Action Agenda to control greenhouse emissions while maintaining the competitiveness of Australian industry.

EP337 Please comment on the suggestion that if the proposal were to go ahead, making the proponent a significant contributor to climate change, it should pay a substantial amount towards biodiversity climate change adaptation, the need for which will be furthered by the additional emissions the Gorgon field will result in, before it proceeds with this proposal.

The Gorgon development should contribute to net global reductions in greenhouse gas emissions. The Australian emissions should be more than offset by global reductions due to displacement of higher carbon fuels by natural gas. (See ESE Review, p.150, Figure 8-1) The development also plans to advance greenhouse gas abatement through development of highly efficient LNG facilities and the implementation of reservoir CO₂ re-injection. Thus, the development will provide a positive contribution to global concerns over greenhouse gas emissions.

The basis of concern over climate change is that anthropogenic emissions of greenhouse gases could be causing an increase in global temperatures. Human activities are believed to be generating sufficient additional greenhouse gases to change the climate. The primary cause of increased greenhouse gas emissions is the demand for energy, and land by society as whole. Therefore society as a whole, as the consumers and generators of energy, will need to contribute to climate change adaptation costs.

The Gorgon development could be jeopardised by additional cost burdens that competing developments worldwide do not face, (such as the suggested biodiversity fee) If the development does not proceed, Australia would lose the substantial economic benefits that would be gained from development of its abundant gas reserves for local industry and the export of LNG. However as the requirement for energy would still exist, either another, less efficient LNG facility (with no CO₂ re-injection) would be constructed elsewhere (most likely in Asia in a country without any greenhouse gas emission targets) or alternatively the energy would be sourced from either coal or oil. It is likely that if the Gorgon development did not proceed, global greenhouse emissions would be larger than if the development proceeds as described in the ESE Review.

EP339 Why has the proponent failed to refer to the WA Parliament tabled paper "Greenhouse measure scenarios for Western Australia" or to put its potential emissions in the context of Western Australia's greenhouse emissions?

Table 8-3 (ESE Review, p159) presents the expected emissions of the Gorgon gas development relative to Western Australia's 1990 emissions and 1995 emissions.

'Greenhouse measure scenarios for Western Australia' (Tabled Paper 630, Legislative Council, 11 December 2002) is a one page excerpt tabled by the Honourable Robin Chapple MLC. The source of the excerpt is unknown (Hon Robin Chapple, Legislative Council Hansard, 11 December 2002).

Without a known source for the data or an understanding of the contents of the remainder of the document the Gorgon Venture considers it inappropriate to utilise this paper for the ESE Review.

EP342 Why has the proponent made no reference to the Brazil proposal for equitable greenhouse accounting (refer to CSIRO Atmospheric Research Technical Paper No. 41)?

The Brazil proposal is not applicable or relevant to the strategic assessment on the restricted use of Barrow Island for the Gorgon gas development. The Brazil proposal sought to develop emission targets for countries based on their past contribution to greenhouse emissions and therefore it is not relevant to an individual development proposal.

EP344 Figure 8-1 shows that the combustion of LNG for power generation (or other uses) is the largest contributor to the total life-cycle greenhouse impact. Does the proponent not consider that financial resources may, on environmental grounds, be more efficiently utilised by promoting decreased power usage?

The Gorgon Venture considers increasing energy efficiency as an important part of its four-fold plan of action in response to climate change, (ESE Review, p145, Box 8-3) and believes Governments and industry can do more to emphasise energy conservation and efficiency. A number of ChevronTexaco's activities, as operator of the Gorgon gas development, (see ESE Review, p146, Box 8-4) are targeted at improving energy efficiency, including the formation of Chevron Energy Solutions to provide services to commercial and industrial customers.

Meeting the energy and electrical power needs of the growing economies of Australia and other Pacific Basin countries will require both improved efficiency and new energy supplies. While the Gorgon Venture may not be able to influence the growth in demand for electricity in these nations, it can ensure that its own gas supply operations are efficient and actively promote fuel switching to natural gas and LNG. Work conducted by the CSIRO for the Gorgon Venture demonstrated that coal produces approximately 84% more greenhouse emission than LNG for a given electrical power demand (see ESE Review, p.150, Figure 8-1)

It is widely acknowledged that increasing the portion of energy sourced from natural gas relative to coal and oil can contribute to a reduction in national greenhouse gas emissions. For example, in the United Kingdom the increased use of gas has been largely credited with a 29 per cent reduction in emissions, despite a 16 per cent increase in electricity use (Department for Environment, Food and Rural Affairs 2001). If the UK's 1990 rate of greenhouse emissions had been maintained, greenhouse emissions would be approximately 63 per cent more than the reported 1999 emissions.

With respect to the Gorgon development LNG facility itself, design improvements and the commitment to reinject reservoir CO₂ have reduced greenhouse emissions by approximately 74 per cent from the initial 1995 design (see Figure 8-4, p160, ESE Review).

EP345 Why will the proponent not reduce greenhouse gas emissions from existing projects as part of its "good corporate citizenship", rather than making this commitment only through the Gorgon ESE process?

ChevronTexaco, as operator of the Gorgon gas development and other facilities around the world is continuously looking at ways to reduce emissions from all of its operations. A number of initiatives to reduce greenhouse emissions were underway before the Gorgon ESE Review process began (see ESE Review, pp146-147, Box 8-4 and Box 8-5)

The existing Barrow Island oil operation has identified and implemented greenhouse gas emission reduction actions as part of the Greenhouse Challenge voluntary program. For example, the electrification of gas lift wells and centralisation and upgrade of the separator stations have both led to reduced greenhouse gas emissions.

Developing a gas processing facility on Barrow Island for the Gorgon gas development will provide additional opportunities to reduce emissions that would not otherwise be available. For example, the gas processing facility would enable the use of the previously wasted flared gas. Another potential option would be to rationalise the power supply on the island, enabling the utilisation of the large efficient gas turbines in the gas processing facility to supply the Island's power.

8.2 Greenhouse Gas Management

EP321 What forms of gas turbines would be utilised for power production and motive power (combined cycle gas turbines or cogeneration)?

EP324 Has the proponent considered using waste heat from power generation for desalination?

The Gorgon Venture is committed to incorporating the best current practices in thermal efficiency and greenhouse emission control where practicable and plans to use high efficiency gas turbines with integrated heat recovery to improve overall energy efficiency. (See ESE Review, pp.152-155, Section 8.4.2). Concept selection for power generation is still in progress; both combined cycle generation and cogeneration may be considered. The current reference case is based on recovering turbine exhaust heat for use elsewhere in the process (i.e. in the acid gas removal system). While the use of recovered heat for desalination has not yet been considered, the development is still in the conceptual design phase, therefore this level of detail will be considered at a later stage in the design and environmental approval processes. The final selection will depend on the heat and power balance of the plant design; however, greenhouse emissions will be a significant criterion.

EP322 What are the total power requirements (motive and electric including standby) of the proposal?

As outlined in the ESE Review, the conceptual development is based on a reference case of a 10 MTPA LNG development with a 300 TJ/d domestic gas supply. This reference case would require in the order of 600 MW of installed power (motive and electric). A more detailed description of the facilities including power requirements will be included in development-specific Environmental Impact Assessment.

EP323 Has the proponent considered renewable energy sources, given Barrow island's high solar gain and probable adequate wind source? If so, has the proponent considered using any excess generated power for desalination?

The intent of the ESE Review was to provide a strategic assessment of the issues that would impact the acceptability of the restricted use of Barrow Island for a gas processing facility. Given that it is not realistic for renewable energy to be utilised as the primary power source for the gas processing facility, this issue has not been considered at this stage in the process.

EP325 Has the proponent considered developing carbon dioxide emissions offsets through vegetation, which has the potential to deliver associated regional economic, social and environmental benefits, and which has clear international recognition?

Use of carbon sequestration options such as forestry and revegetation will be considered as part of the Gorgon greenhouse gas management plan and the contingency plan for reservoir CO₂ re-injection. As detailed in the ESE Review a trial pine plantation is already underway to increase the Venture's understanding and familiarity of forestry issues. However, the Gorgon Venture's focus for greenhouse emission reduction is to concentrate on plant design and CO₂ re-injection where there is greater certainty and control of the benefits and costs.

EP328 Please comment on the suggestion that sequestration into saline aquifers has the lowest storage efficiency of the geological sinks, perhaps as low as 2% of the pore volume, due to unstable displacement fronts and the effects of buoyancy resulting in only the uppermost part of the aquifer being filled at significant distances from the injection well.

The Dupuy reservoir has more than adequate capacity to sequester the reservoir CO₂ from the proposed Gorgon gas development. Computer simulation studies indicate the CO₂ will gradually move southward from the injection wells but it would take thousands of years for it to move the 15 km distance to the crest of the formation.

The suggestion on storage efficiency has been widely quoted in published work on CO₂ sequestration. It is widely recognised (for example by GEODISC published work) that in the proposed use of saline reservoirs to sequester large volumes of CO₂, that the low storage efficiency is offset by the much larger size offered by saline formations. One reference to the 2% 'rule of thumb' is from the paper "CO₂ Storage in the Subsurface" presented by L.G.H. Van der Meer at the 6th International conference of Greenhouse Gas Control Technologies (GHGT6), held in Kyoto, Japan in November 2002. Van der Meer states: "As a Rule of thumb, a maximum of 2% of the total effective pore volume can be made for CO₂ storage by injecting CO₂ at a substantial pressure". He made this statement after conducting computer simulation model studies which assumed worst-case scenarios by ignoring CO₂ dissolution and relative permeability trapping mechanisms. For the proposed use of the Dupuy it is anticipated that injected CO₂ volumes to be significantly under 0.5% of the reservoir volume.

EP348 Why has the proponent not suggested local employment as a greenhouse reduction strategy?

Although the Gorgon Venture would seek to employ a workforce sourced largely from Western Australia, including regional areas, a workforce and their families living on Barrow Island would be unsustainable. Greenhouse advantages from employing a larger Pilbara-based workforce would be negligible.

8.3 Expected Emissions

EP249 By what fraction would CO₂ emissions rise if offshore processing was undertaken? Is this amount significant at the scale of the proposal?

Approval for limited use of Barrow Island would avoid the need for an offshore platform and therefore eliminate it as an emission source (See ESE Review, pp158-160, Section 8.6.

The quantity of emission from an offshore platform is dependent on what level of processing and facilities are required. This is determined by many factors, including the location of the main processing facility, and selection of pipeline materials which determines the requirements for compression or dehydration.

In earlier Gorgon development concepts, offshore platform greenhouse emissions related to an 8 MTPA LNG facility were approximately 0.6 million tonnes of CO₂e with offshore dehydration and compression and 0.1 million tonnes of CO₂e without compression. After correcting for the Reference Case production rate of 10 MTPA of LNG, offshore processing could increase the currently estimated greenhouse emissions by between 4 per cent and 22 per cent.

If CO₂ removal was also completed offshore the offshore emissions estimates would increase significantly and the energy efficiency benefits of integration with the remainder of the LNG facility could be lost.

EP266 Please demonstrate the derivation of the figure of 87% for combustion as the largest contributor to life-cycle greenhouse impact for LNG.

CSIRO studies conducted for the Gorgon gas development indicate that if 10 million tonnes of LNG was combusted for power generation (e.g. in Japan, China or South Korea), approximately 28 million tonnes of CO₂e would be produced. The emissions from LNG production and transportation are less than 4 million tonnes for this quantity of LNG. Total life cycle emissions are thus about 32 million tonnes of CO₂ with 28 million tonnes of CO₂ or 87% due to combustion by the end user. This information was graphically presented as Figure 8-1 in ESE Review.

EP267 Based on the figures in Table 8-1, please provide calculations of the percentages of CO₂ emitted, emissions avoided due to re-injection and emitted during combustion over the total life-cycle of LNG production and use.

This information is presented as Figure 8-1 (p150) in the ESE document and presented in the table below.

	Percentage
CO ₂ emitted during production and transport	13%
Emissions avoided due to re-injection	(13%)
Emission from power generation (eg in Japan, China or South Korea)	87%
Total Life-cycle Greenhouse Emissions	100%

EP268 Is the APPEA emission estimate methodology consistent with AGO methodology?

Yes – the Australian Greenhouse Office utilise APPEA data and methodology to compile the Australian inventory.

EP269 What is the prospective amount of gas that might be fed to the gas complex from oil field operations? Is this significant in the scale of the gas complex? What are the environmental (as opposed to economic) advantages of being able to produce high gas-oil ratio[n] wells which are not now in production?

The quantity of gas that could be supplied from the existing oil field is relatively small compared to the total volume supplied to the gas processing fields from the Gorgon fields. However it will allow the use of a previously wasted 'uneconomic' resource and largely eliminate flaring on Barrow Island. The production of high gas-oil ratio wells will improve the utilisation of the Barrow Island reserves by increasing oil productivity and returns to the State without the requirement to build new oil infrastructure. This would mean the increased oil and gas production would have a negligible increase in the environmental impact, a significant increase in resource utilisation and decreased waste generation (i.e., flaring).

EP270 Does the proponent intend in the future to explore the feasibility of capturing CO₂ from exhaust gases?

It is currently considered infeasible to capture the low concentration of CO₂ from exhaust gases. Further research and development is required to reduce the cost and increase the reliability of these CO₂ 'capture' technologies.

ChevronTexaco is committing substantial funds to research and development of technologies for the capture of CO₂ from exhaust gases. Funding and technical expertise is being supplied to the capture programs of the CO₂CRC (Australia) and the CO₂ Capture Project (International) (ESE Review, p146, Box 8-4), as well as to related joint industry projects and technology field tests through the Gas Technology Institute (USA).

EP292 How much CO₂ would be expected to be emitted during maintenance of the injection system? Has this amount been included in the 3.2mtpa figure for emissions?

Where practicable, maintenance of the re-injection system will be scheduled co-currently with the LNG facility to minimise atmospheric emissions. The estimated greenhouse emissions in Table 8-1 (ESE Review, p157) includes an allowance for plant shutdowns and maintenance of the re-injection system.

EP309 Please provide a rigorous carbon budget for different project configurations and provide a number of scenarios based upon realistic estimates of growth potential of the project.

The estimated CO₂ emissions over a 30 year period are presented in Figure 8-3 (ESE Review, p. 158). The scenario represented in this figure is based on a 10 MTPA LNG facility and a 300 TJ/day domestic gas facility, with production ramped up over 5 years. This was selected for the ESE Review as it represented the most likely scenario based on the current understanding of realistic market opportunities.

If further market opportunities are identified there are sufficient reserves in the Greater Gorgon field area to support additional developments. These could be either on Barrow Island, within the identified 300 ha, or on the mainland. The timing, size, or process/technology for any future development is yet to be defined and was therefore not included in the projected emissions. If an expansion on Barrow Island was to occur, it would most likely be an expansion of the foundation development. For example, if the LNG facility was doubled in capacity to 20 MTPA, the total greenhouse emissions would be expected to be less than double which would be less than 6.6 million tonnes per annum. Given that any such expansion is likely to occur in the future, actual emissions could reasonably be expected to be less than this due to technological improvements.

EP312 Can the proponent demonstrate that this project contributes to a global 60-90% reduction in net greenhouse gas emissions, as called for by the Intergovernmental Panel on Climate Change, within a reasonable time frame?

EP314 Does the proponent have a greenhouse emissions reduction target plan for the development, to work towards emissions reductions of the order of magnitude required (say 80%) and which includes the full product lifecycle carbon footprint of the companies involved?

It is widely acknowledged that increasing the portion of energy sourced from natural gas relative to coal and oil can contribute to a reduction in greenhouse gas emissions. For example, in the United Kingdom the increased use of gas has been largely credited with a 29 per cent reduction in emissions, despite a 16 per cent increase in electricity use (Department for Environment, Food and Rural Affairs 2001). If the UK's 1990 rate of greenhouse emissions had been maintained, greenhouse emissions would be approximately 63 per cent more than the reported 1999 emissions.

Work conducted by the CSIRO for the Gorgon Venture demonstrated that coal produces approximately 84% more greenhouse emission than LNG for a given power demand, when the full life cycle carbon emissions are considered.

With respect to LNG facility, design improvements and the commitment to reinject reservoir CO₂ have reduced greenhouse emissions by approximately 74 per cent from the initial 1995 design (see ESE Review, p160, Figure 8-4).

EP340 Why has there been no attempt to give a presentation of the proposal's relative greenhouse intensity, similar to that provided in Table 11-1 showing the proponent's economic scale in relation to other projects?

Figure 8-5 (ESE Review, p161) shows the Gorgon gas development's relative greenhouse gas intensity compared with other Australian LNG projects. The Gorgon gas development will be the most greenhouse efficient facility of its type in the Asia-Pacific region and one of the most efficient in the world.

For greenhouse emission intensities to be meaningful they need to be compared against intensities for similar products or processes (i.e. using common units of production). For example, a methanol, nitrogen or GTL project uses fundamentally different chemical processes that require a significantly larger percentage of the natural gas feedstock to be consumed for energy (relative to LNG) to convert the remainder into a liquid product. Therefore, the total emissions of an LNG based facility could be more than other resource projects simply because of the large scale of the plant, however the emissions per terra-

joule of gas entering the processing facility would be less than for other projects. On the other hand, domestic gas production requires less energy than liquefaction to process and pipe to WA users and would therefore have a relatively lower greenhouse intensity.

EP343 In claiming a global benefit in avoided emissions through an LNG processing facility on Barrow Island (p.150), does the proponent agree that a similar benefit would accrue from a modern LNG plant not sited on Barrow Island?

A modern LNG plant that reinjects the associated reservoir CO₂ would create a similar lifecycle greenhouse gas benefit even in another location. However, locating the Gorgon gas processing facility in location other than Barrow Island has following greenhouse disadvantages:

- Higher cost for CO₂ re-injection may make it cost prohibitive, reducing the likelihood of it being implemented (in which case, reference case greenhouse emissions would increase by 4.8 million tonnes per annum).
- Extra fuel gas consumption for booster compression to transport the CO₂ a longer distance back to Barrow Island, increasing greenhouse emissions.
- Loss of opportunity to stop flaring of associated gas on Barrow Island.
- Possible requirement for an offshore processing platform, due to the increased pipeline length between the Gorgon field and the processing facility. This leads to additional fuel gas consumption for dehydration and compression and increases in greenhouse emissions of 4 to 22%.
- Increased risk that the Gorgon development will not be competitive with competing sources of energy, thus potentially losing the life cycle benefits.

8.4 Reservoir CO₂ Sequestration

EP251 Given that the term "re-inject" may imply injection of CO₂ back into the same formation it came from, which is not the proposal here, would the proponent consider using the term "inject" or "geosequester" in place of "reinject"?

The term 're-injection' was used as it clearly conveyed the message that the CO₂ will be sequestered or returned to the sub-surface. The Gorgon Venture did not intend to imply that the CO₂ was returned to the formation from which it originated. The description in the ESE Review (ESE Review, p166, Section 8.8.4) was intended to make it clear that the Dupuy saline reservoir is not the reservoir where the CO₂ was originally extracted.

EP255 How does the proponent intend to work with Australian researchers to ensure that new knowledge and technology in the area of geosequestration is shared, thus enabling Australia to become a world leader in the field of greenhouse gas technology?

As outlined in the ESE Review (p. 162-164 and Table 8-4) the Gorgon Venture and its participants already have a strong working relationship with Australian researchers working in the area of geological sequestration. This working relationship has included the provision of technical support and funding to the GEODISC program which will continue with its replacement, the CO2CRC. This group of researchers are considered the peak research body in Australian and are highly respected in the international arena.

GEODISC have acknowledged this participation as demonstrated by the following extracts from their submission on the ESE Review (copy emailed by GEODISC to program participants):

"Involvement of Australian researchers in the above activities, the sharing of the knowledge gained and the development of new knowledge and technology would indeed, as the Report states "make Australia a world leader in this field". The APCRC/CO2CRC welcomes that commitment."

"The APCRC can confirm that as stated in Box 8-3, ChevronTexaco has been a strong supporter of the CRC's research and technology in the area of geosequestration. The support has included not only funding, but the provision of information and expertise, the co-convening of international meetings, and the active participation in research meetings

and conferences. ChevronTexaco has been, and continues to be, a valued member of APCRC/GEODISC research consortia and will play an equally prominent position in the CO2CRC research consortium."

"Should the ChevronTexaco Gorgon geosequestration proposal be approved, then CO2CRC will build on that to strengthen collaboration, further enhancing Australia's lead position in greenhouse gas technologies"

"ChevronTexaco has indicated its wish to have APCRC/CO2CRC fully involved in future assessment and monitoring; from the perspective of the CO2CRC, there is logistic benefit in having Australia's first geosequestration project at an accessible location that would help to ensure effective research, surveying and monitoring of the site."

EP260 To what extent is access to re-injection reservoirs on Barrow Island a strategic future opportunity for whoever holds the rights to it, rather than simply a least cost waste management option?

The least cost option for reservoir CO₂ management is to vent it to the atmosphere which is the current industry practice for all facilities in Australia and the world. This would save the development in the order of \$300 - \$400 million in capital expenditure. Developing a gas processing facility on Barrow Island provides a strategic opportunity to develop the Gorgon reserves with the added benefit of reinjecting reservoir CO₂. This level of expenditure would not be committed on the basis of providing a "strategic future opportunity for whoever holds the rights to it (re-injection reservoirs)".

8.4.1 Alternatives

EP256 In stating (p151) that the Dupuy aquifer represents a "unique opportunity" to reinject reservoir CO₂, does the proponent mean economically, commercially, logistically and socially unique or technically unique, given that it is unlikely that the Dupuy aquifer is unique in its technical suitability for geosequestration?

EP257 Why is the Dupuy on Barrow a "unique" opportunity to re-inject CO₂ when there are other injection sites noted in the document? Is it simply the "least cost" option?

The Dupuy formation was identified by the Gorgon Venture as the best reservoir for CO₂ sequestration in the region based on several factors (see ESE Review, pp.163-167) Section 8.8.3). Its location beneath Barrow Island makes it the closest suitable reservoir to the preferred gas processing facility site and makes it accessible by land based wells for injection and monitoring. The existing operations on Barrow Island also provide the Gorgon Venture with increased knowledge of the reservoir, leading to high level of confidence in the success of the project. The resulting incremental cost for CO₂ re-injection is considered low enough for it to be incorporated while maintaining a competitive development. These factors all contribute to "The Dupuy saline reservoir under Barrow Island presents a unique opportunity to re-inject reservoir CO₂ and reduce greenhouse gas emissions" (ESE Review, p. 151).

EP258 How would the ability to re-inject close to the alternate regional plant locations, or a decision not to require re-injection, affect the cost viability of the alternative locations?

As stated in Chapter 4, sequestration of reservoir CO₂ is seen as a critical issue for a number of stakeholders. Chapter 8 explains why Barrow Island – Dupuy saline reservoir was identified as the best reservoir for CO₂ sequestration. Chapter 15 goes on to make a commitment to plan for re-injection of reservoir CO₂. Based on the assessment by the Gorgon Venture it is highly unlikely that an alternate location exists with a re-injection site nearby that offers the same level of confidence as the Dupuy saline reservoir.

It is therefore consistent that this greenhouse gas management strategy be applied to all alternative locations considered. This then requires that a return line and booster

compression for transporting the CO₂ to the injection site on Barrow Island be included in the comparative cost estimates.

CO₂ re-injection is not a requirement – it is a decision that the Gorgon Venture has voluntarily made with respect to greenhouse gas management that is considerably beyond current best practice anywhere in the world.

If a decision was made not to re-inject CO₂, Barrow Island would still be the best option for Gorgon gas development, albeit by a reduced differential. The primary reason for this is the relative distance of the sites from the gas field.

EP259 Why is it necessary for the selected re-injection reservoir to have the capacity to accept life of project reservoir CO₂ volumes when additional reservoirs could be bought on 10 or 20 years into the project?

EP262 Noting the statement in Box 8-6 committing to “maturing alternative re-injection sites that could be developed in the future such as depleted gas reservoirs” when is it envisaged that alternative injection sites might be available?

EP286 Why has the proponent dismissed the idea of using depleted fields in the vicinity for CO₂ injection (for example Campbell, Sinbad, East Spar, Wonnich and Harriet), when these fields are expected to reach the end of their economic lives within 5-10 years and could potentially hold up to 1TCF of gas?

The Gorgon Venture did review a number of the surrounding fields that have the potential to be depleted in the next 5-10 years. These included the Saladin, Spar and the Harriet - Campbell fields (See ESE Review, pp. 166-167, Figure 8-7 and Table 8-5). None of these individual fields have the capacity to accept the CO₂ volumes from Gorgon. To meet the volume requirements a network of pipelines and sub-sea wells or platforms would need to be utilised. This would significantly increase the cost of CO₂ re-injection, potentially making it a cost prohibitive option. However the ‘conversion of nearby oil and gas reservoirs to re-injection as they reach the end of their production lives’ (ESE Review, p174) will be considered as part of the contingency plan.

Using a reservoir with sufficient capacity for all of the reservoir CO₂ from the proposed Gorgon development:

- reduces risk and uncertainty
- eliminates the need for multiple injection systems, reducing future capital expenditure and new environmental impacts
- results in slower pressure increase, reducing risk of over pressurisation
- provides a large volume of saline water to enhance CO₂ dissolution
- allows the development of long term operational knowledge
- improves ability to reliably re-inject and monitor results.

The availability of depleted gas reservoirs will depend on the economic life and remaining reserves in formations suitable for large scale reservoir CO₂ re-injection. The exact time frame cannot be defined without further study. Prior work suggested that it would require over 10 years to deplete sections of the Gorgon field.

EP261 Would it be possible to utilise the Dupuy below the Montebello’s and if not, why not?

EP319 Has the proponent investigated the potential to inject into the Dupuy formation from other locations, such as the Montebello Islands (which also overlie the Dupuy)?

At the request of stakeholders during the ESE Review process the Gorgon Venture reviewed the suitability of utilising formations under the Montebello Islands. Previous site selection studies had not identified the Montebello Islands as a suitable site for re-injecting CO₂. The ESE Review discussed this option in Section 8.8.3 (ESE Review, pp165-166).

The Gorgon Venture's assessment of the Montebello Islands concluded that reinjecting CO₂ into formations below the Montebello's has risks which are not currently acceptable. The basis for this is:

- The geology is much less understood than on Barrow Island due to the lack of seismic coverage and wells into the formation.
- Current well data in the Montebello Island region suggests poorer reservoir quality and the absence of the Perforan shale barrier which is present on Barrow Island (injection on Barrow Island is planned to occur below this shale).
- Wells on the Montebello Islands have a thinner Dupuy section, which in turn results in lower total reservoir quality. Combined with the increased uncertainty of mapping reservoir sands, this means that injectivity concerns would be much greater for the Dupuy in this area.
- Reservoir surveillance and monitoring on the Montebello Island site would also be more difficult than on Barrow Island.
- The risk of impacting existing oil and gas operation is much greater.

EP329 How can the proponent favour the Dupuy Saline Reservoir when it does not meet at least 2 of the 6 stated criteria on pp.163-164, in that there is no guaranteed containment and the reservoir is a long distance from the carbon source?

The Gorgon Venture believes that the Dupuy saline reservoir meets all of the criteria that were set for geological sequestration of CO₂. The Gorgon Venture's assessment shows that the criteria for containment and distance from the carbon source have been met by the Dupuy saline reservoir.

The Gorgon Venture participants have considerable expertise in injection of CO₂ into reservoirs, as outlined in Section 8.8.2 (ESE Review, p162). In addition, the Venture is utilising acknowledged experts in the area, such as the CO2CRC. Using this knowledge and expertise the Gorgon Venture selected the Dupuy saline reservoir under Barrow Island as the best location for CO₂ re-injection.

Many of the factors that led to the Dupuy being favoured were related to minimising any potential containment risks. One of the major strengths of the Dupuy saline reservoir is that there are multiple seals above it, including the seal that contains the currently operated oil fields which has successfully trapped methane gas for millions of years.

The proposed re-injection well site for the Dupuy is approximately 12 kilometres away from suggested location for the gas processing facility at Town Point on Barrow Island. It is important to note that the 'source' of the CO₂ for the purposes of the selection criteria is the location where the CO₂ is removed from the natural gas.

EP330 In stating that "the Dupuy saline reservoir is the best option" because "the reservoir would be available for re-injection when gas production commences" (p.165), does the proponent agree that other sites with this characteristic exist in the region?

Other prospective reservoirs with adequate capacity are not available for CO₂ injection when gas production commences due to presence of valuable hydrocarbon reserves.

The full quote in context is (ESE Review, p165):

"The review of sites concluded that the Barrow Island – Dupuy saline reservoir, West Tryal Rocks and the Gorgon gas reservoirs offer the best opportunities to re-inject reservoir CO₂.

Among those sites, the Barrow Island – Dupuy saline reservoir was identified as the best reservoir for CO₂ re-injection as it would be available when production from Gorgon gas fields commence."

Figure 8-7 and Table 8-5 (ESE Review, p.166-167,) shows the sites that in general met the screening criteria. Table 8-5 summarises the assessments that were completed that concluded that the Dupuy saline reservoir was identified as the only feasible site for CO₂

re-injection. The following excerpt from the ESE Review (pp164-165) explains why the Dupuy was selected as the best re-injection location:

Some of the major factors that make the Dupuy saline reservoir the best option, and Barrow Island itself the only suitable location, include:

- *The depth and “thinning up-dip” provide the most favourable technical conditions for re-injection (see Figure 8 2 and 8-9).*
- *There is little or no potential to jeopardise current or future production of hydrocarbons.*
- *Re-injection wells that penetrate into the Dupuy reservoir would allow access to other saline reservoirs (Flacourt and Malouet) as mitigation/upside options.*
- *The reservoir would be available for re-injection when gas production commences.*
- *The reservoir is large and deep enough to accept the proposed CO₂ volumes.*
- *The Dupuy saline reservoir is accessible from Barrow Island – removing the need for sub-sea wells and offshore platforms, reducing the risk and cost, and making re-injection more practicable.*
- *The location under a land mass (Barrow Island) and the existing oilfield provides increased geological data and monitoring opportunities to improve knowledge of the behaviour of re-injected CO₂.*

EP331 In citing the Dupuy aquifer's proximity to Barrow Island as an advantage due to the lack of requirements for sub-sea wells and offshore platforms, does the proponent agree that sub-sea wells and offshore platforms, as utilised by the Sleipner Project, are technically quite feasible and may in fact be less expensive in terms of pipeline utilisation?

Offshore CO₂ removal and re-injection is not considered feasible for the Gorgon gas development. The Sleipner Project is considerably smaller than the facilities proposed for Gorgon. Sleipner re-injects approximately one million tonnes of CO₂ per annum. Based on a 10 MTPA LNG facility the Gorgon Project plans to re-inject approximately 5.2 million tonnes per annum. The issues related to offshore CO₂ removal and re-injection include:

- A substantial and expensive platform would be required to support the CO₂ stripping and dehydration facilities, re-injection compressors, power and heat production facilities, accommodation and support facilities.
- The synergies of an integrated gas processing facility are lost causing an increase in greenhouse gas emissions (Approximately 200 MW of heat is required for CO₂ removal; this can be recovered from waste heat in an integrated plant.. An offshore platform would require a dedicated natural gas furnace).
- The preferred re-injection site would still be the Dupuy, requiring a 70 km CO₂ pipeline. The only suitable reservoirs identified in the region of the Gorgon gas fields are the Gorgon gas fields themselves. These fields could not be used for CO₂ sequestration until they were depleted without degrading the natural gas resource.
- The cost involved in an offshore processing platform and long sub-sea CO₂ pipeline are certain to make reservoir CO₂ re-injection cost prohibitive.

EP332 Does the proponent claim that there are no saline reservoirs in the West Tryal Rocks, North Gorgon, South Gorgon and Spar areas, above and below the gas fields?

All these gas reservoirs have water ‘legs’ or layers under the gas accumulations of varying degrees of size and pressure. Both the gas and water zones would require very high injection pressures, making them economically unattractive as injection sites until significant levels of pressure depletion had occurred. Reservoir simulation modelling studies were carried out previously on both South Gorgon and West Tryal Rocks. The modelling showed that any injected CO₂ is likely to recirculate back to the producing wells in a relatively short period of time, due to the relatively high permeability of these formations. This will lead to increasing levels of CO₂ in the produced gas, which turn must be separated and reinjected. Recirculation of CO₂ results in inefficient operations with respect to resource recovery, energy efficiency, environmental impacts and economic viability.

EP333 Does the proponent concede that it knows much more about its own sites and that this extra knowledge may have led to more positive assessments for these sites?

More knowledge is available on the saline reservoirs under Barrow Island, such as the Flacourt, Malouet and Dupuy sands, due to 40 years of operating knowledge, availability of 2D and 3D seismic data combined with the correlation of 27 wells that penetrate to the Dupuy. Other locations would require a more detailed, time consuming and expensive research program to determine if they are feasible. Increased knowledge leads to an improved understanding of the risk which results in improved management and mitigation measures. This increases the probability of re-injection into the Dupuy being technically feasible without being cost prohibitive.

Although the additional data gives greater certainty on the properties of the Dupuy reservoir it still needs to meet the screening criteria and provide the highest probability of success to be chosen as the preferred re-injection site. When re-injection was considered during the previous effort to develop the Gorgon gas fields, with a LNG plant based on the Burrup Peninsula, Barrow Island was also selected as the best re-injection location, despite its considerable distance from the proposed plant site at South Holden Point.

EP335 How does the proponent explain that the best location for CO₂ re-injection is coincident with the proponent's favoured site for the processing plant, Barrow Island?

Many of the factors that make Barrow Island the site of Western Australia's largest oil field also make it an attractive site for the re-injection of CO₂. These characteristics include:

- Barrow Island is a regional high point in the subsurface geological structure. This leads to the oil accumulations beneath Barrow and creates a large water-filled pocket suitable for injection of CO₂.
- Known sealing properties in the area that have retained oil and gas.
- Favourable geological structures.

In addition, increased knowledge of the subsurface reservoirs from 40 years of operating the oil field leads to an improved understanding of the risk, which results in improved management and mitigation measures. This increases the probability that re-injection into the Dupuy being technically feasible without being cost prohibitive.

When re-injection was considered during the previous effort to develop the Gorgon gas fields, with a LNG plant based on the Burrup Peninsula, Barrow Island was also selected as the best re-injection location, despite its considerable distance from the proposed plant site at South Holden Point.

8.4.2 Dupuy Structure and Integrity

EP250 What guarantees are there that the reservoir into which the proponent intends to reinject carbon dioxide will not leak?

EP280 What is the seal capacity of the top seals, and have any capillary pressure injectivity studies been conducted?

EP300 Has the proponent considered the potential for leaking CO₂ to compromise water resources in overlying formations?

EP301 Has the proponent considered the potential for a catastrophic release of CO₂, endangering human life as well as flora and fauna?

The Gorgon Venture participants have considerable expertise in injection of CO₂ into reservoirs (ESE Review, pp.162-163, Section 8.8.2). Based on this experience the Gorgon Venture acknowledges that the main uncertainty for reservoir CO₂ re-injection is the long-term behaviour of the CO₂ in the reservoir. A work program is planned which will include cooperation with Department of Industry and Resources and research bodies (such as

GEODISC and the CO₂CRC), to reduce these uncertainties. All of the studies ChevronTexaco has completed to date indicate that there is a high probability that CO₂ will be safely sequestered in the Dupuy formation over a long period of time.

Using the knowledge and expertise both in CO₂ injection and regional geology, the Gorgon Venture selected the Dupuy saline reservoir under Barrow Island as the best location for CO₂ re-injection. Many of the factors that led to the Dupuy being selected were related to minimising any potential risks by:

- Selecting a deep reservoir to ensure the CO₂ remains at super-critical pressures; this maximises the potential for dissolution, and minimises the physical volume of CO₂ in the reservoir.
- Use of a single, well characterised, injection site for the projected CO₂ volumes avoiding the risk associated with multiple sites and ensuring maximum knowledge is obtained by concentrating resources on a single site.
- Having a reservoir of a large enough size, minimising any pressure build up in the formation (minimises any stress in the formation), and increasing the tendency of CO₂ to dissolve.
- Selecting a site close to the CO₂ source which minimises the length of pipeline required and any associated risks.

The Gorgon Venture's technical studies show that injected CO₂ would move slowly up-slope in a southerly direction and take in the order of several thousands of years to reach the crest of the formation. Over long timeframes the CO₂ will dissolve into the formation water or may react chemically with formation mineralogy resulting in permanent sequestration for practical purposes.

ChevronTexaco's experience with testing and monitoring wells on Barrow Island shows direct evidence that the seal on the Dupuy is effective in providing both salinity and pressure isolation from formations above. One of the major strengths of the Dupuy saline reservoir is that there are multiple seals above it, including the seal that contains the oil and gas for the currently operated oil fields which has successfully sealed the methane gas for millions of years.

This long term containment of hydrocarbons, and gas in particular, is a good indication that the shales which provide the seals for the Dupuy, create favourable circumstances for containment of CO₂. (ESE Review, p169, Figure 8-9) For example the Gorgon gas fields contain a CO₂ content of approximately 14 mol% and have successfully retained their seals for millions of years.

It is therefore extremely unlikely that injected CO₂ would make its way to the surface. The majority of the CO₂ would be permanently immobilised in the reservoir via trapping mechanisms and dissolution into solution. A more likely scenario is that any 'leak', if it occurs, would be saline fluids escaping into one of the reservoirs above the Dupuy. These formations are also considered suitable for smaller volumes of CO₂ sequestration and have many additional seals between them and the surface. This results in a low level of risk that CO₂ would escape into either the atmosphere or shallower freshwater aquifers that have the potential to be used as a water resource.

EP252 What further investigations does the proponent intend to conduct into the properties of the target aquifer to demonstrate its suitability for geosequestration?

EP275 Does the proponent intend to undertake a gap analysis of its CO₂ re-injection program to undertake further investigations to minimise uncertainties (p171-172)?

All of the Gorgon Venture participants have a long history in the development of oil and gas reserves and the management of the uncertainties inherent in sub-surface reservoirs. This knowledge and experience is directly transferable to reservoir management for geological CO₂ sequestration. Based on this experience the Gorgon Venture has developed a step-by-step work program to minimise the uncertainties as detailed in Section 8.8.6

(ESE Review, PP 172-173). As the work program progresses with the detailed assessment of the project, the Gorgon Venture, in combination with regulators (such as DoIR) and research bodies (such as GEODISC and the CO2CRC), will continue to identify where any gaps exist in the work program and take the steps necessary to fill those gaps.

The additional work will provide greater detail on the characteristics of the Dupuy reservoir, and is similar to that which would be expected for any oilfield or gas field development. The results of this work will be summarised and reviewed in various ways including the Reservoir Management Plan, Greenhouse Gas Management Plan, the public Environmental Impact Assessment process and through direct communications with relevant government departments and research bodies .

The work program outlined in the ESE Review included:

- Detailed regional mapping to better define the extent and size of the Dupuy reservoir system.
- Down-hole static pressure measurements to confirm the hydraulic separation of the Dupuy saline reservoir from the formations above such as the Malouet and Flacourt reservoir systems.
- Use of existing reservoir core samples to study mineralogy and CO₂ dissolution effects.
- Consideration of obtaining extra core information to augment existing data sets.
- Detailed work to improve understanding of the sealing behaviour of the main Barrow Fault.
- Detailed subsurface computer modelling of CO₂ re-injection with presentation of the results to government and regulatory bodies.
- Involvement of acknowledged experts and Department of Industry and Resources petroleum specialists who actively research and monitor the state of regional reservoir systems.
- Identification of suitable surveillance and monitoring strategies and determine key early signs of potential improvements to injection or warnings of deterioration in re-inject ability or containment.
- Determination of any additional data requirements.

EP264 How does the proponent define whether an aquifer is "fit for purpose" (e.g. in terms of allowable lateral extent of migration of CO₂; degree of confidence in inferred storage time for CO₂; acceptable rate of leakage; impact on natural resources; lifetime of the storage site; maximum rate of CO₂ injection etc)?

As detailed in the ESE Review, the Gorgon Venture considered (Table 8-5) several possible locations for CO₂ re-injection and these were evaluated using the stated selection criteria. The highest potential sites underwent further geotechnical and engineering model construction and evaluation. The table below describes how the Dupuy meets the primary criteria for CO₂ re-injection.

Criteria	Dupuy Characteristic
Depth of the formation	<ul style="list-style-type: none"> • The Dupuy is over 2100 m deep, increasing the potential for dissolution and trapping of CO₂ and is considerably greater than the 800 m depth required to keep CO₂ supercritical.
Containment (vertical and lateral) of the CO ₂ with minimum potential for leakage	<ul style="list-style-type: none"> • Multiple seals exist above the Dupuy providing vertical containment and multiple barriers to leakage. • Modelling shows the large size and structural shape of the Dupuy cause the CO₂ to very slowly move towards the structural high under the south end of Barrow Island. The majority of the CO₂ remains near the injection site due to dissolution and trapping.

Criteria	Dupuy Characteristic
Acceptable reservoir properties to maximise potential re-injection rates (including porosity, permeability and volume of the reservoir)	<ul style="list-style-type: none"> Modelling has shown that the Dupuy can accept several times the required re-injection rates.
Large reservoir volume to minimise increases in pressure and formation stress	<ul style="list-style-type: none"> Only approximately 0.5 per cent of the available pore volume of the Dupuy is required for all of the CO₂ from the Gorgon fields causing only a small pressure increases in the formation (current estimates in the order of 7 per cent or 200 psi).
Protection of natural resources (e.g., hydrocarbons)	<ul style="list-style-type: none"> Modelling has shown that the multiple seals above the Dupuy, the structural shape and the long residence time will protect local and regional resources.
Long storage/residence times	<ul style="list-style-type: none"> Modelling of residence times in the order of several thousand years demonstrates continued containment of the injected gas.

Sufficient work has been completed on the reservoir CO₂ re-injection plan to select the Dupuy Saline Reservoir as the best candidate for re-injection, offering the highest probability of success (based on technical feasibility and economic impact on the Gorgon development). This conclusion was based on geological assessments, assessment of well logs, studies of core material and modelling of CO₂ re-injection.

EP271 Has the proponent used a satisfactory subsea model to demonstrate the suitability of the Dupuy aquifer for CO₂ injection?

A preliminary computer-based simulation model has been built to test the suitability of the Dupuy aquifer for CO₂ sequestration. Based on this modelling, it is possible to predict behaviour of the CO₂ after injection into the Dupuy. Initially, injected CO₂ will mix with formation water. The model predicts how the CO₂ will behave when injected. It predicts that a fraction will dissolve rapidly, while the balance will coalesce as a separate CO₂ phase. A fraction of the CO₂ will migrate slowly up the slope of the reservoir due to gravity (buoyancy forces) over the next several thousand years.

For injection into saline reservoirs, such as the Dupuy, one key success factor noted is the large residence time of CO₂ in the formation. In the case of the Dupuy, it is 15 km from the likely injection well locations to the crest of the structure. This has been shown, by use of reservoir models and flow simulation, to provide residence times of the order of several thousands of years. Flow simulation studies also show that the portion of injected CO₂ which remains immiscible with the formation water would move slowly up-slope in a south-westerly direction towards the crest.

The modelling also shows that the migration process for the CO₂ leads to dissolution of CO₂ into the water phase and relative permeability trapping of isolated droplets of CO₂; this results in significant volumes of CO₂ being permanently sequestered near the injection site and along the transport path.

At this stage of the development, sufficient work has been completed on reservoir CO₂ re-injection to select the Dupuy Saline Reservoir as the best candidate for re-injection. It offers the highest probability of success, based on technical feasibility and economic impact on the Gorgon development. This conclusion was based on geological assessments (2D and 3D seismic data), assessment of well logs (27 well penetrations), studies of reservoir core material and modelling of CO₂ re-injection.

EP276 What is the structural configuration of the various stratigraphic units from Top Dupuy to surface, including shale layers and the geometry of the sand bodies?

EP281 Given that Barrow Island is dissected by generally NE-SW trending faults (sub-parallel to the main Barrow Island fault), is the area in the north selected as a separate structural compartment? How structurally complex is the Dupuy reservoir level (rather than the simplistic view presented)?

The various stratigraphic units on Barrow Island are presented in Figure 8.9 of the Gorgon Environmental, Social and Economic Review of the Gorgon Gas Development.

Considerable work has been completed to date on the concept of CO₂ sequestration for the reservoir CO₂ removed from the Gorgon gas. This will be supplemented with more detailed work planned between now and the construction of a gas processing facility. An outline of the work program to reduce technical uncertainties on the reservoir and the likely behaviour of the CO₂ is presented in Section 8.8.6 (ESE Review, p172).

Relative to other Australian Basins/Reservoirs, the Dupuy Formation is not characterised by a high degree of structural complexity. Pressure information from other saline formations on Barrow Island shows simple compartmentalisation.

The Dupuy Formation is a sandstone succession with subordinate claystones, at the top of the Dingo Claystone. Reservoir characterisation of the Dupuy Formation is well defined based on detailed core study of numerous wells, onshore and offshore Barrow Island. The geometry of the Dupuy Formation is well understood with the mapping of a number of 2D and 3D seismic surveys and stratigraphic with the correlation of numerous wells which intersects the Dupuy Formation.

The technical requirement of re-injection into the Dupuy saline reservoir required the injection wells to be located near the north end of the island. The reasons for this are:

- The Dupuy Saline Reservoir is significantly thicker at the north end, increasing the volume available for sequestration.
- The reservoir quality is significantly better at the northern end, further increasing the volume available for sequestration.
- Using a location at the northern end of the Island maximises residence time and water/CO₂ contact time which will maximise the ability for dissolution of the CO₂ into the water to occur.

Locating the proposed injection well at the northern end of the Island would therefore maximise the probability of success for re-injection.

EP277 What is the expected CO₂ migration pathway through the subsurface unit(s)?

EP287 What is the risk to established oil and gas fields within nearby permits of injecting into the Dupuy aquifer?

EP289 Will the injection of significant quantities of waste gas into the Jurassic reservoirs affect the regional hydrodynamics of the upper Jurassic reservoirs and will fault leakage similarly affect the hydrodynamics of the shallower reservoirs including those currently producing oil and gas?

EP290 What is the anticipated area expected to be influenced by the migration of the waste gases?

Scoping studies undertaken to date indicate that the re-injection of CO₂ into the Dupuy is technically feasible and would not affect existing or planned oil production operations.

As detailed in the ESE document, the Gorgon Venture evaluated several possible locations for CO₂ injection using the stated selection criteria which included both vertical and lateral containment (ESE Review, p163). The highest potential sites underwent further geotechnical and engineering model construction and evaluation.

Modelling shows the large size and structural shape of the Dupuy cause the CO₂ to very slowly move in a southerly direction towards the structural high under the south end of Barrow Island. The majority of the CO₂ remains near the injection site due to dissolution and trapping.

In the case of the Dupuy formation, the 15 km from the likely injection well locations to the crest of the structure has been shown, by use of reservoir models and flow simulation, to provide residence times of the order of several thousands of years. Moreover, as described in the response to Question EP271, the migration process for CO₂ leads to dissolution of CO₂ into the water phase and relative permeability trapping of isolated droplets of CO₂ resulting in significant volumes of CO₂ permanently sequestered near the injection site and along the transport path.

ChevronTexaco have both 2D and 3D seismic information over the Barrow Island area augmented by stratigraphic correlations of the 27 wells that have been drilled down to the Dupuy and beyond over the last 30+ years. Despite this level of exploration, no significant oil or gas accumulations have been identified in the Dupuy.

To confirm that re-injection presents minimal risk to established hydrocarbon production in the area, to validate the initial scoping work and to further increase the understanding of the key subsurface uncertainties, additional subsurface modelling is being undertaken. This will include scenarios to test what impact CO₂ injection into the Dupuy could have on local and regional hydrodynamics, possible leakage into the overlying Barrow Group, leakage both laterally and vertically via faults to shallower formations.

The Gorgon Venture will in conjunction with the DoIR, be consulting with adjacent tenement operators to discuss modelling and share results.

EP278 What is the porosity, permeability, net-to-gross of the Dupuy saline reservoir and overlying units?

The porosity, permeability and net-to-gross are appropriate for the amount of CO₂ that is to be sequestered in the Dupuy Formation as demonstrated by 27 wells on Barrow Island and data from existing core samples. Details of reservoir properties are confidential and will be discussed with DoIR technical specialists.

EP279 What is the estimated volume of CO₂ the various reservoir units can hold?

There are several mechanisms of CO₂ storage including: structural closure, dissolved CO₂ in formation water, CO₂ droplets trapped along the migration path, mineralogically trapped CO₂, and long subsurface residence time. The volume of pore space available for CO₂ in the Dupuy Formation is more than appropriate for the required amount of CO₂ to be sequestered. The possible sequestered volumes were one of the screening criterion used to select the Dupuy (ESE Review, p.163). The Dupuy Formation emerged as the favoured candidate because of the enhanced ability to dissolve CO₂ and increased depth that ensures the volume of injected CO₂ is relatively smaller than for shallower formations. Candidates shallower than 800 metres were not considered.

In the case of the Dupuy formation, it is 15 km from likely injection well locations to the crest of the structure; this has been shown, by use of reservoir models and flow simulation, to provide sufficient volume with residence times of the order of several thousands of years. Moreover the nature of the migration process for CO₂ leads to dissolution of CO₂ into the water phase and trapping of isolated CO₂ droplets, resulting in significant volumes of CO₂ permanently sequestered near the injection site and along the transport path.

- EP282 Under what conditions could CO₂ injection activities cause the fracturing of the formations?*
- EP283 Are faults capable of vertical and/or lateral transmission of fluids? What part will faulting play in the migration of waste gases to shallower levels and what will be the migration effects of these waste gases at these shallower levels?*
- EP284 Is injecting CO₂ a likely catalyst for renewed movement on existing faults?*
- EP288 To what extent would any movement on faults and fracturing of rock strata in the vicinity change the anticipated migration pathways of the injected gases?*

It is unlikely that the injection of reservoir CO₂ would contribute to any fault movement or rock fracturing. Re-injection induced fracturing of any subsurface formation occurs when the injection pressure exceeds the formation fracture gradient. ChevronTexaco have routinely conducted formation integrity tests (FIT) as part of past drilling campaigns and these tests have established the stress levels at which fracturing would occur. The CO₂ injection pressure is well below the fracture pressure of the Dupuy formation rock. The large size of the Dupuy reservoir means CO₂ injection will only lead to very small and slow pressure increases in the formation. An additional mitigating factor to any changes in the anticipated CO₂ migration pathway is that the Dupuy has multiple overlying seals providing additional containment and limiting migration.

Faults can act as barriers to the migration of fluid in the subsurface and create traps for hydrocarbons and gas; they are also capable of vertical and / or lateral transmission of fluids in some cases. ChevronTexaco's experience with testing and monitoring wells on Barrow Island shows direct evidence that the seal on the Dupuy is effective in providing both salinity and pressure isolation from formations above.

The Gorgon Venture is conducting more detailed studies to evaluate the anticipated behaviour of injected CO₂ under various scenarios including the unlikely events of fault re-activation and/or fracturing of rock strata. An outline of the work program to reduce technical uncertainties on the subsurface and the likely behaviour of the CO₂ is presented in Section 8.8.6 (ESE Review, p. 172).

- EP285 Will the injector wells be vertical, deviated or horizontal?*
- EP291 What type of injector wells will be drilled?*
- EP293 Specifically, where will the injector wells be positioned?*
- EP318 Given that the choice of the north end of the island for re-injection will prevent this part of the island from remaining free from development, does the proponent intend to conduct a detailed assessment of the relative risks, costs and benefits of the location of the sequestration infrastructure closer to the main development area?*

The Gorgon Venture recognises the desire to minimise infrastructure and disturbance at the north end of the Island. This is reflected in the choice not to proceed using the lowest cost development site at the northern tip of the Island (Surf Point).

All three alternatives of vertical, deviated or horizontal wells are being considered and will be modelled at the reservoir simulation stage. ChevronTexaco has world-class expertise and experience in this area that it will use in selecting the best alternative.

The majority of the CO₂ sequestration facilities will be co-located with the gas process facilities at Town Point. However, the technical requirement of re-injection into the Dupuy saline reservoir requires the injection wells to be located near the north end of the island. The reasons for this are:

- The Dupuy Saline Reservoir is significantly thicker at the north end, increasing the volume available for sequestration.

- The reservoir quality is significantly better at the northern end, further increasing the reservoir volume available for sequestration.
- Reinjecting at the northern end of the Island maximises residence time and water/CO₂ contact time which maximises the dissolution of the CO₂ into the water.

Locating the proposed injection wells at the northern end of the Island would therefore maximise the probability of success for re-injection.

The pipeline between the proposed gas processing facility and the re-injection site will be relative small diameter in the order of 250-400 mm. The pipeline will be routed along existing roads wherever possible and designed to ensure that fauna movements are not unduly impacted.

It is therefore anticipated that the environmental impact of CO₂ re-injection would be negligible. A detailed analysis of this would be undertaken as part of the formal Environmental Impact Assessment process to in order to develop appropriate management and mitigation measures.

EP294 How does the proponent intend to address concerns that injection of waste gases into the Dupuy aquifer may destroy the value of the Dupuy as a potential exploration target?

ChevronTexaco have both 2D and 3D seismic information over the Barrow Island area augmented by stratigraphic correlations of the 27 wells that have been drilled down to the Dupuy and beyond over the last 30+ years. Despite this level of exploration no significant oil or gas accumulations have been identified. Based on this information ChevronTexaco's assessment is that no significant oil or gas exploration targets exist in the Dupuy under Barrow Island.

Furthermore all work to date indicates that the injected CO₂ would gradually move in a south-westerly direction and remain under Barrow Island; therefore it would not impact any potential oil and gas prospects in the adjacent oil and gas leases in the Dupuy (See the response to EP 277 for further detail).

EP295 What geochemical reaction is likely to occur at depth and could these reactions affect permeability and porosity?

In Chevron Texaco's experience and in other reported examples, seal integrity or containment problems have not been observed as a result of the reaction of CO₂ with reservoir minerals. It is important to note that the overlying seal which traps hydrocarbon gas and 14 mole % CO₂ gas at the Gorgon gas field, has not been compromised by any possible chemical reactions between reservoir/seal rock and CO₂.

EP296 How well are the hydrodynamics of the Dupuy and other formations understood?

ChevronTexaco has pressure data from the Dupuy and overlying formations such as the Barrow Group. The hydrodynamics and fluid isolation between the Dupuy and other formations is demonstrated by differences in formation water salinity and pressure. To validate the initial scoping work and further increase the understanding of the hydrodynamics of the Dupuy and overlying formations, additional subsurface modelling is being undertaken. On completion of this work, the team will be well positioned to assess both local and regional hydrodynamics.

EP299 How can the proponent guarantee the security of well bores (operational or abandoned) and well caps to prevent CO₂ release?

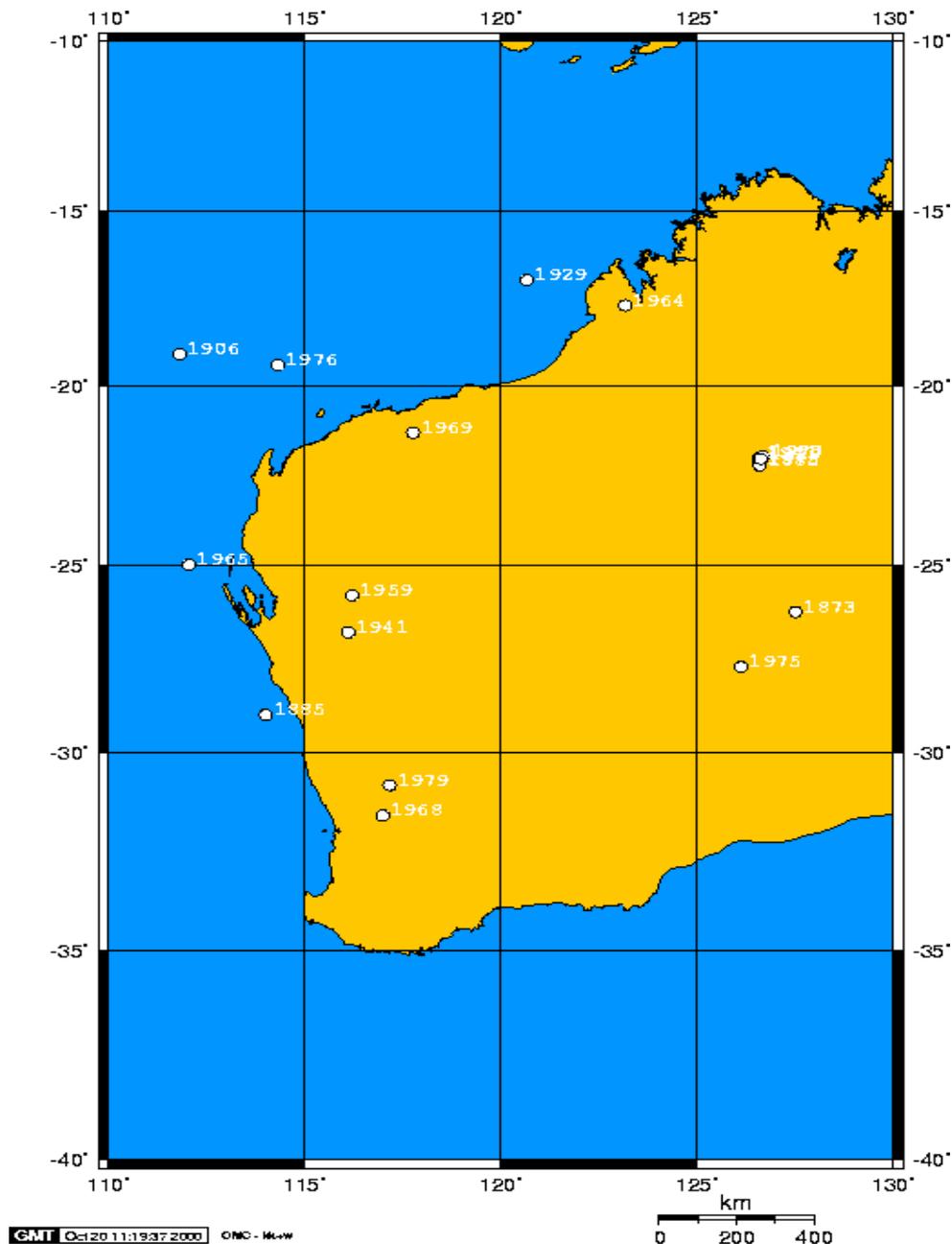
New well bores completed into the Dupuy will be designed, constructed and tested using techniques appropriate for gas wells to prevent any CO₂ release. Section 8.8.5 and 8.8.6 (ESE Review, p171-172) outline a suite of monitoring techniques that could be employed to monitor movement of injected CO₂ and its location with respect to existing operational or abandoned well bores. Monitoring the behaviour of CO₂ injected into the subsurface is

an important priority for a successful geological sequestration project. The Subsurface Reservoir Management Plan for CO₂ Sequestration, will outline technologies that could be used to monitor CO₂ migration. In the event that CO₂ enters existing well bores, permanent abandonment of these bores and well caps is one of the alternatives that the Operations group would evaluate to prevent release of CO₂.

EP303 Has the proponent considered the impact of natural disasters such as earthquakes on the reservoir?

Since the commencement of European settlement in Western Australia in 1824, three (3) earthquakes are known to have caused rupturing of the earth's surface. These were the Meckering earthquake, in 1968, the Calingiri earthquake in 1970, and the Cadoux earthquake in 1979. Barrow Island has large hydrocarbon accumulations that have been trapped beneath the Island for hundreds of millions of years, in formations closer to the surface than the Dupuy reservoir. The natural seismic events recorded since 1824 have not lead to failure of trap integrity at Barrow Island.

Map of West Australian Earthquakes, Magnitude 5.5 And Above (1880 - 1996)



EP306 *Has the proponent conducted a detailed risk assessment on the sequestration proposal, which considers the capture of CO₂ from the source, dehydration followed by compression and liquefaction, transportation and injection into the designated storage site?*

ChevronTexaco, has identified key risk and opportunities for the Gorgon gas development, including the CO₂ sequestration system, and has factored these risks into the forward work plans (ESE Review, p. 172, Section 8.8.6) and contingency plan (ESE Review, p. 173, Section 8.8.8]. The primary risks from the CO₂ separation and compression facilities are well understood from previous international experience (refer to ESE Review, p. 173 Box 8-8). Risks related to geological sequestration have been minimised by the selection of the Dupuy saline reservoir as the preferred re-injection locations (see EP 250, EP 263, EP 264, etc).

The Gorgon Venture has very high confidence in the technical feasibility of injecting CO₂. The compression and injection system is similar to those used commercially for EOR; the design and cost are well understood. The main uncertainty is the long-term behaviour of the CO₂ in the reservoir. A work program is planned which will include cooperation with Department of Industry and Resources and research bodies (such as GEODISC and the CO₂CRC), to reduce these uncertainties

Additional risk identification and assessment work will be conducted as development studies for Gorgon move forward during 2003. As detailed in the ESE a specific development has not yet been determined and consequently only the conceptual design has been completed. A detailed health, safety and environmental risk assessment will occur as the finalised design for the development is prepared.

A more complete identification of environmental risks will occur as part of the preparation of the Environmental Impact Assessment, which would take place after an in-principle decision for access to Barrow Island.

EP308 What is the proponent's response to the suggestion that in the case of saline aquifers: there is a heavy reliance on predictive modelling and upon extrapolation from laboratory scale studies; the physical characteristics of a saline aquifer are highly specific, even for the different regions of a single aquifer; it is extremely difficult to predict capacity, pressure conditions and the probability, nature and scale of fracture and dissolution domains within the aquifer; and case examples of underground fuel-gas storage have shown that unpredictable escape route may arise as a result of unpredictable fracture zones becoming active?

ChevronTexaco, as operator for the Gorgon Venture, has extensive resources and experience in the use of computer simulations or 'modelling' to predict, visualise and understand sub-surface behaviour. The use of computer simulation tools has led to significant increases in the efficiency of extracting oil and gas from reservoirs. These computer simulations are regularly correlated with 'real world' behaviours to confirm the accuracy of the simulation techniques.

Forecasting the likely movement of injected CO₂ in saline reservoirs is similar to using computer simulations for modern oil and gas recovery techniques which rely on gas, water or CO₂ injection. The experience developed within ChevronTexaco is being applied to predicting the behaviour of re-injected CO₂ in the Dupuy.

The computer simulations assist in the understanding of the interaction of the physical processes which include dissolution, multiphase flow and saturation trapping (low CO₂ phase saturations are immobile) and the forces of buoyancy. Each of these factors may be individually studied in the laboratory, but correctly combining these processes requires the use of computer simulations.

ChevronTexaco are very familiar with the limitations of computer simulations and how to cope with natural variations. Reliable, well established techniques are used to cope with these issues. For example, uncertainties can be managed by assuming values for the reservoir properties that err on the side of caution (i.e., there is a high level of certainty that the properties will be better than what was used in the model).

For the Dupuy reservoir the ChevronTexaco has built up a detailed understanding of the geology, the size and structure of the reservoir, and the rock and fluid properties. This is based on data from 2D and 3D seismic surveys and the 27 wells that have penetrated the Dupuy saline reservoir. This information is utilised as input into the computer simulation.

Furthermore the risk related to geological sequestration have been minimised by the selection of the Dupuy saline reservoir as the preferred re-injection locations due to many of its advantageous properties including size, depth and the existence of multiple seals above the formation (see EP 250, EP 263, EP 264, etc).

EP315 Does the proponent intend to commission an independent pilot study investigating all aspects of CO₂ sequestration including protection of biodiversity, geological suitability, security and permanence?

The Gorgon Venture's plans for CO₂ sequestration will be independently reviewed by the relevant technical specialists at DoIR and will be subject to more detailed review through the Environmental Impact Assessment process. In addition it is expected that plans would be peer-reviewed by experts in CO₂ sequestration from the CO2CRC.

- At this time, the Gorgon Venture believes there is little technical benefit from conducting a smaller scale CO₂ re-injection pilot project. The reasons include:
- The relatively small volume of CO₂ injected by a pilot system would not provide accurate information on CO₂ injectivity; several years of operating data would be needed to assess the behaviour of the CO₂ in the reservoir.
- The pilot phase would extend the timeline for full scale reservoir CO₂ injection; during this period the majority of the reservoir CO₂ would be vented to the atmosphere.
- The costs to install a pilot scale CO₂ compression system could be close to those for a full scale system (compressor costs do not directly scale with size).
- The gas processing facility would not be as energy or greenhouse efficiency if the re-injection facilities are not fully integrated into the design.

For the above reasons, together with the Gorgon Venture's confidence in the CO₂ injection scheme, it is planned to commence full scale CO₂ re-injection as soon as practicable after the start up of the gas processing facility.

EP320 What are the views of the owners/operators of neighbouring gas/oil leases regarding the proposal to reinject CO₂ at Barrow Island?

There are ongoing discussions with oil and gas companies with interests in the area. The subject of these discussions includes the proposal by the Gorgon Venture to re-inject reservoir CO₂ in the Dupuy saline reservoir beneath Barrow Island.

8.4.3 Monitoring

EP273 Over what time period does the proponent intend to conduct its monitoring program, given that long term containment of CO₂ is paramount?

EP297 How does the proponent intend to monitor the impacts of CO₂ sequestration both during and after the operational phase of the project?

EP307 Is the proponent committed to meeting the costs of ongoing reservoir monitoring, no matter how long the monitoring program continues (potentially centuries)?

The Gorgon Venture recognises that containment and monitoring are very important aspects of the plan to re-inject reservoir CO₂ into the Dupuy saline reservoir.

The Dupuy saline reservoir was selected as the best reservoir based on many characteristics, including its sealing capacity. There are multiple seals above the Dupuy saline reservoir, including the seal that contains the oil and gas for the currently operated oil fields which has successfully sealed the methane gas for millions of years.

As this would be the 'first of a kind' project, there are no direct precedents in Australia for re-injection of reservoir CO₂. It does however have some similarities with abandoned and capped gas fields which is a relatively common practice with defined responsibilities and regulatory framework. The Gorgon Venture will therefore work with regulators such as the WA Department of Industry and Resources and other acknowledged experts to determine a suitable monitoring program and to identify key early signs of potential improvements to injection or warnings of deterioration in re-injection ability or containment.

A regulatory framework for reservoir CO₂ re-injection will need to be implemented if in-principle approval for the restricted use of Barrow Island is received. A formal regulatory based framework could be implemented by many means including legislation, licence conditions, formal environmental approval conditions or other means determined by the Government. The details of the planned monitoring program would be included in various documents that would be prepared before formal government approval of a specific development. This would include the Greenhouse Gas Management Plan, the Reservoir Management Plan and the Environmental Impact Assessment documentation.

EP274 Is adequate baseline data available to support the CO₂ monitoring program?

ChevronTexaco have 2D and 3D seismic information for the Dupuy saline reservoir over the Barrow Island area. This information is augmented by stratigraphic correlations of the 27 wells that have been drilled down to this level and beyond over the last 30+ years. If additional baseline data is needed, it will be identified and acquired as part of the work program on re-injection discussed in ESE (p172-173, Section 8.8.6).

EP302 Has the proponent investigated the impacts of sequestration on micro-organisms inhabiting the geological formations?

The re-injection of CO₂, would occur into a very deep (>2000m) saline reservoir in the Dupuy formation, which is geologically isolated from shallower formations as demonstrated by pressure and water composition testing.

The subterranean fauna of Barrow Island are restricted to much shallower depths (<150m) and would not be affected by injection of CO₂, in the Dupuy. Note that the main Barrow Island oil reservoir lies between the Dupuy and these subterranean habitat areas.

EP304 What is the proponent's response to the suggestion that as the extensive use of this technology will transfer responsibility for monitoring and control of disposal sites to future generations, then it does not demonstrate intergenerational equity and therefore cannot be considered sustainable?

The knowledge gained through this project will provide a substantial advantage to future generations in improving the effective management of their greenhouse gas emissions.

Reducing greenhouse gas emissions by both efficient design and operation and geologically sequestering CO₂ will reduce any contribution that the Gorgon gas development might be making to climate change, minimising any burden placed on future generations.

Current estimates are that the Gorgon gas project will be operational for at least thirty years. Over this timeframe it is reasonable to expect that the Gorgon Venture's knowledge of the behaviour of sequestered CO₂ will be greatly enhanced and a high level of confidence would be able to be placed on the Venture's ability to predict behaviour at that time. This knowledge will help ensure that risks are minimised and controlled, which in turn will minimise any burden placed on future generations.

The Gorgon Venture believe that the combination of providing cost-effective, low-carbon fuels such as natural gas to growing economies in the Pacific Basin, while simultaneously addressing greenhouse emissions at the source - through energy efficiency and sequestration - is an environmentally beneficial option, which helps future generations meet their needs.

8.4.4 Feasibility

- EP253 Noting the commitment to re-inject CO₂ "unless it is technically infeasible or cost prohibitive" what percentage probability should the State place on the prospect that the benefits of re-injection will be achieved?*
- EP254 Noting the projected costs in the ESE Review of \$400m to strip CO₂ and \$300-400m to re-inject, what level of cost would render re-injection "cost prohibitive"? Is it possible to determine what is "cost prohibitive" in advance of having a firm gas sale contract and hence gas sale price?*

The Gorgon Venture has committed to implement a project to reinject reservoir CO₂. This project will proceed as part of the overall Gorgon gas development. Section 8.8.6 (Technical Feasibility) and 8.8.7 (Economic Impact of Reservoir CO₂ Re-injection) of the ESE Review outline the issues relating to this commitment.

The Gorgon Venture has very high confidence in the technical feasibility of injecting CO₂. The compression and injection system is similar to those used commercially for enhanced oil recovery and as such the design and cost are well understood. The main uncertainty is the long-term behaviour of the CO₂ in the reservoir. A work program is planned which will include cooperation with Department of Industry and Resources and research bodies (such as GEODISC and the CO₂CRC), to reduce these uncertainties. All of the studies ChevronTexaco has completed to date indicate that there is a high probability that CO₂ will be safely sequestered over a long period of time.

The definition of 'cost prohibitive' is difficult as it is interrelated to several other aspects of the project relating to cost and market competitiveness of the Gorgon gas development. Current estimated costs for the development include the cost of CO₂ re-injection and the Gorgon Venture currently believe that the resulting total cost makes the development feasible, based on the understanding of costs and prices from competing projects. If in-principle use of Barrow Island is granted it would ensure that cost of CO₂ re-injection is minimised and therefore would maximise the probability the CO₂ re-injection can proceed without being 'cost prohibitive'. If re-injection was required at some alternative location, significantly increasing the total cost of the project, then the cost of re-injection could become 'cost prohibitive'.

- EP263 What studies are available to support the proponent's claim that "re-injection is technically feasible", given that this project would be the first of its kind in the world in terms of its scale?*
- EP265 What detail does the proponent have on the Dupuy Reservoir to demonstrate its suitability for CO₂ injection, and will this be made available in the forthcoming Greenhouse Gas Management Plan?*

The Gorgon Venture acknowledges that re-injection of CO₂ from the Gorgon gas field is larger than that undertaken before. The Gorgon Venture believes re-injection is technically feasible as the technology to separate the carbon dioxide, compress it, transport and reinject it into subsurface reservoirs is well known and utilised by ChevronTexaco and many other oil companies around the world.

ChevronTexaco has a number of active CO₂ injection projects where carbon dioxide is being injected underground into existing reservoirs to enhance oil recovery. ChevronTexaco's largest current CO₂ injection operation is the Rangely Weber Sand Unit in western Colorado, in the USA. Rangely is the largest oilfield in the US Rocky Mountain area and is the third largest CO₂ enhanced oil recovery operation in the world. Injection of CO₂ began in 1986 and today the operation injects about three (3) million tonnes of CO₂ per annum. In the Lost Hills Oilfield in the Central Valley of California, ChevronTexaco are engaged in a CO₂ migration monitoring pilot study. ChevronTexaco in Australia is drawing on the technical know-how, successes and "lessons learned" from these projects to better position the Gorgon development in accomplishing its goals in greenhouse gas management.

The Dupuy formation under Barrow Island was identified by the Gorgon Venture as the best reservoir for CO₂ sequestration in the region based on the criteria described in Section 8.8.3 of the ESE Review. The criteria used were based on experiences of the Gorgon Venture Participants as well as results from various research organisations around the world conducting research into geological sequestration.

Technical studies performed to date on the Dupuy reservoir indicate:

- The Dupuy has the capacity to contain all the reservoir CO₂ from the Reference Case development, without a significant or excessive increase in reservoir pressure.
- The CO₂ will remain in the Dupuy formation, underlying Barrow Island for thousands of years.

EP272 Does the proponent consider that the necessary regulatory and approval processes could be expedited to allow the time frames for geosequestration suggested in Figure 8-11 to be met?

The Gorgon Venture considers the time frames shown in Figure 8-11 (ESE Review, p171) to be readily achievable, with five years between now and the earliest time that the first re-injection well would be drilled. The time line presented is based on the following milestones:

- In-principle approval for restricted use of Barrow Island – 3rd quarter 2003 (timeline already agreed with government).
- Full environmental approval by the WA Government and the Commonwealth Government by the end of 2004 (1.75 years).
- First re-injection well drilled – 2008 (5 years).
- Re-injection commences 2008-2009 (5-6 years).

Since gas and water re-injection is already addressed by existing oil industry regulations in Australia, and CO₂ re-injection is being commercially applied in the USA and Canada, there should be few regulatory issues which cannot be resolved in this time frame.

EP336 Will the proponent please explain how disposing of its own waste in a responsible manner can be cost prohibitive and is not simply part of the project's operating costs?

The Gorgon Venture is committed to the responsible management of greenhouse emissions. Development of a project to re-inject reservoir CO₂ represents a major financial commitment to greenhouse emission reduction by the Gorgon Venture. This commitment is a significant step beyond current Australian and international standards for greenhouse gas management.

The commitment to reservoir CO₂ re-injection will impose significant additional capital and operating costs on the Gorgon gas development compared to competing developments. No other Asia-Pacific LNG projects are re-injecting reservoir CO₂, even though several have reservoir CO₂ content of 10–15 mol%. No other resource project in Australia plans to reinject CO₂.

All existing Australian and international LNG facilities have chosen venting of the removed reservoir CO₂ to the atmosphere as their management option. This includes all of the other currently proposed gas production and LNG facilities in Australia. For the Gorgon gas development to successfully compete as a supplier of clean gas energy and LNG, the total costs, including CO₂ re-injection must be acceptable. If the capital and operational costs for re-injection are too high then it may threaten the viability of the entire development.

EP338 If the proponent understands the importance of reducing their greenhouse emissions, why has it been so careful to qualify its geosequestration proposal by saying that it will reinject 4.2 million tonnes of carbon dioxide annually "unless it is technically infeasible or cost-prohibitive"?

The Gorgon Venture has committed to both implement current best practices for thermal efficiency and greenhouse emission control and to re-inject reservoir CO₂. The Venture

has a high level of confidence in the feasibility of CO₂ re-injection and is including re-injection in the development cost estimates, discussions with various stakeholders and the forward work plan.

However since reservoir CO₂ re-injection has the characteristic of a unique, 'first of a kind' project, the Venture strives to be open and honest with the public and government to ensure that the risks are known and understood. In reality, the whole Gorgon development is subject to the same feasibility and cost qualifications, and in general people accept this "as a given" for any major development. But the Gorgon Venture has completed more detailed evaluations of the Gorgon area gas reservoirs, including multiple well tests and computer reservoir simulation studies and has a higher degree of certainty and familiarity with respect to their development. Over the last twenty years the Gorgon Venture has spent over \$800m on the development of Gorgon. A large proportion of this spend is associated with understanding the technical and economic feasibility of the project.

8.4.5 Contingency

EP298 What contingency actions could be undertaken in the event of CO₂ leakage from the reservoir?

EP316 Should geosequestration prove environmentally, technically or economically unviable, what is the proponent's contingency plan for CO₂ management?

EP317 Recognising that 65ha of maritime pines does not make a significant contribution to the uptake of the amount of CO₂ generated by the proposal, what level of future planting is the proponent contemplating and prepared to commit to?

The Gorgon Venture acknowledges that the Gorgon gas development would be a significant emitter of CO₂. The Gorgon Venture are therefore committing to design production facilities to incorporate current best practices in thermal efficiency and greenhouse emissions control where practicable, the re-injection of the reservoir CO₂, continued investment into greenhouse gas related research and various other actions outlined in the ESE Review. This greenhouse strategy focuses on the actions where the Gorgon Venture has the greatest confidence in the ability to control emissions reductions.

The pilot pine plantation provides valuable insights into forestry and carbon sequestration issues; no conclusion has been reached on whether this trial should be expanded at this time.

The Gorgon Venture is confident that CO₂ re-injection will prove to be feasible and effective for reducing greenhouse emissions. However, as a prudent measure, the Venture is also committed to develop a contingency plan for implementation if the project for re-injection in the Dupuy is shown to be infeasible. The contingency options which will be considered are listed in Section 8.8.8 (ESE Review, p173-4). Additional forestry plantings and revegetation are one of the options to be evaluated.

The Gorgon Venture believes that the level of detail presented in the ESE Review with respect to greenhouse gas management and the contingency plan is in keeping with strategic nature of the review. The purpose of the ESE Review process is to identify factors that are critical to the question of whether or not restricted use of Barrow Island is acceptable. Details of the contingency plan will be fully developed during the detailed project design phase, prior to completion of the Environmental Impact Assessment.

9 Greenhouse / Environment

EP349 What does the proponent mean when it claims that LNG is "clean" energy, recognising that all forms of fossil fuel are currently implicated in climate change?

When the total life-cycle emissions of various fossil fuels are compared, the total greenhouse gas emissions of natural gas are considerably less than coal or fuel oil. It is widely accepted that when balancing issues such as long-term waste management (nuclear) with greenhouse gas and pollutant emissions (fossil fuels), the use of natural gas will have the lowest environmental impact. This makes natural gas one of the cleanest sources of fossil fuel energy. Natural gas also facilitates commercialisation of higher efficiency power production systems such as gas turbine /combined cycle generation and fuel cells.

For example, in the United Kingdom the increased use of gas has been largely credited with a 29 per cent reduction in greenhouse emissions, despite a 16 per cent increase in electricity use (Department for Environment, Food and Rural Affairs 2001). If the UK's 1990 rate of greenhouse emissions had been maintained, greenhouse emissions would be approximately 63 per cent more than the reported 1999 emissions.

An additional benefit of the combustion of natural gas or LNG, instead of traditional fossil fuels, is that it results in lower levels of emissions such as sulfur oxides, particulates and nitrogen oxides. This can improve local and regional air quality with a corresponding decrease in potential health impacts.

The Western Australian government has acknowledged the greenhouse benefits of natural gas as demonstrated in the *Western Australia and Greenhouse Issue Paper* (2002):

Strategically, Western Australia should expand the use of its natural gas resources and make them available to the rest of the world, while still meeting our greenhouse gas responsibilities. If we are able to do this we will be able to contribute to lower global greenhouse gas emissions by:

- *displacing other more greenhouse intensive fuels, such as coal or petroleum, in Australia and overseas countries; and*
- *using the resources in Western Australia to produce goods or materials using cleaner and more environmentally friendly technologies that are used overseas.*

EP350 What happens to the BTEX if it is captured but the amount re-injected with the CO₂ is minimised (see p64)?

BTEX is not intentionally captured as part of the CO₂ separation process. In an LNG plant, when the CO₂ is removed from the feed gas, a small amount of hydrocarbon from the feed gas, including BTEX, is often co-absorbed with the CO₂. These hydrocarbons may be recovered for fuel, flared or vented with the CO₂.

The Gorgon Venture intends to minimise the quantity of hydrocarbon and BTEX co-absorbed with the CO₂ by utilising improved separation technology. Any quantity of hydrocarbon or BTEX that does get co-absorbed with the CO₂, and it not recovered, would then be re-injected, not vented to the atmosphere, due to the commitment to re-inject the associated reservoir CO₂.

EP351 What does the proponent mean when it claims that LNG is a "transition fuel"? Transition to what, and when?

Natural gas and LNG are often referred to as transitional fuels in the context of fossil fuel use and greenhouse gas emissions. This is due to the recognition that natural gas or LNG has a relatively low greenhouse gas intensity compared to other fossil fuels (see EP 349

and Section 8.3, ESE Review). It also has many properties that make it a suitable fuel for high efficiency, low emission energy conversion devices such as fuel cells.

World oil production is forecast to peak and begin to decline in the coming decades, while natural gas production and LNG are predicted to supply an increasingly large proportion of world energy demand for some time in the future. Methane, the main hydrocarbon in natural gas and LNG, can be produced from renewable sources through biomass conversion.

Natural gas is an obvious choice for the production of hydrogen, which many policy makers view as a likely future fuel. While natural gas could be the transitional fuel to the 'hydrogen economy', in the longer term, hydrogen could be produced from renewable sources, once they have reached a point where they can produce sufficient quantities of energy at a low enough price.

The timing of the transition to a 'low carbon' economy (relying on gas/ renewable energy sources/ hydrogen fuels) is impossible to predict. A fundamental transition such as this will take decades to centuries to complete. It is also most likely occur in a gradual manner with fossil fuels slowly decreasing the portion of world energy demand that they supply.

10 Net Conservation Benefits

EP145 In considering the impact of its proposal and therefore what type of offsets may be considered appropriate, has the proponent identified a broad range of criteria for the measurement of conservation values, which reflect genetic diversity, rarity, naturalness and representativeness, fragmentation impacts, as well as area disturbed?

The Gorgon Venture has committed to implementing a program of Net Conservation Benefits in addition to best practice environmental management associated with the proposed development of a gas processing facility on Barrow Island. The activities undertaken as part of the Net Conservation Benefits program would be determined in consultation with key stakeholders and implemented via the proposed Gorgon Environment Foundation. The Gorgon Venture recognises the need for all such activities to directly relate to the conservation values of Barrow Island that may be impacted or at risk as a result of the Gorgon gas development. A preliminary list of such values is provided in Box 9-1 (ESE Review p. 177). These include some of the values listed above.

EP358 In establishing the Gorgon Environment Foundation to oversee net conservation benefits projects and programs, does the proponent intend to appoint members of the Foundation Board who have prior experience with the environment on Barrow and its nearby islands?

EP361 Does the proponent intend to involve groups with expertise in biodiversity conservation in developing a net conservation benefit strategy?

The Gorgon Venture has committed to a process which would see the establishment of the Gorgon Environment Foundation which would oversee the effective implementation of the net conservation benefits strategy. This Foundation would be comprised of representatives from government departments and/or agencies, academia, a state non-government organisation (NGO), a national NGO and the Gorgon Venture and is considered the most suitable forum to assess the suitability of proposed projects and determine appropriate quantum and outcomes against which to measure the success of projects (p. 179).

It is anticipated that some of the representatives of the Gorgon Environment Foundation would either have direct experience with the environment of Barrow Island and other nearby islands or expertise that is directly relevant to the implementation of programs or projects that relate to the conservation values of Barrow Island, such as experience in biodiversity conservation. Composition of the Foundation is open to further discussion.

EP359 Does the proponent intend to develop a clear framework and process for the delivery of net conservation benefits from the development, incorporating management of environmental impacts, reduction of the overall ecological footprint of activities (including existing operations on Barrow Island), and addressing the environmental issues beyond the mitigation of local impacts?

The Gorgon Venture has committed to implementing a program of Net Conservation Benefits in addition to best practice environmental management associated with the proposed development of a gas processing facility on Barrow Island. This best practise environmental management system would address ecological impacts arising from the development and would reduce the overall ecological footprint on the island. The Gorgon Venture is committed to the preparation and implementation of a comprehensive environmental management plan and system that would account for known and potential ecological impacts. It would also outline management options to mitigate risks (p. 272).

In addition, the Gorgon Venture would seek to enter into a formal Conservation Agreement with CALM which would provide the framework for management decisions concerning the environment of Barrow Island (p. 122, 272).

The establishment of the Gorgon Environment Foundation would oversee the effective implementation of the net conservation benefits strategy. This Foundation would be comprised of representatives from government departments and/or agencies, academia, a

state non-government organisation (NGO), a national NGO and the Gorgon Venture. It would also be a suitable forum to assess the suitability of proposed projects and determine appropriate quantum and outcomes against which to measure the success of projects (p. 179).

The ESE Review net conservation benefits strategy outlines:

- criteria for developing and selecting appropriate net conservation benefit projects
- a mechanism for implementing a net conservation benefit projects.

EP360 What is the proponent's response to the suggestion that appropriate "threshold criteria" for selecting potential conservation strategies linked with the proposed Gorgon Environment Foundation should include:

- **long-term nature conservation benefits will result;**

The Gorgon Venture agrees that net conservation benefits should be premised on the achievement of tangible long-term benefits to conservation that, to the greatest possible extent, replace and exceed the values lost or put at risk as a result of the development. The Gorgon Venture has committed to a process and funding which would see the establishment of the Gorgon Environment Foundation. The Foundation would oversee the effective implementation of the net conservation benefits strategy. The Foundation would select net conservation benefit projects and programs based on an agreed set of criteria. Criteria would include the requirement that projects should relate to the conservation values of Barrow Island and that projects should provide long-term conservation benefits (p.180).

- **critical research needs and known conservation priorities will be addressed;**

The Gorgon Venture acknowledges the importance of incorporating research into a net conservation benefits program and agrees that known conservation priorities should be taken into account when selecting projects and programs.

- **a significant improvement will result for (terrestrial and marine) bioregions linked to Barrow Island, through promoting ecosystem-based management;**

It is considered that the net conservation benefits program should be focussed on addressing the conservation values of Barrow Island as the strategy is aimed at offsetting risks to the environmental and conservation values of developing a gas processing facility on Barrow Island.

- **partnerships and co-management arrangements between industry-government-community and the leverage of other funds will be facilitated?**

The Gorgon Venture acknowledges that the success of a net conservation benefits program is reliant on the formation of strong partnerships between the Gorgon Venture, industry, government, State and Commonwealth departments, agencies, conservation organisations, the community and academic institutions. Partnerships would allow for the direct contribution of State and Commonwealth funds as well as funds from industry and academia, thereby creating leverage effects that, together with the Gorgon Venture funding, could provide sustainable funding for proposals (p. 180-181).

EP362 Why does the proponent's Sustainability Review not address the issue of net conservation benefits and provide no link to the net conservation benefits strategy?

Sustainability criterion 8.4 – Net Conservation Benefits (p. 268) of the ESE Review – requires that the development will clearly result in overall net conservation benefits that are valued by the community. The measurement statement following this states that the Gorgon Venture plans to establish the Gorgon Environment Foundation to coordinate a range of significant conservation programs that will deliver wide-ranging, long-term net conservation benefits to the community.

EP363 Does the proponent consider that the concept of "conservation" embodies ecological restoration?

The Gorgon Venture is committed to both conservation and ecological restoration no matter how they are classified. Ecological restoration is addressed under Principle 5 – Future Generations Commitment (p. 265) of the ESE Review. The Gorgon Venture believes that the environment should be restored to a condition commensurate to that prior to development so that future generations are not burdened with the legacy of rehabilitation and can also benefit from the conservation values of Barrow Island.

Sustainability criterion 5.3 – Acceptable Legacy (p. 265) – states that the proposed development for the Gorgon gas field will result in beneficial legacies, such as net conservation benefits, and will avoid legacies that may burden future generations. The Gorgon Venture's commitment to rehabilitation is outlined in the measurement statement - Commitment to Rehabilitate – which states that the Gorgon Venture will progressively rehabilitate areas of Barrow Island and the surrounding marine environment which are affected by the development.

EP364 By reference to what criteria can it be suggested that \$10m for biodiversity research "offset" this sort of footprint on an A Class nature reserve, let alone the massive greenhouse emissions associated with the project?

The Gorgon Venture believes that providing net conservation benefits is not a matter of money but results. The Venture is committed to a net conservation benefit program that delivers benefits that adequately offset the risks to the conservation values of Barrow Island. The costs of such a program would be determined in consultation with stakeholders through the Gorgon Environment Foundation. The Gorgon Venture believes the type of programs identified to date may require funding of around \$10 million.

11 Economic

EP80 Leaving aside other issues, would Trimouille Is be commercially competitive with Barrow Is?

As stated in the ESE Review (p. 47), the Montebello Islands were excluded due to their lack of usable land and history as a nuclear weapons test site. If the Health, Environment and Safety (HSE) issues with radiation and helicopter transfers, industrial relations and customer perceptions were ignored, then it would be technically feasible to build a gas processing facility on Trimouille Island; and the cost difference with Barrow Island would be relatively small. However, the proposed gas processing facility could not accommodate 300 ha and would not support full development of the Greater Gorgon gas fields.

EP81 If carbon dioxide re-injection was not required, what would be the most commercially competitive option and by how much?

Barrow Island remains the most competitive option for the proposed development, even without carbon dioxide re-injection. However, its cost advantage over the alternatives is reduced by the CO₂ return pipeline cost for those locations.

EP82 If carbon dioxide re-injection was not required, what level of extra resources would be liberated for other actions, like offsets?

Section 8.8.7 of the ESE Review states that the capital cost for the removal of CO₂ is approximately \$400 million for two trains of LNG, and a further capital cost of the injection system would be between \$300 and \$400 million. These resources would not necessarily be directed to offsets as these need to be determined by the magnitude of the risk to the conservation value of Barrow Island rather than the proponent ability to pay.

The Gorgon Venture believes that a gas processing facility on Barrow Island with reservoir CO₂ re-injection offers the best combination of environmental (including greenhouse) economic and social factors. While the financial commitment for CO₂ re-injection is substantial, the net emissions benefit is much larger and more achievable than for other offset options.

EP83 Why are the statements in Figure 4-5 inconsistent with the data in Table 4-3? Eg. "Montebello Islands, present the lowest development cost."

Fig 4.5 only refers to generic site development costs like dredging, site preparation and jetties. Table 4.3 is comprehensive and includes Operating Costs and CO₂ re-injection.

EP84 What is the realistic possibility for external sales of CO₂ from Barrow Island when this proposal envisages no other industrial development on Barrow other than the gas processing complex with its foundation customer?

The gas processing facility would include a CO₂ removal plant to remove reservoir CO₂ from the gas stream. The Gorgon Venture plans to re-inject this CO₂ into a saline reservoir beneath Barrow Island. The Gorgon Venture has investigated without success market opportunities for the use of large volumes of CO₂. If a commercial opportunity should arise for utilising this pure CO₂ by product, some or all of it could certainly be piped or shipped to a customer. The Gorgon Venture would welcome such an opportunity should it arise.

EP90 Noting that it costs an extra ~\$180m to locate the plant site at Town Point (compared to other options like Surf Point), why is it concluded at the foot of p48 that "Barrow Island currently represents the only commercially viable development option" when Table 4-3 lists the relative cost of Trimouille Is as being +\$70m?

As stated in the ESE Review (p. 47), the Montebello Islands were excluded due to their lack of usable land and history as a nuclear weapons test site. Barrow Island has been

identified as the only acceptable location where the development would be commercially competitive. Whilst the Montebello Islands could also be cost competitive, they carry high commercial, legal and reputation risks so have been rejected by the Gorgon Venture.

EP91 What assumptions concerning the price of gas transport have been incorporated into the modelled domestic gas price reduction?

Although many details of economic modelling have been provided in the ESE Review, extending this disclosure to individual gas transport legs would be commercially sensitive.

EP92 What arrangements have been made for the proposal to cross the East Spar lateral pipeline?

ChevronTexaco are very well aware of this pipeline and will account for it in the detailed design stage of the project in consultation with the East Spar pipeline Operator, Apache.

12 Indigenous

EP356 Evidence for Aboriginal occupation of Barrow Island has been found in the past but that the extent and importance of the finds has not been fully evaluated. Does the proponent intend to conduct a thorough archaeological investigation on Barrow Island?

The cultural heritage assessment presented in the ESE Review (Chapter 12, p. 226) was based on a search of the Aboriginal Site Register, a study of previous research material and a systematic field survey for Aboriginal sites that was commissioned by West Australian Petroleum (WAPET) in 1994. The field survey involved pedestrian and vehicular transects throughout Barrow Island.

Further assessment of the proposed development would be undertaken if in-principle approval is granted for restricted use of Barrow Island. This would include a thorough investigation of all aspects of Barrow Island's cultural heritage which would be undertaken by a suitably qualified archaeologist.

EP357 According to Tindale's Aboriginal Tribes of Australia, Barrow Island was frequented by the Noala people, and therefore should be covered by an Aboriginal Land claim under Native Title. Has the proponent investigated Native Title claims on Barrow Island?

There are no native title claims over Barrow Island or the surrounding waters. Barrow Island is a Class A Nature Reserve vested in the Conservation Commission of Western Australia. The island is also subject to Petroleum Lease L1H which was granted to West Australian Petroleum Pty Ltd in 1967 under the *Petroleum Act 1936* and is now held jointly by ChevronTexaco, ExxonMobil and Santos.

There are a number of native title claims that cover mainland areas and adjoining offshore waters along the West Pilbara coastline facing Barrow Island.

The Gorgon Venture would brief and consult with native title claimants regarding any parts of the development that may occur on claim areas.

13 Heritage

EP352 Has the proponent comprehensively researched the cultural heritage values of Barrow Island, with respect to its role in the development of the petroleum industry in the Pilbara and the pearling industry?

Cultural heritage associated with the petroleum and pearling industries would not be affected by the proposed Gorgon gas development. There are no pearling industry sites near the proposed development site. A cultural heritage management plan that addresses aboriginal, oil industry and the pearling industry heritage would be developed if in-principle approval is granted. This would be developed in consultation with relevant stakeholders

EP353 What is the current status of the built heritage on Barrow Island, including infrastructure associated with the progressive resource development in the areas, and facilities provided for employees?

There are currently no registered European heritage sites on Barrow Island. The only existing infrastructure within the proposed development area is the terminal storage tanks, oil load-out line, and flow line to the terminal tanks. All of this infrastructure is still in use and is currently not considered to be of heritage interest.

EP354 With respect to Section 12.10.1, please clarify which statements relate to indigenous heritage sites, archaeological sites and European heritage sites.

The 12 Aboriginal sites reported in the ESE Review are archaeological sites, all of which are comprised of surface artefact scatters. No other sites of Indigenous or European heritage interest have been identified within, or adjacent to, the proposed development area.

EP355 Does the proponent intend to compile a heritage Conservation Plan addressing both built elements and archaeological sites, and including a fully researched history of the location, detailed physical descriptions of elements of interest, and proposals for interpretation and management strategies?

If the proposed development proceeds on Barrow Island, a cultural heritage management plan would be developed to ensure that all cultural heritage sites, including both built elements and archaeological sites on Barrow Island, are protected. Development of a cultural heritage management plan would be guided by additional survey work and consultation with stakeholders.

14 Sustainability

EP85 Why has the proponent included international competitiveness as a sustainability criterion, when competitiveness has nothing to do with sustainability and in fact is a central tenant of neoclassical economics which it has been claimed, contributes to the present unsustainability of the global economic system?

EP86 Does the proponent recognise that economic growth, as opposed to steady-state economics, is a key area of disagreement in the sustainability debate and that the pursuit of ever-increasing economic growth is seen by many as standing in the way of alternative, sustainable economic models?

The Gorgon Venture believes that the integration of environmental, social and economic priorities is one of the key objectives of sustainable development. The Gorgon Venture considers that it is important for the proposed development to contribute to strengthening the economy as this would provide opportunities for community growth and diversification.

The aim of the sustainability criterion 1.2 (p. 261) of the ESE Review is to demonstrate that the development would contribute to increased competition in the energy market which would, in turn, contribute to the long-term viability of the local, regional and national economies. This would also assist in providing opportunities for growth and diversification.

This approach is in keeping with both the National Strategy for Ecologically Sustainable Development (NSED) and the Western Australian State Sustainability Strategy (WASSS).

One of the core principles of NSED is, "to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations". A guiding principle of the NSED states that, "the need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised."

Similarly, one of the foundation principles of the WASSS states that, "sustainability recognises the needs of current and future generations for long-term economic health, diversity and productivity of the earth."

The Gorgon Venture is committed to delivering social and economic benefits to Australia, Western Australia and the Pilbara region as a result of developing the Gorgon gas field.

EP87 Why has the proponent included its own profitability as a sustainability criterion?

The Gorgon Venture considers profitability, and hence the financial viability of the development, to be a key determinant of the success of the sustainability framework. There would be significant operational and incremental costs associated with the numerous environmental and net conservation benefit initiatives and commitments outlined in the ESE Review that could only be met if the development is financially viable.

EP88 If this proposal is claimed to be sustainable, how will the "range of industries that rely on the availability of abundant, competitive supplies of gas" be sustained when the gas runs out?

The Gorgon Venture believes that the use of natural gas as an energy source is currently the most feasible solution to meet energy demand on a large-scale. Through technological development, it is anticipated that long-term solutions will be available in the future to produce the quantity of energy required by the community.

EP89 How did the proponent arrive at the view that "the Gorgon Gas Development will contribute to the ability of future generations to meet their economic and technological needs"?

Development of the Gorgon gas field, as detailed in the ESE Review, would provide long-term economic, strategic and social benefits which would foster growth and development of further benefits and opportunities for future generations. The development would provide energy in the short- to medium-term that would support the communities expected standard of living and enable continued technological development. In addition, development of the gas resource would enhance skills training and research and development opportunities, including research and development of the first CO₂ re-injection facility in Australia – and that would contribute to inter-generational technology transfer and capacity building.

The Gorgon Venture is also committed to implementing a comprehensive net conservation benefits program that would provide wide-ranging, long-term net conservation benefits to the community. The Gorgon Venture has proposed establishing a "Gorgon Environment Foundation" to deliver these benefits.

The Gorgon Venture believes that the use of natural gas as an energy source is currently the most feasible solution for the provision of energy on a large-scale which can contribute to lowering global greenhouse gas emissions. Natural gas is relatively clean burning and has the lowest life-cycle greenhouse gas emissions of any fossil fuel.

EP403 What is the proponent's response to the suggestion that this proposal can be summarised as an attempt by a foreign-owned fossil fuel company to extract a non-renewable resource from an A Class Nature Reserve while injecting millions of tonnes of greenhouse gas into the atmosphere, and therefore cannot be considered to be "sustainable", and that its sustainability principles have been designed to suit the parameters of this project and not to reflect a true state of sustainability?

The Gorgon Venture believes that the use of natural gas as an energy source is currently the most feasible solution to meet energy demand on a large-scale.

The Western Australian government has acknowledged the greenhouse gas emission benefits of natural gas as demonstrated in the *Western Australia and Greenhouse Issue Paper* (2002) which states:

"Strategically, Western Australia should expand the use of its natural gas resources and make them available to the rest of the world, while still meeting our greenhouse gas responsibilities. If we are able to do this we will be able to contribute to lower global greenhouse gas emissions by:

- *displacing other more greenhouse intensive fuels, such as coal or petroleum, in Australia and overseas countries; and*
- *using the resources in Western Australia to produce goods or materials using cleaner and more environmentally friendly technologies that are used overseas."*

Natural gas is relatively clean burning and has the lowest life-cycle greenhouse gas emissions of any fossil fuel. Through technological development it is hoped that better solutions will be available in the future to produce the quantity of energy required by the community.

According to the Gorgon Venture's assessment, the LNG facility proposed for Barrow Island would be the most greenhouse gas efficient LNG facility in the Asia-Pacific region and one of the most efficient in the world (p. 156 of the ESE Review). This level of performance would be achieved through the integration of the greenhouse gas management strategy, which includes geological sequestration of CO₂, into plant design from the early conceptual design stage through to plant operation.

It is the Gorgon Venture's belief that the ten sustainability principles and 32 sustainability criteria outlined in Chapter 14 of the ESE Review reflect the meaning and intent of both the Brundtland Report's definition of sustainability and the Western Australian Government's definition of sustainability.

EP404 How does the proponent reconcile its sustainability principles with definitions such as those cited in the Brundtland Report and the Australian National Strategy for Ecologically Sustainable Development, as well as the six core concepts of sustainability described by Jacobs:

It is the Gorgon Venture's belief that the sustainability principles and criteria outlined in Chapter 14 of the ESE Review reflect the meaning and intent of both the Brundtland Report's and the Western Australian Government's definitions of sustainability.

Jacobs' six core concepts of sustainability, and the Gorgon Venture's position on each concept, are outlined below:

- **Environment-economy integration**

The Gorgon Venture believes that the integration of environmental, social and economic priorities is one of the key objectives of sustainable development.

- **Futurity**

Sustainability Principle 5 of the ESE Review – Future Generations Commitment – states that the Gorgon gas development will meet the needs of the present generation and assist future generations to meet their needs (p. 265).

- **Environmental protection**

Sustainability Principle 6 of the ESE Review – Efficient Resource Use – states that international best practice and continual improvement principles will be applied to manage resources and wastes efficiently (p. 266).

Sustainability Principle 3 of the ESE Review – Biodiversity and Ecological Integrity Protection of Barrow Island – states that the Gorgon gas development will not disrupt ecological structure and function, nor will it result in a loss of biological diversity on Barrow Island (p. 263).

- **Equity**

Sustainability Principle 4 of the ESE Review – Social Equity and Community Well-being Enhancement – states that communities will benefit from improved quality of life and well-being resulting from contributions of the Gorgon gas development such as creation of jobs (p. 264).

- **Quality of life**

Sustainability Principle 4 of the ESE Review – Social Equity and Community Well-being Enhancement – states that communities will benefit from improved quality of life and well-being resulting from contributions of the Gorgon gas development such as creation of jobs (p. 264).

Sustainability Criterion 4.4 – Community Well-being – states that community well-being will be sustained by effective identification and management of potential impacts on people's way of life, their culture or communities (p. 264).

- **Participation**

Sustainability Principle 9 of the ESE Review – Stakeholder Engagement – states that the Gorgon Venture will seek the views of stakeholders and take their interests into account throughout the development of the Gorgon gas fields.

EP405 Why has the proponent made no attempt to document how it would assess its performance against its 10 sustainability principles?

Performance against the ten sustainability principles will be assessed using the 32 sustainability measurement criteria outlined in Chapter 14 of the ESE Review (p. 259, para 5, p. 261).

The Gorgon Venture is committed to the highest standards of governance and accountability. If the proposed development of the Gorgon gas field proceeds, the Venture would report regularly to the community on the sustainability performance of the development in relation to the ten sustainability principles and 32 measurement criteria (p. 270). The Gorgon Venture would also produce a publicly available annual sustainability report for the Gorgon gas field development – as noted on p. 270 of the ESE Review.

EP406 Why has the proponent not presented this review in a sustainability framework which more effectively addresses the negatives (for example the unsustainability of burning fossil fuels in the global context) as well as the positive implications of the proposal?

The Gorgon Venture believes that the ten sustainability principles and 32 measurement criteria presented in the ESE Review reflect the fundamental values and tenets of sustainability and accounts for all issues that are relevant to the sustainability of the proposed development of a gas processing facility on Barrow Island. This includes specific sustainability measurement criteria that address greenhouse gas and waste and emissions management; and commits the Gorgon Venture to managing these issues in accordance with world best practice.

EP407 How will the proponent ensure that decision-makers are prevented from trading environmental goals for economic goals?

The sustainability framework presented in the ESE Review requires all ten principles and 32 criteria of sustainability to be met in order for sustainability to be achieved. As noted throughout the ESE Review, the Gorgon Venture is committed to meeting all of the sustainability principles and criteria which would be reported annually in a public document.

EP408 How can the proponent demonstrate that it is complying with the precautionary principle (sustainability principle 7)?

The Gorgon Venture has committed to a number of precautionary principle measures under Sustainability Principle 7 of the proposed sustainability framework detailed in the ESE Review (p. 267). This includes a commitment to:

- Adopt best practice management for planning, construction, operation and decommissioning of the development.
- Develop a specific Gorgon gas development Environmental Management System and Environmental Management Plan to manage potential environmental impacts and risks and ensure that environmental responsibilities are fulfilled.
- Implement a comprehensive greenhouse gas management plan which results in the LNG facility on Barrow Island being one of the most efficient plants in the world.
- Initiate, participate in and support scientific research programs relevant to the development.
- Undertake monitoring through a comprehensive environmental inspection, monitoring and auditing program.
- Conduct risk assessment and management to ensure that all environmental risks and hazards are identified, assessed and appropriately managed.
- Develop and implement a Gorgon gas development emergency management and response system.

15 Operations

EP366 Is there a contingency plan in event of pipeline leaks?

ChevronTexaco always operates with appropriate contingency plans in place in case of an emergency. The design of the gas transport system would comply with industry standards and regulatory requirements that aim to minimise the probability of any leak ever occurring. If the proposed development proceeds, the emergency response plan for the development would need to be developed and approved by DoIR prior to operation.

EP213 How long does the proponent realistically estimate it would be on Barrow Island (considering that the stated life expectancy of the existing oilfield was 20 years in 1960 and it is still operating)?

EP365 What is a realistic estimate of the likelihood that the gas complex will be operational beyond the nominal 30 year project life? What duration would be realistic, based on discoveries in the Greater Gor[d]on area and prospects beyond that?

The current estimate for the operational duration of the gas processing facility on Barrow Island is 30 years. This period could be extended if further gas discoveries are made in the Greater Gorgon area.

The Barrow Island oilfield has continued beyond its originally foreseen life of 20 years due to improvements in technology and as a result, the economy of WA and Australia has greatly benefited.

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