

Final Environmental Impact Statement/Response to Submissions on the Environmental Review and Management Programme

for the Proposed Gorgon Development



May 2006



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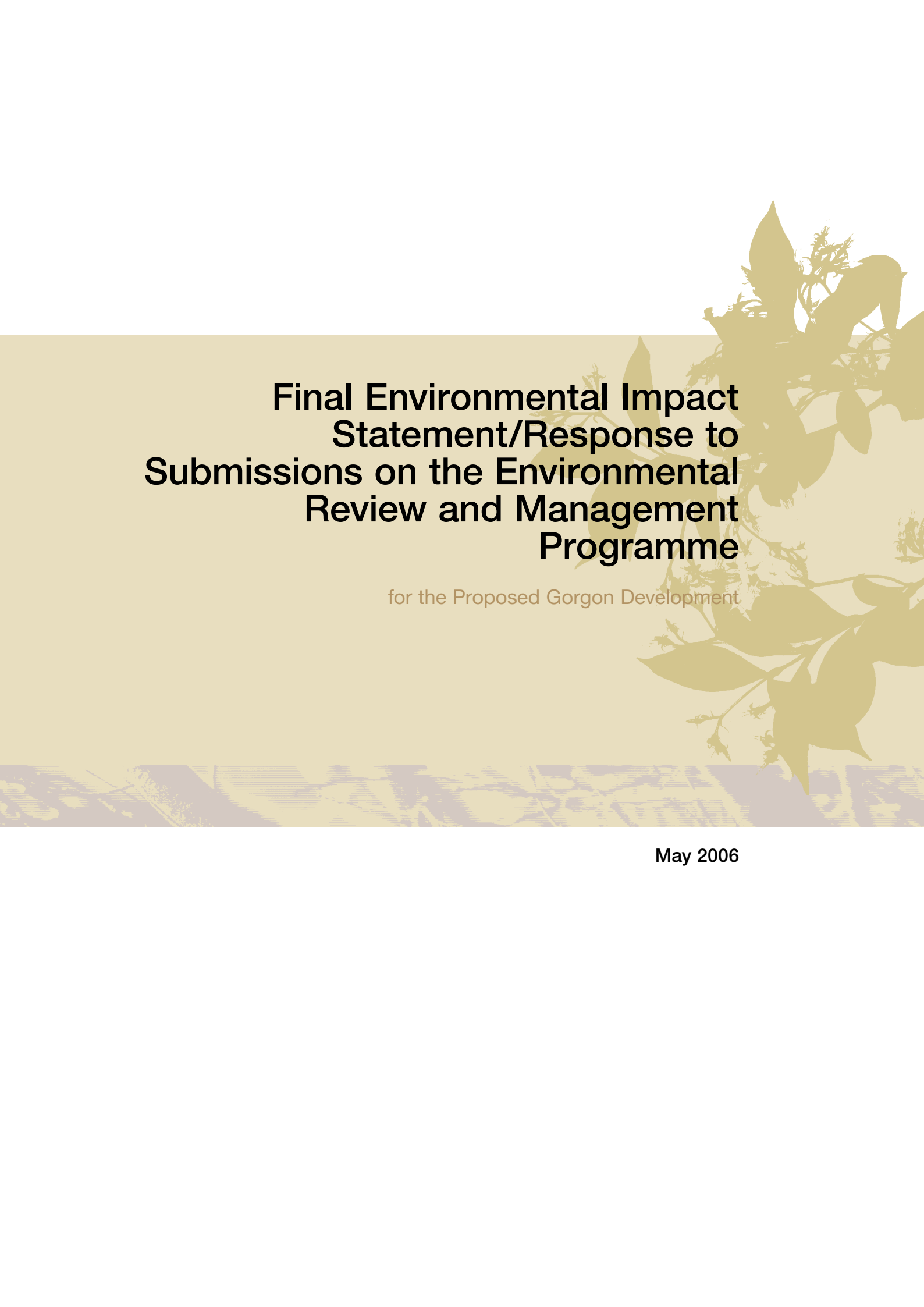
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Contents

Part A – Design Refinements.....	1
Part B – Response to Submissions.....	55
Part C – Technical Report on the Outcomes of Additional Dredge Modelling to Inform Impact Prediction.....	405



Part A – Design Refinements

Final Environmental Impact Statement/
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Contents

1	Introduction.....	3
2	Footprint/Location.....	11
2.1	Proposed Revisions	11
2.1.1	Initial Workforce Accommodation	11
2.1.2	Construction Village.....	12
2.1.3	Administration Buildings and Operations Centre	15
2.1.4	Marine Facilities.....	21
2.1.5	Domestic Gas Pipeline Shore Crossing	23
2.1.6	Barge Landing	23
2.2	Clarification	26
2.2.1	Airport Upgrades	26
2.2.2	Utilities Area.....	29
2.2.3	Utilities Corridor.....	31
2.2.4	Operations Workforce Accommodation	35
2.2.5	Feed Gas Pipeline Shore Crossing.....	37
2.2.6	Onshore Feed Gas Pipeline Route	40
2.2.7	CO ₂ Injection Pipeline Route	43
3	Design	47
3.1	Proposed Revisions	47
3.1.1	LNG Plant Layout	47
3.1.2	Condensate Tank Size.....	47
3.1.3	Energy Optimisation	48
3.2	Choice of Option.....	50
3.2.1	Feed Gas Pipeline Installation	50
3.2.2	Condensate Load-out.....	51
3.2.3	Flare	51
3.2.4	Condensate Loading Parcel Size	53
4	References	54

1 Introduction

As is common for large developments, and as indicated in the Draft EIS/ERMP, the environmental assessment process was conducted in the early design phase when much of the development was at the conceptual level (refer to Draft EIS/ERMP, pg 306). Since the release of the document, front-end engineering and design (FEED) work has continued to result in improved definition and a small number of refinements to the development concept outlined in the Draft EIS/ERMP.

The following sections describe the outcomes of progress in this area. In particular, the FEED work has resulted in:

- Refinements to the location or footprint, from that described in the Draft EIS/ERMP
- Improved definition of the location or footprint of development components
- Design revisions that have no footprint or location implications
- The choice of the preferred option for development components for which a number of alternatives were outlined in the Draft EIS/ERMP

A summary of key elements of the proposed Gorgon development is provided in Table 1, which is an update of Table 1-2 of the Draft EIS/ERMP (Page 11). The first column of this table shows whether each aspect is a deletion, revision, choice or clarification when compared with the Draft EIS/ERMP. If left blank it indicates no change. The middle three columns describe the concept as included in the Draft EIS/ERMP and the final column shows a high level comment regarding the current proposal. Further details on selected aspects are provided in the following sections.

Table 1:
Key Elements of the Proposed Gorgon Development *(Revised Draft EIS/ERMP Table 1-2)*

Category	Element	Description	Detail (As per Draft EIS/ERMP)	Proposal
	Project timeline	Commence construction	Late-2006	No change
		First shipment of LNG	Mid-2010	No change
		Development life	60 years	No change
	Size of recoverable resource	Gorgon field	0.27 Tm ³ (9.6 Tcf) (technically proven and certified)	No change
	Leases	Gorgon field	WA-2-R; WA-3R	No change
	Typical gas composition	Gorgon field	CO ₂ = 14–15%; N ₂ = 2–3%; Hydrocarbon = remainder	No change
		Jansz field	CO ₂ = < 1%; N ₂ = 2%; Hydrocarbon = remainder	No change
	Wells	Design	Subsea	No change
		Location	Gorgon gas field	No change
		Number	18–25	No change
	Feed gas pipeline	Total length	84 km (approx)	No change
		Length offshore	70 km (approx)	No change
		Length in state waters	5.6 km (i.e. 3nm)	No change
		Indicative route offshore	Refer Draft EIS/ERMP Figure 1.4 Page 9 (North White's Beach route) – refer to Section 2.2.5)	No change
		Length onshore (Barrow Island)	14 km (approx)	No change
Choice		Design onshore	Above ground on pipe supports (Draft EIS/ ERMP Box 6-3)	Buried (approx 1000 mm cover) – refer Section 3.2.1
		Construction easement (onshore)	42 ha (approx)	No change

Table 1:

Key Elements of the Proposed Gorgon Development (Revised Draft EIS/ERMP Table 1-2) (continued)

Category	Element	Description	Detail (As per Draft EIS/ERMP)	Proposal
Choice		Shore crossing	North White's Beach (Draft EIS/ERMP Section 6.2.2). Flacourt Bay fallback.	North White's Beach (refer to Section 2.2.5)
Revision		Route onshore	Refer to Draft EIS/ERMP Figure 8.13 Page 233	Refer to Section 2.2.6
	Domestic gas pipeline	Length offshore	70 km (approx)	No change
Revision		Length onshore (mainland)	30 km (approx)	30–40 km. Studies are ongoing to determine the environmentally preferred mainland shore crossing location. Refer Section 2.1.5
Revision		Construction easement (mainland)	90 ha (approx)	90–120 ha
		Offshore route	Essentially direct line – refer Draft EIS/ERMP Figure 1.4 Page 9	No change
Revision		Shore crossing	Immediately to the south of the existing Apache Energy Sales Gas Pipeline	Studies are ongoing to determine the environmentally preferred mainland shore crossing location. Refer Section 2.1.5
Revision		Mainland route	Immediately to the south of, and running parallel to, the existing Apache Energy Sales Gas Pipeline	Studies are ongoing to determine the environmentally preferred combination of mainland shore crossing location and onshore pipeline route. Refer Section 2.1.5.
	CO ₂ injection pipeline	Length	< 5 km	No change
		Easement	< 6 ha	No change – refer Section 2.2.7
	Gas processing facility	Location	Town Point refer to Draft EIS/ERMP Figure 6.10 Page 122	No change
		Number of LNG trains	2	No change
		Size of LNG trains	5 MTPA nominal	No change

Table 1:

Key Elements of the Proposed Gorgon Development (Revised Draft EIS/ERMP Table 1-2) (continued)

Category	Element	Description	Detail (As per Draft EIS/ERMP)	Proposal
Revision		Indicative plant layout	Trains 1 and 2 built on south side.	Trains 1 and 2 built on north side. Refer Section 3.1.1.
		LNG tank size	Approx 135,000 – 155,000 m ³ net each	Approx 135,000 – 165,000 m ³ net each. Negligible change.
Revision		Energy optimisation	Boilers required	Boilers deleted, but direct fired heaters required for startup and rare operational scenarios. Refer Section 3.1.3
			DLN on compression turbines (4 x 80MW)	No change – Refer Section 3.1.3
Revision			DLN on power generation turbines (3 x 116 MW)	Conventional 4 x 116 MW for reliability of supply. Refer Section 3.1.3
Revision		NO _x Emissions	4430 tonnes per annum	6100 tonnes per annum, ground level concentrations reduced due to improved dispersion. Refer Section 3.1.3
Choice		Flare design	Elevated flare (150 m)	Ground flare for main plant flare – refer Section 3.2.3. Elevated flare in storage and loading area (rarely used).
		Domestic gas production rate	300 TJ/day	No change
		Condensate production rate	2000 m ³ /day hydrocarbon condensate	No change
Revision		Condensate tank size	2 x 35,000 m ³	2 x 60,000 m ³ – refer Section 3.1.2
Choice		Condensate load-out concept	Via existing WA Oil loading line or new subsea line or new dedicated line installed on the proposed jetty	Via a new dedicated line installed on the proposed jetty – refer Section 3.2.2
Choice	Construction village	Location	Four options still being investigated. Base Case immediately south of Gas Processing Facility	2.6 km south of Gas Processing Facility (refer to Section 2.1.2)

Table 1:

Key Elements of the Proposed Gorgon Development (Revised Draft EIS/ERMP Table 1-2) (continued)

Category	Element	Description	Detail (As per Draft EIS/ERMP)	Proposal
Deletion		Schedule	Pioneer Camp proposed	Pioneer Camp concept disregarded – refer Section 2.1.1
Revision	Administration and Operations Complex	Composition	Operations centre located within gas processing facility. Administration complex to comprise: <ul style="list-style-type: none"> • Administration buildings • Maintenance centre • Canteen • Fire station • Medical clinic • Laboratory • Mobile equipment storage • Substation 	Operations centre located within Administration complex outside plant boundary – refer Section 2.1.3
Clarification		Location	Near the gas processing facility	refer Section 2.1.3
Choice	Utilities area (Construction)	Location	Near the construction village or near the gas processing facility	Near the gas processing facility – Refer Section 2.2.2
Clarification	Roads	Designated for upgrade	Upgrades of key roads will involve grading, sealing, widening and straightening as appropriate	Upgrade to roads: <ul style="list-style-type: none"> • WAPET Landing to Town Point • Town Point to the Airport (via Construction Village) • Feed gas pipeline route.
	Water supply	Source	Exploratory wells as base case. Options being considered deep well (i.e. CO ₂ data well) and seawater intake.	No change (awaiting hydrogeological survey results) Should sea water intake be required sensitive features on East Coast will be avoided.
		Location	Exploratory wells (as base case) covered by investigatory works.	No change
Clarification		Volume	4500 m ³ /day (approx) raw water supply	5150 m ³ /day (approx) raw water supply

Table 1:

Key Elements of the Proposed Gorgon Development (Revised Draft EIS/ERMP Table 1-2) (continued)

Category	Element	Description	Detail (As per Draft EIS/ERMP)	Proposal
Choice	Waste water treatment		Tiered system to enable separate treatment (if any). Separate treatment of grey and black water to enable reuse.	Tiered system – no change. Combined black/grey water treatment.
	Waste water disposal		Reinjection (deep) of surplus treated effluent.	No change to base case Ocean outfall of treated stream under review as fallback.
			Reinjection (deep) of RO brine as base case, ocean outfall an option.	No change Ocean outfall of treated stream under review as fallback.
			Reinjection (deep) of contaminated streams such as storm water as base case.	No change Ocean outfall of treated stream under review as fallback.
	Power generation and supply (Construction Phase)		Located in the utilities area. Investigate connection to existing supply.	No change
	Utilities corridors	Location	Between utilities area, construction village and gas processing facility.	No change Refer Section 2.2.2.
Clarification	Airport	Modifications	Extension, but may require realignment	Extension of existing runway to the south. No realignment. Refer Section 2.2.1
	Air emissions	Volume of greenhouse gases (with CO ₂ injection)	4.0 million tonnes of CO ₂ e per annum	No change – refer Section 3.1.3 and Section 3.1.4
		Total SOx	0.15 tonnes per annum	No change
		Total particulates (PM10)	241 tonnes per annum	No change (expect lower with ground flare – refer Section 3.2.3)
	Port facilities	Causeway Design	Solid	No change
		Causeway Length	800 m (approx)	No change
		Materials offloading facility (MOF) design	Solid	No change
Revision		MOF length	325 m (approx)	520 m – Refer Section 2.1.4

Table 1:

Key Elements of the Proposed Gorgon Development (Revised Draft EIS/ERMP Table 1-2) (continued)

Category	Element	Description	Detail (As per Draft EIS/ERMP)	Proposal
Revision		MOF access	Constructed channel 1.3 km long x 120 m wide, dredged to 6.5 m relative to chart datum	1.6 km long (approx) – Refer Section 2.1.4
		LNG Jetty design	Open pile structure	No change
Revision		LNG jetty length	3.1 km	2.7 km (approx) – Refer Section 2.1.4
Clarification		Turning basin and access channel design	Turning basin 1 x 900m circle, channel 300m wide minimum	No Change. Options still being investigated – Refer Section 2.1.4
		Turning basin and access channel depth	Dredged to 14 m relative to chart datum	No change. Options still being investigated – Refer Section 2.1.4
		Barge Landing	Use WAPET Landing, as the MOF will not be available	Upgrade WAPET Landing – refer Section 2.1.5
Revision	Dredging	MOF Volume	0.8 Mm ³	1.1 Mm ³ – Refer Section 2.1.4
		MOF dredging program duration	21 weeks (approx)	No change
Revision		LNG turning basin and access channel	7.0 Mm ³ (single berth)	6.5 Mm ³ (dual berth) Options still being investigated, Refer Section 2.1.4
Clarification		LNG turning basin and access channel program duration	45 weeks (approx)	42 weeks (approx)
	Dredge spoil ground	Location	Closest point approx 10km from East Coast of Barrow Island	No change
		Area	1500 ha	No change
Choice	Optical fibre cable	Route	Barrow Island to Onslow or Peedamulla. Refer Draft EIS/ERMP Figure 6.18 Page 139	No change. Use MOF at Barrow Island
	Shipping	LNG export shipments	3 (approx) per week	No change
		LNG ship size	Design to allow 215,000m ³ ship	No change
Revision		Condensate export shipments	1 (approx) per month	1 (approx) per 2 months – refer Section 3.2.2

Table 1:

Key Elements of the Proposed Gorgon Development (Revised Draft EIS/ERMP Table 1-2) (continued)

Category	Element	Description	Detail (As per Draft EIS/ERMP)	Proposal
Revision		Condensate parcel size	300,000 barrels or 50,000 cubic metres (approx)	600,000 barrels or 100,000 cubic metres (i.e. standard tanker size) – refer Section 3.2.4
	Workforce	Number of personnel on Barrow Island at peak	3300 (approx)	No change
		Total number of operations personnel	600	No change
		Number of operations personnel on Barrow Island	150–200	No change – refer Section 2.2.4
		Number of operations personnel on rotation (off the island)	150–200	No change
		Number of operations personnel in Perth office	200–300	No change
	Development Investment	Total investment	\$11 billion (approx)	No change. Class III estimates are being prepared to support project sanction.

2 Footprint/Location

2.1 Proposed Revisions

The Draft EIS/ERMP described each of the proposed Development components and provided an assessment of the associated potential environmental impacts. The proposed location or footprint of each component was described in as much detail, and with as much certainty, as was possible at the time. Where options were still under consideration, or where further engineering work has taken place to increase definition, updates to the information published in the Draft EIS/ERMP are provided.

All potential environmental impacts will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). No unique challenges have been identified that require new or significantly different management approaches from those contained in the Framework EMP. It is concluded that each of these refinements results in a better, or at least equivalent, environmental outcome.

The following addresses each of the more significant design refinements which have a footprint/location aspect.

2.1.1 Initial Workforce Accommodation

The Draft EIS/ERMP outlined the need for a Pioneer Camp to accommodate a workforce of approximately 250 people to mobilise equipment, undertake site preparations and install the main construction village (refer to Draft EIS/ERMP Section 6.3.6 Page 134). As indicated in the Draft EIS/ERMP, the construction of the pioneer camp did not form part of the proposal as it was to be constructed during the Draft EIS/ERMP assessment period and as such would need to be the subject of a separate approval process.

The Gorgon Joint Venturers have revised construction scheduling to avoid the need for a Pioneer Camp on Barrow Island prior to Environmental approval. The Joint Venturers continue to examine options for initial workforce accommodation.

2.1.2 Construction Village

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP identified a proposed location for the Construction Village and six alternatives (Draft EIS/ERMP Figure 6.6 Page 106 and Section 6.3.6 Page 134). While the impact assessment was conducted on the proposed location, it was highlighted that four sites were still under consideration. These sites were to be the subject of more detailed environmental, operational and engineering investigations.

Proposed Location

The more detailed investigations have been completed and considered topography, buffer distances from the gas processing facility associated with emissions and noise, flora, fauna and workforce travel logistics. The results of these investigations have allowed the Joint Venturers to finalise the proposed location

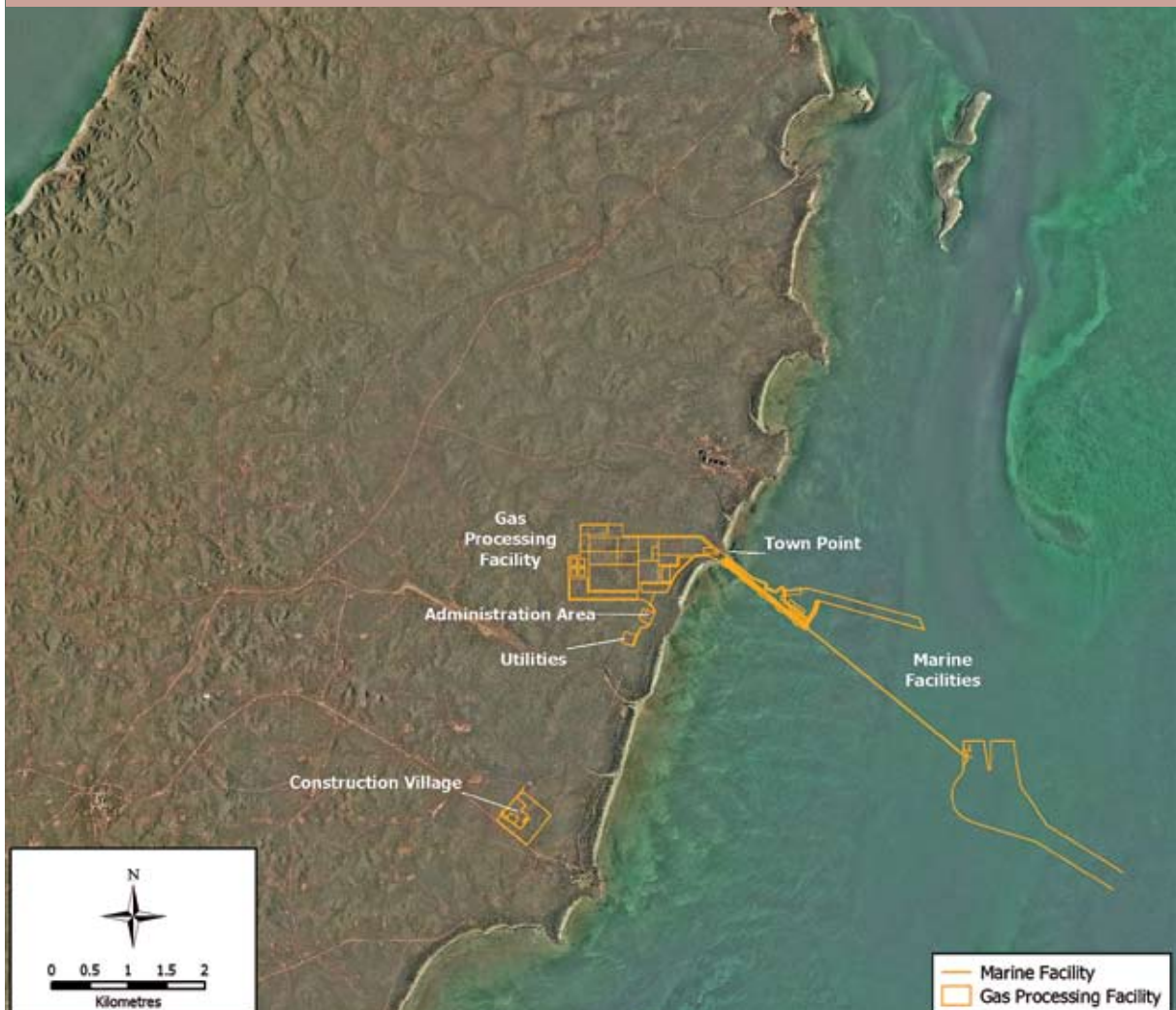
as a site which is a combination of locations CVX1 and CVX2 nominated in the Draft EIS/ERMP (refer Figure 6.17 Page 136). The site is approximately 2.6 km south-west of the gas processing facility and approximately 800 m west of the nearest accommodation building at the existing Chevron operations camp (Figure 1).

Environmental Implications

Vegetation and Flora

Detailed vegetation and flora surveys have been conducted for the proposed location in accordance with EPA Guidance Statement No. 51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004). The area surveyed is shown in Figure 2 and is superimposed with the proposed location of the Construction Village infrastructure. This figure also shows the buffer region,

Figure 1:
Proposed Location of the Construction Village



which was mapped to provide an understanding of the broader distribution of vegetation communities around the site. All geographic coordinates were recorded on hand held GPS units and plants were identified on site and representative samples collected to confirm identifications. These surveys have confirmed that the biodiversity and environmental factors prevailing on that site are equal to or of lower conservation significance than those of the location outlined in the Draft EIS/ERMP.

The vegetation comprised 14 vegetation associations, or communities. The main communities present at the proposed construction village location are listed in Table 2.

No Declared Rare Flora species, as listed under subsection (2) of Section 23F of the Western Australian *Wildlife Conservation Act 1950* or as listed by the Department of Conservation and Land Management (CALM) were located during the survey of the Construction Village and wider survey area. No priority species as listed by CALM were located during the surveys.

Two species that have restricted distributions on Barrow Island and so are considered to be of conservation significance on Barrow Island or are important to threatened fauna and so are considered to be of conservation significance on Barrow Island *Grevillea pyramidalis* subsp *?leucadendron* and *Melaleuca cardiophylla* occur within the proposed construction village area and wider survey area.

Results of the survey are shown in Figure 2, which expands upon the key shown in the Draft EIS/ERMP Chapter 8 Page 228. The main communities present at the proposed construction village location are listed in Table 2.

Fauna

Further detailed fauna surveys were also conducted for the preferred site in accordance with EPA Guidance Statement No. 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004). The same area was surveyed as that surveyed for flora.

The objective of the fauna surveys was to characterise the faunal assemblages of the proposed development areas and to determine the significance of these areas for Barrow Island's endemic terrestrial fauna. An area would be considered of high conservation significance if it:

- supported an unusually high species richness or abundance compared with other parts of Barrow Island;
- contained faunal habitats that were not well represented in other parts of the island;
- contained habitat for site restricted fauna of high conservation significance; for example burrowing bettong warrens; or
- was in a location where development impacts may extend beyond the boundaries of the site and the impacts may lead to the disruption of ecological processes, for example wildlife dispersal.

Table 2:
Proposed Vegetation within the Proposed Construction Village

Community Code	Vegetation Description
F8a	Low Open Shrubland to Open Shrubland of <i>Acacia bivenosa</i> , with the occasional scattered <i>Pentalepis trichodesmoides</i> , <i>Stylobasium spathulatum</i> and <i>Acanthocarpus verticillatus</i> shrubs over Hummock Grassland to Closed Hummock Grassland of <i>Triodia wiseana</i> with occasional <i>Triodia angusta</i> on flats and valley floors.
F8c	Scattered tall <i>Acacia coriacea</i> shrubs Low Open Shrubland of <i>Acacia bivenosa</i> and <i>Pentalepis trichodesmoides</i> with scattered <i>Trichodesma zelanicum</i> , <i>Indigofera monophylla</i> and <i>Solanum lasiophyllum</i> shrubs over Hummock Grassland to Closed Hummock Grassland of <i>Triodia wiseana</i> with patches of <i>Triodia angusta</i> on red/brown sandy flats. This community contains occasional scattered <i>Codonocarpus cotinifolius</i> and <i>Clerodendron</i> sp. shrubs, <i>Cyananchem floribundum</i> herbs and very occasional emergent <i>Ficus brachypoda</i> .
F8e	Open Shrubland to Low Open Shrubland of <i>Acacia coriacea</i> over Low Shrubland of <i>Acacia bivenosa</i> , <i>Solanum lasiophyllum</i> and <i>Acacia gregorii</i> over Hummock Grassland to Closed Hummock Grassland of <i>Triodia wiseana</i> and <i>Triodia angusta</i> over scattered herbs on red sandy soils on mid-slopes.

Subterranean fauna habitats were considered not to be significantly different from those present at the location described in the Draft EIS/ERMP due to similar surface geology and similar distance from the coast. As such, specific surveys for subterranean fauna were not conducted for the proposed location and the residual risk of impacts (such as associated with surface clearing, blasting and spills) is considered to be equivalent to that described in the Draft EIS/ERMP.

Surveys of the buffer areas around the proposed Construction Village have confirmed that there are no bettong warrens within 200m of this area (Figure 3). The vegetated habitats, which are to be cleared for the construction village, support taxa which are restricted to Barrow Island and listed as threatened under state and Commonwealth legislation. However, there are no critical habitats for threatened fauna and no unusual habitats that would suggest other fauna may be restricted to the proposed site. The threatened fauna that occur in this area are generally well represented on the island and all of the habitats that will be cleared are well represented outside the development areas. The proposed area contains no watercourses.

The detailed flora and fauna surveys undertaken at the proposed Construction Village location and surrounding buffer zone during the peak period of the year for such surveys, have confirmed that the biodiversity and environmental factors prevailing on that site are equal to, or of lower conservation significance than, those of the location outlined in the Draft EIS/ERMP.

Management Measures

All potential environmental impacts associated with the construction and operation of the Construction Village will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The revised location does not present any unique challenges that require new or significantly different management approaches from those contained in the Framework EMP.

A detailed Environmental Management Plan will be prepared specifically for the construction village. The EMP will contain management measures that are consistent with those contained in the Framework EMP; however, the measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progresses.

2.1.3 Administration Buildings and Operations Centre

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP indicated that administration buildings and maintenance facilities will be constructed either within the gas processing facility site, or in the vicinity (Draft EIS/ERMP, Section 6.2.10 Page 124). The indicative location was shown in the Draft EIS/ERMP (Figure 6-6 Page 106).

Proposed Location and Layout

Further engineering and design work has allowed the Joint Venturers to refine the location and layout for these facilities, as shown in Figure 4. These differ slightly from the concept outlined in the Draft EIS/ERMP, in that the Operations Centre is proposed to be located within the Administration and Maintenance area, outside of the gas processing facility. In addition to the Operations Centre, the facility will include a canteen, maintenance centre, offices, fire station, clinic, laboratory, mobile equipment storage and substation. As a safety measure, it is proposed that all these facilities be located beyond the modelled influence of blast pressures, without the need for specific blast-rated structural design measures. Other issues influencing the revised concept include topography, and buffer distances associated with emissions and noise from the gas processing facility.

The location of the Administration complex will be south of the gas processing facility adjacent to the existing road as shown in Figure 4.

Figure 3:
Fauna Habitats at Proposed Construction Village Location

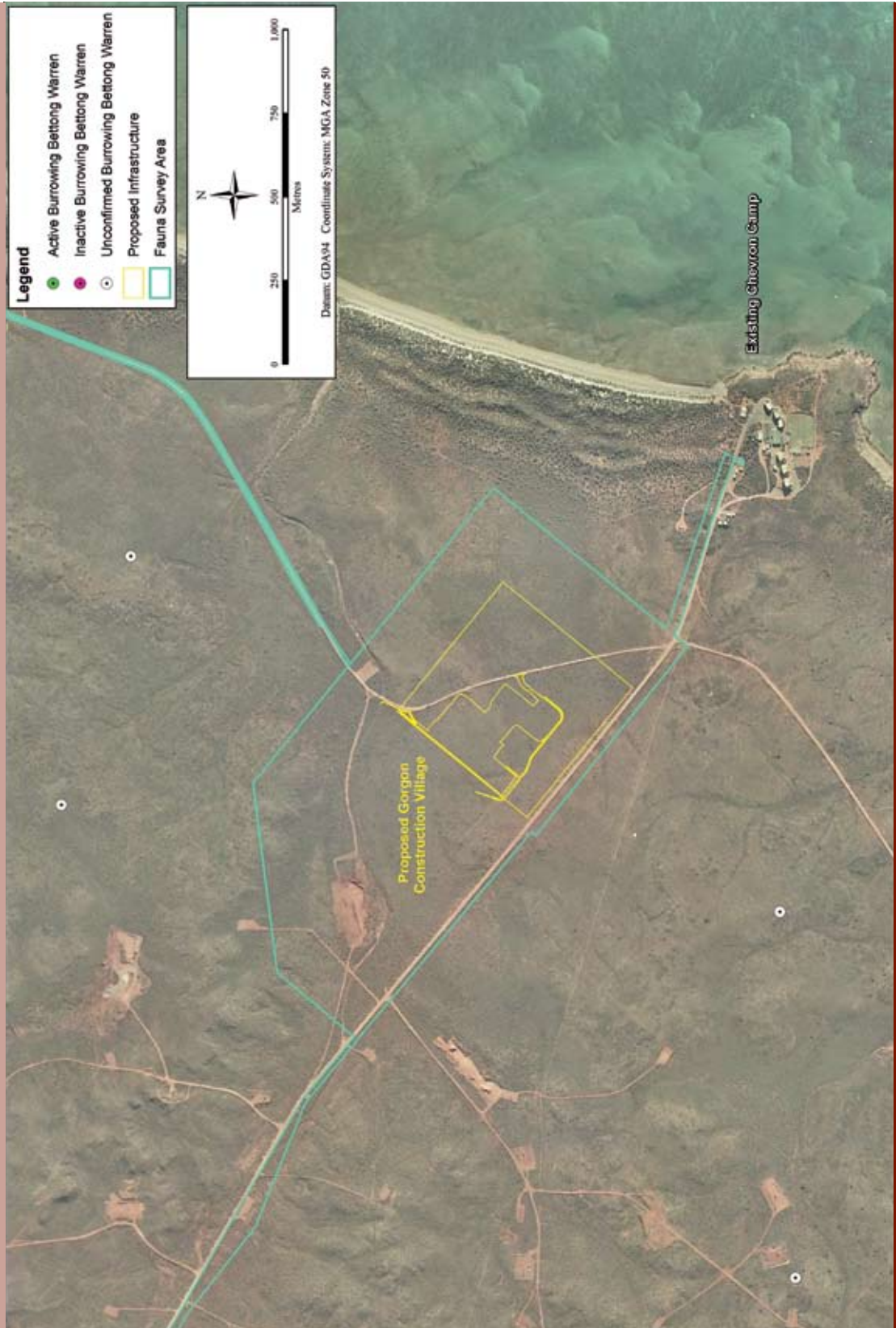


Figure 4: Proposed Location of the Administration Buildings and Operations Centre and Proposed Utilities Area

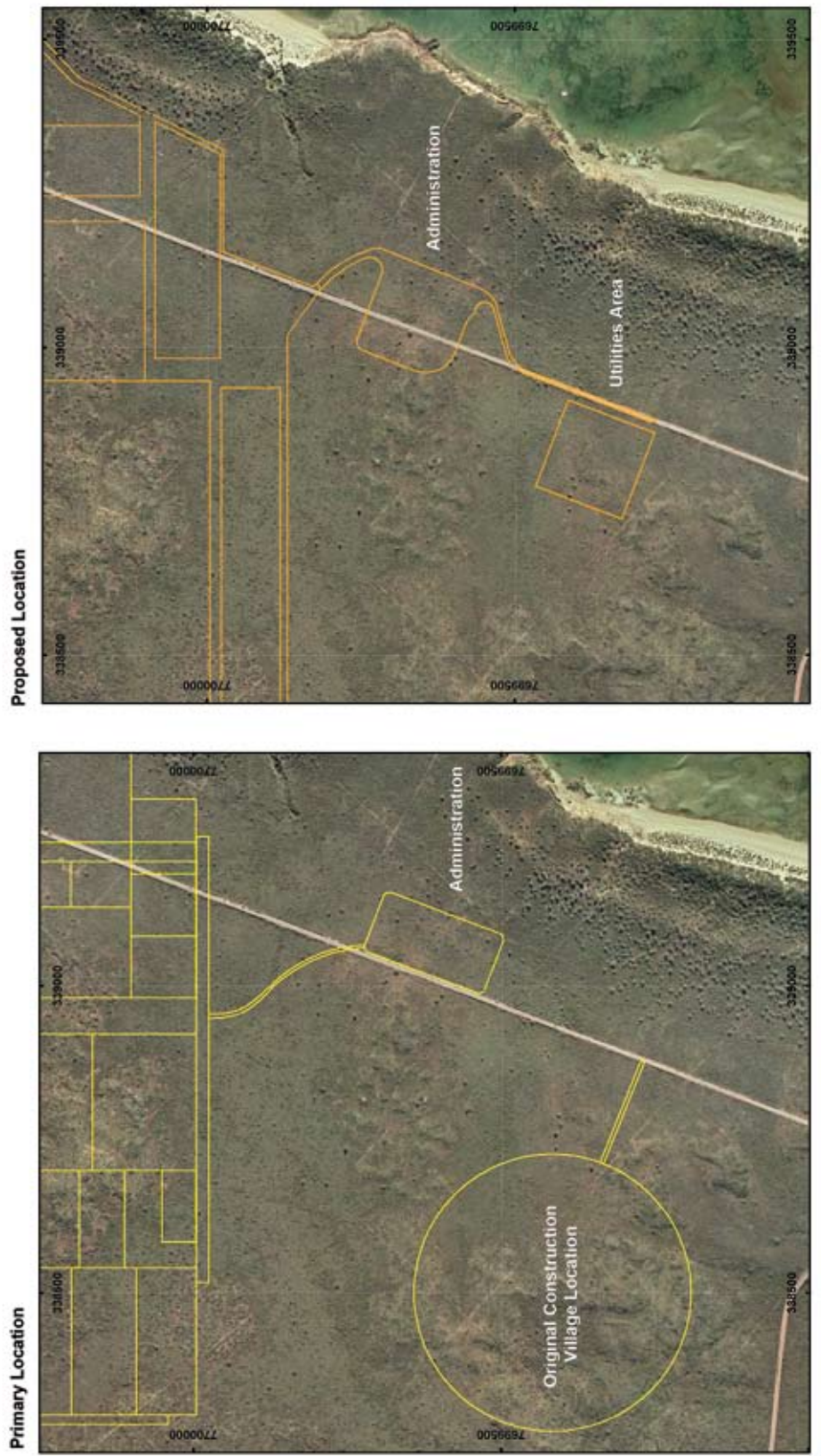
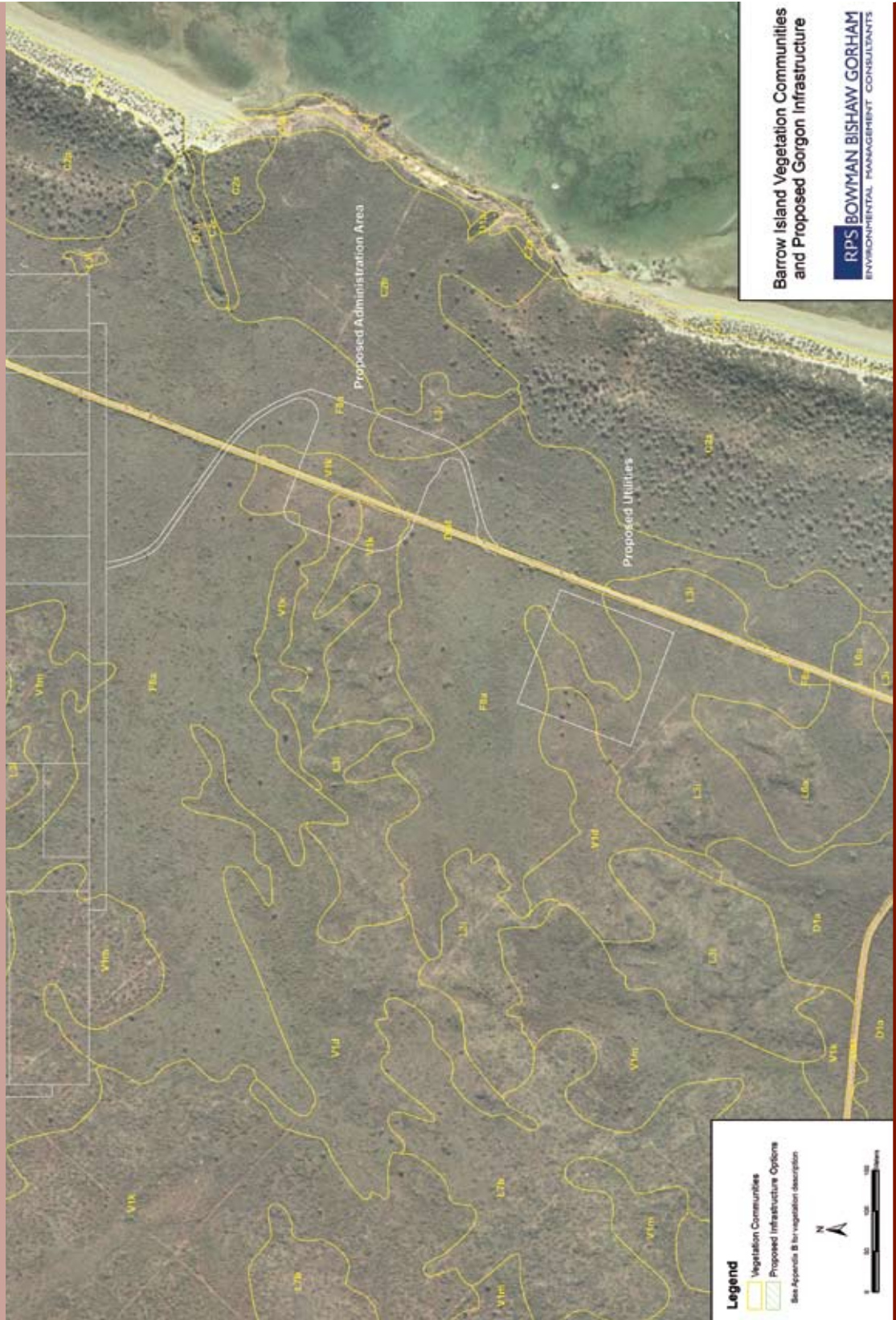


Figure 5:
Vegetation in the Proposed Location of the Administration Complex and Utilities Area



Environmental Implications

Vegetation and Flora

The surveys undertaken for the gas processing facility and surrounding areas are presented in the Draft EIS/ERMP Section 8.3.2 Page 221. These surveys cover the proposed location of the administration facilities (Draft EIS/ERMP Figure 8.15 Page 235). An update of the proposed configuration of the administration complex (including proposed road realignments) is shown in Figure 4 together with vegetation communities.

No Declared Rare Flora species, as listed under subsection (2) of Section 23F of the Western Australian *Wildlife Conservation Act 1950* or as listed by the Department of Conservation and Land Management (CALM) were located during the survey of the Administration Complex and wider survey area. No priority species as listed by CALM were located during the surveys.

Results of the survey are shown in Figure 5 which expands upon the key shown in the Draft EIS/ERMP Chapter 8 Page 228. The main communities present at the proposed administration complex are listed in Table 3.

Fauna

Fauna habitats in the vicinity of the proposed Administration Complex are presented in Figure 6. The objective of the fauna surveys was to characterise the faunal assemblages of the proposed development areas and to determine the significance of these areas for Barrow Island's endemic terrestrial fauna.

An area would be considered of high conservation significance if it:

- supported an unusually high species richness or abundance compared with other parts of Barrow Island;
- contained faunal habitats that were not well represented in other parts of the island;
- contained habitat for site restricted fauna of high conservation significance; for example burrowing bettong warrens; or
- was in a location where development impacts may extend beyond the boundaries of the site and the impacts may lead to the disruption of ecological processes, for example wildlife dispersal.

The fauna survey confirmed that areas to be cleared for the administration complex include taxa that are restricted to Barrow Island and protected under state and Commonwealth legislation. The closest burrowing bettong warren is located approximately 150 metres from proposed infrastructure. None of the identified fauna are restricted to the proposed area, and the fauna are well represented on the island. There are also no critical habitats, or habitats that are not well represented outside the development areas. The proposed area contains no watercourses.

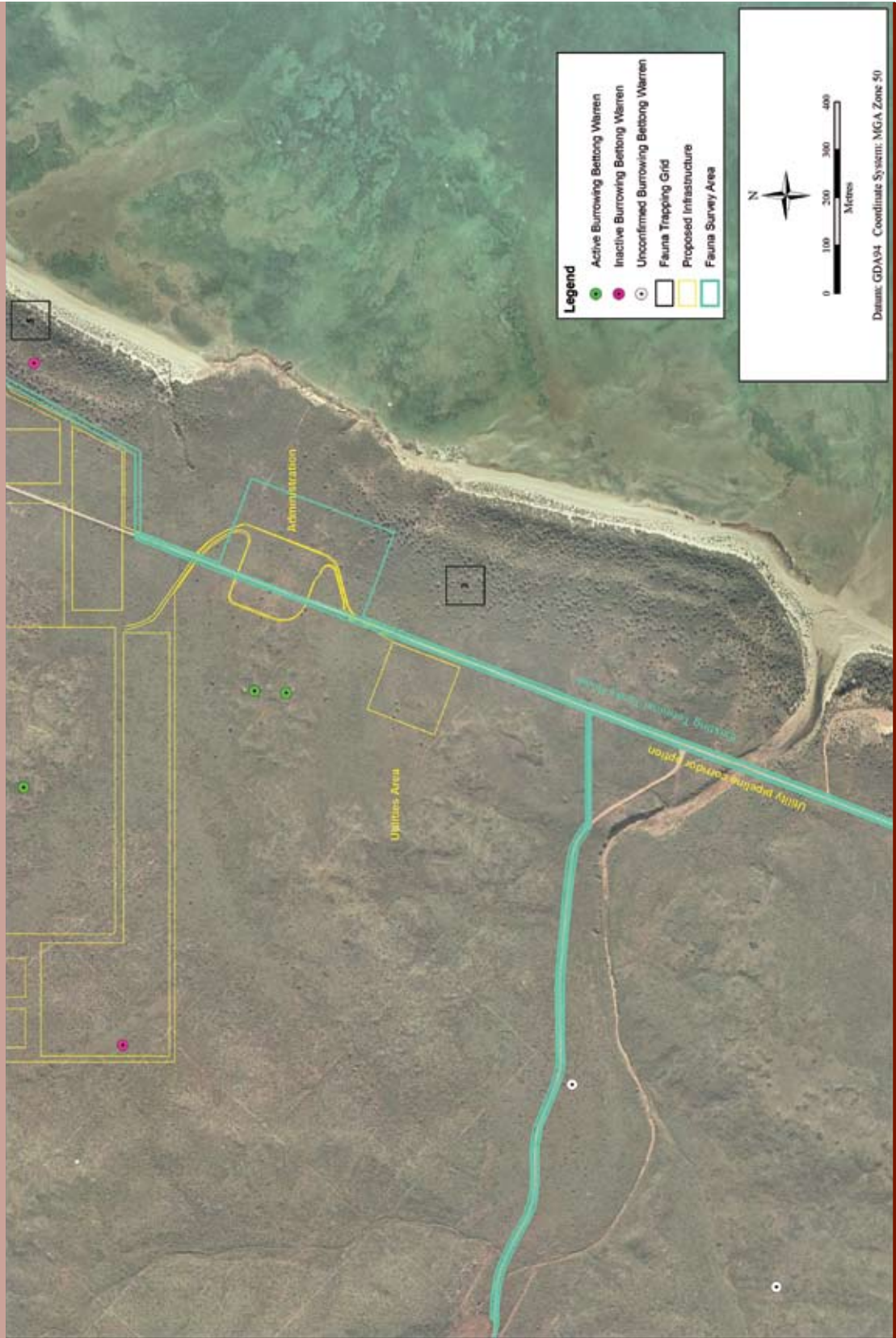
It is concluded that the selection of the location for the Administration area does not change the environmental risk profile and potential impacts are consistent with those outlined in the Draft EIS/ERMP.

Table 3:

Vegetation Communities Present for the Proposed Administration/Operations Complex

Community Code	Vegetation Description
L3i	Low Open Shrubland to Open Shrubland of <i>Acacia bivenosa</i> , with the occasional low scattered <i>Stylobasium spathulatum</i> and <i>Petalostylis labicheoides</i> shrubs over Hummock Grassland of <i>Triodia angusta</i> with occasional <i>Triodia wiseana</i> on limestone slopes, small rises and flats.
V1k	Scattered <i>Acacia pyrifolia</i> and occasional <i>Hakea loreas</i> subsp. <i>lorea</i> shrubs over Low Open Shrubland to Low Shrubland of <i>Melaleuca cardiophylla</i> over Hummock Grasslands <i>Triodia wiseana</i> with patchy <i>Triodia angusta</i> over low scattered <i>Acacia gregorii</i> shrubs on limestone hillslopes and minor drainage lines.
F8a	Low Open Shrubland to Open Shrubland of <i>Acacia bivenosa</i> , with the occasional scattered <i>Pentalepis thrichodesmoides</i> , <i>Stylobasium spathulatum</i> and <i>Acanthocarpus verticillatus</i> shrubs over Hummock Grassland to Closed Hummock Grassland of <i>Triodia wiseana</i> with occasional <i>Triodia angusta</i> on flats and valley floors
C2b	Open Shrubland of <i>Acacia coriacea</i> over Low Open Shrubland of <i>Acacia bivenosa</i> and <i>Pentalepis thrichodesmoides</i> with scattered <i>Acanthocarpus verticillatus</i> over Hummock Grassland of <i>Triodia angusta</i> and <i>Triodia wiseana</i> on red/brown sandy flats.

Figure 6:
Fauna Habitats at the Proposed Administration Complex and Utilities Area



Management Measures

All potential environmental impacts associated with the construction and operation of the Administration Complex will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The location and revised layout does not present any unique challenges that require new or significantly different management approaches from those contained in the Framework EMP.

Construction activities will be addressed in a detailed Environmental Management Plan. Management measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

2.1.4 Marine Facilities

Concept Outlined in the Draft EIS/ERMP

The marine facilities were presented in the Draft EIS/ERMP Section 6.2.9 Page 122, which shows the main features are:

- a causeway at Town Point (800 m long – page 122);
- a materials offloading facility (MOF) (325 m long – Page 122)
- a dredged access channel to the MOF (1.3 km long, 120 m wide and dredged to 6.5 m relative to chart datum – Page 122).
- a piled LNG jetty (3.1 km long – Page 122)
- a dredged access channel to the LNG jetty (~2 km long, 300 m wide and dredged to 14 m relative to chart datum – Page 123), complete with a dredged turning basin (900 m diameter) and ship berth.

This configuration resulted in dredging requirements of approximately 800,000 m³ (Draft EIS/ERMP Section 6.3.8 Page 142) for the MOF channel (which would be partially used in the construction of the MOF and causeway) and approximately 9 Mm³ for the LNG Jetty and associated channel and berthing pockets (Draft EIS/ERMP Section 6.3.8 Page 143). Note this 9 Mm³ accounts for dredging a dual berth configuration and bathymetric information available at the time. An overview of the construction requirements and typical construction equipment are provided in the Draft EIS/ERMP Section 6.3.8 Page 142, while an assessment of potential impacts is

provided in the Draft EIS/ERMP Section 7.8 Page 184, and Section 11.2.1 Page 405. Management measures associated with these construction activities are provided in Technical Appendix A1 Section 3.13 Page 21, while additional model validation is provided in the Additional Information Package Part A.

Proposal

Additional work (including modelling of shipping movements and geotechnical studies) has been undertaken to assist in optimising dredging requirements and layout of the marine facilities. As a result of these optimisations the following is proposed (Figure 7):

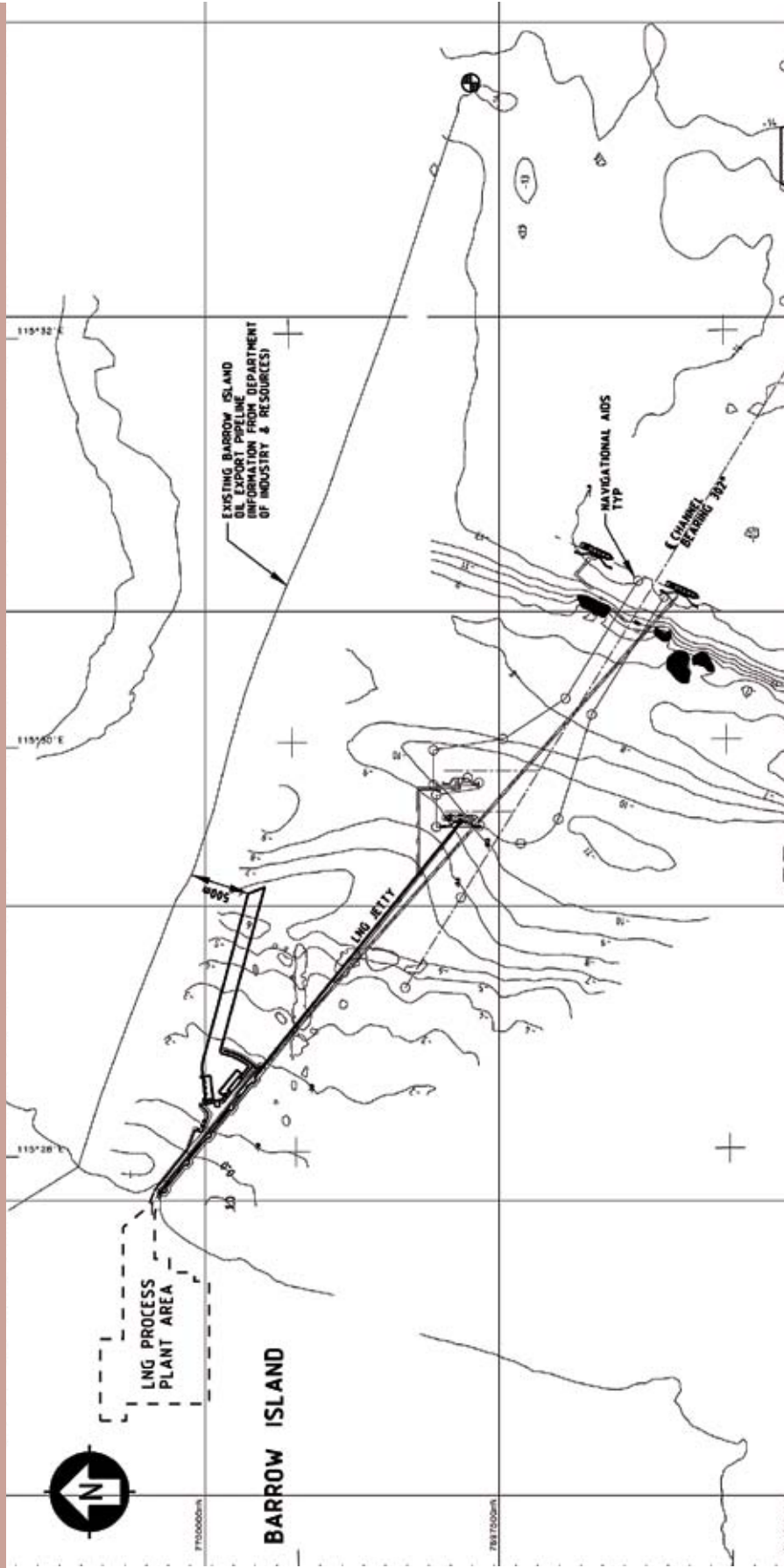
- a causeway at Town Point (800 m long);
- a materials offloading facility (MOF) (520 m long vs 325 m initially proposed)
- a dredged access channel to the MOF (1.6 km long vs 1.3km initially proposed, 120 m wide and dredged to 6.5m relative to chart datum).
- a piled LNG jetty (2.7 km long vs 3.1 km initially proposed)
- a dredged access channel to the LNG jetty (~1.7 km long, 300 m wide and dredged to 14 m relative to chart datum – Page 123), complete with a dredged turning basin (900 m diameter) and ship berth.

This configuration results in dredging requirements of approximately 1.1 Mm³ for the MOF channel (which will be partially used in the construction of the MOF and causeway) and approximately 6.5 Mm³ for the LNG Jetty and associated channel and dual berthing pockets (Table 4). Construction requirements and typical construction equipment are provided in the Draft EIS/ERMP Section 6.3.8 Page 142; while an assessment of potential impacts is provided in the Draft EIS/ERMP Section 7.8 Page 184, and Section 11.2.1 Page 405. Management measures are the same as those provided in Technical Appendix A1 Section 3.13 Page 21.

Table 4:
Design Development of Dredging Requirements

	Draft EIS/ERMP	Proposed
Single Berth	7 M m ³	5.6 M m ³
Dual Berth	9 M m ³	6.5 M m ³

Figure 7:
Proposed Marine Facilities, East Coast, Barrow Island



Environmental Implications

Reducing the volume of dredging associated with the LNG jetty and associated access channel is expected to result in a reduction in environmental risk from dredging operations, without adversely affecting risks during the operational phase. The increase in dredging associated with the MOF channel may slightly increase potential impacts in that area, but when combined with the LNG channel dredging reduction is expected to result in a net reduction of potential risk. Two options are currently being considered for dredging and associated timing, namely to dredge the single berth only, or to dredge the dual berth. The latter would avoid the need to remobilise a dredge and associated support vessels at some time in the future with associated quarantine measures and monitoring programme. It is therefore proposed that the assessment be based on dredging the dual berth.

The LNG shipping channel has been re-orientated to minimise direct impacts to the bombora at the eastern end of the channel. This will reduce impacts on fauna associated with physical structures in the area.

The net result is a reduction in effects from those initially indicated in the Draft EIS/ERMP. Design optimisation to further reduce dredge volume is continuing.

Management Measures

All potential environmental impacts associated with the construction and operation of the MOF, LNG Jetty and associated access channels will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The revisions do not present any unique challenges that require new or significantly different management approaches from those contained in the Framework EMP.

A detailed Environmental Management Plan will be prepared specifically for the dredging activities. The EMP will contain management measures that are consistent with those contained in the Framework EMP; however, the measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

2.1.5 Domestic Gas Pipeline Shore Crossing

In order to limit disturbance to mangrove populations on the west coast of the mainland adjacent to the Apache Energy Sales Gas Pipeline, it is the intention of the Joint Venturers to continue studies into identifying an environmentally preferred shore crossing location. This will be selected following ecological assessments of potential shore crossing locations and the resultant mainland pipeline route. Table 1 above indicates that there is potential for a slight increase in land take, when compared to figures originally suggested in the Draft EIS/ERMP.

All potential environmental impacts associated with the construction of the Domestic Gas Pipeline will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1).

A detailed Environmental Management Plan will be prepared specifically for the construction activities. The EMP will contain management measures that are consistent with those contained in the Framework EMP; however, the measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

2.1.6 Barge Landing

Concept Outlined in the Draft EIS/ERMP

The initial equipment will be landed at the existing barge landing (Draft EIS/ERMP Plate 6.11 Page 142) until a landing can be developed at the Material Offloading Facility site (Draft EIS/ERMP Section 6.3.8 Page 142).

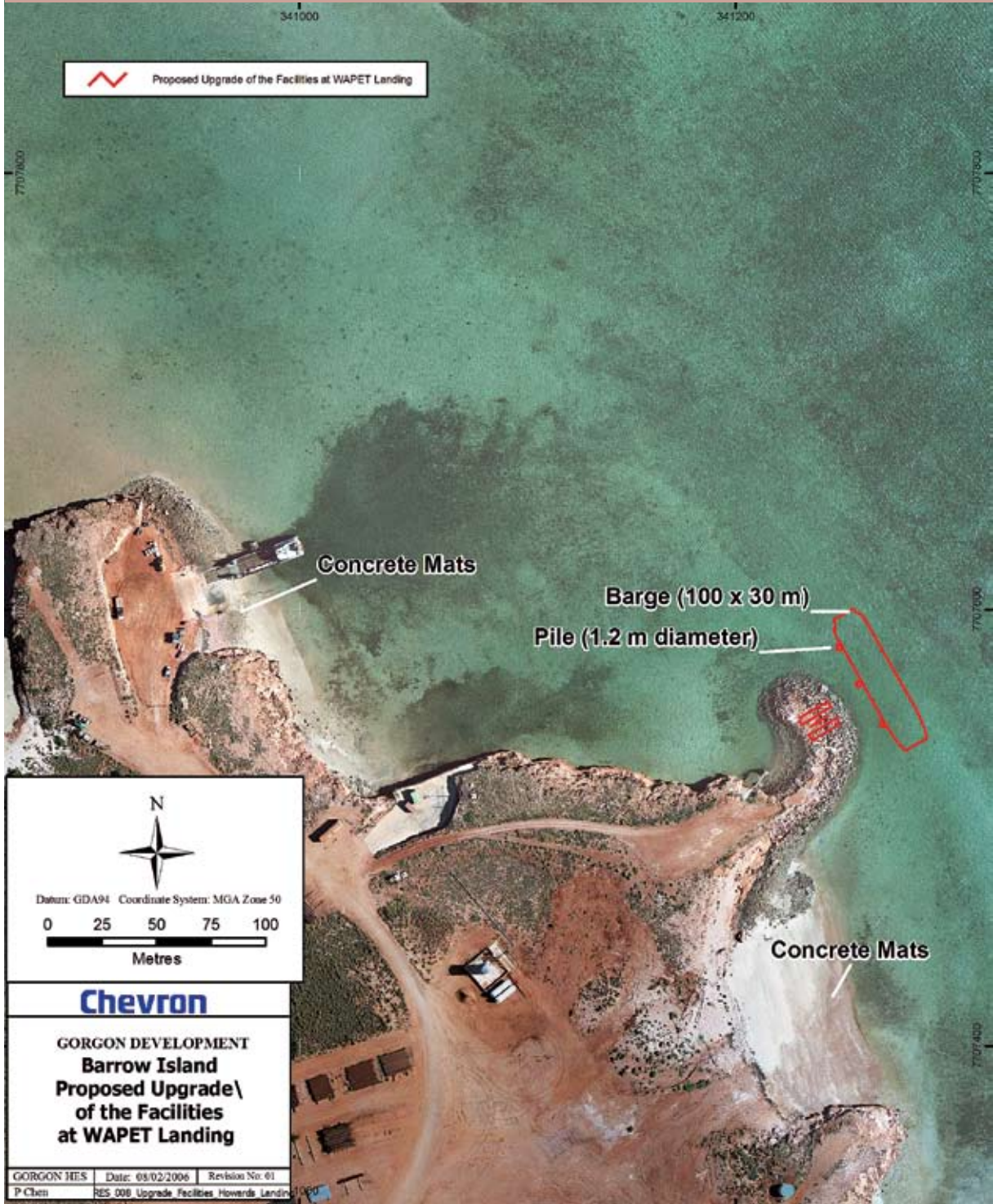
Proposal

It is necessary to land large equipment on Barrow Island to support the construction programme, which includes construction of the MOF and other facilities on Barrow Island. Detailed studies undertaken during FEED have shown that to support the construction programme it is necessary to upgrade the facilities at WAPET Landing.

The proposed upgrades include (Figure 8):

- Installation of temporary concrete landing mats (type “Seamark” or equivalent) to extend the existing Landing Craft Tank (LCT) landing (refer Draft EIS/ERMP Plate 6.11 Page 142) by approximately 20m wide by 45 m length

Figure 8:
Proposed Upgrade of the Facilities at WAPET Landing



- Installation of temporary concrete landing mats (type “Seamark” or equivalent) slightly south of the existing LCT landing to provide an additional, dual LCT landing of approximately 40m wide by 45 m length.
- Installation of two crane pads of approximately 1.8 m width x 20 m length to support a 250 tonne crawler crane on the existing land backed wharf facility adjacent to the earth wall.
- Earthworks and placement of approximately 500m³ of 300mm cement stabilised road base to the existing Groyne area to accommodate the placement of a 450 tonne crawler crane. The road base would be capped with approximately 50m³ concrete pad to support the crane.
- Earthworks and placement of approximately 500m³ of 300mm cement stabilised road base to the existing Groyne area to allow for semi-trailer movements during loading and unloading.
- Civil works associated with installation of safety barriers around the groyne area in the immediate area of the load/unload area.
- Lighting would be achieved by diesel powered portable light stands.
- Installation of 3 (or 4) 1200mm diameter x 12m long (overall) steel tie-back anchor block piles, complete with steel tie-backs and fenders. These piles would be drilled into the seafloor approximately 5m, resulting in a pile which extends approximately 3-6 m out of the water depending on tide.
- Levelling and upgrading of the existing lay down area to cater for increased storage and transport movements.
- Provision of amenities for personnel working at the site such as portable drinking water storage and portable toilets
- A dedicated area for waste segregation and storage
- An area for quarantine
- An existing diesel fuel transfer system exists at the land backed wharf facility and it is intended to duplicate this system with the supply, installation and commissioning of a temporary fuel transfer and storage system to facilitate transfer of diesel fuel to Barrow Island. Transfer of fuel, with flexible hose and dry-break coupling, will utilise a transfer pump at a rate of approximately 40,000 litre per hour giving a monthly average fuel delivery of approximately 1,200,000 litres.
- A temporary diesel fuel storage facility would be approximately 400 m³ and consist of 4 x 100 m³ each self-bunded horizontal tanks, located adjacent to the wharf area, and would be fitted for transfer of diesel to mobile tankers.
- Facilities would meet the requirements of AS1940 as a minimum.
- Installation of storm water drains and levelling out of various low level points, and other road upgrades, along the 13km road from WAPET Landing to Town Point to provide all weather access.

Installation of these facilities would commence as soon as approval is granted to enable access to Barrow Island and is expected to take approximately 6–8 weeks overall.

Once constructed, the landing facilities would be operated on a 24 hour 7-day per week basis. It is expected that the MOF would be ready for first equipment movements after 12 months.

Once there is no foreseen use of the piled mooring it would be decommissioned which would entail removing the supporting steel tie-backs and cutting off the piles at the mud line. The concrete mats would be removed in a similar way to that used in their installation.

Environmental Implications

The activities required to strengthen the groyne and associated road upgrades to cater for safe operations of cranes and transfer of materials occur in pre-disturbed land and thereby expected to have negligible further environmental impacts. The short duration construction activities associated with the upgrade will be planned to avoid peak turtle nesting season and so risks to turtles from these activities are considered low.

Laying of concrete mats at both locations will be accomplished from the shore side and down to the low water mark in pre-disturbed areas, therefore any further environmental implications of the construction and operational phases are anticipated to be negligible.

It is proposed that 3 or 4 piles would be required to act as a mooring for the barges as indicated in Figure 8. This design has a low environmental impact during both construction and operational phases as it avoids the need for anchoring each of the barges.

Shore-side construction equipment will be well maintained in line with manufacturers' requirements to avoid/reduce environmental impacts.

Decommissioning activities associated with the piled mooring and concrete mats would also have a low environmental impact.

Management Measures

All potential environmental impacts associated with the upgrades required at WAPET Landing will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). This work has not identified any issues that would require new or significantly different management approaches from those contained in the Framework EMP.

Construction activities will be addressed in a detailed Environmental Management Plan. Management measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

2.2 Clarification

The following items are considered to be matters where further engineering work has provided clarification that may have an impact on footprint or location.

2.2.1 Airport Upgrades

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP identified that there may be a need for earthworks around the airport associated with potential extensions to, and realignment of, the runway and any expansion of the terminal (Draft EIS/ERMP Section 6.3.6 Page 137).

Proposed Development

Recent engineering studies and discussions between the Joint Venturers, Civil Aviation Safety Authority and representatives from Qantas, National Jet and Bristow (the operator of Barrow island airport), have confirmed that gas processing operations and air transport can be conducted concurrently without realigning the runway. That is, although a Danger Area of approximately 1.5 nautical miles will need to be declared centered on the gas processing facility flare/gas turbines, operational measures and the use of on-board navigation and auto-flight capabilities, will enable the safe landing and take-off for the expected range of aircraft types with an acceptable availability.

An extension of the airstrip to the south, in the order of 100m will be required for landing larger passenger capacity aircraft vessels (B737 or equivalent). A distance of 150m beyond the airstrip at both northern and southern ends will be required for a clearway area. There will be no extension of the current fence line, as the 100m extension of the airstrip and the 150m extensions for the clearway will be within the current fence line. This land is not cleared but is within the existing fence boundary of the airport. The extension of the runway would be undertaken in conjunction with an upgrade of the airstrip/apron, taxiway and aircraft parking areas, existing terminal facilities and fuel storage facilities.

The location of Terminal facility upgrades are yet to be finalised. Upgrades and extensions of terminal facilities will potentially affect approximately 2ha and will occur in close proximity to existing terminal buildings. The final location will be chosen in order to optimise the terminal design and reduce environmental impacts.

Environmental Implications

Vegetation and Flora

Vegetation and Flora surveys undertaken for the Draft EIS/ERMP have been supplemented by further surveys conducted in October 2005 to assess a possible runway realignment (prior to this concept being discounted).

The detailed vegetation and flora surveys have been conducted for the Airport upgrades in accordance with EPA Guidance Statement No. 51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004). The area surveyed is presented in Figure 9.

No Declared Rare Flora species, as listed under subsection (2) of Section 23F of the Western Australian *Wildlife Conservation Act 1950* or as listed by the Department of Conservation and Land Management (CALM) were located during the survey of the runway extension and wider survey area including the area of the terminal expansion. No priority species as listed by CALM were found within the area to be cleared. However, *Corchorus congener* (Priority 3) occurs in the general area and may occur in some of the vegetation communities proposed to be affected by the upgrades and extension of the terminal facility. This species recovers well from disturbance and very well represented on Barrow Island.

Results of the survey are presented in Figure 9 which expands upon the key shown in the Draft EIS/ERMP, Page 228. The main communities present in the area of the runway upgrades are listed in Table 5.

Results of the survey are shown in Figure 9 which expands upon the key shown in the Draft EIS/ERMP, Page 228. The vegetation communities present in the area that may be affected by terminal upgrades are listed in Table 6.

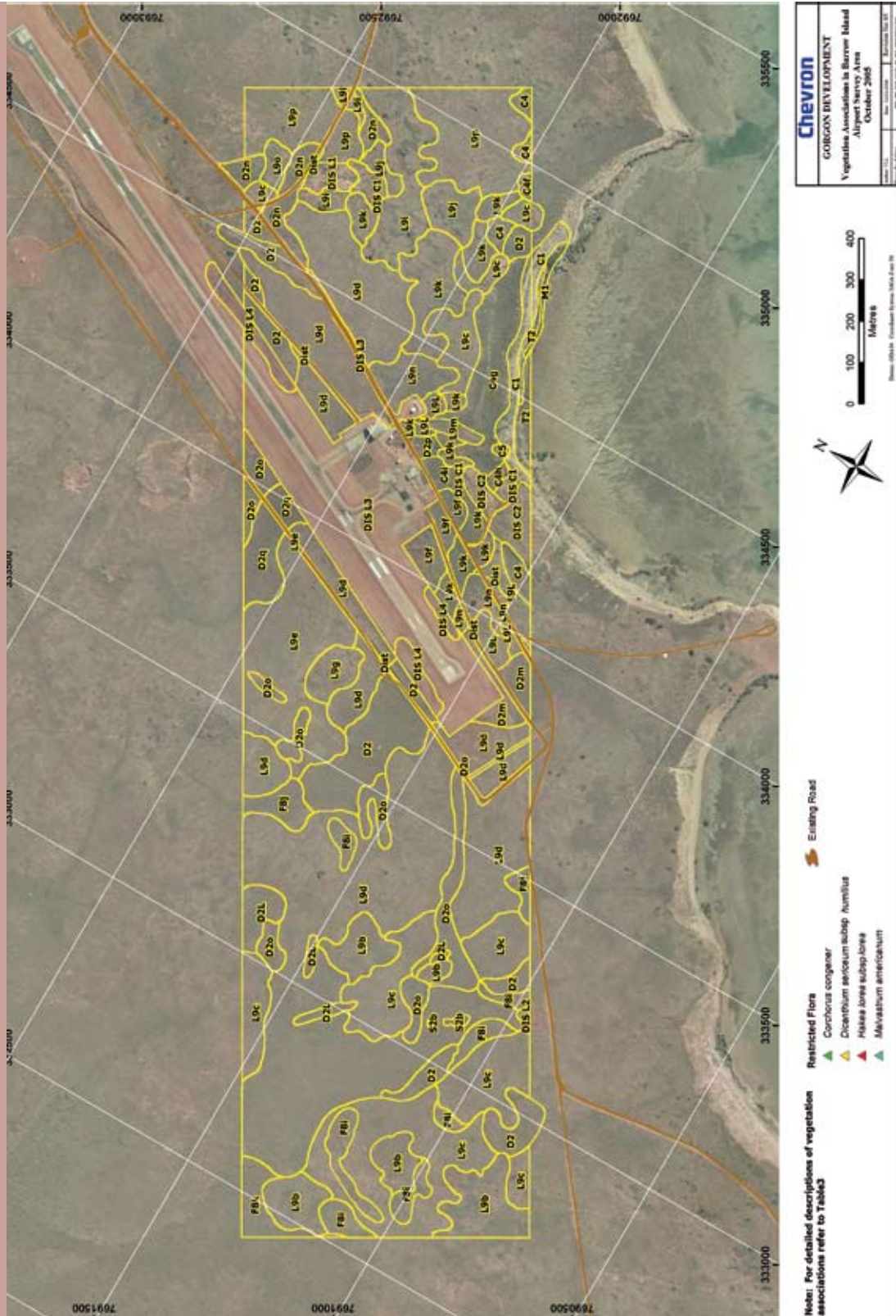
Table 5:
Vegetation Communities Present in the Area of the Runway Extension

Community Code	Vegetation Description
Dis L3	Ephemeral and annual herbland of <i>Streptoglossa bubakii</i> , <i>Pterocaulon sphacelatum</i> with isolated tussocks of <i>Cymbopogon ambiguus</i> . Scattered low shrubs of <i>Solanum lasiophyllum</i> , <i>Solanum ellipticum</i> . Isolated <i>Cenchrus ciliaris</i> – being controlled (Regularly mowed for airport maintenance).
L9 d	Hummock Grassland of <i>Triodia wiseana</i> with scattered sometimes open low shrubs of <i>Pentalepis trichodesoides</i> . There are scattered (<2%) <i>Ficus brachypoda</i> low trees and <i>Acacia bivenosa</i> low shrubs.
D2m	Shrubland (10-30%; 1m) of <i>Pentalepis trichodesoides</i> over Hummock Grassland of <i>Triodia angusta</i> . There are scattered <i>Ptilotus obovatus</i> var. <i>obovatus</i> .

Table 6:
Vegetation Communities Present in the area of the Proposed Terminal Expansion

Community Code	Vegetation Description
L9k	Mixed Open Low Shrubland (2–10%) to Low Shrubland (10–30% 1m) of <i>Ptilotus obovatus</i> , <i>Acacia bivenosa</i> , <i>Solanum lasiophyllum</i> over closed hummock grassland of <i>Triodia angusta</i> with patchy <i>Triodia wiseana</i> . Dense herbland on semi-disturbed areas.
L9 l	Low Shrubland (10–30%; 1 m) of <i>Ptilotus obovatus</i> over Hummock Grassland of <i>Triodia wiseana</i> . Scattered <i>Acacia bivenosa</i> and <i>Adriana urticoides</i> .
D2p	Shrubland (10–30%; 1–2 m) of <i>Stylobasium spathulatum</i> , <i>Acacia bivenosa</i> over low shrubland of, <i>Capparis spinosa</i> var. <i>nummularia</i> with <i>Adriana urticoides</i> over Hummock Grassland of <i>Triodia angusta</i> (and frequent annual <i>Paspalidium tabulatum</i>).
C4i	Open Shrubland (2–10% of <i>Stylobasium spathulatum</i> , <i>Acacia bivenosa</i> over low shrubland (10–20% <1m) <i>Ptilotus obovatus</i> var. <i>obovatus</i> and <i>Solanum lasiophyllum</i> over Hummock Grassland of <i>Triodia angusta</i> with patchy <i>Triodia wiseana</i> . There is an annual Herbland of <i>Pterocaulon sphacelatum</i> , <i>Streptoglossa bubakii</i> and <i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i> .
DIS C1	Low Shrubland (10–30%; 1 m) of <i>Acacia bivenosa</i> over Hummock Grassland (10–30%) of <i>Triodia angusta</i> . Scattered <i>Solanum lasiophyllum</i> and <i>Corchorus congener</i> .
L9F	Open Low Shrubland (2–10% <1m) sometimes Low Shrubland (10–30%; of <i>Ptilotus obovatus</i> var. <i>obovatus</i> sometimes with occasional <i>Adriana urticoides</i> over Open (2–5%; <0.5 m) Dwarf Shrubland of <i>Corchorus congener</i> over hummock grassland of <i>Triodia wiseana</i> with scattered <i>Triodia angusta</i> and <i>Capparis spinosa</i> var. <i>nummularia</i> .
L9M	Open (2–10%; 1 m) Low Shrubland of <i>Ptilotus obovatus</i> var. <i>obovatus</i> over Very Open (2–10%) mixed tussock grass of <i>Cymbopogon ambiguus</i> and sedge <i>Cyperus cunninghamii</i> subsp <i>cunninghamii</i> . Some patchy <i>Triodia angusta</i> – dense around edges. Scattered (2%) <i>Stylobasium spathulatum</i> .

Figure 9:
Vegetation Communities Surveyed for Airport expansions



Chevron
GORGON DEVELOPMENT
Vegetation Associations in Barrow Island
Airport Service Area
October 2005



Existing Road

Restricted Flora

- ▲ *Conchocarpus congener*
- ▲ *Dicranium sibiricum subsp. humilior*
- ▲ *Helioscopes sibirica*
- ▲ *Melaleuca argentea*

Note: For detailed descriptions of vegetation associations refer to Table 3

The airport runway extension will not result in clearing outside of the current fenced area of the airport. The land that will be disturbed is considered pre-disturbed land, or land with low conservation value. The final location of the terminal facility upgrade and the proposed air strip extension will have less impact than the proposed re-alignment and extension mentioned in the Draft EIS/ERMP (Section 6.3.6 Page 137).

Fauna

A fauna survey was conducted for the runway upgrades in October 2005, in accordance with EPA Guidance Statement No. 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004). The area surveyed is the same as that surveyed for flora.

The objective of the fauna surveys was to characterise the faunal assemblages potentially associated with the airport upgrades and to determine their significance. An area would be considered of high conservation significance if it:

- supported an unusually high species richness or abundance compared with other parts of Barrow Island;
- contained faunal habitats that were not well represented in other parts of the island;
- contained habitat for site restricted fauna of high conservation significance; for example burrowing bettong warrens; or
- was in a location where development impacts may extend beyond the boundaries of the site and the impacts may lead to the disruption of ecological processes, for example wildlife dispersal.

Results of the fauna surveys in the Draft EIS/ERMP (Figure 8-17 Page 239) are shown in Figure 10 which indicates that there are no active burrows in the proposed airstrip extension or the proposed terminal facility upgrade. The closest burrowing bettong warrens are located approximately 250 metres from proposed airstrip extension and approximately 270 meters from the terminal facility upgrade. None of the identified fauna are restricted to the proposed site, and the fauna are well represented on the island. The proposed area contains no watercourses.

Management Measures

All potential environmental impacts associated with the extension of the runway will be managed in accordance with the management measures

contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). This work was foreshadowed in the Draft EIS/ERMP, and the further studies have not identified any new issues that would require new or significantly different management approaches from those contained in the Framework EMP.

Construction activities will be addressed in a detailed Environmental Management Plan. Management measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

2.2.2 Utilities Area

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP outlined the intention to establish a single utilities area comprising power generation for the construction phase, fresh and potable water plant, waste water treatment facilities and fuel storage either near the construction village or gas processing facility (Draft EIS/ERMP Section 6.3.6 Page 137).

Proposed Location

Further engineering and design work has allowed the Joint Venturers to select a location for the utilities area as shown in Figure 4.

Environmental Implications

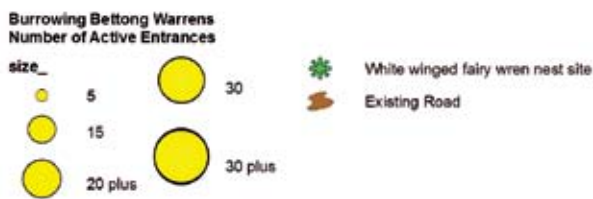
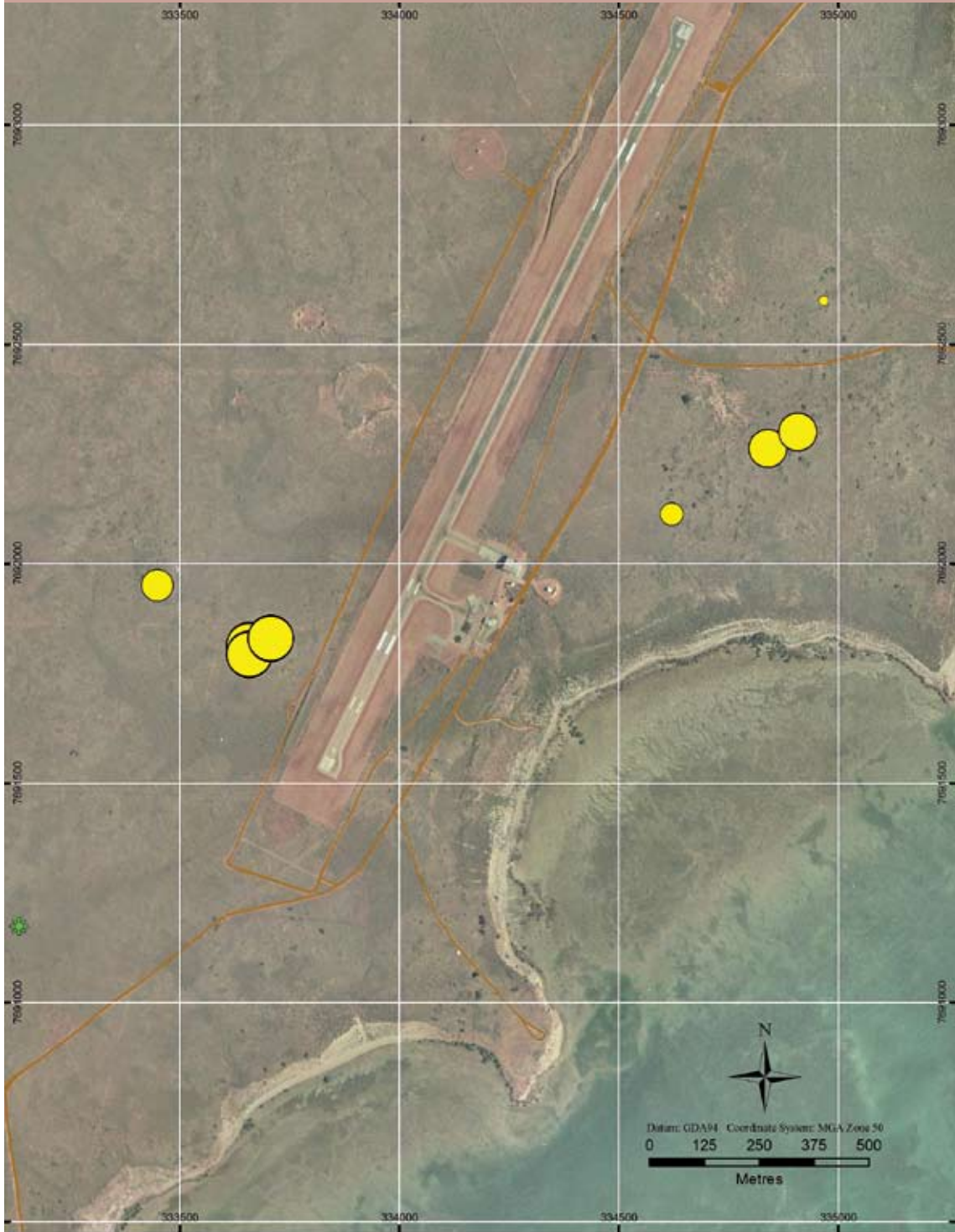
Vegetation and Flora

The vegetation and flora surveys undertaken for the gas processing facility and surrounding areas are presented in the Draft EIS/ERMP Section 8.3.2 Page 221. These surveys covered the proposed location of the utilities area (Draft EIS/ERMP Figure 8.15 Page 235).

No Declared Rare Flora species, as listed under subsection (2) of Section 23F of the Western Australian *Wildlife Conservation Act 1950* or as listed by the Department of Conservation and Land Management (CALM) were located during the survey of the utilities area and wider survey area. No priority species as listed by CALM were located during the surveys.

Results of the survey are shown in which expands upon the key shown in the Draft EIS/ERMP Chapter 8 Page 228. The main communities of relevance to the utilities area are outlined in Table 7.

Figure 10:
Fauna Habitat in the Vicinity of the Proposed Runway Extension



Chevron	
GORGON DEVELOPMENT	
Barrow Island Burrowing Bettong Warrens around airport area	
GORGON HES R.Chen	Date: 08/02/2005 Revision: 2/01 REV 002 AIRPORT FAUNA

Table 7:
Vegetation communities in the Proposed Utilities Area

Community Code	Vegetation Description
F8a	Low open shrubland to open shrubland of <i>Acacia bivenosa</i> , with the occasional scattered <i>Pentalepis trichodesmoides</i> , <i>Stylobasium spathulatum</i> and <i>Acanthocarpus verticillatus</i> shrubs over Hummock Grassland to Closed Hummock Grassland of <i>Triodia wiseana</i> with occasional <i>Triodia angusta</i> on flats and valley floors
V1d	Low Open Shrubland of <i>Acacia bivenosa</i> with <i>Pentalepis trichodesmoides</i> shrubs over Hummock Grassland of <i>Triodia angusta</i> and <i>Triodia wiseana</i> on limestone slopes and low ridges with occasional <i>Melaleuca cardiophylla</i>
L3i	Low open shrubland to open shrubland of <i>Acacia bivenosa</i> , with the occasional low scattered <i>Stylobasium spathulatum</i> and <i>Petalostylis labicheoides</i> shrubs over Hummock grassland of <i>Triodia angusta</i> with occasional <i>Triodia wiseana</i> on limestone slopes, small rises and flats.

Fauna

Results of fauna surveys conducted in the utilities area are presented in Figure 6. The objective of the fauna surveys was to characterise the faunal assemblages of the proposed development areas and to determine the significance of these areas for Barrow Island's endemic terrestrial fauna. An area would be considered of high conservation significance if it:

- supported an unusually high species richness or abundance compared with other parts of Barrow Island;
- contained faunal habitats that were not well represented in other parts of the island;
- contained habitat for site restricted fauna of high conservation significance; for example burrowing bettong warrens; or
- was in a location where development impacts may extend beyond the boundaries of the site and the impacts may lead to the disruption of ecological processes, for example wildlife dispersal.

The survey work identified that the proposed utilities area contains taxa that are restricted to Barrow Island and protected under state and Commonwealth legislation. None of the identified fauna are restricted to the proposed utilities area, and the fauna are well represented on the island. There are also no critical habitats, or habitats that are not well represented outside the development areas. The proposed area contains no watercourses.

It is concluded that the selection of the location for the utilities area does not change the environmental risk profile and potential impacts are consistent with those outlined in the Draft EIS/ERMP.

Management Measures

All potential environmental impacts associated with the construction and operation of the utilities area will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The selected location does not present any unique challenges that require new or significantly different management approaches from those contained in the Framework EMP.

Construction activities will be addressed in a detailed Environmental Management Plan. Management measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

2.2.3 Utilities Corridor

The Draft EIS/ERMP (Section 6.3.6 Page 137) identified that a utilities corridor will be established between the utilities area, the construction village and the gas processing facility to accommodate the various services.

Proposed Location

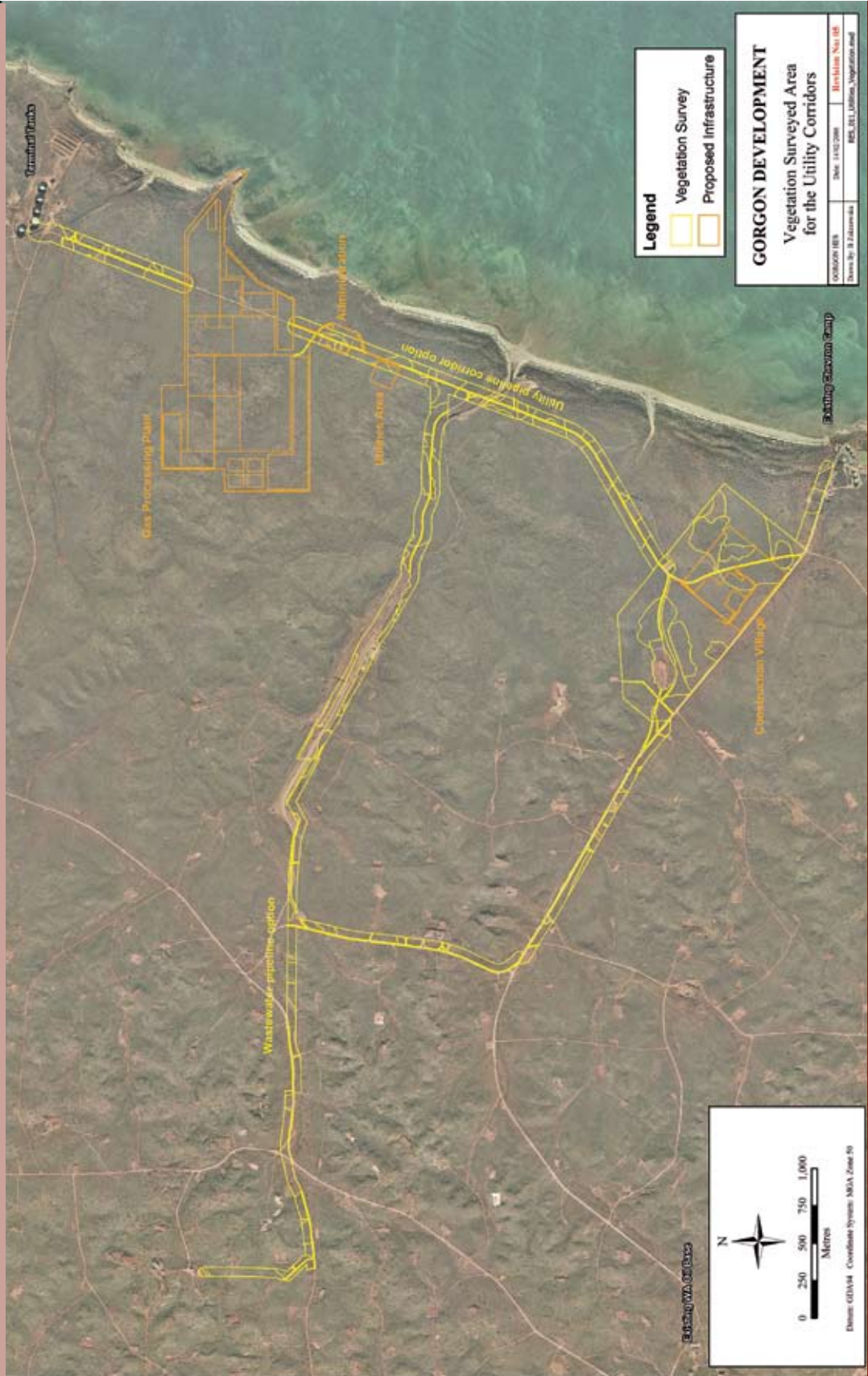
The proposed location of the utilities corridor is shown in Figure 11. The proposed utilities corridor has been chosen as they connect major infrastructure and aligns along an existing road.

Environmental Implications

Vegetation and Flora

The vegetation and flora surveys mentioned above relating to the utilities area also included the utility and pipeline corridors which are proposed to connect major infrastructure as shown in Figure 11.

Figure 11:
Vegetation Communities in the area of the Proposed Utilities Corridors



No Declared Rare Flora species, as listed under subsection (2) of Section 23F of the Western Australian *Wildlife Conservation Act 1950* or as listed by the Department of Conservation and Land Management (CALM) were located during the survey of the utilities and pipeline corridors and wider survey area. No priority species as listed by CALM were located during the surveys.

One area of *Grevillea pyramidalis* subsp. *?leucadendron* which is restricted on the island were found only in the adjacent areas of the proposed clearing area for the utilities corridor and the pipeline corridor.

Results of the survey are shown in Figure 11 which expands upon the key shown in the Draft EIS/ERMP Chapter 8 Page 228.

The main communities of relevance to the utilities corridor which joins the construction village with the gas processing facility are outlined in Table 8.

The main communities of relevance to the pipeline corridors which join the gas processing facility and WA Oil water injection wells are outlined in Table 9.

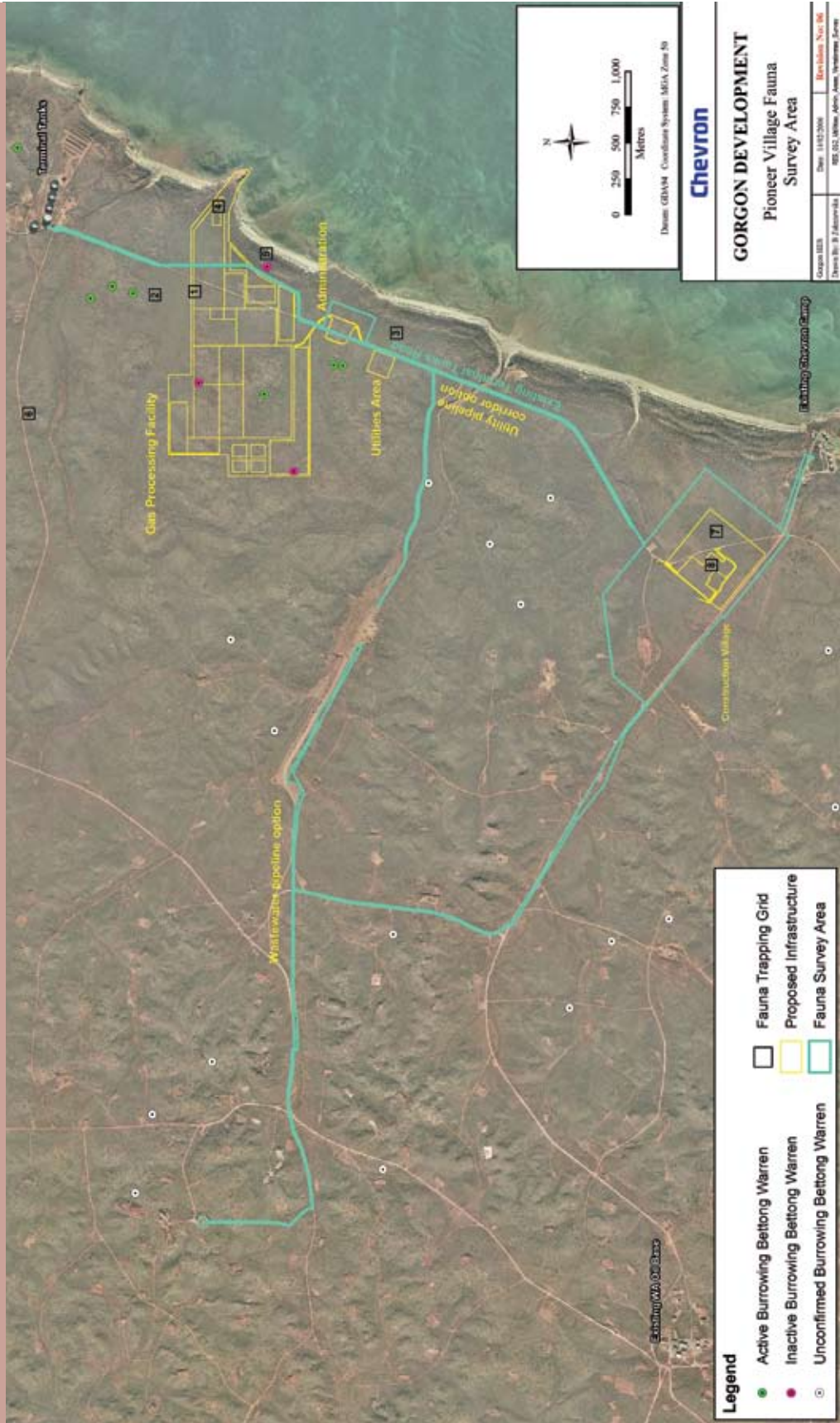
Table 8:
Vegetation Communities in the area of the Proposed Utility Corridors

Community Code	Vegetation Description
F8a	Low Open Shrubland to Open Shrubland of <i>Acacia bivenosa</i> , with the occasional scattered <i>Pentalepis thrichodesmoides</i> , <i>Stylobasium spathulatum</i> and <i>Acanthocarpus verticillatus</i> shrubs over Hummock Grassland to Closed Hummock Grassland of <i>Triodia wiseana</i> with occasional <i>Triodia angusta</i> on flats and valley floors
L3h	Low scattered <i>Pentalepis trichodesmoides</i> shrubs over Hummock Grasslands of <i>Triodia wiseana</i> over low scattered <i>Diplopeltis eriocarpa</i> shrubs on limestone ridges and flats.
L3i	Low Open Shrubland to Open Shrubland of <i>Acacia bivenosa</i> , with the occasional low scattered <i>Stylobasium spathulatum</i> and <i>Petalostylis labicheoides</i> shrubs over Hummock grassland of <i>Triodia angusta</i> with occasional <i>Triodia wiseana</i> on limestone slopes, small rises and flats.
V1k	Scattered <i>Acacia pyrifolia</i> and occasional <i>Hakea loreas</i> subsp. <i>lorea</i> shrubs over Low Open Shrubland to Low Shrubland of <i>Melaleuca cardiophylla</i> over Hummock Grasslands <i>Triodia wisana</i> with patchy <i>Triodia angusta</i> over low scattered <i>Acacia gregorii</i> shrubs on limestone hillslopes and minor drainage lines.

Table 9:
Vegetation Communities in the Area Proposed for Pipeline Corridors

Community Code	Vegetation Description
D1a	Scattered tall <i>Acacia coriacea</i> shrubs over Low Shrubland to Shrubland of <i>Stylobasium spathulatum</i> and <i>Acacia bivenosa</i> over Very Open Herbland of <i>Acanthocarpus verticillatus</i> over Closed Hummock Grassland of <i>Triodia angusta</i> with scattered <i>Triodia wisana</i> on valley floors and deep gullies. The unit contains occasional <i>Hakea lorea</i> subsp. <i>lorea</i> . Unit also contains areas of scoured drainage channel in area of heavy seasonal flow.
L3i	Low open shrubland to open shrubland of <i>Acacia bivenosa</i> , with the occasional low scattered <i>Stylobasium spathulatum</i> and <i>Petalostylis labicheoides</i> shrubs over Hummock grassland of <i>Triodia angusta</i> with occasional <i>Triodia wiseana</i> on limestone slopes, small rises and flats.
V1k	Scattered <i>Acacia pyrifolia</i> and occasional <i>Hakea loreas</i> subsp. <i>lorea</i> shrubs over Low Open Shrubland to Low Shrubland of <i>Melaleuca cardiophylla</i> over Hummock Grasslands <i>Triodia wisana</i> with patchy <i>Triodia angusta</i> over low scattered <i>Acacia gregorii</i> shrubs on limestone hillslopes and minor drainage lines.
Dist	Disturbed, cleared roads

Figure 12:
Fauna Surveys for Utilities and Pipeline Corridors



Fauna

Fauna surveys were undertaken at the same time and in the same manner as those described above for the construction village. Results of the surveys associated with the utilities corridor and the pipeline corridors are presented in Figure 12. The proposed utilities corridor avoids (but is close to) coastal dune vegetation complexes.

The fauna survey concludes that areas which are to be cleared for the utilities corridor and pipeline corridor include taxa which are restricted to Barrow Island and protected under state and Commonwealth legislation. None of the identified fauna are restricted to the proposed areas, and the fauna are well represented on the island. There are also no critical habitats, or habitats that are not well represented outside the development areas. The proposed corridors contain no water courses.

Management Measures

All potential environmental impacts associated with the utilities corridors will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). Further studies have not identified any new issues that would require new or significantly different management approaches from those contained in the Framework EMP.

Construction activities will be addressed in a detailed Environmental Management Plan (EMP). In particular the EMP for the utilities corridor will identify mitigation measures to further protect the coastal dune vegetation complexes. Management measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

2.2.4 Operations Workforce Accommodation

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP (Section 6.2.10 Page 124) outlined alternatives for the operations workforce accommodation. It was proposed that the operations workforce accommodation be within an extension to the existing Chevron operations camp (Draft EIS/ERMP Box 1-3 Page 7); or within a dedicated section of the proposed construction village. Refer to Draft EIS/ERMP Section 6.3.6 Page 134 for details on the site selection process, and additional details on the construction village.

Proposed Location

The location of the Operations workforce accommodation (Draft EIS/ERMP Section 6.2.10 Page 124) has not yet been finalised. The operational workforce will be accommodated in structures built specifically for the Gorgon project operators. The location of these buildings will be at one of the following locations:

- Within an extension to the existing Chevron operations camp (Option 1);
- Within the Construction Village boundary (Option 2); or
- Adjacent to the Construction Village site (Option 3).

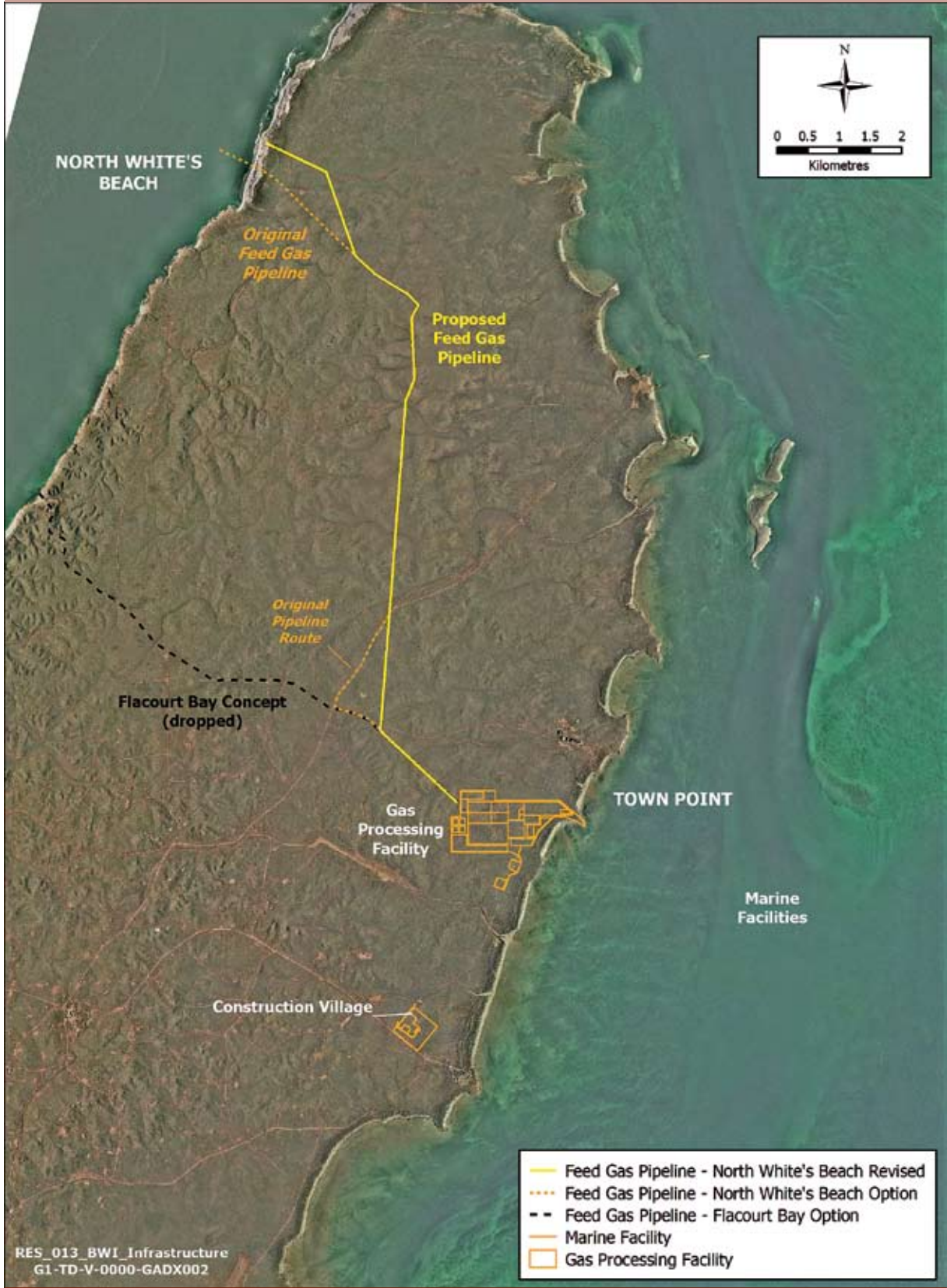
Factors that will decide the final location include infrastructure sharing agreements (Draft EIS/ERMP Box 1.3 Page 7), current and future construction accommodation requirements and predicted operational room numbers. A decision on location will be taken later in FEED. All options will rely on infrastructure developed for the Gorgon project, including power, water, sewage, and communications, however some new service corridors would need to be established for these locations.

Environmental Implications

If Option 1, at the existing Chevron operations camp is chosen there will be minor environmental implications as existing facilities at the WA oil camp would be utilised. In the event that clearing is required, it will be included in the total area of the development footprint and would be configured such that no Declared Rare Flora, priority species or those with restricted distributions would be impacted by the Operations workforce accommodation.

The detailed flora and fauna surveys undertaken at the proposed Construction Village location and surrounding buffer zone during the peak period of the year for such surveys, have confirmed that the biodiversity and environmental factors prevailing on that site are equal to or of lower conservation significance than those of the location outlined in the Draft EIS/ERMP. Therefore if Option 2, within the Construction Village or Option 3, adjacent to the Construction Village is chosen the ecological footprint is expected to remain the same and the potential environmental impacts are expected to be similar or less than mentioned in the Draft EIS/ERMP.

Figure 13:
Feed Gas Pipeline Shore Crossing Location



Management Measures

All potential environmental impacts associated with the Operations workforce accommodation will be managed in accordance with the management measures contained in the Draft EIS/ERMP

– Framework Environmental Management Plan (Technical Appendix A1). Further studies have not identified any new issues that would require new or significantly different management approaches from those contained in the Framework EMP.

Construction activities will be addressed in a detailed Environmental Management Plan (EMP). Management measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

2.2.5 Feed Gas Pipeline Shore Crossing

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP (Section 6.2.2 Page 100) identified North White's Beach as the preferred shore crossing location with Flacourt Bay carried as a fallback option, should geological conditions make North White's Beach not feasible (Figure 13).

Feasibility studies were undertaken for horizontal directional drilling (HDD) as a below ground shore crossing option. Three above ground alternatives were also considered and included: laying the feed gas pipeline on the sea bed and beach; running a pipeline over a jetty; and establishing a groyne on (or in) which the feed gas pipelines would run (Draft EIS/ERMP (Section 3.7.3 Page 63). These studies concluded that HDD was the preferred shore crossing technique.

Proposed Location and Installation Technique

Since the Draft EIS/ERMP was released for public review a geotechnical survey has been undertaken at North White's Beach. This geotechnical survey indicates that the original shore-crossing location at North White's Beach, as described in the Draft EIS/ERMP, is not optimal. A preferred location has been selected slightly northward along North White's Beach as shown in Figure 13. Improved confidence in this location has allowed the fallback option of Flacourt Bay to be disregarded.

It is proposed that the shore crossing will be undertaken using the horizontal directional drilling (HDD) technique.

Environmental Implications

Dropping Flacourt Bay avoids the potential for associated impacts on rock wallabies, Biggada Reef and the Marine Management Area on the West Coast of Barrow Island. Optimisation of the HDD location within North White's Beach has reduced the length of the required drill from approximately 600m to approximately 480m, which reduces risk associated with the HDD operation, and reduces potential environmental impacts (e.g. reduction in sediment/cutting plume at breakout point, and the breakout point is further from the Marine Park).

Vegetation and Flora

Detailed vegetation and flora surveys have been conducted for the proposed location in accordance with EPA Guidance Statement No. 51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004). The area surveyed is shown in Figure 14 with the proposed location of the feed gas pipeline shore crossing outlined. A broad area of vegetation surrounding the proposed development areas was mapped to permit evaluation of the representation of the impacted vegetation types within the local areas (Table 10).

No Declared Rare Flora species, as listed under subsection (2) of Section 23F of the Western Australian *Wildlife Conservation Act 1950* or as listed by the Department of Conservation and Land Management (CALM) were located during the survey. No priority species as listed by CALM were located during the surveys.

The proposed stringing area (Figure 14) will pass through two restricted vegetation communities of (F4b) this community is significant as it contains *Erythrina vespertilio*, a restricted species on the island. The second F4b community will be rehabilitated after immediately after it is no longer required for the stringing laydown area. The pipeline will then follow a route to a pre-disturbed road.

Investigation and design is currently underway that aims to position this 'footprint' in the location that will a) result in limited disturbance to flora and fauna habitat and b) result in the optimal location, given engineering constraints. The final position of this 'footprint' will be presented to the relevant government agencies as soon as the initial design is completed and agreed upon internally.

Results of the survey are shown in Figure 14, which expands upon the key shown in the Draft EIS/ERMP Chapter 8 Page 228. The main communities present at the proposed feed gas pipeline shore crossing location are listed in Figure 8.

Fauna

Further detailed fauna surveys were conducted during October 2005 in accordance with EPA Guidance Statement No. 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004).

Results of fauna surveys conducted in the North White's Beach Feed Pipeline Shore Crossing area are presented in Figure 15. The new proposed stringing

area of the Feed Gas Pipeline was surveyed during December 2005. The Fauna surveys covered the area of direct disturbance and approximately 50 m either side. In an attempt to avoid restricted vegetation communities the pipeline route has been altered since the December 2005 survey.

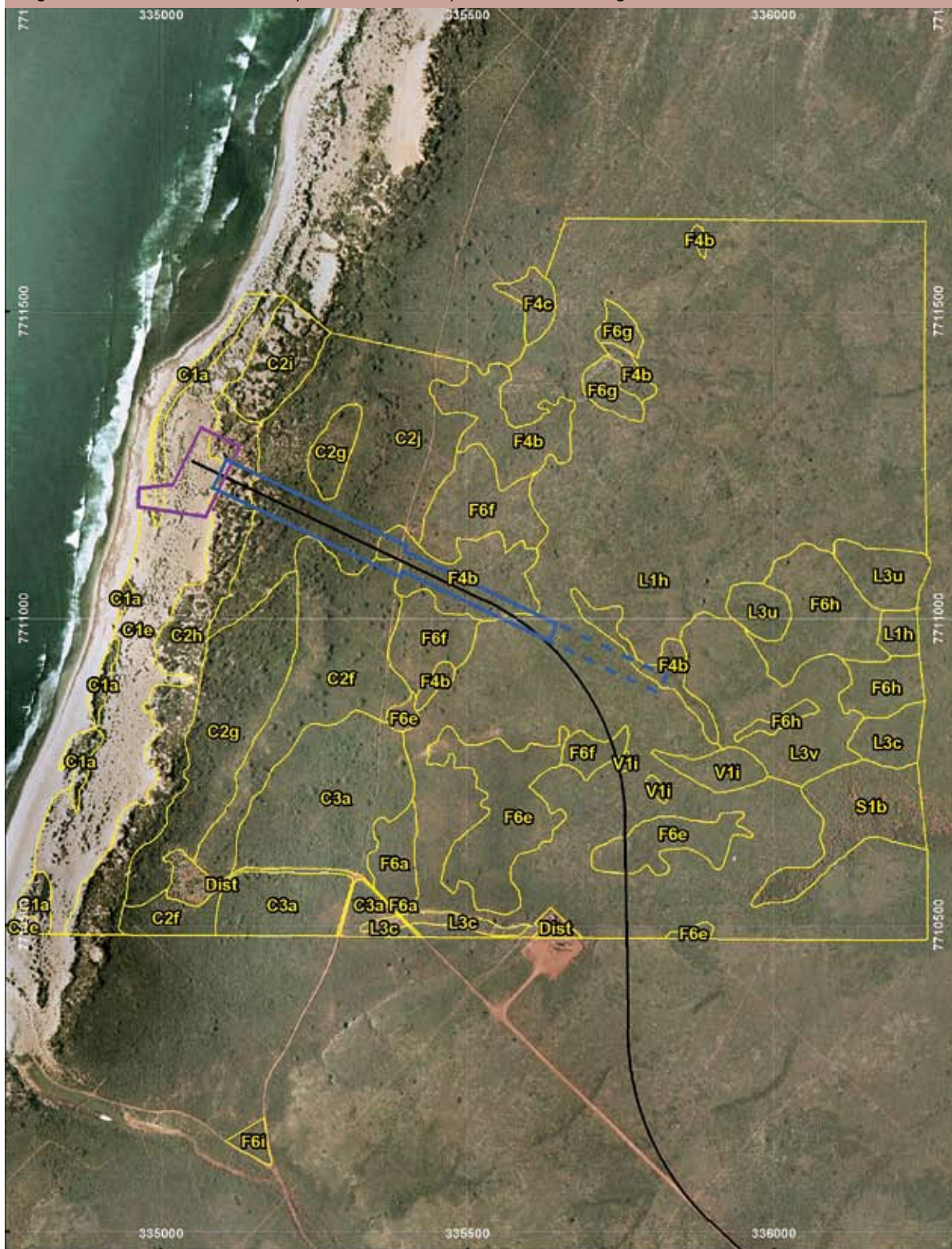
No bettong warrens were found on, or within 50 m of the surveyed areas. Further, there are no reported, but as yet unconfirmed warrens in the vicinity of the route. A White Winged Fairy Wren Habitat was found within the survey area.

The only potentially restricted habitat, an area of open shrubland of *Erythrina*, would be impacted by clearing for the stringing area and the new pipeline route (Figure 14).

Table 10:
Vegetation Communities within the Proposed Feed Gas Pipeline Shore Crossing

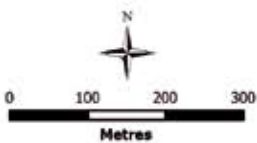
Community Code	Vegetation Description
HDD site	
C1a	Open Grassland of <i>Spinifex longifolius</i> with Low Scattered Shrubs and Herbs of <i>Atriplex isatidea</i> , <i>Myoporum montanum</i> , <i>Euphorbia mytoides</i> and <i>Salsola tragus</i> on seaward face of white sandy foredunes.
C2h	Low shrubland of <i>Acacia coriacea</i> with <i>Rhagodia presii</i> subsp. <i>obovate</i> over Very Open Herbland of <i>Threlkeldia diffusa</i> over Grassland to Hummock Grassland of <i>Triodia epactia</i> and <i>Spinifex longifolius</i> on secondary dune slopes and ridges
C5d	Open Shrubland of <i>Myoporum montanum</i> over Very Open Grassland of <i>Spinifex longifolius</i> with scattered Hummocks of <i>Triodia epactia</i> over Low Open Shrubland of <i>Frankenia pauciflora</i> var. <i>pauciflora</i> with scattered <i>Heliotropium glanduliferum</i> on flat sandy swales with occasional limestone outcropping behind primary dunes.
Stringing area/Pipeline	
C2d	Low Open Shrubland of <i>Acacia coriacea</i> over Low Open Shrubland to Open Shrubland of <i>Spinifex longifolius</i> with patches of <i>Triodia epactia</i> in swales between dunes.
C2j	Low Open Shrubland of <i>Acacia coriacea</i> and <i>Threlkeldia diffusa</i> over Closed Hummock Grassland of <i>Triodia epactia</i> on beige sands on the black slopes of secondary dune slopes and ridges.
F4b	Low Open Woodland of <i>Erythrina vespertilo</i> over Low Open Shrubland of <i>Pentalepis trichodesmoides</i> , <i>Solanum lasiophyllum</i> and <i>Trichodesma zeylanicum</i> over Hummock Grassland of <i>Triodia epactia</i> with patches of <i>Triodia wiseana</i> on red sandy flats with some limestone outcropping.
F6e	Low Open Heath of <i>Stylobasium spathulatum</i> over <i>Diploptis eriocarpa</i> or Scattered Low Shrubs of <i>Solanum lasiophyllum</i> over Hummock Grassland of <i>Triodia epactia</i> over Scattered Herbs of <i>Pterocaulon sphaeranthoides</i> , <i>Nicotiana occidentalis</i> , <i>Swansonia pterostylis</i> and <i>Synaptantha tillaecea</i> var. <i>tillaecea</i> on red brown sandy flats with some limestone outcropping.
F6f	Scattered Shrubs of <i>Acacia coriacea</i> with Low Shrubland of <i>Acacia bivenosa</i> , <i>Pentalepis trichodesmoides</i> , <i>Stylobasium spathulatum</i> , <i>Diploptis eriocarpa</i> and <i>Corchorus walcotti</i> over closed Hummock Grassland of <i>Triodia epactia</i> on red brown sandy flats with limestone outcropping.
L1h	Scattered Low trees of <i>Ficus brachypoda</i> over Low Open Shrubland of <i>Pentalepis trichodesmoides</i> over Hummock Grassland of <i>Triodia epactia</i> and patches of <i>Triodia angusta</i> on red brown sandy slopes with limestone outcropping.

Figure 14:
Vegetation Communities at the Proposed Feed Gas Pipeline Shore Crossing



Legend

- Proposed Feed Gas Pipeline
- ▭ Stringing Area
- ▭ Vegetation Survey
- ▭ Drill Site



Date: GDA 94
Coordinate System: MGA Zone 56

Chevron

GORGON DEVELOPMENT

Vegetation Survey
NWB Area

Author: J Fitzpatrick REV: 1
Drawn by: S Zalizenska Date: 23/01/2006

FIGURE 1

The survey work identified that the proposed shore crossing area contains taxa that are restricted to Barrow Island and protected under state and Commonwealth legislation. None of the identified fauna are restricted to the proposed shore crossing area as surveyed so far, and the fauna are well represented on the island. The proposed area contains no watercourses.

Management Measures

All potential environmental impacts associated with the construction and operation of the feed gas pipeline shore crossing will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The revised location does not present any unique challenges that require new or significantly different management approaches from those contained in the Framework EMP.

A detailed Environmental Management Plan will be prepared specifically for the Feed Gas Pipeline Shore crossing HDD operation. The EMP will contain management measures that are consistent with those contained in the Framework EMP; however, the measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

2.2.6 Onshore Feed Gas Pipeline Route

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP (Section 6.2.2 Page 100) proposed that during subsequent phases of design for the Development, the pipeline design will continue to be reviewed, and the route will be refined as further information and knowledge becomes available.

Proposed Route

A slightly modified onshore feed gas pipeline route is shown in Figure 13. There are two modifications from the initial proposed route, one at the northern end and the other at the most southern corner.

The need for the modification at the northern end is to allow the HDD position to shift approximately 400m further north as discussed in section 2.2.4.

The adjustment at the southern corner is required to avoid an area of existing WA Oil infrastructure. Having a buried pipeline close to existing wells will create a significant concern on the ability to cathodically protect the pipeline.

The stray current interference which exists in this area could result in uncontrolled external corrosion of the pipeline and therefore increase the risk of pipeline failure. Current engineering practice is unable to confidently resolve this complex issue and as such; Australian and International Engineering Standards covering corrosion protection specifically state that avoiding areas of stray current should be achieved wherever possible.

Environmental Implications

Vegetation and Flora

The environmental implications the modifications to the northern end are as discussed in section 2.2.4.

The proposed southern modification (Figure 13) will shorten the route length and hence reduces overall vegetation clearance/land use by approximately 10,000sqm as well as reducing the pipeline length by 330m. The new proposed route will also provide a flatter route which will assist in rehabilitation after the pipe is laid (by reducing water run off issues). Avoiding construction along one side of the main freight routes on the island, which would likely require additional road widening, will provide a safer work site. The new proposed pipeline will also reduce the construction duration by approximately 2 weeks, which will minimise the time personnel stay on the island and also reduce the duration of impact to the environment.

The main communities present at the proposed feed gas pipeline route change (Mattiske 1993) are listed in Table 11.

Table 11:
Vegetation Communities at the proposed change of Pipeline route.

Community Code	Vegetation Description
V1	Hummock Grassland of <i>Triodia wiseana</i> with mixed emergent shrub species on valley slopes
L7	Hummock Grassland of <i>Triodia wiseana</i> with dense pockets of <i>Melaleuca cardiophylla</i> on limestone ridges
L4	Hummock Grassland of <i>Triodia wiseana</i> with dense emergent shrubs of <i>Acacia pyrifolia</i> , <i>Acacia gregorii</i> and <i>Petalostylis labicheoides</i> on limestone ridges

Figure 15:
Fauna survey area at the Proposed Feed Gas Pipeline Shore Crossing

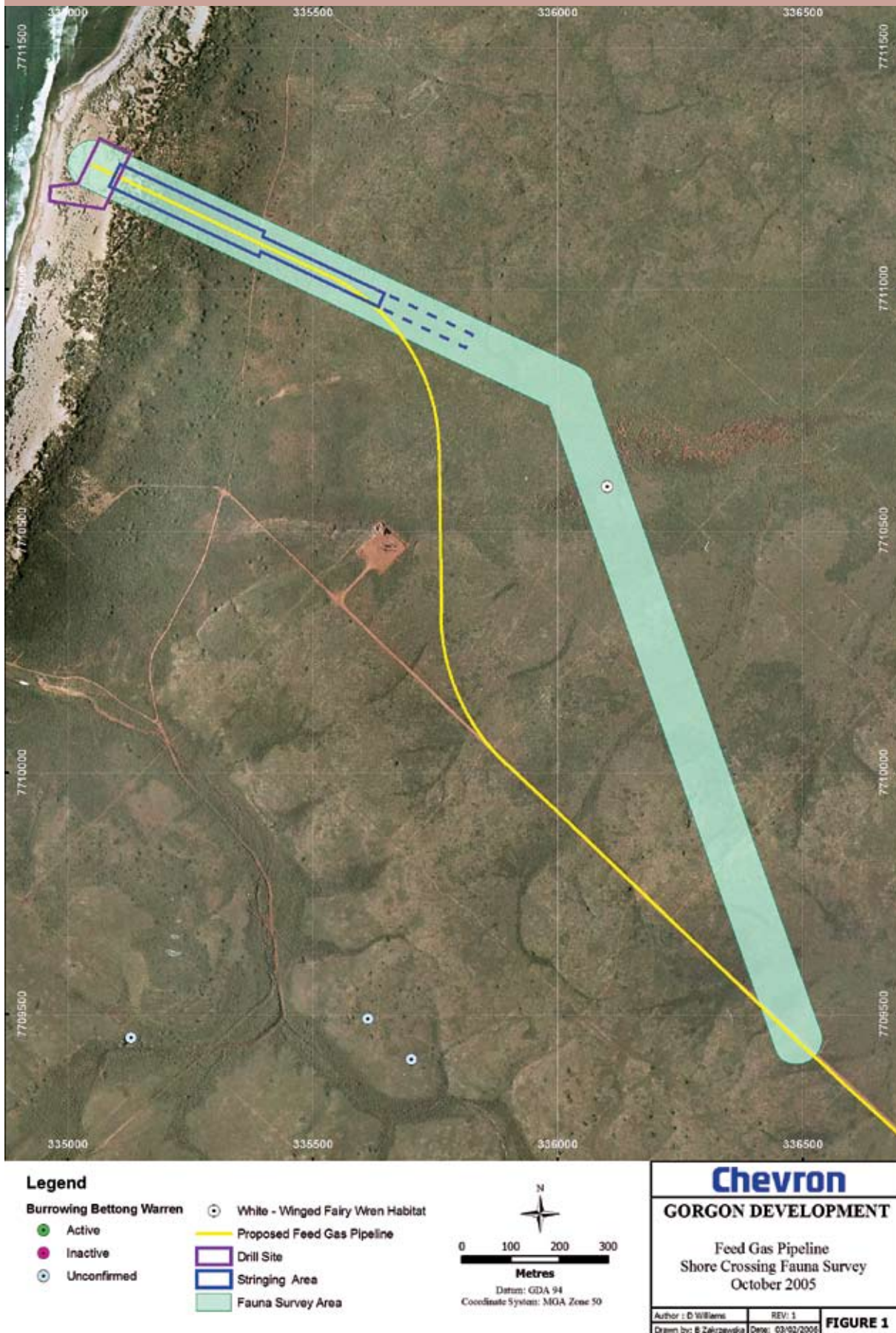
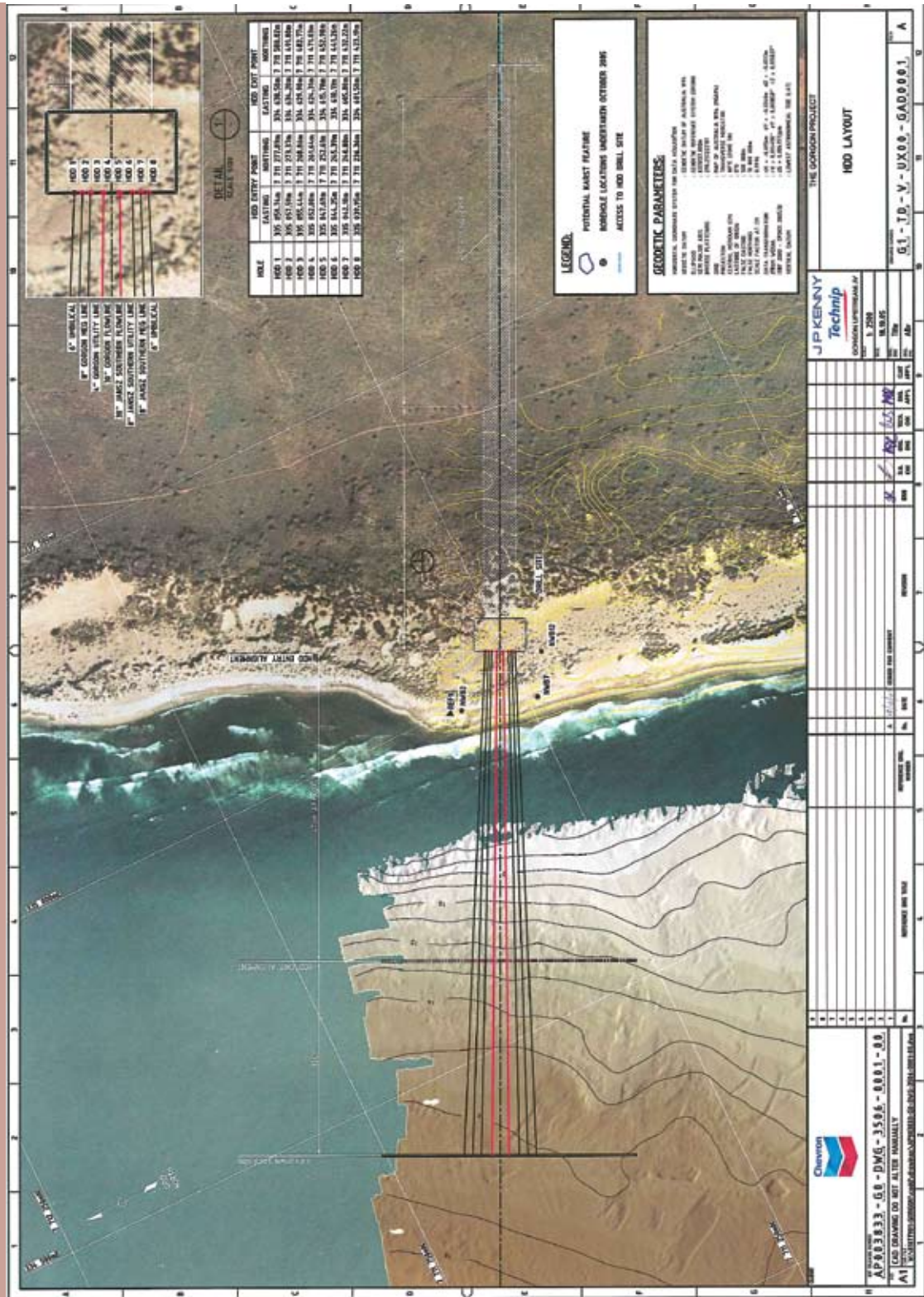


Figure 16:
Proposed Onshore Locations and Breakout Points



Fauna

Further detailed fauna surveys were conducted in October 2005, in accordance with EPA Guidance Statement No. 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004).

The field survey covered the southern area of the new proposed pipeline route (Figure 13). The pipeline survey area covered a 100m wide area to allow for assessment of possible edge effects and disturbance of adjacent fauna and faunal habitats. No bettong warrens were found on, or within 50 m of the surveyed areas. Four Fairy White-Winged Wren habitats were found along this section of the proposed pipeline, White-Winged Fairy Wren, are endemic but abundant on Barrow Island.

The survey work identified that the proposed new pipeline route area contains taxa that are restricted to Barrow Island and protected under state and Commonwealth legislation. None of the identified fauna are restricted to the proposed new pipeline route area as surveyed so far, and the fauna are well represented on the island.

Investigation and design is currently underway that aims to position this 'footprint' in the location that will a) result in limited disturbance to critical flora and fauna habitat and b) result in the optimal location, given engineering constraints. The final position of this 'footprint' will be presented to the relevant government agencies as soon as the initial design is completed and agreed upon internally.

Management Measures

All potential environmental impacts associated with the final route of the feed gas pipeline will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The revised location does not present any unique challenges that require new or significantly different management approaches from those contained in the Framework EMP.

A detailed Environmental Management Plan will be prepared specifically for the Feed Gas Pipeline. The EMP will contain management measures that are consistent with those contained in the Framework EMP; however, the measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

2.2.7 CO₂ Injection Pipeline Route

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP (Section 6.2.4 Page 114) stated that the CO₂ injection pipeline will be above ground and will follow the most direct path practicable to the injection well locations while preferentially using as much previously disturbed land as possible. It also proposed taking measures to ensure the safety of personnel, and at the same time flora and fauna, in the unlikely event of a pipeline release.

Proposed Location

Since the Draft EIS/ERMP was released for public review, the CO₂ injection pipeline design team have conducted a comprehensive study on five possible pipeline routes. The five routes were evaluated in terms of:

- Terrain suitability for pipeline installation with minimum constructability problems. i.e.
 - mild side-hill slopes which allow ease of movement of construction vehicles, installation of sleeper supports and placement of pipe;
 - topography that reduces damage to vegetation from construction activities such as pipeline stabilisation or support;
 - topography that reduces soil erosion hazards due to construction; and,
 - Avoidance of abrupt horizontal or vertical alignment changes (such as streambed crossings) that require special shop-fabricated pipe bends or field bends in the pipe.
- Terrain or topography that do not maximise ease of pipeline installation are covered in the summary table below, as sensitive topography.
- Avoidance of vegetation communities that are considered to be sensitive;
- Avoidance of fauna habitat (primarily Bettong warrens), rugged slopes, and rock outcrops;
- Minimising length (which favours flow hydraulics and reduces capital and operating costs); and,
- Use of previously disturbed areas.

For preliminary design purposes, Option 1 of the five options considered emerged as the preferred, and Option 3 as the next most favourable alternative (Figure 17). These two preferred routes are shown on Figure 17 overlain on vegetation communities. The evaluation of these preferred routes is summarised in Table 12 and further discussed below.

Environmental Implications

Terrain Suitability and Avoidance of Abrupt Horizontal or Vertical Alignment Changes

The terrain of Option 1 is very good for placement of an above-ground pipeline on supports. It allows for good pipeline constructability. The terrain of Option 3 is also generally good for placement of an above-ground pipeline on supports. It allows for very good pipeline constructability. It is not as good as Option 1 between the two well clusters, as it follows higher ground and traverses areas with more rugged terrain, which may require additional construction focus to support and stabilise the pipeline. Both options cross four stream beds which are normally dry, but which will be accounted for during construction to reduce potential for erosion during flood events.

Final routing of either option should avoid all rock outcrops, improving constructability and reducing the risk of encountering undocumented Bettong warrens. Selection of the preferred option will be finalised after review of Light Detection and Ranging (LIDAR) Survey data.

Avoidance of Vegetation Communities that are considered to be Sensitive

Detailed vegetation and flora surveys were conducted for the Draft EIS/ERMP (Section 8.3.2 Page 221) for the CO₂ disposal pipeline routes. Additional surveys will be conducted prior to the preferred route being finalised. Likewise, detailed fauna surveys, were undertaken for the Draft EIS/ERMP, and additional fauna surveys will be conducted prior to the preferred route being finalised.

Current vegetation mapping shows that the preferred route (and alternative) crosses seven vegetation types, based on major landforms, soil type and species composition, and further refined to association, or community, level for this survey.

No Declared Rare Flora species, as listed under subsection (2) of Section 23F of the Western Australian *Wildlife Conservation Act 1950* or as listed by the Department of Conservation and Land Management (CALM) is currently known of in any of the vegetation types.

The main communities present along the pipeline routes are listed in Table 13.

Avoidance of Fauna Habitat (primarily Bettong Warrens)

Current fauna mapping shows that fifteen Bettong warrens (both active and inactive) have been mapped in the area bordered by the LNG plant location in the south, the east coast of Barrow Island, a line drawn east-west at the latitude of the northern injection site, and the north-south portion of the Feed Gas Pipeline. The preferred pipeline routes avoid these sites by a distance of at least 100 meters (or 150 meters from the central point of a warren).

Reducing Length

Option 1 provides the shortest total pipeline length, and the shortest distances from the LNG facility to the South Well Cluster, and from the South Well Cluster to the North Well Cluster.

Option 3 provides the second shortest total pipeline length but with a slightly longer (240 meters) distance from the LNG facility to the South Well Cluster when compared with Options 1 and 2. An advantage is that it provides approximately the same distance from the South Well Cluster to the North Well Cluster as Option 1.

Use of Previously Disturbed Areas

A significant advantage of Option 1 is that it parallels 780 meters of existing pipeline corridor. This advantage is not shared by Option 3.

Table 12:
Route 1 and Route 3 Comparison

Item	Option 1 (preferred)	Option 3 (2nd preferred)
Total CO ₂ Pipeline Length, m	4570	4815
Number of Dry Streambed Crossings	4	4
Distance Traversing Sensitive Topography, m	120	130
Distance Paralleling Existing Pipelines, m	780	0
Distance Paralleling Existing Roads, m	0	620

Figure 17:
Proposed location for CO₂ Injection Pipeline

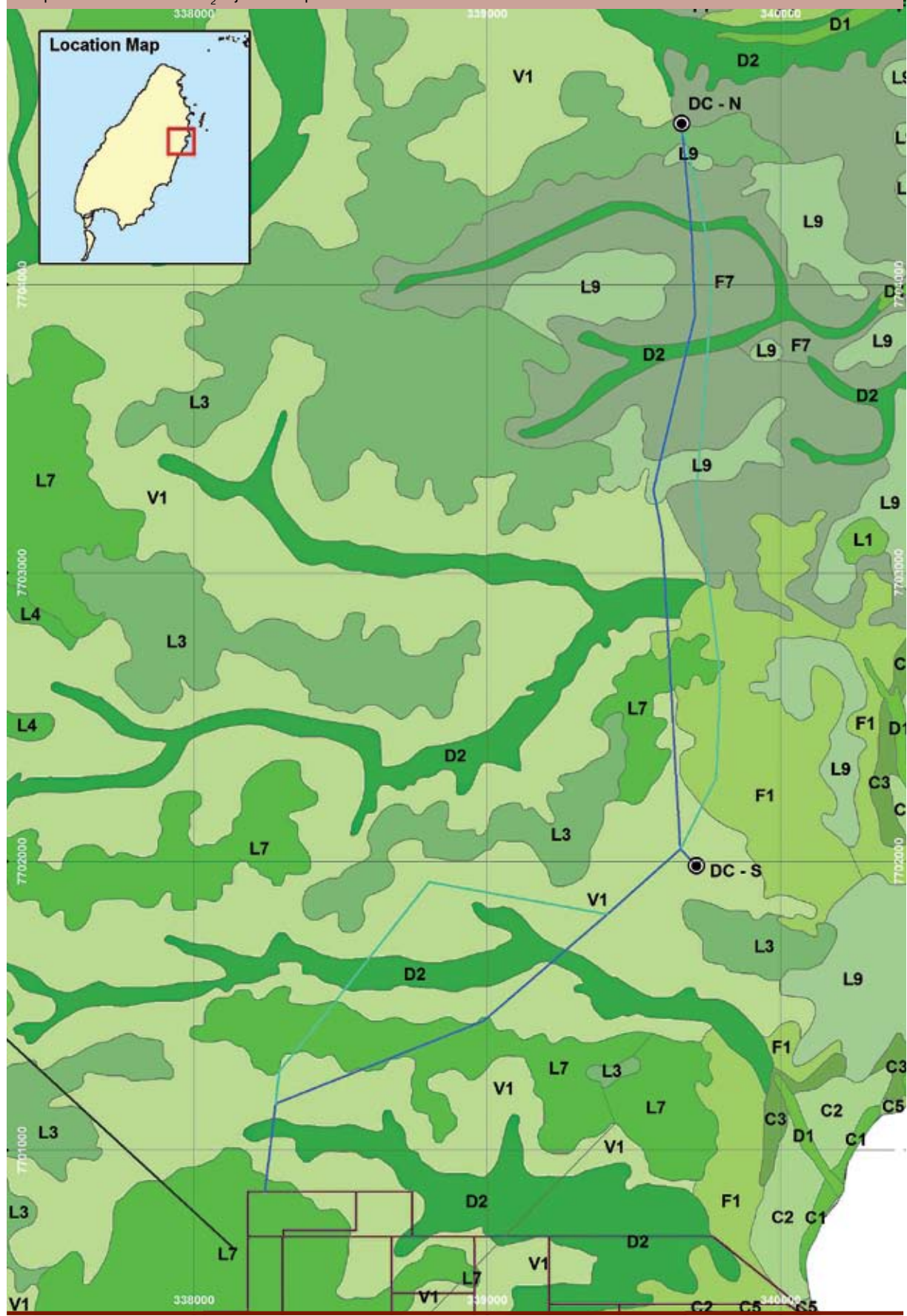


Table 13:
Vegetation Communities along the Preferred CO₂ Pipeline Routes

Community Code	Vegetation Description
D2	Hummock grassland of <i>Triodia angusta</i> along minor creek-lines and drainage lines
F1	Hummock grassland of <i>Triodia angusta</i> on red earth flats and drainage lines
F7	Hummock grassland of <i>Triodia pungens</i> - <i>Triodia angusta</i> - <i>Triodia wiseana</i> on slopes of escarpments on fringes of red earth flats.
L3	Hummock grassland of <i>Triodia wiseana</i> with low mixed shrubs including <i>Acacia gregorii</i> on limestone ridges
L7	Hummock grassland of <i>Triodia wiseana</i> with dense pockets of <i>Melaleuca cardiophylla</i> on limestone ridges
L9	Hummock grassland of <i>Triodia wiseana</i> – <i>Triodia angusta</i> with emergent <i>Sarcostemma viminali</i> spp.australe and <i>Ficus platypoda</i> var <i>platypoda</i> on coastal limestone flats and low ridges with localized pockets of <i>Frankenia pauciflora</i>
V1	Hummock grassland of <i>Triodia wiseana</i> with mixed emergent shrub species on valley slopes

Conclusion

While no sensitive habitats have been identified, additional measures will continue to be undertaken to reduce access to the pipeline route during construction to reduce disturbance to any flora and/or fauna habitat. Exact methods of construction are yet to be determined, however, they will also be chosen to minimise, to the extent practical, disturbance to the natural environment, while maintaining personnel and equipment safety and integrity.

A detailed Environmental Management Plan will be prepared specifically for the construction of the CO₂ pipeline. The EMP will contain management measures that are consistent with those contained in the Framework EMP; however, the measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

Management Measures

All potential environmental impacts associated with the construction and operation of the CO₂ pipeline will be managed in accordance with the management measures contained in the Draft EIS/ ERMP – Framework Environmental Management Plan (Technical Appendix A1).

3 Design

3.1 Proposed Revisions

As the design has progressed a number of revisions have been required to optimise the design. These are highlighted below and each compared against the assessments in the Draft EIS/ERMP.

3.1.1 LNG Plant Layout

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP (Figure 6.6 Page 106) shows a preliminary layout of the proposed gas processing facility.

Proposed Revisions

Optimisation of the proposed plant layout (Draft EIS/ERMP Figure 6.6 Page 106) has resulted in moving equipment within the footprint of each LNG train and within the boundary of the gas processing facility. Also the two trains now being proposed will be built on the North of the site, while potential future expansion would be to the South (Figure 18).

Environmental Implications

The overall footprint remains the same. The main flare is still located to the west and so remains furthest from the beaches. The location of the tanks on the east coast assists with shielding the beaches from potential light impacts.

Management Measures

All potential environmental impacts associated with the proposed layout will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). Construction activities will be addressed in a detailed Environmental Management Plan (EMP). Management measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

3.1.2 Condensate Tank Size

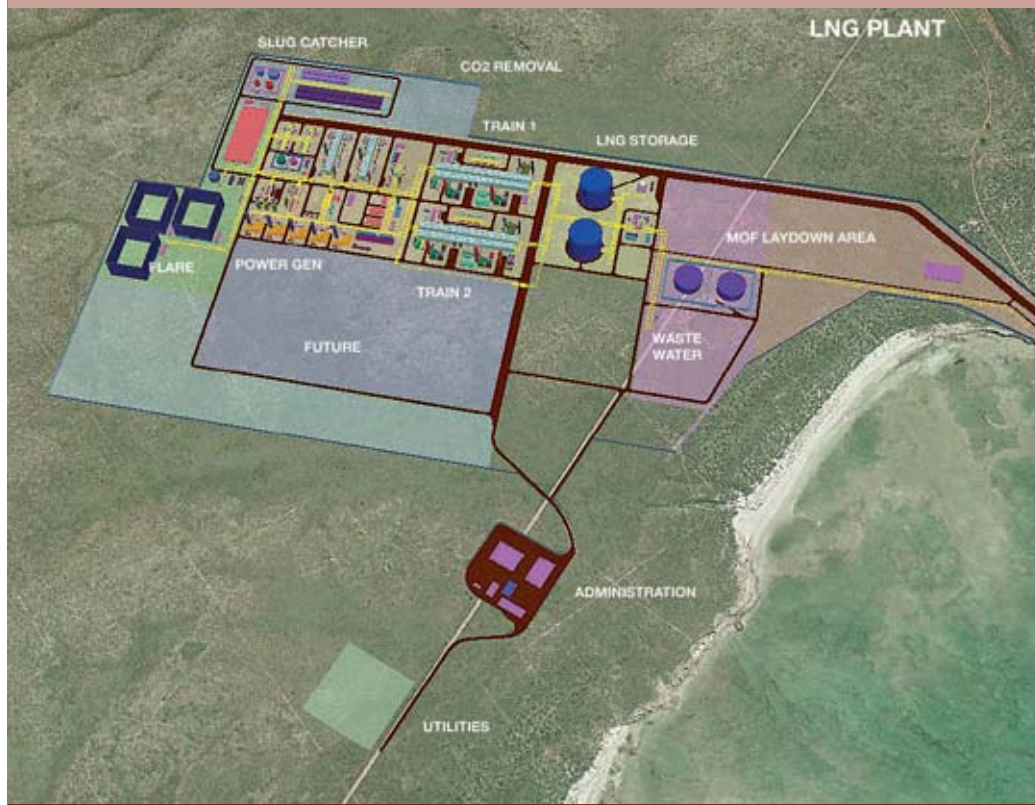
Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP (Section 6.2.3 Page 112) proposed 2 condensate tanks of approximately 35,000 m³ net each.

Proposed Revisions

Condensate tanks have increased in size from 2 x 35,000 m³ net each (Draft EIS/ERMP Section 6.2.3 Page 112) to 2 x 60,000 m³ net each.

Figure 18:
Proposed LNG layout



Environmental Implications

The condensate tanks will be fully bunded and the revised facility layout takes the larger tanks into account. Visual amenity (Draft EIS/ERMP Section 14.9.3 Page 711) will be similar to the original assessment as the LNG tanks are much larger than the condensate tanks, so the LNG tanks are the major factor in amenity. Spill risks will be reduced as there will be less cargo liftings.

Management Measures

All potential environmental impacts associated with the condensate tanks will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). Construction activities will be addressed in a detailed Environmental Management Plan (EMP). Management measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

3.1.3 Energy Optimisation

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP states the following:

- Power for the gas processing facility will be provided by gas turbines (Section 6.2.3 Page 110 and Page 113)
- Boilers will be required (Section 7.2.2 Page 154)
- An energy optimisation study will be undertaken as the design progresses (Box 6.5 Page 113)
- The optimum use of waste heat will be included in the energy optimisation study (Section 6.2.3 Page 113)
- Emissions of CO₂ are described in Chapter 13 (in particular summarised in Table 13.6 Page 609).
- Emissions of NO_x were modelled on Dry, Low NO_x (DLN) burners in both the gas compression turbines and the power generation gas turbines (Section 7.2.2 Page 153), but “the final power and process design will determine the optimum application of DLN burners to most effectively reduce NO_x and greenhouse gas emissions”.

Proposal

The energy optimisation study has been conducted since the Draft EIS/ERMP was released for public review, and concludes:

- Gas compression drivers will be 4 x 80 MW industrial gas turbines with waste heat recovery and with DLN combustion technology
- Power generation will be achieved using 4 x 116 MW industrial gas turbines without waste heat recovery and will use conventional combustion technology. These gas turbines will have the ability to retrofit DLN later if the power requirements increase to a level where DLN technology will operate in a stable mode.
- There will be no boilers, but direct fired heaters will be required to supplement the waste heat recovery system during plant start-up and to operate in rare operational scenarios.

Environmental Implications

The proposed configuration offers lower greenhouse gas emissions, lower ground level concentrations of NO_x while increasing the emission rate of NO_x compared with the Draft EIS/ERMP.

The Joint Venturers acknowledge the EPA Guidance Statement No 15 regarding NO_x reduction. At the required loads the power generation gas turbines would be operating at close to the DLN threshold. Events (such as equipment trips and turndown) push the machines above or below the DLN threshold which can lead to flame instability (i.e. switching between different burner modes) and ultimately result in operational problems and increased flaring. Therefore, it has been concluded that conventional combustion technology will be used on the power generation gas turbines, and DLN will still be used on the compression system gas turbine drivers.

The modelling undertaken for the Draft EIS/ERMP (Section 7.2.2 Page 153) assumed 3 x 116MW Industrial Gas Turbines with Dry Low NO_x (DLN) burners for power generation drivers, 4 x 80 MW industrial gas turbines with DLN burners as the compression drivers and 2 x 150MW boilers.

The net result of the currently proposed configuration is that ground level concentrations (GLC) of NO_x have reduced (refer Table 14), while NO_x emission rates have increased from 4430 tpa NO_x (Draft EIS/ERMP Table 7.1 Page 154) to approximately 6100 tpa NO_x total. The reduction in GLC is primarily because the gas turbine exhausts are hotter without DLN, which results in improved dispersion. Improved dispersion will result in lower impacts on humans and flora and fauna than assessed in the Draft EIS/ERMP Chapter 10.

DLN technology reduces the efficiency of a gas turbine by several percent over conventional combustion technology. As a result, an emission reduction of approximately 30,000 tonnes CO₂ per annum (Draft EIS/ERMP Table 13.6 Page 609) can be expected when operating conventional combustion systems over DLN technology to achieve the same power output from the power generation facilities. This reduction improves the net greenhouse gas emissions by approximately 1% and so benchmarking also improves by approximately 1%. As DLN technology has more equipment it is inherently less reliable than conventional combustion equipment. Therefore DLN would result in more shutdowns and associated flaring but to be conservative this aspect has not been quantified in this evaluation.

The proposed configuration of the power generation gas turbines, resulting from the energy optimisation study, reduces greenhouse gas emissions from power generation by approximately 3% over that included in

Table 14:

Comparison of maximum ground level concentrations (µg/m³)

Heading	2004 Assessment			2005 Assessment		
	1-hour NO _x	1-hour NO ₂	Annual	1-hour NO _x	1-hour NO ₂	Annual
Holding Mode	384	130	4	336	115	2
Loading Mode	381	129	4	333	114	2
Turn Down	328	113	3	359	122	2
Start Up	201	75	-	378	128	-

the reference case (Draft EIS/ERMP Table 13.8 Page 612). This reduction in greenhouse gas emissions is in part due to the larger more efficient gas turbines operating which offsets the smaller less efficient turbines being operated under higher loads. The proposal of four 116 MW gas turbines (operated at part load) is not anticipated to make a material impact on the overall level of greenhouse gas emissions (Draft ESI/ERMP Table 13.6, Page 609) from the Gorgon Project.

The Gorgon Joint Venturers' commitment to Australian industry (Draft EIS/ERMP Chapter 14 Page 683) requires a 50 Hz power system which has had a big bearing on the energy optimisation study. One option considered was to provide power generation systems which are normally associated with 60 Hz systems and adding gear boxes to accommodate the 50 Hz requirement, but this was ruled out because of technical novelty and the large size of the gear boxes required.

Management Measures

All potential environmental impacts associated with the proposed configuration of the power plant will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The energy optimisation studies have not identified any new issues that would require new or significantly different management approaches from those contained in the Framework EMP and the Draft EIS/ERMP (Greenhouse Gas Management Plan Section 13.5 page 677).

3.2 Choice of Option

As the design has progressed a number of areas where options were presented in the Draft EIS/ERMP have been refined to optimise the design. These are highlighted below and each compared against the assessments in the Draft EIS/ERMP.

3.2.1 Feed Gas Pipeline Installation

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP (Box 6.3 Page 103) identified three alternatives for the installation of the feed gas pipelines, namely: above ground installation; surface installation and below ground installation. The Draft EIS/ERMP concluded that the preferred installation technique would be above ground. Surface installation was not preferred due to potential impacts on fauna movement and water movement. Below ground installation was not preferred due to the expectation that the rock is extremely hard and extensive blasting would be required.

Proposed Option

Since the Draft EIS/ERMP was released for public review additional geotechnical studies have been undertaken on the geology along the pipeline route. These and other technical studies have proven that trenching techniques are feasible, without significant (or any) blasting and burial of the feed gas pipelines is now considered the preferred environmental outcome (Draft EIS/ERMP Box 6.3 Page 104).

The basis for this decision is summarised as follows:

- More detailed interpretation of the geotechnical data indicates that burying of the pipe can be achieved by trenching rather than drilling and blasting.
- Bedding material will not need to be imported to the island which alleviates initial concerns over quarantining of imported fill. The above ground construction would have a much higher quarantine burden mainly associated with the pipe supports.
- The extent of vegetation clearing can be reduced by trenching.
- The buried pipeline would not affect flora or fauna by providing shade or water or act as a barrier to fauna movement.
- The pipeline ROW could be rehabilitated directly following installation, whereas the above ground construction would be disturbed again at the end of field life when the pipe and supports are removed (the buried pipe would be left in place)
- The maintenance and inspection requirements of a buried pipeline have advantages over above ground pipeline.

- The cyclone and fire implications for an above ground pipe can be avoided with a buried solution. An above ground pipeline is more likely to be affected which could lead to plant downtime (particularly with umbilical repairs).
- The safety risk associated with vehicle movements along side an above ground pipeline can be avoided with a buried solution.

Environmental Implications

Given the additional information obtained and the investigations undertaken since the Draft EIS/ERMP was published, the environmental impact of a buried pipeline would be equivalent to or less than that of an above ground pipeline, and so it is proposed that the feed gas pipelines will be buried.

Management Measures

All potential environmental impacts associated with the proposed installation of the feed gas pipelines below ground will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The installation optimisation studies have not identified any new issues that would require new or significantly different management approaches from those contained in the Framework EMP. Construction activities will be addressed in a detailed Environmental Management Plan. Management measures will be further developed in consultation with the construction contractor and regulatory agencies as the design and construction planning progress.

3.2.2 Condensate Load-out

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP (Section 6.2.3 Page 112.) identified three alternatives regarding condensate load out, namely: using the existing Barrow Island subsea loading facilities; running a new subsea pipeline, or using the LNG jetty.

Proposed Option

After further investigation, it has been decided that condensate load out will occur from the LNG jetty.

Environmental Implications

Load out using the LNG jetty avoids the environmental impacts associated with installation of a subsea pipeline. It also avoids the need to ensure integrity of the existing pipeline for the life of the Gorgon Development.

Currently, there is a single shipment of crude oil from Barrow Island each month (Draft EIS/ERMP Section 7.3.3 Page 169). Initially it was proposed that an additional condensate ship loading will also occur once every month (Draft EIS/ERMP Section 7.3. Page 169), but this is now expected to be approximately once per two months (refer Section 3.2.4). This decrease in ship loading frequency reduces the chance of a spill associated with condensate loading, as spills are most often associated with connection and disconnection activities. Larger tankers than are currently being used to offload oil from Barrow Island will be utilised in order to lower the risk during condensate transfer.

Management Measures

All potential environmental impacts associated with the proposed load out of condensate from the LNG jetty will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The optimisation studies have not identified any new issues that would require new or significantly different management approaches from those contained in the Framework EMP.

3.2.3 Flare

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP (Section 6.2.3 Page 114) identified the need for a total of three flares for the safe operation of the gas processing facilities. The two main flares directly associated with the gas processing facility were to be located on a flare tower expected to be 150 m high and located to the west of the facility. The third flare is directly associated with the LNG storage and loading facility and is similar to the other two but would be located near the LNG storage tanks. The possibility of a ground flare was also to be investigated (Draft EIS/ERMP Section 6.2.3 Page 114).

Figure 19:
Typical Ground Flare



Proposed Option

The alternative, fully-enclosed, full wall-height ground flare concept has been evaluated and has been selected for the two main flares which are directly associated with the gas processing facility (Figure 19). An elevated flare (Draft EIS/ERMP Plate 6.4 Page 115) is proposed for the LNG storage and loading facility. The storage and loading facility flare system must handle extremely low back pressures, which makes the ground flare concept technically infeasible. Refer to Figure 18 for the location of the ground flares.

Environmental Implications

A ground flare has been selected and this significantly reduces the amount of light associated with flaring because of its design, and because it is at ground level. Therefore, the ground flare is not expected to have any significant affect on turtles. As can be seen in Draft EIS/ERMP (Plate 6.4 Page 115) an elevated flare (approximately 150 m tall) cannot 'be hidden' behind other equipment and so would be seen for a great distance. Further design work undertaken during FEED has shown that the elevated flare concept would have increased from 150m initially proposed to approximately 200m.

The remaining elevated flare (commonly known in this service as the "storage and loading flare") is rarely required and so light emissions are unlikely to affect turtles.

The ground flare proposed for the gas processing facility has significant advantages in terms of reducing direct light emissions since the walls extend to the full height of the flame, and so significantly reduces the potential impacts of flaring on turtles.

Other advantages of the ground flare over an elevated flare for the gas processing facility service are:

- requires approximately 1/3 less land take;
- no significant radiative heat outside flare radiation fence;
- lower noise impacts on personnel and fauna;
- less maintenance expected and easier maintenance, if required;
- less impact on operational activities near the flare;
- can be operated smoke-less without using additional fuel gas, air injection, steam injection or injection of another gas; and
- construction is less complex and construction time is shorter.

The Gorgon Joint Venturers are continuing discussions with the Civil Aviation Safety Authority and other relevant parties regarding heat plumes associated with the gas turbine exhausts and the flare, and potential restrictions these may impose on aircraft movements (refer Section 2.2.1).

Management Measures

All potential environmental impacts associated with the proposed flare configuration will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The optimisation studies have not identified any new issues that would require new or significantly different management approaches from those contained in the Framework EMP.

3.2.4 Condensate Loading Parcel Size

Concept Outlined in the Draft EIS/ERMP

The Draft EIS/ERMP proposed there would be one shipment per month to export condensate (Draft EIS/ERMP Section 7.3.3 Page 169).

Proposed Revisions

Condensate offloading parcel size has increased from the expected 300,000 barrels or 50,000 cubic metres (requiring approximately one shipment per month – Draft EIS/ERMP Section 7.3.3 Page 169) to 600,000 barrels or 100,000 cubic metres, to suit market expectations.

Environmental Implications

This reduces the number of condensate shipping movements from once per month to approximately once per two months. Risk of spills during the offloading operation is linked to the vessel movements and is normally mostly associated with connection and disconnection activities, and so spills risks (Draft EIS/ERMP Section 7.9 Page 188) will be reduced.

Reducing the number of condensate tankers will very slightly reduce potential impacts of lighting on turtles.

Management Measures

All potential environmental impacts associated with the proposed load-out of condensate in larger shipments will be managed in accordance with the management measures contained in the Draft EIS/ERMP – Framework Environmental Management Plan (Technical Appendix A1). The optimisation studies have not identified any new issues that would require new or significantly different management approaches from those contained in the Framework EMP.

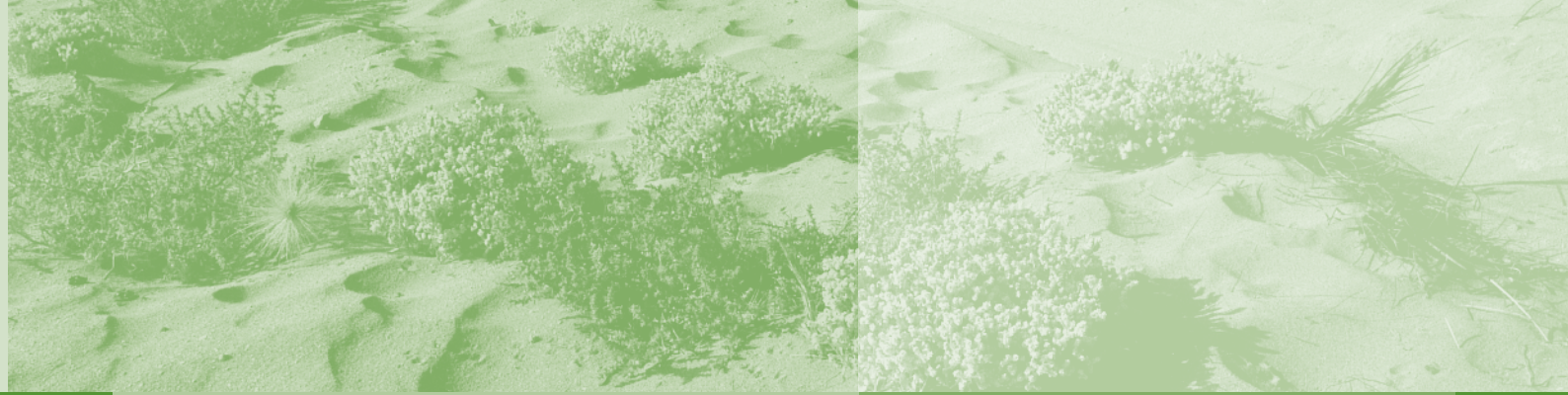
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Part B – Response to Submissions
Final Environmental Impact Statement/
Response to Submissions on the
Environmental Review and Management
Programme for the Proposed Gorgon
Development

Contents

1. Introduction.....	64
1.1 Development Proponent.....	65
1.1.1 Environmental Commitment and Responsibility.....	66
1.2 Development Overview.....	67
1.2.1 Resource under Consideration for Development.....	67
1.2.2 Background to this Development Proposal.....	67
1.2.3 In-principle Approval for Restricted Access to Barrow Island.....	67
1.2.4 Scope of the Proposed Development.....	68
1.2.5 Principal Elements of the Proposed Development.....	69
1.2.6 Relationship to Other Proposals in the Region.....	69
1.2.7 Development Timeline.....	69
1.3 Development Rationale.....	70
1.4 Development Objectives.....	70
1.5 EIS/ERMP Process.....	71
1.6 Key Concepts.....	72
2 Background to the Proposal.....	74
2.1 ESE Review Process.....	75
2.1.1 ESE Review Scoping.....	75
2.1.2 ESE Review Investigation.....	75
2.1.3 ESE Review Assessment.....	75
2.2 Cabinet Decision.....	75
2.3 Barrow Island Legislation.....	76
3 Development Alternatives.....	81
3.1 Introduction.....	82
3.2 Previous Development Attempts.....	82
3.3 Overview of the Development Concept.....	82
3.4 Technical and Commercial Constraints.....	82
3.5 Assessment of Regional Locations.....	82
3.6 Assessment of Barrow Island Sites.....	93
3.7 Assessment of Feed Gas Pipeline Alternatives.....	95
3.8 Defer or not Develop Alternative.....	96

4	Legislative Framework.....	97
4.1	Introduction and General Legislative Framework Responses to Submissions.....	98
4.2	Environmental Impact Assessment Process.....	101
4.3	Other Relevant Legislation.....	103
5	Stakeholder Engagement.....	104
5.1	Introduction and General Responses to Submissions on Stakeholder Engagement.....	105
5.2	Methods of Engagement.....	106
5.2.1	Community Consultation – Quarantine.....	106
5.3	Key Gorgon Development Stakeholders.....	107
5.4	Key Issues Identified by Stakeholder Groups.....	107
5.5	Conclusion and Further Engagement Plan.....	107
6	Development Description.....	108
6.1	General Submissions on Development Description.....	109
6.2	Major Infrastructure Components.....	110
6.2.1	Wells and Subsea Facilities.....	110
6.2.2	Feed Gas Pipelines.....	110
6.2.3	Gas Processing Facility.....	112
6.2.4	CO ₂ Injection Facilities.....	113
6.2.5	CO ₂ Monitoring Activities.....	115
6.2.6	Domestic Gas Pipeline.....	116
6.2.7	Water Supplies.....	116
6.2.8	Drainage and Waste Water System.....	117
6.2.9	Port and Marine Facilities.....	122
6.2.10	Supporting Facilities.....	124
6.2.11	Mainland Supply Base.....	126
6.2.12	Estimated Land Use.....	127
6.3	Construction Activities.....	127
6.3.1	Construction of Offshore Wells.....	127
6.3.2	Construction of Onshore CO ₂ Injection Wells.....	127
6.3.3	Construction and Installation of Subsea Systems.....	128
6.3.4	Construction of the Feed Gas Pipeline.....	128
6.3.5	Construction of the Onshore Feed Gas Pipelines.....	130
6.3.6	Construction of the Gas Processing Facility and Infrastructure.....	132
6.3.7	Construction of Onshore Water Supply/Re-injection Wells.....	137
6.3.8	Construction of Marine Facilities.....	139
6.3.9	Construction of the Domestic Gas Pipeline.....	142
6.3.10	Construction of Optical Fibre Cable.....	142
6.3.11	Other Pipelines.....	143
6.4	Pre-Commissioning, Commissioning and Start-Up.....	144
6.5	Operation of the Gorgon Development.....	144

6.6	Decommissioning.....	144
6.6.1	Decommissioning of Pipelines	145
6.6.2	Decommissioning of Gas Processing Facilities	145
7	Emissions from the Development.....	146
7.1	Introduction and General Submissions on Emissions.....	147
7.2	Atmospheric Emissions.....	147
7.3	Light Emissions.....	152
7.4	Noise Emissions.....	154
7.5	Solid Non-hazardous Wastes	155
7.6	Liquid Wastes.....	155
7.6.1	Liquid Waste Management.....	160
7.7	Hazardous Waste.....	163
7.8	Dredging and Dredge Soil Disposal.....	163
7.9	Accidental Releases (Spills).....	169
8	Existing Environment.....	177
8.1	Introduction/General Submissions on Existing Environment	178
8.2	Physical Environment.....	178
8.2.1	Introduction.....	178
8.2.2	Regional Setting	178
8.2.3	Climate.....	178
8.2.4	Bathymetry and Sea Floor Topography.....	178
8.2.5	Oceanography	178
8.2.6	Topography and Landforms	179
8.2.7	Geology and Soils	179
8.2.8	Seismic Activity	179
8.2.9	Surface Hydrology.....	179
8.2.10	Hydrogeology	179
8.3	Ecology	181
8.3.1	Introduction/General Submissions on the Ecology of the Existing Environment	181
8.3.2	Terrestrial Ecology	181
8.3.3	Marine Ecology.....	194
8.4	Social Environment	201
8.4.1	Introduction.....	201
8.4.2	Population Trends and Demographics	201
8.4.3	Lifestyles and Livelihood	201
8.4.4	Government Policies and Plans	201
8.4.5	Land and Sea Tenure and Use	201
8.4.6	Visual and Aesthetics	202
8.4.7	Cultural Heritage.....	202
8.4.8	Native Title.....	203
8.5	Economic Environment	203

9	Risk Assessment Process	204
9.1	Introduction	205
9.2	Methodology	205
9.2.1	Identification of Stressors	205
9.2.2	Identification of Receptors	205
9.2.3	Definition of Consequences	205
9.2.4	Definition of Likelihood	205
9.2.5	Characterisation of Risk	206
9.2.6	Risk Management.....	207
9.3	Uncertainty	207
9.4	Conclusion	207
10	Terrestrial Environment – Risks and Management.....	208
10.1	Introduction and General Submissions on Terrestrial Environment.....	209
10.2	Physical Environment.....	211
10.2.1	Soil and Landform	211
10.2.2	Surface Water and Groundwater Quality.....	211
10.3	Flora and Vegetation Communities.....	211
10.3.1	Clearing and Earthworks	213
10.3.2	Emissions.....	213
10.3.3	Fire.....	214
10.3.4	Unpredicted CO ₂ Migration to Surface	214
10.3.5	Cumulative Risk.....	214
10.4	Terrestrial Fauna.....	214
10.4.1	Clearing and Earthworks	216
10.4.2	Physical Interaction	220
10.4.3	Noise and Vibration	220
10.4.4	Fire	221
10.4.5	Emissions.....	221
10.4.6	Cumulative Risk	222
10.5	Subterranean Fauna.....	222
10.5.1	Clearing and Earthworks	226
10.5.2	Physical Presence of Gas Processing Facility	226
10.5.3	Wastewater Discharge.....	226
10.5.4	Noise and Vibration	227
10.5.5	Spills and Leaks.....	227
10.5.6	Unpredicted CO ₂ Migration	227
10.5.7	Cumulative Risk.....	227
10.6	Conclusion	227

11	Marine Environment – Risks and Management.....	228
11.1	Introduction and General Submissions on Marine Environment.....	229
11.2	Physical Environment.....	231
11.2.1	Seabed Substrate.....	232
11.2.2	Foreshore.....	233
11.3	Benthic Primary Producers.....	234
11.3.1	Seabed Disturbance.....	238
11.3.2	Leaks and Spills.....	258
11.4	Benthic Primary Producer Habitats.....	258
11.4.1	West Coast and North Coast.....	273
11.4.2	East Coast.....	273
11.4.3	Mainland Coast.....	274
11.5	Marine Fauna.....	275
11.5.1	Seabed Disturbance.....	279
11.5.2	Physical Interaction.....	284
11.5.3	Light.....	285
11.5.4	Noise and Vibration.....	293
11.5.5	Leaks or Spills.....	294
11.5.6	Cumulative Risk.....	296
11.6	Conclusion.....	296
12	Quarantine – Risks and Management.....	297
12.1	Introduction and General Submissions on Quarantine – Risks and Management.....	298
12.1.1	Quarantine Management Objectives.....	300
12.1.2	Key Quarantine Terminology.....	300
12.2	Approach to Quarantine Management.....	301
12.2.1	EPA Advice.....	301
12.2.2	Quarantine Expert Panel.....	302
12.2.3	Community Involvement.....	302
12.2.4	Best Practice Benchmarking.....	302
12.2.5	Expert Advice.....	302
12.2.6	Standards for Acceptable Risk.....	302
12.3	Existing Environment.....	302
12.3.1	Conservation Values of Barrow Island.....	303
12.3.2	Quarantine Experience.....	303
12.3.3	Historical and Existing Presence of Non-Indigenous Species.....	304
12.3.4	Baseline and Early Survey Strategies.....	307
12.3.5	Terrestrial Baseline Data.....	309
12.3.6	Marine Baseline Data.....	312
12.4	Gorgon Quarantine Risk Management.....	312
12.4.1	Introduction to Risk-based Management.....	314
12.4.2	Risk Assessment Method.....	314
12.4.3	Development of Standards for Acceptable Risk.....	314
12.4.4	Identification of Quarantine Threats.....	325

12.5	Quarantine Barrier Selection.....	326
12.5.1	Quarantine Barrier Selection Method.....	326
12.5.2	Systematic Quarantine Barriers for all Pathways.....	335
12.5.3	Management of Quarantine on the Sand and Aggregate Pathway.....	335
12.5.4	Management of Quarantine on the Food and Perishables Pathway.....	337
12.5.5	Management of Quarantine on the Personnel & Accompanying Luggage Pathway.....	337
12.5.6	Management of Quarantine on the Marine Vessels Pathway.....	337
12.5.7	Management of Quarantine for Rodents on Marine Vessels.....	338
12.5.8	Monitoring Strategy.....	338
12.5.9	Response Strategy.....	339
12.6	Quarantine Management System.....	343
12.6.1	Introduction.....	349
12.6.2	Elements of the QMS.....	349
12.6.3	System Implementation.....	349
13	Greenhouse Gas Emissions – Risks and Management.....	351
13.1	Introduction and General Submissions on Greenhouse Gas Emissions.....	352
13.1.1	Commitment to Greenhouse Gas Management.....	352
13.1.2	Impact on National and State Greenhouse Gas Emissions.....	355
13.1.3	The Relative Greenhouse Impact of LNG.....	355
13.2	Alternative Greenhouse Gas Abatement Options.....	359
13.3	Gorgon Development Greenhouse Gas Emissions.....	361
13.3.1	Greenhouse Gas Emissions Efficiency Improvements.....	361
13.3.2	Emissions Estimation Methodology.....	361
13.3.3	Emissions During Construction and Commissioning.....	361
13.3.4	Emissions from Operations.....	362
13.3.5	Greenhouse Gas Emissions during Decommissioning.....	362
13.3.6	Benchmarked Greenhouse Gas Emission Performance.....	362
13.4	Disposal of Reservoir Carbon Dioxide by Injection into the Dupuy Formation.....	363
13.4.1	Assessment of Potential Carbon Dioxide Injection Sites.....	367
13.4.2	Location of Carbon Dioxide Injection on Barrow Island.....	371
13.4.3	Geology of Barrow Island.....	371
13.4.4	Carbon Dioxide Behaviour in the Subsurface.....	372
13.4.5	Reservoir Simulation.....	372
13.4.6	Deviations from Simulation Predictions.....	372
13.4.7	Monitoring of Injected Carbon Dioxide.....	372
13.4.8	Carbon Dioxide Injection Operations Management Plan.....	374
13.4.9	Environmental Impact of Carbon Dioxide Injection Infrastructure.....	377
13.4.10	Potential Failure Modes Related to Carbon Dioxide Injection.....	377
13.4.11	Approach to Long-term Responsibilities.....	378
13.4.12	Approach to Long-term Responsibilities.....	378
13.5	Greenhouse Gas Management Plan.....	380
13.5.1	Membership of Government Programs.....	381
13.5.2	Planned Actions to Reduce Greenhouse Gas Emissions.....	381
13.5.3	Greenhouse Gas Emissions Performance Indicators and Targets.....	382
13.6	Compliance with EPA Guidance Notes.....	382

14	Social and Cultural Environment.....	383
14.1	Introduction and General Submissions on Social and Cultural Environment	384
14.2	Social Factors Requiring Assessment	384
14.3	Government Policy and Plans	384
14.4	Local Communities	384
14.5	Livelihoods and Lifestyle.....	384
14.6	Land and Sea Use and Tenure	385
14.7	Native Title	386
14.8	Cultural Heritage	386
14.8.1	Indigenous Archaeology	386
14.8.2	Maritime Heritage – Subsea	387
14.9	Landscape and Aesthetics.....	387
14.10	Workforce and Public Health and Safety.....	387
14.11	Public Risk Assessment.....	388
15	Economic Environment	389
15.1	Introduction and General Submissions on Economic Environment	390
15.2	Economic Analysis	390
15.3	Impacts on the Domestic Gas Market.....	390
15.4	Local Content.....	390
15.5	Capacity Building	390
15.6	Expansion of the Development.....	390
16	Environmental Management Framework	391
16.1	Introduction and General Submissions on the Environmental Management Framework.....	392
16.2	Key Elements of the Environmental Management System.....	393
16.2.1	Policy	393
16.2.2	Objectives and Targets	393
16.2.3	Leadership and Commitment	393
16.2.4	Organisation Structure and Responsibility	393
16.2.5	Operational Control	393
16.2.6	Documentation and Reporting	393
16.2.7	Training, Awareness and Competence.....	393
16.2.8	Monitoring.....	393
16.2.9	Auditing.....	394
16.2.10	Non-Conformance and Corrective Action.....	394
16.2.11	Emergency Preparedness and Response	394
16.2.12	Incident Reporting	395
16.2.13	System Review	395
16.3	Environmental Management Plans	395
17	Conclusion	401
17.1	Conclusion	402
17.1.1	Gorgon Development Sustainability Principles	402
17.2	Outcomes of the Environmental Impact Assessment of the Proposed Gorgon Development.....	402
17.3	Stakeholder Engagement and Way Forward	403

Responses to Submissions

Information to assist your review of the Gorgon Joint Venturers Response to Submissions: Part B

Number	Submitter
1	Anonymous
2	Chamber of Minerals and Energy WA
3	Department of Indigenous Affairs
4	Anonymous
5	Anonymous
6	Anonymous
7	Anonymous
8	Department of Industry and Resources
9	Environmental Weeds Action Network (WA) Inc.
10	Humane Society international – Michael Kennedy (Campaign Director)
11	Anonymous
12	Wildflower Society Western Australia Inc.
13	WA Museum
14	Conservation Commission of WA
15	Marine Parks and Reserves Authority
16	Waterbird Conservation Group
17	Department of Consumer and Employment Protection – Petroleum and Major Hazards Facilities Safety Branch
18	Department of Conservation and Land Management
19	Department of Environment
20	World Wildlife Fund for Nature (WWF) Australia
21	Anonymous
22	Conservation Council of Western Australia Inc.
23	Department of Fisheries
24	Environmental Protection Authority
25	Department of Environment and Heritage
26	Conservation Council of Western Australia Inc. (Additional information)
27	WWF – Australia (Additional Information)
28	Department of Environment (Additional Information)

The Gorgon Joint Venturers have responded to the submissions received and collated their responses. Many of the answers are of a similar nature, so rather than repeat the same response; questions/statements that have a similar answer are grouped together. These have then been categorised into chapters (based on the theme of the question/statement) which correspond to the chapters of the Draft EIS/ERMP.

Questions have been coded according to submission number (see table above) and the number of the question within the submission. For example, the thirtieth question in the Department of Industry and Resources Submission (8) is coded as 8.30.

Those whose submission was forwarded to chevron anonymously can contact Warren Tacey at the WA Department of the Environmental Protection (ph 08 9222 7061) to request the number they were allocated.

Please find included a Data CD containing all of the information presented in this published document. In order to make it easier to find a particular question and the Joint Venturers' response, please open the Part B document saved onto the CD. This will allow a search for questions ('Edit' dropdown menu, 'Find').

1. Introduction

Twenty eight submissions were received on the Draft EIS/ERMP for the Proposed Gorgon Development. From these submissions approximately 1300 separate questions were identified. Part B of this document contains the list of submissions & directions in regard to finding your questions and the questions and responses. These have been grouped into Chapter topics from the Draft EIS/ERMP.

Chevron Australia in association with our Joint Venture Partners have responded to each question raised via the submissions. It was our aim to provide submitters with accurate information that is available at this stage of development and design of the Gorgon Project. Chevron Australia would like to extend our appreciation to all groups that chose to forward a submission to the Western Australian or Commonwealth Governments as part of this environmental approvals process.

1.1 Development Proponent

22.47 The Submitters' position is that 'successful co-existence' has never been independently established.

Chevron Australia is proud of its environmental performance on Barrow Island and has won several state, national and international awards for its management of oilfield operations in a manner that has successfully maintained the conservation values of Barrow Island. A selection of these is detailed on page 9 of the ESE Review (ChevronTexaco Australia 2003).

22.48 Page 3 – 1.1: As the joint venturers well know, the injection of CO₂ associated with oil recovery has little to do with the kind of geosequestration proposed for this project. This section should be re-written to reflect reality.

Enhanced oil recovery operations provide valuable experience, such as in the compression and pumping of CO₂; CO₂ pipeline construction and operation; injection well design and maintenance; and the subsurface behaviour of the injected CO₂. As an example, it is experience gained with enhanced oil recovery that has highlighted the importance of ensuring existing well penetrations are fit for CO₂ service. World-wide there are over 3100 km of CO₂ pipelines in service transporting over 45 million tonnes of CO₂ per year. Data from these operations has been incorporated into the design of the injection system and the Gorgon Joint Venturers understanding of risk and uncertainty management.

In relation to the subsurface behaviour of injected CO₂, enhanced oil recovery operations have been instrumental in developing an understanding of trapping mechanisms and implementing the required upgrades to tools such as reservoir simulators so that they accurately model CO₂ behaviour.

Oil and gas research has led to the understanding of trapping mechanisms. For the Gorgon Development, residual gas trapping is the primary mechanism by which the injected CO₂ will become permanently trapped in the subsurface. Residual gas trapping also applies to oil and gas field developments.

For example, in oil and gas production operations a residual, or irreducible, oil or gas saturation exists. Residual gas trapping in a natural gas reservoir is analogous to residual CO₂ trapping associated with CO₂ injection. Thus, the understanding of residual trapping comes primarily from the oil and gas industry. Since CO₂ is naturally occurring in many oil and gas reservoirs, and CO₂ has been used in enhanced oil recovery, the physical properties of CO₂ in the reservoir and its interaction with water and hydrocarbons have been extensively studied and are well-known.

22.57 The joint venturers may not be the subject of any Australian proceedings, but given that they are often relying on their international experience in this document, can they confirm that they are not the subject of any international proceedings as well?

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires proponents to disclose any current Australian proceedings. The Joint Venturers all publish global corporate environmental performance data on their respective websites. Chevron Australia is the operator of the Gorgon Development and is proud of its environmental performance and record of demonstrated corporate responsibility. Chevron annually develops its Corporate Responsibility Report <www.chevron.com/cr_report/> which provides the community with an opportunity to review the efforts Chevron have under way to address the issues, assess their performance, and identify issues on the horizon or opportunities to improve. It also helps Chevron demonstrate their commitment to transparency. This process also allows for external organisations to make comment on areas of the business where they can see opportunities for improvement.

1.1.1 Environmental Commitment and Responsibility

16.4 The necessary respect for the biological and ecological values of Barrow Island and its environs, and the necessary level of dedication and commitment to protecting those values, appear to be missing from the Report.

The Gorgon Joint Venturers are committed to maintaining the biological and environmental values of the Barrow Island Nature Reserve and surrounding waters.

16.88 The blurring of the word 'Commitment' with '(action)' is questionable indeed, these are not synonymous. Monitoring, data collection, surveys and the like listed as 'Key Commitments (action)' are worthless on their own.

The Joint Venturers are committed to conducting focussed, meaningful and scientifically valid monitoring, data collection and surveys. In addition, the Joint Venturers have outlined management measures throughout the Draft EIS/ERMP (specifically in Chapters 10–15 and the Framework EMP in Technical Appendix A1) to reduce environmental risks to acceptable levels and to thereby protect the conservation of Barrow Island and the surrounding environments.

18.8 It is a matter for Government to decide whether the proposed development of a gas processing facility on Barrow Island is acceptable. In CALM's view, a combined system of best practice performance, environmental conditions, net conservation benefit outcome projects, and offset projects will be required if the project does proceed.

The Joint Venturers recognise government's role in determining acceptable use of Barrow Island and emphasise the in-principle approval granted by government following the ESE Review process. The Joint Venturers are committed to best practice performance and propose to work with government regarding appropriate environmental conditions. In regard to net conservation benefits and offset programs, refer to 22.2 below and 18.31 Section 2.2.

23.1 The Gorgon Development must meet or exceed the standards set for petroleum projects on the North West Shelf, including other projects in environmentally sensitive areas, such as Woodside and BHP Billiton's petroleum developments off the North West Shelf. If it does not it may create a precedent that will see a decline in environmental standards.

The Joint Venturers are committed to conducting activities associated with the proposed Gorgon Development in an environmentally responsible manner; and aim to implement best practice environmental management as part of a program of continuous improvement.

24.2 Crucially, the EPA is requiring demonstration against standards which exceed those that may be in common practice elsewhere, in recognition of the special values and status of Barrow Island. It is therefore important that the proposal, including its design, operation and management, aim to show how these requirements are being and would be achieved.

The Joint Venturers are committed to conducting activities associated with the proposed Gorgon Development in an environmentally responsible manner; and aim to implement best practice environmental management as part of a program of continuous improvement. An example of this commitment is demonstrated through the engagement of a Quarantine Expert Panel and the development of the Quarantine Management System.

1.2 Development Overview

24.7 What progress has been made to identify the nature and extent of the use and sharing of services, faculties and infrastructure with the Barrow Island Joint Venture, as required under the *Barrow Island Act*?

The Gorgon Joint Venturers are continuing discussions with the WA Oil Joint Venture on sharing of infrastructure as mentioned in Box 1.3 of the Draft EIS/ERMP.

24.20 Where additional clearing or land is required for activities listed in 6.2.10 or other activities associated with integration between the Gorgon proposal and WA Oil operations, will these be addressed as part of the Gorgon development, and covered under the *Barrow Island Act*, or will they be dealt with under the WA Oil license? What are the criteria that will be applied to determine which of these two regulatory controls apply?

Activities directly associated with the Gorgon Development which require land clearing will be included in the 300 ha allocated under the *Barrow Island Act*.

Road modifications associated with the Gorgon Development (which require new land take of undisturbed areas) are included in land take.

The Gorgon Joint Venturers are continuing discussions with the WA Oil Joint Venture on sharing of infrastructure as mentioned in Box 1.3 of the Draft EIS/ERMP.

24.25 Will the existing WA Oil power station continue to operate after the Gorgon power station is in operation (see 7.2.6)?

This aspect is subject to the negotiations mentioned in Box 1.3 of the Draft EIS/ERMP. The WA Oil power station should be assumed to be still running as mentioned in the Draft EIS/ERMP, Table 7.6. Also refer to 24.7 Section 1.2.

1.2.1 Resource under Consideration for Development

No submissions received on this section of the Draft EIS/ERMP.

1.2.2 Background to this Development Proposal

22.58 It is implied that a significant proportion of the \$1 Billion spent on this project thus far was on an alternative sites study. How much was, in fact, spent on this study? More on this later.

Section 1.2.2 of the Draft EIS/ERMP states that 'Over the past 20 years, the Joint Venturers have spent approximately \$1 billion on exploration, planning and marketing to prepare for ultimate development of the Gorgon gas field.' It is clear from this statement that there is no intent to imply that the site selection study cost a significant proportion of the \$1 billion.

1.2.3 In-principle Approval for Restricted Access to Barrow Island

22.1 The Submitters have a very strong in principle opposition to the Gorgon Joint Venture ('GJV') project being allowed to access to the conservation estate for reasons well expressed by the Conservation Commission (WA's conservation estate vesting body) as part of the ESE review of the project in 2003.

The Joint Venturers acknowledge the Conservation Council's concerns associated with obtaining access to the Class A Nature Reserve. The Joint Venturers also acknowledge the recommendations of the Conservation Commission and the EPA regarding the selection of Barrow Island, but emphasise that after intensive deliberation and parliamentary debate, Cabinet decided to grant in-principle approval to restricted access to Barrow Island for the Gorgon Development.

1.2.4 Scope of the Proposed Development

13.1 The Gorgon Development will see a much larger human footprint, both marine and terrestrial and the impacts will be more difficult to manage than ever before.

The proposed Gorgon Development will occupy approximately 1.3 % of the island – a small incremental increase in the human footprint. The Joint Venturers have proposed a range of management strategies to reduce environmental risks to acceptable levels. Proposed mitigation measures are detailed in Chapters 10-15 (for each environmental factor) and again in the Framework Environmental Management Plan, Technical Appendix A1 (for each construction activity).

22.61 What is the shaded blue area? The concept of 'nature reserves' is a purely terrestrial one!

The blue shaded area is noted on Figure 1.4 as the 'Great Sandy Island Nature Reserve'. The submitter's comment is noted. Historical reference to this reserve cannot be traced and an error is admitted.

22.62 While clearing of the whole BI Act 300 ha is considered in this draft, it is of course not the case that 'habitat modification' has been considered at this point in time, because the light, noise and quarantine risks (for example) associated with possible future developments cannot be known at this stage. This section should be re-written to reflect reality.

The Joint Venturers have assessed the clearing of 300 ha as this possibility is foreshadowed in the *Barrow Island Act 2003* and is likely to be required should additional LNG trains be installed. However, aspects such as light and noise emissions cannot be predicted with sufficient certainty as to make them meaningful. As such, these emissions (direct and cumulative) would be the subject of separate approval if and when they are proposed in the future.

22.59 Why has separate development of the Jansz/lo fields never been considered? Are those cleaner fields economic to take straight to the mainland without special pipelines and the need for untried geosequestration?

22.63 On what basis was separate assessment of Jansz allowed?

The Jansz–lo Deepwater Gas Development was separately referred after consultation with the DEH Assessment and Approvals Branch. The basis for a separate referral is that there is a different proponent and operator, different Joint Venturers, different petroleum leases, geographical separation of project areas, and individual commerciality. The larger action is already being assessed at EIS level and the Gorgon Draft EIS/ERMP considers the impacts of processing Jansz–lo gas on Barrow Island.

For the portion of the Jansz pipeline in state jurisdiction, the DoE has requested a separate Section 38 referral under the Environment Protection Act from the Jansz pipeline proponent. The Jansz pipeline will share a common corridor with the Gorgon pipeline, thus the Gorgon Draft EIS/ERMP includes the assessment of impacts from both pipelines. Environmental conditions for the Gorgon pipeline assessment will be applied to the Jansz pipeline.

22.24 Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – most of the subsea components relating to the Jansz/lo field.

The Jansz–lo Deepwater Gas Development is a separate controlled action and Mobil Exploration and Producing Australia Pty Ltd on behalf of Jansz and lo Joint Ventures is designated as the proponent of the action. The subsea components do not form part of the scope of the Gorgon Development Draft EIS/ERMP; however the Barrow Island impacts of processing gas from Jansz–lo are included. Please also refer to 22.63 Section 1.2.4.

22.45 We are frustrated that the supply of domestic gas is consistently presented as a guaranteed part of this proposal, but in fact it may not happen. This section should be re-written to reflect reality.

22.86 As this project is often portrayed as supplying gas to WA, this section should be re-written to explicitly recognize that GJV may not ever need to supply a single joule worth of LNG for WA's direct needs.

The Draft EIS/ERMP includes domestic gas as a principle element of the scope (refer Draft EIS/ERMP, Table 1.2). In addition, the State Agreement (Schedule 1 of the Barrow Island Act) places a range of obligations on the Joint Venturers, including:

- reservation of gas from within the title areas
- submission of a domestic gas project proposal by 31 Dec 2012
- active and diligent marketing program and engineering design work
- reporting of progress.

24.3 It is critical that the proposal is as clearly defined as possible, to ensure that all elements that are planned to be constructed, operated and subject to management are addressed during the assessment. Therefore, the Final EIS/ERMP response to submissions should describe the proposal as it is defined at that time, given that this will be close to the end of the FEED phase, and to identify and describe those elements for which options are still be investigated.

It is the intention of the Joint Venturers to present the Final EIS/ERMP and Response to Submissions based on the most up-to-date scope of works for the proposal. The final format of the Response to Submissions document consists of Part A – a description of adjustments to the base case and options selected; and Part B (this section)– the response to individual questions raised in the submissions as identified by the Joint Venturers.

24.8 This table and related description of the proposal (and related impacts) should be revised and described on the basis of the FEED project and other information available to the joint venture, to incorporate the most up-to-date design and locational information related to all aspects of the proposal being assessed.

The description of adjustments to the Proposal is addressed in Part A of the Response to Submissions document.

1.2.5 Principal Elements of the Proposed Development

Refer to Responses to Submissions in Chapter 6.

1.2.6 Relationship to Other Proposals in the Region

No submissions received on this section of the Draft EIS/ERMP.

1.2.7 Development Timeline

22.66 Given the importance of environmental impact assessment in determining the final design of the Development, why is it intended that FEED is finished before environmental approvals are given?

FEED is only part of the design process. The critical aspect of the decision making process is that environmental approval must be obtained prior to the Joint Venturers' committing funds to proceed with the development into execution. FEED also provides essential input to the Development Proposal required under the Barrow Island Act.

1.3 Development Rationale

16.46a To suggest that Australia is dependant on the proponents for development of this gas field is inaccurate. BHP has a field in the region and its gas is cleaner.

As stated in section 1.3 of the Draft EIS/ERMP, the Gorgon Joint Venturers are obligated under the retention leases to actively seek commercial development opportunities. BHP is not a partner in any of the fields in the Gorgon Development and as such the Joint Venturers cannot comment on their development plans.

16.50 Unlike what is expressed in the Development Objectives, in the Development Rationale, the gas field commercial opportunities are the sole focus, and while broad estimates are given as to the commercial values of the gas, no corresponding estimates are given of the conservation values. This conveys an outright bias towards exploitation and is in contradiction to the Development Objectives.

The judgement of the correct balance between biodiversity values and economic values is a key differentiator across the community. The Joint Venturers consider this a matter for government, rather than individual proponents. The Joint Venturers have not overlooked the biodiversity values of Barrow Island, or the international conservation significance of the island. This is the key reason why so much effort has been expended on identifying and evaluating alternative location options; and why the decision to seek restricted access to the island was only made after exhausting all other alternative development location options.

22.68 Although this seems intentionally written in an obscure way, it is our understanding that neither GJV's gas nor equity in the GJV project has been sold to CNOOC, and it may never be. This section should be re-written to reflect reality.

At the time the Draft EIS/ERMP was prepared, this accurately captured the status of discussions with CNOOC. Since then, the Gorgon Joint Venturers have announced that joint discussions with CNOOC have ended, both for LNG and equity. The individual Gorgon Joint Venture Partners may choose to conduct separate discussions with CNOOC in the future, as they do with other customers.

22.69 This section also seems intentionally obscured. We interpret it as saying that one of the joint venturers has sold gas to themselves, and the operator is in negotiations with themselves to consider the same possibility!

All three Gorgon Joint Venture Partners are integrated oil and gas companies with infrastructure in various markets. As such, one option for marketing their share of LNG from the proposed Gorgon Development is to use that infrastructure to access those markets.

1.4 Development Objectives

16.52 Protection of the marine environment is not included in the Development Objectives. This is totally unacceptable.

Section 1.4 of the Draft EIS/ERMP contains a summary of the high-level objectives for the Joint Venturers in association with this Development. Please refer to Chapter 11 of the Draft EIS/ERMP, which describes specifically the research completed, and the planning and management proposed to protect the marine environment.

16.54 Unachievable Objectives : In its Technical Appendix A, 1.0 Introduction, Gorgon’s stated commitments to conducting its activities on and around Barrow Island in an environmentally responsible manner, and to implementing best practice environmental management, are commendable, but even with the best of intentions it is abundantly clear that most of its environmental objectives will not be achievable. This seems to have been anticipated all along by experts and those who knew the area. It is regrettable that so much time and effort have been wasted to confirm this.

It is the intention of the Joint Venturers to meet the proposed Environmental Management Objectives.

16.58 Social and economic management objectives are not adequately addressed: the preservation of our natural environment is the foundation of our country’s well being. This is not reflected in 1.1 Box 2, ‘Economic Development’.

The Joint Venturers aim to develop the Gorgon gas fields using environmental management objectives that assist with the conservation of Barrow Island and the surrounding environments.

21.4 The proponents state a range of mitigation measures will be put in place to prevent or minimise adverse impacts. This statement is incorrect. The measures may reduce the impacts over taking no measures at all, but will not minimise them.

The objective of the Joint Venturers is to construct an operating LNG processing facility on Barrow Island whilst maintaining the conservation values of the island and surrounding waters. The mitigation measures outlined in this introductory section of the Draft EIS/ERMP express the environmental goals for the Development at a high-level.

22.56 Promises of sustainability are nowhere near enough – what is needed is a comprehensive set of well-expressed, binding Ministerial conditions.

Comment noted.

22.78 Principle 7. Precautionary Principle Application – given concerns outlined throughout this document, this principle is not being met.

Management measures proposed in Chapters 10–14 and Technical Appendix A1, clearly demonstrate a commitment to ‘cost-effective measures to prevent environmental damage’ in the absence of ‘full scientific certainty’.

1.5 EIS/ERMP Process

Refer to Responses to Submissions in Chapter 4.

1.6 Key Concepts

22.83 The definitions of Mitigation Measures, Net Conservation Benefits and Offsets are out of date. They should be updated to take account of the latest EPA offsets draft position statement.

The definitions used in Box 1-5 were based on the EPA's 2004 Preliminary Position Statement: Environmental Offsets. The updated version of this (July 2005) was published after this section of the Draft EIS/ERMP had been prepared for print. The revised definitions will be incorporated into future planning by the Joint Venturers.

Best Practice

16.77 Under 'Key Commitments' there is no mention of best practice being used in any of the actions!

16.87 Despite allusions in various parts of the Report to 'Best Practice' as an intention and an objective, the apparent lack of any stated Commitment to Best Practice for even some of the '(actions)' listed gives no cause for confidence.

The Joint Venturers are committed to conducting activities associated with the proposed Gorgon Development in an environmentally responsible manner; and aim to implement best practice environmental management as part of a program of continuous improvement. The Joint Venturers have adopted the Western Australian EPA's definition of 'best practice' which involves the prevention of environmental impact, or if this is not practicable, minimising the environmental impact, and also minimising the risk of environmental impact through the incorporation of best practice measures. Refer to Box 1-5 in the Draft EIS/ERMP.

16.60 Reasonable and Practicable. Criteria for determining what is 'reasonable and practicable' have not been given. This is unacceptable. In some vitally important instances achieving what is 'reasonable and practicable' will not be possible in terms of prevention in order to fulfil EPA requirements.

'Reasonable and practicable' is intended to mean undertaking the management measures and contingency actions that a developer can reasonably be expected to undertake that are practically feasible. In the case of the Gorgon Development on Barrow Island, this equates to using the 'best practice' management measures and contingencies. Best Practice is defined in Box 1-5 of the Draft EIS/ERMP.

Offsets

16.55 Reliance on 'offsets' to compensate for damage done is unacceptable, even useless. No offsets could match what would be lost as a result of the inevitable impacts, much of it irretrievably. If adequate offsets were available, they should have been stated but they were not.

The Joint Venturers believe that through their extensive studies and planning work that the environmental impacts associated with the Gorgon Development are manageable. Like the Barrow Island Oil operations, it is only through its presence, environmental stewardship and on-island protection that the conservation values on Barrow Island can be protected into the future by the long-term presence of the Gorgon Development and initiatives such as the Barrow Island Coordination Council.

The notion of 'offsets' and 'Net Conservation Benefits' is one supported by the EPA Position Statement No. 9, Environmental Offsets (EPA, 2005), which states that 'environmental offsets aim to ensure that significant and unavoidable adverse environmental impacts are counterbalanced by a positive environmental gain, with an aspirational goal of achieving a 'net environmental benefit' and goes on to recognise that 'one approach currently being used for Environmental Impact Assessment (EIA) is the "net conservation benefit" approach, having been developed by conservation agencies in collaboration with the EPA (EPA Bulletin 1101, 2003)'. Under the State Agreement the Joint Venturers are required to make significant financial contributions, being A\$40 million (indexed) to a Net Conservation Benefit (NCB) Fund, which will go towards supporting many important and beneficial conservation initiatives.

21.5 The proposal to increase in the body of knowledge is welcomed; however, this should not be seen as an offset for adverse impacts.

Environmental offsets have been a significant consideration during the planning and approvals phases of the Gorgon Development. Research is specifically recognised as a Contributing Offset in EPA Position Statement No.9, Environmental Offsets.

22.2 The Submitters note that offsets/net conservation benefits should never have been contemplated for this proposal – some things can and should never be traded!

22.3 The idea that there are not just offsets but net conservation benefits associated with this proposal is farcical!

22.88 Our fundamental concerns with the concept of net conservation benefits are closely allied to those about the notion of 'offsets'. We attach a recent submission on this issue at Appendix 2.

The Joint Venturers acknowledge the Conservation Council's view regarding offsets, but consider this a matter for government. The EPA Position Statement No. 9 specifically cites the Gorgon Development (as addressed in Bulletin 1101) as an example of the Western Australian Government's approach to net conservation benefit and offset strategies.

2 Background to the Proposal

2	Background to the Proposal.....	74
2.1	ESE Review Process.....	75
2.1.1	ESE Review Scoping.....	75
2.1.2	ESE Review Investigation.....	75
2.1.3	ESE Review Assessment.....	75
2.2	Cabinet Decision.....	75
2.3	Barrow Island Legislation.....	76

2.1 ESE Review Process

2.1.1 ESE Review Scoping

No submissions received on these sections of the Draft EIS/ERMP.

2.1.2 ESE Review Investigation

No submissions received on these sections of the Draft EIS/ERMP.

2.1.3 ESE Review Assessment

22.60 This section should be re-written to explicitly note that two of the three Government agencies whose views were sought opposed the in-principle access being sought, and given that GJV's subsequent work has not addressed those agencies' concerns it is assumed that their views will not have changed.

This section of the Draft EIS/ERMP cross-references to Chapter 2 which, on page 28, outlines the position of the EPA and Conservation Commission as presented in their advice to government.

2.2 Cabinet Decision

14.5 The location of any industrial development within a nature reserve is inappropriate. Locating a major development in a nature reserve as important as Barrow Island is particularly inappropriate.

The Joint Venturers recognise the importance of the site selection process and the conservation significance of Barrow Island. The decision to seek restricted access to the island was only made after exhausting all other development locations. Extensive and detailed assessments as recorded in the ESE Review identified Barrow Island as the only location that offers an internationally competitive project. This was confirmed by the Western Australian Government's independent study (the Allen Report).

16.1 The Group remains greatly concerned and very strongly opposed to the Gorgon Joint Venture Project being allowed access to the Conservation Estate.

The Joint Venturers recognise the concern of the submitter. Alternative gas processing facility sites have been thoroughly and independently evaluated. Barrow Island access offers the best chance to enable the Gorgon Development to be internationally competitive. It also offers a unique opportunity to make the development more greenhouse gas emissions friendly. Chapter 16 of the Draft EIS/ERMP contains a description of the Environmental Management Framework proposed for the Gorgon Development.

16.42 The Report flies in the face of the Conservation Commission of WA's and the EPA's strong recommendations in 2003 that the government should not approve the Barrow Island Nature Reserve as a location for the proposed Gas processing facility.

22.1 The Submitters have a very strong in principle opposition to the Gorgon Joint Venture ('GJV') project being allowed to access to the conservation estate for reasons well expressed by the Conservation Commission (WA's conservation estate vesting body) as part of the ESE review of the project in 2003.

The Joint Venturers acknowledge the recommendations of the Conservation Commission and the EPA regarding the selection of Barrow Island, but emphasise that after intensive community deliberation, Cabinet granted in-principle approval to restricted access to Barrow Island for the Gorgon Development. Following the Cabinet decision, the *Barrow Island Act 2003* and the Gorgon Gas Processing and Infrastructure Project Agreement were debated in Parliament over a two-month period before the legislation was passed with the overwhelming support of Members in both Houses.

16.53 Dangerous precedent set: The wider environmental and social implications of allowing industrial development on our State's A-class Nature Reserve are profound yet these matters have not been discussed. This project would undoubtedly set a dangerous precedent. Our entire nation's conservation estate would no longer be safe, no A-class Nature Reserve would be safe. Our country's most valuable biological assets would be placed at an unacceptably high risk.

The wider environmental and social implications of the Gorgon Development on a Class A Nature Reserve have been considered by the State Government. The government was aware that the matter of alternative locations was a critical issue when it granted in-principle approval to the development proceeding on Barrow Island in September last year. Following the government's decision, the Barrow Island Bill 2003 and the Gorgon Gas Processing and Infrastructure Project Agreement were debated in Parliament over a two-month period before the legislation was passed with the overwhelming support of Members in both Houses.

2.3 Barrow Island Legislation

5.9 What about the future. There are rumours of Sasol (Chevron-Salso (sic) partnership) settling on a site adjacent to the proposed LNG Plant. Transparency???? Fairness: If them? Why not others?

The *Barrow Island Act 2003* allows for a total of no more than 300 ha of uncleared land to be leased, or the subject of licenses or easements for use as gas processing facilities on Barrow Island. The Joint Venturers do not have any agreements with external organisations in regard to a future site adjacent to the proposed gas processing facility.

12.7 The area of new disturbance (petroleum pipeline easements, Joint Venturers, gas processing) will be 200 ha vegetation loss. This cumulative nibbling of the vegetation within the Class A Reserve of Barrow is unacceptable.

The *Barrow Island Act 2003* limits gas processing operations on Barrow Island to no more than 300 ha. The Joint Venturers consider this sufficient land to accommodate the gas processing infrastructure and note that this represents only 1.3% of the island's total land mass.

18.61 As a result of constructing a gas processing facility on Barrow Island, the EPA and the Minister for the Environment should consider the potential for future demands for industry development on Barrow Island and the additional impacts these would have on the island's biota.

21.6 It is also noted that the Gorgon/Jansz gas fields are proposed to be the first to be developed. This implies that, having the foot in the door, Barrow will continue to be used for gas processing ad infinitum.

The *Barrow Island Act 2003* limits gas processing operations on Barrow Island to no more than 300 ha. The Joint Venturers consider this sufficient land to accommodate gas processing infrastructure and note that this represents only 1.3% of the island's total land mass. The Joint Venturers have given a commitment to government not to seek further land beyond the 300 ha limit.

21.7 Approval for Barrow would set a dangerous precedent: if Chevron partners can use Barrow, why should other companies with gas fields even further from the mainland not also use Barrow? If the economic benefits are considered to outweigh negative environmental impacts for the Gorgon/Jansz development, would this not be even more the case for other fields?

The *Barrow Island Act 2003* allows for a total of no more than 300 hectares of uncleared land to be leased, or the subject of licenses or easements for use as gas processing facilities on Barrow Island. Additional LNG processing facilities will therefore be limited by the land available for establishment.

14.19 If the project gains environmental approval, it will be critical to include consideration of appropriate offsets. Such offsets may involve 'the replacement of environmental values lost by similar values nearby, perhaps through restoration of degraded land, or through enhancing the protection of land by adding it to the conservation estate. In some instances monetary compensation appropriately directed to equivalent outcomes is acceptable'. Recommendation 8: The Conservation Commission recommends that should the project be approved, it is essential that an acceptable (to the Commission and CALM) range of offsets be instituted to compensate for the loss of environmental values.

Environmental offsets have been a significant consideration during the planning and approvals phases of the Gorgon Development. The Gorgon State Agreement in the *Barrow Island Act 2003* contains a commitment of A\$40 million over the life of the project, of which A\$3 million has already been committed, to provide Net Conservation Benefits (NCB) to the State of Western Australia. The NCB fund is defined under Schedule 1 to the *Barrow Island Act* as 'demonstrable and sustainable additions to or improvements in Biodiversity conservation values of Western Australia targeting, where possible, the biodiversity conservation values affected or occurring in similar bioregions to Barrow Island'. As stated in the Draft EIS/ERMP, the Joint Venturers are committed to managing the impacts that result from the Gorgon Development via avoidance, relocation and rehabilitation. Also refer to 18.31 Section 2.2.

14.20 Recommendation 9: The Conservation Commission recommends that decisions about Net Conservation Benefit options need to first consider and allow for the requirement to provide sufficient offsets. The Conservation Commission further recommends that its advice be sought on the selection of Net Conservation Benefit proposals and for the revision of the Net Conservation Benefit quantum given the differences between the reference case on which the proposals were originally done and the current proposal.

Under the State Agreement the Joint Venturers are required to make significant financial contributions, being A\$40 million (indexed) to a Net Conservation Benefit Fund, which will go towards supporting many important and beneficial conservation initiatives. The use of these funds will be governed by an advisory body, comprised of representatives from the JV, CALM and other independent professionals with conservation expertise.

18.32 CALM recognises the establishment of a general conservation offset fund through the ESE process. Nevertheless, specific project offsets for the Gorgon Project will need to be targeted towards achieving threat reduction and improved environmental quality in areas of the Pilbara, including marine and terrestrial environments. This should include programs encompassing the removal of threatening processes, such as land acquisition for long term protection in the formal conservation reserve system, and funding for management (including fencing, and control of invasive species, and establishing an improved fire regime) which should also extend beyond the formal conservation reserve system to broad scale programs.

18.177 Offsets for the Gorgon Project need to be targeted towards achieving threat reduction and improved environmental quality on other Pilbara islands and on significant areas of the Pilbara mainland (re-establishing ecosystems). Programs should encompass the removal of threatening processes, including land acquisition for long term protection in the formal conservation reserve system, and funding for management (including fencing and control of invasive species such as weeds and introduced predators and grazers) which should also extend beyond the formal conservation reserve system to broadscale invasive species control programs. Programs should also focus on the objective of improved contemporary fire regimes to return appropriate spatial patchiness to important ecosystem types to facilitate protection of key habitats and refuges. It is envisaged that programs of a scale and scope comparable with the Western Shield program in the south-west represent the minimum effort required. A program of similar scope could require funding in the order of at least \$3 million per year.

18.178 Given that an offset quantum and process for implementation has already been developed on the basis of Barrow Island being included for consideration of possible Gorgon related development under the *Barrow Island Act 2003*, a consideration of relevance to the EPA and Government is the extent to which any additional conservation offsets are required given the proposed level of development on the Barrow Island Nature Reserve.

The Joint Venturers are committed to adopting all practicable measures to avoid unacceptable environmental consequences, and are confident that this can be achieved. The Joint Venturers support the concept of offsets as proposed in EPA Position Statement No. 9, Environmental Offsets (EPA 2005). In this regard, the Joint Venturers consider the Net Conservation Benefit Fund (NCB Fund) to be an offset, established to address concept of a development in an important conservation estate. The Joint Venturers note CALM's recognition that the Gorgon NCB Fund establishes 'a general conservation offset fund'. It is noted that the NCB fund is defined under Schedule 1 to the Barrow Island Act as 'demonstrable and sustainable additions to or improvements in Biodiversity conservation values of Western Australia targeting, where possible, the biodiversity conservation values affected or occurring in similar bioregions to Barrow Island'. The Joint Venturers consider this objective to be consistent with CALM's suggested approach.

The Joint Venturers consider this approach consistent with EPA Position Statement No. 9, which states that 'environmental offsets aim to ensure that significant and unavoidable adverse environmental impacts are counterbalanced by a positive environmental gain, with an aspirational goal of achieving a "net environmental benefit"' and goes on to recognise that 'one approach currently being used for Environmental Impact Assessment (EIA) is the "net conservation benefit" approach, having been developed by conservation agencies in collaboration with the EPA (EPA Bulletin 1101, 2003)'. Notably, EPA Bulletin 1101 relates to the Gorgon Development.

22.79 Principle 8. Community Respect and Safeguards – we have extreme concerns about the notion of "net conservation benefits", and do not support this concept as a means of delivering sustainability. Trading one area for another is nonsensical in a biodiversity context (see further below). Even if we were prepared to accept this concept, the level committed to by the proponent is inadequate given the scale of the project.

The notion of 'Net Conservation Benefits' is one supported by the EPA Position Statement No. 9, Environmental Offsets (EPA 2005), which states that "environmental offsets aim to ensure that significant and unavoidable adverse environmental impacts are counterbalanced by a positive environmental gain, with an aspirational goal of achieving a 'net environmental benefit' " and goes on to recognise that "one approach currently being used for Environmental Impact Assessment (EIA) is the 'net conservation benefit' approach, having been developed by conservation agencies in collaboration with the EPA (EPA Bulletin 1101 2003)". Under the State Agreement, the Joint Venturers are required to make significant financial contributions, being A\$40 million (indexed) to a Net Conservation Benefit (NCB) Fund, which will go towards supporting many important and beneficial conservation initiatives.

18.175 Informal arrangements should be made between Chevron Australia and CALM for CALM to undertake annual audits on Barrow Island according to agreed conditions and criteria.

The BICC will be the mechanism for this. The Draft EIS/ERMP Page 32 states 'The BICC will provide a single point of contact and interaction between CALM and the operators on Barrow Island'.

22.89 The CALM permanent presence is unlikely to be adequate, especially during construction. That level of commitment was made when it was anticipated that 2,200 contractors would be on the island, and was no doubt inadequate then also.

This is addressed by the State Agreement and the Gorgon Joint Venturers will continue to work with CALM. Also refer to 22.65 Section 6.3.6.

22.90 In any event, why hasn't work begun on GJV/Oil JV protocols? Work began on the BI Act before Cabinet approval!

Chevron Australia has undertaken considerable work in preparing for the implementation of the Barrow Island Coordination Council. This has included consideration of the form and manner of the commercial and operational arrangement, through which it will be established and operated. This work has taken into consideration both the Gorgon and the Barrow Island Oil operations and their controlling JVs.

22.127 Page 79: It should be underlined that at this mature stage of the approvals process, a regulatory framework for geosequestration has not yet been developed – if something goes wrong after the project's anticipated 60 year life, the taxpayer does not yet know whether and to what extent the State and/or Federal Governments will "carry the can".

The Gorgon Joint Venturers note that the content of this submission is effectively a matter for government and are not necessarily matters that relate to the assessment of the proposed Development's environmental impact.

The *Barrow Island Act 2003* represents the world's first geosequestration-specific legislation and provides legislative mechanisms for the authorisation of CO₂ injection on Barrow Island. Further, the Joint Venturers note that The Ministerial Council on Mineral and Petroleum Resources, recommended (MCMPR 2005; page 46) that 'Liability should be based on existing regulatory arrangements and common law' and that 'Current regulatory principles and common law should continue to apply to liability issues for all stages of CCS projects'. The Gorgon Joint Venturers contend that there is an established regulatory framework for to allow for the injection of CO₂ at Barrow Island.

22.314 While certain elements of existing legislation for oil, gas field and mine sites may be applicable to geosequestration it is simplistic to state that this will provide adequate regulatory oversight for a new technology such as the storage of CO₂ for geological time.

The Gorgon Joint Venturers note that matters of regulation are effectively a matter for government and are not necessarily matters that relate to the assessment of the Developments environmental impact.

The Gorgon Joint Venturers agree that certain aspects of existing legislation will provide regulatory mechanisms for the injection of CO₂ below Barrow Island. As an example the regulations for petroleum pipelines can be readily applied to the transportation of CO₂ by pipeline and this has been connection has been made in the *Barrow Island Act 2003*. In addition petroleum regulations for the drilling of wells and conducting geophysical surveys have obvious application to the proposed CO₂ injection project. The Joint Venturers expect that these regulations would be applied to the Gorgon Development as Ministerial conditions under Section 13(6) of the *Barrow Island Act 2003*.

At no point have the Gorgon Joint Ventures maintained that this existing legislation (that is legislation in place prior to the enactment of the *Barrow Island Act 2003*) would provide 'adequate regulatory oversight' for the CO₂ injection project on Barrow Island. Clearly if this was the case there would be no requirement for the Part 4 of the *Barrow Island Act 2003*, dealing with the 'Conveyance and underground disposal of carbon dioxide'. This legislation is supported by extensive work in the area of regulation of geosequestration undertaken by the Ministerial Council of Minerals and Petroleum Resources and which has involved wide spread community consultation (MCMPR 2005).

22.235.1 Page 286 – Greenhouse Policies: The legal status of geosequestration is still unclear, in fact, notwithstanding the provisions of the BI Act. More on this later.

In the Draft EIS/ERMP (Chevron Australia 2005), the Gorgon Joint Venturers have set out in some detail, their proposals for the injection of CO₂, the physical risks and impacts that might arise and the steps they will take to manage and mitigate the risks associated with CO₂ injection.

The Gorgon Joint Venturers note that this submission is effectively a matter for Government of Western Australia and are not necessarily matters that relate to the assessment of the proposed Developments environmental impact. However, the context of the proposed Development on Barrow Island, the Gorgon Joint Venturers do not agree that the legal status of geosequestration is still unclear. Part 4 of the *Barrow Island Act 2003* provides for the authorisation, by government, of the disposal of carbon dioxide by underground injection.

18.31 CALM considers that the ERMP deals with offsets inadequately, given the values and risks to biodiversity conservation at Barrow Island as a result of the proposed Gorgon gas development. If the Gorgon Project is to proceed on Barrow Island, there is a clear need for substantial and enduring environmental offsets in order to address the direct impacts and residual risks associated with impacts. It is CALM's position that there remains a substantial and long term residual risk to important/ key conservation values related to this project that must be addressed in order to achieve no net loss outcomes for conservation. Accordingly, appropriate offsets to address the 'no net loss' objective are considered to remain outstanding.

The Gorgon Joint Venturers are committed to adopting all practicable measures to avoid unacceptable environmental consequences, and are confident that this can be achieved. The Joint Venturers support the concept of offsets as proposed in EPA Position Statement No. 9, Environmental Offsets (EPA 2005). In this regard, the Joint Venturers consider the Net Conservation Benefit Fund (NCB Fund) to be an offset, established to address the concept of a development in an important conservation estate. The Joint Venturers note CALM's recognition that the Gorgon NCB Fund establishes 'a general conservation offset fund'. It is noted that the NCB fund is defined under Schedule 1 to the Barrow Island Act as 'demonstrable and sustainable additions to or improvements in Biodiversity conservation values of Western Australia targeting, where possible, the biodiversity conservation values affected or occurring in similar bioregions to Barrow Island'. The Joint Venturers consider this objective to be consistent with CALM's suggested approach.

The Joint Venturers consider this approach consistent with EPA Position Statement No. 9, which states that 'environmental offsets aim to ensure that significant and unavoidable adverse environmental impacts are counterbalanced by a positive environmental gain, with an aspiration of achieving a "net environmental benefit"' and goes on to recognise that 'one approach currently being used for Environmental Impact Assessment (EIA) is the "net conservation benefit" approach, having been developed by conservation agencies in collaboration with the EPA (EPA Bulletin 1101, 2003)'. Notably, EPA Bulletin 1101 relates to the Gorgon Development.

3 Development Alternatives

3	Development Alternatives.....	81
3.1	Introduction.....	82
3.2	Previous Development Attempts.....	82
3.3	Overview of the Development Concept.....	82
3.4	Technical and Commercial Constraints.....	82
3.5	Assessment of Regional Locations.....	82
3.6	Assessment of Barrow Island Sites.....	93
3.7	Assessment of Feed Gas Pipeline Alternatives.....	95
3.8	Defer or not Develop Alternative.....	96

3.1 Introduction

No submissions received on this section of the Draft EIS/ERMP.

3.2 Previous Development Attempts

No submissions received on this section of the Draft EIS/ERMP.

3.3 Overview of the Development Concept

22.133 There is way too little said here about the potential development of the field via an offshore platform – which is effectively the option that would allow development with at most a very small footprint on Barrow for geosequestration reasons. Given the very brief reference at pages 96 and 97 about the potential later need for a platform anyway, this issue should have been explicitly factored into the regional alternative sites work.

Chapter 3 of the Draft EIS/ERMP addresses alternative development scenarios, which included using a processing platform. Refer also to 22.35 Section 6.2.1 regarding the compression facility.

3.4 Technical and Commercial Constraints

14.2 The proposal now includes not only the development of the Gorgon files (14-15% CO₂) but also the Jansz field (<1% CO₂) which has similar reserves. Although Jansz is in deeper waters and more distant than Gorgon, there is no discussion in the Draft EIS/ERMP about how the commercial viability of the range of options, particularly a mainland site of Thevenard Island, would be influenced by the combined development.

The introduction of Jansz gas into the Development has helped make the proposal viable. The lower CO₂ content of Jansz gas does not replace the need for the Gorgon field to be developed with the associated need for CO₂ processing on Barrow Island. In addition, the use of Barrow Island enables the Jansz field to be developed via a subsea configuration which would not be possible if the gas processing facility (including the LNG plant) was located on the mainland. This is a function of the length of the pipeline which will already require world-class technology for economic development.

3.5 Assessment of Regional Locations

4.15 The discussion in the EIS/ERMP of alternative sites for the proposed gas plant apart from Barrow Island is very brief and lacks sufficient detail that would allow independent evaluation of both economic and environmental costs of locating the gas plant elsewhere.

10.15 Barrow Island is a site that is of national and international importance and an entirely inappropriate place for a major gas processing plant. HSI feels that the risks imposed by proposed development are too great. We believe that the option of siting this development on the mainland has not been sufficiently addressed by the Gorgon Joint Venture partners, and they should be made to do so given the intractable problems involved on Barrow Island. We strongly advise that the proposal be rejected.

12.2 The consideration of alternative sites to Barrow Island does not appear to have been taken seriously and is inconsistent with other similar studies.

14.5 The location of any industrial development within a nature reserve is inappropriate. Locating a major development in a nature reserve as important as Barrow Island is particularly inappropriate.

16.5 Alternative sites to Barrow Island do not appear to have been given adequate consideration, and the case given by the proponents (Executive Summary: 3 Development Alternatives, pages 15-19) is inconsistent with other studies.

16.40 Gorgon's site selection process was shown to be flawed in 2003.

16.56	Acceptable alternatives need to be considered, they have not been properly examined. This is a serious flaw in the report. There are policy precedents for excluding development in the sensitive environments such as this and these must be upheld.
18.9	It would have been appropriate for alternative locations to have been investigated in light of inclusion of the Jansz field in the analysis.
20.4	The EIS/ERMP fails to provide a comprehensive economic and environmental analysis for the following aspects: A). Alternative locations for the proposed infrastructure development. And,... (refer to 20.5 in Section 3.5.)
20.6	Given that both the Environmental Protection Act (1986) and the Environment Protection and Biodiversity Conservation Act (1999) provide for the examination of forms of development as alternatives to that proposed, we believe further scrutiny by the Environmental Protection Authority and the Department of Environment and Heritage is warranted.
20.11	That the proponents be required to submit full economic and environmental assessments of alternative sites for the proposed development, including a more comprehensive and transparent range of mainland sites. The review of alternate sites should include comprehensive economic scenarios for the next fifty years that consider among other pertinent issues, the option of the Jansz field being developed first, cost recovery through technological advances and economies of scale, and predicted LNG pricing.
22.8	The DEH would be entitled to question why GJV's alternative sites analysis, which has been the subject of much criticism in the last two years, has not been re-done to address those methodological concerns, or even major changes in economic factors such as the prices of oil and gas.
22.42	If Barrow Island is the cheapest option then we can reasonably expect the proponent to continue to push for the development to occur there even if there are viable, but less profitable, alternatives.
22.97	Given the environmental issues at stake and the amount of money the proponent has spent on the project in total, the handling of the alternative sites issue continues to be very disappointing.

The Joint Venturers recognise the importance of the site selection process and the conservation significance of Barrow Island. The decision to seek restricted access to the island was only made after exhausting all other development locations. Extensive and detailed assessments as recorded in the ESE Review identified Barrow Island as the only location that offers an internationally competitive project. This was confirmed by the Western Australian Government's independent study (Allen Consulting Group 2003).

16.1 The Group remains greatly concerned and very strongly opposed to the Gorgon Joint Venture Project being allowed access to the Conservation Estate.

The Joint Venturers recognise the concern of the submitter. Alternative gas processing facility sites have been thoroughly and independently evaluated. Barrow Island access offers the best chance to enable the Gorgon Development to be internationally competitive. It also offers a unique opportunity to make the development more greenhouse gas emissions friendly. Chapter 16 of the Draft EIS/ERMP contains a description of the Environmental Management Framework proposed for the Gorgon Development.

4.16 Since that time of the ESE Review, the international natural gas market, along with oil prices, has changes, but the current EIS/ERMP does not add to the limited information provided in the ESE Review. In addition, the ESE Review covered only the extraction of natural gas from the Gorgon field; the EIS/ERMP proposed extraction from the Jansz field as well and this gas has a significantly lower CO₂ content. Thus the proposed siting of the proposed Gorgon gas plant on Barrow Island Nature Reserve is based solely on outdated economic, costs of development, grounds, even though it is clearer that the risk of irreversible environmental damage is high.

11.3	Why hasn't the work on alternative sites been re-done taking into account the vastly different price of oil since that time? What about the vastly different price of gas since that time?
12.3	We question the suggestion that Barrow is the only commercially viable location. We recommend that additional work needs to be carried out on site selection in what is now a different economic environment to the 2003 analysis. The prices of oil and gas are markedly higher, which would alter the economic viability of alternative sites to Barrow Island.
16.38	Site selection error: 3.1 Development Alternatives, page 15 Executive Summary, discusses site alternatives based on information brought forward ten years ago. That information is now outdated. This fact is ignored. Gorgon's argument that other sites for the gas processing facility would not be economic is untenable and irrelevant as gas now far exceeds oil in importance throughout the world. (See also reference : http://news.bbc.co.uk/1/hi/business/3890045.stm)
20.5	The EIS/ERMP fails to provide a comprehensive economic and environmental analysis for the following aspects: B). The implications of Jansz field product being developed before the Gorgon field.
22.9	To the EPA, apart from noting our expectation that your in-principle opposition to the project will be maintained, the Submitters underline that the proposal before you is substantially different to that which you considered in 2003. Gorgon plus Greater Gorgon are now proposed, but the fields are vastly different – the Greater Gorgon resource (also sometimes called Jansz) is owned by different companies, and is clean enough to be viably piped straight to a mainland plant site.
22.41	Given the rise in gas prices since the ESE was conducted, it seems highly likely to the Submitters that alternative sites are now economically viable.
22.59	Why has separate development of the Jansz/lo fields never been considered? Are those cleaner fields economic to take straight to the mainland without special pipelines and the need for untried geosequestration?
22.94	Various people and groups questioned the alternative sites work done in 2003 since that time, but the Submitters note with disappointment that no further analysis of that nature seems to have been done. Why hasn't the work been re-done taking into account the vastly different price of oil since that time? What about the vastly different price of gas since that time?

The international gas market has strengthened in line with the expectations that the Gorgon Joint Venturers had at the time of the ESE Review (ChevronTexaco 2003). At the prices experienced by the initial LNG suppliers to China, development of the Gorgon field alone would not be viable. The introduction of Jansz gas into the Development has helped make the proposal viable. The lower CO₂ content of Jansz gas does not replace the need for the Gorgon field to be developed with the associated need for CO₂ processing on Barrow Island. In addition, the use of Barrow Island enables the Jansz field to be developed via a subsea configuration which would not be possible if the gas processing facility (including the LNG plant) was located on the mainland. This is a function of the distance and length of pipeline which will already require world-class technology for economic development.

4.17	According to the ESE Review, it would cost an additional \$1100 million to construct the gas plant on the mainland, an estimate that has not been updated in line with the current or future market predictions.
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The Gorgon Joint Venturers have not progressed engineering work on the many potential project configurations which have been previously been shown to be uneconomic. In line with current engineering estimates from the work which is progressing, cost estimates for large, long pipelines, such as that which is the main contributor to the cost differential between Barrow Island and the mainland, have increased substantially. In addition, the introduction of the Jansz field into the Development is also likely to increase this cost differential.

4.18	Cape Preston, the closest mainland landfall, should be reconsidered, as should Onslow.
21.8	Cape Preston was rejected because of an existing mining tenement (not operation) notwithstanding that there is provision for access to Cape Preston for port facilities for other industries. As the load-out point is some distance offshore, it could be expected that there would be room for an 'exclusion zone' around the gas loading point.
22.98	Further to the Submitters' concerns about the credibility of these processes, it is noted that notwithstanding other approvals, BHP still considered there was enough space on Cape Preston for them to co-locate.
	Cape Preston and Onslow, along with other alternative regional sites, were shown to be internationally uncompetitive. This was confirmed by the Western Australian Government's independent study (Allen Consulting Group 2003).
5.1	Do figures include costs to run production and supporting infrastructure on Barrow Island?
	The costs used to assess the commercial viability of the various options included estimates for the Development and operation of the gas processing facility and associated infrastructure.
5.2	Does this include the costs of biological monitoring and quarantine?
	The data used to assess the commercial viability of a Barrow Island location included cost estimates for environmental management, quarantine management and monitoring.
5.3	Alternatively, could Gorgon strip the Gas on Barrow Island and produce and export the Liquid Gas on the Mainland? This stripping of Gas on Barrow, would allow Gorgon to engage in geosequestration and use less expensive pipeline from Barrow to Mainland, thereby significantly reducing costs.
	This concept has been previously studied and, when compared to the alternatives described in the Draft EIS/ERMP, found to be more expensive, less thermally efficient, and would result in more greenhouse gas emissions. It would require a significant gas processing facility on Barrow Island in its own right—occupying about 25–30% of the plant site area required for an LNG plant. Such a development would require two separate CO ₂ removal plants—a bulk removal plant on Barrow Island and a final removal plant at the LNG plant. The Bulk Removal Plant would reduce the CO ₂ content of the gas from 13.5 mol% to 2 mol% (to meet the domestic gas quality needs). The final CO ₂ removal plant would be similar in scale to the bulk plant since it would still need a significant facility to remove the final 2 mol%. The final CO ₂ removed on the mainland would be vented to the atmosphere rather than being injected.
	The economic comparison shows that such a development concept, 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.
5.4	Cost details and those of alternative sites should be made available to the public before making this decision.
22.43	It is because of that vested interest that the Submitters seek an independent analysis or, at the very least, that the entire economic analysis on which this decision is being made should be made public.
22.84	The requirement to "maintain a publicly transparent assessment process" was fundamentally deficient, with the supposed \$1 Billion cost difference between Barrow and the mainland never supported with publicly available data.

22.92 In addition, the suggestion that Barrow was the only commercially viable location to come out of this process is another major factual inaccuracy perpetuated by GJV since the time of the ESE Review. In reality, the analysis was at best authority for the proposition that the various mainland options were not viable. Another, much more environmentally sustainable offshore options were available.

The Joint Venturers have not included detailed cost data, such as relative costs of gas supply and breakeven gas price analysis, in the Draft EIS/ERMP as this would expose commercially sensitive information to potential customers and competitors. However, such data were provided to government-appointed independent experts under a confidentiality agreement as part of the ESE Review process. The assessment of these data confirmed Barrow Island as the only location that offers an internationally competitive development (Allen Consulting Group 2003).

11.4 Although we support the theory of these alternative site studies, we struggle to find them credible when they can yield such vastly different results for different proponents.

16.41 Far better standards are being set by, for example, BHP and Woodside Petroleum.

22.10 Don't take our word for that; ask BHP Billiton, who are progressing access to their much smaller Scarborough field via a proposed site at Onslow – a far less environmentally harmful option than Barrow.

22.95 Although we support the theory of these alternative sites studies, we struggle to find them credible when they can yield such vastly different results for different proponents. The discussion here makes short shrift of the far more environmentally benign Onslow location, even though BHP Billiton Petroleum is now seriously considering that spot having done what is supposed to be a very similar study. The Submitters consider BHP's process to have been far more credible and transparent, and we commend the attached report (Appendix 3) to the regulators for their comparison.

22.96 More recently, Woodside has begun considering plant sites for its Pluto field. We laud Woodside for their upcoming consultation with conservation groups, and we are optimistic that they will avoid doing work like GJV's, which Dr David Annandale and Ross Lantzke described as "fundamentally flawed". We attach their full report (Appendix 4), and we commend it to DEH in particular, who have not yet had the opportunity to consider it.

The Gorgon Joint Venturers cannot comment on other projects. Each project has its own characteristics, requirements and priorities in terms of location, design, gas composition and access to sites. In the case of the Gorgon Development, an additional consideration in site selection was that Barrow Island offered a unique opportunity to inject reservoir carbon dioxide at a location close to the gas processing facility.

In the ESE Review, comparative cost information for other locations was provided to underpin the conclusion that the development would only be internationally competitive if located on Barrow Island. Additional information on alternative development locations was provided in response to submissions received during the public comment period. Commercially sensitive cost information was provided under a Confidentiality Agreement to the Western Australian Government's independent consultants, The Allen Consulting Group. The Allen report observed that despite examining a number of development concepts in detail: 'Devising a commercial strategy to "unstrand" the Gorgon gas resource has proved, over the years, to be an onerous and expensive task.' The Allen Report concluded that based on all the available information: '...Barrow Island represents the only commercial option for monetising the substantial national asset represented by the Gorgon resource.' (Allen Consulting Group 2003).

12.1 The Society has strong in-principal opposition to the proposal being located on Class A Nature Reserve Barrow Island. The island was proclaimed a Nature Reserve in 1910 in recognition of its international importance as a conservation area because of the high level of fauna endemism, and refuge for fauna (some of which are extinct, or near extinction, on the mainland).

The Joint Venturers recognise the importance of the site selection process and the conservation significance of Barrow Island. The decision to seek restricted access to the island was only made after exhausting all other development locations. Extensive and detailed assessment identified Barrow Island as the only location that offers an internationally competitive project. This was confirmed by the Western Australian Government's independent study (Allen Consulting Group 2003).

14.1 The view that an overwhelming case has not been made regarding the requirement to locate the development on Barrow Island Nature Reserve still holds.

14.8 Recommendation 1: The Conservation Commission recommends that the Gorgon gas development should not proceed on Barrow Island Nature Reserve unless and until there is a clear economic case put that other alternatives are not viable and only if the environmental risks can be reduced to acceptable levels.

22.92 In addition, the suggestion that Barrow was the only commercially viable location to come out of this process is another major factual inaccuracy perpetuated by GJV since the time of the ESE Review. In reality, the analysis was at best authority for the proposition that the various mainland options were not viable. Another, much more environmentally sustainable offshore options were available.

The Joint Venturers acknowledge the Conservation Commission's view regarding the selection of Barrow Island as the location for the gas processing facility. However, we reiterate that the decision to seek restricted access to the island was only made after exhausting all other development locations. An extensive and detailed assessment identified Barrow Island as the only location that offers an internationally competitive project. This was confirmed by the Western Australian Government's independent study (Allen Consulting Group 2003).

15.1 We are concerned that the EIS/ERMP do not address the relative impacts of the location of the project on Barrow Island compared to alternatives on the mainland in less environmentally sensitive areas.

The Joint Venturers acknowledge the view of the MPRA regarding the selection of Barrow Island as the location for the gas processing facility; however we reiterate that the decision to seek restricted access to the island was only made after exhausting all other development locations. An extensive and detailed assessment identified Barrow Island as the only location that offers an internationally competitive project. This was confirmed by the Western Australian Government's independent study (Allen Consulting Group 2003).

15.11 In light of these concerns, the MPRA would request that an alternative mainland location be considered. If such an alternative is not considered, the MPRA would expect the proponents to provide clear strategies to mitigate any potential impacts of our concerns as identified above. Additionally, the MPRA would request that the proponents commit to the implementation of a monitoring program to ensure that the project remains ecologically sustainable and socially acceptable.

Alternative locations are discussed in Chapter 3. Barrow Island's Class A Nature Reserve status has been maintained while being home to Australia's largest operating onshore oilfield during the past 40 years. A gas processing facility on Barrow Island will secure management resources to protect the island's conservation values for decades to come. The Gorgon Development has been deliberately sited to avoid areas of particular conservation significance and designed not to impair the conservation values of the island. Environmental Management Plans, including monitoring plans, will be developed and documented through a systematic and consultative process to address environmental factors and risks identified during the environmental impact assessment. The plans will be prepared by the Joint Venturers with technical input from a variety of sources including the design and construction contractor, comment from relevant regulatory agencies and conditions of approval.

16.7 Unquestionably 'Best Practice' in environmental policy and protection is to keep industrial development out of the conservation estate.

Refer to Chapter 3 of the Draft EIS/ERMP for site selection process.

16.39 Gorgon's calculations fail to include the economic values of the A-class Nature Reserve, let alone its other values. This is unacceptable.

18.33 Chevron Australia should provide an analysis of the future value of biodiversity on Barrow Island undisturbed by the proposed development.

The judgement of the correct balance between biodiversity values and economic values is a key differentiator across the community. The Joint Venturers consider this a matter for government, rather than individual proponents. The Joint Venturers have not overlooked the biodiversity values of Barrow Island, or the international conservation significance of the island. This was the key reason why so much effort has been expended on addressing alternative location options; and why the decision to seek restricted access to the island was only made after exhausting all other alternative development locations. Extensive and detailed assessment identified Barrow Island as the only location that offers an internationally competitive project. This was confirmed by the Western Australian Government's independent study (Allen Consulting Group 2003).

16.43 There appears to be an inadequate appreciation by the proponents of the important biological/ecological values of Barrow Island and its associated marine environment. Gorgon's insistence of using Barrow Island would appear to demonstrate a gross disrespect for our country's priceless biological assets, its extraordinary biota, and its fragile arid-land ecosystems. Such disrespect can generate distrust. These places are, and always will be our life support systems and therefore the true foundation of Australia's economy and well being.

The Joint Venturers have not overlooked the biodiversity values of Barrow Island, or the international conservation significance of the island. This was the key reason why so much effort has been expended on identifying and evaluating alternative location options; and why the decision to seek restricted access to the island was only made after exhausting all other alternative development locations. Extensive and detailed assessment identified Barrow Island as the only location that offers an internationally competitive development.

16.44 Delays to date appear to have been largely of the proponent's own making. Any delays could have been reduced had the proponents chosen an appropriate, less contentious site.

The importance of completing comprehensive environmental investigations is well recognised and accepted by the Joint Venturers. This led to extensive fieldwork, modelling, analysis and documentation that have resulted in a more lengthy process than many other recent development projects. Refer also to 20.12 below.

18.34 The proponent should provide information on all of the threatened fauna known to occur at each alternative site for locating the Gorgon gas processing facility in order to justify the figures provided in Table 3-4.

The threatened and migratory fauna known to occur, or likely to occur, at each of the sites is presented for each site in the text preceding Table 3-4 (Chevron Australia 2005; pp 48–51). Marine threatened species are expected to occur at all sites on occasion (Chevron Australia 2005; p 48). These are included in the Table 3-4 tally.

- 20.12 The proponents be given a minimum of a six month extension of the deadline, beyond the new assessment of alternative sites, for the presentation of a new draft EIS/ERMP for the preferred sites. The new draft should address:
- Inadequate data
 - Lack of comprehensiveness of risk assessments.
- This would include the submission of additional independent scientific assessments and analyses to evaluate risk in the primary areas of concern identified by WWF as part of the EIS/ERMP.

In-principle approval for access to 1.3% of Barrow Island for the development of gas processing infrastructure was granted to the Joint Venturers by the Western Australian Government in 2003. This followed the completion of an extensive site selection study conducted between 2001 and 2003. Details of the likely environmental impacts of development at alternative sites were included in the Environmental, Social and Economic Review in 2003 (ChevronTexaco 2003) and is also addressed in further detail in Chapter 3 of the Draft EIS/ERMP (pp 34–55).

The Draft EIS/ERMP, produced by the Joint Venturers, presents the most comprehensive environmental study for any resource development project in Australia. Many millions of dollars have been spent by the Joint Venturers on the studies to date. More than 100 independent experts—recognised nationally and internationally for their work—have contributed scientific data, studies, observations and advice to the process.

The risk methodology used by the proponents was developed to international risk standards in accordance with the principles and guidelines contained in AS/NZS 4360:2004 for Risk Management, SAA Handbook 203:2004 Environmental risk management – Principles and process and AS/NZS 3931:1998 Risk analysis of technological systems – application guide.

- 20.23 WWF-Australia believes that further development on Barrow Island would lead to irreversible environmental damage and that it should not be approved. WWF recommends that reconsideration be given to relocating the proposed development to an alternative mainland location where the threat to flatback turtles would be considerably reduced, although in some locations, not eliminated.

The Joint Venturers recognise the concern of the submitter. Alternative gas processing facility sites have been thoroughly and independently evaluated. Barrow Island access offers the best chance to enable the Gorgon Development to be internationally competitive. It also offers a unique opportunity to inject carbon dioxide stripped from the reservoir gas.

- 21.9 A major consideration for rejecting the Montebello's was stated to be its history as a nuclear test site, and public and marketing perceptions related to this. It is a sad commentary that the proponents are apparently convinced that this perception is more important than the perception of development of the most arguably important conservation area in Australia. In this regard it is noted that this perception is not shared by the tourism or pearling industries established there. There have been no 'above background' readings on the TLDs from the island for many years.

- 22.101 The Montebello's were ruled out without adequate consideration – see further below.

- 22.102 It must be highlighted here that the Trimouille Island option is only \$70m more expensive in this analysis – a trifling amount in the context of so massive a project. More on this later.

- 22.105 It is quite bizarre that the proponents are so concerned about negative image in relation to former nuclear weapons testing on the Montebello's, but have no such concerns about co-locating with an internationally significant nature reserve!

The Montebello Islands were rejected primarily on health, safety, environmental, 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 would be extremely limited. The use of Hermite Island would involve significant site earthworks to yield a limited plant site 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 would require significant site earthworks and the waters on the east coast of the island are not sheltered and as such a fixed berth would have significant weather disruption.

22.22 Furthermore, our perspective on the work done to this stage suggests that either Montebello's or Thevenard Island locations were far better choices regionally.

As noted in Section 3.5 of the Draft EIS/ERMP, prior to detailed commercial assessment, the Montebello Islands were ruled out because of their history as a site of nuclear weapons testing. Thevenard Island was not selected due to a range of reasons including the higher costs (\$500M) and the limited area available for development. A Montebello Island-based or Thevenard Island-based development would also require considerable construction activity, operating facilities and a substantial footprint on Barrow Island associated with the injection of CO₂.

22.106 We refer again to the work of Annandale and Lantzke (Appendix 4) and contend that, as the EPA itself later found (Bulletin 1101, page 21), either Trimouille Island in the Montebello's group or Thevenard would be far superior locations in terms of biodiversity.

The Montebello Islands were rejected primarily on health, safety, environmental, 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 would be extremely limited. The use of Hermite Island would involve significant site earthworks to yield a limited plant site 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 would require significant site earthworks and the waters on the east coast of the island are not sheltered and as such a fixed berth would have significant weather disruption.

Thevenard Island was rejected on the grounds suggested on p 53 of the Draft EIS/ERMP, which include higher costs, insufficient availability of area for the plant and a lack of sheltered or suitable marine areas for offloading facilities.

22.40 Similarly, an independent economic assessment of alternatives to Barrow Island should be conducted.

22.43 It is because of that vested interest that the Submitters seek an independent analysis or, at the very least, that the entire economic analysis on which this decision is being made should be made public.

The Western Australian Government commissioned independent experts, the Allen Consulting Group, to conduct an assessment of the commercial viability of alternative sites for the Gorgon Development's gas processing facility, which confirmed Barrow Island as the only commercially viable option.

22.74 Principle 3. Biodiversity and Ecological Integrity Protection – once again the proponent has not demonstrated sustainability in this area, because the project will have an unacceptable impact on a Class A nature reserve. In addition, the weighting given in the alternative sites analysis to Barrow being a Class A reserve seems to have been reduced because it is not a National Park – the former is the highest level of protection in the conservation estate, and should have attracted the highest possible weighting (see further below).

The significance of the status of Barrow Island Nature Reserve is recognised throughout the assessment through the high conservation significance afforded all taxa in the reserve.

22.81 Principle 10. Accountability – the proponent has failed to provide information on key aspects of this proposal such as the economic analysis on which the decision to go to Barrow was based.

As stated in Gorgon Sustainability Principle 10, the Gorgon Joint Venturers are committed to the highest standards of governance and accountability. Throughout the Environmental, Social and Economic (ESE) Review and EIS/ERMP processes, the Venturers have reported regularly to community and responded to requests for information. A key focus of the ESE Review process addressed why the gas processing facility had to be located on Barrow Island. In the ESE Review, comparative cost information for other locations was provided to underpin the conclusion that the development would only be internationally competitive if located on Barrow Island. Additional information on alternative development locations was provided in response to submissions received during the public comment period. Commercially sensitive cost information was provided under a Confidentiality Agreement to the Western Australian Government's independent consultants, The Allen Consulting Group. The Allen report (Allen Consulting Group 2003) observed that despite examining a number of development concepts in detail:

'Devising a commercial strategy to "unstrand" the Gorgon gas resource has proved, over the years, to be an onerous and expensive task.' The Allen Report concluded that based on all the available information: '... Barrow Island represents the only commercial option for monetising the substantial national asset represented by the Gorgon resource.'

The State Government was aware that the matter of alternative locations was a critical issue when it granted in-principle approval to the development proceeding on Barrow Island in September last year. Following the government's decision, the Barrow Island Bill 2003 and the Gorgon Gas Processing and Infrastructure Project Agreement were debated in Parliament over a two-month period before the legislation was passed with the overwhelming support of Members in both Houses. The Gorgon Joint Venturers believe the reasons for the need to be located on Barrow Island were explained, tested and widely debated by the community.

22.91 After a clear implication on page 6 that a good proportion of \$1 Billion was spent on alternative sites analysis, this page explicitly suggests that "almost \$1 billion" was so expended. This is very likely spin of the highest order – the vast majority of such a huge sum would have been spent on proving up the Gorgon and Greater Gorgon gas resources, which would have been required no matter where it was desired to put the proposed LNG plant. How much was, in fact, spent on this study?

There is no intent in Chapter 1 or the summary to Chapter 3 of the Draft EIS/ERMP to imply that the site selection study cost almost \$1 billion. Also refer to 22.58 Section 1.2.2.

22.99 Why haven't seasonal wading and water birds been identified as a key factor here?

Waterbirds are included in the 'Fauna species and habitats' section. Individual taxonomic groups have not been addressed separately in this section (Chevron Australia 2005; p 44, Table 3-2).

22.104 The Submitters contend that this overview of alternative sites in connection with EPBC triggers is highly misleading as it compares the numbers of different types of known and likely taxa of the locations, not their relative populations. How do the likely flatback populations near Maitland Estate compare to those around Town Point on Barrow, for example? More on flatbacks later. How many endemic terrestrial marsupials are put at risk on Barrow when compared to Thevenard?

Table 3-4 on page 51 of the Draft EIS/ERMP (Chevron Australia 2005) presents tallies of taxa listed under the EPBC Act. Little is known of the population sizes of these taxa at the alternative sites. The levels of endemism are higher on Barrow Island and this is reflected in the higher number of Vulnerable taxa which includes the 'endemic' terrestrial mammals.

22.107 Assuming that no other closer geosequestration options exist (more on that later), a footprint would still be required on Barrow, but that would be very limited in comparison with that contemplated for the complete LNG plant, jetty, dredge channel and the like.

It is correct that the marine footprint would be significantly less if Barrow Island was the site of only the CO₂ injection component of the Development. However, CO₂ injection would still require considerable construction activity, operating facilities, duplication of infrastructure and utilities and a substantial terrestrial footprint on Barrow Island.

22.108 It is interesting to compare the comments made by Allen Consulting to those made in the last few pages of the draft EIS/ERMP. The discussion on page 53 cites lack of useable land on Trimouille as a key problem, but Allens do not mention that at all. Further, they describe concerns about radiation as ‘perceived’!

The Gorgon Joint Venturers do not believe this comment is correct as the Allen Report does refer to the size constraints of both Hermite and Trimouille Islands (Allen Consulting Group 2003; p 35).

27.1 Information Request: WWF requests that the joint venturers provide a comprehensive and up-to-date analysis (economic, social and environmental) of the most viable mainland options to support the processing and export of Jansz field product and Gorgon field product, both separately and combined.

As stated in Gorgon Sustainability Principle 10, the Gorgon Venturers are committed to the highest standards of governance and accountability. Throughout the Environmental, Social and Economic (ESE) Review and EIS/ERMP processes, the Venturers have reported regularly to the community and responded to requests for information. A key focus of the ESE Review process was why the gas processing facility had to be located on Barrow Island. In the ESE Review, comparative cost information for other locations was provided to underpin the conclusion that the development would only be internationally competitive if located on Barrow Island. Barrow Island also represents a unique opportunity for CO₂ geosequestration. Additional information on alternative development locations was provided in response to submissions received during the public comment period. Commercially sensitive cost information was provided under a Confidentiality Agreement to the Western Australian Government’s independent consultants, The Allen Consulting Group. The Allen report observed that despite examining a number of development concepts in detail:

“Devising a commercial strategy to ‘unstrand’ the Gorgon gas resource has proved, over the years, to be an onerous and expensive task.” The Allen Report concluded that based on all the available information: “... Barrow Island represents the only commercial option for monetising the substantial national asset represented by the Gorgon resource.” The State Government was aware that the matter of alternative locations was a critical issue when it granted in-principle approval to the development proceeding on Barrow Island in September 2004. Following the Government’s decision, the Barrow Island Bill 2003 and the Gorgon Gas Processing and Infrastructure Project Agreement were debated in Parliament over a two month period before the legislation was passed with the overwhelming support of Members in both Houses. The Gorgon Venture believes the reasons for the need to be located on Barrow Island were explained, tested and widely debated by the community.

The international gas market has strengthened in line with the expectations that the Gorgon Joint Venturers had at the time of the ESE Review (ChevronTexaco, 2003). At the prices experienced by the initial LNG suppliers to China, development of the Gorgon field alone would not be viable. The introduction of Jansz gas into the Development has helped make the proposal viable. The lower CO₂ content of Jansz gas does not replace the need for the Gorgon field to be developed with the associated need for CO₂ processing on Barrow Island. In addition, the use of Barrow Island enables the Jansz field to be developed via a subsea configuration which would not be possible if the gas processing facility (including the LNG plant) was located on the mainland. This is a function of the distance and length of pipeline which will already require world-class technology for economic development.

3.6 Assessment of Barrow Island Sites

18.35 It is CALM's preferred position that the proposed gas processing facility be located at Town Point.

The Joint Venturers acknowledge CALM's view that should the Gorgon Development receive Ministerial approval, Town Point is the preferred location on Barrow Island for the gas processing facility.

18.36 It is CALM's preferred position that the western shore crossing for the feed gas pipeline be located at North White's Beach given current information and the lack of other alternatives.

The Joint Venturers acknowledge CALM's view that should the Gorgon Development receive Ministerial approval, North White's Beach is the preferred shore crossing location for the feed gas pipeline. The process used to locate the shore crossing for the feed gas pipeline is an example of the Gorgon Joint Venturers' commitment to protecting the environment. Alternatives considered, and the process used to assess them, have been discussed in the Draft EIS/ERMP Chapter 3 (Section 3.7). In particular, the following extract (Section 3.7.4) highlights the importance the Gorgon Joint Venturers place on protecting Barrow Island, including the marine environment around it (which was rated high in Table 3.6). 'From the assessment of shore crossing options, the preferred shore crossing location is North White's Beach, constructed using HDD. The key benefits of this option over the other feasible alternatives are that it: provides lower risks to rock wallabies, turtle habitat, and the Marine Park.'

In addition, the Draft EIS/ERMP Section 3.9 states: 'Of the possible shore crossings (and resultant onshore pipeline routes on Barrow Island), North White's Beach is considered the base case for the development with Flacourt Bay being carried as a fall-back option.' A fallback position was required because there were uncertainties associated with the ground conditions at North White's Beach, and although it looked favourable for HDD, there was further geotechnical survey data required. Some of this data has been acquired and it further improves the Gorgon Joint Venturers confidence in the North White's Beach Shore Crossing.

22.23 Our perspective on the work done to this stage suggests that either Montebello's or Thevenard Island locations were far better choices regionally, and that even if access to Barrow was conceded (which it isn't), Surf Point is a far better location than Town Point.

22.29 Key issues not included in this draft EIS/ERM, or not dealt with in sufficient detail, include: the relative impacts of the Town Point location as compared to say, Surf Point (mentioned above).

22.109 In any event, even if access to Barrow is granted, we question whether Town Point is the best site having regard to economic, social and environmental factors. The Submitters' view is that Surf Point should be the subject of more careful study and comparison with Town Point. The draft EIS/ERMP suggests that the former location could have far less significant environmental impacts, but the site has been disregarded for reasons that seem only partly studied, suggesting a "retro-fitting" of this analysis to the preferred Town Point site (which has the obvious benefits of being closer to the airport and the oil activities).

The Joint Venturers' assessment concluded that Town Point, even though more expensive than Surf Point, was the preferred location on Barrow Island for the gas processing facility. This view is shared by CALM (refer to 18.35 Section 3.6). Key benefits of Town Point over Surf Point are outlined in Sections 3.6.5 and 3.6.6. of the Draft EIS/ERMP.

22.110 Where is the information on Surf Point's vegetation?

As referenced in Section 8.3.2 of the Draft EIS/ERMP, Island-wide vegetation assessments are based on the work of Buckley (1983) and Mattiske and Associates (1993). Refer also to 22.65 Section 6.3.6.

22.101 The Montebello's were ruled out without adequate consideration – see further below.

22.102 It must be highlighted here that the Trimouille Island option is only \$70m more expensive in this analysis – a trifling amount in the context of so massive a project. More on this later.

22.115 It should be noted that GJV is supposedly spending an extra \$180m as compared to the Surf Point location as a result of this 'analysis', which confirms that the 'extra' \$70m for Trimouille was possible!

As noted in Section 3.5 of the Draft EIS/ERMP, prior to detailed commercial assessment, the Montebello Islands were ruled out because of their history as a site of nuclear weapons testing. A Montebello-based development would also still require considerable construction activity, operating facilities and a substantial footprint on Barrow Island associated with the injection of CO₂. Also refer to 22.23 Section 3.6 and 21.9 Section 3.5.

22.116 It is very significant that the Surf Point site is here identified as having much less impact on coral communities (although we accept that more survey work/modelling is probably needed to confirm that position). Why hasn't this factor weighed more heavily against the Town Point location?

It is recognised that a Town Point location is closer to sensitive coral communities than Surf Point. However, the Joint Venturers' assessment concluded that Town Point provides a better overall environmental outcome than Surf Point.

22.117 The Submitters also underline that a jetty half as long, and less dredging, would be needed at Surf Point as compared to Town Point. It is noted that East Spar and Wonich pipelines would need relocation to facilitate dredging at that location, but presumably that has been factored into the \$180m anticipated saving from that site anyway.

It is recognised that a Town Point location would require a longer jetty and a larger volume of dredging than Surf Point. However, the Joint Venturers' assessment concluded that Town Point provides a better overall environmental outcome than Surf Point.

22.118 Once again relative comparisons are inappropriate here – how does Town Point and the vicinity compare to areas other than Barrow Island in terms of seabird usage and importance? Such a comparison has been made for land birds – why the different approach?

The regional and global importance of Barrow Island for marine avifauna is described in Chapter 8 (p 267) of the Draft EIS/ERMP (Chevron Australia 2005). The littoral avifauna of Barrow Island is dominated by migratory species and these birds are concentrated in the south-east and south of Barrow Island, from the existing Chevron camp to the Bandicoot Bay area. The coastline in the vicinity of Town Point and the proposed Development area is of relatively low importance for littoral avifauna compared with other parts of Barrow Island (Chevron 2005; Technical Appendix C3, p 28).

22.120 The Town Point site is not simply 'important' for flatback turtles!

The importance of the beaches in the vicinity of Town Point is clearly acknowledged in numerous places throughout the Draft EIS/ERMP (most notably Section 8.3.3 and Section 11.5).

22.121 Why is the comment about tidal currents at this location so speculative? It is totally unacceptable that such a large project as this has not involved enough tidal current measurements and modelling to accurately estimate the viability of this alternative location.

Comprehensive technical oceanographic and shipping operability studies were conducted by specialist consultants to the engineering team of the Gorgon Development. These confirmed that tidal currents would adversely affect safe operations of LNG carriers at Surf Point.

22.122 What stakeholder consultation has discouraged development at this site, incidentally? We do not recall having expressed such a view.

During consultation undertaken during the ESE Review process, stakeholders such as the Conservation Commission of Western Australia and CALM indicated that sites in the less-developed, northern area of the island were less preferred than those closer to the area of more intensive oil production.

22.123 The expressed concern for restricted vegetation communities seems disingenuous given GJV's regular emphasis on how the island has no Declared Rare Flora and only two Priority Flora. Presumably none of the vegetation near Surf Point is endemic to either that part of the island or Barrow as a whole.

The statements regarding listed threatened flora are necessary to address the standard concerns of conservation of biological diversity in the risk assessments. This does not detract from the proponent's commitment to conserve representative areas of all vegetation types currently known from Barrow Island. The restricted vegetation communities have been identified in work conducted by Chevron Australia; these have been voluntarily highlighted as areas requiring special protection. The vegetation of the northern end of Barrow Island is different to that of the rest of the island, for an example see Buckley (1983), and there are restricted communities such as the clay pan and *Erythrina* communities identified in the Technical Appendix C1 to the Draft EIS/ERMP.

3.7 Assessment of Feed Gas Pipeline Alternatives

15.3 In December 2004, following an extensive public consultation period, the Montebello/Barrow Islands marine conservation reserves were established. At Barrow Island, a marine park was established on the western coast, and a marine management area established on the north and south; excluding the eastern coast. These waters are vested in the Marine Parks and Reserves Authority. The boundaries of the marine park were substantially modified after vigorous representations from the proponent to accommodate the then proposed produced gas pipeline, but we now note that it is proposed to bring the pipeline ashore elsewhere.

The Gorgon Joint Venturers appreciate the opportunity to have worked with the MPRA regarding the proposed Park boundaries. At the time of those discussions, Flacourt Bay was the base case for the shore crossing. Since that time further work has been undertaken and the process used to locate the shore crossing for the feed gas pipeline is an example of the Gorgon Joint Venturers' commitment to protecting the environment. Alternatives considered, and the process used to assess them, have been discussed in the Draft EIS/ERMP Chapter 3 (Section 3.7). In particular, the following extract (Section 3.7.4) highlights the importance the Gorgon Joint Venturers place on protecting Barrow Island, including the marine environment around it (which was rated high in Table 3.6). 'From the assessment of shore crossing options, the preferred shore crossing location is North White's Beach, constructed using HDD. The key benefits of this option over the other feasible alternatives are that it: provides lower risks to rock wallabies, turtle habitat, and the Marine Park...'.

In addition, the Draft EIS/ERMP Section 3.9 states, 'Of the possible shore crossings (and resultant onshore pipeline routes on Barrow Island), North White's Beach is considered the base case for the development with Flacourt Bay being carried as a fall-back option.' A fallback position was required because there were uncertainties associated with the ground conditions at North White's Beach, and although it looked favourable for HDD there was further geotechnical survey data required. Some of this data has been acquired and it further improves the Gorgon Joint Venturers' confidence in the North White's Beach Shore Crossing.

22.124 The Submitters must note that a move to North White's Beach on the west coast without a move north on the east coast is a bad result for the terrestrial environment. The distance on land between North White's Beach and the Surf Point option is much shorter than the crossing contemplated in the ESE (Flacourt Bay to Town Point), but even shorter again than the 'ideal' route suggested by GJV.

The Joint Venturers' assessment indicates that the preferred location for the gas processing facility is Town Point and the preferred shore crossing location for the feed gas pipeline is North White's Beach. Both these conclusions are supported by CALM. Refer to 18.35 and 18.36 Section 3.7.

22.125 GJV's preferred North White's Beach to Town Point option amounts to cutting off the north east corner of Barrow from the rest of the island – and takes the pipeline through the relatively less disturbed northern portion of the island that the proponents seemed so concerned about back on page 61!

22.126 Note that in addition to the North White's Beach – Town Point option being a longer pipeline, it will also follow existing tracks for a significantly shorter percentage of its length.

The pipeline right-of-way will parallel existing roadways for the majority of its length, and, as such, will not result in additional fragmentation of vegetation communities nor impose additional constraints to fauna movement. The decision to bury the pipeline further reduces potential impacts related to such matters. Refer also to 18.49 Section 6.3.5.

3.8 Defer or not Develop Alternative

16.45 The suggestion that a small delay could jeopardize strategic social and economic benefits is surely arguable. Given the rapidly growing demand for gas worldwide in recent times, it seems unlikely that current and future market opportunities would be permanently lost to competitors.

22.71 The Submitters have never been persuaded by GJV's "develop now or lose the opportunity" line of argument. The price of gas has risen so much since the ESE (see below), and lack of access to Barrow would presumably only make the project more and more viable on the mainland (if it is not already viable on the mainland, as we suspect).

The market for LNG is very different to the global market for oil and the spot markets for pipeline gas in the US and Europe. Rather than having many demand and supply sources like oil or pipeline gas, LNG trade still relies on long-term bilateral contracts between a small number of suppliers and customers. As a result, market opportunities arise less frequently (there may be many years between market windows) and these opportunities can be lost, as customers will commit for a long period of time to the supplier that is ready within their market window. Further to this, customers only seek out supply that is available within a certain time horizon, and thus, if the Gorgon Development cannot supply LNG as per a customer's timing requirements, the customer will secure needed LNG from another supplier.

4 Legislative Framework

4	Legislative Framework.....	97
4.1	Introduction and General Legislative Framework Responses to Submissions.....	98
4.2	Environmental Impact Assessment Process	101
4.3	Other Relevant Legislation.....	103

4.1 Introduction and General Legislative Framework Responses to Submissions

22.20 After community consultation is over, internal corporate financial pressures and time deadlines will no doubt lead to major “short cuts”.

It is the intention of the Joint Venturers to continue meeting our regulatory compliance obligations, commitments, EMPs and any environmental conditions imposed as a result of the environmental impact assessment process.

22.314 While certain elements of existing legislation for oil, gas field and mine sites may be applicable to geosequestration it is simplistic to state that this will provide adequate regulatory oversight for a new technology such as the storage of CO₂ for geological time.

The Gorgon Joint Venturers note that matters of regulation are effectively a matter for government and are not necessarily matters that relate to the assessment of the Developments environmental impact.

The Gorgon Joint Venturers agree that certain aspects of existing legislation will provide regulatory mechanisms for the injection of CO₂ below Barrow Island. As an example the regulations for petroleum pipelines can be readily applied to the transportation of CO₂ by pipeline and this has been connection has been made in the *Barrow Island Act 2003*. In addition petroleum regulations for the drilling of wells and conducting geophysical surveys have obvious application to the proposed CO₂ injection project. The Joint Venturers expect that these regulations would be applied to the Gorgon Development as Ministerial conditions under Section 13(6) of the *Barrow Island Act 2003*.

At no point have the Gorgon Joint Venturers maintained that this existing legislation (that is legislation in place prior to the enactment of the *Barrow Island Act 2003*) would provide ‘adequate regulatory oversight’ for the CO₂ injection project on Barrow Island. Clearly if this was the case there would be no requirement for the Part 4 of the *Barrow Island Act 2003*, dealing with the ‘Conveyance and underground disposal of carbon dioxide’. This legislation is supported by extensive work in the area of regulation of geosequestration undertaken by the Ministerial Council of Minerals and Petroleum Resources and which has involved wide spread community consultation (MCMPR 2005).

22.317 GJV’s draft EIS/ERMP should specify, with regard to all stages of the geosequestration process, which statutory regulations ‘they believe’ will provide an appropriate mechanism for managing liabilities. Without detailing both the legislation, as well as on whose legal advice ‘they believe’ it to be sufficient, it is very difficult for the community to reach a conclusion regarding whether or not the existing statutory framework is sufficient to manage the environmental consequences of both planned and unplanned processes and events related to geosequestration.

The Gorgon Joint Venturers note that matters of regulation are effectively a matter for government and are not necessarily matters that relate to the assessment of the Development’s environmental impact. However there are key pieces of existing statutory regulations that can provide appropriate mechanisms for the management of the proposed CO₂ injection project. These include:

- Federal and state environmental protection laws are being used to assess the environmental impacts of the CO₂ injection project.
- Federal and state environmental protection laws will be used to regulate ongoing environmental issues.
- State occupational health and safety laws will apply in the management of health and safety issues around the facility.
- The State Petroleum Pipelines Act will be used to authorise and regulate the construction and operation of the CO₂ pipeline.
- The regulations for the drilling of petroleum wells under the State Petroleum Act will likely be used to regulate the drilling of CO₂ injection and monitoring wells.

- The regulations for the geophysical surveys under the State Petroleum Act will likely be used to regulate the acquisition of seismic surveys related to the monitoring of injected CO₂.
- Adoption of the process in the Petroleum Submerged Lands Act for an agreed Field Development Plan (termed an Injection Operations Management Plant in the context of the proposed CO₂ injection at Barrow Island) to regulate the injection operations.

22.318 While it may be the case that ‘common law will provide an appropriate mechanism’ (Draft EIS/ERMP Main Report page 676) for the management of liabilities, it is uncertain whether it will apply in such a way as to be satisfactory to the Western Australian community, which will not only have suffered some loss if a case arises, but will pay for any remediation if the GJV partners are found to be not liable for any loss arising.

The Gorgon Joint Venturers note that issues to do with the management of liability are matters for government and are not necessarily matters that relate to the assessment of the Developments environmental impact.

The Joint Venturers note that the Ministerial Council on Mineral and Petroleum Resources, recommended (MCMPR 2005; p 46) that ‘Liability should be based on existing regulatory arrangements and common law’ and that ‘Current regulatory principles and common law should continue to apply to liability issues for all stages of CCS projects’.

In relation to the common law, the main potential heads of liability for the Gorgon Joint Venturers, as for any party undertaking the disposal of a product, are trespass (which in broad terms, may arise if there is an intentional or negligent act which interferes with another person’s possession of land, without lawful justification), nuisance (which, in broad terms, may arise if there is an unlawful interference with a person’s use or enjoyment of land, or of some right over it, or connection with it) and negligence (which, in broad terms, applies if there is a duty of care owed to a third party, there is a breach of that duty of care, the third party suffers damage caused by the breach and the damage is not too remote).

Under existing laws, the release of additional greenhouse gas would not give rise to a liability.

Government can mitigate long-term risk by careful attention to the authorisation and supervision of injection operations and by diligent attention to the issue of site closure. If the principle that ‘the residual risk of leakage and resulting liability is acceptably low’ is applied, here should be no significant risk for government and the community in the longer term.

22.76 Page 17; The proponent lists ten sustainability principles, most of which the proponent fails to meet even at the most basic level. Principle 5. Future Generations Commitment – for reasons outlined throughout this document the Submitters do not believe that this principle has been met, given that this proposal will adversely impact on one of the most important nature reserves in Australia, will generate a massive amount of greenhouse gases, and may delay Australia’s move to a more sustainable energy future.

The proposed Gorgon Development will represent a significant source of greenhouse gas emissions. However the Joint Venturers have fully complied with, if not exceeded, both state and federal government policy in relation to best practice greenhouse gas emission management and reduction measures in designing the proposed facility. The undertaking to reduce greenhouse gas emissions by disposing of reservoir CO₂ by injection into the Dupuy Formation represents a commitment that goes beyond what is required by government policy.

Both the Western Australian and Commonwealth Governments acknowledge that natural gas and LNG have the potential to provide energy with low greenhouse gas lifecycle emissions, despite a potential increase in greenhouse emissions within Australian. (Government of Western Australia 2004; p 40 and LNG Action Agenda (Department of Industry, Science and Resources 2000)) Issues such as the sustainability of Australia’s energy future are outside the scope of the Draft EIS/ERMP for the proposed Gorgon Development and are best addressed by government.

22.319 The draft EIS/ERMP has not made any attempt to outline the possible issues that could give rise to common law liability from their project.

The Gorgon Joint Venturers note that issues to do with the management of liability are matters for government and are not necessarily matters that relate to the assessment of the Development's environmental impact.

Also refer to 22.318 above.

22.320 The AGS [Australian Government Solicitors] advises that, 'In cases where the conduct giving rise to the tort occurs in more than one jurisdiction, difficulties can arise in determining which of those jurisdictions should be regarded as the place where the tort was committed.'

In the case of geosequestration, this could result in many situations in which the GJV may avoid application of the common law in the Western Australian jurisdiction, if for example, monitoring equipment fails and was manufactured in another jurisdiction, if well casings corrode, if injection equipment fails etc.

The Gorgon Joint Venturers note that issues to do with the management of liability are matters for government and are not necessarily matters that relate to the assessment of the Development's environmental impact.

The Australian Government Solicitors (AGS 2005a; p 139) state in relation to the quote in this submission, that 'Subject to some qualifications, the law applicable to a contract can be determined by the parties to the contract, and specified in the contract.' It is Chevron's practice (as it is good commercial practice) to agree and specify the applicable governing law when entering into all contracts.

22.321 "There is at present no settled single test for establishing a duty of care applicable in all situations. There is a general concern to avoid the imposition of liability 'in and indeterminate amount for an indeterminate time to and indeterminate class.' The Court in that case also referred to the need for 'some intelligible limits to keep the law of negligence within the bounds of common sense and practicality.'" Clearly with a technology that must prove effective for geologic time, the potential exists for GJV to escape liability for damage arising from their geosequestration activities.

The Gorgon Joint Venturers note that issues to do with the management of liability are matters for government and are not necessarily matters that relate to the assessment of the Development's environmental impact.

In relation to the quote in this submission, the Australian Government Solicitors (AGS 2005a; p 141) went on to say 'However, these concerns have not yet been converted into a single, clear rule. Indeed it is likely to be impossible to do so...' In relation to determining if a duty of care exists the Australian Government Solicitors (AGS 2005a; p142) states '...no single principle or factor has been identified by the courts to determine whether a duty of care exists in all cases. Rather the courts have developed (and sometimes changed) principles which can be used for guidance, having regard ultimately to the particular circumstances of each individual case.'

22.322 There is also the question of the Statute of Limitations as it would apply to negligence by GJV given the long-term nature of geological storage of CO₂.

The Gorgon Joint Venturers note that issues to do with the management of liability are matters for government and are not necessarily matters that relate to the assessment of the Development's environmental impact.

In relation to any time limits that might apply to the bringing of proceedings under common law the Australian Government Solicitors (AGS 2005; page 11) state 'Limitation periods for bringing tort proceedings in a court generally commence from the date when a cause of action arises, which is generally the date when injury is suffered'.

22.154 Given that page 125 says that these matters are yet to be decided, what is this a representation of? How much new clearing is entailed? How much hydrological modification of mangroves is possible?

Figure 6.11 of the Draft EIS/ERMP is a photo of the existing facilities in the Karratha area which form the basis for providing material support in the Pilbara region. Also refer 22.134 Section 4.2.

4.2 Environmental Impact Assessment Process

Scope

18.158	The geographical source of sand and aggregate from the mainland for use on Barrow Island needs to be clarified, and may require formal environmental assessment.
22.134	Where will any rock armour required for the project be sourced from? Why haven't the environmental impacts of this issue been dealt with in this draft EIS/ERMP?
22.153	Why has it not yet been clarified whether a new base or bases will be needed? This issue should be dealt with in the final EIS/ERMP such that the entirety of the project may be fully assessed.
24.18	It is noted that a separate approval will be sought should a new supply base (outside of the existing King Bay infrastructure) be required.
24.103	The EPA SU has recently become aware that the proponent is considering alternative mainland supply base options. It is presumed that mainland supply bases will be critical for construction and operation of the proposal on Barrow Is. and the need for assessment of a new supply base may have significant impacts on the proponent's timelines. It would be preferred that any proposal for a new supply base(s) should be considered as part of the overall proposal. The proponent is requested to confirm whether a new mainland supply base is/will be proposed to support the development on Barrow Is. If so, then the location of that facility must be specified and the environmental information necessary to inform the assessment of a new facility at that location should be provided during the assessment of the ERMP.

The Gorgon EIS/ERMP Scoping Document recognises that: 'Any new, expanded or modified facilities (on the mainland) will be approved through existing statutory processes, including environmental impact assessment, as required.' (ChevronTexaco Australia 2004; Section 2.6). Therefore, any possible rock quarrying operations are outside the scope of the Draft EIS/ERMP, as is the mainland supply base.

19.08 The Department suggests that the proponent also notes that this lack of certainty will have a flow on effect in any potential future environmental approvals such as the works approval, which is required prior to construction commencing. While the Department remains committed to the 60-working day timeframe for granting environmental approvals, as recommended by the Keating Review, this period only commences once the application is received and accepted as complete. A completed application must contain all the appropriate information necessary for assessment and include payment of the required fee.

Based on the information contained within the ERMP, a much more detailed submission would be required from the proponent before an environmental assessment report could be undertaken by the Department. It should be noted that the Keating Review specifically identified the early identification and management of key environmental factors as critical in ensuring a timely assessment process with maximum certainty. The Department's view is that this project has not met this objective and accordingly complications at later stages of assessment of other approvals may be problematic.

The Joint Venturers note that additional information will be needed to secure environmental approval under Part V of the *Environmental Protection Act 1986* and is working to finalise the necessary details. The Joint Venturers will formally engage with the Department of Environment's Perth and regional staff during the first quarter 2006 to define and agree the form, manner and timing of these requirements.

19.09 It is important that the proponent understand the environmental approval process in Western Australia and that the submission of the EIS/ERMP does not automatically lead to a works approval, nor is the ERMP suffice as a works approval application. The Department suggests that the proponent takes note that a works approval is obtained following the submission of an application to the regional office and assessment under Part V of Environmental Protection Act (1986) and is a separate process to the ERMP submission. It may be beneficial for the proponent to produce an environmental management matrix to ensure that all regulatory requirements are identified and understood.

The Proponent acknowledges that the provisions of Part V of the *Environmental Protection Act 1986* are a separate process to the ERMP, which is required under Part IV of the *Environmental Protection Act 1986*.

19.10 It may be beneficial for the Proponent to produce an environmental management matrix to ensure that all regulatory requirements are identified and understood.

The Proponent supports the Department of Environment's suggestion that there may be benefits in producing a matrix that identifies the Development's necessary regulatory requirements. The Proponent currently has a list of all likely approval that are required and their respective administering agency and which will be discussed with agencies to test its accuracy early in 2006.

21.2 Any approval would also set a precedent for processing facilities for other gas fields by other companies.

The EIS/ERMP addresses the scope of work for the Gorgon Development that is known to date. Any further developments resulting from market opportunities will be addressed in accordance with state and Commonwealth Government environmental approvals processes by the proponent seeking to undertake work.

22.7 The Submitters challenge many of these arguments below, but we also underline that the regulators' job is to consider whether this plant, potential underground CO₂ storage system, causeway, jetty and dredging operation is appropriate to the environment into which it is to be imposed.

The Joint Venturers believe that the Draft EIS/ERMP represents one of the most comprehensive environmental assessments undertaken in Australia. Much of the planning work undertaken has been done so to identify ways to reduce adverse environmental and social impacts.

22.70 It is our submission that something as serious as allowing commercial access to a Class A nature reserve not happen unless the EPA and DEH were satisfied that approval, if given, would ultimately be for a viable development. The prospect of construction commencing with the consequent massive dredging and quarantine risks, but without gas ultimately being produced, should be avoided at all costs.

The Minister for State Development can only approve the Development Proposal after the Minister for Environment has set appropriate approval conditions and the Joint Venturers have made a Final Investment Decision, that is, that the Joint Venturers believe that the Development is commercially viable. When these steps have been taken the risk of projects starting, but not completing, is negligible.

22.313 The GJV glosses over the fact that the regulatory environment in which the proposed injection of CO₂ under Barrow Island would operate remains uncertain. It is unacceptable to expect the community to evaluate an environmental management plan for an element of a proposal for which the legal framework has not been established.

The Gorgon Joint Venturers note that matters of regulation are effectively a matter for government and are not necessarily matters that relate to the assessment of the Developments environmental impact.

The *Barrow Island Act 2003* contains the world's first specific legislation dealing with the subsurface injection of CO₂ in order to reduce greenhouse gas emissions. This legislation is supported by extensive work in the area of regulation of geosequestration undertaken by the Ministerial Council of Minerals and Petroleum Resources and which has involved wide spread community consultation (MCMPR 2005).

22.323 It is unreasonable to grant environmental approval to a project for which the legal framework governing environmental protection has not been established.

The Gorgon Joint Venturers note that issues to do with the adequacy of legal frameworks are matters for government and are not necessarily matters that relate to the assessment of the Development's environmental impact.

The existing state and federal environmental protection laws provide the legal framework to enable government to assess the environmental impacts and enable the ongoing environmental management of the proposed CO₂ injection project. It is under these processes that these submissions are being made and responded to.

25.27 It would probably also be wise to consider in the EIS the potential likely impacts associated with the construction and transport of parts of the proposed prefabricated structures required to construct the LNG plant and other facilities.

In the Gorgon EIS/ERMP Scoping Document, it is recognised that that 'Any new, expanded or modified facilities (on the mainland) will be approved through existing statutory processes, including environmental impact assessment, as required.' (ChevronTexaco 2004; Section 2.6).

22.53 Is the oil operation guaranteed to fully rehabilitate the island when they finish or will some of that fall on the State?

Although existing oil operations on Barrow Island are outside the scope of the Gorgon Development EIS/ERMP, it is to be noted that the government is responsible for directing rehabilitation requirements at the time of decommissioning.

24.1 By way of context, the following are some of the key statements and recommendations that the EPA made in its Environmental Advice on the Principle of Locating a Gas Processing Complex on Barrow Island Nature Reserve (Bulletin 1101) and which the proposal, including its design and management commitments, will be measured against.

Comments from the EPA have been factored in to the scope of work for this Development by the Joint Venturers.

4.3 Other Relevant Legislation

18.93 Approvals must be sought under the Wildlife Conservation Act to remove habitat of *Speleostrophus nesiotus* and *Draculoides bramstokeri* at the gas processing plant.

Chevron Australia will follow the due process (with appropriate agencies) prior to commencing earthworks on the gas processing facility area.

5 Stakeholder Engagement

5	Stakeholder Engagement	104
5.1	Introduction and General Responses to Submissions on Stakeholder Engagement	105
5.2	Methods of Engagement.....	106
5.2.1	Community Consultation – Quarantine	106
5.3	Key Gorgon Development Stakeholders	107
5.4	Key Issues Identified by Stakeholder Groups	107
5.5	Conclusion and Further Engagement Plan.....	107

5.1 Introduction and General Responses to Submissions on Stakeholder Engagement

16.8 Of concern, during a community courtesy visit in June 2004 to Barrow Island, anticipated excursions were not provided as requested to the important shorebird and waterbird sites (eg at Bandicoot Bay, and tidal mudflats southeast and south of the Island), so it has been made difficult to assess the situation from direct observation.

The Bandicoot Bay Conservation Area has been identified as an area of significance for littoral avifauna on Barrow Island and has been avoided as a site for infrastructure associated with this Development.

22.67 Who, if anyone, in either the EPA or DEH has agreed to these timelines? If a project as big as this, with a draft EIS/ERMP that took two years to prepare, was reported on by the relevant authorities in the timeframe contemplated, it is the Submitters' opinion that it would be highly unlikely to have been 'assessed' as required by the relevant laws.

The schedule for agency assessment and Ministerial decision was developed by EPA and DEH in consultation with the proponent.

22.80 Principle 9. Stakeholder Engagement – stakeholder engagement has at best been of variable quality with GJV. While time and effort on issues around quarantine has been comparatively good, nowhere near enough effort was put into the key issue of alternative sites for the development, and more generally into marine issues relating to the project (both of which are the subject of considerable discussion below).

The Joint Venturers welcome recognition of the effort regarding consultation related specifically to quarantine, and point out that this was only one area of stakeholder involvement. Over the past four years, the Gorgon Joint Venturers have held hundreds of stakeholder meetings with a broad and diverse cross section of government, industry and community representatives. These consultations have covered all project related matters, including marine management issues and alternative sites.

Also refer to 16.37 Section 5.3.

22.85 This section really de-emphasises the EPA and Conservation Commission reports. Quotes from those reports should be extracted.

The EPA and Conservation Commission reports are publicly available for anyone wishing to read their comments in detail.

22.128 (Page 81 – Draft EIS/ERMP) This section should be amended to spell out which of the MPs and their advisers expressed opposition to the project during consultation or publicly at a later stage.

22.128a (Page 82 – 5.3.2 – Draft EIS/ERMP) This section should be amended to spell out which of the MPs and their advisers expressed opposition to the project during consultation or publicly at a later stage.

22.129 (Page 83 – 5.3.3 – Draft EIS/ERMP) This section should be amended to spell out which Departments and agencies expressed opposition to the project during consultation or publicly at a later stage.

22.130 (Page 83 – 5.3.4 – Draft EIS/ERMP) This section should be amended to spell out which stakeholders expressed opposition to the project during consultation or publicly at a later stage.

22.131 (Page 83 & 84 – 5.3.5 – Draft EIS/ERMP) This section should be amended to spell out which stakeholders expressed opposition to the project during consultation or publicly at a later stage.

22.131a (Page 84 – 5.3.5 – Draft EIS/ERMP) This section should be amended to spell out which stakeholders expressed opposition to the project during consultation or publicly at a later stage.

22.131c (Page 85 – 5.3.7 – Draft EIS/ERMP) This section should be amended to spell out which stakeholders expressed opposition to the project during consultation or publicly at a later stage.

22.131d (Page 85 – 5.3.8 – Draft EIS/ERMP) This section should be amended to spell out which stakeholders expressed opposition to the project during consultation or publicly at a later stage.

Throughout the process, valuable stakeholder feedback has assisted in shaping the way forward for the Development. The basis and arrangements for the discussions with stakeholders has varied and while some would have had no objection to their comments being attributed, other may have felt constrained. A decision was taken to not to publicly identify specific comments with individual stakeholders. This approach was considered to offer the best opportunity for an open exchange of information and views. Given the four year period of discussions, many of comments were based on preliminary views and early information. Formal submission during the public comment period was believed by the Venturers to be the appropriate time and vehicle for stakeholders to formally record their position.

22.55 It is also very difficult to describe the Island as being ‘managed’ by CALM when their access to Barrow is so infrequent and is totally at the whim of Chevron. This section should be re-written to reflect reality.

CALM is not restricted from accessing Barrow Island. All personnel travelling to the Island are required to undertake the relevant Chevron Australia inductions and adhere to Chevron Australia’s quarantine procedures.

22.131b The description of Harry Butler must be amended to clarify that he has been in the employ of WAPET and then Chevron since the 60s – it would be useful to disclose the extent of the payments he has received for this role since that time, and the retainer (if any) he is currently on.

Harry Butler has and continues to be an independent expert conservation advisor to the company (WAPET and now Chevron Australia), not an employee. He has been a Warden of Barrow Island, appointed by CALM. The advice provided by Mr Butler to the company has always been fiercely independent and driven by a desire to protect the conservation values of Barrow Island.

5.2 Methods of Engagement

5.2.1 Community Consultation – Quarantine

22.17 There is no question the GJV have given some recognition of what is at stake with quarantine management, and made some laudable efforts to engage experts and the community.

Comment noted and appreciated.

22.44 The Submitters acknowledge some of the work done by the proponents in their attempts to counter criticisms they received during the in-principle approval process. Of particular note are the workshops held to develop quarantine standards and the effort to set high standards for invertebrate fauna sampling.

Comment noted and appreciated. The Joint Venturers believe that the workshops held, in particular those aimed at developing quarantine standards, were an important part of the assessment process and have produced a better understanding of stakeholder views.

5.3 Key Gorgon Development Stakeholders

16.37 While the prior public consultation provided on Quarantine issues has been commendable, public consultation about other very important aspects of the proposed development is missing. The most important issue – the proposed siting of a major gas processing facility on an A-class Nature reserve – was not dealt with despite many public requests.

The Joint Venturers welcome the recognition that consultation regarding quarantine issues has been commendable. The Joint Venturers believe that extensive consultation has also taken place on other important issues such as alternative plant locations. The ESE Review was a public process established to examine whether in-principle access to Barrow Island should be given for the Gorgon Development. During the ESE Review process, there was comprehensive community involvement which included discussions, briefing sessions, presentation and familiarisation visits to Barrow Island.

Those involved in the process included Commonwealth and State Ministers, backbenchers, advisors and agencies, government advisory bodies, local government, conservation organisations, industry groups, regional and indigenous stakeholders, tertiary institutions and research centres, potential customers and suppliers, employees and contractors, the media and individual members of the community. The process also involved two public comment periods during which the Joint Venturers responded to all the matters raised.

5.4 Key Issues Identified by Stakeholder Groups

No submissions received on this section of the Draft EIS/ERMP.

5.5 Conclusion and Further Engagement Plan

8.13 DoIR strongly recommends that the Gorgon Project team seek comment from the appropriate companies in relation to environmental impacts which may occur outside the Gorgon area of operations.

The Joint Venturers recognise and accept the need to continue with the extensive stakeholder engagement program for the Development and will continue to consult with other land/sea users whose activities may be influenced by the Gorgon Development.

6 Development Description

6	Development Description	108
6.1	General Submissions on Development Description	109
6.2	Major Infrastructure Components	110
6.2.1	Wells and Subsea Facilities	110
6.2.2	Feed Gas Pipelines	110
6.2.3	Gas Processing Facility	112
6.2.4	CO ₂ Injection Facilities	113
6.2.5	CO ₂ Monitoring Activities	115
6.2.6	Domestic Gas Pipeline	116
6.2.7	Water Supplies	116
6.2.8	Drainage and Waste Water System	117
6.2.9	Port and Marine Facilities	122
6.2.10	Supporting Facilities	124
6.2.11	Mainland Supply Base	126
6.2.12	Estimated Land Use	127
6.3	Construction Activities	127
6.3.1	Construction of Offshore Wells	127
6.3.2	Construction of Onshore CO ₂ Injection Wells	127
6.3.3	Construction and Installation of Subsea Systems	128
6.3.4	Construction of the Feed Gas Pipeline	128
6.3.5	Construction of the Onshore Feed Gas Pipelines	130
6.3.6	Construction of the Gas Processing Facility and Infrastructure	132
6.3.7	Construction of Onshore Water Supply/Re-injection Wells	137
6.3.8	Construction of Marine Facilities	139
6.3.9	Construction of the Domestic Gas Pipeline	142
6.3.10	Construction of Optical Fibre Cable	142
6.3.11	Other Pipelines	143
6.4	Pre-Commissioning, Commissioning and Start-Up	144
6.5	Operation of the Gorgon Development	144
6.6	Decommissioning	144
6.6.1	Decommissioning of Pipelines	145
6.6.2	Decommissioning of Gas Processing Facilities	145

6.1 General Submissions on Development Description

18.05 There is minimal detail regarding project design, as 90% of the details of design work have yet to be determined and therefore have not been provided for a full environmental assessment.

The nature, scale and significance of potential environmental risks do not require the completion of the detailed design phase. During the detailed design phase a significant portion of the work is aimed at finalising matters such as equipment dimensions (e.g. pipe 200 mm or 250 mm) and design pressures, which will not result in any measurable difference in potential impact.

18.10 The proposed development, as outlined in the ERMP, still has many uncertainties in regard to construction design and location of infrastructure and facilities. For instance, the location of the western shore crossing on Barrow Island for the feed gas pipeline has not yet been resolved. The location of the construction village, administration building and supporting infrastructure has not been determined. The airport will be expanded, but no detail is provided on the extent of the expansion and the potential environmental impacts. Not enough information was provided to adequately assess the environmental acceptability of constructing an above or below ground feed gas pipeline on Barrow Island.

The Joint Venturers continue to refine the development concept as front end engineering studies progress. For further details on the specific items raised refer to Part A in this document and:

- Feed gas pipeline – refer to 18.49 Section 6.3.5
- Construction village – refer to 18.38 Section 6.3.6
- Administration buildings – refer to 18.13 Section 6.2.10
- Airport – refer to 4.21 Section 6.3.6

18.57 The use of Australian Standards in all project designs needs to be justified in relation to the values at risk and potential consequences, to the requirements of the EPA on the advice of CALM.

The Gorgon Joint Venturers are committed to using Australian Standards as a minimum. Alternative practices of a higher level of standard will be utilised if warranted.

19.02 There is little specific design or emission information for the flare towers, the tiered wastewater management system, cumulative effects of the development including impacts if two additional LNG trains are built at a future date or potential additional emissions from the existing Barrow Island oil loading facilities if they are used for condensate export.

Trains 3 and 4 are outside the scope of this EIS/ERMP. Emissions from the existing facilities are discussed in Chapter 7, Section 7.2.6 of the Draft EIS/ERMP.

22.145 What is the total number of pieces of equipment that will be brought onto Barrow as part of this proposal, incidentally?

The exact number of pieces of equipment will depend on the final design and construction method(s) selected.

22.193 Barrow is not a 'small' island!

Comment noted.

16.6 The EIS and ERMP are disappointing and sub-standard. They appear to have been released in a very incomplete state. It would appear site selection was done before the necessary preliminary studies were made. A number of crucial issues remain unaddressed, many major problems remain unresolved, eg in relation to quarantine, the total amount of clearing of vegetation and to fresh water extraction and the impacts of these. This is totally unacceptable, particularly as these are foremost issues. We feel that the information given in this Report is not of a sufficiently high standard to warrant its acceptance.

The Joint Venturers disagree. The Gorgon Development EIS/ERMP is one of the most comprehensive environmental assessments for a project in Australia. In a limited number of instances, additional studies will be undertaken to assist in decision making related to some aspects of design yet to be finalised. Refer to 20.12 (Chapter 3).

For site selection issues refer to Ch 3 of the Draft EIS/ERMP. For quarantine matters refer to Ch 12 of the Draft EIS/ERMP and the Additional Information Package. For vegetation clearing matters refer to Ch 6 of the Draft EIS/ERMP, Table 6.3. For information relating to fresh water supply refer to Ch 6, Box 6.9., and also refer to 22.33. Further details on these and other aspects are provided in these responses to submissions.

6.2 Major Infrastructure Components

6.2.1 Wells and Subsea Facilities

22.35 Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – the potential for a compression platform at a later stage in the development.

The compression facility (which may be a platform) is outside the scope of this Draft EIS/ERMP, as mentioned in the Draft EIS/ERMP (pp 96–97) which states that: 'In the future, the pressure in the reservoirs will be insufficient to sustain peak production rates. At that time it may be necessary to install compression facilities. This may be a platform, but subsea technology is evolving rapidly and so it could be a subsea facility. The compression facility is outside the scope of this Draft EIS/ERMP, and if required will be the subject of a separate approval process. Other fields may also be tied into the gas processing facility through the subsea systems.'

22.133 There is way too little said here about the potential development of the field via an offshore platform – which is effectively the option that would allow development with at most a very small footprint on Barrow for geosequestration reasons. Given the very brief reference at pages 96 and 97 about the potential later need for a platform anyway, this issue should have been explicitly factored into the regional alternative sites work.

Chapter 3 of the Draft EIS/ERMP addresses alternative development scenarios, which included using a processing platform. Refer also to response to 22.35 above regarding the compression facility.

6.2.2 Feed Gas Pipelines

22.26 Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – the relative impacts of an above or below ground feed gas pipeline on Barrow.

The alternatives considered for the shore crossing for the feed gas pipelines are discussed in Chapter 3, Section 3.7 of the Draft EIS/ERMP (Chevron Australia 2005). A summary of the assessment for the above- or below-ground feed gas pipeline system is described in Section 6.2.2 of the Draft EIS/ERMP. After working with the engineering and design contractors, and assessing improved construction methodology, the Joint Venturers have recently taken the decision to bury the onshore component of the feed gas pipelines (refer to Part A of this document). The ability to achieve a reduced environmental impact was a key criterion in this study. Refer to 18.49 Section 6.3.5 and 24.55 Section 6.2.2.

22.135 The full range of potential impacts for each option must be considered – why, for example, it is assumed that extra shade and water for native fauna is a good thing? The faunal populations of a class A nature reserve should be subject to as few human-induced changes as possible, be they apparently positive or negative.

The Joint Venturers agree in principal that normally fauna should be subject to as few anthropogenic changes as possible. However, the utilisation of resources such as shade that may enhance the survival of fauna that are expected to experience some reduction in habitat, in some way mitigates the impact on these fauna. The decision has recently been finalised by the Joint Venturers to bury the onshore component of the feed gas pipelines.

24.10 In what ways will the offshore pipelines stabilised with rock armour out to the 40 m contour affect ocean conditions and sea bed stability due to their elevation above the sea bed, especially in the shallower waters (greater than 5 m)?

The effects are expected to be negligible. This will be addressed during the preliminary rock berm design.

24.11 To what extent would there be the possibility of cumulative benthic stability effects if pipeline stabilisation/protection was undertaken separately for each feed gas pipeline (initially two but up to four), rather than using a single combined structure for all pipelines?

Given the proposed rock dump methods, there is expected to be negligible difference between single and multiple berms with respect to seabed impact.

24.12 It is understood that there may be risk-related issues associated with having the onshore section of the feed gas pipelines located above ground. If a change to below ground construction is required/selected, the implications of this in terms of easement widths, clearing, fauna, etc will need to be reviewed, where there are expected to be different from that outlined in the draft EIS/ERMP (as anticipated in Box 6-3). This is particularly relevant to issues associated with multiple construction events over time, including disturbance and also rehabilitation.

Following a detailed assessment of the environmental, safety, geotechnical, construction and technical considerations, the Joint Venturers propose to install the feed gas pipelines below ground. The basis for this decision is summarised as follows:

- More detailed interpretation of the geotechnical data indicates that burying of the pipe can be achieved by trenching rather than drilling and blasting.
- Bedding material will not need to be imported to the island which alleviates initial concerns over quarantining of imported fill. The above-ground construction would have a much higher quarantine burden mainly associated with the pipe supports.
- The extent of vegetation clearing can be reduced by trenching.
- The buried pipeline would not affect flora or fauna by providing shade or water or act as a barrier to fauna movement.
- The pipeline ROW could be rehabilitated directly following installation; whereas the above-ground construction would be redisturbed at the end of field life when the pipe and supports are removed (the buried pipe would be left in place). Refer also to 22.37 Section 8.3.1 regarding decommissioning.
- The maintenance and inspection requirements of a buried pipeline would be far less onerous than that of an above-ground pipeline.
- The cyclone and fire implications for an above ground pipe can be avoided with a buried pipeline. An above ground pipeline is more likely to be affected which could lead to plant downtime (particularly with umbilical repairs).
- The safety risk associated with vehicle movements along side an above-ground pipeline can be avoided by burying the pipeline.

Given the additional information obtained and the investigations undertaken since the Draft EIS/ERMP was published, it is believed that the environmental impact of a buried pipeline would be equivalent to, or less than, that of an above-ground pipeline.

24.55 The gas feed pipeline landing at Flacourt Bay is stated as having serious to critical consequences on the restricted coastal vegetation communities, with long-term effects which may reduce the viability of these communities, with a resultant high risk. In view of this, and also in relation to potential consequences to significant fauna, on what basis could the Flacourt Bay pipeline route be considered as an acceptable alternate option to North White's Beach?

North White's Beach is the preferred shore crossing option on the basis of coastal vegetation, landforms, rock wallabies, water quality effects in the Marine Park and economics (requiring less drilling). In the unlikely event that Flacourt Bay had to be re-examined as a shore crossing location, additional studies would be undertaken to help select a route that minimised impacts to the sensitive receptors and select techniques that reduced the risk to an acceptable level (refer to Part A of this document).

24.77 Appendix C1 lists the following vegetation communities within the development area have limited area or which require clarification of their significance:

- North White's pipeline corridor - C1e, L3c, L6b, L6c, L6d
- Flacourt Pipeline corridor - C1d, C4e, C5b
- Gas Plant - L6a

What proportion of the total area of each of these communities on Barrow Island is likely to be impacted by the development?

Has additional work being undertaken as recommended in Appendix C1 - if not, when is it proposed?

The preferred shore crossing option at North White's Beach avoids impacts to the Flacourt Bay coastal vegetation communities and the preferred development areas associated with the gas processing facility avoid the *Grevillea* community (L6a). Additional work is underway in the area of the North White's Beach pipeline route. This work will assist final pipe route selection to avoid or reduce impacts to restricted vegetation communities.

6.2.3 Gas Processing Facility

19.6 The use of high level versus low level flares also has potentially significant implications of light impact and noise emissions on fauna.

The Joint Venturers have selected a ground flare instead of the elevated flare as described in the Draft EIS/ERMP. In making this decision, environmental factors such as light and noise emissions, and workforce safety were considered.

22.36 Key issues not included in this draft EIS/ERMP, or not dealt with in sufficient detail, include: - the relative lighting impacts associated with a flare tower as compared to a flare pit.

22.182 Flaring associated with development commissioning should not be permitted during turtle nesting season. Alternatively, a flare pit should be utilised. Why haven't the relative environmental impacts of a flare pit as against a tower been presented in this draft, by the way?

A flare pit is not appropriate for a gas processing facility. Refer to Section 6.2.3, p 114 of the Draft EIS/ERMP for a discussion on the type of flares being considered (namely elevated or ground flare). It should be noted that a ground flare is not the same as a flare pit. Since writing the Draft EIS/ERMP, the project team has decided to use a ground flare which has significantly lower light emissions. Further information in regard to the ground flare is provided in Part A of this document.

22.141 The top of the flare tower should be designed to discourage osprey nesting, given that flaring will be non-routine and therefore unpredictable.

The Gorgon Joint Venturers have decided to use a ground flare.

24.13	Will the proposal have a dedicated LNG tanker fleet associated with the proposal?
24.42	If the proposal has a dedicated LNG tanker fleet, would it then be possible to define more precisely the operational management of ballast water to reduce possible importation of exotic marine fauna and other quarantine threats?
24.43	Will the proposal have a dedicated LNG tanker fleet associated with the proposal?

Not all LNG tankers servicing the Gorgon Development will be dedicated to this development. However, given the nature of LNG transportation, the Gorgon Joint Venturers expect that most LNG exports will be on ships trading from Barrow Island. Condensate liftings will most likely be done exclusively by third party ships. However, during phase one (i.e. Trains 1 and 2), they are expected to lift once every two months and at that time will only be in port for approximately 24 hours. Every vessel intending to call at Barrow Island will be thoroughly screened using a well-established clearance process to ensure that they are not only in good physical condition, but are manned by trained, experienced and professional crews; and have an effective safety and environmental management system in place.

6.2.4 CO₂ Injection Facilities

8.24	Section 6.2.4 states “One option that may prove feasible is the use of fewer drill centres but the resultant increased well deviation will increase the likelihood of using non-water based muds, which have their own potential environmental impacts”. DoIR considers this option should be seriously investigated as it may significantly reduce land disturbance on the island associated with injection.
8.25	Adequate management and disposal of Synthetic drill fluids and cuttings would need to be clarified if this option was to be implemented.

The Gorgon Joint Venturers are continuing to study the number and location (surface and bottom-hole location) of the required injection CO₂ injection wells. The objective is to reduce the number of injection wells to the lowest number possible, while still providing capacity to inject the expected rate of reservoir CO₂. The number of injection wells and drill centres is anticipated to be the same or less than that identified in the Draft EIS/ERMP.

The option of consolidating the injection wells into one drilling centre has many operational benefits as well as reduced land access. Less land is required not just for the drill centre, but also for access roads, pipelines and control systems. As indicated in the submission, the use of synthetic-based drilling fluids would require management procedures beyond those normally required for water-based drilling fluids. However, the procedures are becoming common practice in the oil and gas industry and thus add complexity to the drilling process.

Issues such as consolidating the number of drill centres and the use of synthetic-based drilling fluids will be further considered once the final number and bottom-hole location of the CO₂ injection wells have been determined. Irrespective of the drilling fluid used, the design of the injection wells and associated environmental management plans are required to be approved by DoIR prior to drilling of each well. These environmental management plans will identify a process for the management and disposal of all drilling fluids and cuttings derived from the CO₂ injection wells.

8.26 Section 6.2.4 states that “Careful selection of the bottom-hole locations of the wells will be required to achieve the desired injection rates and distribution”. How and when will this selection be determined? Does the above imply that the bottom-hole locations identified in the document are not conclusive?

The bottom-hole locations of the CO₂ injection wells provided in the Draft EIS/ERMP are indicative of the location of the injection wells based on the Joint Venturers subsurface understanding at the time the Draft EIS/ERMP document was written. The reference case assumed a total of seven injection wells drilled from two drilling centres.

Given that the injection wells will be drilled from common drill centres, changes in the bottom-hole location of individual wells will not result in a material impact on the environmental values of Barrow Island. Lesser environmental impact will only be achieved if the number of drill centres can be reduced.

The final number of injections wells (and hence drill centres) and the location of the bottom-hole locations will be determined once the results of the soon to be drilled data well have been interpreted. This is expected to occur prior to ministerial consideration of approval for the CO₂ injection project under the provisions of the *Barrow Island Act 2003*. The Joint Venturers currently anticipate that less than seven injection wells (reference case) will be required to enable the injection of 100% of the anticipated rate of reservoir CO₂ from the gas processing facility.

24.9 While Table 6-1 shows the anticipated gas composition for both Gorgon and Jansz gas fields in year 20, this is a 60 year plus proposal. A table or chart showing the expected compositions at decade intervals over the proposed life of the project (60 years) should be provided.

The data provided is the anticipated composition after 20 years of production and represents the average composition over the life of the Development. The composition in any particular year (or decade) is only expected to vary from this composition by a slight amount.

The greenhouse gas emissions quoted in the Draft EIS/ERMP (Chevron Australia 2005; p 609) has been prepared based on a reference case incorporating a series of worst case assumptions. Slight variations in the composition of the natural gas arriving at the gas processing facility will not materially alter the level of these emissions.

24.14 To what extent have the implications to native vegetation and fauna (including subterranean fauna) and other values of Barrow Island been addressed in the draft EIS/ERMP for the ‘up-hole survey’, involving installation of 100–200 30–50 m deep holes? These holes are stated as being located on the seismic source lines, but these lines do not require clearing.

The Submitter is correct in stating that the up-holes will be located on the seismic source lines; however, these lines will be cleared of vegetation to allow access. Source lines will be located on previous lines wherever possible. The Joint Venturers do not plan to clear receiver lines as has been conducted in the past.

As noted in the Draft EIS/ERMP, the monitoring program has yet to be designed, pending the results of ongoing geotechnical, geophysical and environmental investigations. However, the environmental impacts can be assessed as the Joint Venturers have committed to employing a program that:

- avoids bettong warrens
- avoids rock wallaby habitat
- avoids white-winged fairy wren nests
- avoids restricted structural habitats such as termite mounds, rocky ledges, caves and sink holes
- avoids restricted vegetated habitats
- prohibits clearing receiver lines
- prohibits grading of source lines
- prohibits vehicle access to dune areas.

Upholes will not require additional vegetation clearing, and will be similar in impact to the approved geotechnical programs conducted during 2004/05.

- 24.15** The environmental implications of using 4-C receivers below sea level (with the holes required for this receiver option) for a 3-D or 2-D survey programs, have not been addressed at either the individual program or the cumulative marine impact level.

The Gorgon Joint Venturers acknowledge that the environmental impacts of a full onshore 3-D seismic survey using 4 component (4-C) receivers has not been assessed.

On p 118 of the Draft EIS/ERMP (Chevron Australia 2005) it is stated that ‘the very large number of holes required makes this option impracticable for a full 3-D survey’. This is driven by the requirement to drill a hole to at least the top of the water table for each receiver. The Joint Venturers go on to state “the use of 4-C receivers ... may be required for a small portion of a 3-D survey where data quality is particularly poor”.

It is clearly the intent of the Joint Venturers to either not use 4-C receivers or to limit the use to the absolute minimum. If 4-C receivers are to be used, the impacts of such use would need to be assessed as part of the process for gaining approval for each particular survey.

The use of 4-C receivers in the shallow marine environment results in no greater impact on the environment over conventional receivers as the cables containing the receivers are essentially the same.

- 24.78** The vegetation of the area north of the Latitude Point, where the CO₂ injection and monitoring system is to be located, has not been mapped to the same level as the remainder of the development area. When will this be undertaken and how will the data inform this component of the project design?

The final locations of the CO₂ wells and monitoring grid are still under consideration. Vegetation surveys have been initiated and will continue after significant rainfall in 2006 to capture annual and ephemeral species. The area to be impacted will be mapped to the same level as the gas processing facility area to facilitate site selection that reduces impacts to restricted vegetation communities (and fauna).

6.2.5 CO₂ Monitoring Activities

- 18.53** It is recommended that a specific management plan be developed for 4D seismic programs, which includes full investigations of low impact alternatives.

A specific management plan will be prepared for the seismic program which will draw upon the information provided in Technical Appendix A1 (such as Sections 3.9 and 3.10) and Chapter 6, Section 6.2.5, p 115 of the Draft EIS/ERMP (Chevron Australia 2005).

- 22.31** Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – clearing, if any, related to CO₂ injection monitoring.

CO₂ monitoring is described in the Draft EIS/ERMP, Section 6.2.5 on p 115 and in Chapter 13. Clearing for CO₂ injection monitoring is described in Table 6.3 on p 126 of the Draft EIS/ERMP.

- 8.27** Section 6.2.5: There is mention of an ‘up-hole survey’ (involving 100–200 holes drilled to 30–50 m) that will be used to provide an accurate near surface model. What type of equipment will be used in drilling these holes?

The up-hole survey holes will be drilled with a small percussion drilling rig mounted on a four wheel drive vehicle. It is not anticipated that drilling fluids will be used in the drilling of the up-holes.

- 8.28** It should be clarified if holes drilled for the up-hole survey can be ‘re-used’ as shot holes for placing the explosive charges which may be required during seismic acquisition, this minimising the overall number of required drilling sites?

The up-holes will be used to site geophones below the surface of the earth. During an up-hole survey a small weight is dropped on the surface near the hole and the time measured for the shock wave to arrive at the geophone suspended below the surface.

In theory it would be possible to re-use up-holes for explosive charges if such an energy source was to be used as the main energy source for the seismic survey.

6.2.6 Domestic Gas Pipeline

22.146 The information provided about domestic gas pipeline alternatives is surprisingly scant. On what basis have two of the possible alternatives been “ruled out”? Why hasn’t the potential for HDD already been analysed? Why can’t Apache’s corridor be shared?

The two alternatives for the domestic gas export pipeline listed in Box 6.6 of the Draft EIS/ERMP were excluded primarily because they involved additional land take on Barrow Island, and an extra shore crossing. These options were considered feasible when the CO₂ injection site was proposed to be in the far north of the island and any additional land take for the domestic gas pipeline would be negligible. Moving the CO₂ injection site to immediately north of the gas processing facility meant that the additional land take and corridor to the north would only serve the domestic gas pipeline. A marine route for domestic gas export reduces overall land requirements on Barrow Island, whilst still achieving the objectives of the two options in question. Refer also to 8.5 Section 6.3.9 and 8.6 Section 6.3.9 regarding HDD and sharing of easements.

24.79 Vegetation mapping for the Domgas pipeline route on the mainland has only been preliminary. When will more detailed mapping as recommended in Appendix C1 be undertaken, and how will the data inform this component of the project design?

Vegetation surveys will be undertaken in this area in mid-2006. Detailed mapping of the mainland vegetation communities within and around the proposed area of impact will be used in final route selection.

24.132 Assessment of proposed pipeline routes to avoid and minimise BPPH loss/damage is also required to calculate cumulative losses for management units that the routes pass through. Demonstrating all options have been explored to avoid/minimise additional losses due to pipe line and optic fibre cable routes will be important, particularly for those management units where it is predicted that cumulative loss of BPPH is likely to exceed the CLTs due to the effects of dredging.

Pipeline routes are yet to be finalised. Opportunities to reduce impacts to BPPH, such as installing a conduit through the MOF and utilising the existing Apache Energy Sales Gas pipeline approach to the mainland are being appraised (Chevron Australia 2005; p 144). Domestic gas pipeline alternatives that have been considered are outlined in Box 6-6 (Chevron Australia 2005; p 119). A preliminary desktop study has identified a preferred alignment for the installation of the optical fibre cable. A detailed submarine route survey is yet to be undertaken. Possible routes for the optical fibre communications link are shown in Figure 6-18 (Chevron Australia 2005; p 139). Refer to 8.5 Section 6.3.9.

6.2.7 Water Supplies

18.45 Investigations for a potable water supply on Barrow Island require further assessment for the proposed Gorgon gas development. Use of groundwater for the reverse osmosis plant for supply of construction water is not supported due to the sensitive nature of the environment. Reverse osmosis water should be sourced offshore.

Refer to Draft EIS/ERMP, Box 6.9 in Ch 6, p 140 and submission 22.33 Section 6.3.7.

18.94 The abstraction of groundwater should be assessed as a potential risk factor for stygal communities.

In the Draft EIS/ERMP, Chapter 6, Box 6-9, the discussion on Water Supply Alternatives recognises the potential for impact to stygal communities. The protection of these communities will be included in the decision-making criteria for selecting the preferred water extraction alternative.

19.19	The Department is unable to comment on this aspect of the proposal at present and understands that the proponent is currently undertaking groundwater investigations. The Department requests the opportunity to make comment on the proposed water supply once sufficient information becomes available.
19.41	Groundwater extraction – this proposal to use a Tertiary aquifer as a primary water source is identified as needing careful management of the saltwater/freshwater interface. With no hydrogeological data provided, the Branch is unable to provide comment on this proposal. The groundwater investigation is still ongoing in November 2005, so the branch would be unable to provide comment on this until about 3 weeks after receiving the groundwater investigation and assessment report.
19.44	This Branch is not able to provide formal comment on the groundwater aspects of the Gorgon Gas project until supporting information is provided. Only after reviewing the report on the hydrogeological investigations will the Branch recommend controls and licence conditions related to groundwater protection and extraction

The first three water exploration wells are currently being drilled. Results will be made available to the relevant agencies (such as DoE and CALM) as soon as reasonably possible.

25.47	Three alternative potable water supply alternatives are being considered (it is stated it will be subject to a separate approval process)
	The proposed approach to supply water for activities on Barrow Island is described on pages 140–141 of the Draft EIS/ERMP. An Environmental Management Plan (EMP) has been compiled for the hydrogeological investigation program which includes drilling of the (150–250 m deep) water wells and associated testing. The EMP addresses the technical details of the drilling program (such as number of wells, depths, hole sizes, casing requirements, drilling fluid to be used, etc), as well as the environmental aspects of the program and proposed mitigation strategies. The EMP states ‘The extraction rates and design of the well(s) will ensure that the halocline (fresh water/salt water interface) remains stable, and the associated draw down will be minimised, so that any impact to the freshwater lens is avoided or minimal.’ The EMP has been accepted by DoIR. Should the fallback option of direct seawater suction be required, then it would require a pipeline to the ocean, because when this line would be first needed the MOF or jetty would not exist.

6.2.8 Drainage and Waste Water System

16.66	6.10 page 26 Executive Summary: drainage and waste water systems: The proposals to recycle waste water, divert water and treat contaminated waste water are commendable.
	Comment noted and appreciated.
18.42	Further information is required on the wastewater from the dehydration treatment of the gas, how it will be treated and how it will be disposed of if it cannot be reused in the treatment process.
24.99	If this ‘dehydration water’ can not be recycled, how will it be disposed of and what are the predicted environmental effects of its disposal to the receiving environment, if this option is pursued? The second part of this question should be answered in the context of the points listed above.

Dehydration water could potentially contain hydrocarbons and small particles of solid material (from the dehydration medium), as mentioned on p 108 of the Draft EIS/ERMP. If this water cannot be recycled in the process (because of these contaminants) it would be classified as ‘process water’, and so will be treated in the oily water system as described in Section 6.2.8 of the Draft EIS/ERMP.

19.01	Lack of information provided is in relation to critical design and capacity issues for the wastewater treatment plant. The level of detail provided within ERMP is that such a plant will be constructed. Additional information such as the effluent treatment method, a monitoring program (if required) along with information regarding the location, depth and construction of the wells to be used for wastewater disposal is not provided. This information is required for a detailed assessment by the DoE.
19.21	However, the DoE would need more information to adequately assess the deep injection proposal for wastewater disposal. Little design specific information is outlined in the ERMP regarding the proposal in relation to well construction and depth, the total volume of water and the different regimes of water production/disposal that the project will require.
19.24	Specific design information for the disposal technique and geological and hydrogeological data to support a suitably-designed system are required by the DoE before it could make a assessment of the feasibility of waste and greywater injection. This information is not available within the ERMP.
19.25	The Department would require sufficient information regarding the injection system, including a viable and environmentally acceptable alternative disposal method before it could undertake an assessment of this proposal
19.26	The Department also suggests that proponent should view the wastewater as a resource and treat it to an appropriate level that it can be utilised where possible and assist in maximising the water efficiency of the project
19.27	Should the brine from desalination to be disposed of into deep bores, the Department would require further information before it could assess this option. The receiving strata needs to be identified as part of the groundwater report, and the feasibility of reinjection needs to be justified technically. There is ambiguity in the ERMP in regard to this proposal, and it is possible that the receiving geological unit may be the same unit as the potential water source
19.42	Disposal of brine from desalination to deep bores – the EIS does not identify which strata the brine would be injected into. The receiving strata need to be identified as part of the groundwater report, and the feasibility of reinjection needs to be justified technically. There is ambiguity in this proposal, and the receiving geological unit may be the unit previously discussed as a potential water source
19.43	Reinjection of wastes and greywater – this proposal needs environmental licensing subject to a detailed technical analysis of the design. Since the EIS describes this as a potential disposal method, no detail is provided. This proposal cannot be assessed unless geological and hydrogeological data are provided to support a suitably-designed system
19.54	The LWQB question whether using ANZECC 2000 criteria will be adequate enough to protect subterranean biota?
22.32	Key issues not included in this draft EIS/ERMP, or not dealt with in sufficient detail, include: – disposal of waste water;
22.169	Injection being considered again! What is the total amount of waste water/liquid waste for which re-injection is contemplated? What geological work has been done on the capacity of the relevant aquifers to accommodate these amounts?
22.174	What other water/liquid disposals might be occurring at the same time in similar locations during construction? How have those potential cumulative impacts been dealt with, if at all?
24.23	Reuse or disposal of the treated effluent raises several issues: – what processes would be put in place to ensure that reused treated effluent would not lead to the application of nutrient rich water or water containing other contaminants (including introduced fauna), this adversely affecting (including enhancing normal growth regimes) surface and underground systems? – Information about the existing produced water disposal system or proposed deep wells is not adequate to enable a judgement about possible implications and acceptability.

24.183 How will the materials used to clean production systems during commissioning (eg. acid, caustic wash liquids) be disposed of?

25.49 Disposal of waste water is still under investigation.

The base case for disposal of contaminated water is deep well injection and is subject to discussion between WA Oil Joint Venture and the Gorgon Joint Venturers (Draft EIS/ERMP, Box 1.3, p 7). Deep well injection is consistent with the intent of the EPA Guidance Statement No 4 'Guidance for the Assessment of Environmental Factors – Deep and shallow well injection of liquid industrial waste' March 2003.

There are a number of existing WA Oil water injection wells on Barrow Island, which are currently being investigated to determine the feasibility of their use for the disposal of Gorgon waste water streams. These studies include investigation of the following:

- 1) scaling assessment of Gorgon waste water and Gorgon waste water when mixed with WA Oil produced water
- 2) materials and corrosion assessment of Gorgon waste water and Gorgon waste water when mixed with WA Oil produced water
- 3) reservoir souring assessment of Gorgon waste water and Gorgon waste water when mixed with WA Oil produced water
- 4) reservoir injectivity assessment (with respect to reservoir and water properties).

The optimum disposal concept will be able to be finalised following the completion of these studies. Should the use of the existing WA Oil water injection wells not prove feasible, then the Gorgon Joint Venturers may be required to drill new disposal wells or select an alternative disposal option.

It is considered that injection is feasible, however, in the relatively remote event that injection is infeasible and an alternative waste water disposal option is required, the Gorgon Joint Venturers will examine a number of technologies including ocean outfall. If the option of a waste water pipeline discharging to the marine environment is required, potential environmental impacts will be assessed and detailed management measures developed to reduce impacts to acceptable levels. These will be documented in the Environmental Management Plan issued to the relevant agencies for approval.

19.13 The Department considers that it is essential that the proposed facilities meet current DoE requirements which are more stringent and focused on environmental protection.

AS1940 (and similar standards) requires containment of tanks to be related to the containment of the largest tank in a compound, and not '110% of the total capacity of vessels within the area'. The containment bund will be impervious. Other appropriate aspects of the standards as well as other industry documents such as AIP 25 and AIP 4 will be employed as mentioned in the Draft EIS/ERMP Section 6.2.8 and Section 6.2.10. The Gorgon Joint Venturers are aware of the current work relating to bunding which DOCEP (Department of Consumer and Employment Protection) is involved in and will monitor the outcomes of those discussions.

19.14 Containment of environmentally hazardous liquids is seen as one of the most significant potential pollution issues arising from this project.

As mentioned in response 19.13 storage tanks will be bunded in accordance with Australian Standards. This covers not only hydrocarbons but the chemicals (such as aMDEA and MEG) and oily waste water. Also as mentioned in Chapter 16 and Technical Appendix A1 of the Draft EIS/ERMP, the Gorgon Joint Venturers will have in place an approved spill contingency plan.

19.22 During the construction phase, the project would require the wastewater treatment plant and deep well injection process have the capacity to deal with waste from an accommodation camp peaking at 3,300 personal [sic].

Correct – during the construction phase the waste water treatment facilities will be sized to suit the number of personnel.

19.23 In addition, during the construction phase, there would be a requirement for the deep well injection process to handle very large volumes of wastewater as a result of the hydrotesting of pipes. Although the proposal stated that this water “will be reused between services where practicable”, there still will be large volumes of contaminated hydrotest water that will need to be appropriately stored or disposed of.

Correct – hydrotest water will be re-used between services where practicable but that which cannot be re-used is intended to be injected deep beneath Barrow Island well away from stygofauna habitat, or via an ocean outfall.

Refer to 19.01 above in this section for additional details.

19.46 This draft EIS/ERMP is lacking in the technical detail and design which would be needed to assess the environmental impacts of the project. The Water Investigation and Assessment Branch will provide comment on the specifics of the Gorgon Gas proposal once the hydrogeological investigation is reported, and after the design criteria for the underground disposal systems are developed

Hydrogeological studies are included as one aspect in Box 6.9 (p 140) of the Draft EIS/ERMP. As the results of these studies become available they will be provided to DoE.

19.48 Given the above information, there is a high potential that any spill, leak or discharge of contaminating materials from storage and processing facilities will result in rapid migration to the underlying groundwater and potentially have a negative impact on soil and groundwater quality and any subterranean species that may be located within these habitat

All potential contaminated areas of the gas processing facility will be in predominantly paved areas. These areas have been defined according to the type of potential contaminants and have been segregated to allow collection of potentially contaminated run-off to be contained for testing to define level of contamination, necessary treatment (if any) and disposal requirements. All wastewater sources contaminated to a degree which is considered not acceptable for drainage to the natural environment will be disposed of by deep-well injection. Typical containment systems to be provided are as follows:

- Paved areas classified as subject to potential contamination will be segregated to allow drainage to a separate gravity flow sewer system discharging to a lined earthen containment pond. The underground piping and containment pond will be provided with suitable leak detection systems.
- All storage tanks containing potential contaminating materials (e.g. chemicals, hydrocarbons, contaminated wastewater) will be bunded to provide full containment of the contents.
- Process equipment containing significant volumes of contaminating material will be curbed/bunded to contain major spills and leaks of material.
- Where appropriate local low point sumps will be provided to contain run-off from equipment and areas where drainage to the potential contaminated sewer system is not practical.
- CVX Operations will develop and implement a spill containment and maintenance cleaning policy such that spills outside bunded or kerbed areas will be immediately treated; designated storage areas for spill kits etc have been identified in proposed building layout drawings.

All bunds and kerbed areas will be sealed during maintenance cleaning operations and any liquids or solids generated during these operations will be cleaned up and removed, no wash down waters or oils and greases shall be washed down the drainage system.

- Spills or leaks on unpaved areas from temporary or mobile equipment, transfer piping etc, (e.g. Construction equipment, road vehicles, pipeline connections) will be quickly identified and cleaned up in accordance formal written EMP procedures.

Refer also to 19.13 and 19.14.

19.50 6.2.8 Drainage and Waste Water System – The LWQB support the objectives of the waste water system to implement a tiered waste water management plan to maximise the reuse of water, and to protect soils, subterranean fauna, groundwater and the marine environment from contamination.

The support of the Land and Water Quality Branch for the design objectives is noted.

19.51 Direct water in areas that could be contaminated, but are usually considered to be relatively clean, to a holding basin for water quality testing before discharge. (Uncontaminated water will be discharged back to natural drainage areas, while contaminated water will be pumped to a treatment system).

19.52 Send water from areas that are expected to be contaminated (eg sumps and areas around pumps, turbines, etc) to an oil recovery system.

19.56 How will contaminated water be able to be separated from non-contaminated water? What if the water is contaminated with chemicals other than hydrocarbons, will this be able to be treated in an oil recovery system.

19.53 What are the criteria to determine contaminated or not contaminated “relatively clean” water? The EIS/ERMP states that appropriate water quality guidelines such as the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC 2001) will be used. Unfortunately these don’t exist, however Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC 2000) do. Unfortunately these guidelines are limited for the sampling of hydrocarbons and only deal with marine or freshwater receptors. This was a typographical error and should have read ‘2000’.

Clean areas will be drained separately from areas where spills may occur, so that the clean water can be discharged back to the natural environment as close as possible to where it would have drained prior to construction of the gas processing facility. Clean water from outside the site boundary will be directed around the site as much as possible. Areas which can potentially contain oil (in excess of discharge criteria) will be directed to a facility which can remove the oil (such as using a corrugated plate interceptor or similar technology). Chemicals which are water soluble cannot be removed in oil/water separation systems, and so areas in which a chemical spill can occur will be treated separately. Sampling procedures will be defined during the detailed engineering phase.

19.54 The LWQB question whether using ANZECC 2000 criteria will be adequate enough to protect subterranean biota?

As described in the Draft EIS/ERMP (p 120) the ‘... objective of the waste water system is to maximise the re-use of water, and to protect soils, subterranean fauna, groundwater and the marine environment from contamination’. In the context of waste water injection this refers to using deep injection (1000+ m) which is far below areas known to be inhabited by stygofauna. The ANZECC/ARMCANZ 2000 Water Quality Guidelines have been designed to provide an authoritative guide for setting water quality objectives required to sustain future environmental values [uses] for natural and semi-natural water resources in Australia and New Zealand. These criteria are based on minimising effects to aquatic organisms including invertebrates and vertebrates. The guidelines are conservative and are intended to provide protection for a broad range of taxonomic groups. They provide a sound set of tools for assessing and managing ambient water quality in natural and semi-natural water resources.

19.55 Analysis of sampling results often takes at least 2–3 weeks what happens if more water enters the system in that time.

Consistent with industry practice, the gas processing facility will have its own laboratory staffed with trained laboratory professionals who will significantly reduce turn around time for sample analyses thus enabling prompt action to be taken.

6.2.9 Port and Marine Facilities

5.7	Little is known how the solid causeway which leads to the pier to feed the liquid gas to the ships. Solid structures will effect beach alignments.
15.7	The proposed construction of a solid structured causeway is likely to have greater impacts on natural sedimentation processes than an open structure. If the jetty was extended instead, it would reduce the impact on conservation values of marine conservation reserves from the dredging activities in the LNG shipping Channel.
18.12	The proposed construction of a solid structured causeway is likely to have greater impacts on natural sedimentation processes than that of an open structure.
18.52	CALM's preference is for the development of an open jetty structure as an alternative to the proposed solid rock causeway from Town Point to the Materials Offloading Facility. Consideration must be given by the proponent to the development of an open jetty structure, taking into account the environmental impacts of each option. If the solid rock causeway option is favoured by the proponent, justification must be provided as to why an open structure is not preferred.
22.148	Much more information on alternatives to the causeway/MOF contemplated is needed here. While a causeway may reduce dredging it is likely to have major impacts on the long shore drift on the eastern side of the Island, which could simply erode away the beaches used by high numbers of flatbacks.
22.149	The Submitters' view is that a jetty is far superior to a causeway – and if such a jetty could not be made strong enough for use in connection with a MOF, then a land-based MOF should be preferred.
25.21	The basis for selection of the base case causeway/jetty structure over the alternative structures needs greater explanation. The engineering, economic and environmental advantages and disadvantages of each alternative need more explanation than that currently in the draft EIS/ERMP (on page 123).
25.23	Alternative structures, such as a causeway with one or more bridged gaps along its length to allow nearshore water flow along the coast, should be considered. Such a configuration could perhaps reduce the risk of “surging” and present a more natural ambience to approaching would-be nesting turtles.
25.53	Consideration of alternatives to an 800 m solid rock causeway

Field investigations indicate a broad inter tidal reef extending approximately 1 km offshore at Town Point and the coves either side of Town Point contain rock rubble. A review of historical aerial photographs found no evidence to suggest sand movement at Town Point. Modelling of this environment found that the rock platform in front of the beach was responsible for breaking and dissipating wave energy before the wave reached the shoreline. This low energy environment combined with the lack of sand on the rock platform was responsible for the stable environment. The causeway will not result in an increase in the wave energy or an increase the availability of sand to be transported.

Severe cyclonic events may have an impact on this area with or without a causeway. However, aerial photographs indicate the beach alignment in this region has not changed significantly in the period which included major cyclones Bobby 1995, Olivia 1996 or Vance 1999 (refer Section 11.2 of the Draft EIS/ERMP, pp 407 and 408). The MOF and associated causeway is required to deliver the construction material and equipment to site. The design envelope for modules is approximately 30 m wide and up to 5000 t. Although not impossible, it is impractical to construct a 1 km jetty to accommodate such loads. It would also be extremely difficult to drill these piles into the rock shelf in this shallow region. The LNG jetty is only required to carry small mobile cranes and support the export pipes and is therefore suited to an open piled structure. The starting point for the LNG export jetty has been determined by the geotechnical and metocean conditions.

22.151 Why has a sub sea cryogenic line been simply “ruled out”? It may be ‘unproven’, but so is geosequestration!

Since the release of the Draft EIS/ERMP, specialist advice from the design contractor has resulted in the subsea cryogenic line being re-examined as a loadout option. Refer also 8.8 Section 6.3.8.

23.8 While it is noted that the documentation notes other alternatives (such as a longer jetty structure), it is not clear that these options have been seriously considered from the environmental perspective. Recommendation: Alternative dredging techniques that can improve dredge plume outcomes need to be developed.

The base case short-jetty option is based on proven technology and the amount of material proposed to be dredged and disposed of at the spoil ground has been reduced through the development of a long causeway concept in conjunction with the MOF, with the dredged material to be used to fill the MOF. Jetty alternatives are discussed in the Draft EIS/ERMP (Chevron Australia 2005; p 123), as is the overall amount of dredging required for each concept. The short-jetty concept, in association with management measures, engenders a medium level of risk to benthic primary producers and marine fauna. The Gorgon Joint Venturers continue to look for technical and economical solutions to load tankers and reduce the impacts of dredging.

24.180 On page 122 it is stated that “The details of the MOF specification will be reviewed with respect to module and equipment sizes determined as the design proceeds, however the basic concept will not change”.

If the design is not final, is it possible that revisions of the design may lead to increased causeway footprint and/or increased dredge volumes and therefore dredging times? If so, how will these fundamental changes and the associated impact prediction and management be articulated and assessed during the assessment of the proposal?

The layout of the MOF dredging has been finalised as per Part A. There will not be any significant variations from the concept presented. The MOF width may vary slightly however this will not change the assessment of the environmental impacts associated with it.

25.24 Further detail is requested on the extent of proposed activities, such as the expected shipping traffic (vessels and types per week, locations) during construction and operation and the expected vehicular traffic (vehicles and types per day) along the causeway and jetty during construction and operation.

Further detail is requested on the extent of proposed activities, such as the expected shipping traffic (vessels and types per week, locations) during construction and operation and the expected vehicular traffic (vehicles and types per day) along the causeway and jetty during construction and operation.

A number of support vessels will be used in the construction activities for both upstream and downstream. On the west of the island, specialised vessels associated with the construction of the subsea component include: heavy lift vessels, offshore drilling rig, anchor handling vessel, barges or pipe feeder vessels, rock dumping vessels and support vessels. Many of the vessels, such as drilling rigs and anchor handling vessels will remain in the field for up to 2 years. Individual supply vessels may make regular supply trips every 2 – 4 weeks.

Construction of the causeway, Materials Offloading Facility (MOF); LNG jetty, access channel and turning basin off the east coast of the island will require a range of vessels including: offshore installation vessels, tugs, support vessels and supply barges.

Construction of the MOF may require in the order of 1000 supply runs to the mainland over the construction period; while construction of the LNG jetty may require in the order of 60 such runs.

A dredge will operate on the east coast of Barrow Island over a 15-month period. It is expected that disposal of dredge spoil will require approximately 2000 return trips to the disposal site during the dredging program.

Onshore works will commence once the MOF is operational with heavy lift ships and module delivery vessels delivering major plant equipment. It is anticipated that around 50 such voyages will be required. In addition, supply vessels and barges will deliver containerised, bulk and loose cargo daily.

Environmental management measures for vessel movements and activities will be incorporated in detailed Environmental Management Plans.

6.2.10 Supporting Facilities

15.5 The proposed siting of administration buildings and support facilities within the development area does not take advantage of previously disturbed areas and occurs on the coast where development will probably increase effects of light emissions on the flatback turtle rookery. The proponent should be required to properly consider this option. These examples demonstrate that the proponent has not adequately investigated and adopted measures for minimising all impacts to biodiversity conservation on Barrow Island.

Refer to Part A for the final location of the administration and support facilities. The use of existing cleared land, such as existing roads and seismic lines, and light spill onto beaches are both factored into the analyses of the alternative sites. The Gorgon Joint Venturers have committed to manage lighting through design, construction and operation and to seek advice from CALM on such lighting. The administration area will be designed with these protection measures in mind, such as it is currently proposed that all external windows are fitted with electrically operated steel roller shutters that will provide cyclone protection and a barrier to light emission. All EMPs will be written to mitigate light as a stressor – refer Technical Appendix A1, Section 3.12 of the Draft EIS/ERMP.

18.13 The proposed siting of administration buildings and support facilities within the development area does not take advantage of previously disturbed areas and occurs on the coast which will probably increase light emissions on the flatback turtle rookery.

18.39 Supporting facilities for the proposed development must be located in areas that will minimise impacts on biodiversity conservation values, including moving facilities inland to minimise the impacts of light emissions on the coast.

The proposed siting of the administration buildings can not take advantage of previously disturbed areas and maintain its contiguous relationship with the gas processing facility. Its location needs to be sufficiently close to the facility for optimal access and control, but sufficiently remote from the significant blast pressure zone. Commitments in relation to light management are outlined in Draft EIS/ERMP Executive Summary, p 115, and proposed management measures included in Section 3.12 of the Framework EMP (Technical Appendix A1). Overall light management is also discussed in response to submission 18.140 Section 7.3.

19.57 More information is required as to what measures will be initiated to protect piping. Will the pipes be contained and what measures will be in place if a pipe ruptures?

The LWQB recommend as a minimum all pipes should be above ground and have secondary containment and all refuelling areas are fully bunded. In addition a spill management plan dealing with surface and sub-surface spills should be produced and associated equipment should be located on the island so it can be readily accessed in the event of a spill.

The majority of piping will contain natural gas, or LNG not oil. Piping will be designed and protected in accordance with Australian Standards, such as AS2885. If a pipe ruptures, then it would be shutdown as quickly as possible and the Oil Spill Contingency Plan (Technical Appendix A1, Section 3.19) activated. The Australian Institute of Petroleum <www.aip.com.au> Codes of Practice <http://ecom.aip.com.au/index.php?t=publist#cat_9> such as CP4 and CP25 will also be used as relevant (refer Draft EIS/ERMP, Section 6.2.8 and Section 6.2.10) in the design and operation of the facilities. Refuelling areas will be designed and operated in line with AS1940 as a minimum.

19.58 As the system will be temporary, the LWQB is concerned that there is an increased likelihood of leaks and spills during this phase of the operation and a designated fuel storage and dispensing with appropriate containment measures should instead be installed to minimise use of temporary systems.

The Draft EIS/ERMP, Section 6.2.10, p 124 states 'The diesel will be stored in an above-ground tank, bunded to Australian Standard AS1940' and 'A bunded area will also be provided for vehicle refuelling and all diesel day-tanks.' Spill Contingency is discussed in the Framework EMP, Technical Appendix A1, Section 3.19 of the Draft EIS/ERMP. AS1940 has recently been updated to a 2004 revision and in that Section 5.9 refers to specific requirements for self-bunded tanks, while Section 7 (especially 7.3.2) refers to refuelling area requirements.

22.28 Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – the location of the construction village, administration building and related facilities.

The Joint Venturers plan to establish the construction village at the preferred location, 2.5 km south of the gas processing facility site. This option has been selected because it has the lowest net environmental impact and provides the optimum solution for early land based accommodation of the Development workforce – refer also to 18.38 Section 6.3.6 and 22.152 Section 6.2.10.

22.152 Why has it not been clarified where the administration and maintenance facilities are proposed to be located? More importantly, why is there no clear proposal for the location of accommodation facilities large enough to house the peak Island presence of 3,300 extra people (above and beyond the oil operation's much smaller team)?

The operations centre has been relocated to the Administration and Maintenance area, outside the gas processing facility boundary. As a safety measure, all of these facilities will be located beyond the modelled influence of significant blast pressures of a potential explosion and will avoid the need for the structural design to meet blast resistant standards. The operations centre will be united with the administration centre to form a multifunctional operations centre at a location south of the proposed gas processing facility. The final location will be decided in FEED, but will be south of the gas processing facility, adjacent to the existing road alignment, connecting the terminal tanks and Chevron camp. The distance from the plant will be determined by blast pressure modelling. Refer to 18.38 Section 6.3.6 for details on the construction village.

22.162 What would be the environmental consequences of such a proposal as against, among other factors, the emissions associated with the prospect of flying out most of the workforce in the lead up to the storm?

All construction village buildings will be designed to comply with Australian Standard AS1170, part 2 and as such will be capable of sustaining cyclonic wind forces. The Joint Venturers do not expect to lose the availability of camp assets due to cyclone damage. The reliability of services and utilities should ensure that all buildings are habitable after a cyclonic event. A cyclone strategy has not yet been finalised however a range of options are being investigated.

24.19 It is assumed that the estimated land use in Table 6-3 includes clearing for the realignment and/or widening of roads (see 6.2.10).

Road modifications associated with the Gorgon Development (which require new land take of undisturbed areas) are included in land take. Also refer to 16.71 Section 6.3.6.

24.20 Where additional clearing or land is required for activities listed in 6.2.10 or other activities associated with integration between the Gorgon proposal and WA Oil operations, will these be addressed as part of the Gorgon development, and covered under the *Barrow Island Act*, or will they be dealt with under the WA Oil licence? What are the criteria that will be applied to determine which of these two regulatory controls apply?

Activities which require land clearing and which are directly associated with the Gorgon Development will be included in the 300 ha allocated under the Barrow Island Act. Refer to 24.19 directly above and 24.7 Section 1.2.

24.34 The reference to the location of the camp accommodating the operational workforce is very unclear.
– Is there any intention to locate this workforce outside of the existing WA Oil camp, and
– if so, where and what impacts would that generate?

The operational workforce will be accommodated in new structures built specifically for the Gorgon Development operators. The location of these buildings will be at one of the following locations: 1) Within the existing Chevron operations camp; 2) within the construction village boundary; or 3) adjacent to the construction village site (but within the 300 ha limit). Factors that will decide the final location include infrastructure sharing agreements, current and future construction accommodation requirements and predicted operational room numbers. A decision on location will be taken later during FEED. All options will rely on infrastructure developed for the Gorgon Development, including power, water, sewage, and communications.

25.48 Location of the construction camp has yet to be determined (the ERMP states four priority sites remain to undergo detailed ecological study)

A site for the construction village was selected after extensive evaluation of the range of available sites indicated in the Draft EIS/ERMP, including the old airstrip site. The Joint Venturers propose to establish the construction village at a site approximately 2.6 km south-west of the gas processing facility and approximately 800 m west from the nearest accommodation building at the existing Chevron operations camp. The site is a combination of locations CVX1 and CVX2 nominated in the Draft EIS/ERMP. The environmental, social and economic factors applicable to this selection provide greater benefits than the base case (gas processing facility) site. As noted in Part A of this document, detailed flora and fauna surveys have been undertaken within the site of the proposed village and a surrounding buffer zone during the peak period of the year for such surveys. This has confirmed that the biodiversity and environmental factors prevailing on that site are equal to or of lower conservation significance to the base case (gas processing facility) site. Factors considered in this decision are listed in 22.165 Section 6.3.6 Details of the applicable environmental impact assessment are included in Part A.

6.2.11 Mainland Supply Base

24.18 It is noted that a separate approval will be sought should a new supply base (outside of the existing King Bay infrastructure) be required.

Refer to 22.134 Section 4.2. Approvals associated with a mainland supply base are outside the scope of the Draft EIS/ERMP for the proposed Gorgon Development.

22.154 Given that page 125 says that these matters are yet to be decided, what is this a representation of? How much new clearing is entailed? How much hydrological modification of mangroves is possible?

Figure 6.11 of the Draft EIS/ERMP is a photo of the existing facilities in the Karratha area which form the basis for providing material support in the Pilbara region. Also refer 22.134 Section 4.2.

25.27 It would probably also be wise to consider in the EIS the potential likely impacts associated with the construction and transport of parts of the proposed prefabricated structures required to construct the LNG plant and other facilities.

The Gorgon EIS/ERMP Scoping Document recognises that “Any new, expanded or modified facilities (on the mainland) will be approved through existing statutory processes, including environmental impact assessment, as required.” (Scoping Document Section 2.6).

25.26 It will be important in the EIS to address the location and likely impacts, particularly in terms of NES matters, of any part of the Gorgon proposal that, even if the main activities were to be located on Barrow Island, would be located elsewhere, including any onshore facilities or activities on the mainland.

Components of the proposal that have the capacity to affect matters of NES or Commonwealth marine areas are addressed in the Draft EIS/ERMP (Chevron 2005). For example the impacts of the offshore wells and pipelines are included in the marine risk assessment, summarised in Tables 11-12 and 11-23. Refer also to 25.27.

6.2.12 Estimated Land Use

12.8 The proposed construction period on Barrow is estimated at 3 1/2 years with a total of 3,300 people on Barrow at its peak (Exec Summary p.10). The large number of people working on the island has the potential to dramatically increase the use of existing tracks, create a proliferation of new tracks, and spread weeds and pests.

The gas processing operations on Barrow Island covers no more than 300 ha, only 1.3% of Barrow Island’s total land mass. Any new access tracks for the Gorgon Development will be included in the 300 ha. There will be an increase in traffic on existing tracks and roads. This will be managed in accordance with the existing procedures on Barrow Island governing training, speed restrictions, off road access etc. The Gorgon quarantine management system aims to continue protecting the plants and animals on and around Barrow Island. The focus is on preventing introduced species from getting to Barrow Island through pathways such as food, personnel and luggage and materials such as sand and aggregate. Detection and response strategies will also be in place to prevent the establishment of any introduced species in the native environment. Workforce management is also addressed in Technical Appendix A1, Section 3.1 of the Draft EIS/ERMP.

6.3 Construction Activities

6.3.1 Construction of Offshore Wells

No submissions received on this section of the Draft EIS/ERMP.

6.3.2 Construction of Onshore CO₂ Injection Wells

18.55 All areas impacted by seismic acquisition should be included within the 300 hectare clearing limit.

All clearing associated with seismic monitoring will be included in the 300 ha. Refer to Table 6.3 p 126 of the Draft EIS/ERMP.

6.3.3 Construction and Installation of Subsea Systems

No submissions received on this section of the Draft EIS/ERMP.

6.3.4 Construction of the Feed Gas Pipeline

18.117 Further detail should be provided on the spatial and temporal extent to which bentonite clay will remain in the marine environment, and the impacts of this on benthic primary producer habitats and all ecological values in the marine conservation reserves.

Modelling of the behaviour of bentonite discharges were based on a very conservative assumption that all drilling fluids would be released to the seabed. Refer to 22.25 Section 6.3.4.

20.21 WWF-Australia notes that the nesting population of green turtles on the west coast of Barrow Island is regionally significant and that impacts on this population have not been fully evaluated. The Proposed shore crossing and onshore feed gas pipeline option at Flacourt Bay should therefore be avoided.

The shore crossing location can now be confirmed as North White's Beach (refer to Section 6.3.4 of the Draft EIS/ERMP and Part A).

22.25 Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – the western shore crossing of the feed gas pipeline (mentioned above).

18.103 From Fig. 7.5 Technical Appendix B-6, modelling has produced a visible plume extending across a substantial area of the marine management area and marine park. Information on the temporal extent of this plume is required before CALM can assess the impact of this on all the ecological values within the marine park and marine management area.

The alternatives considered for the shore crossing for the feed gas pipelines is discussed in Chapter 3 of the Draft EIS/ERMP, while the proposed technique for construction of the feed gas pipelines is discussed in Section 6.3.4 and Section 6.3.5. The Jansz pipeline will share the same corridor as the Gorgon pipeline. The shore crossing construction will be undertaken in parallel as shown in Figure 6.14. Also refer to 22.63 Section 1.2.4. The onshore HDD site is expected to be approximately 80 m x 110 m and will include:

- HDD drilling rig and power pack
- Control cabin
- Drill pipe rack
- Mud mixing and recycling unit
- Triplex mud pump
- Workshop and stores
- Office and canteen.

Careful consideration will be given to placement of HDD equipment within the location to minimise vehicle and equipment movements and noise and light emissions. The HDD site will be located approximately 100 m from the high water level in the inter-dune area and has been carefully selected to minimise the impact on dunes and foreshore vegetation. Intermittent dunes further assist the shielding of light and noise by partially obscuring the site from the beach.

Eight parallel lines will be drilled using HDD, one for each pipeline at a separation of between 5 m and 10 m at the entry point widening to 15 m at the exit location.

The first phase of each hole is when the HDD rig drills the pilot hole (nominally 300 mm) from the shore location to exit on the seabed, which will be approximately 480 m. A marine vessel may be used to pick up the drill string, remove the motor and steering assembly and replace it with a larger diameter-reaming bit. The onshore rig pulls the bit back through thereby enlarging the hole diameter. The hole will be enlarged with successive passes of progressively larger reaming tools so it is 25–40% larger than the diameter of the pipeline to be inserted.

A biodegradable saltwater polymer drilling fluid is being considered to be used for hole stability, hole cleaning and providing lubrication. The fluid will be used in a closed loop circuit where the returns are separated from the suspended cuttings and pumped back down the drill string and re-circulated through the hole, thereby minimising the volume of fluid required.

The cuttings are separated from the fluid by passing the returns through series of screens. The cuttings will then be disposed of as fill. The volume of cutting is expected to be significantly less than the hole volume due to natural losses to the formation during drilling operations.

The drilling fluid will remain in the hole until the pipe is inserted (a small amount is expected to be discharged when the drill breaks through to the seabed). When the pipe is inserted, it will displace its volume of fluid from the hole, which will be discharged at the entry and exit points. The fluid discharged at the entry point will be contained and re-used for subsequent holes. Any excess fluid at the completion of the operation will be used to fill the annulus between the pipe and the hole.

Hydrodynamic modelling of sediment discharges was undertaken with a summary of results presented in Chapter 7 and assessed in Chapter 11 of the Draft EIS/ERMP. This modelling predicted that using polymer fluids (best case scenario), moderate impacts from HDD are generally restricted to within 100 m of the higher impact zone and allow for dispersal of drilling fluids and cuttings.

The recommended fluid biodegrades within 48 hours. Refer to 24.128 Section 11.4 for further information on the toxicity of the proposed drilling fluid.

Further details on the western shore crossing of the feed gas pipeline will be included in the EMP for the shore crossing.

22.157 More information is required on the alternatives available for cuttings disposal so that this issue may be assessed properly.

Details will be provided in the Environmental Management Plan which is mentioned in the Draft EIS/ERMP, Technical Appendix A1 and Section 3.2. This submission relates to offshore and CO₂ well drilling not HDD (p 127); however disposal of HDD drilling fluid and cuttings is discussed in Submission 22.25 Section 6.3.4.

22.158 Will shore crossing work avoid key turtle nesting times?

Shore crossing construction activities will extend for approximately 12 months, with 3–5 months associated with the HDD operation (Chevron Australia 2005; p 130). Activities are expected to run for 24 hours per day; however, where practical, construction activities will be scheduled for daylight hours to reduce disturbance. Also, where possible, the peak drilling activity will be scheduled to limit coincidence with the peak turtle breeding season.

22.180 No onshore or near shore construction activities should occur during turtle nesting season.

22.267 There should be no onshore or near shore feed gas construction activities during turtle nesting season.

The Joint Venturers will endeavour to ensure that any nearshore and beach activities are scheduled for outside this period where practical. As a result of additional investigations undertaken during the FEED process, the Joint Venturers have moved the North White's Beach shore crossing site further north by 450 m. The new location offers reduced overall environmental impacts (such as clearing, disturbance, and pipeline right of way) and also provides a barrier via the immediate rocky ledge, which makes it an unsuitable site for turtle nesting. The HDD site is located inland from the beach; it is approximately 500 m away from the area where turtles nest, and is partially obscured from the beach by intermittent dunes. Therefore the impacts of any HDD operations are expected to be minimal.

24.76 It is assumed that Figure 6 (Appendix B6) relates to the sites identified in Figure 5, and likewise Figure 8 with Figure 7 – the descriptions beneath Figures 6 and 8 do not state this.

Yes – this is quoted on Figures 5 and 7 of Appendix B6 of the Draft EIS/ERMP.

25.51 The selection of above ground installation for the onshore feed gas pipeline should be substantiated by assessment of all environmental implications

Following a detailed assessment of the environmental, safety, geotechnical, construction and technical considerations, the Joint Venturers have selected the option to install the feed gas pipelines below ground. The basis for this decision is summarised as follows:

- More detailed interpretation of the geotechnical data indicates that burying of the pipe can be achieved by trenching rather than drilling and blasting.
- Bedding material will not need to be imported to the island which alleviates initial concerns over quarantining of imported fill. The above ground construction would have a much higher quarantine burden mainly associated with the pipe supports.

Also refer to Part A of this document.

- The extent of vegetation clearing can be reduced by trenching.
- The buried pipeline would not affect flora or fauna by providing shade or water or act as a barrier to fauna movement.
- The pipeline ROW could be rehabilitated directly following installation; whereas the above-ground construction would be redisturbed at the end of field life when the pipe and supports are removed (the buried pipe would be left in place). Refer also to 22.37 Section 8.3.1 regarding decommissioning.
- The maintenance and inspection requirements of a buried pipeline have advantages over an above ground pipeline.
- The cyclone and fire implications for an above-ground pipe can be avoided with a buried pipeline. An above-ground pipeline is more likely to be affected which could lead to plant downtime (particularly with umbilical repairs).
- The safety risk associated with vehicle movements alongside the above-ground pipeline can be avoided by burying it.
- Given the additional information obtained and the investigations undertaken since the Draft EIS/ERMP was published, it is believed that the environmental impact of a buried pipeline would be equivalent to, or less than, that of an above-ground pipeline.

6.3.5 Construction of the Onshore Feed Gas Pipelines

8.4 Section 6.3.5 identifies that the onshore feed pipeline easement will be 30 m but will be reduced where practicable during the design stage. Many recent pipeline projects have installed trench pipelines with easement of less than 30 m. Detailed explanation will be required within construction EMPs to identify the need for the required easement width and outline efforts to reduce the easement width as far as practicable.

22.159 We understand that an easement of 30 m is quite broad. GJV should be required to commit to a narrower corridor.

The 30 m easement width presented in the Draft EIS/ERMP is inclusive of the initial installation of two feed gas pipelines (and associated auxiliary lines) and allows for another two feed pipeline bundles in the future. It is anticipated that the initial development will require an easement width of up to 20 m. Whilst some trenched pipelines may be constructed with easement widths less than 30 m, these are typically single and smaller diameter pipelines, not multiple and large diameter pipeline installations as will be the case for the Gorgon Development.

The Joint Venturers are committed to reducing the pipeline easement width where practicable and extensive work is currently being performed during the design phase towards this goal. Further details of the required easement width and the efforts made to reduce the easement width as far as practicable will be provided within the onshore pipeline construction EMP.

17.4 It is our understanding that it is intended for the feed-gas and Dom-gas pipelines to be above ground on the island however this is not in accordance with the requirements of AS2885.1-1997 Pipelines – Gas and liquid petroleum – Design and Construction. This issue is not mentioned in the documentation provided but must be addressed early in the FEED process.

Following a detailed assessment of the environmental, safety, geotechnical, construction and technical considerations, the Joint Venturers are now proposing to bury the onshore feed gas pipelines. This decision was made because of the following reasons:

- The geotechnical considerations of the site will allow for trenching rather than blasting. The additional information now available shows that the quantity of blasting required has significantly reduced from first indications and it may be possible to eliminate blasting all together.
- Bedding material would not need to be imported to the island as suitable material would be won from the trench by the trenching machine.
- The extent of vegetation clearing could be reduced by trenching.
- The buried pipeline would not affect flora or fauna by providing shade or water or act as a barrier to fauna movement.
- The pipeline ROW could be rehabilitated following installation. Rehabilitation could commence soon after the pipelines are installed, and so could be fully rehabilitated in the life of the development. Refer also to 22.37 regarding decommissioning.
- The maintenance and inspection requirements of a buried pipeline would be less than that of an above ground pipeline.

Given the additional information obtained and investigations undertaken since the Draft EIS/ERMP was published, it is believed that the environmental impact of a buried pipeline would be equivalent to, or less than that, of an above ground pipeline.

Detailed investigations in regard to the design and location of the domestic gas pipeline on Barrow Island will be undertaken in a similar manner.

18.49 The decision on the best configuration for installing the onshore feed gas pipeline on Barrow Island should be based on a thorough environmental assessment that investigates the full range of environmental impacts and issues related to each of the three onshore pipeline options.

Following a detailed assessment of the environmental, safety, geotechnical, construction and technical considerations, the Joint Venturers propose to install the feed gas pipelines below ground. The basis for this decision is summarised as follows:

- More detailed interpretation of the geotechnical data indicates that burying of the pipe can be achieved by trenching rather than drilling and blasting.
- Bedding material will not need to be imported to the island which alleviates initial concerns over quarantining of imported fill. The above ground construction would have a much higher quarantine burden mainly associated with the pipe supports.
- The extent of vegetation clearing can be reduced by trenching.
- The buried pipeline would not affect flora or fauna by providing shade or water or act as a barrier to fauna movement.
- The pipeline ROW could be rehabilitated directly following installation; whereas the above ground construction would be redisturbed at the end of field life when the pipe and supports are removed (the buried pipe would be left in place). Refer also to 22.37 regarding decommissioning.

- The maintenance and inspection requirements of a buried pipeline would be far less onerous than that of an above ground pipeline.
- The cyclone and fire implications for an above ground pipe can be avoided by burying the pipeline. An above-ground pipeline is more likely to be affected which could lead to plant downtime (particularly with umbilical repairs).
- The safety risk associated with vehicle movements along side an above-ground pipeline can be avoided by burying the pipeline.

Given the additional information obtained and the investigations undertaken since the Draft EIS/ERMP was published, it is believed that the environmental impact of a buried pipeline would be equivalent to, or less than that, of an above ground pipeline.

22.136 The Submitters also note that while open trenches are a potential risk to native fauna they by no means rule out trenching of pipelines, especially when compared to the prospect of a (at least partially) rehabilitated pipeline corridor in the longer term.

The Gorgon Joint Venturers acknowledge the comment regarding open trenches and fauna, but both options (above- and below-ground) will have components which require such protection. This is one input to the decision regarding above and below ground pipelines. Please also refer to 18.49 Section 6.3.5 and 22.25 Section 6.3.4.

6.3.6 Construction of the Gas Processing Facility and Infrastructure

Airport

4.21 Airport. If larger aircraft are to be used to transport workers to the island, as has been discussed, a longer runway seems to be needed. This will probably require a completely new alignment, as with the current runway aircraft will approach and depart overhead the proposed gas plant. A new, longer runway will have a significant impact on the island and should be adjusted to detailed environmental impact assessment.

5.5 Is the airport expansion included in the 300 ha?

18.51 Information should be provided on the proposed upgrade to the existing airport on Barrow Island, to allow a full assessment of this aspect of the proposal.

22.34 Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – the expansion of the airport.

24.22 Little information is provided about the nature, extent and implications on environmental values of the further development (runway extensions, realignment of the runway, or extension of the terminal facilities). This should be described, to address cumulative impacts on Barrow Island associated with the proposal.

25.52 Requirements for airport upgrading are not detailed

The installation of the gas processing facility and associated equipment will require declaration of a Danger Area in the air space above with an approximate dimension of 1.0 to 1.5 nautical mile radius centred on the plant flare. Modelling of the gas and heat emissions from the gas processing facility are being progressed to input into a risk assessment for finalisation of the lateral and vertical dimensions of the Danger Area. As a result of a series of discussions held between the Joint Venturers, Civil Aviation Safety Authority and representatives from Qantas, National Jet and Bristow (the operator of Barrow Island airport), it is considered that the airstrip in its existing alignment, with modified operational measures and the use of on-board navigation and auto-flight capabilities, will enable the safe landing and take-off for the range of aircraft types anticipated to utilise the airport.

An extension of the airstrip to the south is being considered by the Joint Venturers to provide a longer runway length for landing larger passenger capacity aircraft (B737 or equivalent). This would be undertaken in conjunction with an upgrade of the airstrip/apron, taxiway and aircraft parking areas and an expansion of existing terminal facilities. A survey of the potential runway extension area shows no Declared Rare Flora, priority species or species with restricted distributions at this proposed location. Also refer to Part A of this document for further discussion

22.132 A possible upgrade to the current airport on Barrow Island is mentioned here without further discussion elsewhere in the document. This possibility, including any related road upgrades (if any), should be addressed in the final EIS/ERMP.

Refer to 4.21 above in this section. Road upgrades are addressed in Submission 16.71 Section 6.3.5.

Pioneer Camp and Construction Village

14.21	The Conservation Commission recommends that additional and sufficient detail on the Pioneer Camp should be provided to inform the corresponding approval processes. These processes should be provided for consultation with CALM and the Commission and require that all relevant quarantine barriers are in place before the commencement of the works.
18.37	The construction of a pioneer camp to accommodate an additional 250 personnel on Barrow Island should have been included as part of the formal ERMP assessment for the proposed Gorgon gas development. The pioneer camp construction should be subject to a thorough environmental assessment and its impacts considered in combination with the ERMP in order to assess cumulative impacts.
20.44	WWF-Australia notes that Gorgon proposes to construct a 'pioneer camp' before environmental approvals are provided. This construction appears to be subject to a separate approval process (p. 134). This is of great concern as it would obviate a significant part of the EIS/ERMP process. Either construction of the camp should not be permitted until after environmental approvals are granted and full quarantine procedures are in place, or the camp construction should have its own EIS, including public consultation.
22.27	Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – the location of the pioneer village.
22.160	A pioneer camp for 250 people is referred to in the draft EIS/ERMP, yet no information is supplied about where the proposed clearing might take place, what biodiversity is there now, and what will be required in terms of water, waste and the like.
22.161	It is unacceptable that an integral aspect of the proposal, which is presumably planned for the earlier stages of implementation (as the word 'pioneer' suggests), is split off from the main proposal for environmental impact assessment. This approach is explained, incredibly, by reference to the apparent need to commence that work while the EIS/ERMP is being assessed. If that is the case why have we not seen separate State and Commonwealth environmental referrals for this proposed camp?
24.21	What progress has been made to determine the location(s) of the pioneer camp and also construction village, and the comparison to demonstrate 'equal or reduced environmental impact, social and economic factors'?

The Joint Venturers have been able to revise construction scheduling to avoid the need for a pioneer camp. Work on the construction village will not commence until the Gorgon Joint Venturers have received environmental approval from both state and Commonwealth ministers.

18.38 The options for the location of the construction camp must be properly assessed in terms of environmental impacts, and the location selected must have minimal impacts on biodiversity values. The old airstrip, being previously disturbed, should be considered for locating the construction camp, and data should be provided by Chevron Australia to justify why this option would not be pursued.

24.21 What progress has been made to determine the location(s) of the pioneer camp and also construction village, and the comparison to demonstrate 'equal or reduced environmental impact, social and economic factors'?

A site for the construction village has been selected after extensive evaluation of the range of available sites indicated in the Draft EIS/ERMP, including the old airstrip site. The Joint Venturers propose to establish the construction village at a site approximately 2.6 km south west of the gas processing facility and approximately 800 m west from the nearest accommodation building at the existing Chevron operations camp. The site is a combination of locations CVX1 and CVX2 nominated in the Draft EIS/ERMP. The environmental, social and economic factors applicable to this selection provide greater benefits than the base case (gas processing facility) site. Detailed flora and fauna surveys have been undertaken within the site of the village and a surrounding buffer zone during the peak period of the year for such surveys. This has confirmed that the biodiversity and environmental factors prevailing on that site are equal to or of lower conservation significance to the base case (gas processing facility) site. Factors considered in this decision are listed in 22.165. Details of environmental impact assessment are included in Part A of this document.

22.164 On what basis was the Airport site really eliminated? What does "the resultant economic implications for supply of infrastructure" actually mean?

As stated in the Draft EIS/ERMP in Chapter 6, section 6.3.6, p 135; the operational airport site was rejected as a site for the construction village due primarily to its remoteness from the proposed gas processing facility construction site and associated travel time and distance from the construction village to the gas processing facility.

25.36 A pioneer camp (to house an additional workforce of 250 people) is proposed to be constructed before environmental approval of the project. It is stated in the ERMP that this camp will not be assessed as part of the ERMP and will be subject to separate approvals. Any separate approval would require the thorough evaluation of quarantine aspects and a management program in place to minimise the major environmental risks to the Island's biota.

25.50 Separate assessment of a pioneer camp for 250 people is mooted

The Joint Venturers have revised construction scheduling to avoid the need for a pioneer camp before environmental approval. Works for the construction village will not commence until the Joint Venturers have received environmental approval from both state and federal environment ministers.

22.163 Far more information about this option is required. How could a 'floatel' have quarantine downsides that offset the numerous quarantine benefits such an option would offer?

26.7 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: full justification for why the 'floatel' proposal has been dropped.

Floatel accommodation is only acceptable as a short-term solution for a limited number of personnel. Floating accommodation for 2500 people would require several vessels, and has been excluded from being a feasible option. The operator may utilise a floatel at the initial mobilisation to provide housing until the construction village is opened.

22.165 Although we have called for more information on the alternatives presented, the Submitters are at this stage inclined to support the Old Airstrip site on the basis of the reduced need for additional clearing and the reduced light which would reach turtles nesting on the eastern shore. On an Island with such low rainfall we imagine inundation is an issue that can be managed!

Factors that led to the decision not to use the old airstrip site were:

- the airstrip clearing is unsuited to the construction of a small township being long and slender. It therefore offers only a partially cleared site for the proposed footprint of 500 m x 500 m
- adjacent to oilfield operations and therefore presents a risk to construction village occupants
- village operations could potentially interfere with oilfield operations e.g. well sites, concrete batch plant and crusher plant
- utilisation of cleared land would reduce access to potential temporary lay-down areas
- topography at the eastern end is unsuitable
- access to the gas processing facility from the village would be obstructed by water flowing over the road
- social disadvantages due to proximity to the gas processing facility– noise, light, line of sight
- noise disturbance from construction and operations is greater than site selected, see results of noise modelling Technical Appendix B2 of the Draft EIS/ERMP.

Although rainfall on Barrow Island is infrequent, it is often of high intensity, over short periods. The consequence of such rainfall is rapid run-off rather than infiltration, leading to localised flooding and erosion in disturbed ground. A steep topography will accentuate the rate of erosion. It is our opinion that the airstrip is likely to flood several times in the life of the construction village and would require flood mitigation measures to be provided.

22.236 How is it asserted that the location of the construction village has been modified when the location of the construction village has not yet been finalised?

A site for the construction village has been selected after extensive evaluation of the range of available sites indicated in the Draft EIS/ERMP. The Joint Venturers propose to establish the construction village at a site approximately 2.6 km south-west of the gas processing facility and approximately 800 m west from the nearest accommodation building at the existing Chevron operations camp. The site is a combination of locations CVX1 and CVX2 (Figure 6-17) nominated in the Draft EIS/ERMP. The environmental, social and economic factors applicable to this selection provide greater benefits than the base case (gas processing facility) site.

Detailed flora and fauna surveys have been undertaken within the site of the village and a surrounding buffer zone during the peak period of the year for such surveys. This has confirmed that the biodiversity and environmental factors prevailing on that site are similar to the base case (gas processing facility) site. In addition, there are a number of social (health, safety, amenities) factors that favour the new preferred location (refer to Part A of this document).

Roads

16.71 Will additional roads be needed? This is not stated although clearly added roads will accompany the proposed expansion and need for clearing still more native vegetation. See 6.16 page 28 What is meant by 'realignment'? What further clearing is envisaged as a result of realignment? 6.14 page 28 Executive Summary Roads: Will additional roads be needed? This is not stated although clearly added roads will accompany the proposed expansion and need for clearing still more native vegetation.

16.74 The amount of access roads is not stated in the section 6.14, page 28, Roads. This is a serious omission since it relates to the amount of additional clearing which would be needed.

16.75 Just how much additional vegetation will be cleared to enable widening, grading and sealing? What will be the total area cleared to enable the new plant to proceed?

A small number of additional roads, or sections of roads, will be required, but in the main existing roads will be used. The Draft EIS/ERMP, Section 6.2.12, 'Estimated Land Use' states 'The *Barrow Island Act 2003* establishes the basis for land available to be cleared for gas processing and associated infrastructure. The Development team is actively managing land requirements on Barrow Island to minimise footprint and vegetation clearing. The land required for the Development will be monitored during later phases as the design progresses. Table 6-3 presents an estimate of land requirements against the allocation stipulated in the Barrow Island Act.' It should be noted that roads fit within the term 'associated infrastructure'.

Waste Disposal

16.86 It has been indicated that about 3,000 additional employees would be across the Island during the 3–5 year construction phase. How is it intended for the problem of human excrement in the bush to be managed?

Are there any proposals to discourage the use of the bush for toilet purposes? Will portable toilet boxes be available at all work sites at all times? And how would waste disposal from these toilet boxes be managed?

The construction workforce will be working almost exclusively in the development site where the proposed gas processing facility is to be constructed, and will be supplied with appropriate sanitary facilities as required by occupational health and safety legislation.

Only a very small fraction of the workforce will be working outside of the development site (e.g. on pipeline construction, drilling of wells and shore crossing for pipelines, geophysical surveys, etc). The threat of using the bush for toileting purposes has been specifically identified in risk assessment workshops and by the Quarantine Expert Panel. The Joint Venturers have proposed and are committed to providing mobile toilet facilities to workers in the field, which will be serviced by qualified waste management personnel and equipment. The Joint Venturers have also identified the need for awareness training of personnel to ensure a shared understanding of the need to use the facilities provided.

18.59 Management plans should require all wastes to be removed from Barrow Island, unless otherwise approved by CALM.

The Draft EIS/ERMP, p 140, and Technical Appendix A1, Framework EMP, Section 3.15 outlines the proposed facilities and current plans with respect to waste management. The Waste Management Plan (refer Technical Appendix A1, Framework EMP, Table 1) will be developed in consultation with CALM and DoE.

19.59 Without seeing the Waste management plan it is hard to make comment on the plan, while hazardous waste is being stored on the island it has the potential in the event of a spill or leak to enter soil and groundwater

The Draft EIS/ERMP, Section 6.3.6, p 140, states 'Appropriate waste segregation and storage facilities will be provided, such as for food wastes (e.g. covered where possible to keep out fauna), scrap steel (i.e. for recycling), hazardous wastes (e.g. bunding for liquid wastes in line with relevant Australian Standards), and other similar appropriate facilities. These facilities will be designed in accordance with Australian Standards and incorporate best practice principles.' Spill Contingency is discussed in the Framework EMP Technical Appendix A1, Section 3.19.

24.24 The comment that "it is anticipated that sludge will be removed from Barrow Island...." is vague and provides no assurance of the intentions for disposal of this material.

Sludge will be removed from Barrow Island. Also refer to 22.186 Section 7.1.

Plant Construction and Construction Utilities

20.51 Risk Management Solutions, Risk Management Models for Australia, 2005; <http://www.rms.com/Publications/AustraliaCyclone.pdf> describes Barrow Island as lying in an area of significant risk of cyclone damage. 'Since 1960, over 140 cyclones of Saffir Simpson category 1 or higher have impacted Australia. Cyclones approach the country from both the northwest and the northeast, threatening much of the coastline from Perth in the southwest to northern New South Wales in the east'. The maps of 100 year wind speed and historical tracks of cyclones identify Barrow Island as lying in a High Risk Area.

Other large LNG processing facilities exist in the cyclone-prone north-west of Australia, e.g. North West Shelf Joint Venture in Dampier. All engineering and design work associated with the Gorgon Development will be to the appropriate Australian Standards and designed and constructed to withstand cyclonic conditions.

Workforce

22.11 Don't take our word for that; ask BHP Billiton, who are progressing access to their much smaller Scarborough field via a proposed site at Onslow – the peak construction staff is now estimated at 3300, not 2200.

22.65 The number of people contemplated on Barrow during construction has now blown out from 2,200 in the ESE to 3,300. How many personnel movements does this equate to? How does that compare to the number disclosed in the ESE?

The Draft EIS/ERMP is based on workforce numbers with a peak of 3300. Work continues during this front end engineering phase to reduce the size of the construction workforce on Barrow Island.

22.54 GJV has no experience managing the number of FIFO contractors contemplated.

The Joint Venturers have experience in other regions of the world with managing large fly in/fly out workforces. Refer also to:

- Technical Appendix A1 of the Draft EIS/ERMP (Section 1.3 and Section 3.1)
- Submission 22.65 above.

Storage

22.237 Leaks and spills have also occurred as result of non-compliance with procedures! Please refer again to the overview and relevant Parliamentary questions in Appendix 1, and we would also commend the regulators to consider the report conducted by Harry Butler (Appendix 7), in particular the paragraphs indicated at pages 54 to 59.

A gas processing facility is a very clean facility. As mentioned in the Draft EIS/ERMP Section 6.2.10 and 6.3.6, the Gorgon Joint Venturers will use AS1940 as a minimum for storing oils and similar materials. Environmental management processes are discussed in detail in the Draft EIS/ERMP Chapter 16, especially note the reference to ISO14001 in Section 16.1.

6.3.7 Construction of Onshore Water Supply/Re-injection Wells

16.64 Fresh Water Page 27 Executive Summary: Significant quantities of water are said to be required, principally for hydrotesting the feed gas pipelines (quantity needed not stated), and for horizontal directional drilling (approx 20,000 m³) for drilling, but the report is very hazy about where all this water will come from, how the extraction of it will impact, and whether it will be fresh or salt water. This unacceptable. "Three options are being considered – but limited to one or all? The demand for so much fresh water would inevitably produce significant environmental impacts in such an arid region where surface water is now almost nonexistent as a result of earlier development, and where groundwater is in limited supply.

16.65	With what is already being used by ChevronTexaco, what would the total consumption be?
	Integrity testing is a mandatory requirement and the most common form is hydrotesting. Options being considered and the proposed way forward for water production are described in the main body of the Draft EIS/ERMP, Section 6.3.6 pp 137–141, and Section 6.3.7. Also refer to 22.33 Section 6.3.7. Salt water is the preferred option for HDD operations (using a salt water polymer). Sea water is the base case for hydrotesting of the feed gas pipelines and domestic gas pipeline, while fresh water is the base case for the LNG tanks (due to the nature of the steels used in these tanks).
4.2	Because of significant potential for negative impact on the small fresh and brackish groundwater resource and on the stygofauna, including listed threatened species that inhabit it, sea water should be the source for RO plant.
18.46	All drilling for the proposed Gorgon gas development must be cased through formations that are likely to host stygofauna.
18.47	If direct water supply from the ocean is proposed then more information is required to enable assessment of environmental impacts, including: <ul style="list-style-type: none"> – The location of the intake pipe; – Methods of securing the intake pipe; – Details of chlorine treatment; – Information on the fate of chlorine; and – Level of potential environmental impacts of increased sedimentation/total suspended solids resulting from the installation of this pipe.
19.03	For some components, such as the source of water for the development, three alternatives are provided but no clear direction is given as to which alternative will be pursued.
19.07	Where multiple options are given, the Department requests further advice from the proponent regarding what selection criteria they will be using to make a final selection. This will better enable an assessment of the final option by the DoE.
22.33	Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – production of potable water.
22.168	Water supply – yet another area for which separate approvals are sought. The Submitters oppose this and the other attempts discussed above to defer consideration of matters which GJV has been unwilling or unable to do enough investigatory work on!
24.26	Details of the potable water system (including source and disposal) to be developed are vague, especially given that the implications of the options vary considerably.
24.47	For the potable water supply; <ul style="list-style-type: none"> – what pre-treatment of source water will be required – what concentrations of chemicals are expected in the effluent discharge. – what would be the design parameters for a marine discharge option?

The proposed approach to supply water for activities on Barrow Island is described on pp 140–141 of the Draft EIS/ERMP. An Environmental Management Plan (EMP) has been compiled for the hydrogeological investigation program which includes drilling of the shallow (150–250 m deep) water wells and associated testing. The EMP addresses the technical details of the drilling program (such as number of wells, depths, hole sizes, casing requirements, drilling fluid to be used, etc), as well as the environmental aspects of the program and proposed mitigation strategies. The EMP states ‘The extraction rates and design of the well(s) will ensure that the halocline (freshwater/salt water interface) remains stable, and the associated draw down will be minimised, so that any impact to the freshwater lens is avoided or minimal.’ The EMP has been accepted by DoIR. Should the fallback option of direct seawater suction be required, then it would require a pipeline to the ocean, because when this line would be first needed the MOF or jetty would not exist.

4.19	It is not clear whether water will be sourced from bores on island (pp.140).
Extraction from shallow bores is one option being explored. Refer also to 22.33 Section 6.3.7 for additional details.	
4.20	Because of significant potential for negative impact on the small fresh and brackish groundwater resource and on the stygofauna, including listed threatened species that inhabit it, sea water should be the source for RO plant.
Direct sea water suction is a fallback option – refer to 22.33 Section 6.3.7 for additional details.	
24.27	It is understood that much of Barrow Island is underlain by karst forms, raising questions about the loss of drilling fluid for any holes drilled beneath the Island, including those associated with water supply and injection wells. What management would be put in place to protect the superficial groundwater quality from such contamination, especially given current knowledge about subterranean fauna?
The conventional water well drilling methodology i.e. mud rotary drilling will be used, consistent with established practices for oil well drilling on Barrow Island. Drilling mud, consisting of a suspension of bentonitic clay in water coats the wall of the hole, which provides stability of the hole and prevents the loss of drilling fluid to permeable formations. (Refer to section 6.3.7 of the Draft EIS/ERMP, p 141). Refer to 22.33 Section 6.3.7 for additional details.	

6.3.8 Construction of Marine Facilities

8.8	A thorough evaluation of best available technologies for marine facilities and comparisons with similar arrangements overseas should be undertaken and made available to interested parties, such as the proposed design is defensible and agreed as the most practicable option for the marine facilities.
15.7	The proposed construction of a solid structured causeway is likely to have greater impacts on natural sedimentation processes than an open structure. If the jetty was extended instead, it would reduce the impact on conservation values of marine conservation reserves from the dredging activities in the LNG shipping Channel.
18.14	If the jetty was extended, it could significantly reduce the impact on the conservation values of marine conservation reserves from the dredging activities in the LNG shipping channel. The proponent should be required to properly consider this option.
18.115	The proponent should be required to properly consider the option of a longer jetty which would lead to significantly reduced dredging impacts on benthic habitats.
22.150	Much more information comparing the proposed jetty length and dredge channel to a longer jetty/shorter (or no) dredge option is required. For such a financially significant project as this the Submitters urge that no environmental corners are cut, and a drastically reduced dredge impact would improve the project markedly. It should be underlined that reduced dredging has a multiplier benefit, reducing both plume damage and spoil disposal footprint.
22.151	Why has a sub sea cryogenic line been simply “ruled out”? It may be ‘unproven’, but so is geosequestration!

24.17 The basis for selecting the base case jetty structure over the alternative structures (as outlined in Box 6-7) is extremely brief, cryptic and inadequate, especially given the environmental implications of the base case. Considerable additional information explaining:

- The details of the alternatives,
- The engineering, economic and environmental advantages and disadvantages of each, and
- The environmental consequences of each option (and a comparison with the base case) need to be provided.

24.129 With the exception of limited information in Box 6-7, there appears to be little in the way of detailed descriptions of the design options considered to clearly demonstrate that the potential impacts of dredging and reclamation on the east coast of Barrow Is. have been avoided and minimised.

24.130 At this stage of the assessment, this uncertainty is arguably the most significant marine environmental issue for the proposal and could be reduced by adopting an option that would involve less dredging.

The Operator (Chevron Australia) is still examining the technical feasibility of various design concepts (refer to Draft EIS/ERMP, Box 6-7). The Joint Venturers are seeking approval for the base case option as discussed in the Draft EIS/ERMP (i.e. 800 m causeway and 3.1 km jetty). This option was developed following a review of the best available technologies both domestically and internationally. Selection criteria were chosen to suit the specifics of this project from a technical point of view and also to take into account the local environmental conditions.

15.6 The proposed development of the offshore loading facilities and wharfage appears to be of significantly greater scale than was originally mooted by the proponent and will require massive amounts of dredging, and dumping of spoil into an area of great marine conservation significance that is part of the Montebello/Barrow Islands marine reserves. Despite the comments that the area is unvegetated, there are significant benthic invertebrates communities in the area.

The area selected for the spoil ground is on the outer boundary of the unzoned area of the Barrow Island Marine Management Area. The Interim Management Plan for the area (CALM 2004) lists commercial activity as an acceptable use of this area as long as it is compatible with the overall maintenance of the reserves values. The spoil ground is more than 3 km from the nearest sensitive habitats. The habitats supporting invertebrate communities in this area are widespread throughout the region and the modification of a small proportion of the area will not reduce the value of the reserve as a whole. Both the footprint of the proposed marine facilities and the dredge volume has been significantly reduced from the concept proposed in the ESE Review (ChevronTexaco Australia 2003).

18.112 Further information should be provided on the requirements for ongoing maintenance dredging, spoil dumping locations and potential impacts of maintenance dredging on the marine environment.

A siltation study (Metocean Engineers 2005) modelled three significant cyclones that have impacted Barrow Island: Bobby, Olivia and Monty. The maximum siltation in the LNG channel was predicted to be 50 mm as a result of any one of these significant events. The report also indicated that there would be no siltation as a result of ambient conditions. This supports the observations that there is very little sand or silt in the immediate vicinity of the dredge works. Therefore maintenance dredging is not anticipated, but a conservative estimate of possible frequency has been assumed and the potential impacts assessed. Also refer to 8.11 Section 11.3.1.

22.170 If this project is approved, will there ever have been such a large dredging project in Australia before?

The Hamersley Iron channel and North West Shelf channels are both significantly larger in volume than the proposed Gorgon Development dredge program. The layout of the LNG channel and turning basin are undergoing optimisation with a view to reducing the size of the footprint and the dredge volume based on navigational simulation modelling. Present indications are that the total dredge volume for the LNG facilities will be reduced to approximately 6 million m³.

22.171 Why has the preferred dredging method not yet been finalized?

The alternative dredging techniques discussed on p143 is currently being employed in Dampier as part of the North West Shelf Expansion Project. Early indications are that this method of side casting from the cutter suction dredge and pickup by the trailer hopper suction dredge is an improvement over conventional methods. The final assessment of this existing operation will assist in determining our selected dredge technique.

23.6 As an example if it is technically possible to break up the limestone rock to be dredged (either mechanically or with explosives, it may be that the resulting dredge plum will be much less than will be generated by the action of a dredge cutting head grinding at the rock.

Large scale drilling and blasting operations may result in unacceptable impacts to marine fauna, such as turtles and whales, and is not the preferred option. The causeway, in conjunction with the MOF, has been designed to significantly reduce the volume of material to be dredged from the limestone platform. The use of cutter suction and trailer hopper dredges is acknowledged as the most efficient way of mechanically removing hard material and this method is preferred. Sidecasting of material for later removal and pumping the dredged material into the geotextile lined MOF will also substantially reduce turbidity. Other methods, such as maintaining underkeel clearance to reduce prop wash, will be employed during dredging to further reduce turbidity.

24.28 Will the existing barge landing require any upgrading for use for the Gorgon proposal while the MOF is being constructed? Will WA Oil's barge landing be superseded by the MOF, meaning that the barge site (landing and hard stand) can be rehabilitated?

The existing barge landing may require some modifications so that it can be used until the MOF is available. It is possible that the barge landing could be superseded by the MOF. However, these aspects would be subject to the required negotiations stated in Box 1.3 of the Draft EIS/ERMP (Chevron Australia 2005; p 7). It should therefore be assumed that the barge landing will remain in operation and not be rehabilitated in the near-term.

24.29 How would it be envisaged that the 2–4 Mm³ of rock fragments and coarse sand generated from dredging of the LNG berth and turning basin be made available for use elsewhere in the Development, and where would it be used?

Recovered dredge material will be used to construct the core of the MOF and associated causeway. Re-use of dredge material on Barrow Island is extremely unlikely due to the salt content.

24.175 Page 143, right column suggests 50 mm of silts may be deposited in channels following cyclones suggesting there will be a source of readily mobilised sediments on the seabed in the vicinity of the proposal following construction. What are the predicted environmental implications for nearby BPPH of on going silt re-suspension (and potential chronic turbidity) by ship traffic?

The 50 mm of sediment that could be deposited under cyclonic conditions refers to naturally occurring sediments. This illustrates the natural level of sedimentation that the BPPH are subject to currently. Ship traffic may also re-suspend loose sediments that accumulate in the channels. Ongoing impacts to Benthic Primary Producer (BPP) communities from this much localised turbidity and sedimentation are expected to be restricted to the edges of the channels. BPP communities within the high impact zones surrounding the dredged channels are expected to recover in the long- rather than the short-term in response to initial impacts from dredging. The impacts associated with vessel movements (during the operations phase of the Development), maintenance dredging and localised changes in water flow and sediment transport are deemed minimal with no significant short- or long-term effects.

24.181 The methods are very vague in this section, but suggest that there would not be specific areas within the MOF construction area for settlement fines from the dredged material during the construction process before it is discharged to the ambient marine environment. This would not be considered to be best practice management of fines liberation due to construction. Please provide a more thorough description of MOF construction methods with special attention to the discharge of excess water and sediment from the area proposed to be reclaimed.

The MOF construction methods are described on p 142 of the Draft EIS/ERMP. It is stated that fine sediments will pass through the geotextile fabric and overtop the bund. This is the basis of the dredge modelling and the evaluation of the environmental impacts.

24.182 The approach trestle and loading platform will be constructed with a steel open pile design. The ERMP states – “Small plumes of drilling fluid and cuttings will be associated with these activities, but these are very low volumes”. Please identify what drilling fluids will be used and provide a description of impacts and management associated with their use.

Sea water will be circulated to assist in the drilling process should jetty piles require socketing into the rock seabed. The environmental impacts will be negligible.

25.15 It should be specified where the 2–4mm³ of rock fragments and coarse sand generated from dredging of the LNG berth and turning basin would be made use of elsewhere in the Development.

Recovered dredge material is planned to be used to construct the core of the MOF and associated causeway. Re-use of dredge material on Barrow Island is extremely unlikely due to its salt content.

6.3.9 Construction of the Domestic Gas Pipeline

8.5 Horizontal Direction Drilling should be further explored as an option for installation of the domestic gas pipeline shore-crossing at the mainland.

8.6 For the Mainland Domestic Gas Pipeline shore-crossing DoIR strongly recommends that options be explored to utilise the existing cleared easement (that is, occupy a shared easement with the Apache pipeline) or if this is not possible, determine whether increasing the distance between the two pipelines will minimise impacts to the mangrove system.

18.56 The mainland shore crossing for the domestic gas pipeline should incorporate horizontal directional drilling in the areas of densest mangroves.

24.16 What prevents the Domgas pipeline sharing a portion of the Apache Energy Gas sales Pipeline easement, thus reducing the area of disturbance required for the near shore (including mangroves) and also land-based portion of the route?

Detailed investigations will be undertaken into the potential for horizontal directional drilling and the possibility for sharing the Apache Energy Gas Sales Pipeline corridor as the design progresses. A key driver for the selection of the mainland shore crossing site and method will be to reduce potential impacts to mangroves.

6.3.10 Construction of Optical Fibre Cable

Telecommunications

22.167 Why hasn't a particular telecommunications cable route been recommended? More work is required on these alternatives, as is more information to enable them to be assessed in relation to one another.

22.172	As above, more work is required before the optical cable route can be assessed for environmental impact. Specifically, as noted here, assessment should await the detailed submarine route survey referred to here.
24.30	The optical fibre proposal is to be assessed through this ERMP assessment, but details about location and construction are so brief and generally unspecific that assessment at this stage is not possible.
24.30a	In relation to the optical fibre communications link information required to enable assessment includes: <ul style="list-style-type: none"> – has a decision be made on the optical fibre cable route (this includes not only the mainland landfall and route, but also the Barrow Island landfall)? – if the Barrow Island landfall is not at the MOF, the implications of this to the marine and terrestrial values of Barrow Island need to be described. – Construction method (trenching, form of protection and restoration).
25.54	There is very little detail provided in the proposal on the optic fibre proposal to enable environmental assessment to be conducted of this aspect.
25.55	The construction method of activities such as trenching for the optical fibre and domestic gas pipelines will need to be clarified so it can be determined whether the Sea Dumping Act would apply (p144 EIS).

Figure 6.18 shows the base case route for the optical fibre cable. The base case for the Barrow Island landing is to lay a conduit in the MOF during installation, and then to pull the cable through afterwards. The base case for the mainland landing is Onslow (at the boat ramp). A detailed submarine route survey (mentioned in Section 6.3.10) is planned for early 2006, and the results of that survey are intended to assist in finalising the optimal route (e.g. to avoid sensitive habitat) and installation method of the marine section. The current base case for marine installation remains to bury the entire route to avoid damage from trawling and other shipping activities. As mentioned on p 144 of the Draft EIS/ERMP, 'Under the *Telecommunications Act 1997* all of the methods to be used are deemed "low impact"'. Installation of the cable will be conducted in accordance with strict environmental management procedures and controls, and a specific EMP will be prepared prior to installation. Also refer to 22.172 Section 6.3.10.

6.3.11 Other Pipelines

22.30	Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – the CO ₂ injection pipeline.
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Construction of the CO₂ pipeline is discussed in Section 6.3.11 of the Draft EIS/ERMP, while the drill centres for the CO₂ injection wells are shown in Figure 6.8. Since the Draft EIS/ERMP was written, additional work has been undertaken to optimise the route for the CO₂ injection pipeline. Two route options which are currently being considered. The routes identified are short and reduce the amount of new land disturbance. The routes maintain a safe separation distance from existing infrastructure and roads. At the same time, routes were chosen that improve constructability of an above-ground pipeline on supports. Minimum side hill slopes with gentle grades along the route are preferred to install pipe supports and to operate construction equipment alongside the pipeline. This will minimise environmental impacts as well.

While recent engineering work has resulted in the feed gas pipeline being buried, it is considered that the lowest environmental impact for the smaller, simpler CO₂ pipeline is to install it above ground.

The final decision between these two options will be based on field survey of the conditions along the route, including terrain, hydrologic features, surface geology, geotechnical conditions, and existing man-made obstacles and infrastructure. However, environmental consequences are expected to be similar between these two options. It is currently proposed that the CO₂ injection pipeline will be approximately 300 mm diameter, and located such that the bottom of the pipe is typically 200–300 mm above ground on supports to minimise any adverse impacts on the movement of surface water and fauna. The supports are expected to be approximately 12 m apart. Drainage line crossings will be elevated higher to clear anticipated flood flows.

6.4 Pre-Commissioning, Commissioning and Start-Up

No submissions received on this section of the Draft EIS/ERMP.

6.5 Operation of the Gorgon Development

- 24.33 It is understood that the Port of Barrow Island is under the control of Dept of Planning and Infrastructure but is operated by Chevron (as WA Oil).
- What are the environmental standards and procedures that currently apply to the Port of Barrow Island, and
 - What changes are intended to these environmental standards and procedures for the Port of Barrow Island should the proposal proceed?

The Port of Barrow Island is currently used by the WA Oil Joint Venture. Chevron Australia operates the port within Western Australian state laws and regulations. There are numerous standards and procedures used to manage the port operations and which cover various environment related aspects such as waste management, spills prevention, personnel activities, hull antifoulant maintenance and quarantine. As a result 'Over 1000 tanker loadings and 300 million barrels of crude oil have been exported without incident from the east coast of Barrow Island in the last 35 years.' (Chevron Australia 2005; p 509). The Gorgon Joint Venturers' goal is to maintain this record and will be preparing detailed procedures for handling LNG and condensate ships as the design develops, which may involve some enhancements to current practices.

6.6 Decommissioning

- 18.58 CALM recommends that the EPA consider the application of a rehabilitation bond as a default to cover the likely cost of decommissioning and rehabilitation. This should be applied well before the end of the project life and be indexed.

The Joint Venturers do not support the concept of a rehabilitation bond. The Joint Venturers have made specific commitments regarding decommissioning in the Draft EIS/ERMP (Commitments 1.5 and 1.6) and that these would be incorporated into conditions of approval by the State Government of Western Australia and Commonwealth Government of Australia. Furthermore, a bond is not considered necessary as the scale of LNG developments ensures that proponents are, and will continue to be, large, financially strong organisations of a global scale.

- 18.60 It is recommended that the proponent investigate the opportunities for direct transfer of topsoil for the rehabilitation of existing disturbance on Barrow Island.

As part of earthworks procedures on Barrow Island, topsoil is recovered and stockpiled for later use in rehabilitating that area. One of the lessons learnt of the 40 years of rehabilitation experience on Barrow Island is that if soil from one part of the Island is removed and used elsewhere on the Island, it has the potential to induce inappropriate geographical vegetation growth. However opportunities to re-use the stockpiled soil from the plant site will be discussed with WA Oil and CALM staff.

6.6.1 Decommissioning of Pipelines

24.37 If the proposal for the on-shore feed gas pipelines changes to having buried pipelines, does that mean that there will be no commitment to remove them, as would be likely to apply for above ground pipelines?

The onshore pipelines are now to be buried (submission 18.49 Section 6.3.5 and Part A of this document). Accordingly, it is proposed to leave the pipelines buried at completion of service as this would have less impact on the environment versus the alternative of re-excavation, pipeline removal followed by backfilling and re-instatement of vegetation and original land contours. This is consistent with current industry best practice as outlined in the Australian Pipeline Industry Association 'Code of Environmental Practice – Onshore Pipelines' (Australian Pipeline Industry Association Ltd 2005) which states: 'abandonment of buried pipelines in-situ is environmentally preferable to the disturbance associated with the removal of pipeline, which will involve excavation. Buried pipelines should only be removed in the case where damage resulting from the removal to the surrounding environment or disturbance to third party amenity is low.'

6.6.2 Decommissioning of Gas Processing Facilities

24.35 The *Barrow Island Act* requires that Barrow Island remains reserved for conservation of flora and fauna, and that a lease may be granted for a gas processing project, even though the land is part of the reserve. The related Gorgon Gas Processing and Infrastructure Project Agreement requires submission of a closure plan including rehabilitation and long term management plan for injected carbon dioxide. – How consistent with those requirements is the statement that “The aim is to leave the areas utilised by the Development in an appropriate condition....., which means that whatever remains after decommissioning... should pose negligible risk to safety and the environment.”?

The Joint Venturers are committed to decommissioning the proposed Gorgon Development in an environmentally responsible manner. Please refer to Section 6.6 on p 148 of the Draft EIS/ERMP, which states 'Rather than making definite commitments now, the Joint Venturers will adopt best practices in environmental management at the time of decommissioning'. Refer to Table 6-1 of the Draft EIS/ERMP regarding restoration and Chapter 16 for information on long-term management of injected CO₂.

24.36 Given that “the basic principle is that all surface equipment will be removed and the site rehabilitated”, to what extent is the design of the development incorporating the capacity to remove all elements of the development?

An outline of the decommissioning principles which are being used in the design process is provided in Chapter 6, Section 6.6 of the Draft EIS/ERMP. Also refer to 24.37 Section 6.6.1.

7 Emissions from the Development

7	Emissions from the Development.....	146
7.1	Introduction and General Submissions on Emissions.....	147
7.2	Atmospheric Emissions.....	147
7.3	Light Emissions.....	152
7.4	Noise Emissions.....	154
7.5	Solid Non-hazardous Wastes	155
7.6	Liquid Wastes.....	155
7.6.1	Liquid Waste Management.....	160
7.7	Hazardous Waste.....	163
7.8	Dredging and Dredge Soil Disposal.....	163
7.9	Accidental Releases (Spills).....	169

7.1 Introduction and General Submissions on Emissions

No submissions received on this section of the Draft EIS/ERMP.

7.2 Atmospheric Emissions

16.61 Re Executive Summary Section 7.1 Page 33 – Air Quality Criteria. Here only NO_x emissions are dealt with. The report fails to provide the data here for CO₂ emissions, presumably because it is proposed to geosequester them. However, as noted below, there is a proposal to release CO₂ in the event that sequestration is uneconomic. This gas should therefore be listed on table 7.1 p 33 as a possible emission. Without its inclusion the reader is unable to make the correct comparisons for Ambient Air Quality Standards and Guidelines.

The intention of Chapter 7 is to address emissions other than CO₂ as these emissions and proposed mitigation strategies are addressed in Chapter 13 (refer Draft EIS/ERMP, p 152). CO₂ emissions (including ‘contaminants’ in the CO₂ stream) are described on p 163 (Chevron Australia 2005) where it states that ‘The Gorgon Joint Venturers will undertake additional modelling during subsequent design phases to ensure that ground level concentrations of all components are safe.’

Comparisons of other emissions for routine and non-routine operations are provided in Chapter 7 of the Draft EIS/ERMP.

16.63 Anticipated particulate emissions are unacceptably high. The report fails to provide WHO and USEPA figures for averaging period and maximum concentrations of Particles as PM10.

Comparisons of emissions (including particulates) for routine and non-routine operations against various guidelines are provided in Chapter 7 of the Draft EIS/ERMP, Section 7.2, especially Table 7.4, which demonstrates that they are not ‘unacceptably high’.

19.15 However, if the injection process does not prove viable and does not proceed, the Department requests there is a review of the new set of circumstances. The Department requests that the EPA note that these comments relate only to toxicants and that Carbon Dioxide (CO₂) emissions were not assessed by the Department as part of this review of the ERMP. The Department would like to again reiterate that if the current gas disposal option of deep well injection is not pursued or if the circumstances change so as prolonged flaring or venting of gases is required, it would require further information from the proponent regarding expected air emissions and requests the opportunity to assess any new emission modelling.

The Gorgon Joint Venturers will undertake additional modelling during the subsequent design phases to ensure that ground level concentrations of all toxicants are below applicable standards. This modelling will include scenarios where 100% of the reservoir CO₂ is vented. This will enable operational flexibility not just in the unlikely scenario where the injection of reservoir CO₂ does not proceed but also during periods where reservoir CO₂ is vented for periods of maintenance of the injection system.

It is the intent that all matters dealing with operational management of CO₂ injection, including criteria by which the operations would be suspended, would be undertaken in accordance with a Carbon Dioxide Injection Operations Management Plan which would be agreed to and endorsed by regulatory authorities. Refer Section 13.4.8 of the Draft EIS/ERMP (Chevron Australia 2005; p 649).

19.16 The requirements of Section 51 of the *Environmental Protection Act (1986)* are clear in that failure to take “all reasonable and practicable measures to prevent or minimise emissions” is an offence under the Act.

Section 7.2.5, p 163 of the Draft EIS/ERMP states that The Gorgon Joint Venturers will undertake additional modelling during subsequent design phases to ensure that all ground level concentrations are safe. This modelling will also be used to examine other aspects such as odour.

19.28 The report presents a detailed analysis of the potential effects of emissions from the plant on air quality. While there are some issues that need to be addressed, these may be largely matters of detail. In most cases, there is no present indication that emissions from the plant will breach any air quality guideline

Recognition that plant emissions are likely to meet required air quality guidelines is noted.

19.29 The report presents a detailed analysis of the potential effects of emissions from the plant on air quality. While there are some issues that need to be addressed, these may be largely matters of detail. In most cases, there is no present indication that emissions from the plant will breach any air quality guidelines. The sole exception is H₂S concentrations during periods when the CO₂ injection system fails. Model results indicate a potential for high odour concentrations during these periods.

Refer to 19.36 (below in this section) where the issue of odour from H₂S emissions are raised in more detail.

19.30 In the Executive Summary, on page 31, it is mentioned that Dispmod and TAPM were used, but no indication has been given of which was the source of the results plotted, nor of the basis for that choice. Clarification of this point will help readers who only consult this document

Full details of the modelling undertaken are provided in Technical Appendix B1 of the Draft EIS/ERMP, while only extracts are provided in Chapter 7 and the Executive Summary.

19.31 Mention is made of possible dust emissions, and mitigation measures, during construction, but there has been no attempt to estimate whether these emissions will have any significant impact on air quality or public amenity in surrounding areas

The Draft EIS/ERMP mentions various mitigation measures to limit impacts associated with dust, such as paving roads (Chevron Australia 2005; p 124) and use of water for dust suppression (p 152). Refer also to Chapter 10 (e.g. Table 10.2) for various comments regarding dust suppression. Table 17.2 of the Draft EIS/ERMP (Chevron Australia 2005) summarises risks associated with dust as low for construction and low for operations. Therefore, dust will not have a significant impact on either air quality or amenities in surrounding areas.

19.32 It is stated that the current ChevronTexaco accommodation camp is regarded as the nearest residential area, but this site is not shown on any map. In addition, it appears that concentrations at this site are only discussed in the context of H₂S concentrations during process upset conditions

The existing accommodation camp is shown in Figure 1-3: Existing Infrastructure on Barrow Island (Draft EIS/ERMP, p. 8). The outputs from the air emissions modelling contained in Technical Appendix B1 (e.g. Figure 5.1) show this site as the 'WAPET Camp'.

19.33 Emissions during start-up and shut-down operations are implied in a number of places to be greater than for continuous operation, but NO₂ emission estimates for the former are less than for the latter

Emissions of many components will be higher during non-routine operations such as start-up and shut-down, e.g. particulates from the flare and H₂S from the CO₂ vent. NO_x (NO₂) emissions will be primarily associated with the power generation turbines and compression turbines. Thus during start-up and shut-down these may not be at full load, if they are operating at all.

19.34 Peak hourly-averaged NO₂ concentrations for continuous operation were estimated to be 0.063 ppm. This was just over half of the relevant air quality standard, so was reviewed in detail. Comparative modelling using an alternative, locally-developed model (CCS) initially gave slightly lower concentrations, but when mixing depths lower than the model's default estimates were used, the peaks were found to be very similar. It is therefore concluded that the hourly peak concentration estimates for NO₂ are probably representative, and may be a little on the conservative side

Comment noted

19.35 In Table 4.1 of Technical Appendix B-1, some units are quoted as mm/m³, when the correct unit is mg/m³. The units shown in the specialist technical report should be µg/m³ not µm/m³. This was corrected in the Main Report of the Draft EIS/ERMP in Chapter 7, Table 7.3.

19.36 In Technical Appendix B-1 it is stated of the peak H₂S in conditions of failure of the re-injection system, "the maximum value of 113 µg/m³ is less than a quarter of the Victorian EPA design ground level concentration of 470 µg/m³". This statement ignores the fact that the stated concentration relates to toxicity, and that the design limit for odour is 0.14 µg/m³. It would seem that in such failure conditions, severe odour problems may arise. This is of concern, particularly as it is not yet guaranteed that re-injection of CO₂ and H₂S will proceed

Modelling detailed in the Draft EIS/ERMP was based on conceptual design, which sets the basis upon which the project should be assessed. As the design is refined during the front end engineering and design (FEED) and detailed design phases, modelling will be re-run to confirm that potential impacts associated with emissions are equivalent to, or better than, those predicted in the Draft EIS/ERMP. Outputs of this modelling will be included in EP Act Part V applications and will address aspects such as odour.

19.37 On page 156 of the main report, Volume I-HR, it is stated, "the height of the flare will depend on the final facility layout and flare structure location, but is expected to be approximately 150 m." As mentioned in Chapter 6, one option currently being considered is the use of a ground flare similar to that installed at the Darwin LNG plant". A ground-level flare might have much larger effects than one at 150 m, and should not be permitted without separate environmental assessment.

19.5 Another option mentioned elsewhere in the ERMP as currently being considered "is the use of a ground flare similar to that installed at the Darwin LNG plant". A ground-level flare might have much larger air quality effects than one 150 m high, and the Department suggests that this option should not be permitted without separate environmental assessment.

It is proposed that a ground flare will be used. Further modelling is proposed as noted in the Draft EIS/ERMP on p 163 '...to ensure that all ground level concentrations are safe.' Also refer to 19.36, above, in this section.

Further information in regard to the ground flare is provided in Part A of this document.

19.38 On page 163, "Shut-Down of CO₂ Injection System", measures of H₂S are quoted in units of both µg/m³ and ppm. Since standards have been quoted in terms of µg/m³, all measures should use these units

0.1 ppmv H₂S = 144 µg/m³ – which is similar to the other modelling showing 113 µg/m³, and so is below the Victorian GLC limit. Additional modelling will be undertaken as the design proceeds to confirm these predictions and ensure that the ground level concentrations of all components are safe, and that odour effects associated with H₂S are also taken into account. Consistent units will be used in all further modelling.

19.39 The modelled ozone concentrations appear to be in compliance with air quality standards, and experience with photochemical models in such environments suggests the peak estimates may be in excess of what would actually occur

Recognition that ozone concentrations are likely to meet required air quality guidelines is noted.

19.40 Regional modelling has not considered all major sources other than those on Barrow Island and in Dampier (Woodside LNG plant and Hamersley Iron power station). NO_x emissions from Apache Energy on Varanus Island should have been included when examining cumulative effects. However, given the local scale of air quality impacts, with the exception of ozone peaks, it is highly improbable that such sources would contribute measurably to peak concentration estimates. The omission of the Apache emissions should not require remodelling; nevertheless, the proponent needs to provide scientifically defensible evidence that emissions from Varanus Island will not significantly change results of cumulative air quality modelling

The most recently available data in the public domain regarding Varanus Island emissions is on the National Pollutant Inventory (NPI) at <<http://www.npi.gov.au/cgi-bin/npidbsearch.pl?proc=substance>> (then select '2002/2003', 'Oxides of Nitrogen', '-', 'All', '-', 'Pilbara Airshed', and 'none'). (The 2003/2004 data could not be sourced.) These data support the work undertaken in the Draft EIS/ERMP that highlight the major industrial emission sources in the area around the major population centre of Karratha. Varanus Island NO_x emissions represent approximately one-quarter of the emissions shown for Woodside's gas plant, and so the NO_x emissions from Varanus Island would not significantly change the conclusions. These NPI data also show that NO_x emissions from the gas processing facility on Barrow Island would make a very small contribution to overall emissions in the area when all sources (including natural sources such as bushfires) are considered (i.e. total emissions 250 000 tonnes NO_x per annum in the Pilbara airshed).

22.177 The question of sulphur dioxide is dismissed with the comment that emissions will be low, the gas being low in sulphur. This issue needs more discussion. This may well be the case, however any level of emissions has the potential to combine with NO_x and other substances to form acid rain. The document states that most of the deposition will occur in the marine environment where the receiving waters are not considered sensitive to nitrogen deposition. It states that the impact will occur close to the source of pollution as the climate is dry and also that the deposition will be relatively insignificant. However the impact on vegetation and the marine environment is not covered in the depth deserved considering the importance of the receiving environment.

The H₂S (which has the potential to form SO₂ if burnt as fuel) will be removed from the feed gas in the acid gas removal unit as shown schematically in the Draft EIS/ERMP, Figure 6.5; and as described in Section 6.2.3 (Chevron Australia; p 107). Therefore H₂S will be injected with the CO₂ as mentioned in Section 6.2.4 of the Draft EIS/ERMP. Thus, under normal operating conditions it will not be released to the environment as SO₂. Impacts of NO_x emissions are described in Chapters 10 and 11. The possible effects of gaseous emissions of plants around the gas processing facility are described in Section 10.3.2 of the Draft EIS/ERMP (Chevron Australia 2005, p 330). This section also includes the management measures that will be taken to minimise impacts from emissions and the conclusion of low risk to native vegetation and flora.

22.178 The contribution of shipping to sulphur dioxide emissions needs to be covered, given the high sulphur content of marine heavy fuel (around 27000 ppm compared with petrol and diesels 50 ppm). There needs to be a commitment to low emission ships and a plan to reduce emissions from this source.

LNG ships typically use their cargo LNG as fuel (on both the outbound and inbound journeys and while loading), hence SO₂ emissions from this source will be negligible. These ships may, during the life of the development, arrive at Barrow Island burning liquid fuels, but experience from the North West Shelf shows that this is considered the exception rather than the norm. Condensate loading will only occur approximately once every two months with two LNG trains operating. Vessels will be in compliance with the new MARPOL Chapter VI (International Convention for the Prevention of Pollution from Ships) and will be utilising the fuel specified in the recently released 2005 Edition of ISO 8217, which reduces allowable sulphur content from 5% to 4.5% in line with the MARPOL global sulphur cap.

22.179 Construction-related emissions are de-emphasised here, as compared to operational emissions – does this mean they have been disregarded/not analysed?

Construction activities involving dredges, cranes, trucks, earth moving equipment, barges, etc, will result in emissions as noted in the Section 7.2.1 of the Draft EIS/ERMP. The Joint Venturers acknowledge that emissions can be reduced by appropriate planning such as mentioned in the Draft EIS/ERMP Framework EMP (Technical Appendix A1, Section 3.11) which states that ‘Modular construction techniques shall be employed to the extent practical to reduce net emissions from construction machinery’. Also, Chapter 13 shows indicative greenhouse gas emission levels during the construction phase (Table 13.5) and the operational phase (Figure 13.6). These emphasise the relative emissions, namely in the order of 2 million tonnes CO₂e from the entire construction and commissioning phase, but 4 MTPA for the life of the Development from the operational facility.

24.25 Will the existing WA Oil power station continue to operate after the Gorgon power station is in operation (see 7.2.6)?

This aspect is subject to the negotiations mentioned in Box 1.3 of the Draft EIS/ERMP. The WA Oil power station should be assumed to be still running as mentioned in the Draft EIS/ERMP Table 7.6. Also refer to 24.7 Section 1.2.

24.38 EPA Guidance No. 15 places an expectation on the use of DLN burners on gas turbines as current best practice. Any project design which does not propose their application would need to demonstrate environmental benefit of the preferred design.

The Joint Venturers acknowledge the EPA Guidance Statement No 15 <http://www.epa.wa.gov.au/docs/1018_GS15.pdf>. The modelling undertaken for the Draft EIS/ERMP, Section 7.2.2, assumed 3 x 116 MW Industrial Gas Turbines with Dry Low NO_x (DLN) burners for power generation drivers, 4 x 80 MW industrial gas turbines with DLN burners as the compression drivers and 2 x 150 MW boilers. Further design work has removed the need for the boilers, but requires an additional power generation gas turbine to provide a reliable power supply. DLN will not work at the loads required of the individual power generation units, so these will be conventional combustion technology (with the ability to refit DLN later when LNG Trains 3 and 4 are expected to come online and increase power demand). It is still proposed that the compression gas turbine drivers on the LNG trains will use DLN.

The net result of the currently proposed configuration is that NO_x emission rates have increased from 4430 tpa NO_x (Draft EIS/ERMP, Table 7.1, p 154) to approximately 6100 tpa NO_x total, but the combined ground level concentrations (GLC) have decreased according to research completed December 2005 (SKM). This reduction in GLC is primarily because the gas turbine exhausts are hotter without DLN and this will result in improved dispersion. Improved dispersion will result in lower impacts on humans and flora and fauna than assessed in the Draft EIS/ERMP Chapter 10.

24.39 Given the brief discussion on the fate of H₂S if vented through a turbine stack due to the presence of heat and excess oxygen, is this intended to be part of the design?

The decision is yet to be finalised, but the current base case is a dedicated vent. Use of a gas turbine exhaust (compared with the alternative dedicated vent) would assist dispersion (but potentially increase risks within the gas processing facility as the pipe would have to travel through the plant), and so the current evaluation is conservative in terms of dispersion. The Gorgon Joint Venturers are committed (as mentioned in the Draft EIS/ERMP, p 163) to ‘...ensure that ground level concentrations of all components are safe’. In addition, the Gorgon Joint Venturers are committed to ensuring that odour is taken into account in the final design. Refer to 19.16 and 19.36 above in this section.

24.40 If the existing WA Oil power plant is no longer required, what capacity is there for recovery of gas that is flared and how would this be achieved?

The intention is that flare gas would be available to use, possibly as fuel. This is an area covered by sharing of infrastructure discussed in Box 1.3 of the Draft EIS/ERMP. Refer to 24.7 Section 1.2.

7.3 Light Emissions

16.69 The considerable problems associated with lighting have not been sufficiently resolved. This is unacceptable.

The lighting strategy is described in Chapter 7 Box 7.2 of the Draft EIS/ERMP, and potential impacts assessed in Chapter 11. Management of the effects of lighting on fauna will be formulated in the Lighting Impact Mitigation Strategy and will be incorporated into all relevant Environmental Management Plans for the Development.

18.138 Any significant impacts of light emissions on turtle nesting behaviour on Barrow Island as a result of the Gorgon gas development should be viewed as unacceptable. It is CALM's preferred view that Chevron Australia develop a "zero lightfall policy" for Barrow Island at turtle nesting beaches during the turtle nesting season.

18.139 The proponent should ensure that all available measures of reducing light emissions on turtle nesting beaches are employed in order to mitigate impacts.

The landfall location at North White's Beach has been specifically targeted to be away from identified active turtle nesting beaches (refer to 22.267 Section 6.3.4).

The Joint Venturers will implement the mitigation strategies highlighted in Chapter 7 (Section 7.3) and Section 3.12 of the Framework EMP, and will further consult with CALM to refine these strategies and implement appropriate measures that will allow the landfall works to proceed on a 24-hour safe working basis while avoiding or limiting the illumination of the turtle nesting beaches. These specific measures will be outlined in the relevant EMPs. Refer to 22.267 Section 6.3.4 and 24.87 Section 11.5 for additional details on the east coast HDD site.

18.140 A detailed light management strategy should be prepared in consultation with, and to the satisfaction of CALM. The strategy should address lighting design, non-reflective surface colours and textures, and should include regular light audits. The strategy should provide for improvements in lighting strategies as the technology becomes available.

18.142 A monitoring program for light emission impacts on turtles should be developed and implemented in consultation with and to the satisfaction of CALM. Monitoring should be undertaken for the entire life of the operations on Barrow Island, and not be limited to just the initial operations phase. Monitoring of hatchling behaviour should include appropriate contingency measures if a detrimental impact is detected.

Light mitigation strategies and monitoring strategies will be further developed in consultation with CALM to include all the elements outlined in Section 11.5.3 (Chevron Australia 2005) and Section 3.12 of the Framework EMP (Technical Appendix A). Routine light audits will be conducted as part of the ongoing monitoring of the Development. The results of the monitoring and audits will feed back into the continuous improvement of the IMS and associated management plans.

18.141 If it is deemed acceptable that light emissions to turtle hatchlings are unavoidable, the EPA should consider the option of establishing a bond for unacceptable hatchling mortality.

The Joint Venturers do not support the concept of a performance bond for such issues, which would be in addition to the concept of offsets as discussed in 18.31 Section 2.2.

20.33 WWF-Australia notes that according to the proponents, the moonlight reaching the turtle nesting beach will be 2.5x to 10x stronger than the light from the proposed gas processing facility under normal operation, 30 m away from the beach. WWF Australia questions whether this claim is accurate (p 169).

These figures were derived from modelling of the light spill from the proposed gas processing facility and a published value for the luminance from the moon. This applies during the non-dark phases of the lunar cycle. Of course this is not true during the dark phases of the lunar cycle. These figures were provided to give an indication of the strength of the light. The effects of light on turtle hatchlings and nesting females are addressed in Section 11.5.3 of the Draft EIS/ERMP (Chevron Australia 2005).

22.140 The effort made with respect to lighting has been inadequate from the point of view of potential impacts on turtles. Why haven't the health and safety considerations related to lighting yet been finalized? The Submitters are concerned that such an "out clause" risks the reduction or elimination of the various "turtle sensitive" light systems proposed.

The lighting strategy is described in the Draft EIS/ERMP Chapter 7, Section 7.3. Lighting levels related to personnel safety are driven by Australian Standards, and the locations of lights can be designed to suit specific tasks and to suit the equipment layout. The Gorgon Joint Venturers are committed to the strategies described in Chapter 7 and Chapter 11 to avoid or limit potential impacts on turtles.

22.184 It should be noted that there is very little lighting associated with the oil operations on Barrow at the moment, due to the offshore loadout facility.

It is recognised that the existing operations result in only a low level of light emission. The importance of ensuring that light emissions from the proposed Gorgon Development are reduced to acceptable levels is also accepted.

Refer to 24.13 Section 6.2.3 and 22.178 Section 7.2 regarding the ownership of the LNG tanker fleet and the condensate tanker fleet. Condensate tanker lightings are rare, while the Joint Venturers will have significantly more control over the LNG tanker fleet. Refer to pp 497 and 502 of the Draft EIS/ERMP, which says '...manage lighting on LNG tankers at night during January to April (turtle nesting season) to minimise attraction to hatchlings (shield and direct lights onto work areas, use long wavelength light sources and turn lights off when not in use).'

Vessel deck lights are typically focused downwards onto the deck for the purposes of safe operations. Therefore by default, they are not designed to cast light much beyond the limits of the vessels decks. There will be capability to modify the lighting on Joint Venturer controlled vessels through additional screening of deck lights so that lighting is only directed as necessary for safe operations. There may be a limited opportunity to do this on vessels chartered on a long-term basis. It should also be noted that tankers will be 4 km offshore. All other vessels will be under the control of the pilot/loading master anytime the vessels are within port limits so lighting can be kept to a minimum necessary for safe operations. Tugs and other support craft utilised for operations will be built for purpose and will be designed with strict controls over lighting specifications.

22.185 Subject to our comments above, all light strategies mentioned here should be made the subject of detailed Ministerial conditions.

Comment noted. The Joint Venturers will assist regulatory agencies as appropriate to ensure conditions are relevant and practical.

24.41 Comment is made about the implications of the light from the plant flare being visible from the beaches and offshore. To what extent would a ground-based flare reduce the ecological implications of this light source, as an individual source and under cumulative light conditions from the plant and related facilities?

A ground flare has been selected; this significantly reduces the amount of light associated with flaring because of its design, and because it is closer to the ground (refer to Part A of this document). As can be seen in Plate 6.4 of the Draft EIS/ERMP, an elevated flare (approximately 150 m tall) cannot 'be hidden' behind other equipment and so would be seen for a great distance. Therefore, the ground flare will have a significantly lower impact on turtles.

7.4 Noise Emissions

18.144 Given the unknown impacts of noise and vibration on Barrow Island fauna (terrestrial and marine), a precautionary approach should be adopted, with activities causing noise and vibration, such as blasting, prohibited in areas and during periods when their effects are likely to impact detrimentally on marine and terrestrial fauna.

In rock terrain where the use of conventional excavation or ripping equipment alone is not feasible, it will be necessary to undertake controlled blasting. The following environmental management measures (refer Technical Appendix A1 Section 3.10 of the Draft EIS/ERMP) shall apply to all activities that involve blasting (and the generation of associated noise and vibration):

- Drill and blast techniques shall be planned and adopted that reduce dust, noise and vibration effects (i.e. using smaller, more frequent blasts, as opposed to less frequent, larger blasts; using sequential, staggered, or time-delayed charges or shaped charges to minimise cumulative effects of the explosions).
- Blasting shall be scheduled to avoid sensitive lifecycle periods of wildlife species (e.g. breeding, nesting, migration) where practical.
- Blasting shall be scheduled for daylight hours only to avoid activity peaks for nocturnal mammals (dusk to dawn).
- Continuous soft start and repetitious warning shots (air guns) shall be used prior to blasting in the marine environment use.
- A marine mammal observation program shall be developed prior to the commencement of activities.
- Consideration of physical removal of turtles using controlled trawling methods if efforts such as warning shots are not satisfactory and turtles are not clearing the blast area.
- Blasting activities shall be suspended during turtle breeding season if individuals cannot be satisfactorily removed from the area and blasting results in mortality.

19.17 Noise of this level has the potential to interfere with activities taking place at the camp, including the sleep of its occupants. In practice different noise limits, such as those taken from the *Australian Standard AS 2107 (1987)*, would be more appropriate to apply to the activities taking place within the camp. Given the modelling and recommendations set out in *AS 2107*, a more appropriate 'noise buffer' distance from the plant to the accommodation camp in bare flat terrain would be 2,500 m.

19.62 Assuming the above building attenuations, interior noise levels in temporary sleeping quarters during construction would exceed maximum levels in *AS 2107* by 23dB. This will result in personnel sleeping poorly and contending with working conditions where they will find it difficult to concentrate on complex tasks

19.63 Given the modelling results and the recommendations set out in *AS 2107*, during construction a more appropriate 'noise buffer' distance in bare flat terrain is about 2,400m

Due to ongoing Development design and optimisation, the construction village is no longer proposed in the location shown Figure 6.6 and Figure 7.8 of the Draft EIS/ERMP (refer to Part A of this document), and as a result the 'noise buffer' is greater than 2500 m. Also refer to 18.38 Section 6.3.6 and 24.74 (below)

- 24.74 Using this information, the predicted noise levels at the proposed construction/operation camp
- during construction range between 60–70dB(A)
 - during normal LNG plant operation range between 45–60dB(A)
 - during emergency flaring range between 70–75dB(A)

do not appear to comply with the Environmental Protection (Noise) Regulations. If they do comply, on the basis that the existing Chevron Camp should be classed as Industrial premises according to Schedule 1, clauses 7 & 8 of the Environmental Protection (Noise) Regulations (with an assigned level of 65 db(A) for LA10), the noise levels would be expected to be significantly in excess of sleep disturbance levels.

The proposed location of the construction village is some 2500 m from the gas processing facility. Noise modelling, provided in the Draft EIS/ERMP, predicts construction noise at this location in the order of 30 to 45 dB(A) depending on wind direction. Normal plant operation is predicted to be in the order of 35 dB (A). Given these ambient noise levels, within the construction village and buildings design to BCA2005, adequate sound attenuation will be provided and should meet AS2107. Emergency flaring will be non-routine and a nuisance only after the plant is operational.

7.5 Solid Non-hazardous Wastes

- 22.186 Wastes generated on Barrow Island will be generally removed from the island for disposal at an approved disposal facility; it is not said where.

Wastes which are removed from Barrow Island will be disposed at an approved disposal facility – this will most likely be in the Karratha area but equally some specific wastes may come directly to Perth (such as to enable the most appropriate recycling). Refer to 18.59 Section 6.3.5, 19.59 Section 6.3.5, 22.187 Section 7.8 and 24.24 Section 6.3.5.

7.6 Liquid Wastes

- 8.20 Hydrotest water from the Domgas pipeline is proposed to be discharged in two metres of water depth near the MOF. If this water cannot be reinjected it is recommended to discharge this in deeper water, perhaps towards the channel, where dilution rates would be improved.
- 22.173 Why hasn't a preferred method of disposing of hydrotesting water yet been determined? What might be "acceptable risks" for disposing of water off the east coast of Barrow, if that option is selected?
- 24.31 It is noted that hydrotest waters for the feed gas pipelines may be disposed into the ocean, but not definitely. Any disposal of pipeline hydrotest water in the waters around or beneath Barrow Island may threaten ecological values, particularly given the chemicals such as oxygen scavenger (eg ammonium bisulphite) and biocide (eg phosphonium sulphate).
- 24.101 The proponent must confirm whether the proposal involves discharge of hydrostatic test water into State marine waters. If so, the proponent should address matters relating to the discharge in the context of the list of points above. Please note that the criterion of 0.19mg/L proposed for the biocide phosphonium sulphate (based on EC50 48hr test on a freshwater organism) is at least an order of magnitude too high (a low reliability guideline would be 0.019 mg/L following ANZECC 2000). Furthermore, it is stated that the oxygen scavenger ammonium sulphate is added to generate a treatment dosage of 100 mg/L and that this is non toxic. Assuming the concentration of the ammonium component is 10 mg/L then this would have a significant toxic effect on marine biota as the 99% species protection guideline for NH₄ is 0.5 mg/L.

24.102 From the information provided, the EPA SU has concern that the potential environmental effects of discharging hydrostatic test water in State waters, particularly in shallow water near Barrow Is as eluded to on page 182, may be significant and have not been adequately assessed.

The Gorgon Joint Venturers are committed to undertaking additional work on optimising re-use of hydrotest water as much as reasonably possible; and undertaking additional work on the discharge of hydrotest water associated with the domestic gas pipeline (especially because it is land-locked at both ends) to ensure environmental risks are minimised, such as by controlling discharge rates of water and discharge location. Refer to 24.46 Section 7.6.

8.18 Noting the management measures outlined on page 182 which outline that if hydrotest water meets testing requirements it will be discharged to the marine environment, DoIR recommends that the discharge of any wastes within shallow water environments (Domgas, water maker etc) should be avoided and the base case should be injection of all liquid wastes as far as practicable. Only if this is not possible should marine discharge be regarded as an option. This should especially be considered for brine discharge from water makers which would be an ongoing discharge in the order of 100m³/hr throughout the life of the project.

Refer to 24.101 (directly above) regarding hydrotest water. Note that 'water maker brine' is concentrated sea water. Also refer to Draft EIS/ERMP, p 141, Box 6.10 for options being considered.

8.19 Hydrotest water discharge modelling was undertaken for concentration of chemical additives as outlined in section 7.6 although this did not appear to consider impacts of temperature or reduced salinity in the discharge zone. Chapter 11 states discharge of hydrotest water will be to high exchange areas however this seems to only apply to feed gas pipelines.

Refer to 24.101 (directly above) regarding hydrotesting of the domestic gas pipeline.

The temperature of the hydrotest water discharges will be the same as the surrounding seawater temperature as the pipeline is submerged.

Modelling was undertaken using treated seawater as the hydrotest medium.

18.43 More detail is required on the nature of power generator coolant water discharge to the environment, and the nature of, and impacts on, the receiving environment.

22.139 Why isn't cooling water discharge related to the proposed power generation dealt with at all in the draft EIS/ERMP?

23.03 Similarly the potential for cooling water discharge from a power generation plant on the Island is not discussed, and in the absence of information a clear view as to the impact of the proposal cannot be formulated

24.100 The proponent is requested to confirm whether any or all of the power generation facilities would be water cooled. If so, information about the source and disposal of cooling water is required. If cooling water is proposed to be discharged to the marine environment, the proponent must justify the discharge and determine the environmental effects of the discharge in the context of the list of points above.

The facility will be directly air cooled in a similar way to that employed at Woodside's Karratha Gas Plant, but some of the utilities such as lube oil systems may also contain a closed loop cooling circuit which will in turn be air cooled.

18.44 The proponent should provide details on the volumes and types of liquids used for cleaning of systems, the nature of the resultant liquid, and how it will be disposed of.

During the commissioning phase, cleaning fluids used inside process equipment may contain very weak acids/alkalis such as ammoniated citric acid (Draft EIS/ERMP; p 146). These cleaning fluids will be treated (e.g. neutralised) and, where practical, re-used in the process. The base case for the disposal of residual contaminated fluids is deep injection along with the other waste water streams. Refer to 19.01 Section 6.2.8 for further details on injection. In the unlikely event that deep injection is not possible; the Gorgon Joint Venturers will select an appropriate fallback option.

18.48 More information is required to enable assessment of environmental impacts in relation to the brine waste disposal units, including:

- The nature and qualities of pre-treatment additives;
- The location of the offshore disposal of water effluent;
- Information on the effects of the hypersaline water on the marine ecosystem; and
- The level and potential environmental impacts of increased sedimentation/total suspended solids that may result from the laying of disposal pipe.

22.32 Key issues not included in this draft EIS/ERMP, or not dealt with in sufficient detail, include:

- disposal of waste water;

22.169 Injection being considered again! What is the total amount of waste water/liquid waste for which re-injection is contemplated? What geological work has been done on the capacity of the relevant aquifers to accommodate these amounts?

22.174 What other water/liquid disposals might be occurring at the same time in similar locations during construction? How have those potential cumulative impacts been dealt with, if at all?

24.98 Box 6-10 includes the statement that "*The option for disposing brine from the water making system (i.e. reverse osmosis unit or similar) directly to the ocean is currently being investigated*". Similar statements appear on page 183. The proponent is requested to confirm whether the proposal being assessed involves intake of seawater for desalination and discharge of hypersaline brine to the marine environment?

Initial design details for the Reverse Osmosis (RO) plant for the proposed Gorgon Development estimated a fresh water demand of approximately 1000 m³/day (peak 1500 m³/day) resulting in a peak effluent brine stream of 3000 m³/day (Draft EIS/ERMP; pp 140 and 183). Subsequent work has shown that peak water production capacity is expected to be approximately 1800 m³/day of fresh water output. This would require 4500–5150 m³/day raw water, based on the raw water having a salinity which is similar to that of sea water and the RO plant having 35–40% recovery efficiency. The effluent brine flow rate is likely to be in the order of 2700–3350 m³/day.

The base case is injection (Draft EIS/ERMP; p 141) for brine disposal and it is proposed to inject into a formation (150–250 m) beneath Barrow Island which is well below known stygofauna habitat. A hydrogeological assessment is being conducted in early 2006, and further information on water source and re-injection depths will be available once the assessment is completed. The results of the hydrogeological survey will be made available to the relevant agencies as soon as is reasonably possible. Disposal of RO brine may also be undertaken via ocean outfall.

Refer to 19.01 Section 6.2.8 for further details

22.155 Given drilling fluid is re-used “as much as possible”, what happens to it when it is not re-used? What are the environmental consequences of that?

If non water-based fluids are used, they will be returned to the mainland for re-use, recycling or disposal. It is common practice when drilling wells offshore North West Australia, when using water-based fluids, to discharge them to the ocean when they can no longer be re-used. Environmental implications of drilling activities are discussed in Chapter 11. Additional details will be provided in the Environment Plan which is required under the Petroleum (Submerged Lands) (Management of Environment) Regulations. Refer also to the Draft EIS/ERMP Technical Appendix A1 Section 3.2 for additional details. This submission relates to offshore and CO₂ well drilling not HDD (p 127); however disposal of HDD drilling fluid and cuttings is discussed in 22.25 Section 6.3.4.

22.156 What are the environmental consequences of discharging cuttings overboard? Actual and proposed conditions relating to Woodside and BHP Billiton’s Exmouth sub-basin proposals would be relevant for the regulators to consider.

Drilling fluids, cuttings and other drilling wastes to be discharged during drilling activities are discussed in detail in Chapter 7, pp 179–181 (Chevron Australia 2005). The potential environmental impacts from drill cuttings are summarised in Table 11-3 (liquid and solid waste disposal – seabed) on pp 412 and 413 of the Draft EIS/ERMP (Chevron Australia 2005).

22.175 What are the consequences of possible injection of this type of waste water? What are the consequences of offshore disposal?

24.32 Disposal of tank and other plant hydrotest water in the waters around or beneath Barrow Island may threaten ecological values (see 6.3.12 above). In the case of using the waste water injection system, discharge would need to be into an aquifer which is remote from the superficial groundwater system.

24.104 “Once the hydrotest water is no longer required, the current base case is that it will be disposed of through the waste water injection system”.

vs.

“As a last resort, test water will be injected with other waste water streams”.

vs.

“If it (hydrotest water) meets testing requirements, it will be discharged into the marine environment at an approved location and discharge rate. (Page 182)

Environmental consequences of deep (e.g. 1000+ m) injection of hydrotest water will have no impact on the surficial groundwater systems. The Joint Venturers will optimise re-use of hydrotest water as much as reasonably possible. Should offshore disposal of hydrotest water be required, the Joint Venturers will ensure that environmental risks are expected to be negligible. For example, by controlling discharge rates of water and discharge location, especially in the waters on the east of Barrow Island. For the hydrotest water associated with onshore equipment, an option, which will be considered later in the design process, is to re-aerate the water before discharge. Another option, which may prove feasible in some uses (e.g. where only fresh water is used without chemicals or minimal benign chemicals), is to spray the water as dust suppression.

22.187 Produced formation water from the gas fields along with additives such as monoethylene glycol and corrosion inhibitor will be separated from the incoming gas stream and directed into deep injection wells. This is clearly not satisfactory and could well have environmental impacts such as impacts on the subterranean fauna. We would ask that in line with the claim to contributing to sustainability in Western Australia, the proponents produce a Zero Waste Strategy, with public involvement. The Western Australian government is committed to the vision of Zero Waste by 2020, a vision that involves moving away from the concept of ‘managing waste’ to treating waste as a resource. The emphasis is on waste prevention at source – there is no mention in the documentation of waste prevention, rather management of what appear to be toxic and hazardous waste streams.

The Gorgon Joint Venturers are committed to striving for a zero waste outcome as mentioned in the Draft EIS/ERMP, Framework EMP, Technical Appendix A1, Section 3.15 – the first bullet of which states ‘eliminate, reduce, re-use, recycle’. Further details on specific waste streams will be provided in the Waste Management Plan. Refer to 18.59 Section 6.3.5, 19.59 Section 6.3.5, 22.186 Section 7.1 and 24.24 Section 6.3.5. It has been determined for many years (globally) that the management of produced formation water by deep well injection is by far the most environmentally optimum approach. In the case of the Gorgon Development and Barrow Island, injection of waste water would occur well away from stygofauna which are in much shallower zones.

23.03 Similarly the potential for cooling water discharge from a power generation plant on the Island is not discussed, and in the absence of information a clear view as to the impact of the proposal cannot be formulated.

The gas processing facility will be air cooled, similar to the LNG plant in Karratha. Some utilities such as lube oil coolers will use a closed loop cooling water system which in turn will be air cooled.

24.44 In relation to threshold concentrations for effect related to hydrotect chemicals:

- what is the basis for determining the ‘no-effect’ concentration of phosphonium sulphate (nominally <0.19 mg/L) and
- what was the basis for determining the ‘no-effect’ concentration of OS2?

This is discussed in Section 5.6 of Technical Appendix B3 of the Draft EIS/ERMP which states:

- ‘... phosphonium sulphate ... has a reported toxicity at >19 mg/L (48 hr EC₅₀)’ and goes on to relate dilution against ‘the low reliability no-effect concentration (nominally <0.19 mg/L applying a dilution factor of 100 to the above EC₅₀ value)’.
- the oxygen scavenger is treated in such concentration that it ‘would leave no excess’ and the by-product of ‘ammonium sulphate is non-toxic’.

24.45 In relation to the modelled release of hydrotect water at the offshore production

- what was the distance from the discharge point (manifold station 2) for the concentration of phosphonium sulphate to be below 0.0016 mg/L, and area
- what was the distance from the discharge point for oxygen concentrations to be estimated to be above 99% of ambient concentrations?

Full details of the hydrotect water modelling are provided in Technical Appendix B3 of the Draft EIS/ERMP. In particular, hydrotect modelling is described in Section 5.6 and Figure 56 shows full details of the model output for the offshore pipeline discharge. Figure 56 shows 0.0016 mg/L (which is 1.6 µg/L and 1.6 ppb – which is obtained after a 57 000 fold dilution) covers all of the legend shown in Figure 56. This equates to an area in which chemical might be detected and which is delineated by a rectangle which is approximately 10 km x 5 km (50 km²), centred at the discharge point, but directed downstream with prevailing currents. However, this does not mean the zone of impact will be this large.

It must be noted that 0.0016 mg/L is two orders of magnitude less than ‘the low reliability no-effect concentration (nominally <0.19 mg/L applying a dilution factor of 100 to the above EC₅₀ value)’. This is four orders of magnitude less than the EC₅₀. In the same area, oxygen concentrations should be maintained at above 99% of ambient concentrations. Further details will be provided in the Hydrotect Water Management Plan if offshore disposal is required.

- 24.46 In relation to the modelled release of hydrotest water from the domestic gas**
- what was the distance from the discharge point (eastern shore Barrow Island) for the concentration of phosphonium sulphate to be below 0.0018 mg/L, and
 - what was the distance from the discharge point for oxygen concentrations to be estimated to be above 99% of ambient concentrations?

Full details of the hydrotest water modelling are provided in Technical Appendix B3. In particular hydrotest modelling is described in Section 5.6 and Figure 57 (Technical Appendix B3) shows full details of the model output for the Inshore pipeline discharge which address this submission. Work is ongoing to identify alternative destinations for disposal of hydrotest water from the domestic gas pipeline – primarily because it is land-locked at both ends. Figure 57 (Technical Appendix B3) shows 0.0018 mg/L (which is 1.8 µg/L and 1.8 ppb – obtained after a 51 000 fold dilution) covers all of the legend shown in Figure 57. This equates to an area in which chemical may be detected and which is delineated by a rectangle which is approximately 5 km x 3 km (15 km²), centred at the discharge point, but directed downstream with prevailing currents. However, this does not mean the zone of impact will be this large.

It must be noted that 0.0018 mg/L is two orders of magnitude less than ‘the low reliability no-effect concentration (nominally <0.19 mg/L applying a dilution factor of 100 to the above EC₅₀ value)’, and is therefore four orders of magnitude less than the EC₅₀. In the same area oxygen concentrations should be maintained at above 99% of ambient concentrations. Further details will be provided in the Hydrotest Water Management Plan if offshore disposal is required.

- 24.97 Does the proposal involve any discharge of domestic wastewater to the marine environment during construction or operations phases?**

Domestic waste water will be discharged from construction vessels in accordance with MARPOL requirements.

- 18.41 Further information is required on the proposed output from the current sewage outfall.**

The current sewage treatment facilities and associated outfall on Barrow Island are owned and operated by the WA Oil Joint Venture. Operations, monitoring and reporting against the conditions set out in the licence for the outfall are undertaken by WA Oil. Further details regarding the existing outfall are provided in the WA Oil 52 person camp EMP which has been approved by the relevant authorities. These sewage treatment facilities and associated outfall are not large enough to accommodate the Gorgon Development and so new facilities will be installed. It is proposed that treated effluent from the Gorgon facilities will be re-used where reasonably possible (Chevron Australia 2005, p 120) with surplus water deep injected well below known stygofauna habitat. Refer to 19.01 Section 6.2.8 for further details on injection. If the fallback option of ocean outfall is required for the Gorgon sewage treatment plant, the cumulative impacts of possibly having two outfalls will be assessed, and consideration will be given, in negotiation with WA Oil (Chevron Australia 2005, Box 1.3, p 7), to combining these streams into one outfall.

7.6.1 Liquid Waste Management

- 22.147 It is unacceptable that a specific waste water storage and treatment systems have not been proposed for assessment in the draft EIS/ERMP. Re-injection may be very damaging to stygofaunal assemblages.**
- 22.166 Additional flows from the current sewage outfall would have potentially serious consequences as well – careful analysis is required with much more information than has been provided.**

The Joint Venturers are aware that eutrophication (nutrient enrichment) of groundwater is a potentially serious issue for stygofauna. Hydrogeological modelling will be completed with the aim of defining subsurface conditions, assisting in planning and decreasing the likelihood of shallow groundwater contamination by waste water re-injection under Barrow Island. Sustainability of the aquifer is the intention for this aspect of the proposal.

23.02 In the current ERMP it is noted that at sea disposal of saline water from desalination is “under consideration” but that if there is a discharge to the marine environment, then due to the high tidal flow, there will be quote “negligible environmental impact”. However there is no detail justification for this view.

The Gorgon Joint Venturers are committed to undertaking additional work on the discharge of the water maker brine as mentioned in the Draft EIS/ERMP, p 183, which states ‘...at an appropriate disposal location’. It should be noted that the Burrup Desalination Plant which is mentioned in this submission (refer <http://www.epa.wa.gov.au/docs/976_B1014.pdf> is quoted in Table 1 as having a brine effluent rate of up to 77 ML/day, or 77 000 m³/day compared with the proposed Gorgon facility which is expected to have a brine effluent rate of approximately 3000 m³/day (Draft EIS/ERMP, pp 140 and 183). Thus these two facilities are not at the same scale, so should not be compared. Also, it should be noted that in their submission on the Draft EIS/ERMP the DoE (Submission 19.27 Section 6.2.8) requests more details on this effluent brine stream but also quotes ‘that discharge of the brine water to the ocean would be of insufficient size to be managed by the Department under Part V of the Environmental Protection Act’.

24.96 Discharges

The proponent should clearly and unambiguously document and specify all discharges to the marine environment. For each discharge, the proponent’s response must include the following information:

- A demonstration that the waste avoidance, minimisation, reuse and recycling principles have been addressed;
- The characteristics and constituents of the waste discharge, including any chemical additives (eg. corrosion inhibitors, anti-scalants, biocides);
- The location and depth of water at the discharge point;
- Method of discharge (eg. diffuser design);
- Discharge volume and rate;
- Results of whole of effluent testing and calculations of the numbers of dilutions required to achieve 80, 90, 95 and 99% species protection;
- Maps showing contours where the different levels of ecological protection determined from WET testing will be met; and
- Location of sensitive ecological reports.

Refer to 19.01 Section 6.2.8, 18.44 Section 7.6, 18.48 Section 7.6 and 24.97 Section 7.6. Domestic waste water will be discharged from construction vessels in accordance with MARPOL requirements.

26.43 We note with concern that the list of potential impacts on subterranean ecosystems does not include the consequences of waste water re-injection below the Island’s surface.

The primary objective of the Gorgon Joint Venturers’ water management strategy on Barrow Island is “to maximise the reuse of water, and to protect soils, subterranean fauna, groundwater and the marine environment from contamination” (Draft EIS/ERMP Page 120). It is proposed that waste water would be deep injected (1000+ metres) which is deeper than known stygofauna habitat. Also refer to 19.54 in Section 6.2.8.

Ocean outfall of treated waste water is still being considered and assessed as an option.

13.18 Groundwater is a key factor for stygofauna, including species listed under both the EPBC Act and relevant WA legislation. Yet, there appears to be no assessment of the nature of the groundwater system on Barrow Island, despite a long history of usage and spoilage of the groundwater resources by petroleum operations (Humphreys, 2002). This information is a necessary precursor to any risk assessment of activities that might, or will be, impacting on the groundwater, such as water abstraction, the discharge of sanitary waste and hypersaline water, and the risks to the groundwater ecosystem that will be associated with normal operations and accidental contamination from both land and sea.

The difficulty in the completion of these studies is the non-uniformity of the Barrow Island hydrogeology. Studies need to be accurate and will be localised to determine actual hydrogeological conditions. Subterranean fauna sampling programs will focus on stygofaunal population studies for the aquifer environments subject to saline water abstraction.

13.20 The depth to which stygofauna live on Barrow Island is not known, but elsewhere stygofauna, including vertebrates, may be found at depths in excess of 700m (Longley 1992; Essafi et al. 1998) in karst systems. The injection of sanitary waste to 150 -200 m depth may be directly into key stygofauna habitat; it is likely to impact on the more superficial aquifers owing to density differences, and be transported both inland and towards the sea owing to the seasonal movement of the saline interface (Michael et al., 2005) and by normal groundwater discharge.

The focus on the areas near the surface of the saline water interface is expected to reflect the distribution of the fauna. The likelihood that the areas chosen for injection disposal of wastes being 'key' stygofauna habitat is remote. Base case is to reinject waste water deep (1000m+) below Barrow Island. Drill logs will be examined to choose a zone below a non-permeable layer for injection of wastes. This will prevent upward movement of contaminants.

13.21 None of these risk factors appears to have been addressed in the EIS/ERMP despite the direct bearing they may have on EPBC listed fauna.

Deep (1000m+) injection of waste water has not been identified as a likely impact to stygofauna as the wastes are not expected to contaminate the shallower groundwater where stygofauna are known to live. Sampling of the groundwater for stygofauna populations will be conducted at depths where there may be a potential impact to subterranean fauna.

22.147 It is unacceptable that a specific waste water storage and treatment systems have not been proposed for assessment in the draft EIS/ERMP. Re-injection may be very damaging to stygofaunal assemblages. Additional flows from the current sewage outfall would have potentially serious consequences as well – careful analysis is required with much more information than has been provided.

The Joint Venturers are aware that eutrophication (nutrient enrichment) of groundwater is a potentially serious issue for stygofauna. Hydrogeological modelling will be completed with the aim of defining subsurface conditions, assisting in planning and decreasing the likelihood of shallow groundwater contamination by waste water reinjection under Barrow Island. Sustainability of the aquifer is the intention for this aspect of the proposal.

7.7 Hazardous Waste

No submissions received on this section of the Draft EIS/ERMP.

7.8 Dredging and Dredge Soil Disposal

5.5a Dredging – The dredging will be difficult to manage. The last dredging programme along the Western Australian Coast: Geraldton was a disaster. Allowing Gorgon to settle on Barrow Island will only constitute unnecessary potential risk to the marine environment, including coral reefs of high conservation value such as Dugong Reef, off the South-east tip of Barrow Island and the Montebello marine park. The last plume was visible from satellites and spanned from Geraldton to Kalbarri. There are dredged areas available on the mainland where ships already visit.

The extent of visible dredge plume is not considered to be an accurate prediction of significant environmental impacts. A post-dredging appraisal found that the dredge impacts resulting from the recent Geraldton Port dredging program were commensurate with predictions and did not result in significant long term environmental impact. As noted in Section 7.8 (p 188) of the Draft EIS/ERMP, recent studies in the Dampier region found that chronic sedimentation with TSS levels below 40 mg/L did not appear to result in elevated coral mortality. TSS levels that result in visible plumes are estimated at 2 mg/L above background levels. Therefore, a visual plume does not necessarily relate to significant impact on corals. Figure 11-9 (p 441) of the Draft EIS/ERMP indicates the extent of the visible plume as modelled at 2 mg/L above background. Section 11.3 (p 437) concludes that this level of TSS will not result in measurable impacts on benthic primary producers (BPP). Therefore, the risk of significant impact on areas such as Dugong Reef and Montebello Islands is expected to be low.

8.12 Unless a well developed justification can be provided for the existing site, the spoil disposal site should be relocated to deeper water where plume and sedimentation will not impact on shallow sensitive areas containing coral reefs, or an abundance of bonboras or macroalgae.

The spoil site was selected on the basis of being slightly deeper than surrounding areas and within a reasonable and economic distance of the dredge operations. Being slightly deeper indicates a depositional area that will already be subject to sediment accumulation with less potential for resuspension of the spoil. Proximity to the dredge site facilitates hopper barge transit over reasonable time frame. Modelling of the spoil ground is ongoing, but preliminary results indicate that there will be limited resuspension from the spoil ground and no impacts on the nearest sensitive coral habitats. Rather than reducing the area of habitat available to macroalgae and corals, the hard substrates of the spoil ground will support colonisation by macroalgae and a primary producer community is expected to develop.

16.3 The concept of an A-class Nature Reserve being used as a long term rubbish dump for hazardous industrial waste is morally and culturally corrupt.

A Waste Management Plan will be prepared and implemented for hazardous and non-hazardous wastes in consultation with the DoE and will include systems and details for individual waste streams. Solid waste will not be disposed of on Barrow Island, with the exception of waste concrete where it may be used by the existing oilfield operation (Refer to Draft EIS/ERMP; p 809).

The Joint Venturers note that CO₂ is not classified as a hazardous waste under either national or state law.

Wastes which are removed from Barrow Island will be disposed at an approved disposal facility, most likely be in the Karratha area or Perth. Also refer to 18.59 Section 6.3.5, 19.59 Section 6.3.5, 22.187 Section 7.8 and 24.24 Section 6.3.5.

18.2 In fact, information provided in the ERMP gives rise to increased concerns regarding the level of impact and manageability of risks.

The potential impacts due to dredging were foreshadowed in the ESE Review (ChevronTexaco Australia 2003; p 92). However, the extent of impact could not be determined until the results of geotechnical and hydrodynamic investigations were subsequently completed. Both the footprint of the proposed marine facilities and the dredge volume has been significantly reduced from the concept proposed in the ESE Review.

22.38 The Submitters would like to see an independent review of the dredging aspect of this proposal.

The Marine Services Branch in the DoE has experienced technical advisers who will be providing advice to the EPA on the dredging aspects of the Gorgon Development proposal.

23.7 If it is possible to remove the rock as rubble or larger pieces this will have an added benefit in that the spoil ground will, in effect, become rocky reef habitat which will provide environmental offset in terms of increased marine productivity

Dredging for the marine facilities will result in fine material, coarse sand, fist-sized rocks and larger rock fragments. Material transported to the spoil ground will generally comprise coarse sand and larger rock fragments up to approximately 30 cm in diameter. Sands will tend to settle between the rocks at the spoil ground, leaving a complex raised limestone reef structure. This will provide a suitable substrate for the settlement of algae and corals and will be readily colonised by marine BPP.

23.10 The modelled impact of the dredge plumes (the wharf plume and the pipeline plume on the north west quadrant of the Island) indicate that the pearl farms and trap fishing grounds will probably experience turbidity from the dredging plume and that areas of high impact may be adjacent to trap fishing areas. Recommendation; The impact of dredge plumes on adjacent pearl farms and on trap fishing needs to be identified and addressed.

No pearl farms or trap fishing areas are located within areas of potential high or moderate impacts from dredging, drilling or spoil disposal. Levels of turbidity and sedimentation in the zone of influence represent only a transitory (as little as one hour in any one day) and small increase (as little as 1 mg/cm/d) above background levels and this will have no measurable effect on BPP, fish or invertebrates within this zone (Chevron Australia 2005; Figures 11-6 to 11-9). The low level and highly transitory nature of turbidity or sedimentation plumes are predicted to have no measurable effect on pearling or fishing activities in the region. Cumulative deposition zones of sediments over the duration of the dredging are currently being modelled.

24.48 What are the characteristics of the dredge spoil site that would “minimise migration of the spoil from the disposal ground”, under normal tidal and also extreme (eg cyclonic) conditions?

The spoil site was selected on the basis of being slightly deeper than surrounding areas and within an economic distance of the dredge operations. Being slightly deeper indicates a depositional area that will already be subject to sediment accumulation with less potential for resuspension of the spoil. Proximity to the dredge site facilitates hopper barge transit over a reasonable time frame. Modelling of the spoil ground is ongoing, but preliminary results indicate that there will be minimal resuspension from the spoil ground and no impacts on the nearest sensitive coral habitats. Rather than reducing the area of habitat available to macroalgae and corals, the hard substrates of the spoil ground will support colonisation by macroalgae and a primary producer community is expected to develop.

24.105 “LNG Channel and turning basin dredging ~45 weeks (Table 7-11)

vs.

“LNG Channel and turning basin dredging ~55 weeks in Box 7-4

24.106 In clarifying the inconsistency above, the proponent is requested to 1) comment on whether the estimated time lines are considered 'realistic', 2) confirm whether time for 'shut down' periods due to possible exceedance of environmental management triggers have been factored into the anticipated dredging schedule and 3) how much time has been allocated in the dredging schedule to account for potential environmental management requirements.

The actual times will depend upon the variations in geotechnical geological conditions, weather and performance of equipment. The estimated timelines for dredging are based on production volumes from dredging in similar conditions and are realistic for the proposed facility. The 45-week estimate in Table 7-11 was a net estimate while the 55-week estimate in Box 7-4 included 10 weeks stand-down for coral spawning, excess turbidity and cyclone delays. The layout of the LNG channel and turning basin are undergoing optimisation with a view to reducing the size of the footprint and the dredge volume based on navigational simulation modelling.

Indications are that the total dredge volume for the LNG facilities will be reduced to approximately 6 million m³.

24.107 Wind: The wind field used to drive the model is derived from the LAPS model however there is no demonstrated validation of the LAPS winds. The proponent should provide validation for the predicted LAPS winds by comparison against actual measurements within the model domain.

Meso-LAPS model winds were compared with observed winds from the Barrow Island anemometer over the period 2000 to 2003. This was achieved by extracting model winds for the nearest grid point to the anemometer site.

The agreement between the model winds and observations was generally excellent. It is noted, however, that:

- the model winds were available at three-hour intervals compared with hourly anemometer observations
- although well exposed, the anemometer will be subject to some very localised biases
- there is a known bias in the model winds which tends to slightly underestimate wind speeds (by a factor of about 15%).

The model winds used in the dredging and model verification studies have been adjusted to allow for the speed bias.

Sample time series are presented from the year 2000 to illustrate the correlation between the observations and model output. Other years show very similar results.

Figures 1(a) and (b) respectively show speed and direction plots comparing observations against model output – the observations are at hourly intervals and the model at three-hourly intervals.

Figures 2(a) and (b) show a 'zoomed' plot for the May–June period and Figures 3(a) and (b) show the November–December period. These periods were randomly selected within the 'dry' and 'wet' periods to demonstrate typical correlations between the observations and the model winds.

One small, but consistent, difference shows up in the 'dry' months directions (Figure 2(b) when the flow is generally easterly. The observations show a slight diurnal trend which shifts the winds more towards the north-east (compared with the model); this is most likely to be a localised sea-breeze effect which would not be evident over waters off Barrow Island. Thus, the application of the model winds is more likely to produce realistic forcing than the observed winds during such periods.

Figure 1(a):
Response to Submission 24.107

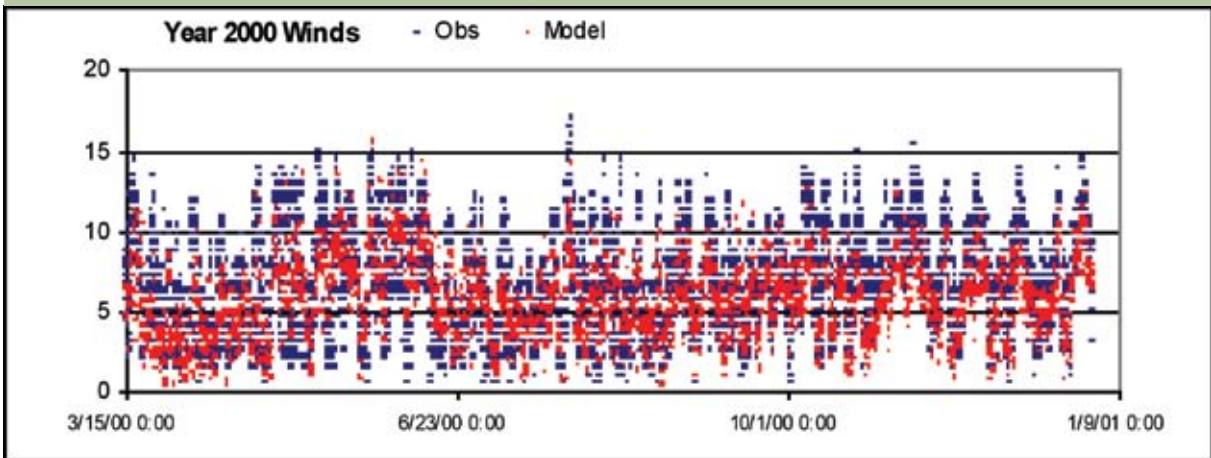


Figure 1(b):
Response to Submission 24.107

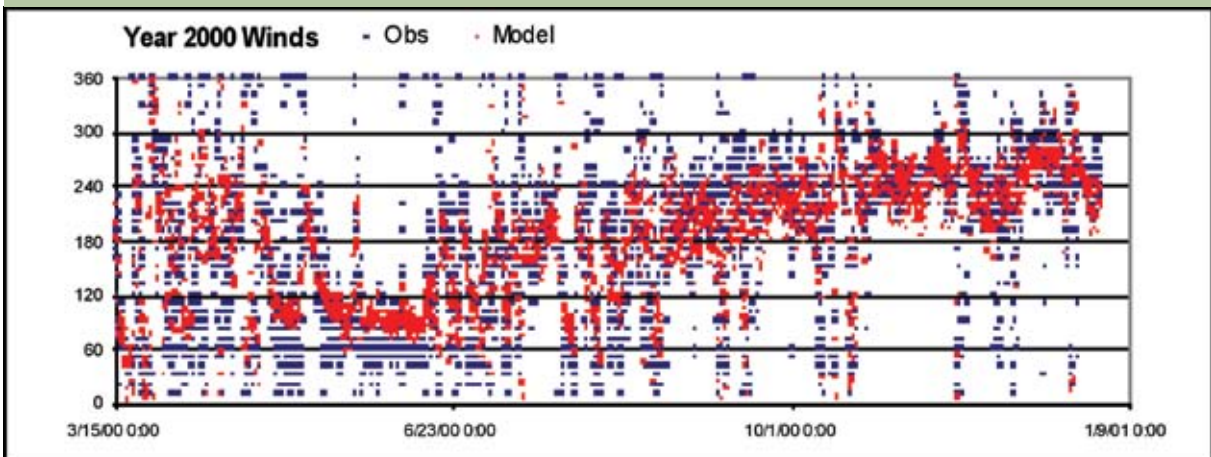


Figure 2(a):
Response to Submission 24.107

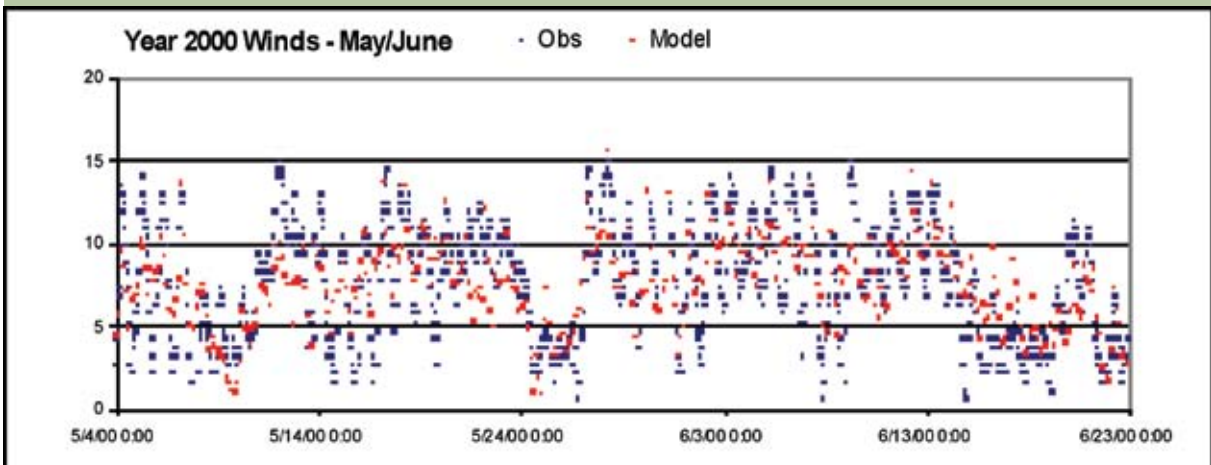


Figure 2(b):
Response to Submission 24.107

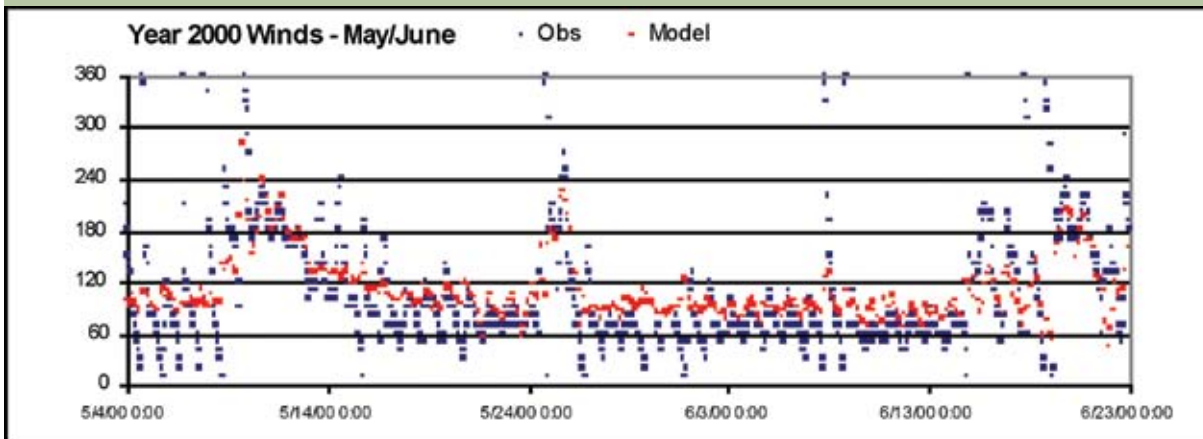


Figure 3(a):
Response to Submission 24.107

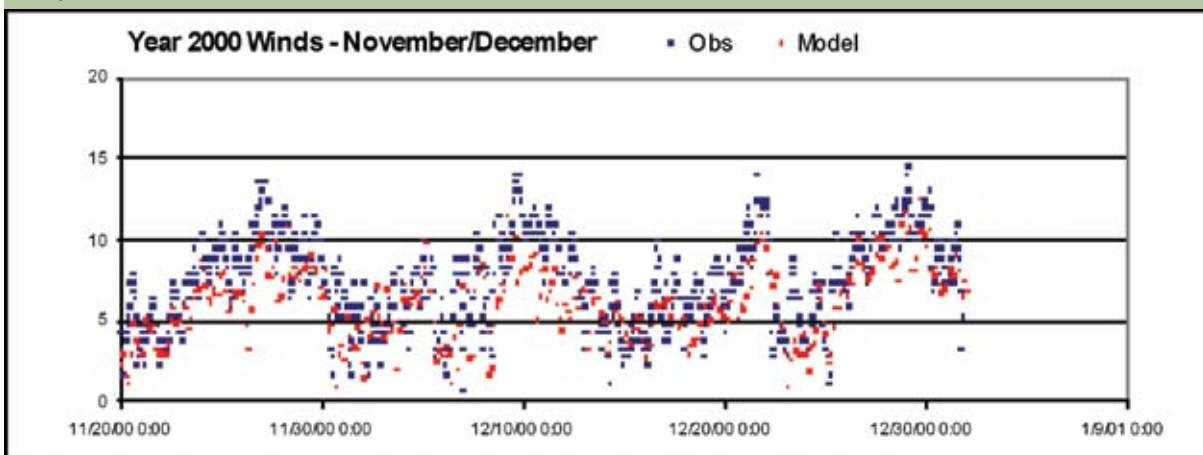
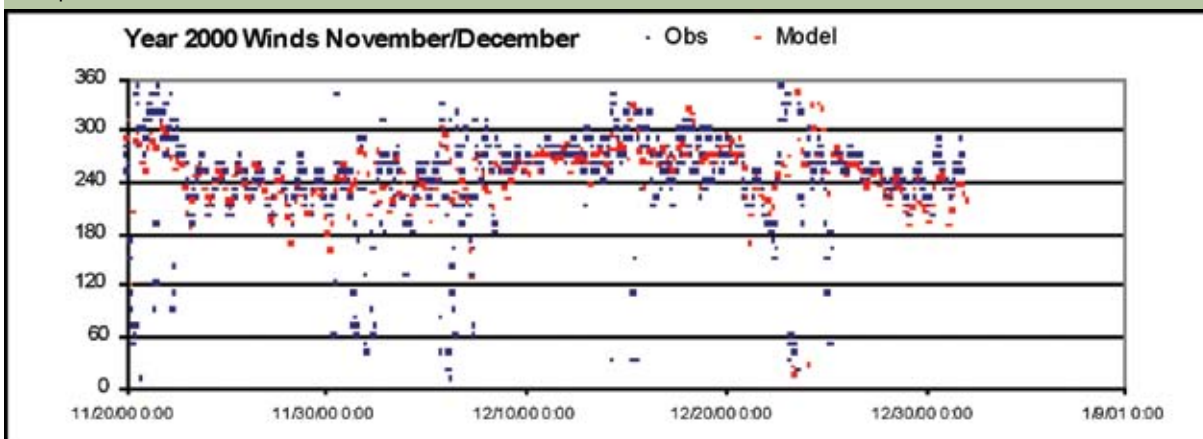


Figure 3(b):
Response to Submission 24.107



24.164 DREDGEMAP model estimates transport, sinking and sedimentation of mixed particle sized sediments. It is unclear whether the model allows for re-suspension and subsequent transport. The proponent should clarify and discuss the implications of this on the impact scenarios presented.

Rather than simplistic deposition at the point where a particle has sunk to the bottom as a product of the sinking rate and time, the component of DREDGEMAP that was applied to this study (SSFATE) applies decision-rules to determine the probability of deposition occurring. This is done for each individual particle at each time-step where the particle is at the benthic boundary. Deposition probability is calculated from a particle-size specific deposition co-efficient, critical suspension velocity and the local current speed and calculated turbulence at the benthic boundary layer.

As the west coast of Barrow Island is energetic, and literature from Environment Canada indicates that bentonite tends not to be cohesive or clump. Therefore, as it might be easily suspended, we applied a conservatively low critical suspension velocity (0.03 m/s) for the bentonite particles. The practical effect in the prevailing current field was to prevent a conservatively large proportion of these particles from settling, and thus represented continuous resuspension of some of the particles. This approach would have resulted in conservatively high average TSS concentrations over an extended period, but would not significantly affect sedimentation rates (because the suspended material represented a small proportion of the discharge mass).

24.165 Hydrodynamic Circulation and Transport – it appears that the model was run for a series of one week periods. This is not a true physical representation, because, while the source of drilling muds may have lasted for a week, the emissions would have continued resuspension/dispersion after the source was interrupted. The subsequent model tests extending for 15 days beyond the cessation of the discharge showed residual suspended particles of bentonite. This seems to invalidate the original (one week period) modelling simulations. The proponent should provide a response to this issue.

For the main stochastic analysis, simulations were run for 2 days beyond discharge in each case (plots shown show concentrations during discharge). By that time, all particles had settled except for a small proportion of the bentonite, for the reasons described above (i.e. due to conservative allowances), which were represented as continuously mobilising. This indicates that cumulative sedimentation estimates were not violated. Moreover, simulations over extended periods indicated that any material still suspended would have migrated from the discharge area (due to net currents moving away from each site) and thus would not have significantly affected TSS estimates.

24.166 Cuttings also required to be discharged – predominantly clay and fine silt. Is there any way these could be flocculated? Why cannot these be contained and appropriately disposed of on the mainland.

This mention of cuttings and discharges on the west coast refers to the materials which do not circulate back to the HDD site. Once the seafloor is penetrated by the HDD equipment, materials released will be released as part of the operation. These cannot be flocculated as the breakout point is located approximately 500 m offshore, and the HDD site is onshore.

24.167 Confirm that the model does not incorporate background TSS and that the criterion used – exceedance of ss conc 25 mg/l at least once per day for 5 consecutive days – includes background. What are the implications of the revised modelling using different criteria to address the issue of cumulative (vs consecutive days of) stress eluded to on page 427 of the ERMP?

The model did not include background TSS, as stated in the Technical Appendix B5. Background TSS tends to cause scavenging. Thus, this approach was also conservative for TSS concentrations and sedimentation estimates (by increasing the spatial extent of the area predicted to receive significant sedimentation). Cumulative stress thresholds for TSS exposure took account of the fact estimates were above background and were in terms of above background concentrations (also stated).

24.168 The last paragraph of Section 4.1 throws large uncertainty over the whole of the model results for drilling mud/directional drilling results. The proponent should address the environmental implications of the statements in this paragraph.

Resuspension of bulk sediments, of all size ranges, by swell waves (originating from a distance) or local storm events was not represented in the modelling. It is appropriate that this be explicitly stated. Experience from other sediment discharges indicate that sediment piles will be redistributed over longer spans (months to years depending on local wave energy and frequency of storm events).

7.9 Accidental Releases (Spills)

8.21 The EIS/ERMP doesn't appear to outline proposed leak detection techniques for pipelines and ancillary lines, perhaps due to the lack of progress on design. Suitable leak detection techniques should be considered for all pipelines, flowlines and umbilicals wherever practicable, in order to provide rapid response and minimise the consequence of a leak event.

The design process is not far enough advanced at this stage for the pipeline leak detection techniques to be established. Leak detection systems and technology, including new technology (such as radarsat or similar technology), will be investigated during detailed design. The process for determination of the project requirements for leak detection will include pipeline safety and environmental risk assessments.

10.6 The inevitable oil pollution that will result from the ships berthing on the proposed jetty is also a serious cause for concern.

The Gorgon Joint Venturers do not accept that oil spills are inevitable as 'Over 1000 tanker loadings and 300 million barrels of crude oil have been exported without incident from the east coast of Barrow Island in the last 35 years' (Chevron Australia 2005; p 509). The Gorgon Joint Venturers are committed to maintaining such a record, and approach the issue of potential spills in two main ways. Firstly and most importantly, through prevention (refer Draft EIS/ERMP, Section 7.9, p 188); and secondly, spill contingency planning as mentioned in Sections 7.9.2 and 16.2.11 of the Draft EIS/ERMP. The assessment in the Draft EIS/ERMP is conservative (i.e. represents a worst case) in that it did not take into account implementing response measures. A comprehensive assessment of spill risks is provided in Chapter 10 (terrestrial) and Chapter 11 (marine) of the Draft EIS/ERMP.

13.5 Recommendation: Before construction begins a study of currents and their potential impacts should be undertaken.

Hydrodynamic modelling of water currents in relation to dredge plumes, oil spills and sediment transport have been presented in the Draft EIS/ERMP (Chevron Australia 2005). Also refer to Technical Appendices B3–B6 and Chapter 11.

16.36 Inevitable Spills: Spills from the oil extraction activities are always of very great concern at any time and cumulative risks would be unacceptably high if a gas processing plant was added. It appears that chronic low level spills are already occurring, and there is always a risk of a massive spill which would be of high impact or possibly disastrous.

Natural gas processing is a very clean activity. The Joint Venturers' approach the issue of potential spills in two main ways. Firstly and most importantly through prevention (refer Draft EIS/ERMP, Section 7.9, p 188); and secondly, spill contingency planning as mentioned in Sections 7.9.2 and 16.2.11 of the Draft EIS/ERMP. The assessment in the Draft EIS/ERMP is conservative (i.e. represents a worst case) in that it did not take into account implementing response measures. A comprehensive assessment of spill risks is provided in Chapter 10 (terrestrial) and Chapter 11 (marine) of the Draft EIS/ERMP.

22.189 Has such modelling been at least as good as that done in connection with BHP Billiton and Woodside's work done in connection with their various Exmouth sub-basin proposals?

The Gorgon Joint Venturers cannot comment on the work undertaken by other operators but the modelling undertaken for the Gorgon Development (Section 7.9.2 and Technical Appendix B3) has employed a field validation step of the model to ensure that results of the model can be relied upon as representative of the real situation.

24.49 Figure 7-13 shows the probability contours from a predicted release 200m from Barrow Island of condensate and produced water from a feed gas pipeline? This figure is based on the Flacourt Bay landing option, which is not the preferred landing site. What would be the equivalent contours for a release offshore from the North White's Beach landing site?

Figure 7-13 of the Draft EIS/ERMP assumed a pipeline failure 200 m off Flacourt Bay on the west coast of Barrow Island, and also assumed that a conventional trenched pipeline construction technique would be used. The main purpose of that modelling was to determine how such a failure might potentially impact on Biggada Reef and the Marine Protected Area south of Flacourt Bay. It is now proposed to use horizontal directional drilling (HDD) further up the coast at North White's Beach (away from Biggada Reef and the Marine Protected Area). It is proposed that the HDD breakout point will be approximately 500 m from the shore line, and at the breakout point the feed gas pipelines would be covered with rock. The Gorgon Joint Venturers will be preparing an Oil Spill Contingency Plan in consultation with the Barrow Island Coordination Council (BICC) (as mentioned on p 32 of the Draft EIS/ERMP) at which time additional modelling may be required.

24.75 To what extent should there be agreement about the model used for predictions about spills close to the west and east coast of Barrow Island, and the outputs from the GEMS modelling? If they should be relatively close, are they and does the APASA modelling suggest support for or different predictions of plume movement from GEMS?

The APASA modelling system was applied to all spill modelling (hydrocarbons and MEG) along both the east and west coasts. Both the APASA modelling system and the GEMS modelling systems were applied to model sediment movement associated different sources of sediment suspension. The APASA system was used to model the fate of sediments suspended along the west coast from Horizontal Directional Drilling. The GEMS system was applied to model the fate of sediments suspended by dredging off the east coast of Barrow Island. Both the APASA and GEMS systems employed separate hydrodynamic and sediment fates sub-models. The APASA system uses the HYDROMAP 3D hydrodynamic model. The GEMS system uses the GCOM3D 3D hydrodynamic model.

The two hydrodynamic modelling systems should agree in terms of general wind and tidally-driven circulation patterns as they use similar or comparable data for bathymetry, tidal forcing and wind-forcing. Each model was applied to answer different questions and each used different samples of wind and tidal data, as suited to these tasks. For example, HYDROMAP was forced by data sampled from an 11-year archive of wind and tidal data, most appropriate for quantitative assessment of risk from accidental discharge. GCOM3D was forced with a 15-month long continuous sample of data to represent a programmed activity. Each model was validated against local current measurements. Although the two modelling contractors were supplied with different data sets to show validations of their respective hydrodynamic models, appropriately high correlations against independent measurements were shown for each model system, including comparisons against currents measured at one common point (Barrow Island Tanker terminal) indicating that both hydrodynamic models represented local circulation patterns adequately.

Example circulation patterns shown for an ebbing tide from GCOM3D (Technical Appendix Part 1 Figure 7) and HYDROMAP (4) show a similar general circulation pattern. Both models predict south-east current flows to split off the south-east coast of Barrow Island, resulting in strong flow northward through the Barrow Island channel (separating Barrow Island and the Lowendal Islands) and then eastward along the northern end of the island. Both models also predict strong westward flow along the southern end of Barrow Island.

Transport patterns shown by the fates sub-models in the two modelling systems similarly indicate general consistency in the representation of major transport routes (bearing in mind differences in the properties of material the fates models were representing). For example, sample TSS plots during dredging of the LNG Access channel (Technical Appendix B5 Figure 7.2 Page 35) indicate a predominant transport route to the north-east (passing immediately south of Varanus Island), with some material also conducted north through the Barrow Island Channel. Results of spill modelling from this site (tanker spills) indicate consistent representation of the most likely trajectory of material (but with more variability in the trajectory of material because oil will be more strongly transported by the wind). Similarly, both systems indicate that the most likely trajectory of submerged material (sediments for the GEMS system, aromatic hydrocarbons from the APASA system) released at the MOF would be northward, with some material then conducted eastward around the northern tip of Barrow Island.

Outputs of the APASA sediment modelling (for HDD discharge off the west coast) indicate some sediment would migrate around the northern end of Barrow Island and down the Barrow Island channel on flooding tides, but sediment moving back westward around the northern end of Barrow Island on an ebbing tide would be carried off the shelf, rather than back down the west coast. This outcome was consistent with results of the GEMS system, which also indicated that sediments transported northward through the Barrow Island channel on an ebbing tide would tend to drift off the shelf.

Some local differences would be expected between the outputs of the two models for similar conditions, because HYDROMAP was configured to operate with finer resolution (250 m) of circulation surrounding the offshore islands and over the bathymetrically complex areas between the islands compared to GCOM3D (500 m). Higher resolution of circulation patterns over these sections should result in resolution of local variations in current flow along the coastlines and through inter-island channels, while lower resolution would spatially average these flows. A high-resolution scheme was specifically applied to spill modelling and sedimentation from Directional Drilling (using HYDROMAP) because the discharge sources were from or immediately adjacent to the coastline.

24.148 The results lead to overall risk estimates of contact with sensitive habitats. The overall environmental harm (consequence) is not referred to in this appendix.

The submission is correct – Technical Appendix B3 quantifies risk of exposure due to an accident occurring and then hydrocarbon components migrating to sensitive resources at above threshold loads and concentrations. Minimum thresholds for reporting of any counts of ‘exposure’ in the probability estimates were based on conservative concentrations indicative of no effect concentrations (French 2000). Also refer to Ch 11 of the Draft EIS/ERMP for the assessment.

24.149 The spill risk assessment mainly considers shore contact as a surrogate for contact with vulnerable biota. Particularly for the non-surface residing plume/deposit from the spill, this is not a reasonable assumption and the proponent should assess the risk to non-shoreline biota.

The documentation and associated graphical summaries provided in Technical Appendix B3 systematically describe, for each spill scenario: 1) the risk of exposure to shorelines and shallow inshore areas from slicks, being an appropriate indicator of the potential for smothering and direct contact toxicity; and 2) the risk of exposure to dissolved aromatic hydrocarbons, being an appropriate indicator for the potential for toxicity to subtidal fauna for most oil types (French 2000). The exception is diesel, which has toxicity greater than expected from aromatic content.

Thus, total entrained hydrocarbons were considered in this case. The assessment of ecological risk associated with spills of various sizes on both coasts of Barrow Island is covered in the Draft EIS/ERMP Chapter 11 (Chevron Australia 2005; Section 11.5.5). This details various scenarios and their predicted impacts to habitats and biota along the shoreline where a low density surface plume is most likely to encounter sensitive receptors. The risk assessment also addresses risk to marine megafauna and subtidal habitats due to entrainment of hydrocarbons in the water column.

24.151 S2.1 – Step-wise changes in rectangular grid (4 cells in one) were used to gain additional spatial resolution around Barrow Island. Can such step-wise changes lead to energy reflection, within the model domain due to numerical error? The proponent should address this question.

The hydrodynamic model, HYDROMAP, uses a step-wise-continuous-variable-rectangular (SCVR) gridding scheme, and associated formulation specifically developed to avoid spatial and temporal discontinuities that can occur across boundaries between cells of varying resolution in nested models. The SCVR formulation applies a uniform spatial nesting ratio = 2 and a temporal nesting ratio = 1 (i.e. a uniform time-step across all levels). The formulation releases the time-step dependence so that longer steps may be used for model efficiency, without numerical instability. Details and general proof are provided in Isaji et al. (2001). Numerical stability of the model for this study area is amply demonstrated by:

- Uniformly high correlation against measured, independently positioned, current and tidal measurements at multiple sites over scales represented at grid scales ranging from 2000 m to 250 m.
- No evidence of distortion at nested boundaries – i.e. current estimates are uniform in speed and direction across boundaries (other forces and bathymetry etc. being equal)
- High stability of the model over time (several months), with no evidence of increasing error over time due to numerical instability (see comparisons against current measurements spanning weeks).

24.152 S2.2 – Please clarify the following questions:

- i) Did the hydrodynamic modelling for spill scenarios use wind forcings from the Barrow Island wind station, or the NCEP/NCAR modelled winds (to provide spatial variability) or a combination of both?**
- ii) Were the NCEP/NCAR predicted winds at Barrow consistent with the measurements of wind at Barrow Island?**
- iii) For the model verification against current meter data, were the Barrow Island winds only used? If so, can the model, as implemented for the spill trajectory analyses be said to have been truly verified?**

- i) Technical Appendix B3 of the Draft EIS/ERMP (p 8) states ‘...a spatially-varying wind field that covered a long duration (11 years: January 1988–December 1998) was used as input to the hydrodynamic model to generate data for use in the spill modelling. Wind data spanning this period were obtained for three locations within the hydrodynamic model domain. These included hourly data from Barrow Island and six-hourly data from two offshore locations located east and west of Barrow Island (Figure 24). The former were electronic records from an observation station located near the centre of Barrow Island (‘The Castle’; source: ChevronTexaco). The latter were output of a global atmospheric model (the NCEP Model reanalysis program; source: NOAA). These data were used to specify a time-varying three-dimensional wind field for the study area applying distance-weighted spatial interpolation.’
- ii) Technical Appendix B3 (p 30) states ‘Analysis of the wind data from each location indicated some differences in the prevailing directions of winds, as well as slight differences in the timing of seasonal changes, along and across the shelf within the study area (Figures 25–27).’ These differences are consistent with the different location of these points and were the impetus for specifying a spatially varying wind field, rather than uniform wind data. Note that the NCEP/NCAR re-analysis program integrates observed atmospheric variables and thus is typically more accurate than forecast models. In addition, long temporal samples (11 years) of wind data from all sites were used to provide a wide range of the possible wind conditions (including spatial variations) over the study area.

iii) Technical Appendix B3 (pp 5–8) mentions that comparisons to current measurements were made using forcing from Barrow Island wind data alone. Validations amply demonstrate that tidal currents were strongly dominant over the shallow ridge supporting the Barrow, Lowendal and Montebello Island complex and that this dominance, and resulting current speeds, directions and timing were well reproduced in the model using the applied tidal forcing, seabed drag and wind forcing. Moreover, wind events measured at Barrow Island were reflected in many, but not all, of the non-tidal flow events observed in deeper waters 60 km from the island, where tide influences were weaker and thus wind influences were larger (i.e. adjacent the proposed production area), indicating that spatial variation in wind conditions were responsible. Thus, it was appropriate to maximise the accuracy of the final current field to apply distance-weighting between the influence of the Barrow Island wind data (dominant around Barrow Island) and the NCEP/NCAR estimates (dominant at the offshore margin of the model domain).

As demonstrated by the supplied current measurements, geostrophic currents are insignificant over the waters of concern for this study. Review of estimates for these currents derived from satellite altimetry (CSIRO Bluelink & NASA GOOS) indicated that they did not penetrate into waters within the path of the simulated spills. Of equal concern, estimates of these currents are considered unreliable over shelf waters due to bias by strong tidal variations (David Griffin, CSIRO pers. comm.). Geostrophic currents are significant off the shelf (in depths generally >200 m) and therefore have the potential to periodically influence waters over the production area only.

A review of historic data for this region indicated that the offshore drift currents in this area are characterised by a complex of multiple, short-lived, eddies (clockwise or anticlockwise rotating) and associated jets, rather than as a laminar flow along the shelf. This analysis is supported by current measurements at this site, which do not indicate sustained flows along the shelf (see Gorgon North plots). Potential variability in current forcing due to short lived influences of drift currents was adequately accounted for in the spill modelling by applying random dispersion at higher rates at this site (10 m²/s) than over the on-shelf sites, where previous studies indicate rates of 1 m²/s are most appropriate (King & McAllister 1997).

24.153 S2.3 – Shallow water current meters are moored mid depth or near seabed. Comparisons between modelled and measured currents were therefore at mid depth or near the seabed. Hence, there are no comparisons between modelled and measured surface currents which are of interest for oil spill trajectories. How has this lack of validation for surface currents been factored into the risk assessments?

Spill modelling addressed transport of both surface slicks (an outcome of surface current drag and windage on the oil) and entrained/dissolved hydrocarbons (an outcome of water currents alone). For this reason, hydrodynamic circulation of the study area was modelled in three dimensions to account for vertical variation in current, accounting for tidal forcing (a bulk water-column force) wind-shear acting at the surface (and penetrating downward) and seabed drag (penetrating upward). Comparisons were then made against independently measured archives of current measurements, supplied by a third party, that were at different heights relative to the seabed and surface. Thus, measurements represented a spectrum of water depths suitable for testing vertical stratification of forcing. For example, comparison of the near-seabed and mid-depth measurements at Mooring 1 demonstrates that the increasing wind influence observed in the measured currents was appropriately scaled in the model data.

HYDROMAP has been regularly applied over the last five years to the North West Shelf as input to spill modelling where it has been widely validated against current measurements and surface drogues and has provided good predictions for the transport of real oil slicks (e.g. Cossack Platform and Varanus Island) as well as drifting objects. After detailed review, the model was adopted by the Australian Maritime Safety Authority as the hydrodynamic engine for the Australian National Plan spill response model. The model is also operated by the Western Australian Police as the source of hydrodynamic data for the Western Australian Marine Search and Rescue model.

24.154 Figure 11 (b) – for a good comparison, not only should the R² value be high, but the slope of the correlation line should be 1. Here the slope is closer to 0.75. The slope should have been stated on each of the scatterplot diagrams. For the mooring 1 mid depth comparison – the correlations were lower, and again slope not equal to 1. How has this been factored into the risk assessments?

Detailed analysis is provided for each comparison, demonstrating that the magnitude, direction and timing of currents are appropriately represented. Analysis of the regression and slope of the best-fit line comparing individual observations and predictions (hourly intervals) for the various comparisons are supplied in Table 24.154 attached below. These and other comparisons indicate a reasonable to very good fit at all sites, with poorest fit in deeper offshore water where model resolution was lowest and very high correlation over shallower waters where model resolution was concentrated. Moreover, correlation plots demonstrate that deviations are homogenous across the range of current velocities. – These outcomes are within acceptable tolerances and in our view demonstrate the model is fit for purpose.

Table 24.154

Analysis of the regression and slope of the best-fit line comparing individual observations and predictions (hourly intervals) for the various comparisons

Directional component	East–West component		North–South component	
	R ²	slope	R ²	slope
Mooring 1 @ 1.5 m ASB	0.856	1.05	0.965	1.00
Mooring 2 @ 1.5 m ASB	0.899	1.05	0.916	0.76
Mooring 1 @ 10 m ASB	0.602	0.75	0.715	0.73
Location 5 @ 6.5 m ASB	0.871	0.95	0.801	0.95
Location 2 @ 110 ASB	0.603	0.62	0.54	0.70
Location 2 @ 180 m ASB	0.432	0.62	0.361	0.63

Note: a perfect comparison = 1 for each parameter

24.155 Was wave forcing part of the forcing governing how the oil would emulsify? If so what wave forcing was used?

24.156 Grounded export tanker – what is the basis for assuming the spill will be brought under control within 1 day?

24.157 Refuelling – what is the basis for assuming the spill will be brought under control within 1 hour?

24.158 Table 5 presents a limited sample of spill scenarios, and the associated primary and secondary risks associated with these. Given that there are a whole range of other scenarios which have not been included, what then is the total cumulative risk?

As mentioned in the Draft EIS/ERMP, Chapter 11, p 509, ‘...over 1000 tanker loadings and 300 million barrels of crude oil have been exported without incident from the east coast of Barrow Island in the last 35 years.’ Thus, the chance of a spill is considered to be remote, but modelling was undertaken nevertheless.

In the model wave-forcing is used to calculate entrainment and emulsification rates. Wave forcing is calculated by SIMAP at each time-step as a spatially varying parameter based on wind-fetch (distance to upwind land) and sustained wind speed.

Table 5 Scenarios

- The grounded tanker scenario assumed that a ship drifted from the tanker mooring onto shallow ground due to wind/tide drift, rather than at high speed, on the basis that ship movements into the mooring are controlled by detailed safety procedures, piloting and support craft. The slow grounding was assumed to cause cracking of outer tanks rather than extensive rupture of tanks, based on review of historic accident records. Chevron Australia considered that it was reasonable to assume that leakages of this type could be controlled within 12–24 hours using on-site equipment, such as by allowing for a tank's contents to be transferred to another tank. Primary risk values accounted for both the size and nature of the spill, while longer duration spill events have lower probability.
- Refuelling operations are controlled by established safety procedures, such as dual monitoring at the supply and receiving points and multiple redundancy levels on the supply system (fuel lines selection, dry-break couplings), which limit the duration of spills to minutes. Primary risk values accounted for both the size and nature of the spill, while longer duration spill events have lower probability.
- A list of scenarios were developed to be representative of each phase (development and operational) and geographic location of the development (offshore production, supply feed, export and support operations). The scenario list was finalised following internal review and presentation to a panel of government representatives.

24.159 Please explain how the near-discharge concentrations and dilutions were calculated. If they are on the basis of the HYDROMAP and CHEMMAP models, then the near field dynamics and mixing processes have been neglected, and there may also be spatial averaging across the model cells.

24.160 Note comments in dot point 1 on page three of this submission relating to the relevance of the proposed criteria that underpin assessment of the modelling scenarios.

Technical Appendix B3, Section 4.1 (Chemical spill modelling system), considers the initial plume dynamics. This was achieved using a near-field dispersion model (a variant of the OOC model (Smith et al. 2004), which calculated initial dilution due to the velocity (based on the pipeline diameter and flow-rate), orientation, and density of the discharge (relative to receiving waters). A far-field dispersion, reaction and transport model then calculated the far-field fate of plumes, after near-field dilution. Spatial averaging is an important issue for both field sampling and model estimation. The problem is minimised by calculation of concentrations at higher spatial resolution. For this application, the near-field model considered scales of meters, while the far-field model operated at a scale of 25 m. Initial concentrations, following near-field dilutions, were reported at the latter scale for the grid surrounding the designated discharge point.

24.161 Please clarify how the spill assessment considers work vessel collision within port approaches – this is not evident in the documentation provided.

Technical Appendix B4, Section 3.6, addresses the issue of work vessel collision within port approaches where it is concluded that ‘...this scenario is very unlikely to occur and result in a marine spill, and will not be considered further.’ The Oil Spill Contingency Plan mentioned in Technical Appendix A1 Section 3.19 will address this issue along with other spill scenarios.

24.163 Confirm that if bentonite is used then Biggada reef in the Barrow Island Marine Park is predicted to receive high concentrations of TSS (exceeding 300 mg/l).

Predicted concentrations at Biggada Reef for discharge at Flacourt Bay were highly variable over time and generally below 50 mg/L. However, individual, short-lived (= 1 or two events at the 1-hour output time step of the mode) were higher. Review of the outcomes reveals that this statement was overly conservative and should read ‘exceeding 100 mg/L’. The example plots provided (plot C for Flacourt Bay discharge) show the highest instantaneous concentration case at ~200 mg/L for one time step, but concentration peaks generally <75 mg/L. (The last peak in each plot shows the highest value recorded during the simulation). A biodegradable saltwater polymer drilling fluid is currently preferred for the HDD drilling fluid and the preferred location is North White’s Beach.

Table 24.154

Analysis of the regression and slope of the best-fit line comparing individual observations and predictions (hourly intervals) for the various comparisons

Directional component	East-West component		North-South component	
	R ²	slope	R ²	slope
Mooring 1 @ 1.5 m ASB	0.856	1.05	0.965	1.00
Mooring 2 @ 1.5 m ASB	0.899	1.05	0.916	0.76
Mooring 1 @ 10 m ASB	0.602	0.75	0.715	0.73
Location 5 @ 6.5 m ASB	0.871	0.95	0.801	0.95
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Location 2 @ 180 m ASB	0.432	0.62	0.361	0.63

Note: a perfect comparison = 1 for each parameter

8 Existing Environment

8	Existing Environment.....	177
8.1	Introduction/General Submissions on Existing Environment	178
8.2	Physical Environment.....	178
8.2.1	Introduction.....	178
8.2.2	Regional Setting	178
8.2.3	Climate.....	178
8.2.4	Bathymetry and Sea Floor Topography.....	178
8.2.5	Oceanography	178
8.2.6	Topography and Landforms	179
8.2.7	Geology and Soils	179
8.2.8	Seismic Activity	179
8.2.9	Surface Hydrology	179
8.2.10	Hydrogeology	179
8.3	Ecology	181
8.3.1	Introduction/General Submissions on the Ecology of the Existing Environment	181
8.3.2	Terrestrial Ecology	181
8.3.3	Marine Ecology	194
8.4	Social Environment	201
8.4.1	Introduction.....	201
8.4.2	Population Trends and Demographics	201
8.4.3	Lifestyles and Livelihood	201
8.4.4	Government Policies and Plans	201
8.4.5	Land and Sea Tenure and Use	201
8.4.6	Visual and Aesthetics	202
8.4.7	Cultural Heritage.....	202
8.4.8	Native Title.....	203
8.5	Economic Environment.....	203

8.1 Introduction/General Submissions on Existing Environment

No submissions received on this section of the Draft EIS/ERMP.

8.2 Physical Environment

8.2.1 Introduction

No submissions received on this section of the Draft EIS/ERMP.

8.2.2 Regional Setting

22.203 Barrow is regularly and inaccurately described in the draft EIS/ERMP as being part of the Pilbara, when in fact we understand it to be part of the Cape Range subregion of the Carnarvon bioregion. Please refer to pages 2 and 3 of the attached report (Appendix 5) by Dr Malcolm Trudgen.

Barrow Island lies within the Interim Biogeographic Regionalisation for Australia (IBRA) Pilbara bioregion, but is close to the boundary with the Carnarvon bioregion. The Draft EIS/ERMP recognises this in the description of regional vegetation affinities (Chevron Australia 2005, pp 222–223) and the subterranean faunal affinities with the Cape Range area (Chevron Australia 2005, pp 249). The distribution of other fauna, for example mammals, generally extends or did extend, beyond the immediate bioregion. The EPBC Act search tool appears to consider Barrow Island as part of the Pilbara as it lists taxa such as the Pilbara leaf-nosed bat as potential inhabitants of the island. The island lies within the Interim Marine and Coastal Regionalisation for Australia (IMCRA) Pilbara offshore marine bioregion.

8.2.3 Climate

No submissions received on this section of the Draft EIS/ERMP.

8.2.4 Bathymetry and Sea Floor Topography

No submissions received on this section of the Draft EIS/ERMP.

8.2.5 Oceanography

11.5 The potential for this development to seriously impact on turtle nesting sites is very significant. Despite the lengths the proponents are prepared to go to in terms of lighting and construction times, there is no guarantee these measures will be successful. Furthermore, the construction of the causeway may have serious detrimental impact on water currents adjacent to the nesting sites. These impacts cannot be accurately predicted as we do not have a thorough enough understanding of turtle nest site selection or of what effects changed currents may have on the structure of the beach. While I accept that when planning a development, not all contingencies can be accounted for, the protection of the breeding ground for a threatened species on a dedicated nature reserve is not something that should be left to chance.

16.49 Gorgon has stated that a causeway could be built out to the proposed jetty to eliminate that need for dredging, but the causeway would create another set of serious problems, not yet resolved.

Current measurements and modelling has been undertaken in the vicinity of the marine facilities on the east coast of Barrow Island. The results of this program indicate that the currents are driven by the tides. These tides occur twice a day and range up to 4.4 m. The currents in the near shore area are generally very low and decreasing toward the shoreline. The ebb tides tend to drain in a north-easterly direction towards the natural channel off the north-east coast of Barrow Island and then in a northerly direction along the channel. The effect of the causeway will direct the current in an easterly direction to the end of the causeway and then head north. Water currents in the vicinity of nesting beaches adjacent to Town Point are buffered by the broad rock platform near the shore. Hydrodynamic modelling indicates that the presence of the causeway will reduce wave energy in near shore waters.

There will be a slight increase in this current as it passes the eastern end of the causeway. The flood currents are less concentrated. Field investigations using drift mats confirm that the currents round the northern end of Barrow then fan out over the Lowendal Shelf. Again there will be a slight increase in the current as it passes the head of the causeway and heads south-west. Lighting impacts and stability of the shoreline are discussed above in Response to Submission 10.9.

8.2.6 Topography and Landforms

No submissions received on this section of the Draft EIS/ERMP.

8.2.7 Geology and Soils

No submissions received on this section of the Draft EIS/ERMP.

8.2.8 Seismic Activity

No submissions received on this section of the Draft EIS/ERMP.

8.2.9 Surface Hydrology

No submissions received on this section of the Draft EIS/ERMP.

8.2.10 Hydrogeology

13.19 It is recognised that the groundwater system of Barrow Island constitutes an anchialine system, and that this comprises both the superficial freshwater component and the transition through to the deeper saline aquifer. This is described on page 249 of Chapter 8 in the Draft EIS/ERMP (Chevron 2005). The expectation that this would be the case was the primary reason for drilling deeper stygofauna monitoring holes and carrying out geophysical studies to identify the halocline and provide for groundwater profiling and targeted sampling of fauna.

It is recognised that the groundwater system of Barrow Island constitutes an anchialine system, and that this comprises both the superficial freshwater component and the transition through to the deeper saline aquifer. This is described on page 249 of Chapter 8 in the Draft EIS/ERMP (Chevron 2005). The expectation that this would be the case was the primary reason for drilling deeper stygofauna monitoring holes and carrying out geophysical studies to identify the halocline and provide for groundwater profiling and targeted sampling of fauna.

13.23 The lack of groundwater modelling, and of information on the vertical and lateral transmissivity of the karst system, prevents assessment of the likely extent of impact on the aquifer of any contamination from pipeline or plant related escapes or marine spills.

The Joint Venturers agree that it would be valuable to have a detailed assessment and (groundwater) model of the groundwater and surface water system of this part of Barrow Island. This is being undertaken as part of ongoing studies of the hydrogeology of the development area. The data and modelling will be used to refine management plans.

13.24 The statement section 3.2 (Subterranean Fauna Survey) that ‘most boreholes profiled showed little evidence of change in the measured groundwater parameters with depth of between holes’ is clearly contradicted by Fig 3.4 which shows the salinity profile typical of anchialine systems as previously reported (Humphreys, 2002).

This is a misleading interpretation of the text in the subterranean fauna survey report. The report (Additional Information Package, Part 3) (Chevron Australia 2005b) went on to expand this comment noting: ‘Temperature and pH showed little variation with depth or between holes, with averages of 30.19°C ±0.8 and 7.55 ±0.2’. Salinity typically increased with depth, with halocline holes such as S5 showing a transition through a superficial freshwater lens (salinity less than 5 ppt) through a halocline of 5–10 m in thickness and into brackish to saline water beneath (15–20 ppt).’As noted in this submission, this is consistent with the profile of an anchialine system. The data provided in Appendix 2 of the technical report also illustrated that, salinity and dissolved oxygen aside, there were no consistent variation of trends in other parameters with depth (consistent with the opening comment). Also refer to 13.25 below.

13.25 Profiling at 5m intervals is inadequate to detect major stratification features in the groundwater physico-chemistry as they often occur on a much finer scale in anchialine systems (Humphreys, 1999, unpublished data)

The work completed to date was intended to provide first-pass data to identify the depth and presence of halocline; not to provide a detailed study of haloclines and chemoclines at the level of the work of Humphreys (1999). The current level of sampling was sufficient to demonstrate the depth of the halocline (Part 3, Additional Information Package) (Chevron Australia 2005b).

22.200 Again, given the importance of this issue, why are phrases like “most likely” still being used?

The term ‘most likely’ is used to reflect the unavoidable level of uncertainty and unpredictability that is inherent in the response of all natural systems to perturbations.

22.201 Why are these comments limited to contamination under and near the proposed development sites? Given that Chevron places so much emphasis on supposed good management of the oil operations in order to support its access to Barrow as part of the GJV, there should be full disclosure of their environmental record thus far. Please again note the overview and relevant Parliamentary questions in Appendix 1.

The purpose of this Draft EIS/ERMP is to assess the likely environmental impacts of the proposed gas processing facility and associated facilities. It is the aim of the proponent to limit all negative environmental impacts where practicable. The Joint Venturers aim to manage all environmental impacts through the implementation of Environmental Management Plans (refer to Chapter 16 of the main report for an overview) specifically related to aspects of the proposal.

19.47 When the consultant’s hydrogeology report becomes available, it should be forwarded to this Branch (Attention Gary Humphreys, Senior Hydrogeologist Northwest) and to the Northwest Regional Office in Karratha. The regional office should also be the first contact for all licensing matters

Details noted

8.3 Ecology

8.3.1 Introduction/General Submissions on the Ecology of the Existing Environment

22.37 Key taxa for which major information gaps (either at the Island or regional scale) include:

- Barrow Island Golden Bandicoots;
- potential short range endemic invertebrates;
- the potentially new species of scorpion and pseudoscorpion;
- flatback turtles (foraging and inter-nesting habitats in particular);
- Dugong populations around Barrow; and
- Sea snakes and kraits.

22.225 Why hasn't more work been done to ascertain dugong populations around Barrow?

Barrow Island golden bandicoots, short-range endemic invertebrates and the new scorpion and pseudoscorpion species were included in the baseline survey work reported in the Draft EIS/ERMP (Chevron Australia 2005; Technical Appendices C2 and C4). Flatback turtles are the subject of baseline surveys reported in the Draft EIS/ERMP (Chevron Australia 2005; Technical Appendix C7) and ongoing monitoring. In hundreds of hours of marine survey work in the waters off the east coast of Barrow Island, only one dugong has been sighted (near Dugong Reef). Other individuals have been observed near Varanus Island. This indicates that they are present throughout the proposed Development area (Chevron Australia 2005; pp 265). However, the absence of major seagrass meadows on which these animals feed indicates they are unlikely to aggregate in significant numbers in this locality.

Sea snakes and kraits are highly mobile fauna and are widespread in the Pilbara region in both offshore and nearshore waters (Chevron Australia 2005; p 271). Their numbers vary on broad spatial and temporal scales and it is highly unlikely that any critical habitats will be impacted by the development. Observations of sea snakes and kraits will be recorded during environmental monitoring for the Development to increase the scientific knowledge base for these species.

22.202 Why is the community being asked consider this draft EIS/ERMP when biological surveys have not been completed?

Sufficient survey work has been completed to assess the risks to terrestrial and marine fauna and habitats. Ongoing survey work will fill gaps in existing knowledge that will facilitate better management planning.

8.3.2 Terrestrial Ecology

10.3 There is lack of information supplied in the sections that describe the fauna communities on the island. It does not give any details on the threat status of 6 of the 7 listed threatened animals on the island.

The six listed threatened or vulnerable mammals and the one priority 4 mammal is described in the section dealing with the mammal fauna of Barrow Island in the Draft EIS/ERMP (Chevron Australia 2005; p 238). Further information on these threatened species is included in Technical Appendix C2.

10.4 There is insufficient information given on the conservation status of reptiles on the island, which is a concern because more than 50% of the terrestrial reptiles on the island have been recorded in the proposed development area.

The only reptile with an official conservation status on Barrow Island is the subterranean blind snake, *Ramphotyphlops longissimus*. As stated in the Draft EIS/ERMP (Chevron Australia 2005; p 243), none of the other reptiles on the island are listed threatened species. However, all reptiles on Barrow Island have been considered as ecologically significant units (given higher conservation status than their official listing) to reflect the probability of genetic divergence from mainland taxa consistent with the principles of genetic biodiversity protection.

13.12 The small northern and apparently endemic species, *Rhagada* sp.1, may have similarly differentiated at the population level. Its vulnerability to any disturbance warrants as detailed an examination, both of its distribution and its generic characteristics, as is possible.

13.14 This was already known and begs the question 'why was the genetic diversity of this species need not be investigated?'

Rhagada sp. 1 has not been recorded from the areas of potential disturbance from the proposed Gorgon Development.

13.13 We question whether the genetic diversity of these pupillid species would have been examined if live specimens had been found?

Rhagada sp. 2 was the only landsnail found in sufficient numbers for meaningful electrophoretic analysis.

13.15 Attachment 2: this attachment consists of lists of survey stations, habitat details, etc., each station being designated by a "Site Code". The descriptions of these 'sites' do not include co-ordinates. These 'Site Codes' do not correspond with the numbering given for the 'Sampling Sites' as listed in Attachment 1, for which the co-ordinates are given, nor do they correspond with the site numbering system used by M.S Johnson in Attachment 4.

Not sure which Attachment is referred to here. Sample Site coordinates are included in Table 2-1, p 9 of Technical Appendix C4 (Chevron Australia 2005). All specimens vouchered at the Western Australian Museum were labelled with GPS coordinates.

13.16 If the northern area of the island is to be used for sequestration of gases, the installation of access roads, pipelines etc. would impact on the small and only known population of this species.

The proposed locations of the CO₂ injection sites are now close to the gas processing plant on the central east coast of Barrow Island. Pipeline routes will be selected to avoid habitats that are not well represented in surrounding areas. The protection of the landsnail habitat will ensure protection of the landsnail populations also.

13.17 The larger species of *Rhagada* spans the remainder of the island, 3 samples were obtained from the Gorgon area. It would appear that here 'Gorgon Area' seems to be interpreted as only consisting of the footprint area for the treatment/storage installations on mid-eastern coast. It does not appear to include areas running across island (W to E, and perhaps S to No) that would be impacted for the installation of access roads, pipelines, etc.

The 'Gorgon area' referred in Attachment 4 is the gas processing facility area. This is the only one of the proposed development areas that is considered large enough to have potential effects on local landsnail populations.

16.30 The favoured nesting sites for the White-winged Fairy Wrens were not identified, this is vital to ascertain.

Recent work on the habitat usage by the white-winged fairy wren was completed in the winter of 2005 (Chevron Australia 2005; Technical Appendix C2 – Attachment 5). This study indicated that the wrens prefer emergent shrubs *Melaleuca* and *Acacia* for roosting and nesting. This is consistent with previous studies by Pruett-Jones and Tarvin (2001) and supports the approach to risk assessment.

16.31 Can an estimate of 9336 of these Wrens on Barrow Island be reasonably extrapolated from a single two-day count made at Town Point on 22–24 October 2004? (2 Methods, page 56).

In addition to the quoted survey, land bird surveys were conducted twice each month from September 2003 to September 2004 within the proposed Development area (Chevron Australia 2005; Technical Appendix C3, Section 2.2.2). Data gathered during these surveys support the population estimate.

16.33 It cannot be supposed that the proposed development at Town Point would only impact on the 315 individual wrens thought to be there during field surveys, since it cannot be known how important these individuals are for the viability of the remaining genetic stocks.

The size of the wren population on Barrow Island, the second most abundant bird on a large island, and their ability to disperse over large distances on the island, does not indicate that genetic depression is likely.

18.18 The ERMP fails to recognise the significance of Barrow Island for biodiversity conservation at the regional, state and national scales. Barrow Island is one of the largest islands in the world that is without any introduced vertebrates. It provides a refuge for a diverse range of flora and fauna, many of which are endemic to Barrow Island and genetically separate to species on the mainland. These features make Barrow Island significant on a global scale, which is not fully recognised by the proponent in the ERMP.

18.21 Given this, CALM is not confident that the proponent has an adequate understanding of the significance of Barrow Island as a refuge for biodiversity at the regional, state and national scales.

18.72 The process undertaken by Chevron Australia to assess the environmental risks associated with the proposed Gorgon development is flawed, and should take into account the increased vulnerability of insular terrestrial fauna populations. Further detail is required from Chevron including a more realistic analysis of the risks to these species.

Barrow Island Nature Reserve was established in recognition of the importance of the mammalian fauna on the island. More recently the significance of its invertebrate, avian, reptile and subterranean fauna has been recognised or assumed due to its isolation from the mainland. The conservation significance of Barrow Island at all spatial scales is recognised in the Draft EIS/ERMP, for example, in the description of the importance of the mammal fauna on Barrow Island within the Pilbara region (Chevron Australia 2005; p 236) and subterranean fauna at all scales (Chevron Australia 2005; p 249).

18.19 The ERMP compares Barrow Island biota with Pilbara Region biota rather than biota of the Carnarvon bioregion, of which Barrow Island is a part. It makes reference to mammals being widespread and abundant on Barrow Island, but does not recognise the significance of these populations at the regional, state and national levels.

Barrow Island lies within the Interim Biogeographic Regionalisation for Australia (IBRA) Pilbara bioregion, but is close to the boundary with the Carnarvon bioregion. This is recognised in the Draft EIS/ERMP in the description of regional vegetation affinities (Chevron Australia 2005; pp 222–223) and the subterranean faunal affinities with the Cape Range area (Chevron Australia 2005; p 249). The distribution of other fauna, such as mammals, generally extends or did extend, beyond the immediate bioregion. The EPBC Act search tool appears to consider Barrow Island as part of the Pilbara listing taxa such as the Pilbara leaf-nosed bat as potential inhabitants of the island. Barrow Island lies within the Interim Marine and Coastal Regionalisation for Australia (IMCRA) Pilbara Offshore marine bioregion.

18.20 The proponent does not acknowledge the particular catastrophic vulnerability of island populations to disturbance and disease – the size of the population on the island is virtually irrelevant in this context.

It is arguable whether island populations on large offshore islands are at greater risk than mainland populations of threatened fauna. The isolation of the offshore islands provides protection from predators, competitors and vectors of disease that can easily travel overland to affect threatened mainland populations. Faunal populations on small islands, with one or a few populations, such as the bettong population on Boodie Island to the south of Barrow Island, are vulnerable to catastrophic impacts. Diseases or predators can rapidly affect the whole island and lead to extinction of some species. Barrow Island is such a large island that it is unlikely that the same level of risk of catastrophic impact exists.

18.50 Where the pipeline corridor intersects or is in close vicinity to significant or restricted communities, as identified in 4.4.1, the proponent should extend the vegetation mapping at the same scale as that undertaken within the corridor with the objective of demonstrating that alignment options that may potentially reduce or eliminate direct or indirect impacts have been fully considered at the finer scale.

Detailed mapping of a broad area covering the potential alignments of the feed gas pipeline where it traverses areas supporting restricted vegetation communities near the North White's Beach shore crossing is currently underway. The extent of significant and restricted vegetation communities in this area has been surveyed; and a preferred route that avoids most or all of these significant/restricted communities is being developed.

18.63 The proponent and EPA should note that the ERMP does not reflect the actual bioregional significance of Barrow Island as part of the Carnarvon Bioregion, and comparisons made of biological values of Barrow Island with the mainland should be reconsidered in relation to the Carnarvon Bioregion, not the Pilbara Bioregion.

Barrow Island lies within the IBRA Pilbara bioregion, but is close to the boundary with the Carnarvon bioregion. This is recognised in the Draft EIS/ERMP in the description of regional vegetation affinities (Chevron Australia 2005; p 222). Discussions in Technical Appendix C1 also referred to the recognised affinities between Barrow Island and the Cape Range, within the Carnarvon Botanical District. Also refer to 22.203 Section 8.2.2.

18.64 The existing flora list for Barrow Island must be revised, and an inventory developed that is nomenclaturally and taxonomically current and cites only those species represented as voucher specimens in herbaria.

The current flora list is based on historical lists and current confirmed species lists for the island. The list will be revised and updated with assistance from the state herbarium to reflect only those specimens vouchered at the herbarium. This will be used in development of a weed Impact Mitigation Strategy (IMS) within the Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plans (OEMP) for the development.

18.65 Following the development of a current and accurate flora inventory for Barrow Island, Chevron Australia should revise its discussion on flora conservation status, impacts and management so that it is consistent with the updated flora list.

The revision of the Barrow Island flora inventory will include removal of taxa not represented by a specimen in the state herbarium. Nearly all of these species of questionable distribution or nomenclature (refer to 18.188–18.201 later in this section) are from historic inventories from other parts of the island. They are included in good faith to reflect the level of floral diversity on the island. The revision of the inventory will not affect the assessment of flora conservation status, impacts or management.

18.66 Chevron Australia should commit to expediting taxonomic research to clarify the status of the 17 unconfirmed plant taxa recorded on Barrow Island prior to the commencement of development.

Most of the 17 unconfirmed taxa are from historical records for the island and specimens may not be available for further taxonomic confirmation. Taxa collected during the current survey that could not be identified due to the lack of fertile material will continue to be targeted in ongoing surveys. In the absence of positive identifications, all of the unresolved taxa were conservatively assessed as locally significant. Collections of these taxa in ongoing vegetation and flora surveys during construction and operations on Barrow Island should provide fertile material that will facilitate future revision of the taxonomy of these groups.

- 18.67** Chevron Australia should undertake a quantitative comparison of floristic communities, floristic richness and vegetation types between Barrow Island and the mainland in order to gain an understanding of the distributional extent at the bioregional level.

The risk assessment is based on the assumption that all vegetation communities and flora in the Barrow Island Nature Reserve represent an important level of genetic biodiversity. Therefore, all communities and taxa are afforded conservation significance. Risks to these taxa are assessed in terms of their distribution on the island. Their distribution on the mainland is of lower importance. For example, *Erythrina vespertilio* is listed as not threatened on the mainland but has a restricted distribution on Barrow Island. To protect genetic biodiversity, it is given a high conservation status in the current risk assessment due to its island distribution.

- 18.70** The proponent should identify the level of rarity and threat under the *Wildlife Conservation Act 1950* and *Environment Protection and Biodiversity Conservation Act 1999* under which the seven fauna species on Barrow Island are listed and any specific increased levels of threat associated with the proposed development.

The six listed threatened or vulnerable mammals and the (one) Priority 4 mammal, are described in the section dealing with the mammal fauna of Barrow Island in the Draft EIS/ERMP (Chevron Australia 2005; p 238). Further information on these threatened species is included in Technical Appendix C2.

- 18.71** The proponent should provide information on the relative conservation significance of each species at the development area level, Barrow Island level, regional level, and State level in order to put into perspective the impacts of the proposed development.

The terrestrial fauna on Barrow Island are all considered to be island 'races' or subspecies and are treated as endemic taxa in the risk assessment. These taxa are listed under Western Australian legislation. Therefore there is no difference in their official conservation significance at the various scales proposed.

- 18.73** Chevron Australia should commit to initiating the process for confirming the taxonomy of reptile fauna on Barrow Island in order to obtain a more reliable understanding of the conservation significance of reptiles on the island and how this will be impacted by the proposed development.

Tissue samples collected during the reptile surveys have been lodged with the Western Australian Museum to aid in their ongoing genetic research. The genetic work will increase the understanding of the taxonomic affinities of the island herpetofauna. All Barrow Island herpetofauna are assumed to be distinct genetic races.

- 18.74** Ongoing sampling for reptile taxa known to be of conservation significance such as the endemic skink and blind snake should be undertaken by Chevron Australia. Sampling should be undertaken within the development area and elsewhere on Barrow Island in order to obtain better knowledge of the abundance and distribution of these and other reptile taxa and the relative significance of particular habitats including the proposed development area.

The endemic skink (*Ctenotus pantherinus acripes*) has been found to be widespread on Barrow Island (Chevron Australia 2005; Technical Appendix C2, pp 14–16). Further survey and monitoring work for reptiles will be undertaken during the construction and operation of the Gorgon Development as part of a program developed in consultation with CALM and DEH. This will provide an additional contributing offset for the loss of individual reptiles. The endemic blind snake is known from a single specimen. Given the rarity of this species, it would not be biologically sensible or cost-effective to undertake independent surveys or studies on this species. Instead, it would be made an integral part of the ongoing work on the distribution of troglifauna on the island. This is the approach followed by the DEH for *Ramphotyphlops exocoeti* as outlined in the Recovery Plan for Australian Reptiles (DEH 1993).

18.75 Chevron Australia should undertake further survey work for invertebrates on Barrow Island, to determine whether the new and undescribed species occur in areas other than the proposed development site.

As part of a program developed in consultation with CALM and DEH, further survey and monitoring work for invertebrates is being undertaken. Areas outside of the proposed development site are included in the survey.

18.76 Chevron Australia should consider initiating taxonomical work to formally describe the new pseudoscorpion and scorpion species found within the proposed development area.

Chevron Australia is supporting taxonomic revision of the *Urodacus* scorpion group that includes the new Barrow Island species by supplementing Western Australian Museum funding for the project.

18.77 An on-ground fauna survey should be undertaken along the proposed alignment for the domestic gas pipeline corridor.

A fauna survey of the proposed mainland domestic pipeline route and shore crossing has been completed (November–December 2005). The study revealed nothing of environmental significance. Part of the mainland pipeline route (shore crossing) is within an existing easement. The remainder traverses Mardie Station, a cattle farming property with high levels of disturbance.

18.84 Chevron Australia should support a program for the collection of voucher specimens of Barrow Island's fauna (vertebrates and invertebrates), with the aim of developing a comprehensive museum collection of the island's fauna, including the full range of modern tissue collection and preservation techniques.

Mammal, reptile and invertebrate specimens were collected and lodged with the Western Australian Museum during the EIS/ERMP field surveys (Chevron Australia 2005; Box 8-5, p 245). The targeted groups were reptiles (Chevron Australia 2005; Technical Appendix C2, p 4), invertebrates (Chevron Australia 2005; Technical Appendix C4, Attachment 1, p 8) and subterranean fauna (Chevron Australia 2005; Additional Information Package, Part 3, p 13). Samples were collected and preserved, using accepted techniques, to facilitate morphological and mitochondrial DNA testing of the taxonomic affinities of the taxa. Additional specimens and tissue samples will be collected during ongoing fauna surveys and during construction of the facilities (Chevron Australia 2005; p 354).

18.179 8.3.2 Terrestrial Ecology, page 222 – In regard to the description of flora and vegetation communities in the Pilbara Region, the statement that “Mineral exploration since the 1960s has increased the knowledge of the area” is not entirely accurate. Biological work as a result of mineral exploration has assisted in recent years in increasing biodiversity knowledge in the Pilbara, however prior to this (mid 1990s and before) biological survey work in the Pilbara by the resource development industry has been limited. There is no acknowledgement of the work by agencies such as CALM, the WA Museum and the Australian Institute of Marine Science (AIMS) that has contributed significantly to biological knowledge in the Pilbara.

The Gorgon Joint Venturers acknowledge the contribution of various agencies to the current level of biological knowledge of the region.

18.180 8.3.2 Terrestrial Ecology, page 222 – It is noted in the ERMP that taxa restricted to creek beds and gullies on Barrow Island are of conservation significance due to the relative rarity of this habitat on the island. It is not acknowledged that the reason for this rarity is the extensive extraction of gravel on Barrow Island for the WA Oil operations, which has concentrated mostly on creek beds and gullies.

The Gorgon Joint Venturers acknowledge that gravel extraction, primarily in creek beds and gullies has caused partial loss of this habitat.

18.181 8.3.2 Terrestrial Ecology, page 223 – It is recognised in the ERMP that no threatened ecological communities have been recorded on Barrow Island. It should be noted that this may be a consequence of the lack of knowledge on the regional significance of terrestrial vegetation communities that occur on Barrow Island.

'Lack of knowledge' is a possible explanation for the non-listing of vegetation communities in many parts of Western Australia. The section describing the significance of Barrow Island vegetation communities mentions official TEC status for completeness. TEC status does detract from the assessment of risks to terrestrial vegetation. The conservation significance of the island vegetation communities is based on their representation on the island.

18.182 8.3.2 Terrestrial Ecology, page 237 – The statement that populations of the Spectacled Hare Wallaby on Hermite Island and Trimouille Island in the Montebello group were driven to extinction by feral cat and possibly black rat predation is not likely to be accurate. It is unlikely that black rats would have preyed on wallabies causing their extinction.

The Joint Venturers accept that this is probably unlikely. The possibility of predation by rats has been raised by several authors, including a media statement by CALM (McNamara): 'Now that the islands have been purged of the rats, we can move on to the next phase of Montebello Renewal and re-introduce several species of native mammals and birds that became locally extinct as a result of predation by black rats and cats,' and Burbidge (2004). This was in relation to the re-introduction of hare wallabies to the Montebello Islands.

18.188 It is highly unlikely that *Commelina ciliata* occurs on Barrow. In WA this species is restricted to the Kimberley. There are no voucher specimens in WA herbaria to substantiate the existence of this species on Barrow.

This species is included in the Draft EIS/ERMP (Chevron Australia 2005) inventory for Barrow Island on the basis of earlier inventories for the island. Removing this species record does not affect the assessment of impacts on vegetation in the proposed Development area.

18.189 It is highly unlikely that *Senna planitiicola* occurs on Barrow. In WA this species is restricted to the Kimberley. Vouchers cited (MRW138 & DET11003) in Attachment F, Appendix C1 are not represented in the WA Herbarium so the correct determination of this entity can not be confirmed. If this species occur on Barrow it is likely to be an introduction.

This species is included in the Draft EIS/ERMP (Chevron Australia 2005) inventory for Barrow Island on the basis of earlier inventories for the island. Removing this species record does not affect the assessment of impacts on vegetation in the proposed Development area.

18.190 It is highly unlikely that *Acacia grasbyi* occurs on Barrow. This species typically grows in the transitional rainfall zone in south western WA. The voucher cited (RB6696) in Attachment F, Appendix C1 is not represented in the WA Herbarium so the correct determination of this entity can not be confirmed. If this species occurs on Barrow it is likely to be an introduction, possibly associated with amenity plantings.

This species is included in the Draft EIS/ERMP (Chevron Australia 2005) inventory for Barrow Island on the basis of earlier inventories for the island. Ongoing survey work will confirm the presence/absence of the species on Barrow Island, and if it is an introduced species, it will be added to the register of weed species.

18.191 It is highly unlikely that *Stemodia glabella* occurs on Barrow Island. This species has a scattered distribution throughout the Kimberley. It is more likely that the taxon on Barrow is *Stemodia* sp. Onslow (A.A. Mitchell 76/148), however without citing a vouchered specimens this proposition cannot be substantiated. *Stemodia* sp. Onslow (A.A. Mitchell 76/148) is known from the Onslow and Cape Range areas. No vouchers of the specimens purported to be *Stemodia glabella* on Barrow Island, despite six being cited in Attachment F, Appendix 1, are currently lodged in the WA Herbarium.

This species is included in the Draft EIS/ERMP (Chevron Australia 2005) inventory for Barrow Island on the basis of earlier inventories for the island. Removing this species record does not affect the assessment of impacts on vegetation in the proposed Development area.

18.192 *Eucalyptus camaldulensis* is cited on this species list. It is very unlikely that this taxon occurs naturally on Barrow. No voucher specimens are cited or lodged in the WA Herbarium. If this species occur on Barrow it is likely to be an introduction, possibly associated with amenity plantings, however it is not listed as an introduced species in the 14 taxa cited as weeds or annotated as such in Attachment A & F, Appendix C1. An identical scenario exists for *Eucalyptus gamophylla* & *Eucalyptus torquata*.

This species is included in the Draft EIS/ERMP (Chevron Australia 2005) inventory for Barrow Island on the basis of earlier inventories for the island. Ongoing survey work will confirm the presence/absence of the species on Barrow Island, and if it is an introduced species, it will be added to the register of weed species.

18.193 *Capparis spinosa* and *Capparis spinosa* var. *nummularia* are both listed as occurring on Barrow. They are the same taxon as *C. spinosa* var. *nummularia* is the only *Capparis spinosa* entity present in WA

Capparis spinosa is included in the Draft EIS/ERMP (Chevron Australia 2005) inventory for Barrow Island on the basis of earlier inventories for the island. *C. spinosa* var. *nummularia* was recorded in the current surveys (Chevron Australia 2005; Technical Appendix C1). Removing the *C. spinosa* record does not affect the assessment of impacts on vegetation in the proposed Development area.

18.194 *Triodia pungens* is not a synonym for *Triodia epactia* as suggested by the consultant. Both species are still valid and occur throughout the Pilbara. Typically, *T. epactia* is a coastal species while *T. pungens* occurs inland. *Triodia epactia* is the only species recorded from Barrow although FloraBase also list *T. pungens* on the island. The identification of the *T. pungens* voucher (D.W. Goodall 1562) has not been confirmed by an experienced *Triodia* taxonomist.

This was an error in terminology. *Triodia pungens* was used synonymously with *T. epactia* in historical collections from Barrow Island. New collections indicate that historical collections were misidentified. *T. pungens* is not included in the species list for the island (Chevron Australia 2005; Technical Appendix C1, Attachment A).

18.195 *Eucalyptus xerothermica* is no longer a manuscript name, the species was formally described in 2000.

Eucalyptus xerothermica MS was included from historical records. It is acknowledged that this is now a formally described species.

18.196 *Aristida holathera* and *Aristida holathera* var. *holathera* are undoubtedly the same entity. It is very unlikely that the other described variety (*A. holathera* var. *latifolia* which occurs in the Kimberley) is present on Barrow. Hence, it appears that this species has been counted twice on the species list for the island.

18.197 *Enneapogon caerulescens* and the two varieties are cited on the species list, however both varieties are no longer valid. Voucher RB6801 formerly identified as *Enneapogon caerulescens* var. *occidentalis* is now determined as *Enneapogon caerulescens* base on a voucher in the WA Herbarium. In this instance the three records should be counted as a single record for the island's species list.

18.198 *Cyperus cunninghamii* and *Cyperus cunninghamii* subsp.*cunninghamii* are the same entity. It is very unlikely that the other variety (*A. holathera* var. *latifolia* which occurs in the Kimberley) occurs on Barrow. Hence it appears that this species has been counted twice on the species list for the island.

18.200 *Hannafordia quadrivalvis* and *Hannafordia quadrivalvis* subsp. *recurva* are undoubtedly the same entity. It is very unlikely that *Hannafordia quadrivalvis* subsp. *quadrivalvis* occur on Barrow as this species occurs throughout the south west interzone from Shark Bay south. Hence it appears that this species has been counted twice on the species list for the island.

18.202 The taxon cited as *Euphorbia* sp. and represented by the voucher RB7111 in the WA Herbarium has been identified as *Euphorbia tannensis* subsp.. *eremophila*. This species is already cited on the flora list for the island so this is another unnecessary addition.

Duplication in species' names in the list of plant species for Barrow Island is due to uncertainty in the identity of the historical collections. It is accepted that on the basis of current distribution, these duplicates should be removed from the species inventory. Removing the duplicate records does not affect the assessment of impacts on vegetation in the proposed Development area.

18.201 *Adriana tomentosa* var. *tomentosa* is no longer a valid species name. It was redefined as *Adriana urticoides* var. *urticoides* in 2003.

The species list for Barrow Island will be revised to include the correct name for this species.

20.2 The material and analysis in the draft EIS/ERMP document is deficient in several key areas of data, and provides insufficient grounds for an accurate assessment of individual and cumulative risks on key environmental and biodiversity values of Barrow Island over the lifespan of the proposed project.

The material presented in the Draft EIS/ERMP is the best available data and considerable new desktop and field research has been conducted to increase the level of understanding of the Barrow Island ecosystems. This additional work increases the confidence in the predictions of impact and the proposed mitigation strategies.

22.103 It should be explicitly noted that all of the listed mammals except the black-flanked rock wallaby are endemic to Barrow. Curiously, such a comment is only made about the Barrow Island Black and White Fairy-wren (for some reason referred to here as the White-winged fairy wren).

All of the resident fauna on Barrow Island, including the black-flanked rock wallaby, have been conservatively considered a genetic race endemic to the island for the purposes of the Draft EIS/ERMP (Chevron Australia 2005). Many of the mammals are not truly endemic at species level as their relationship to mainland populations has not been determined. The term 'endemic' is used to describe these terrestrial mammals as appropriate throughout Technical Appendix C2 (Chevron Australia 2005). White-winged fairy wren is the accepted common name used in the Western Australian Museum FaunaBase.

22.123 The expressed concern for restricted vegetation communities seems disingenuous given GJV's regular emphasis on how the island has no Declared Rare Flora and only two Priority Flora. Presumably none of the vegetation near Surf Point is endemic to either that part of the Island or Barrow as a whole.

The statements regarding listed threatened flora are necessary to address the standard concerns of conservation of biological diversity in the risk assessments. This does not detract from the proponent's commitment to conserve representative areas of all vegetation types currently known from Barrow Island. The restricted vegetation communities have been identified in work conducted by Chevron Australia and has been voluntarily highlighted as areas requiring special protection. The vegetation of the northern end of Barrow Island is different to that of the rest of the island, for example, see Buckley (1983), and there are restricted communities such as the clay pan and *Erythrina* communities identified in the Technical Appendix C1 to the Draft EIS/ERMP.

22.195 It should be underlined that at least 406 plant species exist on Barrow – significantly more than the 250 species conceded by GJV during the ESE process (in response to which we argued there were 350, based on the Conservation Commission’s 2003 ESE response).

The inventory of plants on Barrow Island is under review following comments on the accuracy of historical lists by CALM. It appears the total is approximately 395. Further survey work in other parts of the island is expected to reveal further plant diversity.

22.197 This development should not be further considered for environmental assessment until more is known about the distribution of the new species of scorpion and pseudoscorpion found at the proposed gas plant site.

Technical Appendix C4 (Chevron Australia 2005) describes the likely distribution of these uncommon invertebrates on Barrow Island. Invertebrates are generally associated with a particular suite of structural and vegetated habitats. Protecting restricted habitats and vegetation communities also protects the invertebrate communities dependent on them. None of the vegetation types or structural habitats that would be affected by the proposed gas processing facility are restricted on the island. Therefore none of the associated invertebrate assemblages are expected to be restricted to small areas. The distribution of scorpions and pseudoscorpions on Barrow Island and their taxonomic affinities to congeneric mainland scorpions is under investigation by the Western Australian Museum. These data will be used to refine management plans on an ongoing basis.

22.204 Part of the reason creek bed and similar vegetation is significant on Barrow is it has been heavily cleared for gravel extraction by WAPET/Chevron, with extinctions likely as a result (Trudgen, 1989)! Incidentally, why has that report not been provided as an appendix to this draft EIS/ERMP?

The Joint Venturers acknowledge that the restricted distribution of creek bed and gully vegetation communities on Barrow Island is mainly due to the historical loss of this habitat through anthropogenic disturbance. Only studies conducted for the current assessment are included as appendices. Trudgen (1989) is cited in Chapter 8 (Chevron Australia 2005). Technical Appendices are specialist reports undertaken specifically for the EIS/ERMP assessment process.

22.205 Why is this proposal being considered before the conservation status of a massive 17 taxa has been settled?

Most of the 17 unconfirmed taxa are from historical records for the island and specimens may not be available for further taxonomic confirmation. Taxa collected during the current survey that could not be identified due to the lack of fertile material will continue to be targeted in ongoing surveys. In the absence of positive identifications, all of the unresolved taxa were conservatively assessed as locally significant in accordance with the precautionary approach. Collections of these taxa in ongoing vegetation and flora surveys during construction and operations on Barrow Island will hopefully provide fertile material that will facilitate future revision of the taxonomy of these groups.

22.206 Given the reason cited for dismissing the possible Surf Point location, why aren’t the vegetation communities there listed as significant on this page?

The list of restricted vegetation communities is not intended to be a complete list of these communities. The listed communities are those in areas potentially affected by the proposed Development.

22.207 The Submitters understand that Barrow Island Boodies are a distinct endemic subspecies – why has this not been mentioned?

The Barrow Island burrowing bettong is recognised as a subspecies, but does not have a subspecific name as yet.

22.208 Why are the comments about Barrow Island Golden Bandicoots uncertain? How is one of the icon potentially endemic subspecies on the island, supposedly well-studied since WAPET's operations started in the 60s, still not adequately understood?

There is uncertainty in the level of genetic separation between the Barrow Island and mainland bandicoot populations suggesting the island population may not be a distinct subspecies (Burbidge 2004). While further work is required to clarify this, the impact assessment conservatively assumed the island bandicoots to be an endemic race.

22.209 Why are the spectacled hare wallabies no longer called Barrow Island Spectacled Hare Wallabies?

Lagorchestes conspicillatus conspicillatus is listed under the EPBC Act as the spectacled hare wallaby (Barrow Island) and was previously known only from Barrow Island. It is recognised in the Draft EIS/ERMP as a subspecies restricted to the island (Chevron Australia 2005; p 237).

22.210 When has a mulgara ever been recorded on Barrow?!

The mulgara is presented in the *Regional* fauna section (Chevron Australia 2005; p 238). The mulgara is present in the region.

22.211 Do the Barrow Island Euro population estimates suggest a recent population decline?

The different population estimates cannot be taken as an indication of changing population size as they are based on different census methods. They are both presented to illustrate the range of existing population estimates.

22.212 Why are there no population estimates for the Barrow Island Chestnut Mouse, an endemic threatened species?!

Population sizes are provided from literature estimates, mainly from the CALM mammal monitoring program. CALM have been monitoring mammals on Barrow Island for at least the last six years and have not published an estimate of the Barrow Island chestnut mouse population size.

22.213 Why is this proposal being considered before the taxonomic review mentioned here has been completed?

22.215 Why are the comments about the genetic distinctiveness of the reptile taxa uncertain?

22.216 The conservation status of the potential short-range endemic invertebrates should be resolved before this proposal is further considered.

The review of the taxonomic status of these fauna is not critical to the impact assessment presented in the Draft EIS/ERMP. All island fauna are considered evolutionary significant units, representing distinct island races of their species. They are afforded higher conservation status on this basis, although they are not currently listed as threatened.

22.214 Why haven't biological studies been done to confirm the possible presence of Barrow Island Chestnut Mice in the vicinity of the proposed airport extension?

The layout of the proposed airport extension has not been finalised. Preliminary fauna surveys have been conducted to determine the presence of larger, habitat restricted species such as burrowing bettongs. Further studies, including trapping for the Barrow Island chestnut mouse will be conducted in this area as part of the ongoing surveys.

22.217 Who came to the conclusion that short-range endemism is expected to operate on an island scale? On what basis was that conclusion reached?

The scale of short-range endemism, to narrow range endemism, has been described by Harvey (2002) as less than 10 000 km². Barrow Island is much smaller than this, so animal taxa with the poor dispersal characteristics of SREs would still be expected to cover the whole island. Examples of smaller ranges in SRE taxa are usually associated with geological barriers such as rivers or ravines. None of these exist on Barrow Island.

22.218 Before the project is further considered for environmental assessment, the potentially new species of scorpion and pseudoscorpion should be described and their conservation status ascertained.

The taxonomic status is not critical to the assessment of these species as they have been assumed to be new species that are endemic to Barrow Island. The new scorpion species is subject of a new research involving the Western Australian Museum and an international taxonomist.

24.51 The statement in paragraph 3 is not true for *Urodacus* sp and also *Synsphyronous* sp, as section 10.4.1 indicates that they are only known from the Development site.

The statement in paragraph three of Chapter 10 (Chevron Australia 2005, p 302) refers to the representation of all terrestrial fauna outside the development area. While this has not been established for the two invertebrate taxa mentioned in the submission, the broad distribution of their habitats outside the development area and the previous collection of the scorpion from an unknown location on the island (Western Australian Museum collection), strongly indicates that these taxa are found in areas other than the development area. Technical Appendix C4 (Chevron Australia 2005) describes the likely distribution of these uncommon invertebrates on Barrow Island. Invertebrates are generally associated with a particular suite of structural and vegetated habitats.

Protecting restricted habitats and vegetation communities also protects the invertebrate communities dependent on them. None of the vegetation types or structural habitats that would be affected by the proposed gas processing facility are restricted on the island. Therefore none of the associated invertebrate assemblages are expected to be restricted to the small area to be affected. The distribution of scorpions and pseudoscorpions on Barrow Island and their taxonomic affinities to congeneric mainland scorpions is under investigation by the Western Australian Museum. These data will be used to refine management plans on an ongoing basis.

16.51 The use of the words ‘continuing to protect’ suggests that the conservation values on Barrow Island have been adequately protected in the past when, in fact, life on the Island has become tenuous for many species as a result of previous development (eg. as a result of major fragmentation of vegetation on the southern part of the Island).

There is no evidence that the existence of any taxa on Barrow Island has ‘become tenuous’ due to the operation of the existing oilfield.

22.198 Why is the importance of the troglofauna and stygofauna still the subject of speculation (“may not be as diverse”)?

Geotechnical investigations have shown that karst within the proposed gas processing facility site is not as well developed as in other parts of Barrow Island. The comment that subterranean fauna ‘may not be as diverse’ in the plant area relates to the generally poorer subterranean habitats in the development area than in the areas where very rich stygal assemblages have been recorded. Further work is ongoing to improve the level of certainty in regards to this assessment and to continue to increase the knowledge base with regards to the subterranean biota of Barrow Island.

22.199 How much data supports the conclusions set out here? Given the potential impacts of the proposal on groundwater quality, it is essential that no monitoring shortcuts are taken.

The conclusions in the AIP are based on the best available data and will be revised as further data is collected. Monitoring for the impacts of the development will follow protocols and sampling plans set out in EMPs and designed in consultation with the agencies.

22.200 Again, given the importance of this issue, why are phrases like “most likely” still being used?

The term ‘most likely’ is used to reflect the unavoidable level of uncertainty and unpredictability that is inherent in the response of all natural systems to perturbations.

22.219 Why can’t stygofaunal and troglifaunal sampling be completed before the project is further assessed? We note that because of time constraints we have been unable to consider whether the additional information package satisfies the Submitters’ desire for more information in this regard.

Sufficient subterranean fauna sampling has been conducted to inform the risk assessment process. The difficulties inherent in identifying stygal and troglobitic taxa for which there are currently no experts are beyond the control of the proponent or its consultants and species level identifications cannot be expected for any development proposal.

22.220 Why hasn’t the karstic potential of the North White’s Beach feed gas pipeline shore crossings been ascertained? Why hasn’t stygofaunal sampling yet taken place?

The selection of North White’s Beach for the shore-crossing was a comparatively recent development in the ongoing planning for the Gorgon Development and reflects the proponents’ commitment to incorporating the latest environmental information into the planning process. The Joint Venturers are investigating the subsurface geology in this area as part of ongoing geotechnical work at this location. Two of the geotechnical bores have been fitted with casing suitable for stygofaunal sample collection. Studies are planned for March 2006. Results from these studies will be used during the compilation of the EMP for the HDD shore crossing aspect of the proposal.

22.221 Why hasn’t detailed subsurface geological work been done at Flacourt Bay? Why hasn’t stygofaunal sampling yet taken place?

Detailed subsurface geological work has not been conducted at Flacourt Bay as the geotechnical investigation was re-directed to the preferred shore-crossing location of North White’s Beach.

18.90 It is recommended that the proponent undertake additional survey work outside the gas processing facility to provide more information about distributions of species of subterranean fauna that are listed above as possibly threatened by development.

The studies completed to date have provided some information on the wider distribution of subterranean fauna on Barrow Island. Additional sampling is planned on an ongoing basis to provide further information on the distribution of subterranean species currently recorded from the development area. This will be complemented by additional genetic and taxonomic studies.

18.91 The proponent should initiate taxonomic work on the species of subterranean fauna potentially threatened by development as a matter of high priority, to improve the certainty of species level identifications of these animals.

This work is currently underway, with Chevron contributing to the financial support of a technical officer in the WA Museum terrestrial invertebrates section. This ongoing work will yield species level (or morphotype equivalent) identifications of the collected fauna where possible and will also assist with the description of new taxa.

28.13 P31, para 4; While it is speculated that the distribution of four more widely distributed species may suggest that other more subterranean taxa collected only from the plant footprint may also have wider distributions, is there any evidence for this contention?

It is suggested in Additional Information Package that the distribution of the four, larger taxa that are known to occur outside the area of the proposed gas processing facility, is representative of smaller subterranean taxa for which there is insufficient distributional data. This is based on the relative size of the taxa and the assumption that smaller taxa can move more freely through the karst because they can travel through smaller conduits, fissures in the rock.

8.3.3 Marine Ecology

7.2 The research method of counting the numbers of tracks left by nesting sea turtles is inadequate.

Track counts are not an adequate technique for assessing marine turtle population numbers or actual nesting densities. The track census technique was used as an indicator of beach usage by nesting turtles and for comparisons between beaches. In terms of the risk assessment, the use of the beach as determined from track counts can be more useful as it represents the total amount of activity. For example, an individual that approaches a beach to re-nest several times (due to unsuccessful nesting attempts) is at higher risk of encountering construction vessels.

7.3 There is no indication of the numbers of egg chambers that were attempted by turtles. Before assumptions about nest success can be made in the case of Barrow Island sand temperature, sand moisture and angles of repose of the sand during nest construction need to be taken into account and documented.

The relationship between track numbers and successful nesting was addressed in section 3.5 of Appendix C7 Attachment 1 of the Draft EIS/ERMP. The ongoing monitoring program will further investigate the relationship between nest attempts and nesting success to help elucidate seasonal differences in reproductive effort.

7.4 I had concern about the lack of information about the nature of the nesting beaches and the lengths of the respective beaches. This concern was increased when on pg 17 when the lengths of two were given and extrapolation indicated that large nesting densities were being used without justification. This lack of validation of nesting success and the extrapolation of nesting densities is a cause of concern. The data as presented will not provide sufficient information for the impact of the proposed development to be assessed.

Track densities give the best indication of relative usage of nesting beaches. These are described as 'nesting density' although they really represent activity of nesting females. The comparison between beaches (lengths are provided for all beaches – p 17, Technical Appendix C7) is valid and provides sufficient data to assess the relative importance of each beach. Absolute numbers of turtles or nests likely to be impacted have not been used in the risk assessment. Further data on nesting success during the summer of 2004–2005 are presented in Appendix C7, Attachment 1 of the Draft EIS/ERMP.

7.5 Figure 14 provides information on the average number of hatched nests per day. It is in stark contrast for there to be between 10 and 137 green turtles nesting each night on each kilometre of beach and to have on average only three nests per night hatching on the whole island some two months later. A similar contrast is presented for flatback sea turtles.

Figure 14 does not represent a comparison of nest densities and hatchling emergence incidents. It shows the number of turtle tracks, which does not necessarily relate closely to nest success. Given this, there would be a discrepancy in nest success and hatching success due to infra-specific disturbance of nests and predation by perenties (*Varanus giganteus*).

7.6 It would have been useful to present the characteristics of the tracks and disturbed sand that indicated whether the turtle had laid a clutch successfully. The numbers of tracks and the numbers of nests would be more useful if they had been attributed to particular beaches, as had been the sea turtle track densities.

Comment noted.

7.7 Insufficient data are presented to produce population estimates of the nesting population of green and flatback populations. The assumptions use parameters, the origin of which are not given and may not be applicable to the Barrow Island populations. The procedures for using these assumptions are not given. The errors of the estimates are not given. Hence the estimates of the population sizes may be inaccurate.

The population estimates are qualified in the report as 'rough estimates' and should not be taken out of context (Chevron Australia 2005; Technical Appendix C7, Attachment 1, p 9). The report also states that the current long-term tag and recapture program will provide better estimates.

10.5 HIS is extremely concerned that the ERMP/EIS claims that Barrow Island is a less important rookery for green turtles in Section 8.3.3.

Technical Appendix C7 (p 5) explains the Lacepede Islands rookery appears to be an order of magnitude larger than the Barrow Island rookery. Recent observations as part of the ongoing turtle monitoring program also indicate that the Munda rookery is larger than the Barrow Island one.

16.9 Insufficient knowledge for a formal assessment: The Technical Appendices C3: Avifauna Technical Report, concedes that there is insufficient knowledge of the distribution and abundance of protected and migratory shore bird species on Barrow Island and of the significance to them of the impacted areas, for a formal assessment to be done...'quantitative data on the distribution and abundance of avifauna around the Island are scarce' (9 1 Introduction, page 1).

16.10 Quantitative studies of the avifauna have not been done sufficiently comprehensively apparently due to prior problems of access to the acceptable. Comprehensive, long term studies are needed for a formal assessment in an A-class Nature Reserve.

The statements in the Draft EIS/ERMP, Technical Appendix C3, refer to the situation prior to the survey work undertaken for the Gorgon Development. Ongoing monthly counts of shorebirds around the whole coastline of Barrow Island now provide a better dataset than exists for most of the rest of the Western Australian coast. This information will be provided to the EPA and CALM.

16.11 (Discussion 4.1 page 24.0 It is likely that the integrity of any such proposed conservation zone will be jeopardized by the development. It appears little was known previously about the beaches near Town Point in relation to the rest of the island.

The proposed nature Conservation Area in Bandicoot Bay is well beyond the area that will be impacted by the proposed Development. Prior to the field surveys for the EIS/ERMP, general information was available for all beaches of Barrow Island. The EIS/ERMP-focussed field surveys have compared the Town Point beaches to others on Barrow (Chevron Australia 2005, Technical Appendix C3).

16.12 The field survey done by the ecological consultants covered relatively brief and intermittent periods during 2002, 2003 and 2004. The Waterbird Conservation Group considers this to be too short a time to serve as a reliable basis on which to form well considered estimates and to make longer term projections.

The monthly field surveys conducted from September 2003 to September 2004 (Draft EIS/ERMP, Technical Appendix C3) were adequate to characterise the relative importance of various regions around Barrow Island and the seasonality of their use by migratory shorebirds. The earlier study by Sedgewick (1978) similarly indicated that Bandicoot Bay is the most important shorebird site on the island.

18.96 Chevron Australia should undertake marine biodiversity surveys and finer scale benthic habitat mapping in order to assess whether the benthic habitats impacted by the project are limited to the project area or are more widespread throughout the region.

Statements about the wider distribution of the benthic habitats off the west coast of Barrow Island, and between Barrow Island and the mainland, have been extrapolated from the bathymetric charts of the area. These include, for example, AUS 742, literature on fish stocks and interpretation of survey data of the proposed Development and nearby areas. The charts show bathymetric contours and meso-scale features such as reef ridges running parallel to the coast off Barrow and the Montebello Islands.

Homogeneous seabed features such as sand habitats and reefal ridges were detected in video transect surveys of both the initial Flacourt Bay pipeline route and the revised North White's Beach pipeline route. This indicates the continuity of these features over several kilometres of the west coast. High profile reefs provide an important fish habitat and are widespread through the Pilbara and Kimberley regions (Young, personal communication; Newman et al. 2003). Ongoing marine habitat survey and mapping is resolving more of the distributional questions about marine benthic resources in Development area.

18.97 The proponent should include information on the different genetic stocks of turtles off the north-west coast.

The genetic composition of the stocks of turtles off Barrow Island is discussed in the Draft EIS/ERMP Technical Appendix C7, Attachment 1 p 8 (Chevron Australia 2005). The green turtle population in Western Australia forms a single genetic stock that nests from the North West Cape to the Lacepede Islands. The hawksbill population is represented by a single genetic stock that is centered on Rosemary Island in the Dampier Archipelago and extends south to North West Cape. Flatback turtles in Western Australia form two genetically distinct stocks. Flatback turtles on Barrow Island are part of the southern Western Australian breeding unit that nests from North West Cape to the Lacepede Islands (Fitzsimmons et al. 1996; Limpus 2002; Limpus 2004c in prep).

18.98 Chevron Australia should undertake a complete island survey of turtle nesting beaches in order to gain a better understanding of the distribution of turtle nesting on the island, and to consider the proposed impact sites in their broader context.

Surveys carried out between 1998 and 2004 have identified 78 potential sea turtle nesting beaches on Barrow Island. These are illustrated in the Draft EIS/ERMP Figure 3-2 of Technical Appendix C7 (Chevron Australia 2005). Each has been numbered and results of surveys of these beaches in 2003/2004 are summarised in Table 4-1, Technical Appendix C7 (Chevron Australia 2005).

18.99 It should be recognised that green turtle nesting occurs throughout the year, with low numbers of hatchlings emerging in winter months as well. Subsequently, turtle protection measures must take effect throughout the year.

Green turtle nesting activity peaks in summer on the west coast of Barrow Island (Chevron Australia 2005; Technical Appendix C1, Attachment 1). Turtle protection measures will be maintained throughout the year, but activities that engender the highest risk of impact to turtles will be optimised to non-peak nesting times.

18.100 The proponent should recognise that data available on dugong distribution and abundance in Barrow Island coastal waters are not conclusive, and should undertake targeted surveys to obtain more reliable data on the likelihood of impacts on dugong.

In hundreds of hours of marine survey work in the waters off the east coast of Barrow Island, only one dugong has been sighted (near Dugong Reef). Other individuals have been observed near Varanus Island. This indicates that they are present in the Development area (Chevron Australia 2005; p 265). However, the absence of major seagrass meadows, on which these animals feed, indicates they are unlikely to aggregate in significant numbers in this locality.

18.108 Details of the field surveys of coral distribution around the Lowendal Islands in September–October 2005 should be provided.

The September/October 2005 field surveys targeted areas of ‘unconfirmed coral’ in the CALM map of the area within the predicted dredge plume. The revised habitats are presented in the GIS data that will be provided to CALM once the mapping is completed.

18.109 High resolution benthic habitat mapping in areas potentially affected by the plumes should be undertaken, in consultation with and to the satisfaction of CALM.

The area around Town Point has been mapped at high resolution and these data included in the maps of the predicted plumes. Mapping of areas to the south (Barrow Shoals) and the north (Lowendal Shelf) is ongoing as part of the dredge monitoring baseline program. The latest information will be transferred to CALM Marine Branch for inclusion into the CALM database.

20.20 WWF-Australia calls for the proposed additional work described on p. 273 : “Surveys in winter 2005 will determine whether the sandy seabed off Town Point is important to inter-nesting or hibernating flatback turtles”, to be expanded to include an assessment of juvenile flatback turtle habitats, and that further consideration of the draft EIS/ERMP should be postponed for at least an additional six months to allow this important information to be integrated and risk assessments revised based on current concerns.

The seabed within the proposed dredging area will be searched for foraging or hibernating flatback turtles in the winter of 2006. This was delayed due to changes in location of the proposed dredged channels. The developmental habitat of hatchling and subjuvenile sea turtles is not known for any of the world’s species. This gap in the scientific knowledge is generally recognised and is a very difficult area of study. It is unlikely that the Gorgon Joint Venturers would be able to identify the hatchling/sub-juvenile habitat of (flatback) turtles. Ongoing marine surveys in the area will record sightings of juvenile turtles to add to the database required to address this gap.

Pendoley Environmental is in the process of conducting a satellite tracking program on Flatback Turtles from Barrow Island. The study period from November 2005 to May 2006 will indicate the interesting movements of a sample of four female turtles in the Barrow Island area. Initial results indicate an interesting migration to the adjacent mainland prior to a return to Barrow Island. There are no definite indications that the turtles spend time (other to transient periods) in the vicinity of the dredged channels.

20.24 Increasing pressure on sea turtles in other parts of the world make the Australian habitats and breeding areas globally important.

Global pressure on sea turtle populations is recognised as a threat to the survival of some species or populations. Protection of the Australian rookeries is critical for green turtles that are predated in other parts of the region. Flatback turtles are primarily confined to Australian waters and are therefore less threatened than the other species of sea turtles. Increasing pressure in other parts of the world will have little or no impact on flatbacks in Australian waters. The Joint Venturers believe that the ongoing presence of strict quarantine and access controls on Barrow Island will continue to prevent the introduction of feral predators such as foxes, pigs, cats and dogs that threaten mainland populations. This will maintain the important contribution of the Barrow Island rookeries to the regional and global turtle populations.

20.25 Based on the material presented in the Technical Appendices C6–9, the nesting flatback turtle populations along the East Coast, (of which the beaches either side of Town Point form a significant part), are a significant component of a genetically distinct Western Australian southern breeding stock.

The flatback rookery on the east coast of Barrow Island is recognised as regionally important. Other beaches with equal or greater nesting effort occur on islands within the Montebello group and the Dampier Archipelago and at Mundabullangana station on the mainland.

20.26 Estimates provided in the Technical Appendix of a population of 10,000 animals and the comparative population data provided in the latest review of marine turtles in Australia, indicate that this population is of national, and therefore global and regional significance in terms of its size.

Without a reference to 'the latest review of marine turtles' the Joint Venturers cannot assess the validity of this statement. However, the population estimate of 10 000 flatback turtles on the east coast of Barrow Island is a 'rough estimate', based on 'very limited nesting data' (Chevron Australia 2005; Technical Appendix C7, Attachment 1, p 9). The results of the ongoing tagging program will provide better data for estimating these population sizes.

20.30 Turtle eggs and hatchlings are commonly preyed upon by feral animals, and this is a significant source of mortality in many populations. The lack of feral predators on Barrow Island means that its nesting populations are of higher biodiversity value than equivalent sized nesting populations on the mainland which are prone to feral predator attacks.

Turtle eggs and hatchlings on Barrow Island suffer predation by native fauna such as perenties, bandicoots and seabirds. The level of this predation in comparison with predation by feral animals on the mainland has not been established. It is possible that predation by native animals on Barrow Island is proportionally higher than on the mainland due to the high populations of these fauna and the absence of predatory and competitive interactions with introduced fauna.

21.18 The importance of Barrow for marine turtle nesting is because it is an island free from foxes. The Barrow sites cannot be equated with sites elsewhere.

Unlike most mainland sites, Barrow Island is free from foxes and other introduced predators. However, natural predation of turtle nests is high. Turtle eggs and hatchlings at Barrow are exposed to substantial predation from bandicoots, perenties and seagulls. It is possible that the predation by natural predators is proportionally higher on Barrow Island. (Also refer to 20.30 above)

22.14 The regional importance of Town Point for flatback turtles has only now been recognised;

The ecological work conducted for the Gorgon Development has advanced the knowledge of Barrow Island's biodiversity on many fronts, including the utilisation of different beaches for migratory birds and turtles. It has also for the first time recognised that internesting flatback turtles head to the mainland coast between nesting events.

22.100 Why does it say that Barrow's surrounding waters were being considered for a Marine Management Area? At that stage they were being considered for both a marine park and an MMA – and that is what has subsequently been created there.

This is correct. Section 8.3.3 (p 258) explains in more detail the zoning of the MMA and Marine Park, including the Sanctuary Zone.

22.118 Once again relative comparisons are inappropriate here – how does Town Point and the vicinity compare to areas other than Barrow Island in terms of seabird usage and importance? Such a comparison has been made for land birds – why the different approach?

The regional and global importance of Barrow Island for marine avifauna is described in Chapter 8 (p 267) of the Draft EIS/ERMP (Chevron Australia 2005). The littoral avifauna of Barrow Island is dominated by migratory species and these birds are concentrated in the south-east and south of Barrow Island, from the existing Chevron camp to the Bandicoot Bay area. The coastline in the vicinity of Town Point and the proposed Development area is of relatively low importance for littoral avifauna compared with other parts of Barrow Island (Chevron Australia 2005; Technical Appendix C3, p 28).

22.119 Why is the bullet point on protected marine invertebrates, fish or cetaceans so speculative? It is totally unacceptable that such a large project as this has not involved enough field work and data collection to accurately estimate the impacts on those taxa.

Marine species are often cryptic and highly mobile, making surveys very difficult. Field surveys investigating intertidal and marine ecology and assessing the conservation significance of areas pertaining to the Gorgon Development were undertaken in August 2002, January 2003, January 2004 and September 2005. No significant concentrations of protected marine species or significant habitats for these species have been observed during these surveys. Technical Appendices C6, C8 and C9 to the Draft EIS/ERMP (Chevron Australia 2005) detail the likely distribution of protected marine species in relation to the proposed development area.

22.222 Why weren't intertidal and subtidal habitats near Surf Point studied to provide comparative information?

Surf Point was determined to be a less suitable development site for a number of reasons, the main one being the safe operation of LNG tankers in the area (Chevron Australia 2005, pp 61–62). Broad scale habitat maps for the Surf Point region have been created from aerial photography and ground-truthing of habitat classification data for marine areas around the north of the island has been undertaken as part of the Baseline Marine Monitoring Programme.

22.223 Why wasn't any real benthic work done near Onslow? Why haven't GJV attempted to coordinate with BHP Billiton in this respect?

Benthic surveys near Onslow were not undertaken as the optical fibre cable route was still to be confirmed. The current route crosses scattered seagrass communities on soft sediments between Barrow Island and the mainland. Seagrass meadows in the vicinity of the proposed Onslow shore crossing may be better developed and this will be confirmed and a final route selected to avoid important areas of seagrass.

22.224 Why can't Apache's corridor be shared in order that mangrove clearing be reduced or eliminated?

Detailed investigations will be undertaken into the potential for sharing the Apache corridor as the design progresses. A key driver for the selection of the mainland shore crossing site and method will be to reduce potential impacts to mangroves.

22.226 It is noted that Barrow is an internationally important site for migratory shorebirds, and that this information was not factored into the State Government's decision to allow in-principle access to the Island.

This information has come to light from field studies associated with the Gorgon Development, following on from the initial ecological assessment in the ESE Review (ChevronTexaco Australia 2003). The proposed Development will be located and managed to avoid impacts to migratory waterbirds.

22.227 Why is this the first page we can recall where it is noted that Barrow is the 10th most important marine avifauna site in Australia?

The Joint Venturers consider the 'Marine Avifauna' section is the most appropriate place to include information on marine avifauna (Chevron Australia 2005; p 267).

22.228 How are these population estimates near Town Point expected to be altered by making that area a major light source? How will that altered population impact on turtle hatchling predation rates?

Silver gull populations would be expected to increase in response to the provision of excessive lighting on the jetty. The design of the jetty will minimise the light spill onto adjacent waters and hence also minimise the effect on bird populations. Seabird monitoring will determine whether there has been an unnatural increase in the silver gull population and culling will be considered in consultation with CALM. Silver gulls are culled in other Marine Parks.

22.229 Why weren't sea snakes and kraits specifically sought after in biological surveys?

Sea snakes and kraits are relatively small, cryptic, and highly mobile. They occupy both the surface and deeper waters of nearshore and offshore marine habitats, making surveys extremely difficult and inconclusive. Any sea snakes or kraits killed and recovered during dredging will be vouchered and added to the museum collections to increase the knowledge of snakes and kraits in the region.

22.230 How do the Barrow Island Green turtle rookeries rank when compared to other regional sites?

Information on the relative size of Western Australian rookeries are included in Technical Appendix C7 (Chevron Australia 2005).

22.231 More importantly, how do the Barrow Island flatback turtle rookeries rank when compared to other regional sites?

Information on the relative size of Western Australian rookeries are included in Technical Appendix C7 (Chevron Australia 2005).

22.232 Why haven't GJV funded any work on sea snake/krait ecology, population size and dynamics?

Sea snakes and kraits are relatively small, cryptic, and highly mobile. They occupy both the surface and deeper waters of nearshore and offshore marine habitats, making surveys extremely difficult and inconclusive. Any sea snakes or kraits killed and recovered during dredging will be vouchered and added to the museum collections to increase the knowledge of snakes and kraits in the region.

22.233 What have the (then) planned winter 2005 flatback inter-nesting/hibernating surveys revealed?

Winter surveys of flatback turtle use of the seabed within the proposed dredging area were postponed due to changes in the location of the dredged areas and will be conducted in 2006. Pendoley Environmental are in the process of conducting a satellite tracking program on flatback turtles from Barrow Island. The study period from November 2005 to May 2006 will indicate the internesting movements of a sample of four female turtles in the Barrow Island area. Initial results indicate an internesting migration to the adjacent mainland prior to a return to Barrow Island. There are no definite indications that the turtles spend time (other to transient periods) in the vicinity of the dredged channels.

22.234 Why has only a literature review been undertaken?

Extensive commercial trawl and trap fishing is conducted in the waters surrounding Barrow Island and numerous scientific surveys have been conducted in the region by the Department of Fisheries, Western Australian Museum, CALM, AIMS and various universities. With over 450 species recorded from the Montebello Islands alone, the fish fauna of the region is well documented and we consider that it does not need further intensive investigation. Fish assemblages are generally either highly mobile or associated with particular habitats. Fish loyal to particular sites, for example damselfish, are at most risk from loss of habitat. Habitat protection ensures maintenance of the full diversity of fish in the area.

26.15 What field surveys were conducted? Did they cover the entirety of the area previously classified as "unconfirmed coral"? If there has just been a program of sampling, how comprehensive has the sampling been and to what extent are those results simply being extrapolated into areas that have not been ground-truthed?

Field studies conducted in September 2005 and described in the AIP (Chevron 2005) revealed that there is little coral in the predicted impact area to the south of the Lowendal Islands. Towed video methods were used to cover large areas of the seabed during the survey. The extent of the video survey of unconfirmed coral habitats on the Lowendal Shelf and along the north-eastern coastline of Barrow Island is shown in Figure 26.13 in Section 11.4. The large expanses of 'unconfirmed coral' on the Eastern Lowendal Shelf have been reclassified as limestone pavement supporting variable cover of macroalgae and scattered corals. The CLTs for the Lowendal Island management units (MU2 and MU3) and Barrow Island Port management units (MU5 and MU6) were revised and described in detail on pages 3 and 4 of the Additional Information Package (Chevron 2005).

26.16 On what basis has it been assumed that the scattered corals are generally isolated communities?

Extensive survey of the Lowendal Shelf and along the east coast of Barrow Island for the current project and other proponents in the region have revealed that the macroalgae dominated 'scattered coral' habitat is very widespread in the area. The scattered corals include isolated, individual colonies of small corals such as *Turbinaria* and *Montipora* and larger bimbora of *Porites* that sometimes support small colonies of corals such as *Acropora* and *Pocillopora*. These colonies are widely separated by areas of macroalgae on pavement reef with veneers of sand. This habitat is described in Technical Appendix C8 of the Draft EIS/ERMP.

8.4 Social Environment

8.4.1 Introduction

No submissions received on this section of the Draft EIS/ERMP.

8.4.2 Population Trends and Demographics

No submissions received on this section of the Draft EIS/ERMP.

8.4.3 Lifestyles and Livelihood

No submissions received on this section of the Draft EIS/ERMP.

8.4.4 Government Policies and Plans

No submissions received on this section of the Draft EIS/ERMP.

8.4.5 Land and Sea Tenure and Use

23.9 The Department cannot expend the resources required to analyse in detail the impacts of projects on fisheries but is able to provide expert comment on the adequacy of the assessment documentation. This is not possible in the case of this ERMP because, disappointingly for such a lengthy document, the fisheries impacts are not well documented. In fact the presence of pearl farms at the Lowendale Islands (operated by Fantome Pearls to the north and north west of Varanus Island), and the operation of trap fishing to the west and north of Barrow Island is not documented.

Refer to Section 8.4.5, Land and Sea Tenure and Use, and Section 14.6.4, Sea Use, and Table 14.6 in the Draft EIS/ERMP.

23.11 The project involves the installation of extensive pipelines both to Barrow Island and from the Island to the mainland. The former does not raise any fisheries issues because there are no active trawl fisheries in the area to be traversed

Refer to Section 8.4.5, Land and Sea Tenure and Use, and Section 14.6.4, Sea Use, and Table 14.6 in the Draft EIS/ERMP.

23.12 However the pipeline to the coast will cross through trawl grounds utilised by fishes in the Onslow prawn fishery. The documentation indicates an alignment adjacent to existing pipelines and this is supported because in this way loss of trawl ground will be minimised. It is noted however that detail of the pipeline installation is not available and the potential to mitigate disruption to the fishing fleet is not discussed.

Recommendation; Alignment of pipelines in trawl areas should limit impact on fisheries by closely following existing installations, and impact on fisheries should be addressed.

Refer to Section 8.4.5, Land and Sea Tenure and Use, and Section 14.6.4, Sea Use, and Table 14.6 in the Draft EIS/ERMP.

8.4.6 Visual and Aesthetics

No submissions received on this section of the Draft EIS/ERMP.

8.4.7 Cultural Heritage

13.26 Preliminary archaeological field investigations and surface surveys are an insufficient basis on which to proceed and we would expect a comprehensive survey.

13.27 We would advise that these more comprehensive surveys should take place before construction and should cover 100% of the island so that there is good base line information.

As part of the Cultural Heritage Assessment for the Draft EIS/ERMP approval process, registered historical and cultural heritage sites were identified within and adjacent to the Gorgon Development. Archaeological surveys were also undertaken within the proposed development areas to identify any new cultural heritage sites. No sites were found to be impacted upon by the proposed Development. Further detailed surveys will be conducted in the proposed Development area will be undertaken prior to construction activities, and may involve some subsurface excavations where appropriate. If any new sites are discovered, they will be managed in accordance with the Cultural Heritage Management Plan (CHMP). For more information, please refer to the draft CHMP as provided in Appendix E1 in the Draft EIS/ERMP (Chevron Australia 2005).

13.32 A broad study assessing these and other primary and secondary sources need to be undertaken by a professional historian.

The assessment of historical sources in correlation to archaeological surveys, which verify both primary and secondary sources, was considered sufficient for the EIS/ERMP approval process. No historical sites have been identified within the proposed Gorgon Development area. Further detailed surveys will be undertaken to identify potential historical sites, which will be managed according to the Cultural Management Plan. Refer to Technical Appendix E1 of the Draft EIS/ERMP.

22.335 There has been no detailed archaeological survey undertaken to date. It is stated that that if new sites are discovered during construction which cannot be avoided, suitable recording work will be undertaken and permits to disturb obtained (p. 706). Full archaeological field investigations must be undertaken before proceeding.

As part of the Cultural Heritage Assessment for the EIS/ERMP approval process registered historical and cultural heritage sites were located within and adjacent to the Gorgon Development. Archaeological surveys were also undertaken within the proposed development areas to identify any new cultural heritage sites.

No sites were found to be impacted upon by the proposed Development. Further detailed archaeological studies will be undertaken prior to construction within the proposed Gorgon Development area. If any new sites are discovered they will be managed in accordance with the Cultural Heritage Management Plan (CHMP). For more information please refer to the draft CHMP as provided in Appendix E1 in the Draft EIS/ERMP (Chevron Australia 2005).

22.336 Two sites where historical information has been found (GD04-02 and 888 (FS06) will be impacted by development. More detailed excavations and recording should be undertaken prior to disturbance.

Both registered historical sites, GD04-02 and FS6-A were located by archaeological experts and were found close to the proposed development area. Due to changes in the location of some components of the proposed Development both sites are now well clear of any disturbance. Site GD04-02 was adjacent to the Flacourt Bay feed gas pipeline option, which has been superseded by the preferred North White's Beach option. Site FS6 A was adjacent to the previous location of the CO₂ pipeline, which is now located close to the gas processing facility site. Detailed surveys will be conducted in the proposed development area to find any previously unidentified cultural heritage sites. These surveys will be undertaken prior to construction activities, and may involve some subsurface excavations where appropriate.

22.337 In evaluating the extent to which sites could be impacted it is stated that further investigations will be undertaken with relevant stakeholders. Who are the stakeholders?

Relevant stakeholders include three Aboriginal groups, namely Kurama Marthudunera, Yaburara Mardudhunera and Thalanyji groups and the Department of Indigenous Affairs. Detailed surveys will be undertaken on both Barrow Island and the mainland domestic gas pipeline route. These will include archaeological and ethnographic studies which will have the involvement of Aboriginal people from all three groups.

8.4.8 Native Title

No submissions received on this section of the Draft EIS/ERMP.

8.5 Economic Environment

No submissions received on this section of the Draft EIS/ERMP.

9 Risk Assessment Process

9	Risk Assessment Process	204
9.1	Introduction	205
9.2	Methodology	205
9.2.1	Identification of Stressors.....	205
9.2.2	Identification of Receptors	205
9.2.3	Definition of Consequences	205
9.2.4	Definition of Likelihood	205
9.2.5	Characterisation of Risk	206
9.2.6	Risk Management.....	207
9.3	Uncertainty	207
9.4	Conclusion	207

9.1 Introduction

No submissions received on this section of the Draft EIS/ERMP.

9.2 Methodology

9.2.1 Identification of Stressors

No submissions received on this section of the Draft EIS/ERMP.

9.2.2 Identification of Receptors

No submissions received on this section of the Draft EIS/ERMP.

9.2.3 Definition of Consequences

No submissions received on this section of the Draft EIS/ERMP.

9.2.4 Definition of Likelihood

18.16 The risk assessment process also failed to factor in the temporal nature of risks, which should apply for not just the construction phase, but for the life of the operation, including decommissioning. This is a major flaw.

Temporal aspects are factored into the risk assessment process, by taking the conservative approach of assuming the worst case with respect to seasonal cycles of faunal population sensitivities. For example, the residual risk of adverse effects of noise and vibration from blasting at Flacourt Bay assumed blasting during the peak of the rock wallaby breeding season, when pouch young are most abundant and the population is at greatest risk of disturbance.

The temporal nature of risk has indeed been explicitly considered in the pathway descriptions, identifying the quantities of goods, timing of storage and processing on the mainland, frequency of transport, and scale of supporting activities (Part 2 of the Additional Information Package) (Chevron Australia 2005b). The judgments made regarding the likelihood of infection were made using the definitions of likelihood in Table 12-1 of the Draft EIS/ERMP, where reference is made to annual time frames. Many of the pathways are initially being assessed for construction activities and transparently described as such in Box 12-7 and the supporting text: ‘...additional pathways will be added to this list as they are identified’ (Chevron Australia 2005; p 552).

If any planned activities are identified (including decommissioning activities) that are no longer consistent with a pathway description that has been assessed and managed, then the planned activity must be described as a new pathway of exposure and will be subject to the same risk-based assessment method as any other pathway. The Joint Venturers are committed to the risk-based assessment method for developing quarantine barriers that meet the standards for acceptable risk, for the lifecycle of the proposed development.

9.2.5 Characterisation of Risk

18.15 The adequacy of the environmental risk assessment process for determining the residual risk of an adverse environmental impact as a result of the proposed development on Barrow Island is questionable. A majority of terrestrial and marine values have been allocated a 'medium' or 'low' residual level of risk, which is put forward because of predicted successful consequence and management intervention. Due to uncertainties in risk likelihood and consequence, it is CALM's view that stressors should be ascribed higher levels of risk based on a precautionary approach and the unproven impacts of possible responses.

18.62 The environmental risk assessment process should be reviewed to account for the full range of uncertainties in regard to consequence and likelihood of an adverse environmental impact on Barrow Island, and must account for the temporal nature of risk.

The Gorgon Joint Venturers believe that most stressors to marine and terrestrial environments and biota can be managed to achieve a low or medium level of residual risk. Some of these stressors were initially medium or high risk and have been subject to dedicated management strategies to reduce the residual risk to low or medium. Uncertainties in all stages of the risk assessment have been addressed by applying conservative judgements and devising management plans to counter the worst case scenario in each instance. For example, the potentially high risk of impact to regionally significant coral reef on the east coast of Barrow Island led to development of dredge management strategies, such as maintaining under keel clearance of at least 4 m to reduce resuspension of sediment. These management strategies will reduce the range of effects from dredging, avoiding serious impact to the significant coral with a resultant reduction in residual risk to low to medium.

20.3 Several assessments of impacts of stressors on receptors that represent key environmental and biodiversity values of the Barrow Island class A Nature Reserve, are considered to under-estimate levels of risk.

The risk assessment process and calculations of risk are outlined in Chapter 9 of the Draft EIS/ERMP (Chevron Australia 2005). The risk assessment conforms to the relevant Australian Standards.

20.7 WWF-Australia regards the risk assessments for key biodiversity receptors to be inaccurate. The likelihood and consequence of impacts for these receptors from the proposed development on Barrow Island are assessed as 'Almost Certain' and 'Critical'. Such an assessment would result in an overall 'High Risk' rating.

The risk matrix is presented in Figure 9-2 in Chapter 9 of the Draft EIS/ERMP. Any stressor that was considered 'almost certain' to have a 'critical' impact would be a High risk. There are no examples of this in the Draft EIS/ERMP.

21.10 A risk is considered 'tolerable' if it falls in the medium risk category and is managed to reduce the risk to a level 'as low as reasonably practicable'.

Such a definition cannot apply to threatened species unless it can be demonstrated that 'as low as reasonably possible' will bring it into a 'low' category. To do otherwise makes a mockery of the EPBC and CALM Acts. For example, if, due to 'essential' or 'health and safety' reasons the level of lighting required results in disorientation of turtle hatchlings ALARP can be claimed, but the result is not tolerable.

The Joint Venturers have adopted the application of the 'ALARP' principle from the guidance contained in Standards Australia Handbook 436 (2004), to ensure that risks which are characterised as 'medium' are reduced to a level as low as reasonably practicable. This does not necessarily mean that 'medium' risk will be reduced to 'low' risk in every case, and allows environmental managers to appreciate the risks that require more active attention and vigilance. It would not be reasonable or constructive to expect all environmental risks to be classified as 'low', as it would mask the ability of responsible managers to distinguish between risks that are expected to be acceptable with proposed management practices, and those risks that should be given more attention to ensure that all risk management strategies are effective.

The Joint Venturers have defined consequence categories in consultation with conservation biologists, such that a potential impact to individuals or populations will be judged to be more severe for protected fauna than it would be for general fauna (Table 9-5). This means that protected fauna will always be judged to have a higher level of risk than general fauna, using the environmental risk matrix (Figure 9-2). Thus, risk is not underestimated for protected fauna, and appropriate risk management practices will therefore be applied.

21.11 Clearly the concept of ALARP making things tolerable depends on the effectiveness of the ALARP. Conceivably the situation could arise where 'best practice' has already reduced risk 'as low as reasonably practicable' allowing it to scrape into the 'medium' category, but without this it would be 'high'. Any suggestion that this should somehow be viewed as a lower 'tolerable' risk just because ALARP practices are in place is counter-intuitive: any slight failure/change in ALARP practice would see the risk level increase.

Whether or not a risk is tolerable must be dependant on an assessment of the 'ALARP' for individual cases, not on the misapplication of a generic principle to a hard definition.

There is no situation where the ALARP principle would dictate how risk is categorised in the risk matrix. The classification of risk is based on expert analysis of consequences and likelihood, with consideration of all management measures that are proposed to reduce the severity of potential consequences and reduce the likelihood of occurrence. When a risk is classified as a 'medium' risk, the Joint Venturers have required the risk to be managed to a level as low as reasonably practicable, which requires consideration of additional risk management practices that may be applied.

9.2.6 Risk Management

No submissions received on this section of the Draft EIS/ERMP.

9.3 Uncertainty

No submissions received on this section of the Draft EIS/ERMP.

9.4 Conclusion

No submissions received on this section of the Draft EIS/ERMP.

10 Terrestrial Environment – Risks and Management

10	Terrestrial Environment – Risks and Management.....	208
10.1	Introduction and General Submissions on Terrestrial Environment.....	209
10.2	Physical Environment.....	211
10.2.1	Soil and Landform	211
10.2.2	Surface Water and Groundwater Quality.....	211
10.3	Flora and Vegetation Communities.....	211
10.3.1	Clearing and Earthworks	213
10.3.2	Emissions.....	213
10.3.3	Fire	214
10.3.4	Unpredicted CO ₂ Migration to Surface	214
10.3.5	Cumulative Risk.....	214
10.4	Terrestrial Fauna.....	214
10.4.1	Clearing and Earthworks	216
10.4.2	Physical Interaction	220
10.4.3	Noise and Vibration	220
10.4.4	Fire	221
10.4.5	Emissions.....	221
10.4.6	Cumulative Risk.....	222
10.5	Subterranean Fauna.....	222
10.5.1	Clearing and Earthworks	226
10.5.2	Physical Presence of Gas Processing Facility	226
10.5.3	Wastewater Discharge.....	226
10.5.4	Noise and Vibration	227
10.5.5	Spills and Leaks.....	227
10.5.6	Unpredicted CO ₂ Migration	227
10.5.7	Cumulative Risk.....	227
10.6	Conclusion	227

10.1 Introduction and General Submissions on Terrestrial Environment

6.1 The proposed development would create serious risks to the unique, fragile and threatened ecosystems of Barrow Island, especially regarding the introduction of pest and weed species, as well as the construction and operation of the processing facility including pipelines, roads and dredging.

The Joint Venturers recognise the sensitivity of the ecosystems of Barrow Island and have proposed a range of management strategies to reduce environmental risks to acceptable levels. Proposed mitigation measures are detailed in Chapters 10–15 (for each environmental factor) and in the Framework Environmental Management Plan, Technical Appendix A1 (for each construction activity).

10.1 It is our view that the ERMP/EIS does not fully take into account the outstanding conservation values of Barrow Island. It fails to recognise that Barrow Island is the largest island in Australia without introduced predators and is vital to the survival of several species.

The proponent acknowledges the conservation significance of Barrow Island and has successfully managed its operation on the island for the last 40 years to protect those conservation values. This is why high risks of adverse impacts to significant components of the ecosystem are not considered acceptable (Chevron Australia 2005; p 299). The fauna that are restricted to Barrow Island are believed to be in stable populations that will not be endangered by the habitats loss associated with the proposed Development. The Joint Venturers have also proposed an assortment of mitigation measures (including a comprehensive quarantine program) to safeguard the fauna of Barrow Island.

18.22 The assumption is made by the proponent that the proportion of fauna impacted by the proposed development will correspond to the proportion of area on Barrow Island set aside for the development, which is 1.3%. This assumption fails to recognise indirect impacts resulting from the development that will likely have a broader impact on fauna than 1.3%, such as inappropriate fire regimes, introduction of pathogens and parasites, habitat fragmentation, and the potential introduction of invasive plants and animals.

Direct removal of habitat is expected to affect 1.3% of the area of Barrow Island. The assumption that all of the fauna associated with the affected 1.3% is lost is conservative and does not allow for the persistence of faunal populations in area that are cleared during construction and then allowed to regenerate during the operational phase. Similarly, it does not allow for the continued use of areas such as pipeline easements and drill pad and seismic lines by mobile fauna, especially after rehabilitation. Potential edge effects and habitat fragmentation will be offset by these areas. Pathogens, parasites and other quarantine issues will be addressed by the quarantine management system.

24.14 To what extent have the implications to native vegetation and fauna (including subterranean fauna) and other values of Barrow Island been addressed in the draft EIS/ERMP for the 'up-hole survey', involving installation of 100–200 30–50 m deep holes? These holes are stated as being located on the seismic source lines, but these lines do not require clearing.

The Submitter is correct in stating that the up-holes will be located on the seismic source lines; however, these lines will be cleared of vegetation to allow access. Source lines will be located on previous lines where ever possible. The Joint Venturers do not plan to clear receiver lines as has been conducted in the past.

As noted in the Draft EIS/ERMP, the monitoring program has yet to be designed, pending the results of ongoing geotechnical, geophysical and environmental investigations. However, the environmental impacts can be assessed as the Joint Venturers have committed to employing a program that:

- avoids bettong warrens
- avoids rock wallaby habitat
- avoids white-winged fairy wren nests
- avoids restricted structural habitats such as termite mounds, rocky ledges, caves and sink holes
- avoids restricted vegetated habitats

- prohibits clearing receival lines
- prohibits grading of source lines
- prohibits vehicle access to dune areas.

Up-holes will not require additional vegetation clearing, and will be similar in impact to the approved geotechnical programs conducted during 2004/05.

18.78 Chevron Australia should conduct a further assessment of potential indirect impacts on terrestrial fauna and other biodiversity values on Barrow Island as a result of the proposed development that considers factors other than the clearance of 300 hectares of vegetation, such as the introduction and spread of disease and parasites, weeds, non-native animals and habitat loss and fragmentation.

Habitat loss and fragmentation have been considered in the current assessment of ecological risks associated with the proposed Development. Habitat loss is mainly associated with vegetation clearing, but also includes loss of physical habitats such as bettong warrens, termitaria and rock holes (Chevron Australia 2005; pp 350–356). Habitat fragmentation was taken into account in site selection and contributed to the current location of the proposed gas processing facility. This avoids potential fragmentation effects of bisecting the linear coastal habitats such as dunes. Potential barriers to fauna movement such as pipelines would be raised or buried to allow fauna transit (Chevron Australia 2005; p 368). The potential for reducing habitat fragmentation on the mainland will be examined by attempting to lay the domestic gas pipeline as an extension of the existing easement. The introduction and spread of disease due to micro-organisms has been the subject of extensive consultation with plant and animal disease specialists.

The Joint Venturers obtained advice on potential threats of disease to conservation values in the form of desktop studies, as recommended by the Quarantine Expert Panel. These reports are presented in Technical Appendices D8 and D9 of the Draft EIS/ERMP. Micro-organism threats to terrestrial vertebrate fauna were addressed by the School of Veterinary and Biomedical Sciences at Murdoch University. The plant pathogen threats were discussed by the Curator of the Plant Pathology Herbarium of the Department of Primary Industries and Fisheries, Queensland. Potential pathogens and their hosts were identified in these studies, such that quarantine management would take these into account when developing barriers that will protect sensitive species like the black-flanked rock wallaby mentioned in the submission. The Joint Venturers have committed to an iterative process of pathway and barrier development and as new information and knowledge becomes available on micro-organisms such information and potential modifications to the existing barrier designs will be subject to the same scrutiny as was performed in the original QHAZ workshops.

18.127 A wildfire response plan for Barrow Island must be developed by Chevron Australia, in consultation with and to the satisfaction of CALM.

Refer to 18.126 Section 10.4.4.

10.2 Physical Environment

10.2.1 Soil and Landform

No submissions received on this section of the Draft EIS/ERMP.

10.2.2 Surface Water and Groundwater Quality

19.60 In addition to the measures proposed by the joint venture, the spill response plan should include remediation measures for situations where contaminated material has migrated to underlying soil and groundwater and demonstrate an ability to be able to mobilise appropriate recovery equipment within a short time frame.

The Spill Contingency Plan is outlined in the Framework EMP, Technical Appendix A1, Section 3.19.

10.3 Flora and Vegetation Communities

12.4 Twenty-three restricted flora (limited distribution on Barrow Island or occur as range extensions from other botanical regions in WA) occur on Barrow, of which six species will be impacted by the proposed development (pp 8–10). Two vegetation communities are considered locally significant: *Erythrina vespertilio* and *Grevillea pyramidalis* (L6a, L6b, L6c, 16 d) with 0.6 ha and 2.89 ha likely to be impacted respectively.

The estimated impacts to these restricted communities were based on the base case of the proposed Development as presented in the Draft EIS/ERMP. As the Development concept is further developed, and through ongoing surveys, preferred routes are being selected that will either avoid restricted communities of flora, or have much lower impacts than those reported. Only one *Erythrina vespertilio* was found near the North White's Beach pipeline route and this route is being planned on the basis of recent mapping that will cause limited disturbance to *Grevillea* communities.

12.5 North White's beach pipeline appears to have unacceptable high impacts associated with its implementation.

The route for the feed gas pipeline at North White's Beach is being selected on the basis of new mapping over a broader area. The new route will avoid impacts to the restricted limestone community (L3c). Clearing of *Grevillea* communities will affect a limited proportion of the whole community in this area.

12.6 This low rainfall greatly decreases the likelihood of adequate revegetation outcomes now and in the future.

Following the initial vegetation survey during a period of low rainfall, significant rainfall was recorded on Barrow Island. The normal pattern is for heavy rainfall associated with cyclones with lesser falls scattered throughout much of the year. Vegetation surveys during and after the period of significant rainfall showed much new germination and several new species for the island were recorded. Observations of vegetative regrowth on cleared areas of the island indicate that natural processes facilitate regeneration.

16.76 This makes a mockery of the proposed Environmental Objectives 1.1, Box 1, Introduction, Technical Appendix A1. The stated Management Objectives for Flora and Vegetation Communities, and no doubt also for vegetation dependent Terrestrial Fauna, will not be achievable, and it is unacceptable for the report to suggest otherwise.

The management measures listed in various sections of Chapter 10 of the Draft EIS/ERMP (Chevron Australia 2005) are believed to be achievable. These measures follow the principles of avoidance of impacts by selecting appropriate locations for infrastructure and mitigation to reduce the net ecological effect of the proposed Development.

18.17 Another very significant weakness of the risk assessment process is the failure to consider the introduction and spread of weeds as an environmental risk factor to biodiversity.

The presence of introduced plant species in proposed development areas was considered during the risk assessment process and is identified as 'Potential Environmental Impact/Consequence' with a 'Target' of no spread and associated 'Proposed Measurement Strategies' for the risk assessment (Chevron Australia 2005; Table 10-7, p 335). Risk from weeds is also addressed in discussion of specific areas. The potential for spread of specific introduced species, *Setaria verticillata* (Chevron Australia 2005; p 328) and *Cenchrus ciliaris* and *Prosopis* sp. (Chevron Australia 2005; p 335) were mentioned in particular.

The Joint Venturers have sought advice on the potential threat of introduced weed species with the Quarantine Expert Panel and with other experts in the risk assessment workshops. The Quarantine Expert Panel and other experts consistently advised the Joint Venturers that predictions of the potential impact of weed species on Barrow Island biodiversity were too difficult to attempt with certainty. This advice was shared with stakeholders in the Community Consultation Meetings in 2004.

For this reason, the Joint Venturers proposed a risk-based assessment method, in consultation with experts and the community that did not rely on predictions of consequences, but rather on a rigorous analysis of the likelihood of infection on potential pathways of introduction. It is acknowledged that some organisms that might be introduced could survive on Barrow Island, in the event that they were able to gain a foothold in the native environment. Therefore, the Joint Venturers are committed to a rigorous quarantine regime which leads to a proven low likelihood of introduction (the conclusion of the assessment of three priority pathways in the Additional Information Package). In supporting this commitment, a monitoring system and surveillance system will be developed and implemented that will enable early detection at the proposed development site and in the immediate native environment, so that an appropriate response can be rapidly initiated to protect the conservation values of the Island.

18.129 The environmental risk assessment for terrestrial flora and vegetation on Barrow Island should be extended to include consideration of weed introduction and spread as an environmental threat to biodiversity, particularly considering that buffel grass is still persisting in developed areas of Barrow Island, despite years of control operations.

The assessment of the threat of introduction of weeds to Barrow Island's biodiversity is included in the Draft EIS/ERMP (Chevron Australia 2005; Chapter 12).

22.177 The question of sulphur dioxide is dismissed with the comment that emissions will be low, the gas being low in sulphur. This issue needs more discussion. This may well be the case, however any level of emissions has the potential to combine with NO_x and other substances to form acid rain. The document states that most of the deposition will occur in the marine environment where the receiving waters are not considered sensitive to nitrogen deposition. It states that the impact will occur close to the source of pollution as the climate is dry and also that the deposition will be relatively insignificant. However the impact on vegetation and the marine environment is not covered in the depth deserved considering the importance of the receiving environment.

The H₂S (which has the potential to form SO₂ if burnt as fuel) will be removed from the feed gas in the acid gas removal unit as shown schematically in the Draft EIS/ERMP, Figure 6.5; and as described in Section 6.2.3 (Chevron Australia; p 107). Therefore H₂S will be injected with the CO₂ as mentioned in Section 6.2.4. Thus, under normal operating conditions it will not be released to the environment as SO₂. Impacts of NO_x emissions are described in Chapters 10 and 11. The possible effects of gaseous emissions of plants around the gas processing facility are described in Section 10.3.2 of the Draft EIS/ERMP (Chevron Australia 2005; p 330). This section also includes the management measures that will be taken to minimise impacts from emissions and the conclusion of low risk to native vegetation and flora.

- 24.53 – On what basis can a judgement be made about the level of risk when some of the consequence categories use the same criteria? For example, the same criteria are used for serious, major and critical under the category of general flora and communities – impact on species or community.
- On this basis, why would the consequence be determined as serious rather than critical, with a different risk conclusion?

The consequence definitions for serious, major and critical impacts on terrestrial flora or vegetation communities all involve widespread and long-term disruption of the receptors. The difference in the three categories relates to the associated risk of loss of species or communities. Hence long-term, widespread impacts that reduce the viability of the receptor is defined as a serious consequence, whereas impacts that lead to extinction of the receptor are defined as critical (Chevron Australia 2005; Table 10-4, p 325).

10.3.1 Clearing and Earthworks

- 16.32 Unlike that at Town Point, the vegetation further inland on the southern half of Barrow Island has become heavily fragmented by development and is disturbed daily by traffic, noise and dust, it is therefore unlikely to provide favourable shelter for roosting and nesting. It is very doubtful whether such widely fragmented areas on the Island could support the same density of birds as at Town Point. A small breeding population is more likely.

Disturbance in the southern half of Barrow Island has affected a relatively small proportion of the island (4.5% Chevron Australia 2005; p 327). There is some evidence that land bird densities are higher alongside roads (Pruett-Jones and O'Donnell in prep) suggesting that the densities in the more developed parts of the island may be higher.

- 18.68 Chevron Australia should provide information to justify the values provided in Table 10-5 showing the existing disturbance on Barrow Island. These values should be revised to reflect the true area of existing disturbance on Barrow Island, including indirect impacts and areas impacted by accidental disturbances such as flowline leaks and fires.

- 22.238 How have the estimates of current disturbance (1,050 + 172 ha) on the Island factored in the impacts of dust? Habitat fragmentation? Altered surface drainage? Accidental spills? Please refer again to the overview and relevant Parliamentary questions in Appendix 1.

The figures quoted are the best available and are derived from high quality aerial photography with some ground-truthing. The numbers represent current levels of areas cleared of vegetation on Barrow Island. Areas of fires, whether started by natural events or oilfield activities and are also mapped. Locations of flowline leaks are recorded and reported separately.

10.3.2 Emissions

- 22.176 The document states that best practice technologies to reduce emissions to the lowest levels practicable will be used. The emissions to air have the potential to affect not only human health but the vegetation of the Barrow Island. Impacts of the emission of oxides of nitrogen for instance, include bleaching or killing of plant tissue, reduced growth rate and leaf fall.

The possible effects of gaseous emissions of plants around the gas processing facility are described in Section 10.3.2 of the Draft EIS/ERMP (Chevron Australia 2005; p 330). This section also includes the management measures that will be taken to minimise impacts from emissions such that the native vegetation and flora will be at low risk from emissions associated with the proposed Development. Also refer to 24.38 Section 7.2.

10.3.3 Fire

No submissions received on this section of the Draft EIS/ERMP.

10.3.4 Unpredicted CO₂ Migration to Surface

No submissions received on this section of the Draft EIS/ERMP.

10.3.5 Cumulative Risk

No submissions received on this section of the Draft EIS/ERMP.

10.4 Terrestrial Fauna

10.2 The ERMP/EIS fails to take into account the vulnerability of the populations on Barrow Island to disturbance. The ERMP/EIS fails to take the difference between island populations and mainland populations.

It is acknowledged that the vulnerability of the mammal fauna on Barrow Island to an island-wide catastrophe demands careful management of potential impacts from the proposed Development. The black-flanked rock wallaby is the only mammal population on the island that is thought to be at risk of extinction due to genetic depression. The Joint Venturers have committed to avoiding impacts to the rock wallaby populations and this was a major factor in relocating the shore crossing from Flacourt Bay. As pointed out in earlier statements by the Submitter, Barrow Island is a very large island and fauna on the island do not face the same level of threat that those on smaller islands where small-scale events can threaten the whole population.

13.7 The principal issue that is of concern is the proposed translocation of individuals that likely to be impacted by the development. This translocation will be, as indicated by studies in the literature, purely aesthetic/cosmetic as most populations are at or near carrying capacity and relocated individuals will find difficulty in establishing themselves in already occupied habitat. If it is to be carried out, then a detailed monitoring program should be developed to evaluate the success or otherwise of an expensive management protocol.

18.82 Assessment of impacts on terrestrial fauna of conservation significance on Barrow Island should include a detailed assessment of the potential of the proposed Gorgon development to affect the conservation status of rare and threatened fauna species.

Any fauna translocation/relocation program implemented by the Joint Venturers will be discussed with Department of CALM staff at the development stage.

13.8 No consideration has been given here to the impact of disturbance (to *Rhagada* sp2) over the larger area which would be associated with the installation of the access roads necessary for the erection of W to E pipeline, or that to the north of the island if the sequestering of gases is to occur there.

The *Rhagada* snails collected for the genetic studies were all from vegetated habitats that are very well represented on Barrow Island. These habitats will not be threatened by the proposed Development and nor will the associated cryptic fauna (Chevron Australia 2005; Section 10.3.1).

13.9 There is no mention of genetic studies being planned to establish the degree of relationship between the populations of the taxon 'Rhagada sp.2' on the island and those on the mainland that may be conspecific with it.

Tissue samples and whole snails have been retained in cryogenic storage to facilitate further genetic comparisons with mainland populations. Genetic research into genetic affinities of terrestrial snails is ongoing at the University of Western Australia.

- 13.10 *(Quistrachia barrowensis)* It too will be impacted at the footprint area, as well as by the installation of the pipelines.

Quistrachia barrowensis is widely distributed on Barrow Island (Slack-Smith 2002) and the loss of a small proportion of its habitat will not affect its viability on the island.

- 13.11 Similarly, the two species of *Pupoides*, although deemed to be conspecific with those on the mainland, could well have developed genetically-differentiated races on the island and even have differentiated into distinctive populations there. The impact on these taxa also needs to be addressed – the small sizes of such animals does not diminish their importance.

The two species of *Pupoides* are widely distributed on Barrow Island (Slack-Smith 2002) and the loss of a small proportion of their habitat will not affect their viability on the island.

- 16.13 The following conservation values make it abundantly clear that Barrow Island is highly important to at least 50 species of waterbird and migratory shorebirds/transquatorial migratory waders.

The beaches in the south and south-east of Barrow Island are recognised as an important area for migratory birds (Chevron Australia 2005; pp 266–267).

- 16.29 The conservation category of these Wrens is listed as Vulnerable under the *Wildlife Conservation Act 1950 (WA)* and *EPBC Act 1999*. Their vulnerable status should mean that their protection is raised, not lowered!

The white-winged fairy wren is given a higher level of protection in the risk assessment presented in the Draft EIS/ERMP due to its vulnerable and endemic status (Chevron Australia 2005; Tables 10-8 and 10-9).

- 18.81 If the assumption that the proportion of fauna to be impacted by the proposed development corresponds with the proportion of the total footprint of the project on Barrow Island is to be accepted, data should be provided in support of this assumption.

The assumption of equal distribution over Barrow Island is based on trapping and spotlighting records from a range of habitats across the island which indicate that all species, except the white-winged fairy wren, rock wallaby and water rat, are widely distributed on the island. The white-winged fairy wren appears to prefer coastal habitats and the proportion of the total population affected is predicted to be 2% rather than 1.3% (Chevron Australia 2005; pp 350–351). If the same is assumed for other species the total loss of 2% is still considered not to pose a threat to the survival of these threatened taxa.

- 18.183 10.4 Terrestrial Fauna, page 347 – The statement that “*No high risk stressors to terrestrial flora and vegetation communities were identified through the risk assessment process*” refers to flora and vegetation when it is within the terrestrial fauna section.

This is a typographical error and the statement should read ‘No high risk stressors to terrestrial fauna were identified through the risk assessment process.’

- 22.13 The submitters also wish to highlight issues that have been found to be more important, or aspects of the proposal which are more concerning since the time of the ESE – Barrow’s international significance for migratory birds has only now been recognised.

The ecological work conducted for the Gorgon Development has advanced the knowledge of Barrow Island’s biodiversity on many fronts, including migratory birds.

- 22.111 Since when was translocation mooted? The proponent must know that moving territorial fauna to other spots on the Island will not be successful.

Translocation has been successful for several threatened mammals in Western Australia, including species from Barrow Island, and is central to CALM’s Western Shield program. A discussion of translocation programs is included in the Draft EIS/ERMP (Chevron Australia 2005; pp 353–354).

25.29 The extreme vulnerability of island populations to disturbance or invasion is not given adequate weight in the EIS or the risk assessment. Analysis of risks appears to be understated as assumptions are made that effects will be proportionate to the project's area of disturbance of the Island.

Island populations are vulnerable to catastrophic impacts, such as the invasion of a large feral predator (e.g. cat, dog or fox) or an uncontrolled hot fire. The risk of catastrophic impact to the island's fauna is not expected to be increased by the proposed Development. Conversely, the presence of the Development would provide a degree of control over wild fires, at least in the vicinity of the facilities, and this would reduce the probability of widespread extinctions. Further, the continuing use of Barrow Island by the petroleum industry would also ensure ongoing quarantine controls that virtually eliminate the risk from large feral predators.

25.30 A more realistic analysis of risks is required that should take the extreme vulnerability of the island terrestrial populations, indirect impacts (including the fragmentation of habitats, the introduction of invasive plants animals or diseases) and relative habitat use and significance into account.

Barrow Island is the second largest island in Western Australia and the faunal populations are not at risk of extinction to the same degree as those on small islands. Smaller islands are more likely to suffer island-wide impacts with the potential to cause extinction of endemic fauna. Barrow Island is large enough to the extent that impacts to all populations, or even a large proportion of the island's populations, are extremely unlikely. The one terrestrial population that has been identified as being vulnerable to extinction, due to its habitat limitations and small population size, is the black-flanked rock wallaby. This species has been given extra weighting in the risk assessment as any loss of individuals has been considered a threat to the viability of the island population (Chevron Australia; Chapter 10, p 361). Indirect impacts due to habitat fragmentation by linear features such as pipelines will be alleviated by burying the pipeline or by providing crossing points for fauna.

10.4.1 Clearing and Earthworks

16.17 The proposed vegetation disturbance would inevitably jeopardize breeding, feeding orientation of important avifauna.

Disturbance to terrestrial vegetation is predicted to affect approximately 3–4% of the endemic race of white-winged fairy wrens on Barrow Island (Chevron Australia 2005; pp 350–351). No other land birds are expected to suffer more than this level of impact.

16.23 The relocation of some fauna from the development area prior to clearing is supported by CALM. In consultation with CALM, Chevron Australia must develop a full fauna relocation program, which includes a research component that tracks subject fauna in order to monitor the success of the relocations, and resourcing for habitat management.

13.7 The principal issue that is of concern is the proposed translocation of individuals that likely to be impacted by the development. This translocation will be, as indicated by studies in the literature, purely aesthetic/cosmetic as most populations are at or near carrying capacity and relocated individuals will find difficulty in establishing themselves in already occupied habitat. If it is to be carried out, then a detailed monitoring program should be developed to evaluate the success or otherwise of an expensive management protocol.

18.86 The relocation of some fauna from the development area prior to clearing is supported by CALM. In consultation with CALM, Chevron Australia must develop a full fauna relocation program, which includes a research component that tracks subject fauna in order to monitor the success of the relocations, and resourcing for habitat management

Any fauna relocation program will be designed in consultation with CALM and consistent with CALM's current relocation programs. Relocated fauna will be monitored to assess the success of the programs (Chevron Australia 2005; p 367).

16.35 Because of the inordinately long lengthy construction phase fauna will be without the habitats they presently rely on for a very long time. These impacts are not at all clear and need to be worked out.

The risk assessment in the Draft EIS/ERMP (Chevron Australia 2005; Chapter 10) treats clearing of habitat as permanent loss in calculating the effects on terrestrial fauna. There will be some regrowth, for example along seismic lines and pipelines, so the impacts tend to be over-estimated.

18.83 The Water Rat should be considered as a key receptor species, and appropriate management strategies developed to avoid and/or mitigate impacts on the species on Barrow Island. Further information should be collected on this species on Barrow Island before such a plan is developed.

The water rat is included as a non-listed key receptor (Chevron Australia 2005; p 350) and is known to inhabit coastal sites all around Barrow Island (Chevron Australia 2005, p 241; Technical Appendix C2, p 9). It is anticipated that the construction of the causeway will increase the amount of available habitat for this species.

18.87 Any translocation program for Barrow Island fauna must be developed in consultation with and to the satisfaction of CALM, and must be specifically authorised by CALM. Any program to translocate fauna must include a research component that tracks subject fauna in order to monitor the success of the translocations.

Chevron Australia is not proposing as part of the Gorgon Development to move any animals to the mainland or other islands. However if CALM has a translocation program, fauna from the development site may be suitable candidates for translocation. (Chevron Australia 2005; p 353).

18.184 10.4.1 Clearing and Earthworks, page 353 – In regard to the development of fauna translocation plans, the term 'threatened' should be used instead of 'endangered' when referring to subject fauna. Endangered is a specific category of threatened fauna, but the terms are often incorrectly used interchangeably.

The Gorgon Joint Venturers accept this correction.

22.239 In the absence of a specific proposal to translocate fauna successfully, the regulators would have to assume that all fauna within the development footprint will be killed directly or indirectly (by intra-specific competition, for example).

The impact assessment in Section 10.4.1 assumes that none of the fauna displaced from cleared areas survive. This is an extremely conservative, worst-case approach. Any translocation or relocation as described on p 353 (Chevron Australia 2005), and as part of an existing CALM program, would mitigate these losses. It is expected that the highly conservative estimate of mammal losses is an over-estimate of actual losses.

22.241 In what way does lodging dead animals for science 'offset' the killing of those animals? It is merely examining what we are impacting as we are impacting.

There is a paucity of specimens of most Barrow Island fauna in the collections of the Western Australian Museum. While significant vouchering work has been conducted during the surveys for the Gorgon Development, CALM include a call for additional vouchering in their submission on the current proposal. Tissue and other samples from such specimens will facilitate ongoing taxonomic review of the Barrow Island fauna.

24.51 The statement in paragraph 3 is not true for *Urodacus* sp and also *Synsphyronous* sp, as section 10.4.1 indicates that they are only known from the Development site.

The statement in paragraph three of Chapter 10 (Chevron Australia 2005, p 302) refers to the representation of all terrestrial fauna outside the development area. While this has not been established for the two invertebrate taxa mentioned in the submission, the broad distribution of their habitats outside the development area and the previous collection of the scorpion from an unknown location on the island (Western Australian Museum collection), strongly indicates that these taxa are found in areas other than the development area. Technical Appendix C4 (Chevron Australia 2005) describes the likely distribution of these uncommon invertebrates on Barrow Island. Invertebrates are generally associated with a particular suite of structural and vegetated habitats.

Protecting restricted habitats and vegetation communities also protects the invertebrate communities dependent on them. None of the vegetation types or structural habitats that would be affected by the proposed gas processing facility are restricted on the island. Therefore none of the associated invertebrate assemblages are expected to be restricted to the small area to be affected. The distribution of scorpions and pseudoscorpions on Barrow Island and their taxonomic affinities to congeneric mainland scorpions is under investigation by the Western Australian Museum. These data will be used to refine management plans on an ongoing basis.

24.82 Referring to the following statement in section 3.4.1

“One specimen of a new species of *Synsphyronous* sp. nov. ‘Barrow’ (Plate 3-4) was sieved from leaf litter beneath *Triodia* on limestone, west of Town Point (T57749, site B11.41) in 2003. No specimens had been collected from the mainland or Barrow Island previously (M. Harvey personal communication 2004). This species has the potential to be a SRE, as many other species of this genus are restricted to small areas. A taxonomic description of this new species by Dr Mark Harvey at the WAM is currently in progress.”

On the basis of current knowledge, what would be the expected implications to this species if development occurred as proposed?

Would it potentially lead to the loss of this species?

What additional information will be obtained in relation to this species prior to a decision by the Minister for the Environment on project approval?

The coastal (*Triodia* litter over limestone) habitat of this specimen is widely distributed on Barrow Island. This species is less common than the other pseudoscorpion species in the Town Point area and it is expected to be widely distributed at low abundances in similar habitats around the island. The small proportion of the *Triodia* habitat to be affected by the development is expected to affect a similarly small proportion of the pseudoscorpion and is very unlikely to lead to loss of the species. The pseudoscorpion will be targeted in ongoing invertebrate survey work on the island during construction and operations.

24.57 In view of the presence of significant fauna located only on or beneath the plant site and along the Flacourt Bay gas feed pipeline option route, how can the following targets listed in Table 10-11 be achieved unambiguously:

- <5% estimated island-wide population of any species impacted
- viability of listed fauna species maintained
- critical/restricted fauna habitats avoided?

24.60 For species that have only be found within the Development area (eg. *Urodacus* sp, *Synsphyronous* sp and *Ramphotyphlops*), how can a conclusion of medium risk be determined when the likelihood is stated to be almost certain and the consequence category in Table 10-9 would be either serious, major or critical, resulting in a high risk assessment in Table 9-2?

24.83 Referring to the following statement in section 4 (Technical Appendix C4)

“The scorpion *Urodacus* sp nov. ‘barrow’. This species is known only from two specimens collected from Barrow Island and appears to be a new species (see Section 3.5). One specimen was collected within the proposed Development area and the other in the WAM collection came from an unknown locality. As so few specimens have been collected, it is unclear if the distribution of this species is restricted to a certain area.”

- On the basis of current knowledge, what would be the expected implications to this species if development occurred as proposed?
- Would it potentially lead to the loss of this species?
- What additional information will be obtained in relation to this species prior to a decision by the Minister for the Environment on project approval?

The presence of listed or new fauna only in the development areas is believed to reflect the distribution of sampling effort to date, rather than the complete distribution of the taxa themselves. These taxa are thought to be widely distributed on the island (Chevron Australia 2005; Technical Appendices C2 and C4). For example, the new species of *Urodacus* scorpion was only collected from the proposed Development area, but has also been collected from an unknown location on the island and is anecdotally reported from the centre of the island also. It occurs in a vegetated habitat that is well represented outside the development areas. Further field surveys will be conducted prior during the construction phase to better elucidate the full range of these taxa. In the absence of broader distributional data, habitat protection has been used to protect associated faunal assemblages. By avoiding clearing of restricted vegetation types, any potentially site restricted fauna associated with these habitats are protected.

24.58 The discussion of terrestrial impacts provides details about the abundance of some species within the development area (Table 10-10) and provides some commentary about how many of each of these species might be affected through clearing. However, this doesn’t discuss the effect on the range loss. For example, while one bettong warren is located within the development area, other bettong are likely to use portions of the development area, and this may be significant but not currently addressed. What are the implications of habitat loss and range of those species located on or adjacent to the Development area?

Bettongs have been shown to move over several kilometres in the vicinity of the proposed gas processing facility. It is therefore likely that bettongs (and other fauna) from surrounding warrens forage in the area to be cleared. The effects of the lost foraging habitat will be mitigated by the decrease in the abundance of bettongs in the area competing for the food resource. Ongoing monitoring of the local bettong warrens will determine whether individuals from neighbouring warrens are losing condition (weight and reproductive output). Mitigative management measures will be instigated if this is found to be the case. Such management may include translocation as part of an established program.

24.59 How can the discussion under General Fauna about the “potential permanent, localised decrease in abundance of these [*Urodacus* sp and *Synsphyronous* sp] taxa in the proposed Development Area”, be consistent with Barrow Island, including the Development Area, being a nature reserve for the conservation of flora and fauna?

The localised decrease in abundance of these invertebrates due to clearing the development area is predicted to affect the populations at Town Point only. Populations in similar habitats in other parts of the island, are expected to persist. The viability of these taxa on Barrow Island is not predicted to be under threat.

16.26 The Gorgon development site is evidently important also to the Spinifex Bird; the inevitable impact on these is unacceptable.

Only a small proportion of these bird populations on Barrow Island would be affected by the proposal, including the Spinifex bird. The loss of approximately 2% of the total island bird population is considered ecologically sustainable.

18.80 The significance of loss of particular habitat should be investigated and calculated based on existing levels of habitat use, with estimates of the conservation significance of this for the species involved.

Loss of various vegetated and structural habitats has been included in the risk assessment for terrestrial and marine fauna. Where habitat use could not be quantified, the protection of restricted habitats was used to protect potentially restricted fauna that may be associated with it. No changes are expected in the conservation status of Barrow Island fauna.

10.4.2 Physical Interaction

16.34 The Singing Honeyeaters and Spinifex Birds using Town Point would also be lost or displaced. This is totally unacceptable.

The loss of a small proportion of the total population of these land birds is not expected to affect the viability of these taxa on Barrow Island

18.88 In addition to the relocation of fauna, Chevron Australia should commit to the construction of perimeter fencing around the processing facility for the full construction and operational phases of the project.

The Gorgon Joint Venturers will construct an exclusion fence (or provide similar exclusion devices) around areas associated with the operational gas processing facility which are considered potentially hazardous to fauna (Chevron Australia 2005; p 358). This is consistent with current practice on the island in which not everything is fenced, but certain equipment is protected. This position has been taken because a fence will require extra earthworks, additional land take and will potentially trap animals, and the site perimeter will be delineated by the earth work batters, roads and drainage. The construction activities (apart from pipeline construction) will be fenced, and the construction village will be fenced to delineate the perimeter.

22.26 Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – the relative impacts of an above or below ground feed gas pipeline on Barrow.

The alternatives considered for the shore crossing for the feed gas pipelines are discussed in Chapter 3, Section 3.7 of the Draft EIS/ERMP (Chevron Australia 2005). A summary of the assessment for the above- or below-ground feed gas pipeline system is described in Section 6.2.2 of the Draft EIS/ERMP. After working with the engineering and design contractors, and assessing improved construction methodology, the Joint Venturers have recently taken the decision to bury the onshore component of the feed gas pipelines. The ability to achieve a reduced environmental impact was a key criterion in this study. Also refer to 18.49 Section 6.3.5, 24.55 Section 6.2.2 and Part A of this document.

10.4.3 Noise and Vibration

18.145 A monitoring program should be developed to detect whether noise and vibration are having any detrimental impacts to fauna, and avoidance and/or mitigatory measures should be developed in the event that impacts are detected.

Refer to Sections 3.10 and 4.2 in Technical Appendix A1 of the Draft EIS/ERMP.

10.4.4 Fire

- 18.125** The risk assessment process undertaken for the impacts of fire on fauna survival on Barrow Island should be revised to account for the additional risk of fauna mortality after a fire due to exposure, predation and lack of food, and the overall risk of loss of genetic variability and potential fauna extinction.

The effects of fire in reducing habitat availability, food supply and exposing fauna to predation are considered in the risk assessment (Chevron Australia 2005; pp 362–363). Under the worst case scenario of a widespread hot fire, it is recognised that impacts to fauna would be ‘critical’ which is defined as a long-term impact on fauna populations that may cause extinction on Barrow Island (Chevron Australia 2005; Table 9-5, p 298).

- 18.126** The risk assessment table on fire (page 338) should include as a proposed management measure the development of an appropriate fire management regime for Barrow Island in consultation with and to the satisfaction of CALM.

- 18.127** A wildfire response plan for Barrow Island must be developed by Chevron Australia, in consultation with and to the satisfaction of CALM.

A fire management program, including wildfire response, will be developed by the Barrow Island Coordination Council (BICC) in consultation with CALM and DoIR. Environmental Management Plans will be prepared for various components of the proposed Gorgon Development, including specific Impact Management Strategies (IMS) which will deal with specific protocols and management measures. An IMS for Fire Management and Response will be prepared for all construction and operation activities on Barrow Island.

- 18.128** The proposed policy of not controlling naturally occurring fires that do not pose a threat to the Gorgon facilities or personnel should be clarified in light of the extensive oilfield operation and infrastructure that currently exist on Barrow Island and that may also be at risk from fire.

The existing oil field is owned by WA Oil Joint Venture. Please refer to 18.126 above and note that WA Oil will be represented on the BICC.

10.4.5 Emissions

- 22.244** As GJV concedes, very little is known about the impacts of atmospheric pollution on fauna, either directly via inhalation or indirectly via ingestion of ‘coated’ plants/other animals. How is the use of human health standards as a surrogate justified? The regulators should insist on some such work being done before the proposal is further considered.

Human health standards are set to protect the health of humans exposed to various emissions, over a lifetime of exposure. The much shorter life span of terrestrial fauna adds a considerable safety factor to the extrapolation from humans to other mammals and birds.

- 22.245** Given the lack of relevant information, on what basis have impacts on listed fauna been seen as “possible”, but predicted to be negligible”?

Emission controls on the operating gas processing facility are expected to result in low levels of exposure of listed fauna to emissions from the facility. All of the listed fauna are mobile and unlikely to remain in the area potentially affected by emissions at all times. The residual risk to fauna from emissions is discussed in the Draft EIS/ERMP (Chevron Australia 2005; pp 364–365).

10.4.6 Cumulative Risk

No submissions received on this section of the Draft EIS/ERMP.

10.5 Subterranean Fauna

13.22 The risks to freshwater and saltwater stygofauna of groundwater abstraction and waste (sanitary and hypersaline) not assessed; see also, Box 6-9, box 6-10 and box 16-2. It is assumed, apparently, that drawing saltwater from 150–250 m in itself carries no risk to stygofauna but nowhere is it demonstrated that the saltwater zone is not habitat for stygofauna.

The risks to stygofauna from groundwater abstraction are addressed in Table 10-13 on page 395 of the Draft EIS/ERMP (Chevron Australia 2005). Based on expert advice, Chevron Australia has concentrated subterranean fauna sampling work at depths where it is known or is more likely to occur.

18.89 Given the information provided in the ERMP, it is CALM's view that the proponent has not adequately demonstrated an acceptable lack of threat to subterranean species. The proposed Gorgon gas development on Barrow Island should not be approved until further information or management plans are provided to demonstrate impacts on subterranean fauna are acceptable.

Management plans are being developed and ongoing taxonomic and genetic work will feed into this process. The final management plans to mitigate risks to subterranean fauna during construction and operation of the Development will be determined in consultation with the appropriate government agencies. These plans will be implemented, following the model for the subterranean fauna sampling program that was agreed by CALM, EPA and DEH.

18.92 Prior to commissioning work on the gas processing facility, the proponent should prepare management plans for any subterranean species that appear to be restricted to that site.

Environmental management measures relevant to the protection of subterranean fauna will be addressed in several other plans (e.g. hydrocarbon and potential contaminant storage and handling, surface water management, etc). The requirements for protection of individual taxa will be addressed where they have specific conservation considerations.

19.54 The LWQB question whether using ANZECC 2000 criteria will be adequate enough to protect subterranean biota.

As described in the Draft EIS/ERMP (p 120) the '... objective of the waste water system is to maximise the re-use of water, and to protect soils, subterranean fauna, groundwater and the marine environment from contamination'. In the context of waste water injection this refers to using deep injection (1000+ m) which is far below areas known to be inhabited by stygofauna. The ANZECC/ARMCANZ 2000 Water Quality Guidelines have been designed to provide an authoritative guide for setting water quality objectives required to sustain future environmental values [uses] for natural and semi-natural water resources in Australia and New Zealand. These criteria are based on minimising effects to aquatic organisms including invertebrates and vertebrates. The guidelines are conservative and are intended to provide protection for a broad range of taxonomic groups. They provide a sound set of tools for assessing and managing ambient water quality in natural and semi-natural water resources.

22.112 Why hasn't the issue of stygofauna been considered on a finer scale (not whether or not habitat would be avoided but which areas are less species-rich than others)?

An additional supporting study dealing with stygofauna has been published by the Joint Venture Partners in the Additional Information Package (Chevron Australia 2005b).

22.246 Further environmental assessment should await the further geotechnical and sampling work mentioned here. We note that because of time limitations we have been unable to consider whether the additional information package satisfies the Submitters' desire for more information in this regard.

Sufficient subterranean fauna sampling has been conducted to inform the risk assessment process. Additional subterranean fauna sample collection is planned for March 2006. The period that the submitter had for assessing the AIP (Chevron Australia 2005b) was set by government as appropriate for the level of information that had to be assimilated.

24.61 The discussion under Residual Risk calls into question the conclusions and use of risk assessment. Here, a range of unsubstantiated assumptions are used to argue possible risk levels, where information is currently inadequate. As the subterranean fauna survey information has now been published in the Additional Information Package, what effect does that survey information have on residual risk now?

The high risks to subterranean fauna identified in the risk assessment in the Draft EIS/ERMP were based conservatively on the assumption that there may be taxa restricted to the proposed gas processing facility site; and accounted for the lack of data on hydrogeology and waste water management. New data in the AIP (Chevron Australia 2005b) indicated that it is unlikely that subterranean taxa are restricted to the gas processing facility site. This reduces the level of estimated risk presented in the Draft EIS/ERMP because the risk of loss of an endemic taxon is lower. Further information in regard to the hydrogeology of Barrow Island will be used in EMPs to further manage the risk to subterranean fauna species.

24.62 Is there any published information about the possible implications of vibration of subterranean fauna?

Literature searches are being undertaken in this area at present, but it is not a well studied aspect of subterranean ecology. There are unlikely to be any definitive studies that will allow a quantitative assessment of vibration impacts on troglofauna and stygofauna.

24.63 In view of the information in the Additional Information Package confirming that there are subterranean fauna species only located beneath the plant site, the high residue risk level for subterranean fauna in table 10-14 has been confirmed. How do the proponent's intend to address this high risk, which is considered to be unacceptable according to section 9.2.5.

A conclusion in the AIP (Chevron Australia 2005b) was that it is unlikely that any subterranean fauna are restricted to the gas processing facility area. This reduces from the high residual risk level. The other areas of uncertainty that contributed to the high residual risk level were lack of knowledge of hydrologic processes under the site. This information will be used to re-assess the risk level to subterranean fauna.

24.80 Refer to the following statement in Attachment 9:

"Another species not recorded by this survey, *Ramphotyphlops longissimus*, is the only reptile species endemic to Barrow Island. However, this species is known from only one pair hauled up from below ground with some well casings (Storr et al. 2002). Based on its morphology, this species appears to spend its entire life in subterranean limestone caves. Thus, there is almost no chance of detecting one during a terrestrial survey such as this one. It is hoped that further stygofauna and troglobitic surveys will reveal more specimens."

None appear to have been found in sampling undertaken through the Subterranean fauna Survey. Does this represent a significant species that might be affected by the development?

Even though it has not been caught yet, it is possible that this species occurs in the proposed Development area, given that it probably occurs in suitable habitat across Barrow Island. Individuals therefore might be affected by the proposed Development. However, the Development will affect only a small proportion of the suitable habitat on the island and is not predicted to pose a threat to the viability of this taxon on Barrow Island.

24.84 Referring to the following statement in section 4

“All of Barrow Island has high conservation value. On the basis of the available information, the specific conservation values represented in the vicinity of the proposed development area would be ascribed high conservation value in a regional context because it:

- has records of Schedule One fauna (the stygobite *Nedsia hulbertii* and the troglobite *Draculoides bramstokeri*)
- is the only known location for *Nedsia chevronia* (well MW15; Bradbury, 2002)
- has records of undescribed stygofauna taxa not known from elsewhere on the Island”
 - On the basis of current knowledge, what would be the expected implications to these species if development occurred as proposed?
 - Would it potentially lead to the loss of these species?
 - What additional information will be obtained in relation to these species and taxa prior to a decision by the Minister for the Environment on project approval?

It is acknowledged that some Schedule fauna occur in the subterranean habitats under the proposed gas plant. The threat of extinction of these species is considered low. The troglobite *D. bramstokeri* occurs across Barrow Island and also on Cape Range. The Development would directly affect a portion of the local habitat for this species and could result in the mortality of individuals occurring there. However, the species would still be distributed in locations across the remainder of Barrow Island and on Cape Range, so would not be lost as a result of the Development. The *Nedsia chevronia* has only been recorded from the terminal tanks area to the north of the current planned development footprint, but has been assumed conservatively to occur at the development site also. Further studies will be undertaken to determine the localised extent of distribution.

- 24.85
- On the basis of current knowledge, what would be the expected implications to these species if development occurred as proposed?
 - Would it potentially lead to the loss of these species?
 - What additional information will be obtained in relation to these species and taxa prior to a decision by the Minister for the Environment on project approval?

It is acknowledged that some Schedule fauna occur in the subterranean habitats under the proposed gas processing facility. The threat of extinction of these species is considered low. The troglobite *D. bramstokeri* occurs across Barrow Island and also on Cape Range. The Development would directly affect a portion of the local habitat for this species and could result in the mortality of individuals occurring there. However, the species would still be distributed in locations across the remainder of Barrow Island and on Cape Range, so would not be lost as a result of the Development. *Nedsia chevronia* has only been recorded from the terminal tanks area to the north of the current planned development footprint, but has been assumed conservatively to occur at the proposed Development site also. Further studies will be undertaken to determine the localised extent of distribution.

The coastal habitat (*Triodia* litter over limestone) of this specimen is widely distributed on Barrow Island. This species is less common than the other pseudoscorpion species in the Town Point area and it is expected to be widely distributed at low abundances in similar habitats around the island. The small proportion of the *Triodia* habitat to be affected by the Development is expected to affect a similarly small proportion of the pseudoscorpion and is very unlikely to lead to loss of the species. The pseudoscorpion will be targeted in ongoing invertebrate survey work on the island during construction and operations.

26.9 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: further work on the possibility that the groundwater ecosystems on the Island are chemoautotrophic

Sufficient subterranean fauna sampling has been conducted to inform the risk assessment process. The question of chemoautotrophy would require considerable, multi-disciplinary research effort and an immediate answer cannot be expected from the proponent of any development proposal.

26.10 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: how, if at all, the fauna sampling work done thus far took account of the current uncertainties about the footprint for the proposal

26.11 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: the need for subterranean taxonomic work to be completed, or for more specimens for appropriate taxonomic work to be done, or both.

Sufficient subterranean fauna sampling has been conducted to inform the risk assessment process. The difficulties inherent in identifying stygal and troglobitic taxa, for which there are currently no experts, are beyond the control of the proponent or its consultants. Due to these difficulties, species level identifications cannot be expected for any development proposal.

26.14 If the subterranean work has not yet been completed, why are we being shown it now?

Sufficient subterranean fauna sampling has been conducted to inform the risk assessment process. The difficulties inherent in identifying stygal and troglobitic taxa, for which there are currently no experts, are beyond the control of the proponent or its consultants and species level identifications cannot be expected for any development proposal.

18.3 For example, the potential significant impacts on the marine environment from dredging were not envisaged at the time of the ESE review. Furthermore, a better knowledge of the subterranean fauna values and threats now indicates a potential for significant detrimental impacts.

Both the footprint of the proposed marine facilities and the dredge volume have been significantly reduced from the concept proposed in the ESE Review. The impacts from dredging are considered low to medium. Refer to Chapter 11 for additional details on dredging and impact assessment. Refer to the Additional Information Package for details on the subterranean fauna.

18.89 Given the information provided in the ERMP, it is CALM's view that the proponent has not adequately demonstrated an acceptable lack of threat to subterranean species. The proposed Gorgon gas development on Barrow Island should not be approved until further information or management plans are provided to demonstrate impacts on subterranean fauna are acceptable.

Management plans are being developed and ongoing taxonomic and genetic work will feed into this process. The final management plans to mitigate risks to subterranean fauna during construction and operation of the development will be determined in consultation with the appropriate government agencies. These plans will be implemented, following the model for the subterranean fauna sampling program that was agreed by CALM, EPA and DEH.

18.90 It is recommended that the proponent undertake additional survey work outside the gas processing facility to provide more information about distributions of species of subterranean fauna that are listed above as possibly threatened by development.

The studies completed to date have provided some information on the wider distribution of subterranean fauna on Barrow Island. Additional sampling is planned on an ongoing basis to provide further information on the distribution of subterranean species currently recorded from the development area. This will be complemented by additional genetic and taxonomic studies.

18.91 The proponent should initiate taxonomic work on the species of subterranean fauna potentially threatened by development as a matter of high priority, to improve the certainty of species level identifications of these animals.

This work is currently underway, with Chevron contributing to the financial support of a technical officer in the WA Museum terrestrial invertebrates section. This ongoing work will yield species level (or morphotype equivalent) identifications of the collected fauna where possible and will also assist with the description of new taxa.

18.93 Approvals must be sought under the Wildlife Conservation Act to remove habitat of *Speleostrophus nesiotus* and *Draculoides bramstokeri* at the gas processing plant.

Chevron will follow the due process (with appropriate agencies) prior to commencing earthworks on the gas processing facility area.

10.5.1 Clearing and Earthworks

22.194 The Submitters rebut the assumption in this chapter and elsewhere in the draft EIS/ERMP that impacts on fauna will be restricted to the 300 ha development area. While issues like noise and light are discussed and, to some extent, made the subject of proposed management measures, the impact of those factors on fauna populations is not known. In any event, what is clear to us, but de-emphasised in the document, is that these factors will effectively increase the footprint of the development well in excess of the oft-cited 300 ha BI Act allocation!

Possible edge effects and low level disturbance will be amply mitigated by restoration of cleared areas and use of modified habitats by native fauna. The 300 ha allocation for clearing will not all be cleared at once and will not remain cleared after construction. Areas such as the horizontal directional drilling area at North White's Beach will be rehabilitated after installation of the pipeline. Areas under and adjacent to pipelines and power corridors have been conservatively calculated as a loss. However, there will remain areas of undisturbed vegetation and modified habitats in these easements that will continue to support fauna.

10.5.2 Physical Presence of Gas Processing Facility

No submissions received on this section of the Draft EIS/ERMP.

10.5.3 Wastewater Discharge

18.40 The options for treating and disposing of waste water generated by the Gorgon gas development on Barrow Island, such as reinjection into the subsurface formation and disposal of sludge on the mainland, must be fully assessed in terms of potential environmental impacts.

22.137 What are the consequences of injecting salt below Barrow as described here?

Waste water injection would be into formations deep beneath Barrow Island and well away from subterranean fauna and therefore have negligible environmental impacts. Disposal of sludge would be to an approved waste management site.

18.95 The disposal of treated waste water into the aquifer should be assessed as a potential risk factor for stygal communities.

Treated waste water will not be injected into stygal community habitat. Refer also to 18.40 above.

10.5.4 Noise and Vibration

No submissions received on this section of the Draft EIS/ERMP.

10.5.5 Spills and Leaks

19.61 The LWQB preferred approach, is that prior to the commencement of this project all current contamination areas known to be present on the island are remediated to a level that won't pose a risk to human health or the environment.

There is no contamination known in the areas proposed to be developed.

10.5.6 Unpredicted CO₂ Migration

No submissions received on this section of the Draft EIS/ERMP.

10.5.7 Cumulative Risk

No submissions received on this section of the Draft EIS/ERMP.

10.6 Conclusion

No submissions received on this section of the Draft EIS/ERMP.

11 Marine Environment – Risks and Management

11	Marine Environment – Risks and Management.....	228
11.1	Introduction and General Submissions on Marine Environment.....	229
11.2	Physical Environment.....	231
11.2.1	Seabed Substrate.....	232
11.2.2	Foreshore.....	233
11.3	Benthic Primary Producers.....	234
11.3.1	Seabed Disturbance.....	238
11.3.2	Leaks and Spills.....	258
11.4	Benthic Primary Producer Habitats.....	258
11.4.1	West Coast and North Coast.....	273
11.4.2	East Coast.....	273
11.4.3	Mainland Coast.....	274
11.5	Marine Fauna.....	275
11.5.1	Seabed Disturbance.....	279
11.5.2	Physical Interaction.....	284
11.5.3	Light.....	285
11.5.4	Noise and Vibration.....	293
11.5.5	Leaks or Spills.....	294
11.5.6	Cumulative Risk.....	296
11.6	Conclusion.....	296

11.1 Introduction and General Submissions on Marine Environment

15.2 In general, the EIS/ERMP is severely deficient in that it fails to adopt a holistic approach to assessing marine environmental impacts by only examining components of the marine environment separately (eg. Benthic primary producers, benthic habitats and marine fauna), without considering impacts on the inter-relationships among these components (eg. impacts on fauna habitat). This deficiency is highlighted with the 30 year recovery period used by the proponent to distinguish between permanent loss of, or temporary damage to, benthic primary producer habitat (BPPH). The proponent has not considered the effects of extended periods of loss of BPPH on other components within the ecosystem (trophic cascades).

The assessment on marine impacts focuses on benthic habitats as these are critical to maintain biodiversity. The separation of benthic primary producers (BPP) and their habitats (BPPH) is in accordance with the EPA Guidance 29. Marine fauna are considered separately to account for possible direct impacts from the Development and also indirect effects of habitat loss (trophic cascade). The possible effects of habitat disturbance on fauna are covered throughout the Draft EIS/ERMP section on Marine Fauna (Chevron Australia 2005; Section 11.5). The 30-year recovery period is consistent with advice from the DoE on assessing 'permanent' impacts to BPPH. Recovery represents full return of the faunal and floral diversity to the level of non-impacted habitats. Most faunal populations are expected to recover in a much shorter time frame. For example, the fish fauna of areas of cleared seabed are expected to recover within a few years of the return of structural complexity, through provision of artificial substrates or recovery of BPPH.

15.10 In summary, the MPRA has grave concerns as to the scale and location of this proposed development. Specifically there are three impacts of concern: 1) Impacts of the dredging plume and causeway construction on marine communities. 2) Effects on rare and endangered flatback turtles and on-going necessity for light management. 3) Introduced Marine Pests risks.

Refer to Chapter 7 for light mitigation strategies and Chapter 11 for an assessment of potential impacts. Dredge plume modelling has been completed, with model validation data published in the Draft EIS/ERMP Additional Information Package (Chevron Australia 2005b). Introduced marine pest risks are being addressed through the same risk-based assessment process that has been used for the three priority pathways (refer to the Additional Information Package, Part 2). Substantial progress has been made to date in four IMEA and PBA workshops (refer to Table 12-3 in the Draft EIS/ERMP), to identify threats of introduction and suggestions for quarantine barriers that would be effective to address each threat. Proposed barriers for the marine vessel pathways will be tested for effectiveness in a QHAZ workshop by independent experts, with special reference to the status of the Montebello/Barrow Islands Marine Conservation Reserves.

18.23 For the marine environment, the ERMP also fails to adopt a holistic approach to assessing environmental impacts by examining components of the marine environment separately (e.g. benthic primary producers, benthic habitats and marine fauna), without considering impacts on the inter-relationships between these components (e.g. impacts on fauna habitat).

Benthic biotic habitats and marine fauna are the major components of the marine ecosystem and have to be addressed individually to demonstrate that the range of taxa or habitats have been covered (some taxa do not interact with benthic habitats). The marine fauna assessment focuses on listed threatened species such as turtles, whales and dugong and includes general fauna communities. The risk assessment for the marine fauna is based on direct impacts such as collisions and also loss of habitat. For example, seabed disturbance (habitat loss) was one of the major stressors examined (Chevron Australia 2005; p 484). Also refer to 15.2 above.

24.95 The ERMP states explicitly “The Development is currently in the early design phase with less than 10% of engineering design completed to date. As detailed design progresses, it may become necessary to modify management strategies, particularly those with an engineering element” (Page 403).

A consequence of limited progress on proposal design at the time the ERMP was prepared appears to be that several areas of the proposal are either unclear or the proponent has not made a firm commitment to a preferred option.

A large proportion of the required design work will not have an impact on the environment (10% design completion is normal for pre-environmental approval). Part A of this document includes the most up-to-date explanation of the refinements made to the proposal design since the Draft EIS/ERMP was published in September 2005.

24.169 While the ERMP recognises the Montebello/Barrow Islands marine conservation reserves (MCRs), it does not contain adequate evaluation of the impacts/effects of the proposal against the short-term and long-term targets which are set for ecological and social values in Management Plan for the MCRs. Thorough evaluations of impacts against the MCR targets are required to ensure that the EPA has a detailed picture of the proposal’s impacts on this significant marine area.

Refer to 18.101 Section 11.1. CALM’s Indicative Management Plan has been through a public consultation process and is currently being finalised. Until the final version is available, the key performance indicators cannot be assessed with confidence. The Indicative Plan does not provide sufficient detail on the distribution of these benthic communities to assess the potential proportional loss associated with the proposed Gorgon Development.

24.71 The proponent needs to describe how the development will be consistent with and support the objectives of the Montebello/Barrow Islands Marine Conservation Reserves, at the marine park/marine management areas and also zoning levels.

The Gorgon Development is consistent with the vision and strategic objectives of the Montebello/Barrow Islands Marine Conservation Reserves, which includes not only the conservation of marine diversity but also the facilitation of recreational, commercial and scientific/educational activities. Environmental management objective(s) for the marine environment are contained within Chapter 11 of the Draft EIS/ERMP (Chevron Australia 2005, Tables 11-3, 11-12 and 11-23). These objectives have been designed in line with the objectives of the reserve system (CALM 2004) and activities with the potential to impact on the marine environment, and thus impact on the objectives of the reserve, are the subject of detailed management and mitigation measures specified in Tables 11-3, 11-12 and 11-23 of the Draft EIS/ERMP (Chevron Australia 2005). Potential stressors to the marine environment will be managed to comply with the long-term management targets and key performance indicators set for the ecological and social values of the marine reserve system (CALM 2004).

18.101 Chevron Australia should assess the risk of the impacts of its proposed activities against management targets of the key performance indicators in the Indicative Management Plan for the Barrow Island Marine Park and Marine Management Area. This includes all conservation values such as intertidal reef platform, coral reef communities, filter-feeding communities, mangroves and macrophyte communities.

CALM’s Indicative Management Plan for the Barrow Island Marine Park has been through a public consultation process and is currently being finalised. The Indicative Plan does not provide sufficient detail on the distribution of benthic communities to assess potential proportional loss associated with the proposed Gorgon Development. Habitat mapping for the Gorgon Development will be provided to CALM to improve the regional map and gain better estimates of the representation of various benthic habitats. As design work progresses, the Joint Venturers will work with the appropriate government agencies to refine management measures to ensure they address MCR targets.

18.119 Information on expected TBT levels is required before CALM can assess likely impacts.

TBT may still be present on the hulls of construction vessels. However, there will be no major maintenance activities on these vessels in the Barrow Island area which would result in large scale discharge of such material, and new facilities will not use TBT (refer Draft EIS/ERMP, pp 416 and 417). In addition, these vessels will be moving and so not concentrate their activities in one spot. As a result the risk to the environment from antifoulant coatings is considered very low.

24.141 The proponent is requested to provide the EPA SU with GIS spatial data that underpins the benthic habitat maps and figures which show the boundaries of the predicted impact zones for various impact scenarios, including consecutive and cumulative stress scenarios.

GIS layers will be provided to the EPA SU to facilitate interpretation of monitoring data once the development design is finalised, the baseline monitoring program has commenced and the modelling revisions are complete.

24.79 The (to?) assist the EPA SU to consider the proposal, the proponent is requested to provide GIS spatial data that underpins the benthic habitat maps and figures which show the boundaries of the predicted impact zones for various impact scenarios, including consecutive and cumulative stress scenarios.

GIS layers will be provided to the EPA SU to facilitate interpretation of monitoring data once the development design is finalised, the baseline monitoring program has commenced and the modelling revisions are complete.

11.2 Physical Environment

18.103 From Fig. 7.5 Technical Appendix B-6, modelling has produced a visible plume extending across a substantial area of the marine management area and marine park. Information on the temporal extent of this plume is required before CALM can assess the impact of this on all the ecological values within the marine park and marine management area.

Refer to 22.25 Section 6.3.4.

24.137 The assumption the proponent has made in respect of sediments being rapidly mobilised and exported (<5 years) is questioned, particularly in light of the assessment made that the nearshore sediment transport processes on the east coast of Barrow Is are relatively quiescent in nature (eg. “the existing beaches in the vicinity of Town Point are low energy zones with limited longshore drift” pages 407 and 408). The proponent is requested to better substantiate its assumptions that sediment deposited in the intertidal and nearshore subtidal on the east coast of Barrow Is would be rapidly mobilised and transported.

The hydrodynamic modelling predicts a build up of deposited sediments only in the immediate vicinity of the dredging areas, primarily due to the rapid settlement of any large sediment particles liberated during dredging. Large particles are predicted to settle close to the dredged areas and within the area calculated as ‘permanent loss’. Finer sediment fractions remain suspended for longer periods and are more easily resuspended by currents which facilitate transport from the area. The model assumes that 5% of total dredged material will be less than 75 microns in size and that the distribution of these particle sizes will be similar to that at the Geraldton dredging project, which means that the strong tidal currents and winds will repeatedly move, deposit and resuspend the material due to its small size.

The majority of the dredged material is predicted to be considerably finer than the existing nearshore sediments and will thus mobilise much more rapidly and easily than the material which constitutes the nearshore benthic environment currently. More conservative estimates of the size composition of dredged material, i.e. a greater contribution of fines, are currently being modelled and will be used in the formulation of the EMP and monitoring programme for the dredging operation in consultation with the regulatory agencies.

18.3 For example, the potential significant impacts on the marine environment from dredging were not envisaged at the time of the ESE review. Furthermore, a better knowledge of the subterranean fauna values and threats now indicates a potential for significant detrimental impacts.

Both the footprint of the proposed marine facilities and the dredge volume have been significantly reduced from the concept proposed in the ESE Review. The impacts from dredging are considered low to medium. Refer to Chapter 11 for additional details on dredging and impact assessment. Refer to the Additional Information Package for details on the subterranean fauna.

25.20 Further clarification is requested regarding “a minimal change in shoreline position”, surging and how would it be manifested, and magnitude by “some surging” to the south of the causeway.

Field investigations indicate a broad inter tidal reef extending approximately 1km offshore at Town Point and that the coves either side of Town Point contain rock rubble. A review of historical aerial photographs found no evidence to suggest sand movement at Town Point. Modelling of this environment found that the rock platform in front of the beach was responsible for breaking and dissipating wave energy before the wave reached the shoreline. This low energy environment combined with the lack of sand on the rock platform was responsible for the stable environment. The causeway will not result in an increase in the wave energy or an increase in the availability of sand to be transported.

Severe cyclonic events may have an impact on this area with or without a causeway. However, aerial photographs indicate the beach alignment in this region has not changed significantly in the period which included major cyclones Bobby 1995, Olivia 1996 or Vance 1999 (refer to Draft EIS/ERMP Section 11.2 p407 and 408). The MOF and associated causeway is required to deliver the construction material and equipment to site. The design envelope for modules is approximately 30m wide and up to 5,000 t. Although not impossible, it is impractical to construct a 1km jetty to accommodate such loads. It would also be extremely difficult to drill these piles into the rock shelf in this shallow region. The LNG jetty is only required to carry small mobile cranes and support the export pipes and is therefore suited to an open piled structure. The starting point for the LNG export jetty has been determined by the geotechnical and metocean conditions.

11.2.1 Seabed Substrate

18.185 Table 11-3 Summary of Risk Assessment for Physical Environment, pages 409–421 – Column 2 of Table 11-3 lists potential environmental impacts/consequences for the physical marine environment. Loss of habitat is not recognised in the table as a specific impact, although “*smothering of seabed*”, “*change in seabed type*” and “*change in seabed profile*” are included. While it may be implicit in the impacts that are listed that habitat loss will occur, it should be specifically recognised as an impact of its own.

The summary risk assessment for the Physical Environment (Chevron Australia 2005; Table 11-3) lists potential environmental impacts/consequences to the physical environment only, e.g. change in seabed type. ‘Habitat loss’ is a function of a change in the physical environment which has flow on effects to organisms which occupy that environment (habitat). The potential environmental consequences of stressors to marine primary producers and marine fauna, such as seabed disturbance resulting in habitat loss is specifically dealt with in Tables 11-12 (Marine BPP) and 11-23 (Marine Fauna) in the Draft EIS/ERMP (Chevron Australia 2005).

11.2.2 Foreshore

20.47	Altered coastal and nearshore currents along the eastern coast of Barrow Island, resulting in impacts and loss of species and communities, and contamination and pollution of coral over large areas. The source of disturbance is the construction of the MOF and jetty, causing altered current regimes, and altered patterns of sedimentation. The modelling in appendices B 1-6 does not adequately address this stressor. Altered coastal and nearshore currents will have an almost certain major impact on marine benthic primary producers, and shallow benthic and coastal communities.
20.48	Inadequately accommodate the altered coastal and nearshore currents due to the construction of the MOF causeway, offloading facility and jetty (Technical Appendices B3–B6).
20.49	Inadequately assess impacts under cyclone conditions (Technical Appendices B3–B6).

The jetty and offloading facility are open pile steel structures that will have a minimal impact on local water movements. The impact of the causeway on the local currents and shoreline of Barrow Island was investigated using a 2-dimensional numerical model which used a particle tracking method (Chevron Australia 2005; pp 407–408). Results indicate minimal change in the shoreline position even under the cyclonic conditions experienced during cyclones Monty, Bobby and Olivia, which is a reflection of the very small changes in local currents in response to Development infrastructure in nearshore marine waters. Also refer to 5.7 Section 11.5.2.

20.52	The assessment of the fate of turbid plumes during dredging, commissioned by GEMS and presented in Technical Appendix B6, does not model the fate of materials under severe weather conditions, or incorporate a consideration of the causeway and jetty construction.
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Severe weather, such as cyclones, naturally mobilise large volumes of sediment from the seabed, resulting in significant turbidity and sedimentation. These highly turbid conditions will effectively mask any plumes from dredged material within the model and for this reason have not been explored further. The jetty and offloading facility are open pile steel structures that will have a minimal impact on local water movements. The impact of the causeway on the local currents and shoreline of Barrow Island was investigated using a 2-dimensional numerical model which used a particle tracking method (Chevron Australia 2005; pp 407–408). Results indicate minimal change in the shoreline position even under the cyclonic conditions experienced during cyclones Monty, Bobby and Olivia, which is a reflection of the very small changes in local currents in response to development infrastructure in nearshore marine waters.

22.248	It is disingenuous to claim building a causeway as a positive measure when it will very likely have long term impacts on long shore drift. If GJV are genuinely concerned about reducing dredging, they will build a jetty long enough to reach sufficiently deep waters!
22.251	The Submitters note that the least accurate method of measuring long shore drift has been employed.
22.252	In any event, even if long shore drift is 'limited' as suggested, limited rates over a period of 60 years are likely to have very sizeable impacts! We note here that GJV have no intention of removing the causeway at the end of the project (see page 149).

The impact of the causeway on the shoreline of Barrow Island was investigated using a 2-dimensional numerical model which used a particle tracking method (Chevron Australia 2005; pp 407–408). Results indicate minimal change in the shoreline position, even under the cyclonic conditions experienced during cyclones Monty, Bobby and Olivia. Historical photographs and inspection indicates that the rocky beaches either side of Town Point are void of sand therefore confirm the assessment that there is no longshore sediment transport. The proposed facilities do not provide a mechanism to induce long shore drift. Also refer to 5.7 Section 11.5.2.

23.13 The movement of water, sand and silt along the coastline of Barrow Island is not covered in the documentation. In particular the impact of the loading causeway that is to be built out from the coast for in excess of a kilometre, and the impact of that on coastal erosion and turbidity, especially in the event of a cyclone, is not addressed. Recommendation; The impact of the causeway on coastal processes, particularly in cyclonic conditions should be modelled.

The impact of the causeway on the shoreline of Barrow Island was investigated using a 2-dimensional numerical model which used a particle tracking method (Chevron Australia 2005; pp 407–408). Results indicate minimal sediment infill of dredged channels or change in the shoreline position, even under the cyclonic conditions experienced during cyclones Monty, Bobby and Olivia. Historical photographs and inspection indicates that the rocky beaches either side of Town Point are void of sand therefore confirm the assessment that there is no longshore sediment transport. The proposed facilities do not provide a mechanism to induce long shore drift. Refer also to 5.7 Section 11.5.2.

24.64 How consistent is the target of “no detectable long term change in longshore coastal sediment dynamics” with the target of “foreshore profiles reinstated” and the management strategies of “monitoring of beach alignment either side of Town Point until stabilised” and “routine inspection and maintenance of erosion and sediment control structures”?

The impact of the causeway on the local currents and shoreline of Barrow Island has been investigated using a 2-dimensional numerical model which used a particle tracking method (Chevron Australia 2005; pp 407–408). Results indicate minimal change in the shoreline position even under the cyclonic conditions experienced during cyclones Monty, Bobby and Olivia. Although modelling predicts little change, management/mitigation measures and the ongoing monitoring of the success of those management measures, such as the monitoring of beach alignment, are designed so that activities with potential environmental impacts meet or exceed the specified environmental management objectives and progress can be evaluated in relation to the longer term goal (Chevron Australia 2005; Table 11-3). Using the management measures described in the Draft EIS/ERMP, the goal of ‘no detectable long-term change in longshore coastal sediment dynamics’ is achievable.

24.171 The points on pages 407–408 which are used as a basis for concluding that “the existing beaches in the vicinity of Town Point are low energy zones with limited longshore drift” could be interpreted as suggesting that the beach is in equilibrium, despite some longshore sediment transport.

Historical photographs and inspection indicate that the rocky beaches either side of Town Point are void of sand therefore confirm the assessment that it appears that there has been no longshore sediment transport. The proposed facilities do not provide a mechanism to induce long shore drift.

11.3 Benthic Primary Producers

8.9 Considering the abundance of individual bomboras on the lower shelf, their importance as a component of the marine ecosystem in the region appears to be somewhat understated.

Large coral reefs are considered more significant from ecological and biodiversity perspectives as they are less well represented than other benthic habitats and communities. Scattered coral bomboras that are abundant across the Lowendal Shelf and other limestone platform areas around Barrow Island, and the areas to be impacted, are considered part of a very large area of similar habitat. Consequently, large coral reefs are treated individually as receptors, whereas impacts to the assemblage of scattered bomboras and macroalgae are considered in terms of the area to be lost proportional to the area of that assemblage in the surrounding area.

18.107 Information should be provided by the proponent on cumulative areas of change in coral reef communities and seagrass and macroalgal communities (note: this is different from cumulative loss of benthic primary producers and benthic primary producer habitats).

Changes to benthic assemblages, other than those described in the section of the Draft EIS/ERMP on benthic primary producer and habitat losses (Chevron Australia 2005; Sections 11.3, 11.4) are predicted to be short-term and to have minimal impact on the functioning of the ecosystem.

22.266 Why is dredging contemplated during turtle nesting season? Why is it not guaranteed that dredging will also stop during and around the time of coral spawning?

Management and mitigation measures for marine BPP, including corals, will include avoiding, where practical, dredging in areas adjacent to significant corals during coral spawning (Chevron Australia 2005; Table 11-12, pp 452–461). Complete shut-down of dredging operations during the two coral spawning events each year is factored into the dredge scheduling (Chevron Australia 2005; Chapter 6). This is not considered necessary from an ecological perspective (refer to Chapter 11) unless the dredge is operating within an area where the dredge plume is expected to exert physiological stress on the local corals that may endanger their survival or reproductive output. For turtle response refer to 22.188 Section 11.5.1.

23.5 Available modelling points to the most likely outcome being the loss of coral and other benthic habitats to a degree that is in excess of the standards set out in EPA policy. This is not acceptable and alternatives need to be presented.

The EPA Guidelines for acceptable loss of benthic primary producers are based on what is considered likely to threaten the ecological functioning of the marine ecosystem within defined management units. The acceptable loss is also related to the conservation significance of the area, for example a much lower level of loss is acceptable in a Marine Park than in a port. The units where coral loss was (conservatively) estimated to far exceed the CLT in the absence of adequate survey data were surveyed recently and found to contain little coral. See also response to 22.16 Section 11.4.

24.178 The width of the lines on Figure 11-3 – 11-9 represent up to approximately 200 m – equivalent to the length of 4 Olympic size swimming pools – a considerable source of error when interpreting the spatial extent of impacts from the figures. Please provide finer-scale detailed figures showing benthic habitats, bathymetry and impact zone boundaries, particularly for areas where development of structures and channels are proposed and for areas where high and moderate impacts are predicted to occur.

The scale of the development necessitates the use of a large scale grid that covers a wide geographical area in the hydrodynamic model. The scale of the current figures in the EIS/ERMP (Chevron 2005) is designed to reflect the accuracy of the model in predicting potential impacts within the 100m gridded study area. The current scale also shows the entire area of impact, rather than only specific portions of the impact. The areas of each BPPH type that will potentially be affected were calculated from the GIS, which uses a one-pixel wide line to separate habitat polygons. A detailed analysis of cumulative impacts on marine BPPH from the proposed Development is currently underway and will be used in the formulation of the EMP and monitoring programme for the dredging operation in consultation with the regulatory agencies.

25.1 There is still uncertainty about recovery potential and flow-on effects that may affect habitat structure and food webs. This appears to be due to the approach used of assessing environmental impacts by separately examining parts of the marine environment (eg benthic primary producers, marine fauna) without explicitly considering interrelationships between these components.

Benthic primary producers and associated faunal assemblages in the region are periodically impacted by major natural perturbations, such as cyclones, on large spatial scales. Their persistence in the region is testament to their ability to recover from such impacts, even with the loss of significant elements of the community. The majority of marine BPP and BPPH are expected to recover within 5 years. For example, Brown et al. (1990) that showed a decline in species diversity and coral cover of up to 30% during dredging in Thailand, however the reef recovered rapidly with coral cover and diversity values recovering within 22 months after dredging began. The other main BPP, macroalgae such as *Sargassum* and the seagrass *Halophila* undergo major seasonal changes in biomass in response to natural sediment movements and are also able to rapidly recolonise disturbed areas (Umar et al. 1998, Loneragan et al 2003, Ang, 1985).

The invertebrate epifauna associated with these communities can recover from high magnitude disturbances within 2 weeks (Martin-Smith 1994). Within 2 years of dredging at Heron Island on the Great Barrier Reef, gastropod numbers had recovered to pre-dredging levels and tall algae (mainly *Sargassum*) had increased in overall abundance (Catterall et al. 1992). The inter-relationships between BPP and the associated fauna is addressed in the risk assessment for marine fauna in section 11.5.1 of the Draft EIS/ERMP (Chevron 2005).

25.6 Prediction of the ecological impacts is restricted to impacts on coral colonies and does not explicitly consider impacts on the other key attributes of the marine ecosystem in the area that may be affected by the proposal. This approach assumes corals are a suitable surrogate for predicting the responses of other key elements of benthic primary producer communities to turbidity and sedimentation (such as turf algae and coralline algae). This assumption should be substantiated or preferably each Benthic Primary Producer Habitat (BPPH) should be looked at separately to analyse likely effects.

The criteria for adverse impacts on corals were taken as a conservative indicator of the response of all BPP communities. In the absence of adequate literature on the relationships between other BPP communities, including turf algae and Crustose Coralline Algae (CCA) and TSS concentrations, this approach is considered conservative because coral benthic primary producer habitats (BPPH) are generally considered to be the most likely to suffer long-term impacts from sedimentation and turbidity. Other BPPH are expected to suffer only short-term impacts due to indirect effects of dredging and any potential long-term effects (loss) are addressed individually in the BPPH assessment in Section 11.4 of the Draft EIS/ERMP (Chevron Australia 2005). Non-coral BPP, such as the macroalgae *Sargassum* and the ephemeral seagrass *Halophila* are able to rapidly recolonise disturbed areas and naturally undergo major seasonal changes in biomass in response to natural sediment movements (Umar et al. 1998; Loneragan et al. 2003).

The percentage cover of CCA is known to be related to the sedimentary environment, with lower cover in high sediment inshore reef areas. However, these algae are also known to survive for long periods of burial by sediments (Fabricius and De'ath 2001). Turf algae can colonise hard substrates within days and successions from turf to coralline algal assemblages can occur within months when conditions are suitable. In contrast, well developed coral assemblages may take decades or more to recover fully. Thus, while non-coral primary producers could also be potentially affected by the dredge plume in the areas of high and moderate impact, the impacts are predicted to be less than those for corals in Chapter 11 of the Draft EIS/ERMP. Protection of coral assemblages is considered a conservative means of protecting other BPP assemblages.

25.7 The potential consequences for ecosystem integrity of damaging or removing these elements from the reef over short, medium and long terms have not been considered or not presented.

Benthic primary producers and associated fauna assemblages in the region are periodically exposed to major natural perturbations, such as cyclones, that impact them on large scales. Their persistence in the region and their continuing support of biodiversity and productivity is testament to their ability to recover from such impacts, even with the loss of significant elements of the community. The impacts from dredging, drilling and spoil disposal on the marine environment are expected to be less than those from a severe cyclone. In areas where the BPPH retains its function, the impacts of dredging and drilling are expected to be short-term and the faunal assemblages are expected to rapidly recover through colonisation from surrounding areas. For example, Brown et al. (1990) showed a decline in species diversity and coral cover of up to 30% during dredging in Thailand, with significant mortality of *Porites*, a major reef building species.

However, the reef recovered rapidly, with coral cover and diversity values restored to former levels only 22 months after dredging began. The same reef system had also suffered significant bleaching and mortality associated with climate-related events approximately 10 years later. The reef fully recovered from the effects of exposure and regained its pre-impact function and structure within 12 months (Brown et al. 2002). Experimental studies looking at the recolonisation of *Sargassum* in tropical habitats have shown that they have the ability to recolonise bare substrates in the space of 3–4 months (Ang 1985). In a similar study of *Sargassum* on the Great Barrier Reef, Vuki & Price (1994) found new recruits of *Sargassum* in cleared quadrats three months after the clearing of the substrate, when the substrate was cleared during the reproductive season. Some earlier experimental studies of the colonization of *Sargassum* on an artificial substratum suggested that a time lag of 9–10 months was needed for the recolonisation of *Sargassum* on a fresh substratum (Raju & Venugopal 1971).

Crustose Coralline Algae (CCA) is important for reef calcification and as a settlement substrate for other reef organisms. The percentage cover of CCA is known to be related to the sedimentary environment, with lower cover in high sediment inshore reef areas. However, these algae are also known to survive for long periods of burial by sediments (Fabricius and De'ath 2001). Turf algae colonise substrates, e.g. dead corals, within days and successions from turf to coralline algal assemblages can occur within months when conditions are suitable. Cyclonic perturbations also result in permanent change in the type of BPPH and associated flora and fauna assemblages, for example through burial of hard substrates with sand. Threats to ecosystem function in areas where BPPH loss, or modification, is anticipated to affect only a small proportion of the BPP in the area and will be mitigated by the formation of new assemblages on artificial substrates, for example, the causeway.

25.8 Biological modelling appear to have also focused solely on corals despite macroalgae communities being sensitive to turbidity and large areas being located in zones of high and medium impact.

Refer to response to 25.6. The criteria for adverse impacts on corals that were used in the biological modelling were taken as a conservative indicator of the response of BPP communities in general to TSS and sedimentation. In the absence of adequate literature on the relationships between macroalgal survival and TSS concentrations and sedimentation rates, this approach is considered conservative because macrophyte benthic primary producer habitats (BPPH) are generally believed to be less susceptible than corals to long term impacts from sedimentation and turbidity. The BPPH assessment includes calculation of the areas of macroalgal BPPH in the impact zones. However, these impacts are expected to be short-term and do not represent permanent loss. Non-coral BPP, such as the macroalgae *Sargassum*, are able to rapidly recolonise disturbed areas and naturally undergo major seasonal changes in biomass in response to natural sediment movements. Umar et al. (1998) reported that while very high levels of sediment accumulation (up to 20 mm thick) affected recruitment, growth, survival and seasonal regeneration of *Sargassum*, populations were never killed.

This led the authors to conclude that a two-fold increase in long-term sediment thickness would reduce abundance but not lead to local extinction. Additionally, within 2 years of dredging at Heron Island on the Great Barrier Reef, tall algae (mainly *Sargassum*) increased in overall abundance in response to a variety of factors, including increased recruitment (Catterall et al. 1992). Areas that are anticipated to suffer high levels of macroalgae mortality, i.e. high impact areas, are generally located within 1 km of the source of disturbance, except in the case of the small area on the eastern side of the Lowendal Shelf (Chevron Australia 2005; Figure 11-5). These areas have been treated as permanent loss zones for the assessment.

25.9 Even in relation to coral reefs the approach adopted focuses only on hard coral reefs and does not appear to address the potential ecological consequences associated with impacts on a range of other biota, such as algae, sessile and mobile invertebrates. These elements should also be addressed.

The protection of the coral habitat is of paramount importance in protecting the coral reef assemblages. The invertebrate and algal taxa have much shorter life spans and recovery rates than the coral habitat on well developed reefs. Therefore, the criteria for adverse impacts on corals were taken as a conservative indicator of the response of all BPP communities and faunal elements of coral communities. Non-coral BPP, such as the macroalgae *Sargassum* and the seagrass *Halophila* are able to rapidly recolonise disturbed areas and naturally undergo major seasonal changes in biomass in response to natural sediment movements (Umar et al. 1998; Loneragan et al 2003). The invertebrate assemblages appear to recover rapidly from habitat loss by recolonising the regenerating habitats.

Within 2 years of dredging at Heron Island on the Great Barrier Reef, gastropod numbers had recovered to pre-dredging levels and tall algae (mainly *Sargassum*) increased in overall abundance (Catterall et al. 1992). *Sargassum* epifauna recovered fully within 2 weeks of experimental defaunation of a mature *Sargassum* bed at Magnetic Island (Martin-Smith 1994). The invertebrate assemblages appear to recover rapidly from habitat loss by recolonising the regenerating habitats.

25.10 Additionally only impacts to large coral communities are considered for the risk assessment and impacts on individual coral bomboras or colonies appear not to be regarded as significant. Considering the abundance of individual colonies on the Lowendal shelf their role in marine ecosystem dynamics needs recognition and assessment.

The risk assessment for marine primary producers' details impacts to coral and macroalgae communities, which includes coral bomboras, on the Lowendal Shelf (Chevron Australia 2005; Table 11-12, pp 452–453). Coral colonies on the Lowendal Shelf are widespread but occur in relatively low densities. The isolated colonies are predominantly *Porites* bomboras (Chevron Australia 2005; Technical Appendix C8). High mortality of large *Porites* is not expected in the moderate impact zone and these benthic primary producer habitats are expected to recover from any mortality within 30 years.

11.3.1 Seabed Disturbance

8.10 Given the generally slow growth rate of corals, the impact to, and subsequent recovery of, individual coral colonies does not appear to have been suitably addressed in the risk assessment process.

Most of the individual coral colonies are the resilient *Porites* bomboras. The mortality of *Porites* bomboras on the Lowendal Shelf is predicted to be low and the associated taxa are expected to either survive the impacts of dredging, or to recolonise soon after disturbance (within 5 years). There are currently numerous dead bomboras in the area that supports diverse assemblages of associated fauna. The main contribution of the isolated bomboras to marine diversity in the area is through their function as habitat for a diverse array of vertebrate and invertebrate animals and other corals. This is expected to persist even if a small proportion of the bomboras corals perish.

- 8.11 The need for maintenance dredging at intervals throughout the life of the development has been identified (section 6.3) however the document does not appear to have provided further information on the regularity, volume and impacts of the required dredging.

Maintenance dredging is not anticipated. However, Table 11-12 (p 453) of the Draft EIS/ERMP includes an estimate of periodicity of maintenance dredging (3–5 years) and provides an assessment of the environmental risk associated with such dredging. The risk is low due to the anticipated short duration and small volumes involved. Also refer to 18.112 Section 11.5.1.

- 8.14 The management strategies for dredging during coral spawning periods need to be clarified. There appears to be some inconsistency between page 187 which states dredging will continue throughout the year except periods of coral spawning, whereas page 453 states that the project will “avoid *where practical* dredging in areas adjacent to *significant corals* during coral spawning.”

Complete shut-in of dredging operations during spawning operations is not considered necessary from an ecological perspective (Section 11 of the Draft EIS/ERMP) unless the dredge is operating within an area where the dredge plume is expected to exert physiological stress on the local corals, which may endanger their survival or reproductive output.

- 8.15 Figures 11.3-11.9 and page 432 indicate a small area (15ha) to the north of the dredge spoil area that will be dredged and explains that this area comprises unconsolidated sediments that will be removed over several days by a trailer suction hopper barge. The necessity for this does not appear to have been clearly explained elsewhere in the text. The requirement for dredging at this location should be further explored.

Navigational studies, including under keel clearance studies indicate that the minimum water depth required is 14 m below chart datum. A bathymetric survey of the region has identified the proposed approach channel with the lowest dredge volume, least surface area disturbance and minimum environmental impact.

- 8.16 A tiered structure for managing impacts from dredging has been explained in the document. On page 443, Tier 1 management is outlined to involve a review of recommended management, control and potential action options available in the event that the monitoring results progress to the coral health trigger level. If the coral health threshold levels are exceeded, Tier 2 management options include consulting and seeking agreement and approval with the approving authority to modify the dredging and or spoil disposal operations to allow works to continue. Tier 3 requires work to cease until the Minister of Environment is satisfied that continuation of dredging will not cause further mortality or prevent recovery of corals. These contingencies (management control and action options) under this tiered approach should be determined and agreed prior to commencement rather than at the time of accedence.

There are a number of factors which will affect the water quality, sedimentation and coral health during the course of the dredge program. These factors include the type of material at the particular location and level being dredged, the rate of dredging, the metocean conditions, and the species of benthic primary producer being impacted. It is impractical to prescribe the action to be taken in a particular event as the effectiveness of such action will depend on the factors described above. The action taken will need to be tailored to suit the situation.

- 11.6 The dredging associated with the construction of the causeway is further cause for concern. I do not believe that the proponents have committed to a stringent enough monitoring and intervention strategy. Will there be a process in place whereby the dredging will stop immediately should unacceptable impacts be observed?

The proposed management plan for dredging is comprehensively presented in Section 11.3.1 of the Draft EIS/ERMP (Chevron Australia 2005). It includes a discussion on alert trigger levels that are proposed to provide an increasing degree of action that culminating at Tier 3 where dredging ceases (p 445). Also refer to 24.73 Section 16.3.

11.7 Who will oversee this process and what will be done?

Responsibilities for monitoring and taking action on dredging are also detailed in Section 11.3.1 of the Draft EIS/ERMP. Also refer to 11.6 above.

16.48 In regions such as the outer continental shelf and slope, where there is normally little storm wave damage, organisms are not adapted to frequent natural disturbances, and growth rates are slow. These areas are the most vulnerable to disturbance. Many never recover.

Impacts to the areas of the outer continental shelf and slope are limited to deposition of drilling fluids and cuttings to the seabed in the immediate vicinity of the wells. These impacts will be assessed in EPs for the drilling operations required under the Petroleum (Submerged Lands) (Management of Environment) Regulations.

18.102 More information is required on the effects of the horizontal directional drilling on the water quality in the Barrow Island Marine Park.

The preliminary modelling of the North White's Beach discharge option reported in the Draft EIS/ERMP (Chevron Australia 2005) indicates that the water quality effects will not lead to mortality of benthic communities within the Barrow Island Marine Park. The rejection of the Flacourt Bay pipeline crossing option will limit water quality effects in the marine park to short-term turbidity plumes without lasting biological effect (Chevron Australia 2005; pp 432–436).

18.110 Impacts of TSS and sedimentation plumes should be assessed in terms of the roles and functions of the benthic primary producers in the ecosystems affected by the plumes (e.g. details on successional communities, and long and short term impacts on the ecosystems).

The roles and functions of benthic primary producers are described in the Draft EIS/ERMP (Chevron Australia 2005; p 255 and Technical Appendix C8). There is a paucity of information on successional stages in the benthic assemblages of the area or on the ecosystem level effects of turbidity and sedimentation, beyond the loss of primary producers. Long- and short-term impacts are an integral part of the risk assessment (Chevron Australia 2005; Chapter 9 and Table 11-12).

18.111 Given the likely impacts of sedimentation and TSS plumes on Dugong and Batman reefs, these areas should be allocated to a management unit in order to adequately assess impacts on these habitats.

The coral (primary producer) impact criteria used to delineate lines of moderate and high impact associated with the dredging and directional drilling, are highly conservative. No impacts on the benthic resources of Batman Reef and Dugong Reef are anticipated. Modelling to incorporate cumulative criteria will be used in ongoing assessment of risks to these important resources.

18.114 The dredging and spoil disposal management plan should include seagrass habitats in the monitoring program during and after dredging.

Monitoring of the impacts of dredge related turbidity and sedimentation effects on seagrasses will be included in the marine monitoring programs. Coral communities will be the focus as corals are permanent and seagrasses are not.

20.9 Sedimentation impacts and potential contamination impacts on benthic communities as a consequence of cyclones and severe weather events.

Severe weather, such as cyclones, mobilise large volumes of sediment from the seabed, resulting in significant natural turbidity and sedimentation. These highly turbid, naturally occurring conditions will effectively mask any plumes from dredged material. The additional material liberated during dredging, and possibly remobilised during storms, is not predicted to pose a long term threat to BPP communities other than that detailed in Chapter 11 of the Draft EIS/ERMP (Chevron Australia 2005; pp 425–441). Benthic primary producers in the region are exposed to major natural perturbations, such as severe cyclones, that impact them on large scales. Their persistence in the region is testament to their ability to recover from major impacts.

20.45 Sedimentation of marine benthic primary producers, and shallow benthic and coastal communities, particularly coral communities, resulting in impacts and loss of species and communities, and contamination and pollution of coral over large areas. The source of disturbance is prolonged exposure to sediments (suspended particulate and settled) from the construction of the causeway, the construction of the jetty, the dredging of nine million cubic meters of sediments for access channels, and maintenance dredging, in an area characterised by high tidal current flows and frequent cyclones and storm swells. Sedimentation will have an almost certain major impact on marine benthic primary producers, and shallow benthic and coastal communities.

20.46 The physical disturbance of marine benthic primary producers and shallow benthic and coastal communities, resulting in impacts and loss of species and communities, and contamination and pollution of coral over large areas. The source of disturbance is the construction of the causeway, the construction of the jetty, the construction of access channels, and dumping grounds. Physical disturbance will have an almost certain major impact on marine benthic primary producers, and shallow benthic and coastal communities.

The extent of impacts to the marine environment has been estimated conservatively to reflect the paucity of scientific data on the responses of North Western Australian ecosystems to these stressors. The unavoidable impacts are considered ecologically sustainable on the basis of the representation of similar resources in the region and the lower level of protection afforded the development areas within the Barrow Island Port Limits. A detailed review of the effects of sedimentation and turbidity on corals, definition of impact zones, predicted locations of impact zones, management of operations, residual risk and a Preliminary Dredging, Drilling and Spoil Disposal Management Plan is contained within the Draft EIS/ERMP (Chevron Australia 2005; pp 425–451).

20.50 Are not supported by data deemed necessary to assess sedimentation risk (p. 427). That the provision of this data was foreshadowed in the EIS/ERMP but ultimately not delivered, adds to our concern.

20.53 The volume of material to be dredged (approx 9 million cubic meters) and the duration of drilling operations (p. 156 MOF channel and basin duration 21 weeks; LNG channel and turning ~ 45 weeks), indicate that the net effect will be one of prolonged to high sediment loads, even if dredging is not continuous. Corals would likely suffer chronic levels of turbidity and sedimentation, making the data referred to on page 427 critical to decision making and assessment of overall risk and impact.

Short-term pulses of turbidity and sedimentation within the zone of influence may have a cumulative effect on coral communities. The modelling of zones of cumulative sediment and turbidity effects is currently being completed. These current model investigations are using both consecutive and cumulative coral health threshold criteria. The cumulative coral stress threshold criteria have been recently developed using available published material to augment the consecutive criteria presented in the Draft EIS/ERMP (Chevron Australia 2005; Chapter 11). The cumulative criteria take into account both intensity and duration over given time periods. Consecutive and cumulative coral threshold criteria are being remodelled and will be presented as part of the responses to the Additional Information Package (AIP).

22.39 The combination of the dredging and the causeway are likely to significantly change ecological functions in this area.

The EPA guidelines for acceptable loss of benthic primary producers are based on what is considered likely to threaten the ecological functioning of the marine ecosystem within defined management units. The acceptable loss is also related to the conservation significance of the area, for example a much lower level of loss is acceptable in a Marine Park than in a port. The cumulative loss thresholds (CLT) for the proposed development are met for most of the management units. The extent of impacts to the marine environment has been estimated conservatively to reflect the paucity of scientific data on the responses of North Western Australian ecosystems to these stressors. The unavoidable impacts are considered ecologically sustainable on the basis of the representation of similar resources in the region and the lower level of protection afforded the development areas within the Barrow Island Port Limits. Also refer to 5.7 Section 11.5.2 and 22.16 in Section 11.3 of this document.

22.247 Why is there no estimate here of damage associated with dredge plumes?

Table 11-2 (Chevron Australia 2005; p 405) details direct disturbance to the seabed. Indirect disturbance associated with elevated turbidity and sedimentation are dealt with in detail in section 11-3 (Chevron Australia 2005; pp 423–449).

22.253 Has the assertion on the top of this page about re-colonisation been field tested in any way?

Detailed, long-term scientific studies of re-colonisation by corals and seagrass in the field are provided in Chapter 11 of the Draft EIS/ERMP, e.g. Seagrass Recolonisation in Exmouth (Loneragan et al. 2003) cited in Chevron Australia (2005) (p 425).

22.254 Corals can obviously persist in areas where turbidity is regular, but short-term. What is proposed instead is a year long dredging campaign!

Highly conservative coral health threshold criteria are described in detail on pp 427–431 of the Draft EIS/ERMP (Chevron Australia 2005). These criteria are designed to take into account the length of the dredging campaign and provide a conservative assessment on the impacts of dredging, drilling and spoil disposal on coral communities.

22.255 We note that there is very little information about how sedimentation affects different coral taxa.

As specified on p 427 of the Draft EIS/ERMP, 'There is a paucity of information on how long individual coral taxa can withstand different rates of sedimentation'. The available information has been summarised to provide a description of the zone of high impact to corals from sedimentation and turbidity and is detailed on pp 427 to 430 of the Draft EIS/ERMP (Chevron Australia 2005). Coral taxa discussed in this section include *Acropora*, *Montastraea*, *Diploria*, *Porites*, *Oxypora* and *Turbinaria*.

22.256 What is the second dredge spoil area indicated needed for?

This is not a second dredge spoil area. This is dredging to allow access for the LNG vessels. Refer also to 8.15 Section 11.3.1.

22.257 Further assessment of this proposal should await the work near and around the Lowendals, to confirm the status/importance of the "unconfirmed coral communities".

Field studies conducted in September/October 2005 and detailed in the Additional Information Package (AIP) (Chevron Australia 2005) revealed that there is little coral in the predicted impact area to the south of the Lowendal Islands. The large expanses of 'unconfirmed coral' have been reclassified as limestone pavement supporting variable cover of macroalgae and scattered corals. The CLTs for the Lowendal Island management units (MU2 and MU3) and Barrow Island Port management units (MU5 and MU6) have been revised and are described in detail on pp 3 and 4 of Part 1 of the AIP (Chevron Australia 2005b).

22.258 The Submitters are highly disturbed by this diagram. Zones of moderate or high impact extend around most of the top half of the Island, and well off the east coast of Barrow into sub-tidal communities as well. Impact is even high as far away as the unconfirmed coral communities south of the Lowendals, with a large zone of moderate impact extending as far as the Lowendals themselves.

This figure (11-4 of the Draft EIS/ERMP) represents the worst case scenario for sedimentation and turbidity impacts associated with dredging, drilling and spoil disposal; and does not include management measures that will be implemented during construction, e.g. maintenance of under keel clearance. This highly conservative scenario assumes maximum sensitivity to impacts with little management of operations.

22.260 More work is needed to confirm that sedimentation (or even a visible plume) associated with HDD and/or dredging will have no negative impacts at all on marine flora and fauna (outside estimated moderate and high impact areas, which obviously will have such impacts). The Submitters are particularly concerned, in this respect, that the plume, and even sedimentation, easily extends into the recently created Barrow Island Marine Park.

The limits that define the boundaries of the potential visible plume and extent of sedimentation have been formulated from an extensive review of the literature and represent only a marginal increase in turbidity and/or sedimentation over background levels. The Dredging, Drilling and Spoil Disposal Management Plan will specify adaptive management actions which will be triggered by the results of a comprehensive monitoring program during construction activities should any impacts be detected in areas outside those specified in the Draft EIS/ERMP (Chevron Australia 2005). A preliminary Dredging, Drilling and Spoil Disposal Management Plan is detailed on pp 442–448 of the Draft EIS/ERMP (Chevron Australia 2005).

22.261 We note with disappointment, however, that figures 11-6 to 11-9 do not even show the boundaries of the BI Marine Park!

Figures 11-6 to 11-9 in the Draft EIS/ERMP (Chevron Australia 2005) are designed to show the predicted areas of impact under the best, worst and most anticipated scenarios. The boundaries of the Barrow Island Marine Park, Barrow Island Marine Management Area, Montebello Islands Marine Park, Barrow Island Port Area and Port of Varanus Island have been left off for clarity. Figure 11-13 of the Draft EIS/ERMP (Chevron Australia 2005; p 467) shows the anticipated areas of impact as well as the Barrow Island Marine Management Units and Marine Park and Port Area boundaries.

22.262 Assuming trigger levels are appropriate (and it is beyond our technical capacity to express a view either way), the appropriate first management response should always be the precautionary one – to stop dredging! Instead, the suggested Tier 1 responses are deficient in that there are too many steps in the way of just the possibility of stopping dredging. We also question why CALM, or DoE, or some government agency person is not involved with this vital issue.

A Preliminary Dredging, Drilling and Dredge Spoil Disposal Management Plan, based on the management of dredging operations in the Port of Dampier, is provided within the Draft EIS/ERMP (Chevron Australia 2005; pp 442–448). A detailed EMP will be prepared in consultation with the dredging and drilling contractor and the relevant Commonwealth and Western Australian regulatory agencies. The detailed Dredging, Drilling and Spoil Disposal Management Plan will outline environmental protection and management measures to avoid, reduce or mitigate impacts.

22.263 In addition, why is only coral health monitored? Health of seagrasses and macroalgae should also be considered.

24.143 The biological monitoring is focused solely on corals. This is despite macroalgae being likely to be sensitive to turbidity and sediment stress, and large areas of macroalgal-dominated BPPH and seagrass BPPH being within the zones of high and moderate impacts where mortality is predicted. The proposed biological monitoring during dredging should address impacts on each of the BPPH at threat from the proposed dredging and dumping activities.

The Preliminary Dredging, Drilling and Spoil Disposal Management Plan and Baseline Marine Monitoring Program (BMMP) are focused on corals as they are predicted to be the most sensitive marine receptor. The monitoring plans will be revised to incorporate the monitoring of other BPPH during dredging, including impacts to and recovery of macroalgae and seagrass BPP communities.

22.268 On what basis was a 30 year recovery period selected?! Is this in any way consistent with the precautionary principle, given the prospect of increased frequency of coral bleaching due to climate change?

The extent of impacts to the marine environment has been estimated conservatively to reflect the paucity of scientific data on the responses of North Western Australian ecosystems to these stressors. The unavoidable impacts are considered ecologically sustainable on the basis of the representation of similar resources in the region and the lower level of protection afforded the development areas within the Barrow Island Port Limits. The resilience of coral communities to environmental perturbations and recruitment of juvenile corals during adverse environmental conditions means that coral reefs are often able to recover from perturbations completely and relatively quickly, i.e. almost certainly within a 30-year timeframe when large elements of the community remain undisturbed.

After a 30% loss of coral cover during dredging in Thailand, Brown et al. (1990) reported recovery to pre-impact levels within only 22 months. The same reef system also suffered significant bleaching and mortality associated with climate-related events approximately 10 years later. The reef fully recovered from the effects of exposure and regained its pre-impact function and structure within 12 months (Brown et al. 2002).

22.269 As GJV well knows, brief but significant disturbance of BPPH as a result of cyclone is in no way comparable to sustained disturbance caused by a year of dredging!

Benthic primary producers in the region are occasionally exposed to major natural perturbations, such as cyclones, that impact them on large scales. Their persistence in the region is testament to their ability to recover from such impacts, even with the loss of significant elements of the community. The impacts from dredging, drilling and spoil disposal on the marine environment are expected to be less than that from a severe cyclone. For example, Brown et al. (1990) showed a decline in species diversity and coral cover of up to 30% during dredging in Thailand, with significant mortality of *Porites*, a major reef building species. However, the reef recovered rapidly, with coral cover and diversity values restored to former levels only 22 months after dredging began.

24.107 Wind: The wind field used to drive the model is derived from the LAPS model however there is no demonstrated validation of the LAPS winds. The proponent should provide validation for the predicted LAPS winds by comparison against actual measurements within the model domain.

Meso-LAPS model winds were compared with observed winds from the Barrow Is. anemometer over the period 2000 to 2003. This was achieved by extracting model winds for the nearest grid point to the anemometer site.

The agreement between the model winds and observations was generally excellent. It is noted, however, that:

- the model winds were available at three hour intervals compared with hourly anemometer observations;
- although well exposed, the anemometer will be subject to some very localized biases, and
- there is a known bias in the model winds which tends to slightly underestimate wind speeds (by a factor of about 15 per cent).

The model winds used in the dredging and model verification studies have been adjusted to allow for the speed bias.

Sample time series are presented from the year 2000 to illustrate the correlation between the observations and model output. Other years show very similar results.

Figures 1(a) and (b) (Section 7.8 of this paper) respectively show speed and direction plots comparing observations against model output – the observations are at hourly intervals and the model at three hourly intervals.

Figures 2(a) and (b) (Section 7.8) show a 'zoomed' plot for the May-June period and Figures 3(a) and (b) show the November-December period. These periods were randomly selected within the 'dry' and 'wet' periods to demonstrate typical correlations between the observations and the model winds.

One small, but consistent difference shows up in the 'dry' months directions (Figure 2(b) (Section 7.8) when the flow is generally easterly. The observations show a slight diurnal trend which shifts the winds more towards the north-east (compared with the model); this is most likely to be a localized sea-breeze effect which would not be evident over waters off Barrow Island. Thus application of the model winds are more likely to produce realistic forcing than the observed winds during such periods.

24.108 It is stated that the model was run for three 15 month periods with a) 'typical' conditions and b) with more easterlies and c) more westerlies, than average. Outputs of all three should be presented (as impact zones) to provide an evaluation of the degree of 'interannual variability' that might be encountered and the resultant implications of this on impact predictions.

This was done and has been repeated in the more recent simulations with an April 1st start. A technical report is currently being compiled based on the results of these simulations. This report will be presented to the EPA.

24.109 *Ocean Currents:* The proponent should provide justification for the representation of large-scale ocean currents in boundary conditions to the model and implications of this representation on the area of influence of the sediment plumes.

The influence of large scale ocean currents is included in the boundary conditions from data derived from NOAA satellite altimeter data. These data were derived by CSIRO from satellite passes every 7–10 days. The data were filtered to exclude the impact of local winds and tides and the residual contains the signature of large scale currents (if any). CSIRO have shown correlations of the order of 65% with drifting buoys and current meter data on the north west shelf. GCOM3D is Australia's operational ocean forecast model at AMSA and this method was developed during that implementation. There is no implication for the area of influence of the sediment plumes as the currents predicted by GCOM3D, driven by satellite data, tides and winds, showed very good agreement with observations.

24.110 *Current Measurements.* The proponent should confirm that the current meters were calibrated pre- and post-deployment and provide estimates of the accuracy/precision of current data collected. Data are only available for three fixed current meter locations in relatively deep, offshore water east of Barrow Island. A more comprehensive test of the model would have included comparisons with data from shallow water near the northern tip of Barrow Island. Similarly, comparisons of drifter track v modelled particle tracks are only available for three drifter deployments, all east of Barrow I, with very limited duration (2, 5 and 12 hours). The proponent should provide justification for the lack of validation data to the north and west of Barrow Island and discuss the implications regarding the degree of certainty in model predictions for these areas (particularly as they relate to impact scenarios).

The current meters used were Acoustic Doppler Current Profilers (ADCP) from RDI Instruments and there are no calibratable components in these devices. The ADCP locations were chosen with a view to capturing the key components of the flow around Barrow Island. It is well known that the flood and ebb tide flows around the northern tip of Barrow Island but the major unknowns relate to the way the flood tide behaves (and conversely the ebb tide) after flowing around the northern tip of Barrow Island and across the Barrow Shoals to the south (where does it join up, where does it flow to etc.). Previous models have presented vastly varying flow regimes on the eastern side of Barrow Island and since the dredging is on that side of the island it was important to understand the behaviour of the flood and ebb tides. Consequently the deployment locations were chosen to investigate this major issue.

The northern current meter was located to determine how much of the flood (and ebb) tide moves parallel to, or across, the Lowendal Shelf. The central and southern current meters were located to help understand where the flood tide joins (ebb tide splits) and flows to (from). The location of the drifters was chosen based on the same logic.

24.111 *Wave Forcing: Wave forcing will be an important factor influencing sediment transport and no discussion is presented on how wave forcing was incorporated in the simulations. Wave forcing would presumably vary strongly in space and time, particularly in the near-shore Barrow Island and Lowendal Shelf regions. The proponent should provide details on how wave forcing has been applied and present validation data to support this treatment.*

Wave forcing (particularly orbital velocities) in the sediment plume model is either derived from wave model output or from calculations based on wind speed and the well-known Pearson-Moskowitz spectrum. The latter method has been used world-wide for many years by Meteorological Departments to forecast waves but has its limitations and is being progressively replaced as wave models improve in accuracy. In this study wave model data were not available and so calculations were based on Pearson-Moskowitz. There are no data on the orbital velocities which contribute to resuspension and so verification was not possible but it is expected that this approach, or the use of wave model data, can only predict orbital velocities with limited accuracy.

24.112 *Re-suspension and Deposition Algorithms: Similarly, the proponent should provide detail on the extent to which the re-suspension and deposition algorithms have been validated in response to the key forcings and the results of that validation.*

There are limited ground truth data for sediment plume modelling and there is definitely not sufficient data to carry out detailed comparisons of resuspension and deposition algorithms. The TSS data to be collected during the actual dredge program will not be sufficient to investigate resuspension and deposition. The only ground truthing of suspended materials of a qualitative nature has been carried out at the Geraldton harbour dredging project where good agreement was obtained between model predictions and in situ TSS data on a few days during the dredge program (GEMS Geraldton Verification Report supplied to EPA). Much more detailed data are required however to provide comprehensive verification.

24.113 *The proponent should provide an assessment of the implications of differing grain size distributions to those forecast. This could be done through detailed sensitivity analysis and comparisons of resultant TSS and sedimentation fields and resultant impact prediction scenarios.*

The CSIRO conducted pre-dredging tests on the characteristics of the hard limestone material to be dredged in Geraldton, the results of which significantly underestimated the amount of fines produced, primarily because of the unaccounted for 'shearing' action of the cutter head. Grain size in the hydrodynamic model in question uses the actual composition of the dredged material from Geraldton, as sampled from the hopper barges (which carry the spoil) and is a more accurate reflection of the behaviour of hard limestone material when it is dredged. To allow for possible differences in the behaviour of the Barrow Island rock under dredging, additional model scenarios, assuming a greater composition of fines are underway. The additional model scenarios will test the sensitivity of the modelled impact zones to changes in the proportion of fine sediments. The results will be presented in a technical paper to be forwarded to the EPA. Experiments on the influence of grain size on sedimentation rates and light attenuation are planned as part of the 2005/2006 Baseline Marine Monitoring Programme.

24.114 *Grain size and TSS:* Wrapping up all the sediment grain sizes into one TSS value is of questionable value for impact prediction. It clouds the ability to predict and interpret what the effects of the resultant turbidity or LAC may be. Because of the variability in the effects that different sediments (fine cf. coarse) in the water column would have on light penetration and therefore the responses in light-dependent benthic biota, the proponent should provide a technical justification for only modelling TSS and not explicitly modelling light penetration in combination with TSS. If this cannot be justified on an ecological basis then the proponent should model light penetration/availability at the seabed and link this to the health of benthic primary producer communities.

No universal relationship between TSS, turbidity or light attenuation exists and any experimentally determined relationship is not only site specific but also suspension specific. Experiments to determine the relationship between dredged material and light attenuation are planned as part of the 2005/2006 Baseline Marine Monitoring Programme. Once established, the relationship between TSS, turbidity and light attenuation for the waters surrounding Barrow Island will be used to interpret the outputs from the existing hydrodynamic model in relation to light attenuation at depth.

24.115 1.2.3.1 A detailed description of the basis and implementation of the model DREDGETRAK, including:

- i) the sediment transport equation used in the model,
- ii) a description of the terms in the sediment transport equation and the processes represented in the model,
- iii) clarification of whether a lagrangian or eulerian method is used for evaluation of sediment transport and a description of how this is implemented in the model,
- iv) the implementation of sediment source terms for dredging operations – introduction of particles into the appropriate vertical layer,
- v) the forcing for resuspension and how this is implemented, including a response to the following
 - how was the wave forcing data for the model generated?
 - what wave data were used to force DREDGETRAK?
 - if the wave field was modelled to provide spatial and temporal variability, were the results of the wave forcing model verified (provide details)?
 - provide plots of wave forcing data used to force DREDGETRAK including spatial variability and correlation between wave energy and resuspension response, and
- vi) Describe in detail how sediment particle size distribution is dealt with within the model.

The sediment transport method is a second order, non-linear, lagrangian particle advection algorithm. The model does not work in layers but tracks each particle with an associated size, density, latitude, longitude, depth, vertical and horizontal velocity. Current speeds and direction at the depth of each particle is interpolated from the GCOM3D output. Wave forcing is discussed in 24.111.

24.116 1.2.3.2. The proponent should specify whether the implementation and settings of the hydrodynamics and transport models were identical for both the verification of the model (in the Additional Information Package report) and the dredge simulations (in the original Technical Appendix Report). (Eg 100 m grid resolution around Barrow Island). Describe in detail any differences.

GCOM3D was run on a 100m grid around Barrow Island in both cases. The sediment transport model is not grid resolution dependent (Refer to 24.115 above).

24.117 1.2.3.5. Currents between Barrow Island and the Lowendal Islands are shown in Figures 5.1 and 5.2 (Appendix B5) and in Figures 4 and 5 (Additional Information Package). The principal axis of the currents from these two pairs of diagrams is roughly perpendicular. Please explain why this is the case. Was the model implemented and set up identically for the original dredging-related and additional simulations?

Figure 5.1 (TAR) shows a flood tide with a strong southerly wind resulting in the “joining” of the flood tide on the eastern side of Barrow Island occurring further north than in Figure 4 (AIP) which shows a flood tide joining during a mild northeasterly wind. Figure 5.2 (TAR) and Figure 5 (AIP) cannot be compared because Figure 5 (AIP) illustrates the beginning of the ebb tide at the northern and southern ends of Barrow which occurs before the flow changes along the Lowendal Shelf and around the Montebello Islands.

24.120 Turbidity stress on corals only factors in periods of exposure during day light hours and is intended as a surrogate measure for light deprivation. The approach does not explicitly consider effects of suspended sediment on the feeding efficiency of corals and other filter feeding biota at night when feeding activity of some filter feeders can be at its greatest. The proponent is requested to provide an assessment of the effect of including night-time turbidity stress on the extent of high and moderate impact zones.

Turbidity and sedimentation has been identified as adversely affecting corals and other benthic primary producers. Coral responses to sediments are mainly related to shading and smothering, however there is a range of lesser effects including decreased feeding efficiency. These are described in detail in the Draft EIS/ERMP (Chevron 2005, pg 426). Sedimentation, rather than turbidity, is the main cause of feeding and abrasion related effects. These effects were accounted for in the consecutive coral health criteria, as sedimentation effects are assessed over a 24 hour period.

24.121 The approach taken to benthic habitat impact prediction has been to calculate where, within the transport model domain, a threshold level of turbidity or TSS would be exceeded for a set number of consecutive days over the dredging period. This approach does not consider the potential impacts of cumulative stress – i.e. the total amount of time for which the threshold levels are exceeded over a defined period of time. The proponent has been requested to re-evaluate impacts of dredging and dumping by taking account of cumulative stress.

Cumulative coral stress threshold criteria are being developed using the available literature and will be informed by a review currently underway by the DoE. These criteria allow for the effects of a series of pulse events and take into account both intensity and duration over given time periods. Preliminary comparison of the zones of impact based on cumulative and consecutive criteria indicates that the cumulative impacts are only slightly larger than those predicted using the consecutive criteria. A detailed analysis of cumulative impacts on marine BPPH from the proposed Development is currently underway and will be used in the formulation of the EMP and monitoring programme for the dredging operation in consultation with the regulatory agencies.

24.123 Please clarify that 1) the model output does not include background, and 2) the thresholds are based on literature and have not had background subtracted from them (eg. 20mg/L – 2mg/l (background TSS) = 18mg/l

The model output does not include background TSS or sedimentation values. For example, the visible plume from dredging (Figure 11-9) is presented as 2 mg/L above background. Threshold levels derived from the literature have not had background levels subtracted. This is for two main reasons. Firstly, much of the work was conducted experimentally in the laboratory and represented a total volume of sediment added or a level of TSS consistently maintained e.g. 25 mg/L in aquaria. Secondly, for field observations of corals, ‘background’ levels were not often detailed and published material was generally only specific of ‘impact’ water quality parameters.

24.124 The TSS and sedimentation thresholds applied by the proponent to define the high and moderate impact zones are based solely on effects on hard corals, which are, in coral reef coral reef habitats around Barrow Is are the ubiquitous structural elements. The approach taken does not explicitly consider the potential effects of certain TSS and sedimentation regimes on other critical functional, though often cryptic, components of 'coral reef' habitats.

It is assumed that the loss of the main BPP (macroalgae or corals) also leads to the loss of associated fauna and minor flora until a short time after the BPP community has fully recovered. The recovery times used in the risk assessment include the time expected for recovery of the associated flora and fauna as described in the Draft EIS/ERMP Chapter 11. In areas outside the zone of impacts to corals, impacts to other BPP and fauna are expected to be limited. Crustose Coralline Algae (CCA) is important for reef calcification and as a settlement substrate for other reef organisms. The percentage cover of CCA is known to be related to the sedimentary environment, with lower cover in high sediment inshore reef areas. However, these algae are also known to survive long periods of burial by sediments, much longer than can be expected of most corals (Fabricius and De'ath 2001). Turf algae colonise substrates, e.g. dead corals, within days and successions from turf to coralline algal assemblages can occur within months when conditions are suitable (Fabricius and De'ath 2001).

24.136 In relation to impacts on coral reefs, the approach taken by the proponent only explicitly considers impacts on the hard coral elements of coral reef habitats and does not appear to address of the potential serious ecological consequences associated with impacts on the range of other biota such as algae, sessile and mobile invertebrates, which together with hard corals form fully functioning coral reef communities and habitats. The proponent is request to address this gap in its approach to assessment of loss of, and damage to, coral reef habitats.

It is assumed that the loss of the main BPP (macroalgae or corals) also leads to the loss of associated fauna and minor flora until a short time after the BPP community has fully recovered. The recovery times used in the risk assessment include the time expected for recovery of the associated flora and fauna as described in the Draft EIS/ERMP Chapter 11. In areas outside the zone of impacts to corals, impacts to other BPP and fauna are expected to be limited. Crustose Coralline Algae (CCA) is important for reef calcification and as a settlement substrate for other reef organisms. The percentage cover of CCA is known to be related to the sedimentary environment, with lower cover in high sediment inshore reef areas. However, these algae are also known to survive long periods of burial by sediments, much longer than can be expected of most corals (Fabricius and De'ath 2001). Turf algae colonise substrates, e.g. dead corals, within days and successions from turf to coralline algal assemblages can occur within months when conditions are suitable (Fabricius and De'ath 2001).

The criteria for potential adverse impacts on corals were taken as a conservative indicator of the response of all benthic primary producer communities, including turf algae and CCA, since coral communities are generally sensitive to sedimentation and turbidity and are predicted to take the greatest amount of time of all marine BPP to recover from any impacts. While non-coral primary producers could also be potentially affected by the products of dredging in the areas of high and moderate impact, this is predicted to be on a similar, if not smaller scale to that described for corals in Chapter 11 of the Draft EIS/ERMP (Chevron 2005). The recovery eriods incorporate the recovery of faunal assemblages following recovery of the coral habitat.

24.142 The proponent has clearly commenced development of a preliminary dredging/HDD management framework. This is encouraging and it is anticipated that the management plan for this element of the proposal will be critical part of the EPA's assessment. To this end, the proponent is strongly encouraged to continue development of the dredging/dumping/HDD management plan and to provide a draft plan to the EPA as part of its assessment.

A preliminary dredging, drilling and spoil disposal management plan was outlined in the EIS/ERMP (Chevron 2005, pgs 442-449). As specified, this plan will be further refined in consultation with both the Commonwealth and State regulatory agencies and the dredge contractor. As the Development Concept is finalised, the proponent will make more specific commitments to environmental protection through a more detailed final dredging, drilling and spoil disposal management plan as specified in the Framework Environmental Management Plan (Chevron 2005, Technical appendix A1).

24.172 Both the anticipated and best case scenarios assume that sediment accumulation does not occur due to rapid resuspension and export associated with the daily tidal cycle.

The proponent should make predictions about 1) where sediments liberated by dredging and HDD will be exported to and 2) the potential environmental consequences of sediment export and subsequent deposition?

The visible plume and extent of sedimentation represent the outer limit of elevated sedimentation and turbidity generated by dredging and HDD (Figures 11-6 to 11-9, Chevron 2005). TSS and sedimentation rates of 2 mg/L and 1 mg/cm²/d above background, respectively, were used to define these zones. These levels represent only a marginal increase above ambient levels. Areas outside the zone of moderate impact, but within this outer limit of elevated TSS and sedimentation, are not predicted to experience any measurable impact from marine construction activities. The hydrodynamic modelling predicts a build up of deposited sediments in only the immediate vicinity of the dredging areas, primarily due to the rapid settlement of any large sediment particles liberated during dredging. Finer sediment fractions remain suspended for longer periods and are predicted to be exported from the area to mix with deeper offshore waters where the concentrations will not be discernible above background concentrations.

Strong currents and winds will move, deposit and resuspend the material due to its small size, dispersing the material over a large area at very low concentrations. This material is considerably finer than the existing nearshore sediments and will thus mobilise much more rapidly, and easily, than the material which constitutes the nearshore benthic environment currently. Current predictions and ecological data suggest that the dispersal of this fine material at very low concentrations will have no measurable impact on marine BPPH outside of the high and moderate impact zones.

24.173 If the lines on figures 11-7 and 11-9 represent "at least" some level of TSS/sedimentation above background, what are the upper limits that the lines represent?

The upper limits of TSS and sedimentation within the area of influence are the lower limits set for the moderate impact zone. The boundaries of the moderate impact zone are being revised to accommodate the possibility of effects from cumulative stress from the dredge plume.

24.177 Page 428 – "The 5 mg cm⁻² d⁻¹ rate represents approximately twice the natural rate of sedimentation". What data have been collected to support this? Where were these data collected and what is the relevance of data from the sites to conditions currently experienced in marine waters likely to be affected by the proposal?

Data on background rates of sedimentation are based on data from near Varanus Island in the Lowendal Islands and are presented in the Draft EIS/ERMP (Chevron 2005, page 431). The rate set as twice the background level (5 mg/cm²/day) is conservative to account for the lack of site specific data. Background sedimentation rates in the region range between 2.9 to 9.0 mg/cm²/d, with a mean value of approximately 5 mg/cm²/d (IRCE 2002). Sediment traps will be deployed as part of the Baseline Marine Monitoring Programme.

24.6 It should be noted that section 11.3.1 of the Draft EIS/ERMP indicated that this information would be included in the AIP.

Additional dredge plume modelling has been designed as requested by the EPA SU. The new data will be presented to the EPA SU following the completion of the modelling work. The Joint Venturers will interpret the results of the dredge plume modelling and incorporate the information into the EMP.

24.86 Given that Green turtles feed on algae in relatively shallow waters, to what extent (quantitatively and qualitatively) will the predicted impacts of sediment and turbidity resulting from dredging and directional drilling affect the use by turtles of littoral and other marine areas around Barrow Island?

The algal habitat favoured by green turtles for foraging is very common along the west coast of Barrow Island. The short-term loss of algae arising from dredging, drilling and spoil disposal activities is described in Section 11.3 (Benthic Primary Producers) of the Draft EIS/ERMP is not predicted to have a detectable effect on foraging turtles. Only a very small proportion of the available foraging habitat will be affected. Turtles are highly mobile and will forage in other areas until the macroalgal assemblages have recovered in the development areas.

24.88 Referring to the following statements in section 5 (Technical Appendix C8):

“The coral assemblages on the south-western corner of the Lowendal Shelf are of regional conservation significance. The extensive patch of *Acropora* in this location is one of the few extensive patches of fragile acroporid corals in the region. Some of the *Porites* coral bomboras in the area are three to four metres high and are estimated to be several hundred years old. These corals support diverse assemblages of fish and invertebrates. The coral reef areas on the subtidal pavement adjacent to Barrow Island are locally significant because they represent a benthic habitat with restricted distribution around the Island. The individual coral bomboras are of low conservation significance as they are very widely distributed along the east coast of the island.”

- Given the regional significance of the coral assemblages on the south-western corner of the Lowendal Shelf, is the predicted impact from sedimentation and turbidity adequately and appropriately described?
- Will the level of loss predicted be consistent with an area with regional significance?

The risk assessment of the potential impacts of the dredging program on marine BPP takes into account the conservation status of the BPP that may be affected. Preliminary modelling based on the original dredge management scenario, indicated potential for unacceptable adverse impact to this regionally significant reef. This led to revision of the dredge program and introduction of further management scenarios: namely, increasing the under-keel clearance for the operating dredge. This reduces the area of sedimentation that would affect the reef. The current scenario does not include any impact to this reef. See Sections 11.3 and 11.4 of the Draft EIS/ERMP.

24.119 On page 185 (dot point one) it is stated that predictions have relied (in part) on “surveying ... species sensitivities in the proposed development area”. [T]he proponent should explain what this entailed, including scope and coverage, and provide the results obtained from these surveys of ‘species sensitivities’.

Marine habitats were assessed using aerial photography, underwater tow camera and diver surveys. Details of these field surveys are provided in the Draft EIS/ERMP (Chevron Australia 2005; Technical Appendix C8, pp 1–23). Additional habitat mapping is being conducted as part of the Marine Monitoring Program. Dot point one refers to basing impact prediction on ‘surveying marine habitats’, and on ‘species sensitivities’. ‘Species sensitivities’ was intended to mean the likely responses of the various marine taxa to dredge impacts. This involved an extensive literature review of the responses of marine biota to turbidity and sedimentation. The results of this review are summarised in the Draft EIS/ERMP (Chevron Australia 2005; pp 425–431).

24.125 The assumption that full recovery will take place over 30 years has many dependent assumptions associated with it and does not consider that loss of one or more less tolerant elements of the community may in fact lead to irreversible changes in key the biological, chemical and physical processes that would be associated with the pre-impact natural community.

Benthic primary producers in the region are occasionally exposed to major natural perturbations, such as cyclones, that impact them on large scales. Their persistence in the region is testament to their ability to recover from such impacts, even with the loss of significant elements of the community. The impacts from dredging, drilling and spoil disposal on the marine environment are expected to be less than that from a severe cyclone. For example, Brown et al. (1990) showed a decline in species diversity and coral cover of up to 30% during dredging in Thailand, with significant mortality of *Porites*, a major reef building species. However, the reef recovered rapidly, with coral cover and diversity values restored to former levels only 22 months after dredging began.

24.126 Moreover, because of the uncertainties about whether full recovery might occur, the proponent should consider alternative scenarios where impacts may constitute a loss of, or serious damage to, the habitat's contribution to overall ecosystem integrity by shifting the fundamental structure and function of the pre-impact habitat – regardless of whether some of the more 'resilient' species in the pre-impact community survive or can recover.

24.127 In summary, because the areas within the high and moderate impact zones are very large and there is uncertainty about recovery potential, recovery trajectories, consequences of flow-on effects for local and regional food-webs that may be associated with permanent or temporary shifts in habitat structure and function over time, great caution needs to be exercised when making assumptions and assertions about the capacity of BPPHs to recover from very significant impacts (e.g. total mortality of all corals to mortality of specific coral taxa, mortality of individual colonies, or partial death of colonies in high impact zones, to total mortality of susceptible coral taxa and partial mortality (~30%) of resilient taxa) over generational time frames (~30 years).

The resilience of coral communities to environmental perturbations and recruitment of juvenile corals during adverse environmental conditions means that coral reefs are often able to recover from perturbations completely and relatively quickly, i.e. almost certainly within a 30 year time frame when large elements of the community remain undisturbed. After a 30% loss of coral cover during dredging in Thailand, Brown et al. (1990) reported recovery to pre-impact levels within only 22 months. The same reef system also suffered significant bleaching and mortality associated with climate-related events approximately 10 years later. The reef fully recovered from the effects of exposure and regained its pre-impact function and structure within 12 months (Brown et al. 2002).

24.138 The assumption that key structural algae such as *Sargassum* would rapidly recolonise areas where it has been lost is also questioned. Firstly, although *Sargassum* spp do senesce back to basal structures, little is known about the tolerance of *Sargassum* bases to light deprivation and sedimentation. If bases were to be killed by sediments or light deprivation, these algae rely on recruitment of propagules to recolonise disturbed substrata. This raises a second issue surrounding the dispersal of *Sargassum* propagules. Work in energetic subtidal and intertidal environments in southwest WA suggest that *Sargassum* communities are relatively closed systems, with very short scale dispersal of propagules (eg. Kendrick and Walker 1995). For organisms that rely on short scale propagule dispersal, even spatially patchy disturbance of their habitat has potential to lead to long-term habitat fragmentation and significant shifts in community structure, biomass, and therefore function.

High impact areas are generally located within 1 km of the source of disturbance, except in the case of the small area on the eastern side of the Lowendal Shelf (Chevron Australia 2005; Figure 11-5). These areas have been treated as permanent loss zones for the assessment. Given the strength of the winds in the region, the large tidal amplitude (~4 m) and the large areas of *Sargassum* that will remain undisturbed in close proximity to the proposed marine facilities, it is both highly unlikely that dispersal will be as limited as it is in south-western Australia and that recruitment and recolonisation to affected areas will be compromised. *Sargassum* dispersal rates of up to 193 km/yr are reported in the literature (Shanks et al. 2003). Umar et al. (1998) reported that while very high levels of sediment accumulation (up to 20 mm thick) affected recruitment, growth, survival and seasonal regeneration of *Sargassum*, populations were never killed. This led the authors to conclude that a two-fold increase in long-term sediment thickness would reduce abundance but not lead to local extinction.

24.144 The ERMP indicates that the monitoring in the high impact zone is for investigation purposes only and will not trigger any management action. If the proponent is to continue to hold the view that there will be full recovery of macroalgal, macroalgal and scattered coral and seagrass BPPH in this zone, then robust monitoring should be undertaken to track recovery trajectories. Data from this monitoring should be evaluated with pre-determined recovery criteria, which if not met over pre-determined time periods, will trigger proponent actions to enhance recovery.

Monitoring of recovery of BPP within high impact zones will be undertaken and assessed against the recovery periods specified in the Draft EIS/ERMP (Chevron Australia 2005). If the recovery rates are not as predicted, contingency management will be instigated in agreement with the EPA.

24.145 Under the dredging/HDD management framework proposed on pages 442 – 449, the proponent has only committed to consider and agree on proposed tier 1, 2, and 3 activities and management actions. In this respect the framework is open ended and requires firmer commitments by the proponent to increase auditability, enforcement and utility of the framework for environmental protection.

A preliminary Dredging, Drilling and Spoil Disposal Management Plan was outlined in the Draft EIS/ERMP (Chevron Australia 2005; pp 442–449). As specified, this plan will be further refined in consultation with both the Commonwealth and State regulatory agencies and the dredge contractor. As the Development Concept is finalised, the proponent will make firmer commitments to environmental protection through a more detailed and auditable final dredging, drilling and spoil disposal management plan as specified in the Framework Environmental Management Plan (Chevron Australia 2005; Technical Appendix A1).

24.146 The proponent is requested to clarify the timeframes for implementing responses to accedence of various criteria. In particular, the proponent should confirm the minimum and maximum time that would elapse between detecting an accedence in the alert levels and implementing tier 2 and tier 3 management (cease dredging) to address potential environmental problems resulting from the dredging and dumping activities. In addressing the above, the proponent should ensure that the time elapsed between detecting early warnings of a problem and implementing interventive management is relevant to the periods of time over which sensitive benthic receptors would be predicted to have adverse responses to dredge-related stress.

The preliminary Dredging, Drilling and Spoil Disposal Management Plan will be finalised in consultation with the dredging contractor, EPA, CALM and DoE, prior to the dredging operation commencing, as specified in the Framework Environmental Management Framework (Chevron Australia 2005; Technical Appendix A1). This will include commitment to all management responses, monitoring triggers and timeframes for implementation and response.

24.147 1.4.1. There is a potential mismatch between the predictions in the ERMP that there will be no impact on BPPH in “Zone 3” and the proposed for coral health criteria in that zone. Although the ERMP predicts there would be no impact on BPPH in this zone, proposed criteria for coral health are based on 10% bleaching (alert and threshold levels) and a 10% reduction in the cover of live corals (limit level). The proponent should investigate means to significantly improve the power of the coral cover monitoring to resolve smaller changes or to revise its proposed management framework to better reflect the impact predictions one 3 (eg trigger management based on sublethal changes in coral health).

Zone 3 – the potential area of visible plume and extent of sedimentation is predicted to be indirectly influenced by dredging activities but at levels that will have no measurable impact on corals. A level of 10% (bleaching or reduction in live coral cover) is likely to be the minimum level of detection feasible using current coral monitoring techniques. Therefore, if any change is detected, management actions are implemented. Investigations are currently exploring the power of various coral monitoring techniques to detect smaller levels of change and other possible techniques to measure sub-lethal stress in corals, the results of which will be incorporated into the final dredging, drilling and dredge spoil disposal management plan, which will form part of the detailed EMP series for the Gorgon Development (Chevron Australia 2005; Technical Appendix A1).

24.162 Previous work compared impacts of dredging a pipeline trench (turbidity and seabed burial issues) with directional drilling (discharge of bentonite clay). It would seem that now the proponent is favouring directional drilling to either 600 to 1200 m offshore and that a water soluble polymer is being considered as an alternative to bentonite. The proponent should clarify the proposal.

The current engineering proposal is for directional drilling to approximately 500 m from shore line with approximately 300 m tail section extending to approximately 800 m from shore.

A biodegradable saltwater polymer drilling fluid is currently preferred for the HDD drilling fluid. This will significantly reduce the sedimentation impacts associated with a bentonite fluid (refer to Section 11.3.1 of the Draft EIS/ERMP and 24.128 Section 11.4).

24.174 The ERMP suggests sediment trap data may assist the proponent in estimating current levels of sediment deposition, understand the potential for infilling of dredged channels and estimate the sedimentation rates that corals are presently exposed to.

Where were sediment traps deployed in relation to key BPPHs and what were the environmental conditions experienced during deployment? What were the physical characteristics of sediments deposited in the traps? Please provide a concise summary of the data from sediment trap deployments.

The 50 mm of sediment that could be deposited under cyclonic conditions refers to naturally occurring sediments. This illustrates the natural level of sedimentation that the BPPH are subject to currently. Ship traffic may also re-suspend loose sediments that accumulate in the channels. Ongoing impacts to BPP communities from this much localised turbidity and sedimentation are expected to be restricted to the edges of the channels. BPP communities within the high impact zones surrounding the dredged channels are expected to recover in the long-term rather than the short-term in response to initial impacts from dredging. Small ongoing impacts associated with vessel movements, maintenance dredging and localised changes in water flow and sediment transport may extend the recovery period.

24.176 Page 432 – “*The effects on benthic primary producers in the moderate impact zone would range from bleaching of individual colonies, to partial (< 30%) mortality of long-lived reef building corals such as Porites...*”

Is this mortality of 30% of all Porites colonies present within the zones or 30% tissue mortality on individual colonies, or a combination of both?

Partial mortality (<30%) of coral communities refers to a 30% reduction in live coral cover, which incorporates both partial tissue mortality on individual colonies and the possibility of the loss of an entire colony.

25.2 The draft EIS/ERMP (Section 11-3 page 422) asserts that the “macrophyte and coral assemblages in the vicinity of the proposed marine facilities of the east coast of Barrow Island are widespread and are capable of readily colonising new substrates”. However, this statement is unsupported by any cited references or references to a marine habitat map within the draft EIS/ERMP.

Statements about the wider distribution of the benthic habitats around Barrow Island have been extrapolated from the CALM benthic habitat map of the area (CALM 2004), bathymetric charts of the area (e.g. AUS 742), published literature and the interpretation of survey data of the proposed development areas and nearby areas. Figures 11-3 to 11-9 in the Draft EIS/ERMP (Chevron 2005) show the widespread nature of the major benthic habitats of the area. Macrophyte and coral assemblages have been found to recover well from disturbance by rapidly colonising new substrates. For example, Brown et al. (1990) showed a decline in species diversity and coral cover of up to 30% during dredging in Thailand, however the reef recovered rapidly with coral cover and diversity values restored to former levels only 22 months after dredging began. Growth of marine BPP on jetty piles at Point Murat in Exmouth Gulf included 10–15% hard coral cover (Halford and McIlwain 1996, McIlwain and Halford 2001, Chevron 2005 pg 449).

Experimental studies looking at the recolonisation of *Sargassum* in tropical habitats have shown that they have the ability to recolonise bare substrate in the space of 3-4 months (Ang, 1985), with their associated invertebrate infauna able to recover from high magnitude disturbance within 2 weeks (Martin-Smith 1994). In a similar study of *Sargassum* on the Great Barrier Reef, Vuki & Price (1994) found new recruits of *Sargassum* in cleared quadrats three months after the clearing of the substrate, when the substrate was cleared during the reproductive season. Some earlier experimental studies of the colonization of *Sargassum* on artificial substratum suggested that a time lag of 9-10 months was needed for the recolonisation of *Sargassum* on a fresh substratum (Raju & Venugopal, 1971), however Chauhan (1972) found that coral pieces pre-treated with seawater could be colonized by gemlings in the space of one month. Propagule dispersal rates of *Sargassum* of up to 193 km/yr have been reported (Shanks et al. 2003), indicating significant recolonisation potential in affected areas.

25.3 The report does not appear to feed field verification data back into the impact modelling. Further clarification is requested.

The field program verified that GCOM3D, driven by LAPS wind, satellite data and tides derived around Australia by GEMS for AMSA, provided an excellent agreement with observations. This result means that the dominant physical processes driving the currents around Barrow Island are well represented by GCOM3D and the abovementioned driving data. It is not appropriate to adjust the model predictions with field data as adjustments at the location of the observations may be quite inappropriate at other locations around the grid. Furthermore the cause of these small errors may be in the winds, tides or satellite data and so making alterations to GCOM3D current predictions based on comparisons at a few points could cause significant errors. Instead, if major errors occur, the causes should be determined and improvements made.

24.5 Chevron has been requested to review the criteria and to apply alternative criteria to take into account cumulative exposure (intensity and duration) over given time periods, with the intention of testing alternative impact scenarios.

The broken lines are indicative of a minimal extent of turbidity and sedimentation around these areas that had not been modelled at the time of the Draft EIS/ERMP release. Based on observations of other large dredging programs, the dredge spoil ground was assumed not to receive any fine material as these are all liberated at either the cutter head of the dredge, or in overflow from the hopper barge. Ongoing modelling is investigating the effects of changing these assumptions to include some transport of fine particles to the spoil disposal site to support assessment of management scenarios that may involve changes to barge filling procedures. These data will be used in formulation of the EMP for the dredging operation in consultation with the regulatory agencies.

25.5 One of our major concerns is that the EIS/ERMP predicted impacts of turbidity plumes were based on criteria that considered days of consecutive stress whereas in fact exposure would be cumulative both in intensity and duration over given time periods.

Cumulative coral stress threshold criteria are being developed using available literature and will be informed by a review currently underway by DoE on indicators of coral stress. These criteria take into account both intensity and duration over given time periods.

25.11 We also have concerns that turbidity stress only factors in periods of exposure in daylight and considers only light deprivation and does not examine other effects of turbidity such as on the feeding efficiency of corals. Feeding activity can be at its greatest at night.

Turbidity and sedimentation have been identified as the most serious physiological threats to corals and other benthic primary producers. Coral responses to sediments are mainly related to shading and smothering; however there is a range of lesser effects including decreased feeding efficiency. These are described in detail in the Draft EIS/ERMP (Chevron Australia 2005; p 426). Sedimentation, rather than turbidity, is the main cause of feeding and abrasion related effects. These effects were accounted for in the consecutive coral health criteria as sedimentation effects are assessed over a 24-hour period.

25.13 The draft EIS/ERMP (Section 11-3 page 422) asserts that the “macrophyte and coral assemblages in the vicinity of the proposed marine facilities of the east coast of Barrow Island are widespread and are capable of readily colonising new substrates”. However, this statement is unsupported by any cited references or references to a marine habitat map within the draft EIS/ERMP.

Statements about the wider distribution of the benthic habitats around Barrow Island have been extrapolated from the CALM benthic habitat map of the area (CALM 2004), bathymetric charts of the area (e.g. AUS 742), published literature and the interpretation of survey data of the proposed development areas and nearby areas. Figures 11-3 to 11-9 (Chevron Australia 2005) show the widespread nature of the major benthic habitats of the area. Macrophyte and coral assemblages have been found to recover well from disturbance by rapidly colonising new substrates. For example, Brown et al. (1990) showed a decline in species diversity and coral cover of up to 30% during dredging in Thailand; however the reef recovered rapidly with coral cover and diversity values restored to former levels only 22 months after dredging began.

Growth of marine BPP on jetty piles at Point Murat in Exmouth Gulf included 10–15% hard coral cover (Halford and McIlwain 1996; McIlwain and Halford 2001; Chevron Australia 2005, p 449). Experimental studies looking at the recolonisation of *Sargassum* in tropical habitats have shown that they have the ability to recolonise bare substrate in the space of 3–4 months (Ang 1985), with their associated invertebrate infauna able to recover from high magnitude disturbance within 2 weeks (Martin-Smith 1994).

In a similar study of *Sargassum* on the Great Barrier Reef, Vuki & Price (1994) found new recruits of *Sargassum* in cleared quadrats three months after the clearing of the substrate, when the substrate was cleared during the reproductive season. Some earlier experimental studies of the colonisation of *Sargassum* on artificial substratum suggested that a time lag of 9–10 months was needed for the recolonisation of *Sargassum* on a fresh substratum (Raju & Venugopal 1971); however Chauhan (1972) found that coral pieces pre-treated with sea water could be colonised by germlings in the space of one month. Propagule dispersal rates of *Sargassum* of up to 193 km/yr have been reported (Shanks et al. 2003), indicating significant recolonisation potential in affected areas.

25.16 Assumptions in relation to macroalgal/reef habitat and macroalgal reefs with scattered corals that sediments would be rapidly mobilised and exported need better explanation as these Barrow east coast beaches are described in the EIS as being low energy zones as being low energy zones with limited onshore drift.

The hydrodynamic modelling predicts a build up of deposited sediments in only the immediate vicinity of the dredging areas, primarily due to the rapid settlement of any large sediment particles liberated during dredging. Sedimentation at a level of impact to BPP is expected to be restricted to the high and moderate impact zones. The dredge plume modelling assumes that 5% of total material will be cut below 75 microns in size based on the distribution of particle sizes in plumes generated during the Geraldton harbour dredging project. Strong tidal currents and winds will repeatedly move, deposit and resuspend such material due to its small size.

The majority of the dredged material is predicted to be considerably finer than the existing nearshore sediments and will thus mobilise much more rapidly and easily than the material which constitutes the nearshore benthic environment currently. More conservative estimates of the size composition of dredged material, i.e. a greater contribution of fines, are currently being modelled and will be used in the formulation of the EMP and monitoring programme for the dredging operation in consultation with the regulatory agencies.

25.18 We request that Gorgon provide an updated sediment quality report and also explains deviations in the SAP methods and changes to the layout plan for dredging and disposal.

The final version of the Sediment and Analysis Plan (SAP) was submitted in January 2005 and accepted by DEH in April 2005 following some clarifying communications regarding the value of TPH versus PAH analyses with Mr Chris Murphy. The Joint Venturer's agree that the sediment quality report (SQR) which DEH received in November 2004 does not reflect the scope of the SAP, for the following key reasons:

- (i) The SQR was and remains focused on resolving dredging assessment and management questions pertaining to the dredging management and approval requirements of the WA Department of Environment;
- (ii) The SAP refers to additional surface and core samples that were undertaken by diver and barge-mounted equipment in May-June and July 2004 respectively to meet the requirements of the Sea Dumping permit application. Please note the Joint Venturer's intention to submit the results of the latter investigations, which further confirm the benign nature of the dredged material as reported in the SQR, as technical supportive documentation to our Sea Dumping Permit application. This SQR will directly relate to our final SAP plus address any deviations to the layout plan for dredging and disposal that was described in the Draft EIS/ERMP.

18.3 For example, the potential significant impacts on the marine environment from dredging were not envisaged at the time of the ESE review. Furthermore, a better knowledge of the subterranean fauna values and threats now indicates a potential for significant detrimental impacts.

Both the footprint of the proposed marine facilities and the dredge volume have been significantly reduced from the concept proposed in the ESE review. This reflects the Joint Venturers' commitment to incorporating the results of environmental impact analyses of various scenarios into the process of project design. While the ESE recognised that there would be significant marine impacts associated with dredging, it was too early in the design and impact assessment phase to detail the predicted extent of impacts. Since this time advanced design of the proposed dredging programme and hydrodynamic modelling of the behaviour of dredge plumes have permitted delineation of predicted plumes and risk assessment of impacts to BPPH.

Refer to the Additional Information Package for updated information in relation to Subterranean Fauna.

11.3.2 Leaks and Spills

25.25 Spill risk assessment concentrates on shore contact as a surrogate for contact with valuable biota. This does not appear to be a reasonable assumption as it does not consider the effects of non surface plumes or deposits.

Accidental spills would not be treated with dispersants in shallow waters and the probability of a dense plume or deposit that would contact the seabed is very low. Spills of fuel hydrocarbons would float and are most likely to have environmental impacts if the volatile elements are washed ashore where they would contact the beach or intertidal areas, depending on the tide. The risk assessment addresses the worst case scenarios where spills of various sizes contact sensitive receptors in these areas.

11.4 Benthic Primary Producer Habitats

16.47 The marine environments associated with the Barrow, Lowendal and Montebello Islands are fortunately now a Marine Conservation Area. We are greatly concerned for the protection of this Marine Conservation zone, which would inevitably be impacted and subjected to high risks if the development goes ahead on the Barrow Island location.

Chapter 11 of the Draft EIS/ERMP describes the Marine Environment and the Risks and Management Measures proposed for the Gorgon Development. Computer generated modelling has been completed and field tested in order to identify areas of impact associated with the construction activities in the areas surrounding Barrow Island. The Marine Conservation Park associated with Biggada Reef and the Bandicoot Bay Conservation Area have been avoided in order to lessen impacts from activities such as dredging, offloading of LNG product and feed gas pipeline shore crossing. All impacts will be managed through the use of specific Environmental Management Plans that will aim to provide maximum protection for sensitive marine environments during construction and operation of Gorgon Development associated infrastructure.

18.24 This is highlighted with the 30 year recovery period used by the proponent to distinguish between permanent loss of, or temporary damage to, benthic primary producer habitat. The proponent has not considered the effects of extended periods of loss of benthic primary producer habitats on other components within the ecosystem (trophic cascade).

The 30-year recovery was proposed by the DoE to represent a change noticeable in a human lifetime for assessment of benthic primary producer habitat loss. This time span is not used in the risk assessment for potential impacts to marine fauna. The risk assessment used the shorter time span of five years to define short-term impacts (Chevron Australia 2005; p 291, Table 9-1). Extended loss of habitat (> 5 years) with anticipated effects of fauna, including potential for trophic cascade, was assigned a higher level of risk. None of the potential losses of primary producer habitats were considered large enough to cause any loss of productivity in the ecosystem. In some areas, the provision of hard substrates is expected to increase productivity.

18.106 Information should be provided by the proponent on the methods used for estimating cumulative impacts of plumes on the marine environment, in order for a detailed assessment to be made of the cumulative loss of benthic primary producers and benthic primary producer habitats.

Methods used for calculating cumulative losses of benthic primary producers and their habitats are described in Section 11.4 (Chevron Australia 2005; pp 462–480).

18.105 More information is required on the methods used by the proponent to determine cumulative areas of change of coral reef communities and seagrass and macroalgal communities affected in the marine park. The cumulative area of change of these is not to exceed 1% of each habitat type in the general use areas of the marine park. Without this information CALM cannot assess if this level will be exceeded.

Predicted cumulative losses of benthic primary producers (and their habitats) are detailed in Section 11.4. This assessment follows the guidelines for assessing such cumulative losses against criteria established by the WA EPA as described in Guidance 29 (EPA 2004). The areas that would be impacted were estimated from 3D hydrodynamic modelling of the turbidity and sedimentation plumes from the dredging. Direct physical impacts associated with construction are within the areas affected by the plumes. See Section 11.3 and 11.5 (Draft EIS/ERMP) for the risk assessment on the impacts on BPP and marine fauna respectively. The hydrodynamic modelling indicated that there will be no impacts on either the Biggada Reef Marine Park or the Montebello Islands Marine Park.

24.5 Chevron has been requested to review the criteria and to apply alternative criteria to take into account cumulative exposure (intensity and duration) over given time periods, with the intention of testing alternative impact scenarios.

Cumulative coral stress threshold criteria are being developed using the available literature and will be informed by a review currently underway by the DoE. These criteria allow for the effects of a series of pulse events and take into account both intensity and duration over given time periods. Preliminary comparison of the zones of impact based on cumulative and consecutive criteria indicates that the cumulative impacts are only slightly larger than those predicted using the consecutive criteria. A detailed analysis of cumulative impacts on marine BPPH from the proposed Development is currently underway and will be used in the formulation of the EMP and monitoring programme for the dredging operation in consultation with the regulatory agencies.

18.118 Further assessment should be made of the proposed water-based polymer and its consequences on the marine environment in comparison to the bentonite clay.

Literature on the effects of the two proposed drilling fluids indicate that the polymer has less environmental effects. It is less cohesive and less likely to smother benthos. However, its feasibility for directional drilling at North White's Beach is unknown. Investigations into the feasibility of using polymer drilling fluids instead of bentonite clay fluids are continuing and will be presented with an appraisal of the environmental effects of both fluid types.

18.117 Further detail should be provided on the spatial and temporal extent to which bentonite clay will remain in the marine environment, and the impacts of this on benthic primary producer habitats and all ecological values in the marine conservation reserves.

Modelling of the behaviour of bentonite discharges were based on a very conservative assumption that all drilling fluids would be released to the seabed. Refer to 22.25 Section 6.3.4.

22.16 It is now apparent that the project will be unable to meet a number of the EPA's cumulative loss thresholds for benthic primary producer habitats (including coral reefs).

The cumulative loss thresholds are a guide to the amount of primary producer habitat that can be lost without affecting the ecological function of an area. The management units established for this assessment are based on the size suggested by the EPA in the BPPH guidance statement (EPA 2004). They are based on ecological units, but their size is an arbitrary 5 km x 10 km although the habitats are widespread in the areas surrounding the management units. Loss of the habitats within these units, beyond the threshold criteria, does not represent a loss of ecological function. Cumulative loss thresholds are used by the EPA to provide an indication of the acceptability of the impacts associated with a particular proposal. However, given the lack of a scientific basis for setting boundaries of management units and difficulty in reliable measurement of the area of some benthic primary producer habitats, these thresholds are not considered rigid limits (EPA 2004).

The acceptability of benthic primary producer habitat damage/loss is, in all cases, a judgement of the EPA, based primarily on its assessment of the overall risk to the ecosystem integrity within a defined management unit if a proposal were to be implemented. Expected recovery of BPP communities is taken into account in assessing the ecological implications of the habitat disturbance. The acceptable loss is also related to the conservation significance of the area. The cumulative loss thresholds (CLT) for the proposed development are met for most of the management units.

22.259 These results should feature more heavily in all documentation relating the project, including the Executive Summary. An estimate of the high and moderate impact 'footprint' (i.e. in hectares) should also be included.

The potential impacts from the development on marine BPP are detailed in section 11.2 of the Executive Summary of the Draft EIS/ERMP (Chevron Australia 2005), including a diagrammatic representation of the anticipated area of impact from dredging, drilling and dredge spoil disposal (Figure 11-1). Cumulative loss calculations for each Management Unit, including the total area of BPPH before disturbance (ha) and the percentage (%) permanent loss under each scenario are provided in Tables 11-13 to 11-19 of the Draft EIS/ERMP (Chevron Australia 2005).

22.270 The Submitters underline that one BPPH cumulative loss threshold will be seriously breached here (25% as against 10%) and another will be absolutely ignored (63% as against 2%!).

Cumulative loss thresholds are used by the EPA to provide an indication of the acceptability of the impacts associated with a particular proposal. However, given the lack of a scientific basis for setting boundaries of management units, difficulty in reliable measurement of the area of some benthic primary producer habitats, and given the difficulty in determining the ecological significance of their loss, these thresholds are not considered as rigid limits (EPA 2004). The acceptability of benthic primary producer habitat damage/loss is, in all cases, a judgement of the EPA, based primarily on its assessment of the overall risk to the ecosystem integrity within a defined management unit if a proposal were to be implemented. Expected recovery of BPP communities is taken in account in assessing the ecological implications of the habitat disturbance.

22.281 Apparent breaches of BPPH cumulative loss thresholds in two areas of unconfirmed coral habitat should not be dismissed until those management units have actually been the subject of appropriate field surveys!

Field studies conducted in September/October 2005 and detailed in the Additional Information Package (AIP) (Chevron Australia 2005b) revealed that there is little coral in the predicted impact area to the south of the Lowendal Islands. The large expanses of 'unconfirmed coral' have been reclassified as limestone pavement supporting variable cover of macroalgae and scattered corals. The CLTs for the Lowendal Island management units (MU2 and MU3) and Barrow Island Port management units (MU5 and MU6) have been revised and are described in detail on pp 3 and 4 of the AIP (Chevron Australia 2005b).

24.92 In view of the potential for large-sale impacts and the limited understanding of potential flow-on effects of even temporary loss of habitat over the areas in question, significantly greater technical justification is required for the proponents assumptions that 1) there will be full recovery of macroalgal and macroalgal/scattered coral BPPHs and, 2) the loss of any BPPH, whether that is temporary or permanent, would not effect overall ecosystem integrity.

Benthic primary producers in the region are occasionally exposed to major natural perturbations, such as cyclones, that impact them on large scales. Their persistence in the region is testament to their ability to recover from such impacts, even with the loss of significant elements of the community. The impacts from dredging, drilling and spoil disposal on the marine environment are expected to be less than that from a severe cyclone. For example, Brown et al. (1990) showed a decline in species diversity and coral cover of up to 30% during dredging in Thailand, with significant mortality of *Porites*, a major reef building species. However, the reef recovered rapidly, with coral cover and diversity values restored to former levels only 22 months after dredging began. The same reef system also suffered significant bleaching and mortality associated with climate-related events approximately 10 years later. The reef fully recovered from the effects of exposure and regained its pre-impact function and structure within 12 months (Brown et al. 2002).

24.118 A general comment is that predictions of ecological impacts are solely based on predicted responses of corals to thresholds based on consecutive days of exposure to TSS and sedimentation. The exposure thresholds for corals have been derived by the proponent from a review of published scientific literature, and from that perspective the approach is logical and reasonable. However, this approach assumes that corals are a suitable surrogate for predicting the responses of other critical elements of coral reef communities (eg turf algae, sponges and other sessile invertebrates), algal reef or seagrass communities (BPPH) to turbidity and sedimentation. Adequate justification and substantiation of this assumption has not been found in the documentation supplied. The proponent should provide such justification or otherwise respond to and address this fundamental issue.

The criteria for adverse impacts on corals were taken as a conservative indicator of the response of all BPP communities. In the absence of adequate literature on the relationships between seagrass or macroalgal survival and TSS concentrations, this approach is considered conservative because macrophyte benthic primary producer habitats (BPPH) are expected to be less susceptible than corals to long-term impacts from sedimentation and turbidity. Non-coral BPP, such as the macroalgae *Sargassum* and the seagrass *Halophila* are able to rapidly recolonise disturbed areas and naturally undergo major seasonal changes in biomass in response to natural sediment movements. Benthic primary producers and benthic invertebrate communities in the region are occasionally exposed to major natural perturbations, such as cyclones, that impact them on large scales. Their persistence in the region is testament to their ability to recover from major impacts.

24.128 The proponent should discuss the potential toxicity of the HDD drilling muds/fluids and determine the effect of any toxicity by predicting the contours for relevant species protection criteria derived from WET testing on the drilling muds that may be released to the nearshore marine environment. Loss of, and/or serious damage to, BPPH should be couched in the context of GS No.29.

A biodegradable saltwater polymer drilling fluid is currently preferred for the HDD drilling fluid. Toxicity data for Zanflo®, which is a typical polymer drilling fluid is given below:

‘The following data have been classified using criteria adopted by the European Economic Community for aquatic organism toxicity:

- 96-hr LC₅₀: rainbow trout; 490 mg/l (practically non-toxic)
- 48-hr LC₅₀: *Daphnia magna*; 980 mg/l (practically non-toxic)
- 96-hr LC₅₀: mysid shrimp, using 2 lb/bbl xanthan gum in standard drilling mud; >500 000 ppm suspended particulate phase.’

Due to the polymer drilling fluids being bio-degradable, it may be necessary to use a biocide to extend product life if circumstances arise that require it to be left in hole for longer than 48 hours (such as delays with the pipe or cyclones). The use of these products (and alternatives) will be further discussed in the EMP for the shore crossing activities.

24.139 There are concerns that if such shifts were to occur as a result of this proposal, the flow on effects to biota that are dependent on the benthic habitats presently found around Barrow Is. are very poorly understood and have been all but ignored in the ERMP. In view of the uncertainties surrounding potential impacts and recovery of macroalgal-dominated BPPH, the proponent should provide significantly more robust justification for its assumption that recovery will occur and that overall ecosystem integrity will not be threatened by permanent or temporary loss of macroalgal-dominated habitats.

While there is limited information on the responses of macroalgal communities to environmental perturbations and their subsequent recovery potential, the published information does suggest that full recovery of macroalgal BPPH will occur in the short- to medium-term. This assumption has been based on the fact that macroalgal benthic primary producers in the region are exposed to large scale, natural perturbations, such as cyclones and their persistence in the region is testament to their ability to recover from such impacts. Umar et al. (1998) reports that while very high levels of sediment accumulation (up to 20 mm thick) affected recruitment, growth, survival and seasonal regeneration of *Sargassum*, populations were never killed. This led the authors to conclude that a two-fold increase in long-term sediment thickness would reduce abundance but not lead to local extinction. Propagule dispersal rates of *Sargassum* of up to 193 km/yr have been reported (Shanks et al. 2003), indicating significant recolonisation potential in affected areas.

24.122 This public commitment has not been followed though as the additional information package does not contain assessment of the sum of short pulse stress events. Accordingly, the proponent's response to the EPA SU's requests for alternative impact prediction scenarios based on cumulative stress remains outstanding and we reiterate the importance of this work to the ability of the EPA SU to provide informed advice to the EPA.

A series of short pulses of turbidity or sedimentation within the zone of influence may have a cumulative effect on the corals. Cumulative coral stress threshold criteria and short term 'pulse' criteria are being developed using the available literature and will be informed by a review currently underway by the DoE. These criteria allow for the effects of a series of pulse events and take into account both intensity and duration over given time periods. Preliminary comparison of the zones of impact based on cumulative and consecutive criteria indicates that the cumulative impacts are only slightly larger than those predicted using the consecutive criteria. A detailed analysis of cumulative impacts on marine BPPH from the proposed Development is currently underway and will be used in the formulation of the EMP and monitoring programme for the dredging operation in consultation with the regulatory agencies.

24.134 The proponent has not included “damage” or “temporary loss” of BPPH in the estimates of cumulative BPPH loss which are then assessed against the cumulative loss thresholds. The proponent’s rationale for not including the areas of BPPH damaged by the proposal is that it predicts there will be full recovery of the damaged habitats within 30 years. To help substantiate the proponent’s predictions and to inform the EPA’s assessment, for the habitats assumed to recover the proponent should estimate the extent damage/loss of each BPPH in the high and moderate impact zones after 5-year intervals (a short-term time frame by the proponent’s definition) commencing from the time dredging and dumping activities are completed to the time when full recovery has been achieved (eg. 0, 5, 10, 15 years and so on).

There is an expectation that the majority of marine BPP and BPPH will recover within the first 5 years following dredging, although a conservative measure of 30 years has been used in the assessment. If BPP and BPPH are estimated to take longer than 30 years to recover, they have been identified as ‘loss’. Recovery of BPP within 5 years is based on published material, such as Brown et al. (1990), that showed that while a decline in species diversity and coral cover of up to 30% occurred during dredging in Thailand, the reef recovered rapidly with coral cover and diversity values restored to former levels only 22 months after dredging began. This included the recovery of the reef building species *Porites*. *Sargassum* and the seagrass *Halophila* are also able to rapidly recolonise disturbed areas and naturally undergo major seasonal changes in biomass in response to natural sediment movements (Umar et al. 1998; Loneragan et al 2003).

24.135 Examples of coral-dominated BPPH which have not been accounted for in the proponent’s cumulative loss calculations include coral reef habitat within the moderate impact zone for the anticipated case in Management Units 4 and 8, despite impacts in the moderate protection zone being predicted to include mortality of susceptible coral taxa (e.g. *Acropora*) and possible partial mortality (<30%) of resilient coral taxa (e.g. *Porites*) in the moderate impact zones.

Cumulative coral stress threshold criteria are being developed using the available literature and will be informed by a review currently underway by the DoE. These criteria allow for the effects of a series of pulse events and take into account both intensity and duration over given time periods. These cumulative criteria are being developed to augment the consecutive criteria presented in the Draft EIS/ERMP (Chevron 2005). Preliminary comparison of the zones of impact based on cumulative and consecutive criteria indicates that the cumulative impacts are only slightly larger than those predicted using the consecutive criteria. A detailed analysis of cumulative impacts on marine BPPH from the proposed Development is currently underway and will be used in the formulation of the EMP and monitoring programme for the dredging operation in consultation with the regulatory agencies.

24.140 For each impact scenario, the proponent should determine the areas of all BPPH to be ‘damaged’ or ‘temporarily lost’ in each management unit and present the resultant percentage loss values in a table for reference and assessment against the CLTs.

The proponent should provide the above data in two separate tables. One table should contain data for the current impact prediction scenarios based on consecutive days of stress and the other table should contain the data for the impact predictions driven by cumulative sediment and turbidity stress.

Areas of indirect damage leading to loss of BPPH are included in the ‘loss’ calculations. The areas of ‘temporary loss’ of BPPH is not included and is not specifically required and for example they are not included in the worked calculations of loss, in Guidance Statement No. 29 (EPA 2004). The very conservative nature of the moderate impact zone makes it impractical to attempt to delineate areas of temporary loss within this zone. If the total areas of BPPH in the zone were used to calculate loss, the resultant figures would be unrealistically high as impacts are expected to be limited in many parts of the zone. The zone was established to indicate the area of possible effects and to guide establishment of monitoring sites.

24.178 The width of the lines on Figure 11-3 – 11-9 represent up to approximately 200 m – equivalent to the length of 4 Olympic size swimming pools – a considerable source of error when interpreting the spatial extent of impacts from the figures. Please provide finer-scale detailed figures showing benthic habitats, bathymetry and impact zone boundaries, particularly for areas where development of structures and channels are proposed and for areas where high and moderate impacts are predicted to occur.

The scale of the development necessitates the use of a large scale grid that covers a wide geographical area in the hydrodynamic model. The scale of the current figures in the Draft EIS/ERMP (Chevron 2005) is designed to reflect the accuracy of the model in predicting potential impacts within the 100m gridded study area. The current scale also shows the entire area of impact, rather than only specific portions of the impact. The areas of each BPPH type that will potentially be affected were calculated from the GIS, which use a one-pixel wide line to separate habitat polygons. A detailed analysis of cumulative impacts on marine BPPH from the proposed Development is currently underway and will be used in the formulation of the EMP and monitoring programme for the dredging operation in consultation with the regulatory agencies.

25.1 There is still uncertainty about recovery potential and flow-on effects that may affect habitat structure and food webs. This appears to be due to the approach used of assessing environmental impacts by separately examining parts of the marine environment (eg benthic primary producers, marine fauna) without explicitly considering interrelationships between these components.

Benthic primary producers and associated faunal assemblages in the region are periodically impacted by major natural perturbations, such as cyclones, on large spatial scales. Their persistence in the region is testament to their ability to recover from such impacts, even with the loss of significant elements of the community. The majority of marine BPP and BPPH are expected to recover within 5 years. For example, Brown et al. (1990) that showed a decline in species diversity and coral cover of up to 30% during dredging in Thailand, however the reef recovered rapidly with coral cover and diversity values recovering within 22 months after dredging began. The other main BPP, macroalgae such as *Sargassum* and the seagrass *Halophila* undergo major seasonal changes in biomass in response to natural sediment movements and are also able to rapidly recolonise disturbed areas (Umar et al. 1998, Loneragan et al 2003, Ang, 1985).

The invertebrate epifauna associated with these communities can recover from high magnitude disturbances within 2 weeks (Martin-Smith 1994). Within 2 years of dredging at Heron Island on the Great Barrier Reef, gastropod numbers had recovered to pre-dredging levels and tall algae (mainly *Sargassum*) had increased in overall abundance (Catterall et al. 1992). The inter-relationships between BPP and the associated fauna is addressed in the risk assessment for marine fauna in section 11.5.1 of the Draft EIS/ERMP (Chevron 2005).

25.6 Prediction of the ecological impacts is restricted to impacts on coral colonies and does not explicitly consider impacts on the other key attributes of the marine ecosystem in the area that may be affected by the proposal. This approach assumes corals are a suitable surrogate for predicting the responses of other key elements of benthic primary producer communities to turbidity and sedimentation (such as turf algae and coralline algae). This assumption should be substantiated or preferably each Benthic Primary Producer Habitat (BPPH) should be looked at separately to analyse likely effects.

The criteria for adverse impacts on corals were taken as a conservative indicator of the response of all BPP communities. In the absence of adequate literature on the relationships between other BPP communities, including turf algae and Crustose Coralline Algae (CCA) and TSS concentrations, this approach is considered conservative because coral benthic primary producer habitats (BPPH) are generally considered to be the most likely to suffer long-term impacts from sedimentation and turbidity. Other BPPH are expected to suffer only short-term impacts due to indirect effects of dredging and any potential long-term effects (loss) are addressed individually in the BPPH assessment in Section 11.4 of the Draft EIS/ERMP (Chevron Australia 2005). Non-coral BPP, such as the macroalgae *Sargassum* and the ephemeral seagrass *Halophila* are able to rapidly recolonise disturbed areas and naturally undergo major seasonal changes in biomass in response to natural sediment movements (Umar et al. 1998; Loneragan et al. 2003).

The percentage cover of CCA is known to be related to the sedimentary environment, with lower cover in high sediment inshore reef areas. However, these algae are also known to survive for long periods of burial by sediments (Fabricius and De'ath 2001). Turf algae can colonise hard substrates within days and successions from turf to coralline algal assemblages can occur within months when conditions are suitable. In contrast, well developed coral assemblages may take decades or more to recover fully. Thus, while non-coral primary producers could also be potentially affected by the dredge plume in the areas of high and moderate impact, the impacts are predicted to be less than those for corals in Chapter 11 of the Draft EIS/ERMP. Protection of coral assemblages is considered a conservative means of protecting other BPP assemblages.

25.7 The potential consequences for ecosystem integrity of damaging or removing these elements from the reef over short, medium and long terms have not been considered or not presented.

Benthic primary producers and associated fauna assemblages in the region are periodically exposed to major natural perturbations, such as cyclones, that impact them on large scales. Their persistence in the region and their continuing support of biodiversity and productivity is testament to their ability to recover from such impacts, even with the loss of significant elements of the community. The impacts from dredging, drilling and spoil disposal on the marine environment are expected to be less than those from a severe cyclone. In areas where the BPPH retains its function, the impacts of dredging and drilling are expected to be short-term and the faunal assemblages are expected to rapidly recover through colonisation from surrounding areas. For example, Brown et al. (1990) showed a decline in species diversity and coral cover of up to 30% during dredging in Thailand, with significant mortality of *Porites*, a major reef building species.

However, the reef recovered rapidly, with coral cover and diversity values restored to former levels only 22 months after dredging began. The same reef system had also suffered significant bleaching and mortality associated with climate-related events approximately 10 years later. The reef fully recovered from the effects of exposure and regained its pre-impact function and structure within 12 months (Brown et al. 2002). Experimental studies looking at the recolonisation of *Sargassum* in tropical habitats have shown that they have the ability to recolonise bare substrates in the space of 3–4 months (Ang 1985). In a similar study of *Sargassum* on the Great Barrier Reef, Vuki & Price (1994) found new recruits of *Sargassum* in cleared quadrats three months after the clearing of the substrate, when the substrate was cleared during the reproductive season. Some earlier experimental studies of the colonization of *Sargassum* on an artificial substratum suggested that a time lag of 9–10 months was needed for the recolonisation of *Sargassum* on a fresh substratum (Raju & Venugopal 1971).

Crustose Coralline Algae (CCA) is important for reef calcification and as a settlement substrate for other reef organisms. The percentage cover of CCA is known to be related to the sedimentary environment, with lower cover in high sediment inshore reef areas. However, these algae are also known to survive for long periods of burial by sediments (Fabricius and De'ath 2001). Turf algae colonise substrates, e.g. dead corals, within days and successions from turf to coralline algal assemblages can occur within months when conditions are suitable. Cyclonic perturbations also result in permanent change in the type of BPPH and associated flora and fauna assemblages, for example through burial of hard substrates with sand. Threats to ecosystem function in areas where BPPH loss, or modification, is anticipated to affect only a small proportion of the BPP in the area and will be mitigated by the formation of new assemblages on artificial substrates, for example, the causeway.

25.8 Biological modelling appear to have also focused solely on corals despite macroalgae communities being sensitive to turbidity and large areas being located in zones of high and medium impact.

Refer to response to 25.6. The criteria for adverse impacts on corals that were used in the biological modelling were taken as a conservative indicator of the response of BPP communities in general to TSS and sedimentation. In the absence of adequate literature on the relationships between macroalgal survival and TSS concentrations and sedimentation rates, this approach is considered conservative because macrophyte benthic primary producer habitats (BPPH) are generally believed to be less susceptible than corals to long term impacts from sedimentation and turbidity. The BPPH assessment includes calculation of the areas of macroalgal BPPH in the impact zones. However, these impacts are expected to be short-term and do not represent permanent loss. Non-coral BPP, such as the macroalgae *Sargassum*, are able to rapidly recolonise disturbed areas and naturally undergo major seasonal changes in biomass in response to natural sediment movements. Umar et al. (1998) reported that while very high levels of sediment accumulation (up to 20 mm thick) affected recruitment, growth, survival and seasonal regeneration of *Sargassum*, populations were never killed.

This led the authors to conclude that a two-fold increase in long-term sediment thickness would reduce abundance but not lead to local extinction. Additionally, within 2 years of dredging at Heron Island on the Great Barrier Reef, tall algae (mainly *Sargassum*) increased in overall abundance in response to a variety of factors, including increased recruitment (Catterall et al. 1992). Areas that are anticipated to suffer high levels of macroalgae mortality, i.e. high impact areas, are generally located within 1 km of the source of disturbance, except in the case of the small area on the eastern side of the Lowendal Shelf (Chevron Australia 2005; Figure 11-5). These areas have been treated as permanent loss zones for the assessment.

25.12 In terms of areas of benthic primary producers (BPP) affected, the draft EIS/ERMP (Section 11-3 page 422) lists the major communities to be affected but does not state what areas of each may be directly disturbed.

Section 11.4 of the Draft EIS/ERMP includes a detailed assessment of the areas of each BPP habitat that may be directly disturbed. The Gorgon joint Venturers have adopted the EPA's risk-based approach, as outlined in Guidance Statement No. 29 (EPA 2004), to assess unavoidable cumulative impacts to benthic primary producer habitats. Fourteen management units were defined to assess impacts to BPPH associated with the development. The total area and percentage loss of BPP communities within each management unit are presented in a series of tables in Section 11-4 of the Draft EIS/ERMP (Chevron Australia 2005).

25.14 The proponent assumes full recovery of BPPH's will take place over 30 years and does not consider that one or other effects on parts of the coral community may lead to irreversible changes in key processes. The proponent has not included damage or temporary loss of BPPH (<30 years) in the estimates of cumulative BPPH loss which are then assessed against cumulative loss thresholds. The proponent's rationale for not including the areas of BPPH damaged by the proposal is that it predicts these losses will be temporary and there will be full recovery of the damaged habitats within 30 years. Yet serious impacts on ecosystem dynamics may be caused. Substantiation of these predictions should be presented. The proponent should analyse the extent of damage or loss of each BPPH in the high and moderate impact zones at intervals from the time of dredging.

The 30 year time for recovery was applied only to the BPPH assessment, at the advice of the EPA SU. This assessment deals specifically with the irreversible loss of habitats that support the BPP communities. Possible flow on effects to ecosystem dynamics could include changes in the structure and function of associated flora and faunal assemblages. The predicted impacts on flora and fauna associated with loss of BPP and seabed habitats are addressed in the risk assessment for BPP and marine fauna in the Draft EIS/ERMP Sections 11.3 and 11.5.1 respectively. This section follows the risk assessment process as described in detail in Chapter 9 (Chevron 2005) where a short-term impact is one that affects the receptors for only five years or less. The majority of marine BPP and BPPH will recover within 5 years with only short-term effects on the ecosystem dynamics.

Benthic primary producers and their associated faunal assemblages in the region are periodically exposed to major natural perturbations, such as cyclones, that cause mortality of BPP and modification or loss of their habitat. The persistence of these communities is testament to their ability to recover from such impacts, even after the loss of significant elements of the community. The spatial extents of impacts from dredging, drilling and spoil disposal on the marine environment are expected to be less than that from a severe cyclone.

25.17 There appears to be considerable uncertainty regarding the potential impacts and recovery of macroalgal dominated BPPH. Greater evidence is needed for the conclusions that recovery will occur and ecosystem integrity will not be risked by permanent or temporary loss of habitats dominated by macroalgal communities.

While there is limited information on the responses of macroalgal communities in the north west of Western Australia to environmental perturbations and their subsequent recovery potential, macroalgal assemblages in other areas have recovered fully in the short to medium term. *Sargassum* is the dominant macroalgal taxon on the broad limestone pavements around Barrow Island. Experimental studies have shown that *Sargassum* can recolonise bare substrate in the space of 3-4 months in tropical habitats (Ang, 1985). In a similar study of *Sargassum* on the Great Barrier Reef, Vuki & Price (1994) found new recruits of *Sargassum* in cleared quadrats three months after the clearing of the substrates, when the substrate was cleared during the reproductive season. Some earlier experimental studies of the colonization of *Sargassum* on an artificial substratum suggested that a time lag of 9-10 months was needed for the recolonisation of *Sargassum* on a fresh substratum (Raju & Venugopal, 1971), however Chauhan (1972) found that coral pieces pre-treated with seawater could be colonized by gemlings in the space of one month.

Umar et al. (1998) reports that while very high levels of sediment accumulation (up to 20 mm thick) affected recruitment, growth, survival and seasonal regeneration of *Sargassum*, populations were never killed. This led the authors to conclude that a two-fold increase in long-term sediment thickness would reduce abundance but not lead to local extinction. Within 2 years of dredging at Heron Island on the Great Barrier Reef, tall algae (mainly *Sargassum*) increased in overall abundance (Catterall et al. 1992). Propagule dispersal rates of *Sargassum* of up to 193 km/yr have been reported (Shanks et al. 2003), indicating significant recolonisation potential in affected areas.

26.1 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: the absence of directly relevant coral sensitivity data;

A total of 229 scleractinian coral species from 57 genera have been recorded from the Dampier Archipelago (Giffith 2004) and at least 150 species from 54 genera have been recorded to date from surveys of the Montebello/Barrow Islands Marine Conservation Reserves (Berry 1993). The extensive literature review provided in the Draft EIS/ERMP (Chevron 2005) on the effects of sedimentation and turbidity on corals provided a summary of information of the most abundant genera in the marine waters surrounding Barrow Island, e.g. *Acropora* and *Porites*, and included information from Dampier, Ningaloo Reef and the Great Barrier Reef. Highly conservative criteria for impacts to corals and other BPP have been selected to account for uncertainty and fluctuations in the responses of specific coral species, light attenuating characteristics of the dredged sediments at Barrow Island, possible differences between natural and dredge generated sediments and potential additive effects of other stressors such as high water temperatures, gamete production and natural turbidity. The conservatism built into the criteria used in the biological modelling account for the paucity of directly relevant coral sensitivity criteria. Only field measurement of the response of corals in the Barrow Island area to the dredge plume generated by dredging for the proposal will provide directly relevant data. The monitoring program for the dredging project will gather valuable information that will guide assessment of future dredging operations in the north west of Western Australia.

26.2 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: – the basis for a 30 year recovery period.

The 30 year recovery period for BPPH was selected to differentiate temporary ‘damage’ from permanent ‘loss’ as required in the BPPH assessment EPA (2004). The 30 year period was selected on the advice of the DoE to represent a time period relevant to a human life span over which people would perceive a change in the environment as permanent.

26.3 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: – the absence of plume model ground-truthing across different seasons.

26.4 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: the absence of plume model ground-truthing for extreme weather events

There are no ground truth data for sediment plume modelling in any season yet. We are hopeful that such data will be collected during the actual dredge program. The only ground truthing of a qualitative nature has been carried out at Geraldton where good agreement was obtained between model predictions and in situ TSS data on a few days during the dredge program (see GEMS Geraldton Verification Report). Much more detailed data are required however to provide comprehensive verification.

26.12 It is stated that “the numerical model predicted likely impacts to a reasonable degree of accuracy”. What is “a reasonable degree of accuracy”?

26.29 It is stated in the first paragraph on this page that the “agreement between... model predictions... and observations is very good in all cases”. “Very good” as compared to what? How does this ‘standard’ compare to the “reasonable degree of accuracy” referred to on page 3 of the AIP?

26.30 The next paragraph states that GCOM3D is simulating the circulation around Barrow with a “good level of accuracy”. “Good” as compared to what? Why only ‘good’ as compared to the “very good” in the previous paragraph? How does this ‘standard’ compare to the “reasonable degree of accuracy” referred to on page 3 of the AIP?

The statement “a reasonable degree of accuracy” is actually very conservative. As can be seen by the comparison of GCOM3D predictions with observations the agreement, particularly in such a complex flow regime, is very good. The drifter comparisons and the progressive vector diagrams at all three sites are particular evidence of the very good agreement as errors compound in these sorts of analyses. As stated earlier, the important outcome of any verification program is to show that the ocean model, together with the driving forces, represent the dominant physical processes very well. This is definitely evident in this study and therefore provides the first modelling program to successfully simulate the ebb and flood tide around Barrow Island.

26.13 Have the BPPH within the likely area of influence of the dredging all been ground-truthed, or has there just been a program of sampling? If the latter, how comprehensive has the sampling been and to what extent are those results simply being extrapolated into areas that have not been ground-truthed?

Not all areas within the area of influence have been surveyed. However, nearly all of the habitats within the zones of moderate and high impact have now been ground truthed. Areas that have not been ground truthed have been extrapolated from nearby survey data using bathymetry and wave climate data to predict the likely distribution of various benthic habitats in the area. Benthic habitat distribution within other parts of the zone of influence has been derived from the habitat map published in the CALM Interim Management Plan (CALM 2004). Ground truthing of marine benthic habitats is described in detail in Technical Appendix C8 (Chevron 2005). Further sampling (September 2005) augmented the data collected during those earlier surveys and ground truthing of benthic habitats will continue during the Baseline Marine Monitoring Programme. Tracklogs of the September 2005 ground truthing of unconfirmed coral habitats on the Lowendal Shelf and along the north-eastern coastline of Barrow Island are shown in Figure 26.13.

Figure 26.13:

Towed Video Survey Routes



- 26.17 On what basis was it then assumed that BPPH impacts primarily relate to the dominant macroalgae? How many biological surveys, if any, were done to establish what that dominant macroalgae is?

Brown macroalgae are the major benthic primary producer in the areas marked as 'Macroalgae (limestone reef)' in the BPPH assessments (Chapter 11 of the Draft EIS/ERMP) in terms of spatial coverage and biomass. Qualified marine biologists have undertaken many biological surveys of the marine waters surrounding Barrow Island as described in Technical Appendix C8 (Chevron 2005). While there is a diversity of macroalgae in the area, a few taxa dominate. Intertidal and shallow subtidal surveys on the east coast of Barrow Island revealed a total of 112 species of algae, dominated by large brown algae, particularly *Sargassum* spp. (BBG 1997).

- 26.18 Given the abovementioned absence of directly relevant data about sensitivity, what studies have been done to justify the assertion here about an abundance of "resilient corals"? In any event, what is meant by the suggestion that these corals "would not suffer high mortality"?

Turbinaria and Porites coral are generally found to be more resilient than many other coral taxa (Chevron 2005 pgs 425-431). An extensive review of the available literature on the effects of sedimentation and turbidity on corals identified these genera as being considerably more resilient to increases in sedimentation and turbidity than other coral genera. However, there are no studies that involve experimental demonstration of the sensitivities of the species at Barrow Island. Further, uncertainties in the physical properties of the sediments that will be generated during dredging at Barrow Island and the responses of the local species to these sediments preclude direct application of published responses. The published data provide a valuable guide to relative sensitivities of various genera and growth morphologies. This lack of local data was addressed by using very conservative criteria for predicting the zones of effect in the biological modelling.

'High mortality' refers to loss of greater than 30% of colonies in an area, or more than 30% of the live coral cover on individual colonies. Corals within the predicted moderate impact zone are not expected to suffer more than partial mortality. This means either, death of less than 30% of the colonies in an area, or partial death of individual colonies, for example mortality of the horizontal polyps. Coral threshold criteria (Chevron 2005, pgs 425-431) that delineate zones of high and moderate impact were conservatively set such that, in the moderate impact zone, high mortality of Porites is not expected.

26.19 On what basis have estimates about coral recovery been made? Isn't there an absence of directly relevant data for this matter?

Benthic primary producers in the region are occasionally exposed to major natural perturbations, such as cyclones and warm water events, that cause wide spread mortality. Their persistence in the region is testament to their ability to recover from such impacts, even after the loss of significant elements of the community. While there are no recovery data in the literature directly applicable to the Barrow Island corals, coral assemblages in other parts of the world have recovered from major disturbance over a period of years. For example, Brown et al. (1990) showed a decline in species diversity and coral cover of up to 30% during dredging in Thailand, with significant mortality of *Porites*, a major reef building species.

However, the reef recovered rapidly, with coral cover and diversity values restored to former levels only 22 months after dredging began. The same reef system also suffered significant bleaching and mortality associated with climate-related events approximately 10 years later. The reef fully recovered from the effects of exposure and regained its pre-impact function and structure within 12 months (Brown et al. 2002). However, very large coral colonies or assemblages can take decades to centuries to develop and are not expected to recover within 30 years. Loss of these corals was considered permanent for the risk assessment in the Draft EIS/ERMP.

26.20 As we questioned in our submission in response to the draft EIS/ERMP, on what basis was a 30 year recovery period selected? Is this in any way consistent with the precautionary principle, given the expected impacts of climate change?

The 30 year recovery period for BPPH was selected to differentiate temporary 'damage' from permanent 'loss' as required in the BPPH assessment EPA (2004). The 30 year period was selected on the advice of the DoE to represent a time period relevant to a human life span over which people would perceive a change in the environment as permanent. The effects of climate change are unpredictable in terms of their possible influence on the recovery rate of marine benthic habitats and assemblages.

26.21 On what basis have estimates about macroalgae dominated BPPH recovery been made? Is there also an absence of directly relevant data for this matter?

While there is limited information on the responses of macroalgal communities to environmental perturbations and their subsequent recovery potential, the published information does suggest that full recovery of macroalgal BPPH will occur in the short to medium term. Experimental studies looking at the recolonisation of *Sargassum* in tropical habitats indicate that they recolonise bare substrates in the space of 3-4 months (Ang, 1985). In a similar study of *Sargassum* on the Great Barrier Reef, Vuki & Price (1994) found new recruits of *Sargassum* in cleared quadrats three months after the clearing of the substrate, when the substrate was cleared during the reproductive season. Some earlier experimental studies of the colonization of *Sargassum* on an artificial substratum suggested that a time lag of 9-10 months was needed for the recolonisation of *Sargassum* on a fresh substratum (Raju & Venugopal, 1971); however Chauhan (1972) found that coral pieces pre-treated with seawater were colonized by germlings in one month.

Umar et al. (1998) reports that while very high levels of sediment accumulation (up to 20 mm thick) on the Great Barrier Reef affected recruitment, growth, survival and seasonal regeneration of *Sargassum*, populations were never killed. This led the authors to conclude that a two-fold increase in long-term sediment thickness would reduce abundance but not lead to local extinction. Within 2 years of dredging at Heron Island on the Great Barrier Reef, tall algae (mainly *Sargassum*) increased in overall abundance (Catterall et al. 1992). *Sargassum* spp. release fertile branches bearing reproductive bodies that can travel great distances and aid in the colonisation of remote areas. The abundance of macroalgae in the areas surrounding the areas impacted by the dredging will provide a ready source of recruits for recolonisation. Propagule dispersal radii of *Sargassum* of up to 193 km/yr have been reported (Shanks et al. 2003), indicating significant recolonisation potential in affected areas.

26.22 Why is GJV apparently only worried about “well developed coral communities” in the high impact zone? How many other types of coral communities are in the high impact zone?

The focus on ‘well developed coral communities’ in the impact zones is necessary to distinguish impacts that are expected to have long-term effects and those expected to have short-term effects. Serious impacts to well developed communities are treated as a permanent loss, whereas loss of smaller colonies and assemblages is considered temporary. See 26.19 above. In addition to well developed communities, corals occur as scattered individual colonies or small assemblages.

26.23 How many other types of coral communities are in the moderate impact zone?

In addition to well developed communities, corals occur as scattered individual colonies or small assemblages through out the region. Ground truth data indicated that the majority of unconfirmed coral in MU3 (613 ha) that falls within the moderate impact zone of dredge related impacts is macroalgae dominated BPPH (subtidal limestone reef platform with macroalgae and scattered corals) as described in the Additional Information Package (Chevron 2005). The scattered coral colonies are widely dispersed; they occur in relatively low densities and are generally resilient *Porites* or *Turbinaria* colonies. There are also small areas of *Acropora*, *Pocillopora* and *Montipora* that would be expected to recover from disturbance in less than 30 years.

26.24 In any event, where in the draft EIS/ERMP is the unconfirmed coral habitat which is supposedly ground-truthed here? Page 473 shows no such thing.

The ‘unconfirmed’ corals were included in the area of ‘coral habitats’ category in the Draft EIS/ERMP Table 11-15 (page 473). This is a conservative approach to the uncertainty in the true distribution of corals at the time of the Draft EIS/ERMP. The unconfirmed coral communities are shown in Figure 11-13 (Chevron 2005, pg 467).

26.25 Even if we were to accept GJV’s methodology, it should be noted that anticipated BPPH losses are very close to cumulative loss thresholds for Management Unit 2, and much greater than cumulative loss thresholds for Management Units 8, 10 and 11 (see pages 473 and 475 of the draft EIS/ERMP). BPPH losses are also close to cumulative loss thresholds for Management Unit 9 (they were at 7% before ground-truthing was done – see page 470 of the draft EIS/ERMP). On the mainland, of course, the worse case scenario puts BPPH loss at MMU 1 at double the relevant cumulative loss threshold.

The cumulative loss thresholds are a guide to the amount of primary producer habitat that can be lost without affecting the ecological function of an area and have not been related to an area this size before. The management units established for this assessment are based on the size (5km x 10 km) suggested by the EPA in the BPPH guidance statement (EPA 2004). They are based on ecological units, for example a reef chain or the platform adjacent the island (see 11.4). However, their size is arbitrary and they encompass only parts of the habitats they cover. These habitats are generally widespread in the areas surrounding the management units. Even under the worst case scenario, where the area of these habitats that would be lost within these units is beyond the threshold criteria, it does not represent a serious threat to the ecological function of the area.

Cumulative loss thresholds are used by the EPA to provide an indication of the acceptability of the impacts associated with a particular proposal. However, given the lack of a scientific basis for setting boundaries of management units and the difficulty in reliable measurement of the area of some benthic primary producer habitats, these thresholds are not considered rigid limits (EPA 2004). The acceptability of benthic primary producer habitat damage/loss is, in all cases, a judgement of the EPA, based primarily on its assessment of the overall risk to the ecosystem integrity within a defined management unit if a proposal were to be implemented.

Expected recovery of BPP communities is taken into account in assessing the ecological implications of the habitat disturbance. The acceptable loss is also related to the conservation significance of the area. Most of the management units lie within the Barrow Island Port boundary which is of lower conservation significance than other areas of the marine conservation reserve. The cumulative loss thresholds (CLT) for the proposed development are met for most of the management units. The location and management of the mainland shore crossing is being revised to ensure that the final design does not compromise the integrity of the mangrove system in this area of high conservation significance.

26.26 Why is an “ongoing literature review” planned, rather than some actual field work?

The ongoing literature review will be augmented by the Baseline Marine Monitoring Programme including additional field surveys. The programme outline is currently undergoing peer review before further implementation. Baseline studies of coral habitat distribution, coral health and reproduction and water quality have been designed to gather the necessary data to quantify the pre-impact status of the coral communities and waters that may be affected by the Gorgon Development’s dredging and drilling programme. These baseline data will be required to provide a basis on which to design the ongoing monitoring programme and against which to further assess the impacts of the dredging and drilling programmes.

26.27 The “further field measurements” appear minimalist. On what basis was this number of ADCP’s considered adequate? A full spring to neap tidal cycle has been covered, but has any account been taken of seasonal variations? What about the need to ground-truth during extreme weather events?

On the contrary, the three ADCP sites and the drifters sampled significantly different regions of the flow regime around Barrow Island and are definitely sufficient for model verification. If the model, and its driving forces, are shown to adequately representing the dominant physical processes with these data then extra data not add any further understanding.

26.28 Was the full three-dimensional current field used for running GCOM3D? This page seems to suggest that such modelling is only done for potential oil spills. If so, why was such a short cut taken in this case?

GCOM3D is a 3D “z” coordinate ocean model and cannot be run in “2D mode”.

28.1 P3, Management Unit 2; Why is 30 years chosen as an acceptable recovery period for zero cumulative BPPH loss?

The 30 year recovery period for BPPH was selected to differentiate temporary ‘damage’ from permanent ‘loss’ as required in the BPPH assessment EPA (2004). The 30 year period was selected on the advice of the DoE to represent a time period relevant to a human life span over which people would perceive a change in the environment as permanent.

28.2 What evidence supports the contention that damage to macro-algae is expected to recover full functionality in 5-10 years?

While there is limited information on the responses of macroalgal communities to environmental perturbations and their subsequent recovery potential, the published information does suggest that full recovery of macroalgal BPPH will occur in the short to medium term. This assumption has been based on the fact that macroalgal benthic primary producers in the region are exposed to large scale, natural perturbations, such as cyclones and their persistence in the region is testament to their ability to recover from such impacts. Experimental studies looking at the recolonisation of *Sargassum* in tropical habitats have shown that they have the ability to recolonise bare substrate in the space of 3-4 months (Ang, 1985). In a similar study of *Sargassum* on the Great Barrier Reef, Vuki & Price (1994) found new recruits of *Sargassum* in cleared quadrats three months after the clearing of the substrate, when the substrate was cleared during the reproductive season. Some earlier experimental studies of the colonization of *Sargassum* on artificial substratum suggested that a time lag of 9-10 months was needed for the recolonisation of *Sargassum* on a fresh substratum (Raju & Venugopal, 1971), however Chauhan (1972) found that coral pieces pre-treated with seawater could be colonized by gemlings in the space of one month.

Umar et al. (1998) reports that while very high levels of sediment accumulation (up to 20 mm thick) on the Great Barrier Reef affected recruitment, growth, survival and seasonal regeneration of *Sargassum*, populations were never killed. This led the authors to conclude that a two-fold increase in long-term sediment thickness would reduce abundance but not lead to local extinction. Within 2 years of dredging at Heron Island on the Great Barrier Reef, tall algae (mainly *Sargassum*) increased in overall abundance (Catterall et al. 1992). Propagule dispersal rates of *Sargassum* of up to 193 km/yr have been reported (Shanks et al. 2003), indicating significant recolonisation potential in affected areas. The 5-10 year recovery period is conservative, as the published literature suggests macroalgal recruitment and regrowth will occur in less than 5 years.

11.4.1 West Coast and North Coast

10.14 It notes that water quality will be affected on the west side of the island, and simply states that no benthic primary producers will be affected. This is an important potential threat to the future of the green turtles feeding grounds, and must be addressed before the damage is done.

Temporary degradation of water quality is not expected to cause *permanent* loss of benthic primary producers except possibly minor macroalgal loss in rock pools where the drilling fluids from the HDD are not resuspended. The absence of permanent effects on benthic primary producers on the west coast is due to the very high energy regime resulting in rapid dispersal of turbid water plumes and sedimentation. Even under the worst case scenario (Chevron Australia 2005; p 466), there would only be a temporary reduction in the availability of macroalgae for turtles to feed on. Future turtle feeding grounds are expected to be increased by the provision of hard substrates around the pipeline emergence point.

11.4.2 East Coast

24.131 In relation to the pipeline and optic fibre cable routes, the proponent seems to defer addressing the impact and avoidance principles of Guidance Statement No29 to management strategies, which are included in a list on page 437. This is not consistent with the GS, which recommends that proponents clearly demonstrate up front how impact avoidance and minimisation principles have been addressed in proposal design. Deferring the principles to management strategies to be implemented post-approval does not provide the opportunity for the EPA or the community to fully understand the scope of potential impacts of proposals on BPPH.

The final domestic gas pipeline and fibre optic cable routes have not been selected, but the route selection process will follow the principles of impact avoidance and minimisation that have been used throughout the design process and are detailed in Chapter 6 of the Draft EIS/ERMP (Chevron Australia 2005; pp 94–149).

The fibre optic cable and the domestic gas pipeline will both pass through a large expanse of homogeneous seabed that lies within a general coastal waters area and has a CLT of 5 %. The two Development components are narrow and linear and would not exceed the 5 % threshold within an arbitrary series of 5 km by 10 km management units. Five percent of a unit of this size is a strip 10 km long and 250 m wide.

24.133 The proponent has generally applied the above aspects of GS No29 appropriately. We hold the view that the cumulative loss threshold for Category E (10%) has been misapplied in some of the management units within the Barrow Is port boundary. The GS refers to “inner port areas” as being where the Category E 10% cumulative loss threshold could be applied. It is not appropriate to apply the Category E cumulative loss threshold to large parts of port areas which are not critical for day-to-day port operations. At a minimum, the losses of BPPH in Management Units 5, 6 and 7 should be assessed against the cumulative loss threshold for Category D (5%).

The Barrow Island Port Area contains the Barrow Island Oil Pipeline and has regular vessel traffic associated with both oil export and oil field maintenance on the island. The port area is not part of the Barrow Island Marine Management Area. The port is not a ‘Non-Designated Area’ (Category D) but is critical to day-to-day operations of the Barrow Island oilfield. The whole area comes under the management of the harbour master who can restrict all shipping movements within the port limit, pursuant to Section 10 of the *Shipping Pilotage Act 1967*. Following the worked examples provided in GS No. 29, the Barrow Island Port has been classified as a Category E Development Area. The worked example in GS No. 29 details a proposed development within a bay (4 km radius), with an existing port, access channels, sewage outfall and proposed marina development. The entire semi-circular bay in the example, including the coral barrier reef, are classified as a Category E – Development Area and represents a directly comparable scenario to that proposed in the Draft EIS/ERMP (Chevron Australia 2005).

11.4.3 Mainland Coast

24.89 Refer to the following statement in section 4.2.2 (Technical Appendix C9):

“All of these habitats and taxa are very widespread along the mainland coast. They are all of low conservation significance, except the mangroves, which the EPA (2001) has identified throughout the Pilbara region as having high conservation significance and particular areas as having very high significance (regionally significant arid zone mangrove areas). The proposed shore crossing is approximately 6 km from the nearest mangal of very high conservation significance.”

Plate 8-22 in section 8 shows that there has been little mangrove recolonisation of the Apache Energy Sales Gas Pipeline mainland landfall. What methods would be implemented to achieve better rehabilitation and stability standards than those shown in Plate 8-22?

Plate 8-22 (aerial photo) of the Draft EIS/ERMP shows that there has been some recolonisation of the Apache Energy Sales Gas Pipeline mainland landfall, although the scale of the photo does not clearly represent the level of regrowth. A more detailed photo of this recolonisation can be found in Technical Appendix C9 (p 18) which shows regrowth and the stability of the substrate. The mangrove IMS within the mainland shore crossing CEMP will include rolling or slashing trees to encourage regrowth from root stock and the installation of appropriate erosion and sediment control structures where required. Mangrove rehabilitation in the disturbed area will also be undertaken following construction and the use of geotextile mats during construction to reduce impacts to vegetation and sediments will be investigated. This has been described in the Draft EIS/ERMP (Chevron Australia 2005; p 437 and Table 11-12).

11.5 Marine Fauna

10.6 The Gorgon development will pose a direct threat to marine turtle populations primarily through disturbance to their nesting habitats. Alteration of beach foreshores and light pollution are among factors that are likely to have very serious consequences for breeding. The inevitable oil pollution that will result from the ships berthing on the proposed jetty is also a serious cause for concern. The Commonwealth Recovery Plan for Marine Turtles in Australia identifies development at nesting habitats as a major threat to North West Shelf (Western Australian) marine turtle populations.

Refer to Section 7.3, p 168 of the Draft EIS/ERMP for light mitigation strategies. Oil spills are not inevitable – refer to Chapter 7, Section 7.9, and Technical Appendices B3, B4 and B5 and Chapter 11. Also refer to 10.7 Section 11.5.3.

16.14 Under CAMBA and JAMBA international agreements, Australia has obligations to ensure protection of listed migratory species and their habitats. An industrial development of the proposed size and nature of GJV's would make it very difficult if not impossible to afford the necessary protection and this is very concerning.

Bird surveys for the Gorgon Development have identified the important areas of Barrow Island for conservation of migratory birds. None of these are predicted to be affected by the proposed Development. The risk assessment recognises that a small number of listed migratory birds are likely to be adversely affected or lost as a result of the proposed Development. However, this does not represent a threat to populations of any protected species (Chevron Australia 2005; p 513).

16.15 There is insufficient information in the Report to predict whether Barrow Island species will be impacted significantly.

The proposed Development will affect only a very small part of the shoreline that is of low importance for waterbirds. It is anticipated that the birds will continue to use most of these sites. Also refer to 16.14 above.

16.16 The Criteria used to determine when an action will have an impact are: if action substantially modifies, destroys, or isolates an area of habitat importance, or if it seriously disrupts the life cycle of an ecologically significant proportion of the population. It is likely that one or more of these criteria would be met for some bird species if the GJV project goes ahead as proposed on Barrow Island.

The Gorgon Development is not predicted to substantially modify, destroy, or isolate any areas of habitat importance. Nor will it seriously disrupt the life cycle of an ecologically significant proportion of any population.

16.18 The island is also used for wintering by some birds. Permanent undisturbed locations such as Barrow Island are vital to large populations of a number of bird species. For migratory birds these are essential points on their annual cycles, and include breeding grounds, wintering sites and foraging and stopover points.

The importance of Barrow Island is recognised and important sites in the south and south-east of the island will not be impacted by the Development.

18.124 Chevron Australia should commit to implementing an ongoing turtle monitoring program on Barrow Island in order to detect any changes to nesting abundance that may be attributed to activities associated with the Gorgon gas processing facility, as well as the existing oilfield operations on Barrow Island. This will require the development of demographic models for green and flatback turtle populations using Barrow Island. The turtle monitoring program must be developed in consultation with and to the satisfaction of CALM.

The Gorgon Joint Venturers have committed to a turtle monitoring program (Chevron Australia 2005; Chapter 11) that will be designed in consultation with CALM. Demographic models are being improved through the current tagging and tracking studies underway on Barrow Island and the mainland.

20.8 Nesting behaviour modification of globally significant populations of marine turtles, particularly flatback turtles, and disturbance of associated critical habitat.

While the flatback turtle population on Barrow Island is undoubtedly an important one, its relative importance in the region and globally is not well understood. Assertions of the relative size of various rookeries are largely based on anecdotal evidence. The tagging program that is currently underway on Barrow Island and the Western Australian mainland will provide data upon which more accurate population estimates can be made. This is necessary to assess the 'global' significance of the Barrow Island population.

20.13 WWF-Australia assesses the risk categories of flatback turtles as critical (widespread long-term impact on population) and almost certain, for the populations nesting on the two beaches directly to the north and south of the Town Point site. These two populations are a significant component of the regionally and globally important flatback turtle population, and potentially represent genetically distinct lineages from other regional nesting populations.

Under the worst case scenario, where management fails to protect most of the hatchling flatback turtles and ongoing losses through collisions cannot be avoided, a major consequence is possible. This is reflected in the risk assessment where the level of risk to turtles from light is medium-high (Chevron Australia 2005, pp 502-503). It is anticipated that the consequences will be much less (medium risk) due to active management and intervention as necessary. Flatbacks in Western Australia fall into two genetic groups: northern and southern. Barrow Island falls within the southern Western Australian breeding unit. Turtles nesting on all Barrow Island east coast beaches are from the same breeding unit and do not display strict nesting beach fidelity, i.e. flatbacks may nest on any of the east coast nesting beaches during a season and are not confined to a single beach only. It is therefore unlikely turtles using different beaches to nest will be genetically distinct since they appear to move freely between, not only beaches, but regional nesting locations.

20.14 WWF-Australia assesses the risk to the collective Barrow Island flatback turtle nesting populations on Barrow Island as major (local, long-term or widespread, short-term impact leads to loss of local population/s and reduced viability of the race on Barrow) and likely.

Under the worst-case scenario, where management fails to protect most of the hatchling flatback turtles and ongoing losses through collisions cannot be avoided, a major consequence is possible. This is reflected in the risk assessment where the level of risk to turtles from light is medium-high (Chevron Australia 2005; pp 502-503). It is anticipated that the consequences will be much less (medium risk) due to active management and intervention as necessary.

20.22 In addition, the foraging areas of resident green, loggerhead and hawksbill turtles in the waters off Barrow Island, have not been fully identified and the impacts examined. Further work needs to be conducted on species and size composition, habitat use, local movements and home ranges of these populations. The impacts of the proposed dredging and jetty construction including lighting and noise impacts on the resident foraging turtles should be conducted.

Green turtles forage on macroalgae covered reefs along the west coast of Barrow Island. Loggerheads have not been documented foraging in the Barrow/Lowendals/Montebello region; however their bivalve and other molluscan food sources are likely to occur throughout the area. Hawksbill turtles feed on sponges and are likely to forage on coral and other reef habitat throughout the region. None of the marine benthic habitats in development areas are expected to be critical habitat for these turtles.

Ongoing tagging studies will provide further data on the size and composition of the green and flatback populations and additional surveys on light impacts are planned for the summer of 2005/2006. In view of the paucity of data and the difficulty in collecting meaningful data in a short time period, the Joint Venturers have conservatively assumed that noise will disturb inter-nesting turtles on the east coast. This is taken into account in the risk assessment and management measures proposed to minimise the risk (Chevron Australia 2005; Section 11.5.4).

20.28 Evidence presented in Technical Appendix C7 indicates that to avoid impacting the behaviour of inter-nesting turtles, construction would need to stop from August to March.

While preliminary tracking data indicate that inter-nesting flatback turtles move well out of the Barrow Island area, it is assumed that inter-nesting and resident turtles may be present throughout the construction period and management measures have been proposed to minimise impacts on these animals. These management measures are outlined for each of the major stressors in Chapter 11 of the Draft EIS/ERMP (Chevron Australia 2005). Further management strategies will be outlined in the EMP/EPs.

20.29 Adult female turtles have the highest conservation value of individuals of a turtle population. Evidence presented in Technical Appendix C7 indicates that adult female flatback turtles return annually or biannually, therefore construction over a two year cycle, potentially impacts the entire nesting population, with serious risk consequences for the overall population viability.

Technical Appendix C7 used a re-nesting interval of three years in estimating breeding populations on Barrow Island (Chevron Australia 2005; Technical Appendix C7, Attachment 1, p 9). While there is uncertainty in the actual re-nesting interval and variation between individuals, it is unlikely that more than two-thirds of the nesting females will be exposed to construction impacts. Further, only the females in the vicinity of Town Point, conservatively estimated at 50% of the breeding population of the island, would be affected. This means approximately one-third of the population would be exposed to potential impacts. Management measures will reduce the impacts on the affected fraction of the population and actual impacts are expected to be much lower.

20.34 WWF-Australia notes that relocation of nesting populations is an extremely controversial management strategy for marine turtles and does not support its use.

The GJV propose to avoid or mitigate the potential effects of the development on nesting turtles such that no interventionist management is required. However, if monitoring of the breeding turtles indicates that management measures are not sufficiently effective during some periods, intervention would be required. The proposed intervention is to relocate hatchlings rather than eggs. This is less controversial as the possible effects on hatching success are avoided.

22.113 Why hasn't turtle nesting been considered on a finer scale (not whether or not turtle nesting sites will be impacted but how many individuals are likely to be impacted)?

Where possible, the expected proportions of the existing populations that are likely to be affected, or could potentially be affected, have been estimated. These estimates are included throughout Chapter 11 (Chevron Australia 2005). An intensive turtle tagging program on the east coast beaches of Barrow Island will provide better estimates of turtle population sizes.

22.114 Where is the information about dugong impacts?

Dugongs are a key receptor in the marine fauna risk assessment matrix (Chevron Australia 2005, p 482). The potential impacts, management and residual risk to dugongs from seabed disturbance (pp 485 and 487), physical interactions (pp 489–495), light, noise and vibration, leaks and spills and cumulative impacts on this species and other listed marine fauna are discussed in detail in the Draft EIS/ERMP (Chevron Australia 2005, pp 494–513). Detailed EMPs covering all Development activities will include Impact Mitigation Strategies (IMS) to minimise the potential impacts on dugongs.

22.119 Why is the bullet point on protected marine invertebrates, fish or cetaceans so speculative? It is totally unacceptable that such a large project as this has not involved enough field work and data collection to accurately estimate the impacts on those taxa.

Marine species are often cryptic and highly mobile, making surveys very difficult. Field surveys investigating intertidal and marine ecology and assessing the conservation significance of areas pertaining to the Gorgon Development were undertaken in August 2002, January 2003, January 2004 and September 2005. No significant concentrations of protected marine species or significant habitats for these species have been observed during these surveys. Technical Appendices C6, C8 and C9 to the Draft EIS/ERMP (Chevron Australia 2005) detail the likely distribution of protected marine species in relation to the proposed Development area.

22.249 How might large-scale disturbance of this type indirectly impact on the taxa separately discussed in this chapter (e.g. turtle foraging habitat loss)?

Potential impacts to marine fauna, including turtles, from seabed disturbance, physical interaction, light, noise and vibration and leaks and spills are discussed in detail in section 11-5 of the Draft EIS/ERMP (Chevron Australia 2005; pp 480–513). A summary of the risk assessment for marine fauna is provided in Table 11-23 (Chevron Australia 2005; pp 514–526).

22.271 What work has been done to justify the comment that dugongs are “uncommon visitors” to the east coast of Barrow?

In hundreds of hours of marine survey work in the waters off the east coast of Barrow Island only one dugong has been sighted (near Dugong Reef). Other individuals have been observed near Varanus Island. This indicates that they are present throughout the development area (Chevron Australia 2005; pp 265 and 485). However, the absence of major seagrass meadows on which these animals feed indicates they are unlikely to aggregate in significant numbers in this locality. Detailed records of observations of dugongs will be maintained during all environmental monitoring for the Development.

24.87 Refer to the following statements in section 7 (Technical Appendix C7):

“Nesting flatback turtles favour mid-east coast beaches on Barrow Island. Of the beaches surveyed, the highest average density of flatback turtle tracks (48/night/km) was recorded in January 2004 on Bivalve Beach.”

“Barrow Island is a feeding ground for green turtles and appears to be a feeding ground and juvenile habitat for flatback turtles. The superior nesting habitat for green turtles (i.e. sand > 1 m deep) at Flacourt Bay supports a larger population of nesting green turtles than the shallow sands at North White’s Beach. Nesting at North White’s Beach is dominated by very low numbers of hawksbill turtles, probably because they are able to nest in shallow (30–40 cm) sand.”

Given that Bivalve Beach is located immediately south of Town Point and Flacourt Bay is the alternate feed gas pipeline landfall, on what basis (using relevant ecological criteria) would a level of impact from the project be considered acceptable?

The risk assessment for marine fauna (including turtles) is summarised in Table 11-23 of the Draft EIS/ERMP (Chevron Australia 2005). Stressors such as seabed disturbance, physical interaction, physical presence, wastewater discharge, light, noise and vibration and leaks or spills are described in detail, including potential environmental impacts and consequences. Management measures that will be implemented by the Joint Venturers and management targets and measurement strategies are also described. The Joint Venturers are committed to no long-term impacts to significant marine communities and maintaining the long term viability of listed fauna species. Turtle nesting on Flacourt Bay was one of the major drivers for selecting a horizontal drilling method for installing the pipeline. This would avoid impacting the nesting turtles. Light spill is the major potential stressor to turtles nesting on Bivalve Beach. Light impacts will be managed to an acceptable level as described in Section 11.5.3 (Chevron Australia 2005).

11.5.1 Seabed Disturbance

5.5a Dredging – The dredging will be difficult to manage. The last dredging programme along the Western Australian Coast: Geraldton was a disaster. Allowing Gorgon to settle on Barrow Island will only constitute unnecessary potential risk to the marine environment, including coral reefs of high conservation value such as Dugong Reef, off the South-east tip of Barrow Island and the Montebello marine park. The last plume was visible from satellites and spanned from Geraldton to Kalbarri. There are dredged areas available on the mainland where ships already visit.

The extent of visible dredge plume is not considered to be an accurate prediction of significant environmental impacts. A post dredging appraisal found that the dredge impacts resulting from the recent Geraldton Port dredging program were commensurate with predictions and did not result in significant long-term environmental impact. As noted in Section 7.8 (p 188), recent studies in the Dampier region found that chronic sedimentation with TSS levels below 40 mg/L did not appear to result in elevated coral mortality. TSS levels that result in visible plumes are estimated at 2 mg/L above background levels. Therefore, a visual plume does not necessarily relate to significant impact on corals. Figure 11-9 (p 441) indicates the extent of the visible plume as modelled at 2 mg/L above background. Section 11.3 (p 437) concludes that this level of TSS will not result in measurable impacts on benthic primary producers. Therefore, the risk of significant impact on areas such as Dugong Reef and Montebello Islands is expected to be low.

A Dredging Management Plan will be developed in consultation with relevant regulatory agencies (refer to 22.262 Section 11.3.1).

7.1 The impact of the proposed development [on sea snakes] is not mentioned on these EPBC1999 listed species. Two notable omissions from the table on page 9 are the WA endemic *Aipysurus tenuis* and the inshore and reef dwelling *Hydrelaps darwiniensis*, both of which have been recorded from Barrow Island and adjacent mainland region. With (trawler-induced) mortality occurring in the region, a major development such as the proposed Gorgon Gas Development could adversely affect the remaining sea snake populations.

The risk of adverse impacts to sea snakes and kraits are described in Chapter 11 of the Draft EIS/ERMP (Chevron Australia 2005; pp 488 and 513). The two species identified by the submitter are omissions from the list of EPBC Act marine species. The list in the Technical Appendix C6 should be viewed as indicative of the level of sea snake diversity in the area. The Museum FaunaBase list of reptiles from the waters surrounding Barrow Island <<http://www.museum.wa.gov.au/faunabase/search>> similarly did not identify these species as being present in the area. The likely impacts of the Gorgon Development are negligible in comparison with the level of impact due to the trawl fisheries of the region. Accidental loss of a small number of sea snakes will not affect the viability of local populations.

8.17 Page 489 states that there is a lack of information on flatback foraging and inter-nesting grounds which leads to the assumption that resident/breeding flatbacks may be present on the seabed in areas. Page 490 goes on to state that turtle deflection devices will only be used if surveys confirm the presence of flatbacks. This does not seem to be a precautionary approach. Deflection devices should be used wherever there is any likelihood of the dredge impacting turtles.

Chevron Australia is undertaking a turtle tagging, satellite tracking and monitoring program during the 2005/2006 nesting season. This will provide the appropriate data for the assessment of inter-nesting turtle and determine the likelihood of impacting these turtles. Initial results from the satellite tracking program indicate that the internesting flatback turtles move to the adjacent mainland shore between nesting events. At the end of the nesting season, data will be gathered on the location of tracked turtles between nesting seasons. Turtle deflection devices will be used if there is a significant likelihood of impacting turtles.

10.10 Dredging through prime turtle habitat is a significant risk to turtles feeding or basking in the area even if the dredgers are adapted to avoid killing turtles.

While it is assumed that nearshore waters are important for resident and inter-nesting turtles, the Joint Venturers are currently conducting a satellite tracking program to establish the inter-nesting habitats. Preliminary results suggest this might be over 50 km away along the mainland coast. Green turtles tracked several years ago inter-nest in shallow nearshore water off the west and some east coast beaches. The ongoing turtle monitoring program will include investigations to identify foraging grounds for resident flatback turtles and the location of mating aggregations. Management measures for the dredging operations will be determined in consultation with the appropriate authorities and the resultant procedures included in the Dredging IMS. The effectiveness of management measures for the dredge operations will be monitored and contingency responses will be instigated as necessary to reduce unacceptable impacts.

10.11 This dredging will also have an impact on the seagrass beds in the vicinity, which are sensitive to increased levels of sedimentation. A reduction in such critical foraging habitat for the turtles could well be significant.

10.13 It is interesting that Chapter 11 mainly discusses the potential impact of the dredging and subsequent turbidity problems on coral with little regard for the potential damage to the important sea grass pastures required by the green turtles.

Seagrass meadows are not very well developed around Barrow Island. They appear absent from the west coast probably due to high wave energy and poorly developed on the east coast probably due to substrate instability. The ephemeral seagrasses on the east coast are adapted to dynamic sediment movements, especially during storms, by being able to rapidly recolonise disturbed areas. Flatback turtles are the most abundant turtles on the east coast and, being carnivorous, are not predicted to be dependent on ephemeral seagrass meadows.

16.20 Without further information, such potential impacts cannot be assessed.

16.21 Unacceptably, no predictions or risk assessments appear to have been presented in the report of the nature and extent of the inevitable impacts of the proposed development on the above avifauna conservation values.

16.22 Marine Facility in particular would seriously impact on roost locations used by Waterbirds, especially from January through to March. Figure 3-15 covers only a seven month period, the roosting patterns for the remaining months appear to be unknown.

The potential impacts associated with habitat loss at Town Point are covered in the risk assessment presented in the Draft EIS/ERMP (Chevron Australia 2005; p 488). The risk of adverse impacts on avifauna is shown to be low.

18.2 In fact, information provided in the ERMP gives rise to increased concerns regarding the level of impact and manageability of risks.

The potential impacts due to dredging were foreshadowed in the ESE Review (ChevronTexaco Australia 2003; p 92). However, the extent of impact could not be determined until the results of geotechnical and hydrodynamic investigations were subsequently completed. Both the footprint of the proposed marine facilities and the dredge volume has been significantly reduced from the concept proposed in the ESE Review.

- 18.104** More information is required on the spatial and temporal extent of blasting associated with the excavation of the access channels, particularly as it is noted in the ERMP that this will cause injury or mortality to fish and can potentially injure or kill turtles.

Indications from geotechnical investigation, laboratory testing and discussions with dredge contractors suggest that drilling and blasting will not be required during construction of the dredge channels. However, there may be some isolated locations of extremely hard material in between the drilled boreholes. Although there is no indication that these exist, it is possible that some minor drilling and blasting will be required at isolated locations. As the number and size of these locations would be small the impacts have been assessed as minor.

Further information should be provided on the requirements for ongoing maintenance dredging, spoil dumping locations and potential impacts of maintenance dredging on the marine environment.

A siltation study (Metocean Engineers 2005) modelled three significant cyclones that have impacted Barrow Island: Bobby, Olivia and Monty. The maximum siltation in the LNG channel was predicted to be 50 mm as a result of any one of these significant events. The report also indicated that there would be no siltation as a result of ambient conditions. This supports the observations that there is very little sand or silt in the immediate vicinity of the dredge works. Therefore maintenance dredging is not anticipated, but a conservative estimate of possible frequency has been assumed and the potential impacts assessed. Also refer to 8.11 Section 11.3.1.

- 18.113** Consideration should be given to the impacts of seagrass recolonising on the access channels on marine fauna such as turtles and dugongs that feed on seagrass.

It is possible that green turtles and dugong will occasionally forage on seagrass colonising the sandy bottom of dredge channels. This is likely to be an uncommon event given the rarity of both these taxa on the east coast of Barrow Island. Environmental Management Plans for operation of the marine facilities will require vessel operators to be vigilant for turtles and dugong in these areas.

- 18.120** Physical disturbance to turtle nesting beaches during construction must be minimised, with activities avoided during the turtle nesting season. A program of monitoring of turtle activity at affected beaches before, during and after construction work should be implemented, as should a mitigation program to mitigate any detrimental impacts detected in respect of turtle nesting as a result of beach disturbance.

Measures to reduce physical disturbance of turtle nesting beaches will be detailed in the Impact Mitigation Strategy (IMS) for fauna interaction and will be included in the Construction and Operations EMPs for the Development. Pre-access surveys will be conducted at all times of year in recognition of the low level of nesting through the winter. Disturbance to beaches that affect turtle nesting or nest success will be avoided during the peak of the turtle nesting season. The EMPs will include provisions for restorative work to ensure beaches remain suitable for turtle nesting and that nest surveys are performed prior to any beach access. Additional baseline data on beach utilisation by flatback turtles is being gathered during the 2005–2006 season.

- 18.122** Further information should be provided to clarify whether warning chains as stated on page 517 of the ERMP are a type of turtle deflection device, and if not, include the use of turtle deflection devices on dredging equipment as a strategy for reducing impacts of dredging on turtles.

Chains fitted to the hopper dredge head have been used successfully in Florida to reduce impacts to turtles during dredging (Dickerson et al. 1990).

- 18.123** CCTV cameras should be used on dredges in addition to turtle deflection devices in order to provide data to assess the efficiency of the device in deflecting turtles and other marine macro-fauna.

Methods for assessing the efficacy of the turtle harm reduction procedures will be outlined in the Fauna Interaction IMS. This will be developed after reviewing the practical experience from other dredging operations. Turbidity will preclude the use of CCTV cameras.

20.18 Sedimentation and physical disturbance of interesting habitat from the construction of the causeway, the construction of the jetty and the dredging of nine million cubic metres of sediments for the boat channel and its frequent use by large vessels represents a significant impact on the interesting habitat, and is an almost certain major impact on interesting turtles.

Seabed disturbance during construction of the causeway, jetty and dredge channels will affect a small proportion of the amount of potential foraging and inter-nesting habitat along the east coast of Barrow Island. Turtles cover large distances during their foraging forays and inter-nesting movements and the benthic marine habitats at Town Point are not considered critical habitats. The risks to turtles have been recognised as medium–high and therefore necessitate prudent management measures (Chevron Australia 2005; pp 490–491). See also response to 20.17 (Section 11.5.2) for recent information on the location of interesting female flatback turtles.

20.27 Based on material in the Technical Appendix C7, the coastal and nearshore habitats to the east of Barrow Island are likely to be important to the juvenile flatback turtle habitat and adult flatback turtle foraging grounds. This important biodiversity value has not been incorporated into risk assessments.

Seabed disturbance during construction of the causeway, jetty and dredge channels will affect a small proportion of the amount of potential foraging and inter-nesting habitat along the east coast of Barrow Island. The potential impacts from disturbing this area of the seabed are addressed in the risk assessment in the Draft EIS/ERMP (Chevron Australia 2005; Chapter 11).

21.12 The document notes that two thirds of the migratory nesting population of this regionally significant flatback rookery could be present during dredging operations. It further notes that the overall risk to flatback turtles is low to high, dependant on the (unknown) extent to which turtles utilise dredging areas, and the success or otherwise of modifications to the trailer suction dredge.

The results of a proposed survey in winter of 2005 have not been published in the “additional information” package.

Whilst there is uncertainty as to the extent of use of the area, or the effectiveness of dredge modifications, a precautionary approach must be taken. It is not acceptable to hope that the risk will not be high.

The possible presence of two-thirds of the nesting turtle population is due to the dredging project continuing through two turtle nesting seasons, assuming approximately one-third of the population nest each year (re-nesting interval of three years). The presence of inter-nesting and resident turtles in the dredge areas is being investigated in the ongoing monitoring program using satellite tracking. The surveys will continue through 2006 and the information used to refine management strategies. Modifications to dredges have been found to be effective in reducing turtle mortalities (Chevron Australia 2005; p 491).

22.272 Further consideration of the project should be deferred until the work planned for the possible flatback inter-nesting and resident use has been completed.

Tracking studies of flatback turtles to determine their foraging and inter-nesting habitats is underway. The presence of resident and possible hibernating flatback turtles will be investigated in the winter of 2006. The results of these surveys will influence the management plans, but not the assessment of impacts as a very conservative approach has been followed in assessing risks.

22.280 Why haven't turtle deflection devices been mentioned here?

Warning chains are a form of turtle deflection device. If monitoring during dredging shows that turtles are being injured by the dredge, the chains will be modified to form an exclusion net. This has been used effectively in the United States (Dickerson et al. 1990).

24.81 Referring to the following statements in section 4.1 (Technical Appendix C3):

“Barrow Island is an internationally significant littoral avifauna site because it meets the Ramsar criterion of supporting >1 % of a species population for the ruddy turnstone, red-necked stint, grey-tailed tattler, sanderling, greater sand-plover, lesser sand-plover, fairy tern and for the ophthalmicus race of the sooty oystercatcher.”

To what extent (quantitatively and qualitatively) will the predicted impacts of sediment and turbidity resulting from dredging and directional drilling affect the use by birds of littoral and other marine areas around Barrow Island, including North west, North, Upper east and Mid east littoral regions?

Waterbird studies undertaken for the Gorgon Development clearly demonstrate that Barrow Island is important for shorebirds, including migratory species, but they also demonstrate that the important parts of the island are in the south-east and south; areas not to be directly affected by the proposal.

The proposed Development will affect only a very small part of the shoreline that is of lower importance for waterbirds. Predicting impacts of the proposal upon waterbirds in this area is very difficult, but experience from elsewhere in the world indicates that waterbirds are very tolerant of industrial developments and continue to forage nearby.

25.44 Mortalities could affect both populations. DEH believes that a precautionary approach could be adopted whereby deflection devices will be used by dredges wherever there is a likelihood of the dredge impacting turtles.

Chevron Australia is undertaking a turtle tagging, satellite tracking and monitoring program during the 2005/2006 nesting season. This will provide the appropriate data for the assessment of inter-nesting turtles and determine the likelihood of impacting these turtles. Initial results from the satellite tracking program indicate that the internesting flatback turtles move to the adjacent mainland shore between nesting events. At the end of the nesting season, data will be gathered on the location of tracked turtles between nesting seasons. Turtle deflection devices will be considered if there is a likelihood of impacting turtles.

22.188 Why is dredging contemplated during turtle nesting season? Why is it not guaranteed that dredging will also stop during and around the time of coral spawning?

The total dredge program will extend over a period of 18 months. The turtle season extends over a period of about 6 months therefore the Joint Venturers are not in a position to cease dredging for this period. The management measures detailed in Table 11-23 (Chevron Australia 2005; pp 514–526), such as the use of warning chains on the dredge, marine monitors and surveys to determine turtle use of channel areas will be implemented to limit impacts on turtles. For coral response refer to 2.266 Section 11.3.1.

25.19 An explanation of the effect of the predicted impacts of sediment and turbidity resulting from dredging on the use by birds of littoral and other marine areas around Barrow Island needs to be provided.

Waterbird studies undertaken for the Gorgon project clearly demonstrate that Barrow Island is important for shorebirds, including listed migratory species. Surveys of the whole coast of the island showed that the critical habitats for marine avifauna are in the south-east and south (Draft EIS/ERMP Technical Appendix C3). These areas will not be affected by the project. The proposed development will affect a small proportion of the shoreline in a part of the island that is of marginal importance to avifauna. Sedimentation in intertidal foraging areas in the vicinity of the dredged channels is expected to have limited impact on Barrow Island's marine avifauna. Turbidity plumes may cause temporary displacement of foraging seabirds if baitfish avoids the plume of turbid water.

11.5.2 Physical Interaction

- 10.8** The ERMP/EIS blithe assumption in section 11.5.2 page 492, that the development will only have a minor impact on the nesting turtle populations demonstrates a woeful ignorance of turtle behaviour and the sensitivity of turtles to the slightest increase in disturbance during the nesting season.

The minor impact refers to the possible reduction in egg development or retention rates due to disturbance. Other potential impacts associated with the proposed Development are assessed as engendering a medium to high risk to turtle's populations in recognition of their sensitivity to interference with their breeding cycle. However, the persistence of turtle nesting at human impacted nesting sites around the world suggest that turtles have a certain amount of resilience to disturbance during the nesting season.

- 25.22** The potential impact of the physical presence of the causeway/MOF structure affecting use of Terminal Beach and Bivalve Beach by nesting turtles (and also possibly the adjacent seabed off Sandy Point for inter-nesting or hibernating turtles) is still uncertain.

Nesting turtles are expected to experience minor behavioural disturbance due to the presence of the causeway and MOF at Town Point. Coastal currents in the nearshore waters adjacent this side of Barrow Island are weak and the minor influence of the causeway would not affect the turtles' ability to reach the shore. Sea turtles are reasonably intelligent and can use visual cues for finding beaches at short range.

- 16.19** This is of great concern given the 'The proposed development area near Town Point includes littoral and terrestrial habitats used by shorebirds, seabirds and land birds.' and that 'Direct loss of some of these habitats and disturbance to surrounding areas is likely to affect local avifauna. The report fails to say in what way and to what extent these birds are likely to be 'affected'.

Only a small proportion of the populations of waterbirds use these habitats at Town Point. These birds are expected to either continue to use the area or to move to adjacent beaches with analogous habitat. No population level effects are expected.

- 16.24** The development site contains a nesting site for the *ophthalmicus* race of Sooty Oystercatchers, and the report notes the loss of this nesting site were this development to take place. This is totally unacceptable. Locations and abundance of other breeding sites was not clear. Disruption of their breeding would be in breach of the *EPBC Act 1999*.

The nests of the sooty oyster catcher are very cryptic and only three have been positively identified on Barrow Island during the monthly surveys. However, the nests that were found were widespread around the north and east of the island and the species occurs as breeding pairs around most of the coast. It is likely that this species nests on most of the rocky headlands on Barrow Island. The breeding pair at Town Point is expected to relocate to another site and may nest on the causeway in future.

- 16.27** Grey-tailed Tattlers and Greater Sand Plovers using Town Point would also be impacted. This is also unacceptable.

Only a small proportion of these bird populations on Barrow Island would be affected by the proposal. These birds are most abundant in the south and south-east of the island. The displacement of these individuals to other beaches is considered ecologically sustainable.

- 16.90** Recreational fishing would need to be banned altogether. The assignation of Turtle beach for recreational fishing is unacceptable. This is a crucial turtle breeding site.

The Draft EIS/ERMP, Chapter 11, p 490 refers to the management of recreational fishing activities during construction of the LNG processing plant. Recreational fishing by Chevron Australia and WA Oil staff from the shores of Barrow Island is currently strictly regulated and managed internally. This approach to fishing will be continued throughout the operational phase of the Gorgon development. A management program/policy will be implemented in conjunction with the appropriate authorities.

20.17 Altered coastal and nearshore currents in the interesting area as a consequence of the construction of the MOF and jetty, causing a potential disorientation of foraging and interesting flatback turtles and disruption of behaviour. The altered currents may cause alteration of beach characteristics that could alter nesting and/or hatching success. The modelling in Technical Appendices B3–6 does not adequately address this stressor.

The solid causeway and open pile jetty are predicted to have a minimal effect on beach profile or local water currents. Examination of historical beach profiles and modelling by MetOcean Engineers (2005) indicated limited changes in sedimentation and beach profiles even under cyclonic conditions. If, as expected, the beaches remain stable then turtle nesting success rates will be unaffected. Beach profiles will be monitored as part of the CEMP. If unforeseen changes in the beach profile due to development related factors are detected that may affect the success of turtle nesting, contingency management measures will be implemented. The open pile jetty will not impede water currents significantly and the solid causeway will cause micro-scale current changes only. These changes are not predicted to affect the local turtle population. The use of the nearshore areas by foraging and inter-nesting turtles is uncertain. However, preliminary satellite tracking of interesting flatback turtles indicates they leave the local Barrow Island region and interest in shallow waters along the mainland coast.

22.235 Is it contemplated that any or all of the GJV contractors will be able to fish off the coast of Barrow? What impacts might that have?

22.242 The proposed physical access management measures here do not go far enough. The implication is that recreational access by contractors will be possible, even when 3,300 people (plus say 150 for WA Oil) are on a Class A Nature Reserve at once!

The Draft EIS/ERMP Chapter 11, p 490, refers to the management of recreational fishing activities during construction of the gas processing facility. Recreational fishing by Chevron Australia and WA Oil staff from the shores of Barrow Island is currently strictly regulated and managed internally. This approach to fishing will be continued throughout the operational phase of the Gorgon Development. A management program/policy will be implemented in conjunction with the appropriate authorities.

22.241 The proposed physical access management measures here do not go far enough. The implication is that recreational access by contractors will be possible, even when 3,300 people (plus say 150 for WA Oil) are on a Class A Nature Reserve at once!

Refer to 22.235 above.

25.43 The EIS(p273 & 406) indicates that surveys in winter 2005 will determine whether the sandy seabed off Town Point is important to inter-nesting foraging or hibernating Flatback turtles. However the results of these surveys do not appear to have been reported.

No hibernating turtles were found off the east coast of Barrow Island during marine benthic habitat ground-truthing surveys in the spring of 2005. The hibernation surveys will be continued in winter 2006. Satellite-tracking studies to follow the movements of inter-nesting turtles are under way at present. Preliminary data indicate that foraging flatback turtles range far from Barrow Island.

11.5.3 Light

10.7 Limpus (Unpublished) states that if turtles shift from preferred nesting areas with their presumably good conditions for egg incubation, hatchling emergence success, hatchling imprinting and hatchling dispersal, then movement of nesting adults to breed on alternate beaches leaves them vulnerable to laying eggs in areas where the population may function sub-optimally.

Possible reduction in nesting success due to displacement of nesting females is included in the Draft EIS/ERMP in the description of the effects of light on turtles (Chevron Australia 2005; pp 495–497). The consequences to turtle populations associated with this displacement are included in the risk assessment (Chevron Australia 2005; p 497).

10.9 Salmon et al. (2000 in Limpus Unpublished) advises that “lighting should be entirely excluded not only from the beach, but also from areas behind the beach in the form of a buffer (no development zone”. The ERMP/EIS, while acknowledging the threats, cannot provide any guarantee that these likely impacts of the Gorgon development will be mitigated. The proposed location of the gas processing facility is at Towns Point, which is within a significant flatback turtle rookery. The construction and the operation of the facility will require abundant light emissions. In addition to this the proposed location of administration buildings and support facilities is in currently undisturbed areas on the coast, which is likely to increase light emissions. Limpus (Unpublished) advises that the current infrastructure on Barrow Island is already likely to be impacting on flatback turtle rookeries and this impact is largely unquantified. Another consequence of changed night-time illumination over sizable areas of sea as occurs with oil and gas production platforms, is that it is now possible for gulls and terns to forage extensively at night where previously they didn’t, increasing their predation of hatchlings (Limpus Unpublished quoting Dr Prince, pers. comm.; K. Pendoley, pers. comm.).

The construction lighting is temporary and is for specific purposes and will be different to the operational lighting that is specifically designed to reduce potential impact to turtles in line with the lighting strategy. During construction the marine vessels lighting will be limited to minimum safety levels (Table 11-23, p 521). During operation there will be no requirement to illuminate the beach area. Illumination of the marine facilities will be kept to a minimum required for operator inspections and safety using coloured and/or shielded lights (Table 11-23, p 522). As the design progresses a number of other mitigation measures will be considered as discussed in Section 7.3 of Chapter 7, and Section 3.12 of Technical Appendix A1 of the Draft EIS/ERMP.

The Draft EIS/ERMP (p 812) states that no permanently on lighting for the gas processing facility will be located within 500 m of a turtle nesting beach. The administration area and the causeway are actually closer to the coast than the 500 m. However, the Gorgon Joint Venturers have committed to manage lighting through design, construction and operation and seek advice from CALM on such lighting. The administration area will be designed with these protection measures in mind, such as it is currently proposed that all external windows are fitted with electrically operated steel roller shutters that will provide cyclone protection and a barrier to light emission. All EMPs will be written to mitigate light as a stressor. Also refer Technical Appendix A1, Section 3.12 of the Draft EIS/ERMP.

15.4 The project will generate significant light emissions during both construction and operation phases, and the ERMP does not demonstrate that the proponent is committed to fully mitigating all impacts of light emissions on turtles on both the east and west coasts of Barrow Island.

Some level of impact from artificial lighting is unavoidable given the scale of the proposed Development. The Joint Venturers are committed to minimising the effects of light on turtles on both coasts of Barrow Island through facility design and active management as described in the Draft EIS/ERMP (Chevron Australia 2005; Table 11-23 and pp 501–502).

16.28 Lights and gas flares pose major risks and problems to birds and turtles and their hatchlings. Lights are thought likely to affect Wedge-tailed Shearwater breeding. These are vital matters which have not been resolved despite recent modifications to GJV plans.

The final lighting plan of the proposed gas processing facility and associated infrastructure will limit light spill from the Development. The impacts to shearwaters and other fauna will be minimised through plant design and management as described in the Draft EIS/ERMP (Chevron Australia 2005; Table 11-23). The Lighting Impact Mitigation Strategy (IMS) during operations will include monitoring to assess the efficacy of the management measures and agreed contingency responses.

18.11 Chevron Australia fails to demonstrate in the ERMP that it plans to adopt development designs that will result in the best outcomes for biodiversity conservation. For example, the proposed location of the gas processing facility at Town Point is within a significant rookery for the internationally threatened flatback turtles, and is likely to disturb nesting patterns of this species during both construction and operation. The project will require significant light emissions during both construction and operation phases, and the ERMP does not demonstrate that the proponent is committed to fully mitigating all impacts of light emissions to turtles on both the east and west coasts of Barrow Island.

Refer to Chapter 3 for site assessment, Chapter 7 for light mitigation strategies and Chapter 11 for assessment.

18.135 The risk assessment undertaken for impacts of light emissions on turtles should be revised to adopt a precautionary approach given that the long term impacts of light emissions as a result of the Gorgon development are unknown. Risk levels should be increased to accurately reflect the likelihood of impact.

Under the worst-case scenario, where management fails to protect most of the hatchling flatback turtles and ongoing losses through collisions cannot be avoided, a major consequence is possible. This is reflected in the risk assessment where the level of risk to turtles from light is medium–high (Chevron Australia 2005; pp 502–503). It is anticipated that the consequences will be much less (medium risk) due to active management and intervention as necessary.

18.136 Comparisons of light impacts between turtle species is not appropriate, and should only be made if data are available to demonstrate that different turtle species respond to light in a similar way.

Flatback hatchlings are used in the light experiments on the east coast of Barrow Island in recognition that other species may vary in their sensitivity to light. Where data are not available in the literature, especially for flatback turtles, extrapolation from other species was necessary. This is treated with caution due to the possible inter-specific differences in response.

18.137 The potential impact of marine lighting sources on emergent hatchlings should be included in the risk analysis, particularly regarding entrapment and exposure to predation once they enter the water.

The gas processing facility and other infrastructure will be designed to use the best available technology and will be operated in an effective and efficient manner. The Joint Venturers' commitments to reducing the effects of light spill on turtles are outlined on pp 496–497 of the Draft EIS/ERMP (Chevron Australia 2005).

18.138 Any significant impacts of light emissions on turtle nesting behaviour on Barrow Island as a result of the Gorgon gas development should be viewed as unacceptable. It is CALM's preferred view that Chevron Australia develop a "zero lightfall policy" for Barrow Island at turtle nesting beaches during the turtle nesting season.

18.139 The proponent should ensure that all available measures of reducing light emissions on turtle nesting beaches are employed in order to mitigate impacts

The landfall location at North White's Beach has been specifically targeted to be away from identified active turtle nesting beaches (refer to 22.267 Section 6.3.4.).

The Joint Venturers will continue to implement the mitigation strategies highlighted in Chapter 7 (Section 7.3) and Section 3.12 of the Framework EMP, and will further consult with CALM to refine these strategies and implement appropriate measures that will allow the landfall works to proceed on a 24-hour safe working basis while avoiding or limiting the illumination of the turtle nesting beaches. These specific measures will be outlined in the relevant EMPs. Refer to 22.267 Section 6.3.4 and 24.87 Section 11.5 for additional details on the east coast HDD site.

18.140 A detailed light management strategy should be prepared in consultation with, and to the satisfaction of CALM. The strategy should address lighting design, non-reflective surface colours and textures, and should include regular light audits. The strategy should provide for improvements in lighting strategies as the technology becomes available.

18.142 A monitoring program for light emission impacts on turtles should be developed and implemented in consultation with and to the satisfaction of CALM. Monitoring should be undertaken for the entire life of the operations on Barrow Island, and not be limited to just the initial operations phase. Monitoring of hatchling behaviour should include appropriate contingency measures if a detrimental impact is detected.

Light mitigation strategies and monitoring strategies will be further developed in consultation with CALM to include all the elements outlined in Section 11.5.3 (Chevron Australia 2005) and Section 3.12 of the Framework EMP (Technical Appendix A). Routine light audits will be conducted as part of the ongoing monitoring of the Development. The results of the monitoring and audits will feed back into the continuous improvement of the IMS and associated management plans.

18.141 If it is deemed acceptable that light emissions to turtle hatchlings are unavoidable, the EPA should consider the option of establishing a bond for unacceptable hatchling mortality.

22.264 At what level of seriousness is a financial penalty/loss of bond contemplated for coral and other BPPH damage caused by GJV?

The Joint Venturers do not support the concept of a performance bond for such issues, which would be in addition to the concept of direct offsets as discussed in 18.31 Section 2.2.

18.143 A program of detailed scientific investigation into the impact of the development on the Barrow Island flatback turtle population should be developed and implemented, in consultation with and to the satisfaction of CALM. Such a program should address impacts on adults and hatchlings, and particularly address demographic modelling of the population in the long term.

The Operational Environmental Management Plan and Construction Environmental Management Plan will include monitoring of the light emissions from the development and the effects on nesting turtles during the breeding season. The monitoring plan will be designed in consultation with state and Commonwealth regulatory agencies and will occur annually until such time as the results of the monitoring indicate this is not necessary. The Impact Mitigation Strategy will include mitigation strategies and contingency measures that will be assessed regularly. Demographic studies are currently underway and will continue.

20.16 Light during construction and operation. This is likely to cause flatback turtle hatchling disorientation in the two nesting beaches in the vicinity of the proposed Development. This poses a risk through disorientation of hatchlings, potential disorientation with respect to their return to their natal nesting beach as adults, and potentially increased predation of hatchlings attracted to jetty and ship lights. The studies in Technical Appendices C6 – C9, on the reaction of turtle hatchlings to different light sources, and the survey of existing lighting, underscores the likelihood of this risk, and does not adequately address the risk from the proposed development when fully operational.

Technical Appendix C6 (Chevron Australia 2005) comprises technical information and the results of field surveys and experiments conducted for the Gorgon Development. The assessment of the risks associated with lighting the operational development is included in Chapter 11 (Chevron Australia 2005; Section 11.5.3).

20.31 Evidence in the Technical Appendices C6–9 show that flatback turtle hatchlings are sensitive to light and that this will have a seriously disorientating effect.

The Technical Appendices C6–9 (Chevron Australia 2005) shows disorientation due to specific light types above threshold intensity. Not all light will cause disorientation and light reduction measures such as shielding have been used successfully internationally. The Gorgon Joint Venturers recognise this as an important issue to be managed and are committed to reducing the light emissions to as low as practicable using best available technology (Chevron Australia 2005; Section 11.5.3).

21.3 The EIS confirms that there will be adverse impacts on the marine turtles from dredging and light sources arising from this development.

Independent research has shown that turtles nest all along the coastline of northern Australia, including Barrow Island, between November and March each year. The gas processing facility will be carefully constructed to limit impact in the immediate vicinity. The operations are restricted to a very localised area of Barrow Island and turtles migrate, feed and breed along the entire northern coast of Australia and beyond into the Indo–Pacific region. Research into the behaviour of sea-turtles and their relationship with Barrow Island and the surrounding marine environment is continuing so that the best available knowledge for the design of management plans for turtle protection is available.

A lighting strategy will be adopted to avoid light impacts to turtles including siting the gas processing facility back from the coast, minimising light sources, shielding lights, using low-impact lights and scheduling construction activity on the beach outside of the peak nesting period.

21.13 The statement that light will only disrupt turtle hatchlings if the intensity is five or greater times the open horizon levels is of interest, but unfortunately the basis for this statement is not referenced. This is particularly interesting in view of Technical Appendix C7 wherein it is stated that the threshold level for glow could not be determined because of a lack of sufficient sensitivity in instruments is used.

This statement in the Draft EIS/ERMP (Chevron Australia 2005; p 495) refers to research by Witherington (1992) cited in Lohmann et al. (1996). The reference is included on p 495, at the start of the paragraph. Witherington conducted experiments investigating the dynamics of hatchling response to open horizons and artificial lights. The effects of glow on hatchlings are recognised by Gorgon Joint Venturers and further studies are planned for February 2006 to investigate the effects of sodium vapour, fluorescent and metal halide light glow on hatchlings. These data will feed into final plant lighting design.

21.14 Because there is no single, measurable level of artificial brightness on nesting beaches that is acceptable for sea turtle conservation, the most effective conservation strategy is simply to use ‘best available technology’ to reduce the effects from lighting.

21.15 This may be relevant for turtle managing beaches next to established developments such as towns in view of subsequent knowledge about light impacts, but it is certainly not an excuse to establish a new development that will affect regionally significant nesting populations of a threatened species. The most effective conservation strategy is to not create the problem in the first place!!

The Gorgon Joint Venturers are committed to minimising light impacts on turtles through use of appropriate technology and careful management of the type and quantity of light spill onto beaches as described in the Draft EIS/ERMP (Chevron Australia 2005; pp 499–502). The engineering objective used in the plant design is minimal light emissions. Lights will be of the longest wavelength practicable, directed, shielded, lowered, and restricted to the ocean side of vessels and equipment. The use of non-reflective paints will be investigated and dark colours to be used where possible. Red lights, reflective tape, motion sensors and timers to be used where possible.

21.16 The proponents claim an estimated 5 nights during nesting season. This appears an underestimate based on the experience of operations at Woodside, where shutdowns are in progress around 30% of the time, and in addition flaring necessarily occurs during any “upset” to relieve pressure. The extent of the shutdowns may be greater at Woodside because of the size of the operation, but the proponents have foreshadowed that this development is the “first”; therefore more flaring can be anticipated in the future. There is little doubt that light from flaring will affect hatchling survival numbers.

Woodside’s facility may have portions of their complex gas processing facility ‘where shutdowns are in progress around 30% of the time’. However, the duration of a shut-down does not relate to the extent of gas flaring, as flaring typically only occurs as equipment is ‘depressured’ and at the end as the system is brought back on line. The Gorgon Joint Venturers have committed (Box 7.2 of the Draft EIS/ERMP) to plan the major maintenance shutdown activities to avoid the peak turtle hatchling periods as much as reasonably possible. The Gorgon Joint Venturers have also decided to use a ground flare which has a significantly lower impact than an elevated flare. The potential impacts associated with flaring have been assessed in Chapter 11 of the Draft EIS/ERMP.

21.17 The level of risk for operations is assessed as “medium”, provided management of light is successful, but “high” (and by the definitions within the EIS/ERMP, unacceptable) if this is not the case. The report notes the (unknown) success of lighting management is critical.

The success of lighting management is important to ensure the impacts are acceptable without intervention. If monitoring shows the light impacts from the applied technologies and a well-designed gas processing facility, are causing a significant impact on the turtle populations intervention may be justified. This may take the form of manual intervention throughout the hatchling season for the duration of the Development.

22.181 The emphasis of this discussion seems to be whether lighting has been reduced in relation to ‘conventional’ systems, but we reiterate that the regulators’ sole concern should be whether the light system presented imposes unreasonable risks on the turtles in question in an absolute sense, not as compared to alternative systems.

Lighting will be designed to minimise light spill and glow that may affect turtles. Potential impacts associated with this level of lighting and management measures proposed to reduce risks to an acceptable level are described in Section 11.5.3 (Chevron Australia 2005).

22.273 In the Submitters’ view it would be unacceptable to allow GJV to aspire to simply “best available technology” when it comes to the prospect of harming turtle hatchlings via artificial light. GJV should be required to at least aim for zero artificial lightfall during nesting season.

The landfall location at North White’s Beach has been specifically targeted to be away from identified active turtle nesting beaches.

The Joint Venturers will continue to implement the mitigation strategies highlighted in the Draft EIS/ERMP Chapter 7 (Section 7.3) and Section 3.12 of the Framework EMP (Chapter 16), and will further consult with CALM to refine these strategies and implement appropriate measures that will allow the landfall works to proceed on a 24 hour safe working basis while limiting the illumination of the turtle nesting beaches. These specific measures will be outlined in the relevant EMPs. Refer to questions/responses 22.267 and 24.87 for additional details on the West Coast HDD site.

22.267 – The Joint Venturers will endeavour to ensure that any nearshore and beach activities are scheduled for outside this period where practical. As a result of additional investigations undertaken during the FEED process, the Joint Venturers have moved the North White’s beach shore crossing site further north by 450m. The new location offers reduced overall environmental impacts (such as clearing, disturbance, and pipeline right of way) and also provides a barrier via the immediate rocky ledge, which makes it an unsuitable site for turtle nesting. The HDD site is located inland from the beach, is approximately 500m away from the area turtle’s nest and is partially obscured from the beach by intermittent dunes. Therefore the impacts of any HDD operations are expected to be limited.

24.87 – The risk assessment for marine fauna (including turtles) is summarised in Table 11-23 of the EIS/ERMP (Chevron 2005). Stressors such as seabed disturbance, physical interaction, physical presence, wastewater discharge, light, noise and vibration and leaks or spills are described in detail, including potential environmental impacts and consequences. Management measures that will be implemented by the GJV and management targets and measurement strategies are also described. Turtle nesting on Flacourt Bay was one of the major drivers for selecting a horizontal drilling method for installing the pipeline and moving the shore crossing location to North Whites Beach. This would avoid impacting the nesting turtles. Light spill is the major potential stressor to turtles nesting on Bivalve Beach. Light impacts will be managed to an acceptable level as described in the Draft EIS/ERMP Section 11.5.3 (Chevron 2005).

22.274 The turtle monitoring suggested should be extended to at least five years post-commissioning so that the impact of the project on flatback and green turtle populations can be properly observed.

The tagging and monitoring program for adult turtles and sea-finding success for hatchlings on the beaches most likely to suffer impacts due to the proposed Development will be monitored during construction and for least three years post-construction. This includes the continuation of the current program of tagging turtles and doing track counts.

22.275 In addition, who will conduct the suggested nesting beach monitoring regular lighting inspections?

Lighting audits and turtle monitoring program responsibilities will be included in the relevant EMPs.

22.276 What “contingency responses” are planned if negative impacts are observed? Are we really expected to believe that manual reorientation of hatchlings will occur every night during nesting season for the duration of the project life?!

The Joint Venturers are committed to ensuring that flatback turtle breeding success is maintained on Barrow Island. This will primarily be through design of the plant and construction measures such as controlling behaviour of the workforce and light spill from all sources. If monitoring during the construction or operational phases shows an unacceptable disorientation of hatchlings, manual intervention may be instigated. Manual intervention can be maintained until the impacts are reduced.

22.183 What will be done to minimise lighting associated with LNG loading? How might the lighting choices made by the tankers be influenced by GJV?

22.277 How might the lighting choices made by the tankers be influenced by GJV?

A program of detailed scientific investigation into the impact of the development on the Barrow Island flatback turtle population should be developed and implemented, in consultation with and to the satisfaction of CALM. Such a program should address impacts on adults and hatchlings, and particularly address demographic modelling of the population in the long term.

22.278 The Operations Environmental Management Plan and Construction Environmental Management Plan will include monitoring of the light emissions from the development and the effects on nesting turtles during the breeding season. The monitoring plan will be designed in consultation with state and Commonwealth regulatory agencies and will occur annually until such time as the results of the monitoring indicate this is not necessary. The IMS will include mitigation strategies and contingency measures that will be assessed regularly. Demographic studies are currently underway and will continue.

The potential reduced survival of hatchlings during construction is relatively short-term in nature and will be limited to the beaches immediately adjacent to the proposed Development. This is not expected to affect the viability of the local population on these beaches.

22.279 It is underlined that GJV has acknowledged that the beaches surrounding the proposed development site represent 50% of all east coast hatchling emergence, and that the complete mortality of these hatchlings during the three years of construction is 'possible'.

This was referring to a situation under which all management actions failed and the hatchlings were exposed to light for the entire construction period. This would cause a short-term reduction in juveniles recruiting into the adult breeding population 30 years following construction; however it would not drive the entire local population to extinction. This is the extreme case and will not occur. The Gorgon Joint Venturers have committed to implementing a suite of turtle protection measures.

25.39 The three year construction phase at Town Point will impact three to four nesting seasons for Flatback turtles. Flacourt Bay (the alternate feed gas pipeline landfall on the west coast) is an important green turtle nesting habitat.

This is recognised in the Draft EIS/ERMP in Chapter 11, page 497 and has been included in the risk assessment. The importance of Flacourt Bay for green turtles is recognised in both the Technical Appendix (C7) and Chapters 8 and 11 of the Draft EIS/ERMP (Chevron 2005) and was a major consideration in moving the shore crossing to North Whites Beach.

25.40 On page 498 it is recognised that three seasons of impacts on Flatback turtle hatchling due to construction for the Gorgon development will result in a decrease in the breeding population in 30-40 years. The consequence given to this risk is "possible with an overall risk rating of "medium". Given the unknown consequences of these impacts for the overall conservation status this risk rating appears understated and needs revision.

The possible impact of construction lighting on hatchling survival on the beaches at Town Point is conservatively considered 'serious' under the worst case scenario where all management measures fail and the viability of the local population is threatened. The decrease in the breeding population in 30 – 40 years time does not indicate that there will be no breeding flatback turtles at that time. Flatbacks breed over decades and hatchlings from the decades prior to construction will enter the breeding population and continue breeding through that period. Reduction in breeding success at these beaches is not likely to affect breeding success on other beaches, or to endanger the flatback population for the whole east coast rookery.

Medium risk is an appropriately conservative level for an impact that may lead to local reduction in the flatback population, but is not expected to affect the viability of the species on the island. It is expected that the management measures will be effective in reducing the effects of lighting on the hatchlings to a 'minor' consequence with a medium residual risk level.

25.41 A precautionary stance where maximum light management strategy is adopted is required. The strategy should address, *inter alia* avoiding construction work near turtle nesting beaches at night during peak nesting seasons, elimination of non-essential lighting, utilisation of light shields or shades, lighting design, non reflective surfaces and should include regular light audits and provide for upgrading as technology improves.

Light mitigation strategies and monitoring strategies will be further developed in consultation with CALM to include all the elements outlined in the Draft EIS/ERMP Section 11.5.3 (Chevron 2005) and Section 3.12 of the Framework EMP (Chapter 16). Routine light assessments will be conducted as part of the ongoing monitoring of the development. The results of the monitoring and assessments will feed back into the continuous improvement of the IMS and associated management plans.

25.42 Lighting impacts near nesting beaches may lead to a shift to sub-optimal areas and thus alteration to nesting distributions. Lighting infrastructure on the jetty, causeway and shipping may directly attract hatchling turtles leading to direct mortality (probably by predation) once hatchlings have entered the water due to increased visibility to predators. The EIS/ERMP should include these aspects in its analysis of impacts and risk.

These issues are included in the risk assessment described in detail in Chapter 11 of the Draft EIS/ERMP – see pages 495 (alteration of nesting) and 499 (predation and light spill) and Table 11-23.

11.5.4 Noise and Vibration

18.145 A monitoring program should be developed to detect whether noise and vibration are having any detrimental impacts to fauna, and avoidance and/or mitigatory measures should be developed in the event that impacts are detected.

Refer to Section 3.10 of Technical Appendix A1 of the Draft EIS/ERMP. Also refer to 19.18 Section 11.5.4.

19.18 The EPA may consider noting that although there is no specific scientific literature on the subject, the Department has concerns on the effect of the noise emissions from the plant, particularly during construction, on the nearby turtle breeding sites. It is thought that turtle hatchlings may use a combination of light, noise and vibration to locate the ocean after hatching on the beach. The noise emissions from the plant may interfere with the navigational processes of the hatchlings. The Department suggests that further study regarding this subject is required.

19.64 It is possible that the navigation makes use of multiple cues from the environment including noise and vibration. Applying the precautionary principle, we would prefer to see a program of intervention by the Proponent at hatching time to assist hatchlings to find the ocean.

Turtle hatchlings on beaches adjacent to industrial plants generally find their way to the sea once the lights onto the beach have been shielded or extinguished. Construction noise is expected to be too irregular to attract or disorientate hatchlings. However, it is possible that noise and vibration from the operating gas processing facility may interfere with the sea-finding success of hatchlings. The monitoring that is part of the Turtle IMS will detect any reduction in the sea-finding ability of the hatchlings near the gas processing facility; and contingency measures, such as manual relocation, will ensure the population impact is limited.

20.15 Underwater noise associated with the construction, possible blasting and on-going operation of the proposed Development. This is likely to affect the flatback turtle nesting population (both internesting and foraging individuals) using the east coast of Barrow Island. The anticipated result is reduced nesting frequency. This stressor and its impact have not been adequately addressed in the documentation and studies. Noise will also affect the behaviour of green, hawksbill and loggerhead turtle (adult and juvenile) foraging populations along the east coast. The EIS/ERMP does not address this problem or investigate potential impacts.

20.32 The impact of this stressor has not been adequately considered in the risk assessment or modelling.

The Draft EIS/ERMP recognises that noise and vibration associated with construction on the east coast is likely to cause a short-term decrease in reproductive output and possible mortalities in the breeding turtle populations (Chevron Australia 2005; pp 506–507). Sea turtles are generally resilient to loss of a few individuals at a population level. This was assessed as a medium level risk for flatback turtles and a low risk for other turtles. Management measures such as avoiding blasting and pile driving during the breeding season if practicable and monitoring and shepherding megafauna out of the blast area are expected to reduce these risk levels further. Also refer to Section 3.10 of Technical Appendix A1, and to 18.104 Section 11.5.1 and 19.18 Section 11.5.1.

24.65 Although the target of “no blasting outside of daylight hours” is given, should blasting also be precluded during turtle nesting periods, even though nesting occurs at night?

Indications from geotechnical investigation, laboratory testing and discussions with dredge contractors suggest that there is no need to do any drilling and blasting. However, there may be some isolated locations of extremely hard material in between the drilled boreholes. Although there is no indication that these exist it is possible that some minor drilling and blasting will be required at isolated locations. As the number and size of these locations would be small the impacts have been assessed as minor. In order to reduce potential disturbance to turtles, no blasting will be undertaken outside of daylight hours, warning charges will be used, techniques to reduce zone of effect will be implemented and overlap between construction schedules in nearshore areas with key breeding periods for turtles will be minimised. If turtles are detected within a specified radius, no blasting will be undertaken. Additional noise and vibration management measures can be found in Table 11-23 of the Draft EIS/ERMP (Chevron Australia 2005).

11.5.5 Leaks or Spills

13.5 Recommendation: Before construction begins a study of currents and their potential impacts should be undertaken.

Hydrodynamic modelling of water currents in relation to dredge plumes, oil spills and sediment transport have been presented in the Draft EIS/ERMP (Chevron Australia 2005). Also refer to Technical Appendices B3–B6 and Chapter 11.

16.25 It has to be remembered that in the event of an accident at the proposed Town Point terrestrial gas processing facility, or at its associated marine infrastructure, areas would be affected well beyond Town Point. The risk posed by “stressors” and accidents over the three to five year construction period could be high. Spills are inevitable. Further high risks exist due to the long term nature of this proposed major industrial project.

A large spill is unlikely to occur, but the possible serious-to-major consequences of such a spill are recognised in the risk assessment (Chevron Australia 2005; Table 11-23). Spills are assessed as posing a medium level of risk to marine fauna. The Gorgon Joint Venturers will also have in place a comprehensive spill contingency plan (refer to Technical Appendix A1, Section 3.19).

20.19 Chemical pollution. No chemical baseline data have been collected from the water and nesting beaches in the Town Point area. This is essential to ensure that the beaches remain pollutant free to enable normal development of the turtle embryos in the sand. A regular monitoring program and relevant management actions would need to be developed for this stressor.

Chemical pollution of the beaches around Town Point will be avoided by management of construction and operational activities with the potential for causing spills. The management measures proposed for the development are outlined in Section 11.5.5 of the Draft EIS/ERMP (Chevron Australia 2005). Soil and water quality monitoring programs will be established in consultation with the relevant authorities prior to construction.

22.191 How does this spill modelling compare to Blue Whale migratory pathways?

A detailed description of the protection status, regional occurrence, aggregation areas and migration season of blue whales is provided in Technical Appendix C6, pp 13–17 of the Draft EIS/ERMP (Chevron Australia 2005). The anticipated effects on whales from accidental spills are described in Section 11.5.5 (Chevron Australia 2005). As noted in the Draft EIS/ERMP, Chapter 8, Page 265 ‘Humpback and other whales are unlikely to occur in the shallower waters over the shelf between Barrow Island and the mainland.’ Therefore spill modelling of most relevance is associated with the feed gas pipelines and associated construction activities. Failure of the feed gas pipeline during the operations phase is extremely unlikely, while potential spills associated with construction activities are small and unlikely, and so the risk to blue whales is low (refer to the Draft EIS/ERMP, pp 508–511).

22.192 What are the total number of regional (i.e. on the Lowendals and the Montebellos as well as Barrow) turtle nesting sites potentially impacted by the spill risks modelled here?

'The nature of LNG production and supply necessitates robust and reliable design and execution to meet corporate and stakeholder expectations. Consequently, control and planning during execution should achieve optimum supply reliability. This, in turn, will provide the lowest possible risk of hydrocarbon release by ensuring that the highest standards of design, material selection and construction and operation are applied' (Chevron Australia 2005; Section 7.9, p 188).

The likelihood of various spill scenarios has been investigated and the results shown in Table 7.13 (p 197 of the Draft EIS/ERMP). The maximum spatial extent of a number of spill scenarios are presented in Figures 7.12 to 7.15, while full details of spill modelling undertaken are provided in Technical Appendix B3 (Chevron Australia 2005). The anticipated effects on turtles from these accidental spill scenarios modelled are described in Section 11.5.5 of the Draft EIS/ERMP (Chevron Australia 2005). Turtle rookeries would be most affected at the closest beaches, with lessening effects with increasing distance from the source.

Figure 7.12 shows that no turtle nesting sites would be affected by this scenario. Figure 7.13 includes a very conservative assumption that a feed gas pipeline of the size proposed would fail completely given that '...to date there have been no known incidents of full bore rupture of large diameter (609 mm OD to 1067 mm OD) offshore trunklines in operation. Such pipelines are extremely robust and are protected (or kept remote) from known significant risk factors such as vessel anchoring or dropped objects. The data sets applied for the spill modelling relate to failure frequencies of smaller pipelines and are therefore inherently conservative.' (Chevron Australia 2005; p 190).

Figure 7.14 also includes very conservative assumptions given that 'Over 1000 tanker loadings and 300 million barrels of crude oil have been exported without incident from the east coast of Barrow Island in the last 35 years.' (Chevron Australia, p 509). Figure 7.15 shows the risk of a diesel spill impacting the Montebello Islands is extremely low to negligible. It shows that a diesel spill on the east coast could potentially impact the Lowendal Islands and Barrow Island. The modelling for this scenario also includes very conservative assumptions based on the current operational experience.

It must also be noted that (apart from including conservative assumptions which overestimate likelihood of release) the modelling shown in Figures 7.12 to 7.15 and assessment of potential impacts also assume there is no intervention from the Joint Venturers if a spill occurred (Chevron Australia, p 189). A comprehensive spill contingency plan will be in place (Draft EIS Chapter 16 and Technical Appendix A1, Section 3.19), and potential impacts on turtle nesting beaches will be an input to the oil spill contingency planning and will be a primary focus.

24.150 Further work should be done for each of the spill types to map probability contours in relation to the following impacts: [1] (a) acute toxicity to marine biota; (b) sub-acute toxicity; (c) no detectible toxicity effect; and [2] physical smothering resulting in (a) long-term (> 5 year) loss or damage; (b) short to medium term (< 5 years) loss or damage; and (c) no loss or damage. In interpreting these contours, consideration should be given to the roles and functions of the particular ecological attributes which may be affected, the ecological consequences of loss or damage and the probability of complete recovery to the pre-impact state.

Marine biota varies greatly in their likelihood of exposure and their sensitivity to hydrocarbon spills. Generic test organisms have been shown to be sensitive to North Gorgon condensate in ecotoxicology experiments (Chevron Australia 2005, p 507). There is currently insufficient data on the responses of individual taxa to exposure to different concentrations of hydrocarbons for meaningful contours to be drawn up. However, all taxa exhibit a dose: response relationship where greater concentrations entail greater impact. The output from the oil spill modelling is intended to demonstrate the most likely behaviour of spilled hydrocarbons under a variety of scenarios.

It can be assumed that the greatest ecological response will occur in the highest concentration zones. While exposure times and hydrocarbon concentrations vary due to environmental factors such as temperature, wind and tidal state, the risk assessment in Section 11.5.5 of the Draft EIS/ERMP covers the range of scenarios. The worst case scenarios assume contact with undiluted and non-degraded hydrocarbons that have been shown to be acutely toxic to marine biota. The expected recovery times are described in Section 11.5.5. This section covers the consequences of volatilisation of hydrocarbons from the water surface and entrainment in sediments in terms of the time for recovery of the impacted assemblages.

11.5.6 Cumulative Risk

Responses to submission questions on Cumulative Risks to marine receptors have been included in answers related to relevant sections above.

11.6 Conclusion

24.93 At this stage with the information currently before us, we do not believe it is possible to provide informed technical advice to the EPA about marine environmental impacts outside of raising concerns about the considerable uncertainty surrounding the proposal design, the proponent's approach to marine environmental impact prediction and the conclusions it has drawn from these predictions.

In the absence of complete scientific data to fully assess all of the possible consequences of the marine works and remaining uncertainty in project design, the GJV consultants have followed a precautionary approach as recommended by the EPA. This situation is common to all marine assessments of this scale and the ongoing technical investigations and monitoring will add to the body of knowledge required to better address these issues in future. The studies about the proposed Gorgon Development have added to the knowledge base already and that these studies are among the most comprehensive ever undertaken in the region.

24.94 In the absence of a more comprehensive and definitive project proposal and assessment of marine environmental impacts than that contained in the ERMP under review, it would be difficult to argue that the marine impacts of this project are manageable and compatible with protecting the environmental and conservation values of this area.

The extent of impacts to the marine environment has been estimated conservatively to reflect the availability of scientific data on the responses of north-western Australian ecosystems to these stressors. The impacts of the proposed Development are considered ecologically sustainable on the basis of the representation of similar resources in the region and the lower level of protection afforded the development areas within the Barrow Island Port Limits.

12 Quarantine – Risks and Management

12 Quarantine – Risks and Management.....	297
12.1 Introduction and General Submissions on Quarantine – Risks and Management.....	298
12.1.1 Quarantine Management Objectives.....	300
12.1.2 Key Quarantine Terminology.....	300
12.2 Approach to Quarantine Management	301
12.2.1 EPA Advice	301
12.2.2 Quarantine Expert Panel.....	302
12.2.3 Community Involvement.....	302
12.2.4 Best Practice Benchmarking	302
12.2.5 Expert Advice	302
12.2.6 Standards for Acceptable Risk.....	302
12.3 Existing Environment	302
12.3.1 Conservation Values of Barrow Island.....	303
12.3.2 Quarantine Experience	303
12.3.3 Historical and Existing Presence of Non-Indigenous Species.....	304
12.3.4 Baseline and Early Survey Strategies.....	307
12.3.5 Terrestrial Baseline Data	309
12.3.6 Marine Baseline Data.....	312
12.4 Gorgon Quarantine Risk Management	312
12.4.1 Introduction to Risk-based Management.....	314
12.4.2 Risk Assessment Method.....	314
12.4.3 Development of Standards for Acceptable Risk	314
12.4.4 Identification of Quarantine Threats	325
12.5 Quarantine Barrier Selection.....	326
12.5.1 Quarantine Barrier Selection Method.....	326
12.5.2 Systematic Quarantine Barriers for all Pathways.....	335
12.5.3 Management of Quarantine on the Sand and Aggregate Pathway	335
12.5.4 Management of Quarantine on the Food and Perishables Pathway	337
12.5.5 Management of Quarantine on the Personnel & Accompanying Luggage Pathway.....	337
12.5.6 Management of Quarantine on the Marine Vessels Pathway	337
12.5.7 Management of Quarantine for Rodents on Marine Vessels	338
12.5.8 Monitoring Strategy	338
12.5.9 Response Strategy	339
12.6 Quarantine Management System	343
12.6.1 Introduction.....	349
12.6.2 Elements of the QMS	349
12.6.3 System Implementation.....	349

12.1 Introduction and General Submissions on Quarantine – Risks and Management

1.1 “It was in great interest, by chance, I read your invitation for public comment 24/10, on environmental issues, and the attached, the likes of which, I have been fruitlessly pursuing for months, having similar traits, with no luck, perhaps you can see the close association, they should be, sunk on sight when in Australian waters, the occupants retrieved and immediately deported back to Indonesia, or is this, again, wishful thinking.”

Border security is a Commonwealth Government responsibility. As such, the Gorgon Joint Venturers do not have the authority to intercept or detain illegal foreign fishing vessels.

However, in the event of a threat of introduction from illegal foreign fishing vessels, the Joint Venturers will refer to Chevron Australia’s Introduced Animal Contingency Plan (and emergency response procedures which will be incorporated in the Quarantine Management System).

18.17 Another very significant weakness of the risk assessment process is the failure to consider the introduction and spread of weeds as an environmental risk factor to biodiversity.

The presence of introduced plant species in proposed development areas was considered during the risk assessment process and is identified as ‘Potential Environmental Impact/Consequence’ with a ‘Target’ of no spread and associated ‘Proposed Measurement Strategies’ for the risk assessment (Chevron Australia 2005; Table 10-7, p 335). Risk from weeds is also addressed in discussion of specific areas. The potential for spread of specific introduced species, *Setaria verticillata* (Chevron Australia 2005; p 328) and *Cenchrus ciliaris* and *Prosopis* sp. (Chevron Australia 2005; p 335) were mentioned in particular.

The Joint Venturers have sought advice on the potential threat of introduced weed species with the Quarantine Expert Panel and with other experts in the risk assessment workshops. The Quarantine Expert Panel and other experts consistently advised the Joint Venturers that predictions of the potential impact of weed species on Barrow Island biodiversity were too difficult to attempt such predictions with certainty. This advice was shared with stakeholders in the Community Consultation Meetings in 2004.

For this reason, the Joint Venturers proposed a risk-based assessment method, in consultation with experts and the community that did not rely on predictions of consequences, but on a rigorous analysis of the likelihood of infection on potential pathways of introduction. It is acknowledged that some organisms that might be introduced could survive on Barrow Island, in the event that they were able to gain a foothold in the native environment. Therefore, the Joint Venturers are committed to a rigorous quarantine regime which leads to a proven low likelihood of introduction (the conclusion of the assessment of three priority pathways in the Additional Information Package) (Chevron Australia 2005b). In supporting this commitment, a monitoring system and surveillance system will be developed and implemented that will enable early detection at the proposed development site and in the immediate native environment, so that an appropriate response can be rapidly initiated to protect the conservation values of the island.

18.156 The fate of chemicals used to clean and disinfect vessel hulls should be clarified. If chemicals are to be discharged into the ocean, information should be provided on the potential impacts of this practice on the marine environment.

Only approved chemicals as per AQIS prescriptions will be used on vessels. All vessels to access Barrow Island will already be quarantine compliant.

21.21 The inclusion of terrorism in this list may be considered by some as far-fetched, or if it occurs of such significance that the environment pales to significance. This latter attitude is of course a major concern in any emergency situation. The former is perhaps not so far-fetched. It is my understanding (perhaps mistaken) that the Pilbara Regiment was initially established in recognition of the strategic importance of the NW Shelf developments. Since then the strategic importance of the area has increased, as has the threat of terrorism. I agree that perhaps the environmental impacts may be of lesser concern than the loss of life and possible catastrophic effects of a terrorist attack, however perhaps this should be considered when siting such a target. It would be prudent to avoid the threat to the environment by locating it elsewhere.

At the very least, the risks from each of these scenarios must be assessed, and if use of Barrow is approved, contingency plans prepared.

Security aspects are not part of the Draft EIS/ERMP but are part of the development.

18.147 To ensure appropriate standard of performance in regard to quarantine management, the EPA should consider the option of establishing a substantial financial bond.

22.19 GJV have been asked time and again whether they will “put their money where their mouth is” and back-up their quarantine promises with an appropriate financial bond to be accessed for (at least attempting) to deal with the consequences of a breach. The regulators should note that such requests have been consistently refused by GJV.

22.292 Even more concerning in this context is GJV’s persistent unwillingness to put up a suitable bond to be accessed for (at least attempting) to deal with the consequences of a breach.

26.33 We also urge that “systemic barriers” include a system of financial penalties and bonds directly affecting GJV, with the capacity for GJV to on-charge contractors as appropriate.

The Joint Venturers do not support the concept of a performance bond for environmental management. It is anticipated that the achievement of agreed environmental management standards will be a condition of approval which must be met by the Joint Venturers. In addition, the DoE will have the power to issue environmental protection notices to require the Joint Venturers to take/avoid specific actions to protect the environment.

In the unlikely event of a breach of an environmental management standard, the DoE would have recourse to all its normal regulatory enforcement actions, including prosecution of the Joint Venturers for breach of conditions and/or environmental harm (with penalties of up to \$1 million). In addition, it is noted that the DoE does not yet have a policy on when/whether to require financial assurances, and has yet to impose such measures on any proponent.

22.288 It should be emphasised that the black rat was only present on part of the Island, we question in such circumstances whether the long-gone pearlshells can be blamed for its introduction!

Comment noted.

24.42 If the proposal has a dedicated LNG tanker fleet, would it then be possible to define more precisely the operational management of ballast water to reduce possible importation of exotic marine fauna and other quarantine threats?

Refer to 24.13 Section 6.2.3 regarding the ‘dedicated’ aspects of the fleet. All ships have to comply with international requirements for managing ballast water (MARPOL Requirements) and all ships entering Australian waters have to comply with Australian requirements regarding ballast water. Refer to Chapter 12 of the Draft EIS/ERMP for additional details on quarantine as related to Barrow Island.

26.41 The Submitters' view is that recreational access to the Island should be totally prohibited, at very least during the lengthy construction phases.

The Joint Venturers will be providing an extensive range of recreational opportunities for all personnel working on the project within the construction village. In addition, sporting facilities and opportunities to enjoy nature linked to environmental programs will be offered. These opportunities will not increase the quarantine risk to the Barrow Island environment.

22.17 There is no question the GJV have given some recognition of what is at stake with quarantine management, and made some laudable efforts to engage experts and the community.

Comment noted and appreciated.

22.295 The Submitters are concerned that there is entirely too much explicit or implicit emphasis here on cost and timelines. GJV should be required to take quarantine measures that are appropriate to the environmental assets put at risk or it should not be permitted to access Barrow – simple as that.

The Joint Venturers have developed the Barrow Island Quarantine Policy, which requires that quarantine compliance cannot be compromised (Box 12-1 of the Draft EIS/ERMP). To date, there have been no situations that would suggest that cost or schedule have compromised proposed quarantine barriers. No quarantine barriers have been eliminated in the transparent barrier selection process that would have further reduced risk (Part 2 of the Additional Information Package).

12.1.1 Quarantine Management Objectives

24.90 If the quarantine rules that apply to the Gorgon development are not also applied to WA Oil's operations on Barrow Island, and taking into account improved knowledge of introduced plant and animal species on Barrow Island resulting from surveys undertaken for the Gorgon development, what will the implications to achieving the quarantine assessment standard stated in Appendix D2 of:

“A zero tolerance of invasions target, where the risk of introducing an alien species to Barrow Island is sufficiently low to prevent the possibility of establishment and invasion.”?

In terms of the Barrow Island Quarantine Policy (Draft EIS/ERMP; p 532) all activities that Chevron Australia controls on Barrow Island will be subject to the QMS. This infers that any 'improved knowledge' that will enhance the quarantine management ability of the Joint Venturers would populate the appropriate functional domains of the QMS. This process is iterative and the QMS is designed to accommodate these improvements through a change management capacity that would apply across Chevron Australia's operations on the island.

12.1.2 Key Quarantine Terminology

28.6 How does 'infection' score translate to an 'introduction' score? Are these terms being used interchangeably? See for example Para 2, page 13 of this part

The definitions for 'infection' and 'introduction' are stated in Box 12-2 of the Draft EIS/ERMP (Chevron Australia 2005; p 533), and are used consistently in the Additional Information Package (Chevron Australia 2005b).

The infection score is the likelihood of infection at each pathway step, which may contain one or more barriers designed to reduce or eliminate the likelihood of infection. The introduction score is the residual risk which is present after all the barriers in all the steps in each pathway have been applied. These definitions were discussed and developed in the Risk Standards Workshops (Chevron Australia 2005; Technical Appendix D3) and which were reported to the wider community during the development of the risk standards framework (starting with Community Consultation Meeting #2, 20 April 2004, and in subsequent meetings). Therefore, the terms cannot be used interchangeably as each represent a specific value at a specific stage of each of the pathways.

28.9 P13, para 3; What is the definition of 'very low' please? This term is not used in the scenarios in App. D3.

28.12 P19, para 2; How is 'very low' defined and how does it relate to the terms in the scenarios in App. D3?

The words 'very low' are part of the explanatory prose in this section, and therefore should not be interpreted as a formal term requiring definition. All of the risk scores representing defined terms are shown in Tables 6 and 7 on the same page of Technical Appendix D3 (Chevron Australia 2005).

28.10 P14, last para; What is the relationship of an 'incursion' to 'introduction'? What is the definition of 'low' as used here and how does it relate to the terms used ('extremely remote' and 'highly unlikely') to describe a score of one for introductions in App. D3?

The terms 'incursion' and 'introduction' are defined in Box 12-2 of the Draft EIS/ERMP (Chevron Australia 2005). The statement was collectively made by the independent experts who participated in the QHAZ workshop, as a summary statement of the outcome of the assessment of the personnel and luggage pathway, in readily understood terminology.

12.2 Approach to Quarantine Management

24.91 How will these issues/comments related to protection of terrestrial vertebrates on Barrow Island be addressed in the monitoring and quarantine management proposals?

Technical Appendix D2 was specifically prepared to outline the methodology for conducting a risk-based assessment of potential quarantine threats during the construction and operation of the proposed Gorgon gas processing facility, and the associated marine terminal and carbon dioxide re-injection program. Statements in this appendix are therefore mainly focussed on and informing the approach to the Gorgon Development.

The aim of the Technical Appendix D2 was to draw upon the best practices for ecological risk assessment and apply such practices in a manner that realises a quarantine management system for the Gorgon Development that meets the EPA recommendation to the Western Australian Government that if the proposed development of a gas processing facility on Barrow Island is to proceed, 'it could only be with a policy of zero tolerance of invasions'.

The Joint Venturers believe this was demonstrated successfully in the development of a Quarantine Policy (Chevron Australia; p 532), the commencement of the QMS development and the publication of the proposed barriers for the three priority pathways in Part 2 of the Additional Information Package (Chevron Australia 2005b).

The Barrow Island Quarantine Policy and the QMS is applicable to all activities on Barrow Island. The logistics requirements of the existing oilfield operations will be managed through the same supply bases and under the same high quality quarantine regime as the proposed Gorgon Development activities. In the event that the existing oilfield operations present circumstances which depart from the pathways described for the Gorgon Development, new pathways will be described and assessed under the same risk-based assessment method and standards for acceptable risk as all other pathways.

12.2.1 EPA Advice

No submissions received on this section of the Draft EIS/ERMP.

12.2.2 Quarantine Expert Panel

18.146 The continuation of a Quarantine Expert Panel to inform baseline investigations and general quarantine procedures is supported by CALM.

The Joint Venturers have committed to continue the involvement of experts to provide advice on baseline surveys and other quarantine matters in a Quarantine Advisory Committee, which has met on three occasions since September 2005 (Chevron Australia; p 593). Both CALM and the Western Australian Department of Environment have again been invited to fully participate in discussions.

Meeting records of the Quarantine Advisory Committee are published on the Development's quarantine website to communicate the Committee's activities to stakeholders (www.gorgon.com.au then follow links to Managing Our Environment and Quarantine).

12.2.3 Community Involvement

22.284 The Submitters underline that after considerable community/expert effort with developing standards for acceptable risk, they have since been ignored!

Refer to 4.5, 4.6 and 4.7 Section 12.4.3.

12.2.4 Best Practice Benchmarking

12.2.5 Expert Advice

12.2.6 Standards for Acceptable Risk

No submissions received on these sections of the Draft EIS/ERMP, but see section 12.4.3.

12.3 Existing Environment

18.148 It is recommended that baseline quarantine data be collected by measuring current infection of existing pathways to Barrow Island before project implementation.

The Joint Venturers are committed to collecting baseline quarantine data on existing logistics pathways for the Barrow Island oilfield operation, in advance of the commencement of full implementation of quarantine barriers for the proposed Development. This will inform the Joint Venturers of the current infection risks of personnel, materials and vessels managed under the current quarantine procedures for the Barrow Island oilfield operation.

20.37 At the recent Community Consultation Meeting held in Perth on 10 November 2005 it was acknowledged that invited experts at the workshops suggested risk scores with limited hard data and pointed out that they were working in an information vacuum. Also at the Community Consultation Meeting, Gorgon staff acknowledged that no attempt has been made to measure infection of existing pathways operated by Chevron to service the oilfield. Several plane loads of passengers and luggage fly to Barrow every week in addition to many barge trips that bring food and equipment each month, and this would have been an easy task.

A significant body of literature exists on the threats to biodiversity on islands and in isolated ecosystems. Scientific evidence supports the precautionary approach the Joint Venturers are taking in managing the potential risks associated with the introduction of non-indigenous species to Barrow Island. The 'information vacuum' primarily refers to potential introductions and the impact of such introductions on Barrow Island conservation values. Addressing this 'vacuum' can be considered a desired outcome of a successful QMS.

The process has also identified an information gap that exists on the baseline knowledge of the invertebrate assemblages on the island. Barrow Island was proclaimed a Class A Nature Reserve in 1910 and, to date, vertebrate and plant baselines have been the areas of most scientific effort by government, academia and Chevron Australia. The Joint Venturers have recently committed significant resources to addressing this information gap and are gathering data on the island's invertebrates to assist in their decision-making process.

The Joint Venturers are aware of the opportunity to sample the existing logistic pathways of the oil operator. Data from such a sampling program can inform the barrier assessment process and any findings will be considered by the Joint Venturers in line with the commitment to continuously improve the efficiency and effectiveness of the quarantine management program.

12.3.1 Conservation Values of Barrow Island

18.161 It is recommended that the proponent note that the sentence on page 542 (first paragraph in section 12.3.1) should more correctly read *“These populations, particularly the mammal populations, form a genetic reservoir that is important to biodiversity and conservation and could be important as a source for controlled translocations of these species to other areas if circumstances warranted it.”*

The Joint Venturers agree with the rewording of this sentence to include the phrase ‘if circumstances warranted it’. It was implicit in the statement that the translocation would only occur under advice from CALM as part of their established translocation programs.

12.3.2 Quarantine Experience

22.52 There is no question WAPET/Chevron's relatively small team of long-term employees have had some level of quarantine success, and that State management money has thereby been saved.

Comment noted.

18.28 Given this, there is a need to consider what will happen in the event of a significant quarantine breach on Barrow Island, which could ultimately result in the loss of significant conservation values, including species extinction. CALM does not believe that the proponent has adequately considered this likelihood.

The Joint Venturers, through Chevron Australia as the operator of the existing Barrow Island oilfield operations, have 40 years of quarantine experience that has served to protect the conservation values of Barrow Island, an accomplishment of which the operator is proud. In this regard, Chevron Australia has developed a competent quarantine capacity in the organisation. This capacity has advanced from its initial grass-roots beginnings of quarantine management 40 years ago to a visible quarantine culture evident throughout the organisation today. This achievement is supported by the fact that no loss in biodiversity has been recorded to date on Barrow Island during the 40 years of oil operations.

Consistent with this achievement, the Joint Venturers are developing effective barriers for all of the potential pathways of introduction, with the goal of no introductions, which will meet the standards for acceptable risk. In addition to the effective barriers, the Joint Venturers are committed to developing a monitoring program that will rapidly detect an introduction, and mobilise an immediate Response and Eradication Strategy. This approach is informed by current practices on Barrow Island, which have successfully eradicated introduced species in the past.

Given the experience and achievement of Chevron Australia as the operator on Barrow Island, and recognising the current initiatives of the Joint Venturers to progress ‘beyond best practice’, the Joint Venturers are confident that the emerging Quarantine Management System developed specifically for the Gorgon Development, will safeguard the conservation values of Barrow Island in a manner that will not lead to species extinction.

24.54 Where introduced species have been identified and located on Barrow Island, will the proponent's undertake to eradicate them (subject to agreement by CALM)?

It is acknowledged that organisms have the potential to be introduced to Barrow Island, and possibly survive. The Joint Venturers have committed to a rigorous quarantine regime which will lead to a low likelihood of incursions (the conclusion of the assessment of three priority pathways in the Additional Information Package). The Joint Venturers will also implement a monitoring system that will enable early detection at the proposed development site and in the immediate native environment, so that an appropriate response can be rapidly initiated to protect the conservation values of the Island.

12.3.3 Historical and Existing Presence of Non-Indigenous Species

4.8 Gorgon has made much of the existing oilfield's quarantine success. However, even with the relatively low intensity of the existing oilfield operations, there have been many documented quarantine breaches.

The oilfield operation has existed on Barrow Island for more than 40 years. During this time, Chevron Australia (as the operator) has recognised the importance of quarantine and implemented both strict measures to prevent introductions and developed a strong quarantine culture in the workforce. Notwithstanding these efforts, some quarantine breaches have occurred. In keeping with the oilfield operator's commitment to quarantine, which safeguards the conservation values of the island, there have been instances when vigilant and competent personnel have denied barges from offloading on Barrow Island. These non-compliant vessels and their cargoes were instructed to return to the mainland for quarantine treatment without regard to cost or schedule.

On the few occasions when non-indigenous species have been discovered in vessels, they have been dealt with swiftly and effectively with advice from CALM. Where weeds have been discovered, they have been the subject of a managed containment and eradication program to prevent their spread. As a result of these pre-border, border and post-border efforts, Chevron Australia has prevented impacts to conservation values and continues to improve its quarantine performance.

The Joint Venturers have recognised the need for a world-class Quarantine Management System that will effectively manage the risks of introduction from the proposed Development and have made substantial progress to develop solutions that have been tested under the scrutiny of independent experts. The community recognise that there cannot be a 'zero risk' solution for quarantine; however, the Joint Venturers have faithfully addressed the community's expectations for acceptable risk to prevent the establishment of non-indigenous species on Barrow Island. In doing so, the Joint Venturers have considered all the recommendations of conservation and ecological specialists to prevent introductions on pathways of people, cargoes and vessels.

The proposed quarantine barriers for the three priority pathways are discussed in detail in the Additional Information Package to the Draft EIS/ERMP (Chevron Australia 2005b); with the advice of the experts being that the likelihood of incursions is low. Border and post-border surveillance and monitoring activities are being designed to provide early warning of any organisms that might arrive on Barrow Island, so that a response to an incursion can be dealt with rapidly, preventing establishment in the native environment.

4.11 Even this brief pilot study has already detected one introduced 'tramp' ant with the possibility of an introduced collembolan being raised recently. Baseline studies, especially on terrestrial invertebrates, are a case of 'too little to late'.

The discovery of a tramp ant on Barrow Island demonstrates that introduced species can be detected and identified. The tramp ant occurs extensively throughout northern Australia, and independent experts do not regard the species as a threat to the native environment and the conservation values of Barrow Island.

18.162 It should be recognised that incursions of introduced species to Barrow Island have occurred in the past as a result of the oilfield operations.

The Joint Venturers acknowledge that some introductions of species to Barrow Island have occurred in the past, either by oilfield operations, other anthropogenic causes, or by natural turnover of species. The historical and existing presence of non-indigenous species is discussed in Section 12.3.3 of the Draft EIS/ERMP (Chevron Australia; p 543).

22.49 Contrary to the suggestion that the Island has been very well managed, WAPET has introduced vertebrate pests which they then had to remove, with damaging consequences to native fauna. This section should be re-written to reflect reality.

22.50 WAPET has also introduced a species of crazy ant and a species of spider, neither of which have been eradicated. These are new discoveries that the Submitters, at least, have only become aware of since the ESE process.

22.51 The critical issue here is that WAPET/Chevron's operations were and are relatively small compared to the GJV proposal and they had quite strict quarantine measures in place. Despite this, they still had serious quarantine breaches. The chance that the much larger human presence on Barrow associated with the GJV could occur without very damaging quarantine breaches is close to zero.

The oilfield operation has existed on Barrow Island for more than 40 years. During this time, Chevron Australia (as the operator) has recognised the importance of quarantine and implemented both strict measures to prevent introductions and developed a strong quarantine culture in the workforce. Notwithstanding these efforts, some quarantine breaches have occurred. In keeping with the oilfield operator's commitment to quarantine which safeguards the conservation values of the island, there have been instances when vigilant and competent personnel have denied barges from offloading on Barrow Island. These non-compliant vessels and their cargoes were instructed to return to the mainland for quarantine treatment without regard to cost or schedule. On the few occasions when non-indigenous mice or rats have been discovered, they have been dealt with swiftly and effectively.

Where weeds have been discovered, they have been the subject of a managed containment and eradication program to prevent their spread. As a result of these pre-border, border and post-border efforts, Chevron Australia has prevented impacts to conservation values and continues to improve its quarantine performance. The Joint Venturers have clearly recognised the need for a world-class Quarantine Management System that will effectively manage the risks of introduction from the proposed Development, and have made substantial progress to develop solutions that will account for the increased human presence and activities on the island. The proposed solutions have been tested under the scrutiny of independent experts.

The community recognised that there cannot be a 'zero risk' solution for quarantine; however, the Joint Venturers have faithfully addressed the community's expectations for acceptable risk to prevent the establishment of non-indigenous species on Barrow Island. In doing so, the Joint Venturers have considered all the recommendations of conservation and ecological specialists to prevent introductions on pathways of people, cargoes and vessels. The proposed quarantine barriers for the three priority pathways are discussed in detail in the Additional Information Package, with the advice of the experts being that the likelihood of incursions is low. Border and post-border surveillance and monitoring activities are being designed to provide early warning of any organisms that might arrive on Barrow Island, so that a response to an incursion can be dealt with rapidly, preventing establishment in the native environment.

22.82 As noted above, it can no longer be said that Barrow has no introduced fauna.

22.87 As noted above, it can no longer be said that Barrow has no introduced fauna.

22.196 It should also be noted here that 14 introduced flora species have made it to Barrow, even with WAPET and then Chevron's relatively good quarantine management.

Comment noted. The reference to Chevron Australia's 'relatively good quarantine management' is appreciated.

It is acknowledged that organisms have the potential to be introduced to Barrow Island, and possibly survive. The Joint Venturers have committed to a rigorous quarantine regime that would significantly improve on the existing successful quarantine program on Barrow Island. The Joint Venturers appreciate the challenge of developing such a world class QMS for the proposed Gorgon Development which builds on the legacy of the existing quarantine management program in a manner that can accommodate the increased activities associated with the proposed development.

The existing oilfield operations have managed the potential impacts of weeds through flora surveys and a Weed Management Program that seeks to contain, monitor and eradicate non-indigenous plant species on Barrow Island. There are a total of 15 non-indigenous plant species that have been detected, with six of these in highly restricted distributions (Section 12.3.5 of the Draft EIS/ERMP).

The weed management program shows that the efforts have contained the spread of the weeds of concern and is systematically reducing their distribution with the objective of complete eradication from the island over time. In the case of mice and rats, the existing oilfield operator has successfully eradicated a mouse introduction, disturbing a very small area of the island, and CALM has carried out a rat eradication effort on the southern end of the island. Non-native rats are believed to be completely absent on Barrow Island. In the case of the tramp ant, discovered as a direct result of the Joint Venturers' baseline survey efforts of invertebrates, experts consider this particular species of ant which is prevalent in northern Australia to be a 'cosmopolitan species' which is not likely to survive in the native environment (to be confirmed in an expanded baseline survey program). The tramp ant may have established itself on the island under a natural colonisation pathway, as happens frequently on islands; or it is possible that it was introduced by oilfield activities. However, this cannot be determined with certainty.

The Joint Venturers will put in place a competent monitoring and surveillance program supported by a Response and Eradication Strategy. The Joint Venturers are committed to respond quickly and effectively to any quarantine emergency that might threaten the biodiversity of the island, as stated in the Barrow Island Quarantine Policy (Box 12-1), and described in Section 12.5.9 of the Draft EIS/ERMP.

22.283 Regarding the recent crazy ant discovery, we note that the taxa is not expected to influence negatively on native biodiversity (Jonathan Majer, pers. comm.), but we also note that a yellow crazy ant species on Christmas Island was introduced between 1915 and 1934, but has only experienced a population explosion and become a major problem in recent years. <http://www.deh.gov.au/minister/env/2003/mr28feb03.html>

It is the considered opinion of conservation biologists with ant expertise that the tramp ant is a cosmopolitan species with little chance of establishing a viable population in the native environment. The baseline surveys of invertebrates are being expanded to confirm that this is the case. Once sufficient information on the biology and distribution of the tramp ant is known, an appropriate response strategy will be developed in consultation with experts.

22.287 If the American Cockroach and/or the Daddy Long Legs spider are detected by current or planned invertebrate baseline work, what are the potential biodiversity consequences of their presence?

The Joint Venturers have been advised by experts and the Quarantine Expert Panel that the potential biodiversity consequences of the presence of cockroaches and daddy-long-legs spiders are negligible. These are known to be 'cosmopolitan' species that will not establish in the native environment.

22.289 How many native animals are estimated to have been killed by the eradication of house mice on the three occasions WAPET's quarantine failed?

The existing oilfield operation has developed a comprehensive management programs for weeds and introduced animals which amongst others, demonstrate the containment of the weeds and animals such mice and rats. It is always a very focussed and targeted eradication response. The existing oilfield operator has successfully eradicated a mouse introduction, disturbing a very small area, and CALM has carried out a rat eradication effort on the southern end of the island. The exact mortality of native animals is unknown to the Joint Venturers. The Joint Venturers acknowledge that eradication options, in the event of an introduction, may result in very limited mortalities of plants and animals. However, proven containment procedures of the introduced species involve a very small area of the native environment being isolated and in the case of rodents live traps were used to capture and remove as many native animals as possible prior to the use of poison bait.

9.2 The relative success of the management of adverse impacts from the current Chevron Texaco oil project has given, we believe, an unrealistic and false expectation that further impacts can also be managed.

The existing oilfield operations have managed the potential impacts of weeds through flora surveys and a Weed Management Program that seeks to contain, monitor and eradicate non-indigenous plant species on Barrow Island. There are a total of 15 non-indigenous plant species that have been detected, with six of these in highly restricted distributions (Chevron Australia 2005; Section 12.3.5).

The Joint Venturers will manage all potential pathways of introduction to prevent the introduction of new plant species to Barrow Island, and maintain custody and control of all material and equipment within the proposed Development footprint. The Development site will be denuded of vegetation on the advice of CALM and the Quarantine Expert Panel.

This approach will, in the event of an introduction, contribute to the containment of any introduced organism within the Development site as it would be easily detected in the denuded area.

Notwithstanding the rigorous precautionary measures to be taken to prevent introductions, there may be a chance of a non-indigenous species establishing in the native environment. Irrespective of the low risk of introduction, the Joint Venturers are committed to a world-class monitoring and surveillance program supported by a robust response and eradication strategy.

12.3.4 Baseline and Early Survey Strategies

4.10 Gorgon commissioned a report from CSIRO on baseline survey methodology, but then ignored it, opting for a much cheaper and less rigorous approach. Thus, terrestrial invertebrate fauna surveys have started and very late and so far considered only of a 'pilot' project.

All advice on baseline surveys for invertebrate fauna from independent experts has been carefully reviewed and scrutinised. The CSIRO report was considered, along with advice from other invertebrate specialists. The author of the CSIRO report and other specialists (including CALM) participated in a workshop in Karratha on 6 July 2004, where the issues around baseline survey design were debated and discussed to determine the best approach. Professor Jonathan Majer of Curtin University, a respected invertebrate biologist, has designed a rigorous sampling methodology for identification of indigenous species and introduced species that incorporates the recommendations of a number of experts. The methodology is fit-for-purpose, and the Joint Venturers are allocating substantial resources to establish a baseline of invertebrate species.

The proposed approach for invertebrate baseline surveys has been discussed with the Quarantine Expert Panel, and has been subject to two peer reviews, both before and after field work that was undertaken to trial the baseline survey methodology. The peer review group discussed some recommendations to improve the methodology for subsequent field work over more sampling sites. This group expressed the view that the baseline survey work for invertebrates was proceeding satisfactorily.

4.12 There is clearly no chance that there will be adequate baseline data on invertebrates prior to the commencement of construction should the project be approved.

The Joint Venturers engaged CALM to develop a comprehensive bibliography of all biological surveys of Barrow Island. This inventory revealed a lack of knowledge about invertebrate species on the island. The Joint Venturers immediately responded by commissioning CSIRO to provide advice on baseline survey design, and consulted with a number of independent invertebrate experts to gain an understanding of the scope and desired strategy. Careful consideration was given to the respective advice, and in consultation with the Quarantine Expert Panel, a decision was made to proceed with a pilot study designed with the benefit of peer review.

The pilot baseline survey of invertebrates has been considered to be a positive step by the peer reviewers, which included experts from the Department of Agriculture, CALM and CSIRO. The peer reviewers advised the Joint Venturers on an expanded baseline survey to be undertaken during two periods in 2006. The second phase of baseline surveys will incorporate the recommendations of the peer review group, and will complete an adequate baseline of invertebrate species with regard activities associated with the proposed Gorgon Development.

The Joint Venturers will consult with CALM to gain insight into their existing and future strategies for baseline studies supporting Barrow Island. It is desirable to foster collaborative research and for the Joint Venturers' baseline objectives to complement CALM's scientific endeavours.

20.42 Detection of any threat is not possible without quality baseline data. Baseline data on the invertebrate fauna of Barrow Island are extremely scanty and invertebrate studies commenced only very recently. Gorgon commissioned a report from CSIRO on baseline survey methodology but subsequently opted for a cheaper and less rigorous approach. Thus, terrestrial invertebrate fauna surveys have so far consisted only of a 'pilot' project. Invertebrate collections are necessarily large and identifications take a lot of time, and invertebrate studies are slow to produce results. Like all biological surveys, they need to cover several years and different seasons before reaching a level of comprehensiveness. However, this brief pilot study has already detected one introduced 'tramp' ant, showing repeated claims of 'no introduced animals' on Barrow Island to be based on incomplete data. It therefore seems no longer possible to collect adequate 'baseline' data on invertebrates prior to the commencement of construction should the project be approved.

The Joint Venturers have compiled a comprehensive bibliography of all biological surveys of Barrow Island. A data gap is the limited knowledge of invertebrate species on the island. The Joint Venturers immediately responded by commissioning CSIRO to provide advice on baseline survey design, and consulted with a number of independent invertebrate experts to gain an understanding of the scope and desired strategy. All advice on baseline surveys for invertebrate fauna from independent experts has been carefully reviewed and considered. The CSIRO report was considered, along with advice from other invertebrate specialists. The author of the CSIRO report and other specialists participated in a workshop in Karratha on 6 July 2004, where the issues around baseline survey design were debated and discussed to determine the best approach.

Professor Jonathan Majer of Curtin University, a respected invertebrate biologist, has designed a rigorous sampling methodology for identification of indigenous species and introduced species that incorporates the recommendations of a number of experts. The methodology is fit for purpose, and the Joint Venturers are allocating substantial resources to Curtin University to establish a baseline of invertebrate species.

The pilot baseline survey of invertebrates has been considered to be a very positive step by the peer reviewers, which included experts from the Department of Agriculture, CALM and CSIRO. The peer reviewers also advised the Joint Venturers on an expanded baseline survey to be undertaken during two periods in 2006. The second phase of baseline surveys will incorporate the recommendations of the peer review group, and will complete an adequate baseline of invertebrate species with regard to proposed Gorgon Development activities.

The Joint Venturers will consult with CALM to gain insight into their existing and future strategies for inventory studies supporting this important Class A Nature Reserve. It is desirable to ensure that CALM's scientific endeavours complement the data acquisition objectives of the Joint Venturers in a collaborative manner.

In the case of the tramp ant, discovered as a direct result of the Joint Venturers' baseline survey efforts of invertebrates, experts consider this particular species of ant to be a 'cosmopolitan species' which is not likely to survive in the native environment (to be confirmed in an expanded baseline survey program). The tramp ant is prevalent in northern Australia and may have established itself on the island under a natural colonisation pathway, as happens frequently on islands; or it is possible that it was introduced by oilfield activities. However, this cannot be determined with certainty.

12.3.5 Terrestrial Baseline Data

12.8 The proposed construction period on Barrow is estimated at 3 1/2 years with a total of 3,300 people on Barrow at its peak (Exec Summary p.10). The large number of people working on the island has the potential to dramatically increase the use of existing tracks, create a proliferation of new tracks, and spread weeds and pests.

The existing oilfield operator has managed the potential impacts of weeds through flora surveys and a Weed Management Program that seeks to contain, monitor and eradicate non-indigenous plant species on Barrow Island. There are a total of 15 non-indigenous plant species that have been detected, with six of these in highly restricted distributions (Chevron Australia 2005; Section 12.3.5).

16.82 There appears, however, to be no indication as to how the continuing surveillance for pests on the Island is to be achieved.

The Joint Venturers engaged CALM to develop a comprehensive bibliography of all biological surveys of Barrow Island. It revealed that there is a limited amount of data of invertebrate species on the island. The Joint Venturers immediately responded by commissioning CSIRO to provide advice on baseline survey design, and consulted with a number of independent invertebrate experts to gain an understanding of the scope and desired strategy. Careful consideration was given to the respective advice, and in consultation with the Quarantine Expert Panel a decision was made to proceed with a pilot invertebrate baseline survey. This pilot baseline survey, sanctioned by the peer reviewers, which included experts from the Department of Agriculture, CALM and CSIRO. Following the relative success of the pilot baseline survey, the same peer review group advised the Joint Venturers on an expanded baseline survey which will be conducted in 2006.

This second phase of the invertebrate baseline survey will complete an adequate baseline of invertebrate species with regard to proposed Gorgon Development activities. The Joint Venturers will consult with CALM to gain insight into their existing and future strategies for baseline studies supporting this important Class A Nature Reserve. It is envisaged that this baseline survey complement CALM's own baseline activities in a collaborative manner and in conjunction with existing baseline information on vertebrates and plants provide information for the design of ongoing monitoring of the proposed development site and the immediately surrounding native environment for introduced species.

18.130 The proponent should provide comprehensive information on the current weed situation on Barrow Island, including details of the distribution and abundance of weeds on the island, the current weed management regime, and any progress made in controlling or eradicating weeds, particularly buffel grass and kapok.

Chevron Australia, as the operator of the oilfield on Barrow Island, has provided comprehensive information on the weed population on Barrow Island to CALM in the Weed Management Plan (Astron Environmental 2006), which is updated annually. The Plan includes knowledge of the current distribution of weeds, and progress on management activities to control and eradicate weed species (including buffel grass and kapok).

The Joint Venturers are currently performing a gap analysis of existing information to identify any further weed surveys which should be undertaken to augment a baseline for the proposed Development activities. Results of the gap analysis will be presented to CALM through its participation in the Quarantine Advisory Committee, and published on the Developments quarantine website.

18.132 The discrepancy in the number of weed species on Barrow Island cited in chapters 8 and 12 should be corrected.

The text should read '15' weed species in both cases.

18.133 Information should be provided by Chevron Australia regarding the introduction of *Setaria verticillata* on Barrow Island in terms of how it is thought to have been introduced to the island, its distribution and numbers on the island, eradication measures, and ongoing monitoring.

Sectaria verticillata was first recorded by Mr Harry Butler (a copy the 1979 collection list is available where he listed *Setaria carnie*, as it was previously known). Therefore, the Joint Venturers are of the opinion the species has been on the island for some time. Presently, the species occurs in dense *Sporobolus virginicus* grassland in semi-saline sand at the mouth of a drainage line that continues down to White's Beach. This drainage line was likely, a long time ago, used as a road by WAPET. It is also possible that there was also some sort of a camp in the vicinity.

Environmental contractors to the oil operation and their own personnel have surveyed almost the entire pipeline on Barrow Island in the past five years. These surveys included the low, undulating limestone hill slopes and also coastal plains towards the southern end of the island and this species was not encountered anywhere in these areas. It seems therefore that this species does not commonly occur in these habitats.

Originally, only four plants were found in quadrants behind White's Beach during the survey for the Gorgon Development. However subsequently personnel surveyed the wider area and found between 100–200 plants growing amongst dense *Sporobolus virginicus* on the flats at the mouth of the drainage line. Plants were seeding at that stage. To date no additional surveys could be conducted in other similar habitats (i.e. behind coastal dunes on the west side of the island) to ascertain the distribution status of this species as surveys need to be done again after rainfall which has not yet occurred in this season. The location of this population has been added to the existing Barrow Island joint Venture Weed Program database for the island.

The species is a very well known invasive plant which may have established on the island naturally or anthropogenically. The weedy *Setaria verticillata* species is a weed species known to interfere in disturbed and managed habitats. Several globally successive waves, from pre-agricultural times to the present, have resulted in widespread infestation around the world. The success of the *Setaria verticillata* is well documented and relates to its intimate relationship with humans, man-made perturbations and land management practices.

The exact introductory history of this plant arriving on Barrow Island is unknown. A realistic introductory pathway may be seabirds as they move between islands. The species is not known from Varanus Island (closest to Barrow) but *Setaria dielsii* does occur. The Joint Venturers do not have a species list from CALM for the Monte Bello Islands to determine the status of the species on that island as it may be a source of introduction following the disturbance regimes on that island in the past that may have created a colonising opportunity for the species post-disturbance. *Setaria dielsii* occurs on Varanus – Serrurier – and Airlie Islands and grows prolifically in sands disturbed by wedge-tailed shearwaters. These sands are semi-saline, loosely consolidated and regularly disturbed by the birds. It could be expected that *Setaria verticillata* would survive in such disturbed, semi-saline sands which further complicates speculation as to the potential source of introduction on Barrow Island.

The ability to adapt rapidly to local conditions is the hallmark of this weed species. Genotypic and phenotypic biodiversity equips this species with remarkable abilities to colonise and adapt to a wide range of habitats around the world. The dormancy in seed during embryogenesis is one such adaptation where the formation of long-lived, heterogeneous seed pools in the soil is the consequence.

After-ripening, the temporal occurrence of seed germination and an induction of a secondary dormancy, influenced by seasonally and diurnally levels of oxygen present in the soil, availability of water, and temperature pulses ensures this species a competitive advantage through a phenotypic plasticity. This maximises growth and reproduction to the specific localised conditions encountered.

These attributes of *Setaria verticillata* challenges science in making accurate predictions as to status and distribution. The discovery on Barrow Island may be a singular colonization event or it may be more advanced with a successful foothold. A baseline survey and desktop study has been undertaken to determine the current status of the species and the available knowledge on the species. Once completed the Joint Venturers, in collaboration with oil operator, will include the findings as part of the Weed Management Plan for Barrow Island.

These traits for adaptation of this species that needs careful consideration before embarking on an eradication campaign include tolerance to many inhibitory chemicals (e.g. herbicides, salt), vegetative stimulation to mechanical damage, and drought. In addition, genetic traits such as self-pollination and small genome size contribute to a highly diverse collection of locally adapted genotypes and phenotypes ready to exploit any opportunities provided by an ill-founded eradication strategy. The history of invasion and colonisation pathway (i.e. where is the original genetic source), the local life histories, and the evolutionary potential of this weed group emphasise the need for accurate prediction of its behaviour before embarking on an eradication program. The Joint Venturers recognise the importance of an appropriate response to any instructions of non-indigenous species but are aware of an inappropriate eradication response.

In the interim, the Joint Venturers will collaborate closely with the oil operator and CALM in devising a competent monitoring and surveillance plan to support management in its decision-making regards this weed.

18.168 The proposed monitoring program for quarantine management on Barrow Island should include an additional objective to determine what factors have caused any environmental change (page 546).

It is recommended that all baseline surveys should be prepared in consultation with CALM. The results of baseline surveys should be made available to CALM.

All baseline surveys, contributing to the ongoing monitoring of the success of quarantine programs, will be designed with input from a range of experts including CALM. The Chevron Australia Incident Investigation process will include determination of the cause of potential breaches in the quarantine system as is currently undertaken for the existing Barrow Island operations. Monitoring results will be reported to CALM.

12.3.6 Marine Baseline Data

23.14 However it is important to emphasize that Chevron Australia intent to base construction activity out of Dampier Harbour. Dampier is one of Australia's busiest ports and does not have a current survey of introduced marine pests (IMP). This is a risk factor that should be addressed to reduce the risk of transference of IMP from Dampier to Barrow.

Recommendation; If extensive supply boat shipping is to move between Dampier Harbour and Barrow Island then a Introduced marine pest surveys of Dampier must be completed

24.66 Has the Dampier Port agreed to participate in the collaborative baseline survey of Dampier?

The Joint Venturers support a collaborative baseline survey of the Port of Dampier (Chevron Australia; p 547).

The Joint Venturers note that although the Ports of Dampier and Onslow have not yet been the subject of a baseline survey, 'the Joint Standing Committee on Conservation/Standing Committee on Fisheries and Aquaculture (SCC/SCFA) National Task Force on the Prevention and Management of Marine Pest Incursions has recommended that baseline surveys be undertaken for all Australian first ports of call'. The Joint Venturers recognise that the Department of Primary Industry is the responsible authority for Ports in Western Australia. Port areas in Dampier should be surveyed in 2006 or 2007 to determine which introduced species are in the port that may be subsequently transferred to Barrow Island. The Joint Venturers remain faithful to the commitment to collaborate with the Port Authority. The Joint Venturers will agree to participate in a baseline survey that investigates the status of marine pest species, if any, in the Port of Dampier, with regard to quarantine risks to Barrow Island.

12.4 Gorgon Quarantine Risk Management

4.14 The Gorgon EIS/ERMP approach to quarantine seems less than realistic. In Chapter 10, at pp. 302, no high risk stressors are identified, i.e., apparently Gorgon does not believe that quarantine failure poses not significant environmental risks.

Quarantine incidents are clearly recognised as a potential threat to the biodiversity of Barrow Island, and are dealt with extensively in Chapter 12 of the Draft EIS/ERMP. As explained in the text on p 304 of the Draft EIS/ERMP: 'Risks associated with the accidental introduction of non-indigenous species or pathogens are discussed in Chapter 12'.

5.6 Gorgon will propose unnecessary quarantine threats to the terrestrial and marine environment.... Besides introduced species, diseases and bacteria may be introduced that may have devastating effects on "Noah's Ark".

The threats of introduction along the terrestrial and marine pathways have been identified in a comprehensive and systematic manner in the risk-based assessment methodology for quarantine. This methodology was developed in consultation with experts and involving a high level of public consultation (Chevron Australia 2005; Section 12.4). For each identified threat, at every pathway step, barriers to prevent the 'infection' of people, cargoes and vessels have been considered in a transparent manner, relying on the advice and critique of independent experts. The proposed barriers for every pathway are subject to the Quarantine Hazard Analysis (QHAZ), to verify that each barrier will meet its design intention and result in an overall likelihood of introduction on each pathway that is low. Details of the three priority pathways are presented in the Additional Information Package of the Draft EIS/ERMP (Chevron Australia 2005b).

The Joint Venturers obtained advice on potential threats of disease to conservation values in the form of desktop studies, as recommended by the Quarantine Expert Panel. These reports are presented in Technical Appendices D8 and D9 of the Draft EIS/ERMP. Micro-organism threats to terrestrial vertebrate fauna were addressed by the School of Veterinary and Biomedical Sciences at Murdoch University. The plant pathogen threats were discussed by the Curator of the Plant Pathology Herbarium of the Department of Primary Industries and Fisheries, Queensland. Potential pathogens and their hosts were identified in these studies, such that quarantine management would take these into account when developing barriers, particularly for the food and perishables and personnel pathways.

- 6.1 The proposed development would create serious risks to the unique, fragile and threatened ecosystems of Barrow Island, especially regarding the introduction of pest and weed species, as well as the construction and operation of the processing facility including pipelines, roads and dredging.

The Joint Venturers recognise the sensitivity of the ecosystems of Barrow Island and have proposed a range of management strategies to reduce environmental risks to acceptable levels. Proposed mitigation measures are detailed in Chapters 10–15 (for each environmental factor) and in the Framework Environmental Management Plan, Technical Appendix A1 (for each construction activity).

- 8.22 The text of the quarantine chapter outlines a commitment to undertake hull inspections prior to loading of cargos destined for Barrow Island and cleaning and maintenance of anti-foul paint if necessary (pg 559). This does not appear to have been carried through the Marine Environmental Risk Assessment chapter which seems to only reference AQIS ballast water requirements.

The Draft EIS/ERMP states: ‘To mitigate translocation of species from foreign ports during the construction period, inspection of wetted hull surfaces (followed by cleaning/disinfection and maintenance of anti-fouling paint, if necessary) will be required to verify that threats of introduction are being managed prior to loading of cargoes destined for Barrow Island.’ The quarantine barriers for marine vessels are at present being developed and will be subject to the same risk-based assessment method as all other pathways.

- 12.8 The proposed construction period on Barrow is estimated at 3 1/2 years with a total of 3,300 people on Barrow at its peak (Exec Summary p.10). The large number of people working on the island has the potential to dramatically increase the use of existing tracks, create a proliferation of new tracks, and spread weeds and pests.

The gas processing operations on Barrow Island covers no more than 300 ha, only 1.3% of Barrow Island’s total land mass. Any new access tracks for the Gorgon Development will be included in the 300 ha. There will be an increase in traffic on existing tracks and roads. This will be managed in accordance with the existing procedures on Barrow Island governing training, speed restrictions, off road access etc. The Gorgon quarantine management system aims to continue protecting the plants and animals on and around Barrow Island. The focus is on preventing introduced species from getting to Barrow Island through pathways such as food, personnel and luggage, and materials, such as sand and aggregate. Detection and response strategies will also be in place to prevent the establishment of any introduced species in the native environment. Workforce management is also addressed in Section 3.1 of Technical Appendix A1 in the Draft EIS/ERMP.

- 18.78 Chevron Australia should conduct a further assessment of potential indirect impacts on terrestrial fauna and other biodiversity values on Barrow Island as a result of the proposed development, that considers factors other than the clearance of 300 hectares of vegetation, such as the introduction and spread of disease and parasites, weeds, non-native animals and habitat loss and fragmentation.

Habitat loss and fragmentation have been considered in the current assessment of ecological risks associated with the Development. Habitat loss is mainly associated with vegetation clearing, but also includes loss of physical habitats such as bettong warrens, termitaria and rock holes (Chevron Australia 2005; pp 350–356). Habitat fragmentation was taken into account in site selection and contributed to the current location of the proposed gas processing facility. This avoids potential fragmentation effects of bisecting the linear coastal habitats such as dunes. Potential barriers to fauna movement such as pipelines would be raised or buried to allow fauna transit (Chevron Australia 2005; p 368). The potential for reducing habitat fragmentation on the mainland will be examined by attempting to lay the domestic gas pipeline as an extension of the existing easement. The introduction and spread of disease due to micro-organisms has been the subject of extensive consultation with plant and animal disease specialists.

The Joint Venturers obtained advice on potential threats of disease to conservation values in the form of desktop studies, as recommended by the Quarantine Expert Panel. These reports are presented in Technical Appendices D8 and D9 of the Draft EIS/ERMP. Micro-organism threats to terrestrial vertebrate fauna were addressed by the School of Veterinary and Biomedical Sciences at Murdoch University. The plant pathogen threats were discussed by the Curator of the Plant Pathology Herbarium of the Department of Primary Industries and Fisheries, Queensland. Potential pathogens and their hosts were identified in these studies, such that quarantine management would take these into account when developing barriers that will protect sensitive species like the black-flanked rock wallaby mentioned in the submission.

The Joint Venturers have committed to an iterative process of pathway and barrier development and as new information and knowledge becomes available on micro-organisms such information and potential modifications to the existing barrier designs will be subject to the same scrutiny as was performed in the original QHAZ workshops.

12.4.1 Introduction to Risk-based Management

No submissions received on this section of the Draft EIS/ERMP.

12.4.2 Risk Assessment Method

13.6 We would comment that there appears to be no mention of fouling organisms in relation to the aggregate barges. If these are mentioned elsewhere in the documentation, it would be useful to cross reference the pathway.

Marine vessels are a separate pathway of potential marine introduction to the waters surrounding Barrow Island; irrespective of the cargoes they carry (Chevron Australia 2005; Box 12-7, p 552). Marine vessels have been the subject of the same risk-based assessment method as all other pathways, and much progress has been made to identify the threats and suggest possible quarantine barriers for ballast water and hull fouling organisms (Chevron Australia 2005; Table 12-3, p 561). Quarantine barrier selection is in progress and will be scrutinised in QHAZ workshops. Refer also to Draft EIS/ERMP Section 12.5.6 Page 575.

12.4.3 Development of Standards for Acceptable Risk

4.5 Despite the amount of work undertaken, Gorgon can not demonstrate that it will be able to meet the 'Community expectations for acceptable risk' requested by the EPA and developed under the guidance of the Quarantine Expert Panel (pp. 555–556).

The Joint Venturers participated in several community workshops to gain an understanding of community expectations for acceptable risk (Technical Appendix D3), which were reported to the wider community through public consultation meetings. In the second and third public workshops, there was considerable discussion regarding situations where the risk scores would not meet the community expectations for acceptable risk. As a result of the consultation with the community and experts, the Joint Venturers developed standards for acceptable risk (Chevron Australia 2005; Boxes 12-9 to 12-12). These standards give attention to the expectations of the community, and have been addressed for the three priority pathways in the Additional Information Package (Part 2) of the Draft EIS/ERMP (Chevron Australia 2005b).

- 4.6 The three 'priority' pathways detailed in the 'Additional Information Package' all finish up with infection scores allocated by the experts above '1', eg, for food and perishables, the scores are invertebrates 2, vertebrates 2, plants 2-3 (See Additional Information Package, Part B, pp. 8-9, 12 and 18. Note also that the 'decision rules' described in Chapter 12 were removed from the scoring process following advice from the QAC).

The Joint Venturers demonstrated that risk standards can be achieved to meet the expectations of the public. The possibility that introduction scores could not be reduced to a score of '1' was discussed transparently in the Risk Standards Workshops #2 and #3 (Chevron Australia 2005; Technical Appendix D3). This was reported to the wider community during the development of the risk standards framework (starting with Community Consultation Meeting #2, 20 April 2004, and in subsequent meetings). However, the Joint Venturers also noted the view expressed by the community in these Risk Standards Workshops, that there should be a commitment 'to a risk scaling of 3 as an upper limit'. This is the limit that the community and the technical experts viewed as acceptable levels of risk within the context of a 'zero tolerance' approach to introductions of non-indigenous species to Barrow Island. As such, the introduction scores for the food and perishables pathway are consistent with this upper limit, and the Joint Venturers standards for acceptable risk (Chevron Australia 2005; Box 12-9).

- 4.7 The first of the three acceptable risk scenarios, which has an infection score of '1', is the only one that can be applied to this project. This is because it is not possible to allocate a survival score of less than 4 (as there will always be a proportion of organisms that will survive on the island once they arrive, as demonstrated by the weeds, rats and tramp ant that have already survived there) and Chevron is unable to demonstrate (and has not tried to do so) that detection and eradication scores will be less than 4, let alone 1.

The Joint Venturers demonstrated that risk standards can be achieved to meet the expectations of the public. The possibility that introduction scores could not be reduced to a score of '1' was discussed transparently in the Risk Standards Workshops #2 and #3 (Chevron Australia 2005; Technical Appendix D3). This was reported to the wider community during the development of the risk standards framework (starting with Community Consultation Meeting #2, 20 April 2004, and in subsequent meetings). However, the Joint Venturers also noted the view expressed by the community in these Risk Standards Workshops, that there should be a commitment 'to a risk scaling of 3 as an upper limit'. This is the limit that the community and the technical experts viewed as acceptable levels of risk within the context of a 'zero tolerance' approach to introductions of non-indigenous species to Barrow Island. As such, the introduction scores for the food and perishables pathway are consistent with this upper limit, and the Joint Venturers standards for acceptable risk (Chevron Australia 2005; Box 12-9).

The result of the community Risk Standards Workshops was a view that 'the risk of establishment of introduced species is acceptably low if it conforms to the Risk Standard Framework' (Technical Appendix D3, Item 3 in the record of Workshop #3). This framework consists of three scenarios. The first scenario (infection score of '1') was considered the highest priority by the community. However, two other scenarios were put forward if the infection score could not be reduced to '1', which states that the infection scores should be '3' or less. The community expressed the view that introductions could not be entirely prevented ('risks would not be zero') in developing the risk standards framework, and that 'the consequences which resulted in the establishment of an introduced species would be unacceptable' [emphasis added].

It is acknowledged that some organisms that might be introduced could survive on Barrow Island and become established in the native environment. The Joint Venturers have committed to a rigorous quarantine regime which leads to a low likelihood of incursions (the conclusion of the assessment of three priority pathways in the Additional Information Package). The Joint Venturers are also committed to implementing a monitoring system that will enable early detection at the proposed Development site and in the immediate native environment, so that an appropriate response can be rapidly initiated to protect the conservation values of Barrow Island.

The examples of weeds, rats and the tramp ant species are shared concerns. In the case of weeds, the existing oilfield operation has developed a comprehensive weed management program. The eradication and management efforts have contained the spread of the weeds of concern. The oilfield operation is systematically reducing the weed distribution with the objective of eradication from Barrow Island. The existing oilfield operator has successfully eradicated a mouse introduction, whilst disturbing only a very small area of Barrow Island. CALM has carried out a rat eradication effort at the southern end of the island. Non-native rats are believed to be completely absent on Barrow Island.

The tramp ant, which is prevalent in northern Australia and was discovered on Barrow Island as a direct result of the Joint Venturers' baseline survey efforts of invertebrates, is considered by experts as a 'cosmopolitan species' that is not likely to survive in the native environment (to be confirmed in an expanded baseline survey program). The tramp ant may have established itself on Barrow Island under a natural colonisation pathway, as happens frequently on islands. However, this cannot be determined with certainty.

The Joint Venturers will establish a competent monitoring and surveillance program supported by a Response and Eradication Strategy. The Joint Venturers are committed to respond quickly and effectively to any quarantine emergency that might threaten the biodiversity of Barrow Island, as stated in the Barrow Island Quarantine Policy (Chevron Australia 2005; Box 12-1), and described in Section 12.5.9 of the Draft EIS/ERMP.

14.11 Thus as yet there is not yet any scoring of survival, detection or eradication it cannot be determined if community standards can be achieved. It is noted that this is acknowledged as work needing to be done but when this will be done, how this information will be used and how it will be disseminated is unclear.

The Joint Venturers transparently communicated the advice of independent experts with regard to the difficulties of scoring survival, detection and eradication for a wide range of potential organisms. This was discussed with the Quarantine Expert Panel, and communicated to the Community Risk Assessment Workshop and the Community Consultation Meeting in April 2004.

Since the objective of quarantine risk assessment and barrier selection is to prevent all introductions, allowing for a wide variety of potential sources, it is impossible to score survival with any confidence. Survival, however, has been considered in an important way through the advice of experts when proposing barriers for consideration. Often the broad types of organisms that might infect a pathway were identified, such as windblown seeds and crawling invertebrates at a quarry. There are many cases of barriers which will greatly reduce the likelihood of survival, even if survival was not explicitly scored.

Examples from the three priority pathways (Part 2 of the Additional Information Package) are: the prohibition certain types of food which would be likely to survive if released to the native environment on the Food and Perishables Pathway; the pre-qualification of quarries, where weed management programs must be in place to reduce the likelihood of infecting clean quarried sand and rock with weeds of concern (e.g. kapok and buffel grass) on the sand and aggregate pathway; the processing sand and aggregate through a high energy vibrating hopper which is very likely to sufficiently impair any vertebrates, invertebrates and plant propagules; the treatment of aircraft holds with insecticide on the personnel and luggage pathway; and the custody and control of personnel and their belongings at the construction village.

14.12 At this time the Gorgon gas development has not met the standards for risk developed through community and agency consultation. The Commission participated in the development of these standards and regards them as the minimum acceptable standards for a biodiversity assess as valuable as Barrow Island Nature Reserve.

The Joint Venturers have developed a set of standards for acceptable risk, with advice from experts and substantial community input, and explicitly acknowledging the useful advice of the Conservation Commission of WA (Chevron Australia 2005; Technical Appendix D3). These standards are presented in Boxes 12-9 through 12-12 of the Draft EIS/ERMP. Details of the three priority pathways are presented in Part 2 of the Additional Information Package (Chevron Australia 2005b), showing how the standards have been met in a rigorous and transparent manner for the three priority pathways, relying on the judgment and advice of independent experts participating in QHAZ workshops.

The Joint Venturers transparently discussed the possibility that introduction scores could not be reduced to a score of '1' in the Risk Standards Workshops #2 and #3 (Chevron Australia 2005; Technical Appendix D3), and also reported this to the wider community during the development of the risk standards framework (starting with Community Consultation Meeting #2, 20 April 2004, and also in subsequent meetings). The Joint Venturers discussed the additional measures that have been adopted in situations where risk scores cannot be reduced to '1'. The community also expressed the view in these Risk Standards Workshops, that there should be a commitment 'to a risk scaling of 3 as an upper limit'. As such, the introduction scores for the pathways presented in Part 2 of the Additional Information Package are consistent with this upper limit, and meet the Joint Venturers' standards for acceptable risk.

It is important to note, as stated in the Additional Information Package, that the scores for introduction cannot be further reduced based on the advice of independent experts attending the QHAZ workshops. The experts also expressed the view, on many occasions, that the scores for introduction reflect a precautionary judgment of risk (maximum scores) based on a lack of performance data for the barriers that have been proposed, which will set a new standard for quarantine protection not observable elsewhere.

The Joint Venturers will monitor the performance of proposed barriers on each pathway to ensure that the barriers are effective, and to continuously improve barrier performance under the QMS to protect the biodiversity of Barrow Island.

14.14 Recommendation 3: The Conservation Commission further recommends that the inability to produce risk scoring for survival, detection and eradication must be explained with the provision of an alternative mechanism to describe risk in these areas. This alternative mechanism and the acceptability of the project's environmental risks should be subject to a further period of public and agency review.

The Joint Venturers transparently communicated the advice of independent experts with regard to the difficulties of scoring survival, detection and eradication for a wide range of potential organisms. This was discussed with the Quarantine Expert Panel, and communicated to the Community Risk Assessment Workshop and the Community Consultation Meeting in April 2004.

Since the objective of quarantine risk assessment and barrier selection is to prevent all introductions, allowing for a wide variety of potential sources, it is impossible to score survival with any confidence. Survival, however, has been considered in an important way through the advice of experts when proposing barriers for consideration. Often the broad types of organisms that might infect a pathway were identified, such as windblown seeds and crawling invertebrates at a quarry. There are many cases of barriers which will greatly reduce the likelihood of survival, even if survival was not explicitly scored. Examples are mentioned in the assessment of the three priority pathways (Part 2 of the Additional Information Package).

Substantial experience has been gained over almost two years with the risk-based assessment method in some 21 workshops, involving 29 independent technical experts attending one or more workshops (not counting government and stakeholder observers). The scoring of introduction and survival is relevant to pre-border assessment of quarantine barriers on potential pathways of introduction. It has not been possible to score detection and eradication, a post-border barrier to establishment of any species that might slip through pre-border and border quarantine barriers. Detection and eradication is a species-specific, border and post-border quarantine barrier, which is independent of the pathway that might introduce an organism to Barrow Island.

While explicit scoring for detection and eradication is not possible for the wide range of organisms that might be introduced (even though the risk of introduction is low), the Joint Venturers will implement an effective surveillance and monitoring program to enable early detection of organisms at the border and in the native environment. Progress on the surveillance and monitoring program is benefiting from the advice of experts and the Quarantine Advisory Committee. Early detection of an incursion, in the unlikely event that a non-indigenous species arrives and survives on Barrow Island, will be followed by immediate and effective species-specific response (Figure 12-14 of the Draft EIS/ERMP) that will be guided by appropriate experts from (in no particular order) the Department of Agriculture, the Western Australian Museum, CALM, Curtin University, University of Western Australia, Murdoch University, CSIRO, conservation biologists and any other specialist expertise that may be needed.

Eradication has also been dealt with in the risk assessment workshops, through the suggestion of barriers which are designed to avoid the possibility of introducing organisms which would be particularly difficult to eradicate. Numerous examples can be taken from the assessment of the three priority pathways (Part 2 of the Additional Information Package).

18.25 Quarantine management is one of the most significant concerns of the proposed Gorgon gas development. It is CALM's view that, despite the establishment of a quality framework to undertake an overall approach to quarantine management on Barrow Island that is sound, the subsequent detailed risk assessment and scoring process determined through workshops has considerable flaws. The accuracy of risk score values is questionable, and a precautionary approach should be applied in the use of risk scores given their subjectivity based on the personal judgment of individuals.

The Joint Venturers have undertaken 21 workshops as of the publication of the Additional Information Package (Chevron Australia 2005b), involving 29 independent technical specialists in one or more workshops. The workshops have been professionally facilitated to ensure that the risk scores and definitions have been consistently applied by the participants, and a wealth of experience has been gained to demonstrate how the scores are used in practice. The accuracy of the judgments is assured through the proven risk assessment practice of engaging technical experts as a group, where debate and discussion among independent experts occurred transparently. In the event of uncertainty or differences of opinion, the range of scores was recorded in every case. The results of all workshops are published on the Gorgon Development quarantine website <www.gorgon.com.au>. Ultimately, the accuracy of scoring rests with the independent experts who have repeatedly attended workshops and confidently exercised their interpretation of the scores with their colleagues.

It is important to note, as stated in the Additional Information Package, that the scores for introduction cannot be further reduced based on the advice of independent experts attending the QHAZ workshops. The experts also expressed the view, on many occasions, that the scores for introduction reflect a precautionary judgment of risk (maximum scores) based on a lack of performance data for the barriers that have been proposed, which will set a new standard for quarantine protection not undertaken elsewhere.

18.27 Regardless of the vast array of quarantine measures proposed to be implemented as part of the Gorgon gas development on Barrow Island, it must be recognised that there still remains a risk of a major quarantine breach. It is CALM's view that the proponent has not demonstrated that the risk standards can be met with a very high level of confidence.

The Joint Venturers believe they have demonstrated that the Standards for Acceptable Risk (Boxes 12-9 through 12-12 of the Draft EIS/ERMP) can be met with a very high level of confidence. The presentation of the proposed barriers for the three priority pathways, and the scoring of risk by independent experts confirms this, in Part 2 of the Additional Information Package (Chevron Australia 2005b).

The community expressed the view that introductions could not be entirely prevented ('risks would not be zero') in developing the risk standards framework, and that 'the consequences which resulted in the establishment of an introduced species would be unacceptable' [emphasis added].

It is acknowledged that some organisms that might be introduced could survive on Barrow Island, in the event that they were able to gain a foothold in the native environment. The Joint Venturers have committed not only to a rigorous quarantine regime which leads to a low likelihood of incursions (the conclusion of the assessment of three priority pathways in the Additional Information Package), but also to implement a monitoring system that will enable early detection at the proposed development site and in the immediate native environment, so that an appropriate response can be rapidly initiated to protect the conservation values of the island.

The examples of weeds, rats and the tramp ant species are cases in point. In the case of weeds, the existing oilfield operation has developed a comprehensive weed management program which shows that the efforts have contained the spread of the weeds of concern and is systematically reducing their distribution with the objective of complete eradication from Barrow Island over time. In the case of introduced animals, the existing oilfield operator has successfully eradicated a mouse introduction, disturbing a very small area of the native environment, and CALM has carried out a rat eradication effort on the southern end of Barrow Island. Non-native rats are believed to be completely absent on Barrow Island.

In the case of the tramp ant, discovered as a direct result of the Joint Venturers' baseline survey efforts of invertebrates, experts consider this particular species of ant which is prevalent in northern Australia to be a 'cosmopolitan species' which is not likely to survive in the native environment (to be confirmed in an expanded baseline survey program). The tramp ant may have established itself on Barrow Island under a natural colonisation pathway, as happens frequently on islands; or it is possible that it was introduced by oilfield activities.

Benefiting from the existing successes on the island, the Joint Venturers will also put in place a competent monitoring and surveillance program supported by a Response and Eradication Strategy. The Joint Venturers are committed to respond quickly and effectively to any quarantine emergency that might threaten the biodiversity of the Island, as stated in the Barrow Island Quarantine Policy (Box 12-1 of the Draft EIS/ERMP), and described in Section 12.5.9 of the Draft EIS/ERMP (Chevron Australia 2005).

18.134 A potential conservation offset would be for Chevron Australia as operator for Gorgon and the oil operations on the island to eradicate completely buffel grass and other weed occurrences. A zero tolerance for weeds as well as animal pests would be a good environmental outcome. Chevron Australia should commit to the eradication of existing weed infestations on the Barrow Island oil leases, including Middle and Boodie Islands, and any of the smaller islands close to Barrow

Chevron Australia, as the operator of the existing oilfield on Barrow Island, has undertaken surveillance and management of buffel grass, as reported to CALM in the Weed Management Program (Chevron Australia 2005). Progress to date indicates that eradication and management efforts have contained the spread of the weeds of concern and are systematically reducing their distribution with the objective of complete eradication from Barrow Island over time. The Joint Venturers are committed to continue the progress being made.

The Joint Venturers have already committed to a 'zero tolerance of invasions target', as reflected in the development of standards for acceptable risk (Technical Appendix D3).

18.149 It is recommended that the Scenario 1 risk profile for quarantine management (Figure 12-4) represents the only acceptable risk scenario.

The result of the community Risk Standards Workshops was a view that 'the risk of establishment of introduced species is acceptably low if it conforms to the Risk Standard Framework' (Technical Appendix D3, Item 3 in the record of Workshop #3). The framework consists of three scenarios. The first scenario (infection score of '1') was considered the highest priority by the community. However, two other scenarios were put forward if the infection score could not be reduced to '1', which stated that the infection scores should be '3' or less. The community expressed the view that introductions could not be entirely prevented ('risks would not be zero') in developing the risk standards framework, and that 'the consequences which resulted in the establishment of an introduced species would be unacceptable' [emphasis added].

18.150 CALM recommends that in regard to residual risk, a score of above 1 is not an acceptable risk.

The Joint Venturers have developed a set of standards for acceptable risk, with advice from experts and substantial community input, and explicitly acknowledging the useful advice of CALM (Chevron Australia 2005; Technical Appendix D3). These standards are presented in Boxes 12-9 through 12-12 of the Draft EIS/ERMP (Chevron Australia 2005). Details of the three priority pathways are presented in Part 2 of the Additional Information Package, showing how the standards have been met in a rigorous and transparent manner for the three priority pathways, relying on the judgment and advice of independent experts participating in QHAZ workshops.

The Joint Venturers transparently discussed the possibility that introduction scores could not be reduced to a score of '1' in the Risk Standards Workshops #2 and #3 (Technical Appendix D3), and also reported this to the wider community during the development of the risk standards framework (starting with Community Consultation Meeting #2, 20 April 2004, and also in subsequent meetings). The Joint Venturers discussed the additional measures that have been adopted in situations where risk scores cannot be reduced to '1'. The community also expressed the view in these Risk Standards Workshops, that there should be a commitment 'to a risk scaling of 3 as an upper limit'. As such, the introduction scores for the pathways presented in Part 2 of the Additional Information Package are consistent with this upper limit, and meet the Joint Venturers' standards for acceptable risk.

It is important to note, as stated in the Additional Information Package, that the scores for introduction cannot be further reduced based on the advice of independent experts attending the QHAZ workshops. The experts also expressed the view, on many occasions, that the scores for introduction reflect a precautionary judgment of risk (maximum scores) based on a lack of performance data for the barriers that have been proposed, which will set a new standard for quarantine protection not observable elsewhere.

The Joint Venturers will monitor the performance of proposed barriers on each pathway to ensure that the barriers are effective, and to continuously improve barrier performance under the QMS to protect the biodiversity of Barrow Island.

18.165 The EPA should not consider approving the Gorgon gas development unless the Joint Ventures commit, and are legally required, to manage quarantine for all prescribed activities for Barrow Island to the same standard.

The Joint Venturers have committed to manage quarantine for all pathways, encompassing all development activities, using the same risk-based assessment method, barrier selection process, and meeting the standards for acceptable risk (Draft EIS/ERMP Section 12.7 Page 593).

20.35 It is WWF-Australia's view that the draft EIS/ERMP fails to adequately assess the increased potential risk of the introduction of exotic animals, plants and microorganisms to the integrity of the biodiversity within the Barrow Island Nature Reserve. WWF-Australia assesses the risk of quarantine breach and invasive plant and animal species becoming established on Barrow Island as critical (widespread long-term impact on population. Extinction of race) and almost certain. WWF-Australia maintains that these risks disqualify Barrow Island as a candidate site for the proposed development.

The Joint Venturers have relied on independent advice to conclude that the risks associated with the proposed development, when managed through barriers which meet standards for acceptable risk in all the identified pathways, is low. This conclusion is supported by the current oil operations on the island.

The Joint Venturers, through Chevron as the operator of the existing Barrow Island oilfield operations, already have 40 years of quarantine experience that has served to protect the conservation values of Barrow Island. This is an accomplishment the operator is proud of. The Joint Venturers appreciate the challenge of developing a world class QMS for the proposed Gorgon Development which builds on the legacy of the existing quarantine management program in a manner that can accommodate the increased activities associated with the proposed development. In this regard Chevron Australia has made substantial progress in developing a competent quarantine capacity in the organisation. This capacity has advanced from its initial grass-roots beginnings of quarantine management to a visible quarantine culture evident in the workforce.

The Joint Venturers are developing high performance barriers for all of the potential pathways of introduction with the goal of no introductions and consistency with the standards for acceptable risk. In addition to the high performance barriers, the Joint Venturers are committed to developing a monitoring program that will rapidly detect an introduction, and mobilise an immediate Response and Eradication Strategy. This approach is informed by current practices on the island, which have successfully eradicated introduced species in the past. The Joint Venturers are confident in their ability to improve on the existing practices.

The assessment of priority pathways by independent experts (Part 2 of the Additional Information Package) has resulted in a judgment that the risk of introduction is low.

20.38 At present, despite the amount of work undertaken, Gorgon can not demonstrate that they will be able to meet the 'Community expectations for acceptable risk' developed under the guidance of the Quarantine Expert Panel (pp555–556). (WWF-Australia notes that, as stated at the Community Consultation Meeting, the 'decision rules' relating to an end-score for a series of barriers described in Chapter 12 of the main document have been scrapped, following advice from the newly set up Quarantine Advisory Committee).

The three 'priority pathways detailed in the 'Additional Information Package' yielded infection scores above '1' for food and perishables, invertebrates, vertebrates and plants. (See additional Information Package, pp. 8–9, 12 and 18). Within the three acceptable risk scenarios, an infection score of '1' is clearly the only one that can be applied to the project. It is not possible to allocate a survival score of less than 4 (as there will always be a proportion of organisms that will survive on the island once they arrive, as demonstrated by the weeds, rats and the tramp ant that have already survived there) and Gorgon is unable to demonstrate that detection and eradication scores will be less than 4, let alone 1.

The Joint Venturers have demonstrated that risk standards can be achieved that meet the expectations of the public. The possibility that introduction scores could not be reduced to a score of '1' was discussed transparently in the Risk Standards Workshops #2 and #3 (Technical Appendix D3). This was reported to the wider community during the development of the risk standards framework (starting with Community Consultation Meeting #2, 20 April 2004, and also in subsequent meetings).

The Joint Venturers also noted the view expressed by the community in these Risk Standards Workshops, that there should be a commitment 'to a risk scaling of 3 as an upper limit' which the community and the technical experts viewed as acceptable levels of risk within the context of a 'zero tolerance' approach to introductions of non-indigenous species to Barrow Island. As such, the introduction scores for the food and perishables pathway, the sand and aggregate pathway and the people and luggage pathway are consistent with this upper limit, and the Joint Venturers standards for acceptable risk (Box 12-9 of the Draft EIS/ERMP).

20.39 Chevron has made much of the existing oilfield's quarantine success, despite numerous documented quarantine breaches. While Gorgon states that there will be a better quarantine management system in place for the gas plant, the very large size of this industrial development, with a peak construction work force of more than 3000 people and involving the transport of many thousands of tonnes of sand, aggregate, equipment and food to the island suggests that the chances of a breach free quarantine system are extremely low.

The oilfield operation has existed on Barrow Island for more than 40 years. During this time, Chevron Australia (as the operator) recognises the importance of quarantine and has implemented strict measures to prevent introductions and developed a strong quarantine culture in the workforce. Notwithstanding these efforts, some quarantine breaches have occurred. In keeping with the oilfield operator's commitment to quarantine, which safeguards the conservation values of the island, there have been instances when vigilant and competent personnel have denied barges and their cargoes from offloading on Barrow Island. These non-compliant vessels were instructed to return to the mainland for quarantine treatment without regard to cost or schedule. On the few occasions when non-indigenous mice or rats have been discovered, they have been dealt with swiftly and effectively with advice from CALM. Where weeds have been discovered, they have been the subject of a managed containment and eradication program to prevent their spread.

As a result of these pre-border, border and post-border efforts, Chevron Australia has prevented impacts to conservation values and continues to improve its quarantine performance.

Given this success, the Joint Venturers have clearly recognised the need for a world class QMS that will effectively manage the risks of introduction from the proposed Development that will be of a significantly larger magnitude. Substantial progress has been made in furthering the development of effective quarantine practices to cope with the significant logistical increases. Such measures have been tested under the scrutiny of independent experts. The community recognised that there cannot be a 'zero risk' solution for quarantine; however, the Joint Venturers have faithfully addressed the community's expectations for acceptable risk to prevent the establishment of non-indigenous species on Barrow Island.

20.41 Microorganisms seem to have effectively been ignored. However, each person visiting the island brings along a suite of commensals and other microorganisms which can only be contained through a conscious focus on disease. To date, there has been minimal effort to survey the island's biota for natural and invasive diseases, and no quarantine barriers have been suggested to prevent disease infecting the island's biota.

25.38 Micro organisms do not appear to have been treated.

Micro-organisms have been discussed at great length. It is acknowledged as a complex issue with many divergent views. The Joint Venturers obtained advice on potential threats of disease to conservation values in the form of desktop studies, as recommended by the Quarantine Expert Panel. These reports are presented in Technical Appendices D8 and D9 of the Draft EIS/ERMP (Chevron Australia 2005). Micro-organism threats to terrestrial vertebrate fauna were addressed by the School of Veterinary and Biomedical Sciences at Murdoch University. The plant pathogen threats were discussed by the Curator of the Plant Pathology Herbarium of the Department of Primary Industries and Fisheries, Queensland.

Potential pathogens and their hosts were identified in these studies, such that quarantine management would take these into account when developing barriers, particularly for the food and perishables and personnel pathways. The Joint Venturers have committed to an iterative process of pathway and barrier development and as new information and knowledge becomes available on micro-organisms such information and potential modifications to the existing barrier designs will be subject to the same scrutiny as was performed in the original QHAZ workshops.

22.18 By their own admission, however, they cannot guarantee to stop further quarantine incursions, and even the experts can't predict how well those animal and plant pests will survive and thrive when those inevitable breaches come.

The Joint Venturers have adopted a 'zero tolerance of invasions' target, and are consequently developing a rigorous quarantine regime in consultation with experts and the community. It is the considered opinion of independent experts that the likelihood of an incursion of non-indigenous species (NIS) to Barrow Island will be low. This has been demonstrated for the three priority pathways that have been described in the Additional Information Package. The remaining pathways and respective barriers are being developed with the same dedication and attention to detail and will be subject to the same risk-based assessment method. It is expected that the ongoing evaluation of the remaining pathways will also result in a low likelihood of incursion.

The Joint Venturers are in the process of undertaking select baseline studies which will contribute to the overall understanding of biodiversity on the island, with regard to species composition, structure and function – specifically relating to the development site and the immediate native environment and the potential development impacts in those areas. This information will inform the design of monitoring programs associated with the development, which will enable early detection of any introductions that might occur. If an introduced species is detected in the native environment, it will be detected early enough to contain the incursion and respond accordingly to protect the conservation values of the island.

22.21 In fact, a very significant change of that nature has already happened – after a lengthy expert/ community process of developing standards of acceptable quarantine risk for Barrow, GJV has now abandoned the model!

The Joint Venturers have been faithful to the community expectations for acceptable risk in the risk standards that have been developed (Boxes 12-9 through 12-12 of the Draft EIS/ERMP).

The Joint Venturers demonstrated that risk standards can be achieved that meet the expectations of the public. The possibility that introduction scores could not be reduced to a score of '1' was discussed transparently in the Risk Standards Workshops #2 and #3 (Chevron Australia 2005; Technical Appendix D3). This was reported to the wider community during the development of the risk standards framework (starting with Community Consultation Meeting #2, 20 April 2004, and also in subsequent meetings). The Joint Venturers also noted the views expressed by the community in these Risk Standards Workshops, that there should be a commitment 'to a risk scaling of 3 as an upper limit' which the community and the technical experts viewed as acceptable levels of risk within the context of a 'zero tolerance' approach to introductions of non-indigenous species to Barrow Island. As such, the introduction scores for the food and perishables pathway are consistent with this upper limit, and the Joint Venturers' standards for acceptable risk (Box 12-9 of the Draft EIS/ERMP).

22.293 GJV claims that they have a community mandate for "doing the best they can" where they can't meet community standards, but this is completely inaccurate – the Council's Cameron Poustie was heavily involved with the development of the community standards. During the Risk Standards meeting on 12 May 2004 it was specifically conceded by GJV that "as low as reasonably practicable" did not equate to acceptable risk (see the minutes attached at Appendix 9).

The Joint Venturers will remain faithful to this public commitment and will complete the remaining pathways with the same commitment that was demonstrated in the development of the first three pathways in the commitment to develop and implement a world class quarantine system.

26.31 It is stated that the assessment method being used will result in barriers that "meet the standards for acceptable risk" but this is misleading. To the extent that the EPA required GJV to meet community standards for acceptable risk, this standard has now been dropped – see more below.

26.34 It is stated here that risk of introduction has been reduced to between 1 and 3, in line with community expectations, but this is misleading. The community expectations illustrated on pages 555 and 556 only accept introduction scores of up to 3 in limited circumstances – essentially if survival, detection and eradication scores were low enough as well.

26.35 The last paragraph on this page is more honest – community expectations are no longer being met; they are now in the condescending position of being "taken into account".

The Joint Venturers demonstrated that risk standards can be achieved to meet the expectations of the public. The possibility that introduction scores could not be reduced to a score of '1' was discussed transparently in the Risk Standards Workshops #2 and #3 (Chevron Australia 2005; Technical Appendix D3). This was reported to the wider community during the development of the risk standards framework (starting with Community Consultation Meeting #2, 20 April 2004, and in subsequent meetings). However, the Joint Venturers also noted the view expressed by the community in these Risk Standards Workshops, that there should be a commitment 'to a risk scaling of 3 as an upper limit'. This is the limit that the community and the technical experts viewed as acceptable levels of risk within the context of a 'zero tolerance' approach to introductions of non-indigenous species to Barrow Island. As such, the introduction scores for the three priority pathways now completed are consistent with this upper limit, and the Joint Venturers standards for acceptable risk (Chevron Australia 2005; Box 12-9).

26.40 On this, the last page of the quarantine section of the AIP, the phrase “[w]here the community expectations for acceptable risk scores cannot be achieved” is at last used!

The Joint Venturers demonstrated in the Additional Information Package that risk standards can be achieved to meet the expectations of the public. The possibility that introduction scores could not be reduced to a score of ‘1’ was discussed transparently in the Risk Standards Workshops #2 and #3 (Chevron Australia 2005; Technical Appendix D3). This was reported to the wider community during the development of the risk standards framework (starting with Community Consultation Meeting #2, 20 April 2004, and in subsequent meetings). However, the Joint Venturers also noted the view expressed by the community in these Risk Standards Workshops, that there should be a commitment ‘to a risk scaling of 3 as an upper limit’.

28.3 P4 para 2; The statement that “the risk of introduction has been reduced to a score of ‘1’ to ‘3’, addressing the community expectations for acceptable risk” is misleading. Values greater than 1 for introduction risk are only acceptable to the community if the risk score for survival, detection or eradication is at 1. Please explain why the community expectations have been re-interpreted in this way.

28.5 A number of references are made to infection scores of ‘1’ to ‘3’. Please note the comments at 1 above.

28.7 Where and when was it agreed by the community group that scores of 1 to 3 were acceptable to that group? Appendix D3 shows that the score must be 1 to be acceptable unless survival, detection or eradication is 1. Has this changed?

The Joint Venturers demonstrated in the Additional Information Package (Chevron Australia 2005b) that risk standards can be achieved to meet the expectations of the public. The possibility that introduction scores could not be reduced to a score of ‘1’ was discussed transparently in the Risk Standards Workshops #2 and #3 (Chevron Australia 2005; Technical Appendix D3). This was reported to the wider community during the development of the risk standards framework (starting with Community Consultation Meeting #2, 20 April 2004, and in subsequent meetings). However, the Joint Venturers also noted the view expressed by the community in these Risk Standards Workshops, that there should be a commitment ‘to a risk scaling of 3 as an upper limit’.

This is the limit that the community and the technical experts viewed as an acceptable level of risk within the context of a ‘zero tolerance’ approach to introductions of non-indigenous species to Barrow Island. As such, the introduction scores for the three priority pathways now completed are consistent with this upper limit, and the Joint Venturers’ standards for acceptable risk (Chevron Australia 2005; Box 12-9).

12.4.4 Identification of Quarantine Threats

15.8 The increase in traffic between Dampier and Barrow Island from the construction of the proposed facility means not only risks from ballast water discharge, but also the potential for hull fouling to be a significant vector in the translocation of marine species particularly in situations where vessels remain in ports for extended periods.

Ballast water discharge and potential hull fouling impacts have been discussed in detail and acknowledged in risk assessment workshops for marine vessels. Substantial progress has been made to date in four IMEA and PBA workshops (Table 12-3 in the Draft EIS/ERMP), to identify threats of introduction and suggestions for quarantine barriers that would be effective to address each threat. The Gorgon Joint Venturers are currently reviewing the technical requirements for the suggested barriers to prevent marine introductions. Proposed barriers for the marine vessel pathways will be tested for effectiveness in a QHAZ workshop by independent experts.

26.38 Incidentally, why haven’t any comments been made in this section about the ‘floatel’ proposal?

The floatel is not considered the base case for consideration in the risk assessment process. Should the base case change, the same risk assessment procedure will be applied to the changed based case. Also refer to 26.7 Section 6.3.6.

12.5 Quarantine Barrier Selection

12.5.1 Quarantine Barrier Selection Method

4.9 It seems highly unlikely that there will be sufficient detail on all pathways, properly evaluated, in place and tested before construction commences.

The Joint Venturers are committed to completing the barrier selection process and independent assessment of all pathways prior to construction. Progress to date indicates that this will be achieved by April 2006. A review period of at least three months will be undertaken, aimed at identifying any shortcomings in the quarantine process, the quarantine procedures, barrier design specifications and performance.

22.290 Despite years of work on this critical issue, GJV have provided details of 'barrier' design for only three of at least 12 quarantine pathways. Whether or not the information on those pathways is comprehensive (and we don't have the technical expertise to express a view either way), the regulators must understand that GJV have conducted a completely theoretical exercise. Despite recommendations from experts, GJV have made no attempt to 'ground test' any of their analysis by reference to existing Barrow quarantine pathways.

The Joint Venturers have committed to complete all pathway assessments, develop pathway-specific barriers, test the proposed barriers in QHAZ workshops with independent experts, and implement the barriers prior to the start of proposed construction activities. These tasks will be complete for all pathways by April 2006, enabling the Joint Venturers to trial barriers, collect data and implement the proposed set of barriers for each pathway over a three month period prior to the start of construction.

Information developed for quarantine barriers on all pathways will be subject to the same risk-based assessment method, standards for acceptable risk, and transparency as presented in for the three priority pathways in Part 2 of the Additional Information Package. Results of all workshops and barrier selection documents will be posted on the Gorgon Developments quarantine website to make the information publicly available.

The Joint Venturers have focussed the attention on pre-border quarantine compliance. This focus was a strategic decision which had a goal of securing quarantine compliant logistics and entrenching custody and control of such compliant goods and services pre-border. This has been proven to be a successful strategy as was demonstrated in the three priority pathways (Part 2 of the Additional Information Package).

However, the development of the pathways has now progressed sufficiently enough to expand the focus to quarantine issues associated with post-border activities. The Joint Venturers have consulted with a number of monitoring and surveillance experts and eradication specialists. In addition the Joint Venturers are well aware of the current monitoring and eradication practices for undesirable species recommended by the WA Department of Agriculture and the CSIRO.

8.23 It is noted in section 12.5.1 (pg 563) that if a barrier fails a feasibility test it is dropped from further consideration. Legal or regulatory constraints were included within the feasibility criteria. If the environmental benefit of a barrier is significant, options could be explored to seek exemption/approval from the particular constraint. The opinion of DoIR is that regulatory constraints shouldn't eliminate an otherwise suitable barrier from further consideration.

Comment noted. The Joint Venturers consider legal and regulatory constraints in proposing a set of barriers for each pathway from a large number of potential barriers suggested by experts in IMEA and PBA workshops (Figures 12-3 and 12-5 of the Draft EIS/ERMP). In doing so, some barriers that are not feasible to implement are dropped from further consideration, leaving other barriers that are deemed to be feasible and address the same threats.

The risk-based assessment method is used to scrutinise the design intent of all the barriers that are proposed following feasibility analysis for each pathway (Steps 5D and 6 in Figure 12-5 of the Draft EIS/ERMP). At the end of each Quarantine Hazard Analysis (QHAZ), the workshop participants are asked if there are any other barriers that could be considered to further reduce risk. Therefore, if there were any other barriers that could further reduce risk, including those previously eliminated for any legal or regulatory reasons, those barriers would be identified and reconsidered.

The Joint Venturers will subject any potential improvement to pathway barriers to the same level of scrutiny to continuously improve barrier performance. The process is demonstrated in the Additional Information Package for the three priority pathways.

14.9 Measures for reducing introduction as described in Section 12 of the Main Report and in the Additional Information Package appear to be comprehensive. The incorporation of barriers is generally good and appears to represent practice beyond that applied elsewhere.

Comment noted.

14.13 Recommendation 2: The Conservation Commission recommends that all significant barriers considered, but not included, and the reasons for them not being included should be described in a publicly available report.

The Joint Venturers have transparently explained the reasons for dropping certain suggested barriers from further consideration in Part 2 of the Additional Information Package (refer to the Barrier Selection Documents contained in the Appendices for each priority pathway). In cases where barriers are deemed to be infeasible, the Joint Venturers have proposed other barriers that have been recommended for consideration. The set of barriers proposed for each pathway address all of the threats identified in the risk-based assessment method, and have been independently assessed in the QHAZ workshops.

14.15 The proposed decision rules in table 12.6 are not considered to be valid and it is our understanding that they will in fact not be used. This should be confirmed by Chevron. Recommendation 4: The Conservation Commission recommends that Chevron confirm that future quarantine risk evaluations to generate an overall infection score will be based on expert quarantine panel assessment rather than a set of rules.

The Joint Venturers have not found it necessary to use the decision rules (Table 12-6 of the Draft EIS/ERMP), and have dropped them from the barrier selection and assessment process. Experts attending the QHAZ workshops have demonstrated their ability to judge the overall risk of introduction on a particular pathway, based on a qualitative interpretation of the infection scores at each pathway step and consideration of the systematic barriers proposed for each pathway (Part 2 of the Additional Information Package).

Consultation with the Quarantine Advisory Committee has resulted in advice that the decision rules are unnecessary in these circumstances, and will not be used for any of the remaining pathway assessments.

14.16 Recommendation 5; The Conservation Commission recommends that the completion of pathway assessments and barrier description should occur prior to significant environmental impacts occurring on Barrow Island. These assessments and descriptions should include advice on compliance with community standards and be publicly available.

Significant progress has been made on all of the pathways which have the potential to introduce terrestrial or marine organisms to Barrow Island and the surrounding waters. The Joint Venturers have committed to complete all pathway assessments, develop pathway-specific barriers, test the proposed barriers in QHAZ workshops with independent experts, and implement the barriers prior to the start of proposed construction activities. These tasks will be complete for all pathways by April 2006, enabling the Joint Venturers to trial barriers, collect data and implement the proposed set of barriers for each pathway over a three month period prior to the start of construction.

Information developed for quarantine barriers on all pathways will be subject to the same risk-based assessment method, standards for acceptable risk, and transparency as presented in for the three priority pathways in Part 2 of the Additional Information Package. Results of all workshops and barrier selection documents will be posted on the Gorgon Project quarantine website to make the information publicly available.

16.79 Environmental impacts would be impossible to contain within the proposed 300 ha cleared area. Quarantine poses insurmountable problems. This was raised many times during the consultative period. Weeds, pests and pathogens know no boundaries. The impact of ca 3,000 construction contractors and their equipment would make quarantine breaches inevitable and frequent.

The scale of the proposed development, and the speed at which it is proposed to be set up, means that even with great dedication to the task perfect quarantine would be impossible.

The Joint Venturers have developed a risk-based quarantine assessment method and standards for acceptable risk in consultation with experts and the community. Three priority pathways were nominated by the Quarantine Expert Panel as presenting the greatest management challenge for meeting the standards for acceptable risk, based on the results of risk assessment, expert opinion and community consultation.

The Joint Venturers have considered a range of possible barriers for these pathways that were suggested by experts in Infection Modes and Effects Analysis (IMEA) and Preliminary Barrier Analysis (PBA) workshops. A set of systematic and pathway-specific quarantine barriers has been proposed for each of these pathways through the barrier selection process described in Section 12.5 of the Draft EIS/ERMP (Chevron Australia 2005). The proposed barriers have been independently assessed in QHAZ workshops by independent experts, with the stated advice that the likelihood of an incursion is low. The risk scores for these pathways are all within the community expectations for acceptable risk (maximum score of '3'), and meet the Joint Venturers standards for acceptable risk (Box 12-9 of the Draft EIS/ERMP). In meeting the standards for acceptable risk, the Joint Venturers have been faithful to the community expectation that scores of '3' or less are necessary to prevent the establishment of species on Barrow Island.

The Joint Venturers will manage all potential pathways of introduction to prevent the introduction of new plant species to the island, and maintain custody and control of all material and equipment on the proposed development footprint. The development site will be denuded of vegetation on the advice of CALM and the Quarantine Expert Panel.

This approach will, in the event of an introduction, contribute to the containment of the organism within the development site, where it would be easily detected in the denuded area. Notwithstanding the very rigorous precautionary measures to be taken to prevent introductions, there may be a chance of a non-indigenous species establishing in the native environment. Irrespective of the low risk of introduction, the Joint Venturers are committed to a world-class monitoring and surveillance program supported by a robust response and eradication strategy.

18.6 Furthermore, only three of the quarantine pathways have been evaluated to date and management plan commitments are largely limited to broad objectives.

The proposed Gorgon Development is in the Front End Engineering Design (FEED) stage, and the detail of the pathways of people, materials and vessels is under development. The Joint Venturers recognised in 2004 that all pathways could not be fully described and assessed under the risk-based assessment method by the submission date of the Draft EIS/ERMP. The Joint Venturers obtained advice from the Quarantine Expert Panel that in order to demonstrate its ability to develop effective quarantine barriers and meet standards for acceptable risk, that three priority pathways could be progressed to completion. The Quarantine Expert Panel nominated the three priority pathways, which were considered to present the greatest management challenge for meeting standards for acceptable risk, based on the results of risk assessment, expert opinion and community consultation.

The EPA agreed to a proposal by the Joint Venturers to publish the proposed barriers and results of independent assessment for the three priority pathways during the public review period of the Draft EIS/ERMP. This information was published in Part 2 of the Additional Information Package on 24 October 2005, so that the public could have the opportunity of a ten week review and comment period, through 3 January 2006. The Joint Venturers are committed to consider all public submissions and will investigate and assess any promising improvements that may be suggested.

Significant progress has been made on all of the pathways which have the potential to introduce terrestrial or marine organisms to Barrow Island and the surrounding waters. As of the date when the Draft EIS/ERMP was submitted, 21 workshops had been undertaken, and nearly all of the pathway assessments had commenced (Tables 12-2 and 12-3 of the Draft EIS/ERMP).

The Joint Venturers have committed to complete all pathway assessments, develop pathway-specific barriers, test the proposed barriers in QHAZ workshops with independent experts, and implement the barriers prior to the start of proposed construction activities. These tasks will be complete for all pathways by April 2006, enabling the Joint Venturers to trial barriers, collect data and implement the proposed set of barriers for each pathway over a three month period prior to the start of construction.

Information developed for quarantine barriers on all pathways will be subject to the same risk-based assessment method, standards for acceptable risk, and transparency as presented in for the three priority pathways in Part 2 of the Additional Information Package. Results of all workshops and barrier selection documents will be posted on the Gorgon Developments quarantine website to make the information publicly available.

18.26 Furthermore, given the values at stake on Barrow Island, all feasible barriers should be properly considered, and CALM does not believe that this is the case in the ERMP. For example, CALM has for a considerable time been suggesting that extreme heat treatment via a kiln should be investigated and trialled for the treatment of sand and aggregate prior to loading onto barges. Despite CALM's advice, this option has not been committed to in the ERMP.

26.8 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: full justification for why the heat treatment of aggregate has been dropped

The Joint Venturers have proposed a set of effective high performance barriers on each of the three priority pathways which have been independently tested in QHAZ workshops (Additional Information Package). The barrier selection process includes feasibility studies and additional consultation with specialists to determine which combination of barriers will be most effective for each pathway. Although every proposed barrier is investigated, there is no need to adopt every barrier suggested for consideration, as some barriers will do very little to further reduce the level of risk and will therefore be redundant.

In the case of the proposal for high temperature treatment of sand and aggregate, feasibility studies have found that such a barrier will require enormous energy requirements and will not be effective in the thermal destruction of all species of seeds. In fact, expert advice has cautioned that thermal treatment will stimulate seeds of some species to germinate, which would be a very undesirable outcome, increasing the risk of introduction and establishment. The volume of sand and aggregate is so large that it would require an unprecedented level of thermal treatment. Present heat treatment technology will be ineffective in reliably and in a sustainable manner producing the required heat regime for the large volume of material that must be processed. Unproven heat treatment technology would not further reduce the risk.

Reference to the proposed barriers and residual level of risk in the Additional Information Package shows that for the barriers proposed, there are no other treatments that would further reduce the likelihood of introduction on this pathway.

18.152 The proponent should be required to test and discuss all proposed and recommended barriers well in advance of implementation. The final selection of quarantine barriers should be subject to approval by CALM and the Department of Environment.

The Joint Venturers will complete the barrier selection process and independent assessment of all pathways well ahead of the construction commencement date. Progress to date indicates that this will be achieved by April 2006. A review period of at least 3 months will be undertaken, aimed at identifying any shortcomings in the quarantine process, the quarantine procedures, barrier design specifications and performance.

The final selection of quarantine barriers will be the result of the transparent barrier selection process and testing of the proposed barriers in QHAZ workshops by independent experts. The process is demonstrated for the three priority pathways in Part 2 of the Additional Information Package (Chevron Australia 2005b). The Joint Venturers have invited CALM and the Department of Environment to all of the risk assessment workshops, including four QHAZ workshops, to observe and scrutinise all of the discussions and scoring of risk. The last step of each workshop is to solicit information from the independent experts as to whether there are any other barriers not already considered which would further reduce risk. Once this systematic and rigorous process is complete, the proposed set of barriers are formalised in the QMS and communicated to stakeholders, including CALM and the Department of Environment.

In the event that CALM or the Department of Environment wish to propose an alternative set of quarantine barriers for any particular pathway for independent scrutiny, this can (and has been) done within the risk assessment workshops, where alternatives can be assessed by technical experts in disciplines representing all relevant biological groups. This process has, and will, ensure that CALM and the Department of Environment have the ability to participate fully in the barrier assessment process to ensure that the standards for acceptable risk are met.

The Joint Venturers will monitor the performance of proposed barriers on each pathway to ensure that the barriers are effective, and to continuously improve barrier performance under the QMS to protect the biodiversity of Barrow Island.

18.153 Decision rules should not be adopted generically. Every pathway and barrier must be evaluated case by case for each organism group.

The Joint Venturers have not found it necessary to use the decision rules (Table 12-6 of the Draft EIS/ERMP), and have dropped them from the barrier selection and assessment process. Experts attending the QHAZ workshops have demonstrated their ability to judge the overall risk of introduction on a particular pathway, based on a qualitative interpretation of the infection scores at each pathway step and consideration of the systematic barriers proposed for each pathway (Part 2 of the Additional Information Package).

Consultation with the Quarantine Advisory Committee has resulted in advice that the decision rules are unnecessary in these circumstances, and will not be used for any of the remaining pathway assessments. Every pathway and barrier will be evaluated case-by-case for each organism group.

18.154 All quarantine measures, including barrier options and detailed prescriptions, should be reviewed and subject to approval by CALM and the Department of Environment. The proponent should put in place a firm commitment to resourcing CALM and the Department of Environment for this task.

The final selection of quarantine barriers will be the result of the transparent barrier selection process and testing of the proposed barriers in QHAZ workshops by independent experts. The process is demonstrated for the three priority pathways in Part 2 of the Additional Information Package. The Joint Venturers have invited CALM and the Department of Environment to all of the risk assessment workshops, including four QHAZ workshops, to observe and scrutinise all of the discussions and scoring of risk. Furthermore, the last step of each workshop is to solicit information from the independent experts as to whether there are any other barriers not already considered which would further reduce risk. Once this systematic and rigorous process is complete, the proposed set of barriers are formalised in the QMS and communicated to stakeholders, including CALM and the Department of Environment.

In the event that CALM or the Department of Environment wish to propose an alternative set of quarantine barriers for any particular pathway for independent scrutiny, this can (and has been) done within the risk assessment workshops, where alternatives can be assessed by technical experts in disciplines representing all relevant biological groups. This process has, and will, ensure that CALM and the Department of Environment have the ability to participate fully in the barrier assessment process to ensure that the standards for acceptable risk are met.

The Joint Venturers will monitor the performance of proposed barriers on each pathway to ensure that the barriers are effective, and to improve barrier performance under the QMS to protect the biodiversity of Barrow Island.

18.163 Permanent active rodent baits must be maintained, monitored and reported for all vessels travelling to Barrow Island.

Table 12-7 represents the conceptual advice of vertebrate experts who participated in a PBA workshop of marine 'topsides'. At the time of the workshop, the experts advised that it may not be effective to install traps and baits on an un-powered barge that consists of a low deck with smooth surfaces and few places for rodents to hide.

The barriers for marine vessels (barges) on the sand and aggregate pathway have not yet been tested in a QHAZ workshop. Once the barrier selection process has been completed for barges, a proposed set of quarantine barriers will be scrutinised by experts in a QHAZ. If there are places for rodents to hide on the types of barges that will be used for shipping sand and aggregate, then the use of baits and traps will be proposed.

20.40 Only three 'priority' terrestrial pathways have been completed to the 'barrier design' stage and details of these three pathways have been provided late in the comment period. Some additional progress has been made on marine pathways. However, there are more than 12 pathways in total, and it seems highly unlikely that sufficient evaluated detail on all pathways will be in place before construction commences. The construction of a jetty would increase the risk of establishment of introduced species, something that does not seem to be covered by the quarantine pathway approach.

The Joint Venturers are committed to completing the barrier selection process and independent assessment of all pathways prior to construction. Progress to date indicates that this will be achieved by April 2006. A review period of at least 3 months will be undertaken, aimed at identifying any shortcomings in the quarantine process, the quarantine procedures, barrier design specifications and performance.

22.294 Despite years of work on this critical issue, GJV have provided details of 'barrier' design for only three of at least 12 quarantine pathways. What percentage of this work do we expect will actually get exposed to scrutiny by the regulators? It is clear the public will have little or no opportunity to participate in the development of these barriers.

The proposed Gorgon Development is in the Front End Engineering Design (FEED) stage, and the detail of the pathways of people, materials and vessels is under development. The Joint Venturers recognised in 2004 that all pathways could not be fully described and assessed under the risk-based assessment method by the submission date of the Draft EIS/ERMP. The Joint Venturers obtained advice from the Quarantine Expert Panel that, in order to demonstrate its ability to develop effective quarantine barriers and meet standards for acceptable risk, three priority pathways could be progressed to completion. The Quarantine Expert Panel nominated the three priority pathways, which were considered to present the greatest management challenge for meeting standards for acceptable risk, based on the results of risk assessment, expert opinion and community consultation. The EPA agreed to a proposal by the Joint Venturers to publish the proposed barriers and results of independent assessment for the three priority pathways during the public review period of the Draft EIS/ERMP.

This information was published in Part 2 of the Additional Information Package on 24 October 2005 (Chevron Australia 2005b), so that the public could have the opportunity of a 10-week review and comment period, through 3 January 2006. All public submissions have been considered as presented in this document and will investigate and assess any promising improvements that may be suggested.

Significant progress has been made on all of the pathways which have the potential to introduce terrestrial or marine organisms to Barrow Island and the surrounding waters. As of the date when the Draft EIS/ERMP was submitted, 21 workshops had been undertaken, and nearly all of the pathway assessments had commenced (Tables 12-2 and 12-3 of the Draft EIS/ERMP).

The Joint Venturers have committed to complete all pathway assessments, develop pathway-specific barriers, test the proposed barriers in QHAZ workshops with independent experts, and implement the barriers prior to the start of proposed construction activities. These tasks will be complete for all pathways by April 2006, enabling the Joint Venturers to trial barriers, collect data and implement the proposed set of barriers for each pathway over a three month period prior to the start of construction.

Information developed for quarantine barriers on all pathways will be subject to the same risk-based assessment method, standards for acceptable risk, and transparency as presented in for the three priority pathways in Part 2 of the Additional Information Package. Results of all workshops and barrier selection documents will be posted on the Gorgon Developments quarantine website to make the information publicly available.

25.31 Although Chevron is to be commended in trying to develop a quarantine system of a higher standard than anything that exists currently in the world, we question whether there will be sufficient detail on all pathways properly evaluated, in place and tested before construction starts. DEH and other regulatory authorities would need to evaluate all these pathways before the project commences.

Significant progress has been made on all of the pathways which have the potential to introduce terrestrial or marine organisms to Barrow Island and the surrounding waters. The Joint Venturers intend to complete all pathway assessments, develop pathway-specific barriers and test the proposed barriers in QHAZ workshops with independent experts by April 2006, enabling the Joint Venturers to trial barriers, collect data and implement the proposed set of barriers for each pathway prior to the start of construction.

Information developed for quarantine barriers on all pathways will be subject to the same risk-based assessment method, standards for acceptable risk, and transparency as presented in the three priority pathways in Part 2 of the Additional Information Package (Chevron Australia 2005b).

25.32 Details have not been provided for decontamination of barrier facilities, such as the kitchen facility, where the likelihood of contamination is higher, and where the decontamination process needs to be built into the design of the facilities (by compartmentalisation or redundancy) in such a way that normal operations can be maintained during the decontamination process.

The design of the kitchen pays careful attention to aspects relating to custody and control of food and perishables. This includes secure loading and offloading facilities, compartmentalisation of working areas and storage areas, temperature regimes, airflows and air filtration, waste water management, personnel movement and detection and eradication protocols.

25.35 On p11 &12 of the original additional information it is stated that pre-processing procedures may include: trained visual inspection etc, unpacking, pre processing, repacking and storage for load out. It is advisable to specify what at a minimum will occur.

Procedures will be developed for each of the barriers of each pathway. These procedures will include the specific activities to be performed at each barrier and will include the minimum acceptable standard which will ensure quarantine compliance.

26.5 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: full details of all proposed quarantine measures, not just barriers for some of the anticipated pathways.

Significant progress has been made on all of the pathways which have the potential to introduce terrestrial or marine organisms to Barrow Island and the surrounding waters. The Joint Venturers intend to complete all pathway assessments, develop pathway-specific barriers, and test the proposed barriers in QHAZ workshops with independent experts by April 2006, enabling the Joint Venturers to trial barriers, collect data and implement the proposed set of barriers for each pathway prior to the start of construction.

Information developed for quarantine barriers on all pathways will be subject to the same risk-based assessment method, standards for acceptable risk, and transparency as presented in the three priority pathways in Part 2 of the Additional Information Package (Chevron Australia 2005b).

26.6 We are surprised at how many questions still arise from key areas in this apparently substantial document. Key issues not included in the AIP, or not dealt with in sufficient detail, include: ground-truthing of the personnel/luggage and food/perishables pathway modeling using the current Chevron oil operations.

The Joint Venturers have targeted to complete all pathway assessments, develop pathway-specific barriers, and test the proposed barriers in QHAZ workshops with independent experts by April 2006, enabling the Joint Venturers to trial barriers, collect data and implement the proposed set of barriers for each pathway prior to the start of construction. On advice from an independent expert, the Joint Venturers plan to ground-truth the complete set of pathways in addition to the three priority pathways presented in the Additional Information Package (Chevron Australia 2005b).

26.32 We have always been concerned about how a commitment to quarantine might manifest in practice in the context of a massive project with supposedly tight financial constraints. The two uses of the sentence “Balance of effort and benefits”, and also the reference to “Compatibility with project timelines”, in the process outlined on this page, reflect those very concerns.

The Joint Venturers have developed the Barrow Island Quarantine Policy, which requires that quarantine compliance cannot be compromised (Box 12-1 of the Draft EIS/ERMP). No quarantine barriers have been eliminated in the transparent barrier selection process that would have further reduced risk (Part 2 of the Additional Information Package).

26.36 The Submitters regret that this pathway wasn't ground-truthed using the existing Barrow Island operations. Indeed, we would go further and note our disappointment that work hasn't yet begun on GJV/Oil JV protocols. Work began on the BI Act before Cabinet approval!

Significant progress has been made on all of the pathways which have the potential to introduce terrestrial or marine organisms to Barrow Island and the surrounding waters. The Joint Venturers intend to complete all pathway assessments, develop pathway-specific barriers, and test the proposed barriers in QHAZ workshops with independent experts by April 2006, enabling the Joint Venturers to trial barriers, collect data and implement the proposed set of barriers for each pathway prior to the start of construction.

26.37 As pointed out above, these introduction scores are only acceptable if S, D and E are low enough as well. Where is this information?

The Joint Venturers have succeeded in meeting the community expectation with regards the risk scores of the three priority pathways (refer to 26.31 Section 12.4.3). Significant progress has been made on all of the pathways which have the potential to introduce terrestrial or marine organisms to Barrow Island and the surrounding waters. The Joint Venturers intend to complete all pathway assessments, develop pathway-specific barriers, and test the proposed barriers in QHAZ workshops with independent experts by April 2006, enabling the Joint Venturers to trial barriers, collect data and implement the proposed set of barriers for each pathway prior to the start of construction.

Information developed for quarantine barriers on all pathways will be subject to the same risk-based assessment method, standards for acceptable risk, and transparency as presented in the three priority pathways in Part 2 of the Additional Information Package (Chevron Australia 2005b).

26.39 Incidentally, why haven't any comments been made in this section about the proposal to heat treat the aggregate?

The Joint Venturers have proposed a set of effective performance barriers on each of the three priority pathways which have been independently tested in QHAZ workshops (Chevron Australia 2005b). The barrier selection process includes feasibility studies and additional consultation with specialists to determine which combination of barriers will be most effective for each pathway. Although every proposed barrier is investigated, there is no need to adopt every barrier suggested for consideration. A sufficient number of barriers will be selected to provide an appropriate level of redundancy.

26.42 As above, we question why the consortium agreement relating to other operators using Barrow as a transit point has not already been re-negotiated, given how long it has been since the GJV proposal was first suggested.

28.8 Table 5, pathway step 4; What will happen with regards to helicopter flights to Barrow ex Karratha and particularly the use of Barrow Airport by third parties?

The Joint Venturers have considered the quarantine risk associated with other operations that use Barrow Island as a transit point. The design of the airport arrival facility and the arrival procedures is part of a dedicated pathway identified in the Draft EIS/ERMP. In addition, all other relationships will be governed by the Barrow Island Quarantine Policy (Box 12-1 in the Draft EIS/ERMP) that specifically requires cooperation between other operators on the island (BICC will oversee island-wide implementation). The rigorous and comprehensive risk-based quarantine assessment method used to develop quarantine barriers to prevent introductions (Figure 12-3 in the Draft EIS/ERMP) applies to all potential pathways of introduction and by definition informs the relationships between all operators on the island. The transport of personnel via helicopter is a pathway that will be assessed in the same way as all other pathways.

12.5.2 Systematic Quarantine Barriers for all Pathways

No submissions received on this section of the Draft EIS/ERMP.

12.5.3 Management of Quarantine on the Sand and Aggregate Pathway

14.10 However, not all measures have been incorporated (e.g. high temperature treatment of sand and gravel). It is surprising that this has not been done given that the risk of introduction remains as high as three for some organisms/pathways as detailed in the Additional Information Package of October 2005.

The Joint Venturers have proposed a set of effective barriers on each of the three priority pathways which have been independently tested in QHAZ workshops (Additional Information Package). The barrier selection process includes feasibility studies and further consultation with specialists to determine which combination of barriers will be most effective for each pathway. Not all potential barriers need to be included in the pathway as some become redundant when they do not contribute to any further risk reduction in that pathway.

In the case of the high temperature treatment of sand and aggregate, feasibility studies have discovered that such a barrier will require enormous energy requirements and will not be effective in the thermal destruction of all species of seeds. In fact, expert advice has cautioned that thermal treatment will enable some species of seeds to germinate, which would be a very undesirable outcome, increasing the risk of introduction and establishment. Reference to the proposed barriers and residual level of risk in the Additional Information Package shows that for the barriers proposed, there are no other treatments that would further reduce the likelihood of introduction on this pathway.

The Joint Venturers will put in place a competent monitoring and surveillance program supported by a Response and Eradication Strategy. The monitoring program and Response and Eradication Strategy will be implemented prior to the start of construction, and will be communicated to interested stakeholders on the Developments quarantine website.

18.157 It is [this] CALM's view that sourcing 'clean' sand and aggregate from a mainland quarry can not be guaranteed. As such, the proponent needs to demonstrate it is capable of removing or destroying the viability of seeds prior to exporting sand and aggregate to Barrow Island.

The Joint Venturers have demonstrated that the risk of introducing viable seeds to Barrow Island on the sand and aggregate pathway meets the standards for acceptable risk. The proposed barriers and discussion of seeds (and other plant propagules), in particular, is presented in Part 2 of the Additional Information Package (Chevron Australia 2005b).

In the case of the scores for plants (seeds and propagules) on the sand and aggregate pathway, the risk of introduction was scored on the basis of the proposed quarantine barriers contained in the Barrier Selection Document (Technical Appendix 3 in Part 2 of the Additional Information Package) by plant biologists with a wealth of knowledge and experience in Western Australia and the Pilbara Region. The workshop specifically considered and discussed wind blown seeds at length. There are a number of systematic and pathway-specific quarantine barriers that were proposed for consideration by QHAZ workshop participants, all of which contribute to keeping the quarried material relatively free of wind blown seeds, as documented in Part 2 of the Additional Information Package.

The opinion of experts was supported by sampling of numerous stockpiles of quarried sand and aggregate in the Pilbara Region, where the 'total organic content' of each sample was published in the Barrier Selection Document and provided to all workshop participants. Therefore, the experts who scored the risk of infection at the quarry were not only guided by their substantial knowledge and experience in relation to the proposed barriers, but by relevant data as well.

The submission is incorrect in its summary of the proposed pathway activities:

- The description of how ‘machinery will transfer seeds from the topsoil through the soil profiles’ is not correct. The topsoil and overburden will be removed prior to quarrying sand and aggregate for high strength concrete, as discussed in the Barrier Selection Document, and no such transfer through the soil profiles will occur.
- There are no ‘cumulative risk’ scores estimated by workshop participants. Each step in the pathway is scored on the basis of adopting all proposed barriers at the subject step, and all previous pathway steps. The term ‘cumulative risk’ is not used or inferred anywhere in the QHAZ workshop record (refer to the report of the QHAZ workshop on the quarantine website).
- ‘Mechanical agitation’ of sand and aggregate to destroy or remove the activity of seeds is certainly not a ‘theoretical process’. Photographs of equipment operating in other similar material handling situations were presented to workshop participants and the scale and throughput of the proposed high energy mechanical hopper was described. The independent experts, including two highly experienced plant biologists, gave their expert opinion that this treatment would be highly effective in destroying seeds or greatly reducing their ability to disperse, and scored the risk of infection accordingly.

It is notable that the scoring of risk on this pathway is completely independent of the exact source of sand and aggregate, as discussed in the QHAZ workshop. The first proposed barrier proposed for this pathway is the prequalification of suppliers and their quarries, as documented in the Barrier Selection Document (Additional Information Package Part 2 Page 15). The pre-selection process will ensure that the quarry can supply sand and aggregate which meet all of the specifications for quarantine, such that the quarry will achieve the low risk scores recorded for plants in the QHAZ workshop.

21.22 Even where the individual/annual risk may be low, this is not necessarily the case for the cumulative risk over the life of the project. As an illustration, at a recent briefing the engineering requirement for less than 0.001% organic content in concrete was cited to show the risk of weed introduction would be extremely low (even in the absence of specific requirements for quarantine). However over the 161,000 tonnes of sand and aggregate, this is equivalent to 1610 kg: even a small fraction of this represents potentially an enormous quantity of seed.

The Joint Venturers note that high strength concrete specifications are guided by Australian Standards which require a very low organic content in the quarried sand and aggregate used to make the concrete. This is only the starting point for the quarantine barriers and controls on the sand and aggregate pathway, and cannot be construed as the basis for calculating cumulative risk. It is not correct to calculate a discrete mathematical summation of the organic content limit of the concrete specification. This does not translate to the mass of organic material that would be contained in sand and aggregate after processing the material through all the pathway steps and applying the corresponding quarantine barriers that are proposed (Part 2 of the Additional Information Package).

28.11 P15, sect 4.1; Is Chevron certain that sand will only be required for making concrete? What about for uses other than concrete, for example for pipe bedding, minor fill, making cement to fix gas feed pipeline supports in the field etc?

All imported sand and aggregate will be batched with cement and placed as concrete on site (refer to Barrier 27 of the sand and aggregate pathway in Technical Appendix 3 of the Additional Information Package) (Chevron Australia 2005b). None of the sand and aggregate will be used as ‘raw fill’. This reference to concrete applies to all cement products which will ensure that any residual risk of organisms is encapsulated in the solid, stable material.

12.5.4 Management of Quarantine on the Food and Perishables Pathway

28.4 P7, sect 2.2, para 2; Will special arrangements be required and implemented for meals (eg. cribs) that are removed from the Kitchen Facility for consumption at remote sites?

All meals will be consumed in designated dining areas. These areas will be the subject of procedures that include the management of waste, as discussed in the QHAZ workshop for the food and perishables pathway.

12.5.5 Management of Quarantine on the Personnel & Accompanying Luggage Pathway

18.159 The proponent needs to discuss how they intend to manage quarantine for personnel and aircraft departing for Barrow Island from locations other than Perth.

The Joint Venturers have proposed barriers and undertaken a QHAZ for the personnel and luggage pathway, using Perth Airport as the principle port of departure for direct flights to Barrow Island. The pathway is not, however, restricted only to Perth Airport. All proposed barriers in the Barrier Selection Document (Technical Appendix 2 in Part 2 of the Additional Information Package) are intended to apply to all airport locations used to fly personnel and luggage to Barrow Island.

In the event that other airports are identified, where some different quarantine strategies are necessary, the departure of personnel and luggage from that airport becomes a new pathway and will be subject to the same risk-based assessment method as all other pathways.

25.33 Amnesty bins at aircraft exits seems to be the last point personnel can legitimately deal with luggage breaches. However we suggest that there should be another avenue at the camp where luggage is unpacked.

Arrival procedures at the airport on Barrow Island will have the facility for random and planned inspections of luggage. All breaches in the quarantine status of luggage will be re-inspected and trained project inspectors will be authorised to conduct verification checks at any stage. Amnesty bins will be available at the Barrow Island airport.

12.5.6 Management of Quarantine on the Marine Vessels Pathway

15.9 The EIS/ERMP does not adequately consider the risks posed to the marine environment by introductions of invasive species.

The Draft EIS/ERMP has given substantial attention to the risks posed to the marine environment by introductions of invasive species. The Barrow Island Quarantine Policy (Box 12-1 in the Draft EIS/ERMP) specifically requires protection of the conservation values of the Barrow Island Nature Reserve and the surrounding waters. The rigorous and comprehensive risk-based quarantine assessment method used to develop quarantine barriers to prevent introductions (Figure 12-3 in the Draft EIS/ERMP) applies to all potential pathways of introduction, and has been the subject of consultation with the Quarantine Expert Panel, marine experts and the community through five community consultation meetings. Standards for acceptable quarantine risk have been developed to protect marine conservation values (Box 12-10 in the Draft EIS/ERMP), and strategies for marine vessels have been discussed (Section 12.5.6 of the Draft EIS/ERMP). Marine baseline data (Section 12.3.6 of the Draft EIS/ERMP), and monitoring and response strategies have also been discussed (Sections 12.5.8 and 12.5.9, respectively).

15.10 In summary, the MPRA has grave concerns as to the scale and location of this proposed development. Specifically there are three impacts of concern: 1) Impacts of the dredging plume and causeway construction on marine communities. 2) Effects on rare and endangered flatback turtles and on-going necessity for light management. 3) Introduced Marine Pests risks.

Refer to Chapter 7 for light mitigation strategies and Chapter 11 for an assessment of potential impacts. Dredge plume modelling has been completed, with model validation data published in the Draft EIS/ERMP Additional Information Package (Chevron Australia 2005b). Introduced marine pest risks are being addressed through the same risk-based assessment process that has been used for the three priority pathways (refer to the Additional Information Package, Part 2). Substantial progress has been made to date in four IMEA and PBA workshops (refer to Table 12-3 in the Draft EIS/ERMP), to identify threats of introduction and suggestions for quarantine barriers that would be effective to address each threat. Proposed barriers for the marine vessel pathways will be tested for effectiveness in a QHAZ workshop by independent experts, with special reference to the status of the Montebello/Barrow Islands Marine Conservation Reserves.

16.70 The issues relating to the jetty have not been addressed, eg. The potential this structure has to enable vermin such as rodents, ants, etc. to move onto the island. This problem does not appear to have been resolved.

The Joint Venturers have considered the jetty, referred to in the Draft EIS/ERMP as the Materials Offloading Facility (MOF), on every pathway that uses marine vessels to transport cargoes to Barrow Island. As an example, the threats and barriers proposed for the sand and aggregate pathway when this cargo arrives at the MOF is Step 5 of the pathway assessment described in Part 2 of the Additional Information Package (Technical Appendix 3 of the Quarantine Pathways – Barrier Selection Report).

Substantial progress has also been made on the development of quarantine barriers for marine vessels. The management of quarantine for rodents on marine vessels, to prevent the infection of marine vessels sailing to Barrow Island, is outlined in Section 12.5.7 of the Draft EIS/ERMP.

16.83 The Report does not state from where ships and equipment arriving at the Island will come. These pose a high risk of introducing marine pests and pathogens.

The Joint Venturers have identified marine vessels as a potential pathway of introduction of pest species to Barrow Island, and four IMEA and PBA workshops have been held to date, where experts have identified the types of threats that must be managed for both domestic and international vessels. A comprehensive identification of the threats and barriers under consideration is contained in the IMEA and PBA workshop reports published on the Developments quarantine website.

12.5.7 Management of Quarantine for Rodents on Marine Vessels

18.186 12.5.7 Management of Quarantine for Rodents on Marine Vessels, page 578 – The first paragraph identifies frogs as reptiles. Frogs are amphibians, not reptiles.

Comment noted

12.5.8 Monitoring Strategy

13.4 Recommendation: Long-term monitoring strategies for introduced marine biota need to be developed so that potential impacts and risks to marine ecosystems through the Gorgon Development can be managed to an acceptable level.

The Joint Venturers are committed to ongoing marine monitoring (Chevron Australia 2005; Section 12.5.8), as part of the wider Ecological Monitoring Structure outlined in Chapter 16 of the Draft EIS/ERMP.

12.5.9 Response Strategy

4.2 Eradication in natural areas is difficult and often is not possible without also destroying indigenous species. For example, it would not be possible to eradicate black rats or house mice once they become established within more than a very small area of Barrow Island because the only available technique – poisoning with rodenticide – would also kill native mammals, especially the native rodents, and possibly other elements of the fauna as well.

The Joint Venturers have adopted a ‘zero tolerance of invasions’ target, and are consequently developing a rigorous quarantine regime in consultation with experts and the community. It is the considered opinion of independent experts that the likelihood of an incursion of non-indigenous species (NIS) to Barrow Island will be low. It is acknowledged that some organisms that might be introduced could survive on Barrow Island, in the event that they were able to gain a foothold in the native environment. The Joint Venturers have committed to a rigorous quarantine regime which leads to a low likelihood of incursions (the conclusion of the assessment of three priority pathways in the Additional Information Package). The Joint Venturers have also committed to implement a monitoring system that will enable early detection at the proposed development site and in the immediate native environment, so that an appropriate response can be rapidly initiated to protect the conservation values of the island.

The existing oilfield operation has developed a comprehensive weed management program which shows that the efforts have contained the spread of the weeds of concern and is systematically reducing their distribution with the objective of complete eradication from the island over time. In the case of mice and rats, the existing oilfield operator has successfully eradicated a mouse introduction, disturbing a very small area of the island, and CALM has carried out a rat eradication effort on the southern end of the island. Non-native rats are believed to be completely absent on Barrow Island. In the case of the tramp ant, discovered as a direct result of the Joint Venturers’ baseline survey efforts of invertebrates, experts consider this particular species of ant which is prevalent in northern Australia to be a ‘cosmopolitan species’ which is not likely to survive in the native environment (to be confirmed in an expanded baseline survey program).

The Joint Venturers acknowledge that eradication options, in the event of introductions, may result in very limited mortalities of plants and animals. However, proven containment procedures of the introduced species involve a very small area of the native environment being isolated and in the case of rodents, live traps were used to capture and remove as many native animals as possible prior to the use of poison bait.

4.13 Gorgon has made no effort as yet to develop protocols for eradication of introduced species once they establish. The risk based approach used by Gorgon scores infection, survival, detection and eradication. Almost all work has been on the first, with some attention to the second, even less to the third and nothing to the fourth.

The Joint Venturers have consulted with a number of eradication specialists and are aware of the current eradication practices for undesirable species as recommended by the Western Australian Department of Agriculture and the CSIRO.

Chevron Australia (as the operator of the existing oilfield) has demonstrated its response capabilities to eradicate mice and rats on the few occasions that they were discovered, and successfully manage weed eradication efforts, in consultation with appropriate experts. These proven protocols for response and eradication, and the experience gained, is already informing the Joint Venturers in the development of their Response and Eradication Strategy.

The Joint Venturers recognise that eradication efforts will be organism-specific, and have committed to a rapid response strategy utilising the advice of technical specialists (Chevron Australia 2005; Section 12.5.9). The detail of the strategy is being developed and will be subjected to peer review and field training exercises prior to the commencement of construction activities for the proposed Gorgon Development. The Response and Eradication Strategy will include a Detection Plan; Incursion Report; point of contact and incursion authority; response inventory (e.g. equipment and instructions); category of incursion and category of response; Response Protocol; and a Species Action Protocol. In line with Joint Venturers’ commitment to transparency, this information will be available to interested stakeholders.

11.1 Once quarantine is breached and introduced species become established there will be little that can be done in most instances.

16.80 Once quarantine is breached and introduced species become established little that can be done in most instances to eradicate it. Harm is likely to be irreversible.

21.1 Whilst the annual risk of introductions (failure of quarantine) under normal operating conditions is considered in the EIS to be low, breaches of quarantine are inevitable in the longer term.

It is acknowledged that organisms have the potential to be introduced to Barrow Island, and possibly survive. The Joint Venturers have committed to a rigorous quarantine regime which will lead to a low likelihood of incursions (the conclusion of the assessment of three priority pathways in the Additional Information Package). The Joint Venturers will also implement a monitoring system that will enable early detection at the proposed development site and in the immediate native environment, so that an appropriate response can be rapidly initiated to protect the conservation values of the island.

The existing oilfield operation has developed a comprehensive weed management program which shows that the efforts have contained the spread of the weeds of concern and is systematically reducing their distribution with the objective of complete eradication from the island over time. In the case of mice and rats, the existing oilfield operator has successfully eradicated a mouse introduction, disturbing a very small area of the island, and CALM has carried out a rat eradication effort on the southern end of the island. Non-native rats are believed to be completely absent on Barrow Island. In the case of the tramp ant, discovered as a direct result of the Joint Venturers' baseline survey efforts of invertebrates, experts consider this particular species of ant which is prevalent in northern Australia to be a 'cosmopolitan species' which is not likely to survive in the native environment (to be confirmed in an expanded baseline survey program).

Furthermore, the tramp ant may have established itself the island under a natural colonisation pathway, as happens frequently on islands; or it is possible that it was introduced by oilfield activities. However, this cannot be determined with certainty. The Joint Venturers will put in place a competent monitoring and surveillance program supported by a Response and Eradication Strategy. Furthermore, the Joint Venturers are committed to respond quickly and effectively to any quarantine emergency that might threaten the biodiversity of the island, as stated in the Barrow Island Quarantine Policy (Box 12-1 of the Draft EIS/ERMP), and described in Section 12.5.9 of the Draft EIS/ERMP.

18.30 Chevron Australia's approach to quarantine management in the event of a quarantine breach, which is to first determine which operator is responsible for the breach rather than rapidly responding to the breach, is not adequate in the circumstances and would appear to indicate inadequate commitment to achieving the best outcomes for biodiversity conservation on Barrow Island. Valuable time wasted in apportioning blame could forfeit the chance of eradication of an introduced pest or weed. This is not acceptable to CALM.

The Joint Venturers remain committed to a responsible approach to all quarantine introductions on Barrow Island. All introductions will be investigated to establish the root cause; however this will not delay the commencement of an appropriate response. The key success factor is early detection and rapid response. This was envisaged at the time of the State Agreement and the Barrow Island Act as they require a Barrow Island Coordination Council (BICC) as a single point of contact for the government agencies for issues such as possible quarantine breaches.

18.131 The proponent should detail the measures by which buffel grass and other weeds known to be persistent on Barrow Island will be prevented from establishing on the Gorgon lease, particularly in areas of soil disturbance.

The Joint Venturers will manage all potential pathways of introduction to prevent the introduction of new plant species to Barrow Island, and maintain custody and control of all material and equipment on the proposed development footprint. The development site will be denuded of vegetation on the advice of CALM and the Quarantine Expert Panel.

This approach will, in the event of an introduction, contribute to the containment of the organism within the development site, where it would be easily detected in the denuded area. Notwithstanding the very rigorous precautionary measures to be taken to prevent introductions, there may be a chance of a non-indigenous species establishing in the native environment. Irrespective of the low risk of introduction, the Joint Venturers are committed to a world class monitoring and surveillance program supported by a robust and well-funded response and eradication strategy.

The existing management measures for buffel grass and other weeds in the native environment are described in the Weed Management Plan (Chevron Australia, 2005). The Joint Venturers will put in place a competent monitoring and surveillance program supported by a Response and Eradication Strategy. Furthermore, the Joint Venturers are committed to respond quickly and effectively to any quarantine emergency that might threaten the biodiversity of the island, as stated in the Barrow Island Quarantine Policy (Box 12-1), and described in Section 12.5.9 of the Draft EIS/ERMP.

18.155 Contingency plans and protocols for the inspection and treatment of hull infestations, particularly for foreign vessels, should be developed in consultation with, and to the satisfaction of, the Department of Environment, Department of Fisheries and CALM.

On p 559 of the Draft EIS/ERMP it states: 'To mitigate translocation of species from foreign ports during the construction period, inspection of wetted hull surfaces (followed by cleaning/disinfection if necessary) will be required to verify that threats of introduction are being managed prior to loading of cargoes destined for Barrow Island.' The quarantine barriers for marine vessels will be subject to the same risk-based assessment method as all other pathways.

Any stakeholder, including CALM, the Department of Environment, or the Department of Fisheries (the lead agency for introduced marine pests) can propose an alternative set of quarantine barriers for any of the marine pathways. Such proposals will be introduced to the appropriate risk assessment workshops, where all alternatives will be assessed by the Joint Venturers and technical experts. In the past this process has, and will, ensure that proponents of viable proposals have the opportunity and ability to participate in the barrier assessment process.

18.166 Contingency plans for responding to all potential quarantine breaches must be developed and agreed to by CALM, prior to project implementation.

The Joint Venturers have consulted with a number of eradication specialists and are aware of the current eradication practices for undesirable species recommended by the WA Department of Agriculture and the CSIRO.

Chevron Australia (as the operator of the existing oilfield) has demonstrated its response capabilities to eradicate mice and rats on the few occasions that they were discovered, and successfully manage weed eradication efforts, in consultation with recognised experts. These proven protocols for response and eradication, and the experience gained, is already informing the Joint Venturers in the development of their Response and Eradication Strategy.

The Joint Venturers recognise that eradication efforts will be organism-specific, and have committed to a rapid response strategy utilising the advice of technical specialists (Section 12.5.9 of the Draft EIS/ERMP). The detail of the strategy is being developed and will be subjected to peer review and field training exercises prior to the commencement of construction activities for the proposed Gorgon Development. The Response and Eradication Strategy will include a Detection Plan; Incursion Report; point of contact and incursion authority; response inventory (e.g. equipment and instructions); category of incursion and category of response; Response Protocol; and implementation of a Species Action Protocol. In line with Joint Venturers' commitment to transparency, this information will be available to interested stakeholders.

An important part of the Response Protocol will be pre-planned contingency plans for specific types of quarantine breaches, and emergency situations that might occur (e.g. medical evacuation, distress of a vessel at sea requiring assistance). The Response and Eradication Strategy will be completed prior to the start of construction.

20.43	Gorgon has not developed protocols for eradication of introduced species once they establish. The risk based approach used by Gorgon scores infection, survival, detection and eradication. Almost all work has been on infection, with some attention on survival, less on detection and none on eradication.
22.291	Another major gap is the failure to have even commenced work on protocols for dealing with quarantine breaches, when they inevitably happen.
25.37	Eradication procedures for infestation of barrier facilities are poorly addressed for all of the pathways and should be specified.

The Joint Venturers have focussed the attention on pre-border quarantine compliance. This focus was a strategic decision which had a goal of securing quarantine compliant logistics and entrenching custody and control of such compliant goods and services pre-border. This has been proven to be a successful strategy as was demonstrated in the three priority pathways (Part 2 of the Additional Information Package). However, the development of the pathways has now progressed sufficiently enough to expand the focus to quarantine issues associated with post-border activities.

The Joint Venturers have consulted with a number of monitoring and surveillance experts and eradication specialists. In addition, the Joint Venturers are well aware of the current monitoring and eradication practices for undesirable species recommended by the Western Australia Department of Agriculture and the CSIRO.

Chevron Australia (as the operator of the existing oilfield) has demonstrated its response capabilities to eradicate mice and rats on the few occasions that they were discovered, and to successfully manage weed eradication efforts. This has been achieved in consultation with appropriate experts from government regulatory bodies including CALM. These proven protocols for response and eradication, and the experience gained, are already informing the Joint Venturers in the development of their Response and Eradication Strategy for the island.

The Joint Venturers recognise that eradication efforts will be organism-specific, and have committed to a taxa targeted strategy utilising the advice of technical specialists (Section 12.5.9 of the Draft EIS/ERMP). The detail of the strategy is being developed and will be subjected to peer review and field training exercises prior to the commencement of construction activities for the proposed Gorgon Development. The Response and Eradication Strategy will include a Detection Plan; Incursion Report; Point of Contact and Incursion Authority; Response Inventory (e.g. equipment and instructions); Category of Incursion and Category of Response; Response Protocol; and implementation of a Species Action Protocol. In line with Joint Venturers' commitment to transparency, this information will be available to interested stakeholders.

22.286 Some of the measures necessary to prevent proliferation of introduced vertebrate pests have caused significant loss of native fauna as well – in order to kill house mice, for example, one must fence off and poison everything in a particular area!

The Joint Venturers will implement a Response and Eradication Strategy which will enable early detection of an introduced species to contain the organism and minimise the area that is subject to an appropriate response. CALM have successfully eradicated introduced black rats from the southern end of Barrow Island while maintaining populations of native mammals.

22.296 It is totally unacceptable to limit proposed rapid response activities to introductions caused by GJV. Who would need to prove that the incursions were not caused by GJV for rapid response activities to be avoided?

The Joint Venturers remain committed to a responsible approach to all quarantine introductions on Barrow Island. All introductions will be investigated to establish the root cause; however this will not delay the commencement of an appropriate response in partnership with CALM as the management authority. The key success factor is early detection and rapid response.

12.6 Quarantine Management System

4.1 Gorgon is attempting to develop a quarantine system of a standard higher than anything that currently exists anywhere in the world. The time frame available to develop such a system is short and there is little possibility it can be properly tested before construction begins. If failures relate to organisms that survive and establish, then failure will probably be for all time. The probability of detecting most introduced organisms before they become common is low.

The Joint Venturers, through Chevron Australia as the operator of the existing Barrow Island oilfield operations, have 40 years of quarantine experience that has served to protect the conservation values of Barrow Island, an accomplishment of which the operator is proud. The Joint Venturers appreciate the challenge in developing a world-class Quarantine Management System (QMS) for the proposed Gorgon Development on Barrow Island. In this regard, Chevron Australia has made substantial progress in developing a competent quarantine capacity in the organisation. This capacity has advanced from its initial grass-roots beginnings of quarantine management 40 years ago to a visible quarantine culture evident in the workforce today.

The Joint Venturers are developing high performance barriers for all of the potential pathways of introduction, with the goal of no introductions, which will meet the standards for acceptable risk. In addition to the high performance barriers, the Joint Venturers are committed to developing a monitoring program that will rapidly detect an introduction, and mobilise an immediate Response and Eradication Strategy. This approach is informed by current practices on Barrow Island, which have successfully eradicated introduced species in the past.

4.3 No attempt has been made by Gorgon, despite recommendations from experts, to measure infection of existing pathways operated by Chevron to service the oilfield.

The Joint Venturers have approached the oilfield operator for information on inspections of the existing pathways and consulted with technical experts in developing a scope for any additional sampling of the existing pathways that may be necessary. If the scoping exercise identify a significant need that may improve the knowledge base that informs the approach of the Joint Venturers, such work will be undertaken as part of the development of the QMS (refer to the objectives and targets of the QMS in Table 12-9 of the Draft EIS/ERMP, p 586).

4.4 This would have been a relatively easy task, as there are several aircraft with passengers with luggage flying to Barrow every week, plus many barge trips with food, etc. per month.

The Joint Venturers have approached the oilfield operator for information on inspections of the existing pathways and consulted with technical experts in developing a scope for any additional sampling of the existing pathways that may be necessary. If the scoping exercise identify a significant need that may improve the knowledge base that informs the approach of the Joint Venturers, such work will be undertaken as part of the development of the QMS (refer to the objectives and targets of the QMS in Table 12-9 of the Draft EIS/ERMP, p 586).

9.1 This impact and risk is not appropriate for a state natural asset that is recognized by protection within an A Class Reserve.

Independent experts have helped build a world-class quarantine system that will continue to protect the plants and animals on and around Barrow Island.

9.3 Any increased development will reduce the size of the biodiversity asset and because of its restricted size, could potentially have a detrimental impact on the conservation qualities of the island.

The Joint Venturers have committed to implementing a rigorous, world-class Quarantine Management System (Chevron Australia 2005; Section 12.6). Barriers proposed on the three priority pathways, where plant introductions are a major threat, are described in the Additional Information Package of the Draft EIS/ERMP (Chevron Australia 2005b). The outcome of the risk-based assessment of the proposed barriers on these three priority pathways is that the likelihood of a plant incursion is low.

12.9 The scale and time frame of the proposed development means that, even with the best of intentions, perfect quarantine control would be impossible. While the likelihood of catastrophic impacts can be greatly reduced with an effective quarantine plan, it cannot be eliminated and once quarantine is breached and introduced species become established there will be little that can be done in most instances. The potential for irreversible damage to this unique site is simply a risk that should not be taken.

The Joint Venturers will manage all potential pathways of introduction to prevent the introduction of new plant species to Barrow Island, and maintain custody and control of all material and equipment on the proposed Development footprint. The Development site will be denuded of vegetation on the advice of CALM and the Quarantine Expert Panel. This approach will, in the event of an introduction, contribute to the containment of an introduced organism within the Development site, where it would be easily detected in the denuded area. Notwithstanding the very rigorous precautionary measures to be taken to prevent introductions, there may be a chance of a non-indigenous species establishing in the native environment. Irrespective of the low risk of introduction, the Joint Venturers are committed to a world-class monitoring and surveillance program supported by a robust response and eradication strategy.

14.17 Recommendation 6: The Conservation Commission recommends that Chevron considers providing managed access for workers to areas outside the camp and construction site to participate in programs that will improve awareness of environmental matters and contribute to environmental management programs.

The Joint Venturers support this view of the Conservation Commission, and will develop strategies for appropriate and constructive exposure of personnel to the Barrow Island environment. Opportunities will be sought for promoting environmental awareness and understanding of the conservation values of Barrow Island among the construction workforce. Involvement and contributions to environmental management programs will be encouraged.

14.18 Recommendation 7: The Conservation Commission recommends that it be recognised that the Commission conducts audits of management systems rather than detailed operational assessments.

The Joint Venturers recognise that the Conservation Commission of Western Australia will conduct audits of management systems, such as the QMS. The Joint Venturers also recognise that CALM will have a continuous presence on Barrow Island, with the ability to observe any and all quarantine management activities.

18.187 General Appendix B Key Commitments – Quarantine, page 814 – All commitments included in Appendix B for quarantine management, except for commitment 11.5, should be adopted by the proponent and implemented to the requirements of the EPA on the advice of CALM.

The Joint Venturers remain faithful to the commitments stated in General Appendix B.

16.81 The experience of other places is that disturbed areas are quickly colonized by exotic colonists.

The development site will be denuded of vegetation on the advice of CALM and the Quarantine Expert Panel, and kept free of plants during construction activities. This strategy of keeping the disturbed area denuded of vegetation will, in the event of an introduction, facilitate the detection and eradication of any plants (native or introduced) that appear on otherwise bare ground.

16.84 Scrupulous and unbiased auditing (of ballast water management) is paramount. This is not possible if Gorgon Joint Venturers do their own auditing as proposed. (Key commitments 11.5, Executive Summary page 117). Auditing should be conducted at the proponents' expense by independent agencies, eg. Department of Fisheries, NOT by the Gorgon Joint Venturers, in order to verify conformance with domestic and international regulations.

Progress is being made on barrier selection, and the proposed set of barriers for marine vessels will be assessed by independent experts in QHAZ workshops with the same scrutiny as all other pathways. The Joint Venturers have proposed independent auditing as one of the many systematic barriers on the three priority pathways (Part 2 of the Additional Information Package). Similarly, auditing will be proposed as one of the many systematic barriers for the marine vessel pathway.

Audits will include the marine contractor's obligations to assess their procedures and records; the Joint Venturers' obligations to assess management processes; and independent third-party audits of any and all quarantine commitments.

The Australian Quarantine Inspection Service (AQIS) will have a statutory role in compliance checks of foreign vessels, which will be required to meet Australian and International Maritime Organisation (IMO) requirements for the prevention of translocating ballast water and hull fouling organisms.

16.85 Is auditing enough? Once contaminated/infestation has occurred it would be virtually impossible to reverse. The costs of trying to repair such quarantine breaches would be astronomical. And who would bear such costs? GJV must agree to bear any such costs.

It is acknowledged that organisms have the potential to be introduced to Barrow Island, and possibly survive. The Joint Venturers have committed to a rigorous quarantine regime which will lead to a low likelihood of incursions (the conclusion of the assessment of three priority pathways in the Additional Information Package). The Joint Venturers will also implement a monitoring system that will enable early detection at the proposed development site and in the immediate native environment, so that an appropriate response can be rapidly initiated to protect the conservation values of the island.

The existing oilfield operation has developed a comprehensive weed management program which shows that the efforts have contained the spread of the weeds of concern and is systematically reducing their distribution with the objective of complete eradication from the island over time. In the case of introduced animals, the existing oilfield operator has successfully eradicated a mouse introduction, disturbing a very small area of the island, and CALM has carried out a rat eradication effort on the southern end of the island. Non-native rats are believed to be completely absent on Barrow Island. In the case of the tramp ant, discovered as a direct result of the Joint Venturers' baseline survey efforts of invertebrates, experts consider this particular species of ant which is prevalent in northern Australia to be a 'cosmopolitan species' which is not likely to survive in the native environment (to be confirmed in an expanded baseline survey program).

The tramp ant may have established itself on the island under a natural colonisation pathway, as happens frequently on islands; or it is possible that it was introduced by oilfield activities. However, this cannot be determined with certainty.

Benefiting from the existing successes on the island, the Joint Venturers will also put in place a competent monitoring and surveillance program supported by a Response and Eradication Strategy. The Joint Venturers are committed to respond quickly and effectively to any quarantine emergency that might threaten the biodiversity of the island, as stated in the Barrow Island Quarantine Policy (Box 12-1 of the Draft EIS/ERMP), and described in Section 12.5.9 of the Draft EIS/ERMP.

18.160 Baiting and trapping in the village must include a strategy for eliminating impacts to non-target species (indigenous fauna). This must be developed in consultation with and to the satisfaction of CALM.

The Joint Venturers have proposed such consultation with CALM and the Department of Agriculture for Barrier Number 28 of the personnel and luggage pathway (Technical Appendix 2 in Part 2 of the Additional Information Package, p 18).

20.10 Extinction risk of endemic biota and introduction of feral animals through quarantine breaches as a consequence of increased visitation and development.

The Joint Venturers are very aware of the extinction phenomena and the loss of biodiversity associated with oceanic islands and isolated ecosystems as a result of the introduction of non-indigenous species. It is in this knowledge that the Joint Venturers, through their operating partner, Chevron Australia, are proud of the achievements of the oilfield operations on Barrow Island over the past 40 years. To date, no extinctions have been recorded as a result of the oilfield operations and no major incursions have resulted from the presence of the oil operations located on the island.

Compared to other islands in the region, it could be suggested that the presence of the oil operations on Barrow Island have contributed to the protection of this important conservation asset.

The Joint Venturers reiterate their commitment to the establishment of a QMS that expands and builds on the existing quarantine management of the island. This commitment will deliver a world class QMS that offers a very high degree of protection to the island against any quarantine breaches (including the introduction of non-indigenous species and the establishment of viable populations of such species).

In the context of the proposed development, the introduction of non-indigenous species has been the subject of debate in relation to assessing the impacts of stressors to the island's biodiversity values. The Joint Venturers have always maintained a very responsible attitude in regard to preventing incursions of non-indigenous species to the island. As such, the Joint Venturers have embarked on a very robust, rigorous and transparent public process that aims to meet the communities' expectations of acceptable risk associated with the development.

Through collaboration with independent experts and the broad community, the Joint Venturers have developed great confidence in their abilities to develop an efficient and effective QMS which ensures that the risks to the conservation values are acceptable and manageable, and meet the community expectations. Therefore, the proposed development, inclusive of increased visitations and other project related activities as stressors, has been judged to be a low risk.

20.36 While Chevron has a reasonably good history of quarantine on Barrow to date, it is attempting to develop a quarantine system of a standard higher than anything that currently exists anywhere in the world. However, the chance of doing this successfully in the short time available before construction is proposed to commence is very low. While Gorgon have made a commitment to quarantine, it is unlikely that quarantine will take precedence to construction timetables once the project gets underway. If early failures relate to organisms that survive and establish, those failures will be for all time. The probability of detecting most organisms before they become common is low. Eradication is not possible for most organisms without also destroying indigenous species, as most eradication attempts will involve use of poisons.

The Joint Venturers have adopted a 'zero tolerance of invasions' target, and are consequently developing a rigorous quarantine regime in consultation with experts and the community. It is the considered opinion of independent experts that the likelihood of an incursion of non-indigenous species (NIS) to Barrow Island will be low. This has been demonstrated for the three priority pathways that have been described in the Additional Information Package (Chevron Australia 2005b). The remaining pathways and respective barriers are being developed with the same dedication and attention to detail and will be subject to the same risk-based assessment method. It is expected that the ongoing evaluation of the remaining pathways will also result in a low likelihood of incursion.

The Joint Venturers are in the process of undertaking baseline studies which will establish, for the first time, a recognised biodiversity index that informs management on the status of biodiversity on the island, with regard to species composition, structure and function – specifically relating to the potential development impacts. This information will inform the design of monitoring programs on the island, which will enable early detection of any introductions that might occur. If an introduced species is detected in the native environment, it will be detected early enough to contain the incursion and respond accordingly to protect the conservation values of the island.

Substantial progress has been made in the development of a world class Quarantine Management System (QMS) which commits the Joint Venturers to a seamless and fully integrated approach to the threat of non-indigenous species becoming introduced to the island. This includes a pre-border, border and post-border intervention strategy with a primary focus on pre-border quarantine compliance. The QMS is also a requirement in terms of the Barrow Island Quarantine Policy (refer to Box 12-1 of the Draft EIS/ERMP).

Implementing its elements will commence as early as possible, with full implementation prior to construction. The Barrow Island Quarantine Policy specifically states that construction schedules will not take precedence over compliance with quarantine requirements. Chevron Australia, as operator, will react to any potential quarantine situation by mobilising its Response and Eradication Strategy, a core component of the QMS. This strategy includes a Detection Plan, Response Protocol (that is species-specific), Incursion Report, Point of Contact, the Incursion Authority to act, a Response Inventory, the Category of Incursion, the Category of Response Strategy and Implementation Plan.

The Joint Venturers will complete the barrier selection process and independent assessment of all pathways well ahead of the construction commencement date. Progress to date indicates that this will be achieved by April 2006. A review period of at least 3 months will be undertaken, aimed at identifying any shortcomings in the quarantine process, the quarantine procedures, barrier design specifications and performance.

21.19 The oil industry on both Barrow and Varanus Islands have implemented 'best practice' quarantine for a number of years, and the risk has also been considered low. Despite this, mice reached both islands in the 90's. In recent years Toll have (fortunately) detected a quarantine breach in equipment shipped by Department of Conservation and Land Management (CALM) staff before the equipment reached Barrow Island, but there have been at least two other breaches that were only picked up and rectified by other CALM staff subsequent to arrival at Barrow. The number of quarantine breaches that have gone unreported is unknown, however if these mistakes can be made with people who should be well aware of the implications, it highlights the vulnerability of any system when a large number of people with little/no direct interest in the conservation outcome are involved.

Over the 40 years of successful oilfield operation, quarantine management on Barrow Island has developed into a sophisticated, practicable quarantine management process that has significantly contributed to the conservation values present on the island. One of the strengths of this process has been the application of lessons learnt over the years. Quarantine management is embedded in every project undertaken on Barrow Island and in every logistical activity. Visitors to the island, whether from government agencies or community organisations understand that there is pervasive quarantine culture on the island that has developed over time. This is an accomplishment the operator is proud of. The Joint Venturers appreciate the challenge of developing a world class QMS for the proposed Gorgon Development which builds on the legacy of the existing quarantine management program in a manner that can accommodate the increased activities associated with the proposed development. In this regard Chevron Australia has made substantial progress in developing a competent quarantine capacity in the organisation.

This capacity has advanced from its initial grass-roots beginnings of quarantine management to a visible quarantine culture evident in the workforce. The continued development and promotion of this culture will permeate all of the proposed development activities, as evidenced in the systematic barriers proposed for the three priority pathways (Part 2 of the Additional Information Package).

The Joint Venturers are developing high performance barriers for all of the potential pathways of introduction with the goal of no introductions and consistency with the standards for acceptable risk. In addition to the high performance barriers, the Joint Venturers are committed to developing a monitoring program that will rapidly detect an introduction, and mobilise an immediate Response and Eradication Strategy. This approach is informed by current practices on the island, which have successfully eradicated introduced species in the past. The Joint Venturers are confident in their ability to improve on the existing practices and prevent similar breaches by people travelling to the island.

21.20 The times quarantine is most likely to break down is when unusual or emergency events occur. Such events could include wildfires, oil-field fire, serious accident, ships in distress, acts of terrorism, or even major failure of a part of the gas plant that does not threaten life or the environment directly, but threatens large economic losses if not rectified quickly. In these 'pressure cooker' situations, mistakes are more likely.

The Joint Venturers have already noted that contingencies for abnormal situations and emergencies will require consideration in quarantine procedures as noted in risk assessment workshop records. Documented examples include medical evacuations, extreme weather events, and maritime emergencies.

25.34 We note that non-compliance is linked to employment, which stresses its importance, however we suggest that Gorgon should also adopt a no-blame declaration/reporting policy for all quarantine breaches or there is a risk of breaches being dealt with inappropriately or covered up.

The Joint Venturers will maintain an open and transparent quarantine management regime with a specific approach that embraces the concept of 'no-blame' for those personnel who report quarantine incidents and quarantine breaches and promptly follow the procedure for reporting such incidents.

24.91 How will these issues/comments related to protection of terrestrial vertebrates on Barrow Island be addressed in the monitoring and quarantine management proposals?

Technical Appendix D2 of the Draft EIS.ERMP (Chevron Australia 2005) was specifically prepared to outline the methodology for conducting a risk-based assessment of potential quarantine threats during the construction and operation of the proposed Gorgon LNG gas processing facility, and the associated marine terminal and carbon dioxide re-injection program. Statements in this appendix are therefore mainly focussed on and informing the approach to the Gorgon Development.

The aim of the Technical Appendix D2 was to draw upon the best practices for ecological risk assessment and apply such practices in a manner that realises a quarantine management system for the Gorgon Development that meets the EPA recommendation to the Western Australian Government that if the proposed development of a gas plant on Barrow Island is to proceed, 'it could only be with a policy of zero tolerance of invasions'.

The Joint Venturers believe this was demonstrated successfully in the development of a Quarantine Policy, the commencement of the QMS development and the publication of the proposed barriers for the three priority pathways in Part 2 of the Additional Information Package (Chevron Australia 2005b).

The Barrow Island Quarantine Policy and the QMS is applicable to all activities on Barrow Island. The logistics requirements of the existing oilfield operations will be managed through the same supply bases and under the same high quality quarantine regime as the proposed Gorgon Development activities. In the event that the existing oilfield operations present circumstances which depart from the pathways described for the Gorgon Development, new pathways will be described and assessed under the same risk-based assessment method and standards for acceptable risk as all other pathways.

12.6.1 Introduction

No submissions received on this section of the Draft EIS/ERMP.

12.6.2 Elements of the QMS

14.6 There are significant environmental impacts associated with the Gorgon gas development including its footprint and offshore dredging requirements, and there is an unacceptable risk to the island's biodiversity conservation values (its unique species, populations and ecosystems) from the introduction of exotic invasive species.

The Gorgon quarantine management system aims to continue protecting the plants and animals on and around Barrow Island. The focus is on preventing introduced species from getting to Barrow Island through pathways such as food, personnel and luggage and materials such as sand and aggregate. Detection and response strategies will also be in place to prevent the establishment of any introduced species in the native environment. The record of protecting the conservation values of the island over 40 years while producing and shipping 300 million barrels of oil, gives confidence to seek restricted use of the island for the Gorgon Development.

12.6.3 System Implementation

18.164 The proponent should appoint a dedicated quarantine coordination position/role to ensure continuity and open communication between the Joint Ventures and stakeholders.

The Joint Venturers have appointed a dedicated Quarantine Manager during the FEED phase of the proposed Development. 'The responsibility for quarantine management at an organisational level and the roles and responsibilities of specific personnel will be established' as part of the QMS (Table 12-9, p 588). The overall responsibility for quarantine performance will rest with the Joint Venturers.

18.167 Table 12-9 of the ERMP should include record keeping in respect of quarantine breaches

Comment noted and agreed. The Joint Venturers include record keeping of quarantine non-compliance, breaches and incidents as the intent in the record keeping element of the QMS (Chevron Australia 2005; p 589).

22.297 When it comes to quarantine, the devil could be in the absence of detail! All proposed barriers will be relevant in order for the regulators to take a view on whether the Island is exposed to too much risk by the proposal. The Submitters contend that for these reasons all but the last three bullet points on this page [pg 591] should be completed before the project's environmental impact assessment is finalised.

The Joint Venturers have clearly recognised the need for a world-class Quarantine Management System that will effectively manage the risks of introduction from the proposed Development, and have made substantial progress to develop solutions that have been tested under the scrutiny of independent experts. The community recognised that there cannot be a 'zero risk' solution for quarantine; however, the Joint Venturers have faithfully addressed the community's expectations for acceptable risk to prevent the establishment of non-indigenous species on Barrow Island. In doing so, the Joint Venturers have considered all the recommendations of conservation and ecological specialists to prevent introductions on pathways of people, cargoes and vessels. The proposed quarantine barriers for the three priority pathways are discussed in detail in the Additional Information Package, with the advice of the experts being that the likelihood of incursions is low.

Border and post-border surveillance and monitoring activities are being designed to provide early warning of any organisms that might arrive on Barrow Island, so that a response to an incursion can be dealt with rapidly, preventing establishment in the native environment.

The proposed Gorgon Development is in the Front End Engineering Design (FEED) stage, and the detail of the pathways of people, materials and vessels is under development. The Joint Venturers recognised in 2004 that all pathways could not be fully described and assessed under the risk-based assessment method by the submission date of the Draft EIS/ERMP. The Joint Venturers obtained advice from the Quarantine Expert Panel that in order to demonstrate its ability to develop effective quarantine barriers and meet standards for acceptable risk, that three priority pathways could be progressed to completion.

The Quarantine Expert Panel nominated the three priority pathways, which were considered to present the greatest management challenge for meeting standards for acceptable risk, based on the results of risk assessment, expert opinion and community consultation.

The EPA agreed to a proposal by the Joint Venturers to publish the proposed barriers and results of independent assessment for the three priority pathways during the public review period of the Draft EIS/ERMP. This information was published in Part 2 of the Additional Information Package on 24 October 2005, so that the public could have the opportunity of a ten week review and comment period, through 3 January 2006. The Joint Venturers are committed to consider all public submissions and will investigate and assess any promising improvements that may be suggested.

Significant progress has been made on all of the pathways which have the potential to introduce terrestrial or marine organisms to Barrow Island and the surrounding waters. As of the date when the Draft EIS/ERMP was submitted, 21 workshops had been undertaken, and nearly all of the pathway assessments had commenced (Tables 12-2 and 12-3 of the Draft EIS/ERMP).

The Joint Venturers have committed to complete all pathway assessments, develop pathway-specific barriers, test the proposed barriers in QHAZ workshops with independent experts, and implement the barriers prior to the start of proposed construction activities. These tasks will be complete for all pathways by April 2006, enabling the Joint Venturers to trial barriers, collect data and implement the proposed set of barriers for each pathway over a three-month period prior to the start of construction.

Information developed for quarantine barriers on all pathways will be subject to the same risk-based assessment method, standards for acceptable risk, and transparency as presented in for the three priority pathways in Part 2 of the Additional Information Package. Results of all workshops and barrier selection documents will be posted on the website www.gorgon.com.au/quarantine. to make the information publicly available.

13 Greenhouse Gas Emissions – Risks and Management

13	Greenhouse Gas Emissions – Risks and Management.....	351
13.1	Introduction and General Submissions on Greenhouse Gas Emissions.....	352
13.1.1	Commitment to Greenhouse Gas Management	352
13.1.2	Impact on National and State Greenhouse Gas Emissions.....	355
13.1.3	The Relative Greenhouse Impact of LNG.....	355
13.2	Alternative Greenhouse Gas Abatement Options.....	359
13.3	Gorgon Development Greenhouse Gas Emissions	361
13.3.1	Greenhouse Gas Emissions Efficiency Improvements.....	361
13.3.2	Emissions Estimation Methodology	361
13.3.3	Emissions During Construction and Commissioning.....	361
13.3.4	Emissions from Operations	362
13.3.5	Greenhouse Gas Emissions during Decommissioning	362
13.3.6	Benchmarked Greenhouse Gas Emission Performance.....	362
13.4	Disposal of Reservoir Carbon Dioxide by Injection into the Dupuy Formation.....	363
13.4.1	Assessment of Potential Carbon Dioxide Injection Sites.....	367
13.4.2	Location of Carbon Dioxide Injection on Barrow Island	371
13.4.3	Geology of Barrow Island	371
13.4.4	Carbon Dioxide Behaviour in the Subsurface.....	372
13.4.5	Reservoir Simulation.....	372
13.4.6	Deviations from Simulation Predictions.....	372
13.4.7	Monitoring of Injected Carbon Dioxide	372
13.4.8	Carbon Dioxide Injection Operations Management Plan.....	374
13.4.9	Environmental Impact of Carbon Dioxide Injection Infrastructure	377
13.4.10	Potential Failure Modes Related to Carbon Dioxide Injection	377
13.4.11	Approach to Long-term Responsibilities.....	378
13.4.12	Approach to Long-term Responsibilities.....	378
13.5	Greenhouse Gas Management Plan.....	380
13.5.1	Membership of Government Programs.....	381
13.5.2	Planned Actions to Reduce Greenhouse Gas Emissions	381
13.5.3	Greenhouse Gas Emissions Performance Indicators and Targets.....	382
13.6	Compliance with EPA Guidance Notes	382

13.1 Introduction and General Submissions on Greenhouse Gas Emissions

20.1 We would also like to confirm that WWF-Australia is not opposed to LNG production in the Pilbara. Quite the contrary; we see LNG as an important source of energy as the global economy begins its transition to sustainable sources of energy.

The Joint Venturers recognise WWF-Australia's support for LNG as a transition fuel. As outlined in Box 13-1 of the Draft EIS/ERMP, the Joint Venturers concur with this view.

22.31 Key issues not included in this Draft EIS/ERMP or not dealt with in sufficient detail include – clearing, if any, related to CO₂ injection monitoring.

Monitoring of CO₂ is described in the Draft EIS/ERMP Section 6.2.5 on p 115 and Chapter 13, while clearing for CO₂ injection monitoring is described in Table 6.3 on p 126 of the Draft EIS/ERMP.

24.9 While Table 6-1 shows the anticipated gas composition for both Gorgon and Jansz gas fields in year 20, this is a 60 year plus proposal. A table or chart showing the expected compositions at decade intervals over the proposed life of the project (60 years) should be provided.

The data provided is the anticipated composition after 20 years of production and represents the average composition over the life of the Development. The composition in any particular year (or decade) is only expected to vary from this composition by a slight amount.

The greenhouse gas emissions quoted in the Draft EIS/ERMP (Chevron Australia 2005; p 609) has been prepared based on a reference case incorporating a series of worst case assumptions. Slight variations in the composition of the natural gas arriving at the gas processing facility will not materially alter the level of these emissions.

13.1.1 Commitment to Greenhouse Gas Management

14.4 Thus the use of Barrow Island Nature Reserve is being proposed based on a need to control CO₂ yet the great majority of the CO₂ directly or indirectly associated with the project is unlikely to be managed.

Apart from utilising best available technology in the gas processing plant, which is independent of a location on Barrow Island, there is currently no law or government policy that requires the Joint Venturers to control the Development's greenhouse gas emissions. The juxtaposition of the gas processing facility and an ideal subsurface injection location at Barrow Island provides the opportunity to significantly reduce greenhouse gas emissions by subsurface injection, such that the Gorgon Joint Venturers have voluntarily proposed this action.

The Gorgon Joint Venturers maintain that all of the 'direct' greenhouse gas emissions associated with the proposed Development will be managed in accordance with the Development's Greenhouse Gas Management Strategy and Management Plans (Chevron Australia 2005; pp 598 and 677). The design of the gas processing facility incorporates currently applied best practice in the areas of subsea development, LNG technology selection and waste heat recovery. In addition, the Joint Venturers have adopted a policy of no routine flaring or venting of hydrocarbons. The success in managing the Development's 'direct' greenhouse gas emissions is highlighted by the greenhouse gas efficiency benchmark data provided in section 13.3.5 of the Draft EIS/ERMP (Chevron Australia 2005; p 615).

Indirect greenhouse gas emissions, that is, those resulting in the ultimate use of LNG, are outside the scope of the Gorgon Joint Venturers' management. The consumption and management of greenhouse gas emissions from the burning of LNG will fall under the respective laws and policies of the government of the country in which the LNG is used. The Gorgon Joint Venturers highlight the lifecycle greenhouse gas emissions benefits of LNG as a fuel compared to alternative energy sources (Chevron Australia 2005; p 600).

16.62 We note with concern that the Gorgon Area General Manager, on page 598 of the Main Report, indicates that the project should go ahead even if CO₂ sequestration proves to be not feasible. The statement is further enunciated on page 110 of the Executive Summary. This approach is unacceptable and throws into doubt the intention, expressed throughout much of the Report, of the Gorgon Joint Venturers to provide LNG with little negative environmental impact.

The Gorgon Joint Venturers have given a commitment to significantly reduce the greenhouse gas emissions of the Gorgon Development by underground injection of reservoir CO₂, removed as a routine part of the gas processing, rather than by emitting the CO₂ to the atmosphere. This commitment includes a number of qualifiers, documented on p 597 of the Draft EIS/ERMP (Chevron Australia 2005). This commitment exceeds the actions that are required by government policy and is an activity that is not being undertaken by our LNG competitors, some of which have higher levels of reservoir CO₂ in their gas than does the Gorgon Development

It should be noted that qualifiers dealing with CO₂ injection uncertainty have been provided to manage what are anticipated to be a remote outcomes and should not be interpreted as reflecting the expected performance of the CO₂ injection project.

Refer to submission 16.59 Section 13.4 for a discussion on the CO₂ content of Gorgon Development gas.

22.306 The commitment to “continue to advocate increased use of gas based fuels, in preference to more carbon intensive options, to reduce greenhouse emissions,” is more of a market-development commitment than a greenhouse management tool. True commitment to greenhouse mitigation would clearly include the development, promotion and transition to renewable zero-emissions technologies and fuels.

This statement refers to an undertaking in the Gorgon Gas Development Greenhouse Gas Management Strategy.

It should be noted that the Gorgon Joint Venturers have been formed with the express purpose of developing the Greater Gorgon gas fields. Advocating for the increased use of natural gas in preference to more carbon intensive fuels is within the scope of the Joint Venturers’ agreement and can therefore be included in the Gorgon Development Greenhouse Gas Management Strategy.

22.307 The development of a contingency that “could provide a partial offset for reservoir CO₂ if a sequestration project becomes infeasible” should be required to be undertaken prior to any approval that may be given to this project, given that sequestration of the high level of reservoir CO₂ is a central component of this proposal.

Since the ESE Review (ChevronTexaco Australia 2003), the Gorgon Joint Venturers have made an undertaking to exceed federal and state government policy in reducing greenhouse gas emissions by proposing the subsurface injection of reservoir CO₂.

Prior to commencing construction of the Gorgon Development, should the proposal to inject reservoir CO₂ prove infeasible, the State Government may require the implementation of a greenhouse gas emissions reduction contingency plan to partially offset the reductions that would have been achieved by the CO₂ injection proposal. These are matters for the State Government of Western Australia to address through the approval provisions in the Gorgon Gas Processing and Infrastructure Project Agreement.

The studies that the Gorgon Joint Venturers have undertaken to date have shown that the CO₂ injection proposal remains technically feasible, and it remains the intent of the Joint Venturers to proceed with this proposal as an integral component of the Gorgon Development.

22.308 Limiting best practice greenhouse gas management technologies ‘where practicable’ is a highly limiting caveat in an industry where cost differential is marginal. Any greenhouse mitigation strategy that goes beyond ‘no-regrets’ would be unlikely to be implemented.

As described on pp 610 and 611 of the Draft EIS/ERMP, under the discussion on gas turbine and power generation selection, a range of factors must be considered in selecting any particular alternative.

These factors include:

- Safety hazard risk
- Technology risk and contingency level
- Availability and reliability
- Greenhouse gas emissions
- Capital and operating cost
- Land area required to be cleared (of particular importance on Barrow Island).

An alternative can only be selected after all these factors have been considered and appropriately weighted. Matters such as safety hazard risk take priority over the level of greenhouse gas emissions.

The proposal to inject reservoir CO₂ is a ‘beyond no regrets measure’ that the Joint Venturers are committed to implementing and has the potential to reduce the Developments greenhouse gas emissions by, in excess of 3 million tonnes CO₂e per year.

22.332 Approval of the GJV proposal to geosequester CO₂ underneath Barrow Island could in fact do more damage to industries hoping to develop and utilize geosequestration technology. Most reports into its application cite ‘public acceptance’ as a crucial element of large-scale uptake of geosequestration technology. There is no public acceptance of this project and there is unlikely to be while the local and global risks remain with no resolution regarding monitoring, remediation and liability.

To date the Gorgon Joint Venturers have received a large amount of public support and encouragement for its proposal to significantly exceed the requirements of government policy in relation to greenhouse gas management and to go ‘beyond no regrets’ in undertaking, at some considerable expense a world-leading greenhouse gas mitigation program.

24.67 A primary rationale for identifying Barrow Island as the preferred Gorgon development site related to the capacity to reduce greenhouse gas emissions from the development, and the subsequent *Barrow Island Act* made specific provision related to the underground disposal of CO₂. What would be the implications to the Gorgon development if the re-injection of CO₂ into the Barrow Island Dupuy saline reservoir was found to be “technically infeasible or cost prohibitive” at any stage of the operation on the proposal?

Statements qualifying the economic viability of the CO₂ injection project have been provided in the Draft EIS/ERMP (Chevron Australia 2005; p 597). It should be noted that qualifiers dealing with CO₂ injection uncertainty have been provided to manage what are anticipated to be a remote outcomes are should not be interpreted as reflecting the expected performance of the CO₂ injection project.

If the Joint Venturers were unable to continue to inject reservoir CO₂, or were only able to inject a proportion of the reservoir CO₂, then the implication would be that the greenhouse gas emissions for the Gorgon Development would increase from 4 MTPA to potentially as high as 6.7 MTPA. It is worth noting that with these increased levels of greenhouse gas emissions, the greenhouse efficiency benchmark (Chevron Australia 2005; p 615) would increase from 0.35 tonnes CO₂e per tonne LNG to 0.55 tonnes CO₂e per tonne LNG, which would be comparable to the soon to be commissioned Darwin LNG plant. The lifecycle greenhouse gas emissions from the Gorgon Development without the injection of reservoir CO₂ would still have significant benefits over alternative fuels such as coal and fuel oil. Also refer to 22.301 Section 13.1.3.

24.68 Would it be correct to interpret the following statement “In the unlikely event of unpredicted migration of CO₂ that could reach the surface, the Gorgon Joint Venturers will place the safety of the workforce and the environmental values of Barrow Island above the mitigation of increased atmospheric greenhouse gas emissions” as meaning that re-injection of CO₂ would cease and gas field CO₂ would be discharged into the atmosphere?

The Joint Venturers state on p 597 of the Draft EIS/ERMP (Chevron Australia 2005) immediately prior to the above quote that ‘if at any time the Joint Venturers consider that the injection of reservoir CO₂ represents an unacceptable risk to the environmental values of Barrow Island, or a safety risk, then CO₂ injection operations would be suspended and the remaining CO₂ vented to the atmosphere’.

It should be noted that qualifiers dealing with CO₂ injection uncertainty have been provided to manage what are anticipated to be a remote outcomes are should not be interpreted as reflecting the expected performance of the CO₂ injection project.

It is the intent that all matters dealing with operational management of CO₂ injection, including criteria by which the operations would be suspended, would be undertaken in accordance with a Carbon Dioxide Injection Operations Management Plan which would be agreed and endorsed by regulatory authorities. Refer Section 13.4.8 of the Draft EIS/ERMP (Chevron Australia 2005; p 649).

The Gorgon Joint Venturers expect that the Submitters (Environmental Protection Agency) are not arguing that the injection of CO₂ should continue even if it is recognised that an unacceptable environmental risk has been identified.

13.1.2 Impact on National and State Greenhouse Gas Emissions

22.309 Given the uncertainties of the technical and financial feasibility of the geosequestration component of the GJV proposal, Tables 13-1 and 13-2 should have contained the total greenhouse emissions relative to baseline emissions exclusive of geosequestration, as on page 159 of the February 2003 Environmental, Social and Economic Review of the Gorgon Gas Development on Barrow Island.

The Gorgon Joint Venturers had elected not to include the data exclusive of geosequestration, given the significant technical studies undertaken since 2003 and the improved confidence in the CO₂ injection proposal. The Joint Venturers are confident that atmospheric emissions of greenhouse gases from the Gorgon Development, as defined in the Draft EIS/ERMP, will not exceed 4.0 MTPA CO₂e.

It is a simple task to recalculate the increase in Australia's and Western Australia's greenhouse gas emissions relative to 1990 assuming no injection of reservoir CO₂. The percentage increases are 1.2% and 9.64% respectively. It should be noted that the Gorgon Joint Venturers acknowledge that the Gorgon Development will have a significant impact on the level of Australia's and Western Australia's greenhouse gas emissions. This increases the Joint Venturers desire to design one of the world's most efficient projects in terms of greenhouse gas emissions.

13.1.3 The Relative Greenhouse Impact of LNG

22.15 Life-cycle greenhouse emissions from the condensate associated with the project were not previously disclosed, and therefore add 1.35 million tonnes per year of CO₂ emissions to the greenhouse ‘footprint’ of the proposal, even if geosequestration is successful.

The Gorgon Joint Venturers have not discussed the lifecycle greenhouse gas emissions of the condensate associated with the production of LNG because condensate represents less than 4% of the produced hydrocarbon on a tonne-for-tonne basis. Including the lifecycle emission from condensate in the comparison of lifecycle greenhouse gas emissions shown in Figure 13.3 of the Draft EIS/ERMP (Chevron Australia 2005; p 600), increases the greenhouse ‘footprint’ of the development from 31.8 to 33.1 million tonnes of CO₂e per year. This compares to a lifecycle footprint 59.2 million tonnes per year for Middle East fuel oil and 62.7 million tonnes per year for Australian coal. There remains a compelling case for LNG (with its associated condensate) over these competing fuels on a lifecycle greenhouse gas emissions basis.

22.72 Page 17: The proponent lists ten sustainability principles, most of which the proposal fails to meet even at the most basic level. Principle 1: Clean Energy Supply – as discussed below, this is an extremely ‘dirty’ gas, and is still a fossil fuel in any event, which is at best a transition fuel in a move to a truly renewable energy future.

The Gorgon Joint Venturers welcome the acknowledgement that gas has an important role to play as a transition fuel in the context of lowering greenhouse gas emissions.

As a general rule, all gas fields contain a certain percentage of CO₂. The following table provides some examples of naturally occurring CO₂ in a number of competing LNG developments and Australian domestic gas suppliers. Note this is not an exhaustive list and while there are many fields with very low CO₂ contents, there are also fields with what could be considered very high CO₂ contents. The giant Natuna gas field in South China Sea has a reservoir CO₂ content of over 70%.

The Gorgon Joint Venturers have provided data in the Draft EIS/ERMP in relation to the lifecycle emissions compared to competing energy fuels and benchmarked greenhouse efficiency performance against a number of comparable LNG developments (Chevron Australia 2005; pp 600 and 615).

These data show that the manufacture of LNG by the Gorgon Development will be amongst the most greenhouse gas emission-efficient in the world and that LNG has significant lifecycle greenhouse gas emissions benefits when compared to competing energy fuels. It is also well recognised that natural gas has additional advantages over competing fuels such as coal and fuel oil in areas such as particulate and sulphur emissions. Combined, these data show that energy provided by the Gorgon Development will have one of the lowest greenhouse gas emission footprints with less sulphur and particulate emissions compared to other major energy sources.

Refer to table 22.72 and 16.59 below.

Table 22.72 and 16.59

Reservoir CO₂ Content of Competing LNG Producers.

Gas Field	Reservoir CO ₂ Content (%)
Gorgon field average	14–15%
Jansz field average	0.28%
Gorgon Project Average	7–7.5%
Competing LNG Producers	
Arun (Indonesia)	13%
Tangguh (Indonesia)	10%
Darwin LNG	6%
North West Shelf Project	3%
Browse Basin (to be developed)	7%
Australian Domestic Gas Producers	
BassGas	15%
Bonaparte Basin	13%

22.298.1 The Submitters consider that it is reckless to consider approval of a project that could potentially result in greenhouse pollution of 7 Mtpa of CO₂ in the current situation where reductions in greenhouse pollution of 60–80% of 1990 levels are required by 2050 to stabilise CO₂ concentrations in the atmosphere. This recklessness is exacerbated when placed in the context that little economic benefit will accrue to the Western Australian community, which will nonetheless bear the greenhouse ‘footprint’ of the project.

These are essentially matters for consideration by government in setting policy in areas such as greenhouse mitigation/reduction and support for economic development.

It is true that the Western Australian community will bear the greenhouse ‘footprint’ which will increase with the emissions associated with the gas processing on Barrow Island. However, given greenhouse emissions are a global concern, consideration should also be given to the lifecycle emissions resulting from the use of LNG from this development. Reference should be made to p 600 of the Draft EIS/ERMP where the lifecycle emissions of Gorgon LNG are compared to fuel oil and coal which are also competing to supply energy into markets targeted by the Gorgon Joint Venturers (Chevron Australia 2005).

22.299 The GJV proposal also relies heavily on the claim that the life-cycle comparison of Gorgon LNG greenhouse gas emissions is superior to that of coal or fuel oil, with GJV claiming that “the use of LNG from the Gorgon development will result in significantly less greenhouse emissions over the full energy lifecycle than alternative fuel sources such as coal or fuel oil...”[1] and that they therefore are required to limit the expenditure on greenhouse gas reduction in order to maintain a competitive advantage against these fuel sources.

The Submitters consider the logic of this argument to be dubious as there is no indication that competition for GJV’s LNG will come from these fuels, nor have these life-cycle analyses been supplied for confirmation. Rather, it is alternative LNG suppliers that will compete with GJV’s product. While the gas industry claims that it is impossible to prove that gas is displacing more greenhouse intensive fuels, the Submitters consider that an analysis of the fuel mix from power generation or other industrial processes over even a few years would reveal whether or not gas is indeed replacing these fuels or if it just being used in addition to these fuels.

The Gorgon Joint Venturers have not argued that Gorgon LNG would replace fuels such as coal and fuel oil in the markets in which we compete. Markets, particularly in Asia, are experiencing high rates of energy demand growth and Gorgon LNG competes to capture that market growth, with other LNG producers in addition to traditional fuels such as coal and fuel oil. Coal imports into Asian countries are forecast to grow by 5.1 million tonnes between 2004 and 2005 (ABARE 2005). This increase in coal imports will result in an increase in global greenhouse gas emissions of approximately 13.5 million tonnes CO₂e per annum. If this growth in demand had been met by Gorgon LNG, then the resulting increase in greenhouse gas emissions would have been limited to approximately 6.7 million tonnes per annum, a benefit in annual greenhouse gas emissions of over 6.7 million tonnes CO₂ per year.

Gorgon gas has a clear lifecycle greenhouse emissions benefit over coal and fuel oil, but it also has a modest lifecycle benefit over competing LNG suppliers as evidenced by the benchmarking study documented in the Draft EIS/ERMP (Chevron Australia 2005; p 615). Greenhouse gas emissions from the use of LNG are broadly similar, the distinguishing factor being the emissions associated with LNG production (there are some minor differences due to distance the LNG must be shipped). For example, if an LNG project in the Middle East were to win markets in East Asia at the expense of Gorgon, then annual greenhouse gas emissions on a lifecycle basis would be over one million tonnes higher than if Gorgon was to supply that energy. (This is based on the assumption that Qatargas supplies 10 million tonnes of LNG per year).

Page 600 of the Draft EIS/ERMP (Chevron Australia 2005) contains a summary of the lifecycle data developed for the Gorgon Joint Venturers by the CSIRO. Included in this discussion is a reference to the CSIRO report, which the Joint Venturers can provide upon request.

22.301 The full life cycle analysis with and without successful geosequestration of reservoir CO₂ needs to be supplied to enable comparison not only with alternative (non-competing) fuels such as fuel oil and coal but also with alternative LNG providers. This is particularly crucial in the circumstance where geosequestration proves either technically or financially unviable.

22.302 The benchmarking of LNG efficiency unfortunately does not take into account a life-cycle analysis comparison with other LNG producers.

The Gorgon Joint Venturers do not agree with the suggestion that LNG does not compete in some markets with fuels such as coal and fuel oil. For example, recent media reports, from China (Dow Jones and Reuters, 24 November 2005) suggest that China is scaling back its plans for LNG imports due to the cost and availability of LNG supply. The resultant energy demand will likely be met by indigenous coal suppliers.

LNG supplied by different producers result in similar emissions of greenhouse gases when burnt by the consumer. Therefore, lifecycle greenhouse gas emissions of alternative LNG supplies are, in the main, determined by the different levels of greenhouse gas emissions during processing of the raw gas to make LNG. There are small differences due to the slightly different heating values of the LNG and the distance travelled by the LNG ships but these are relatively minor compared to differences in LNG manufacture. The Joint Venturers were unable to identify any publicly available data on greenhouse gas emissions due to shipping.

Table 22.301 below lists the lifecycle greenhouse gas emissions for the Gorgon Development (with and without CO₂ injection), Middle Eastern oil, coal and a number of LNG producers competing for the same market as Gorgon.

Table 22.301

Life Cycle Greenhouse Gas Emissions for Gorgon LNG, other Recent LNG Developments, Middle Eastern Fuel Oil and Australian Coal

	Emissions at Point of Energy Supply (MTPA CO ₂ e)	Emissions at point of Energy Consumption (MTPA CO ₂ e)	Lifecycle Greenhouse Gas Emissions (MTPA CO ₂ e)
Gorgon LNG (with CO ₂ injection)	3.5	28.3	31.8
Gorgon LNG (without CO ₂ injection)	5.5	28.3	33.8
Middle East Oil	15.8	43.5	59.3
Australian Coal	5.1	57.6	62.7
North West Shelf	5.1	28.3	33.4
Darwin LNG	5.4	28.3	33.7
Oman LNG	3.6	28.3	31.9
RasGas	4.7	28.3	33.0
Qatargas	4.7	28.3	33.0

Note

1 – Only those developments that compete to sell LNG in the Asia–Pacific market have been included in this analysis.

2 – Data available is restricted to Australian LNG developments, or plants that have been commissioned in the last five years and as such represent current best design practice. Note there are many older LNG plants which also compete for the Asia–Pacific markets for which greenhouse emissions intensity data are unavailable but which are anticipated to result in higher lifecycle emissions than those projects presented.

3 – The Middle Eastern LNG suppliers (Oman LNG, RasGas, and QatarGas) would have higher greenhouse emissions associated with shipping LNG to market, but this has not been included in this analysis due to unavailability of data.

22.303 The life-cycle greenhouse emissions from the condensate associated with the project have not been incorporated at any stage of the greenhouse analysis. Given that the production and sale of condensate is an important factor in the financial viability of the Gorgon project and that GJV are so anxious to promote the positive life-cycle aspects of their LNG product, it is remiss to totally ignore the greenhouse contribution of this product.

GJV estimate that 12000bbl/day of condensate will be produced from both the Gorgon and Jansz fields [1]. Taking into account the combustion element alone, this results in a life-cycle contribution to global greenhouse emissions of 1.35Mtpa CO₂ emissions.

The Gorgon Joint Venturers have not discussed the lifecycle greenhouse gas emissions of the condensate associated with the production of LNG as condensate represents less than 4% of the produced hydrocarbon on a tonne-for-tonne basis. Inclusion of the lifecycle emission from condensate in the comparison of lifecycle greenhouse gas emissions shown in Figure 13.3 of the Draft EIS/ERMP (Chevron Australia 2005; p 600) increases the greenhouse 'footprint' of the development from 31.8 to 33.1 million tonnes of CO₂e per year. Compared to a lifecycle footprint of 59.2 million tonnes per year for Middle East fuel oil and 62.7 million tonnes per year for Australian coal. There remains a compelling case for LNG (with its associated condensate) over these competing fuels on a lifecycle greenhouse gas emissions basis.

Also refer to 22.15 Section 13.1.3

22.305 While the greenhouse efficiency is benchmarked against other projects on pages 616 and 617 of the draft EIS/ERMP, this only includes production and energy required for injection and venting.

LNG supplied by different producer's results in similar emissions of greenhouse gases when burnt by the consumer. Therefore, lifecycle greenhouse gas emissions of alternative LNG supplies are, in the main, determined by the different levels of greenhouse gas emissions during processing of the LNG. There are small differences due to the slightly different heating values of the LNG and the distance travelled by the LNG ships but these are relatively minor compared to differences in LNG manufacture. The Joint Venturers were unable to identify any publicly available data on greenhouse gas emissions due to shipping. Also refer to 22.301 Section 13.1.3.

13.2 Alternative Greenhouse Gas Abatement Options

19.4 For other components, such as the injection of waste gas below the island, one option is proposed but there is no discussion of alternatives or possible emissions if the current option does not prove to be viable. With so much uncertainty remaining in the design of the project, it is a difficult task for the DoE to make specific comment or recommendations to the EPA.

State Government greenhouse gas emissions policy, as documented in EPA Guidance Note 12, p 9 (EPA 2002) requires that proponents of major projects 'Consider a wide range of carbon sequestration options and include intended measures for research and adoption. Options include:

- Forestry or other revegetation;
- Geological re-injection;
- Chemical methods;
- Soil uptake; and
- Re-use.'

Note that proponents are only required to consider these actions and that the policy does not require any particular option to be undertaken. In complying with this policy, the Gorgon Joint Venturers have elected to exceed the requirements of the policy and undertake a significant geological re-injection program. The reasoning behind the selection of CO₂ injection over the alternatives is outlined on p 601 of the Draft EIS/ERMP (Chevron Australia 2005).

Prior to commencing construction of the Gorgon Development, should the proposal to inject reservoir CO₂ prove infeasible, the State Government of Western Australia may require the implementation of a greenhouse gas emissions reduction contingency plan to partially offset the reductions that would have been achieved by the CO₂ injection proposal. These are matters for the government to address through the approval provisions in the Gorgon Gas Processing and Infrastructure Project Agreement.

The studies that the Gorgon Joint Venturers have undertaken to date have shown that the CO₂ injection proposal remains technically feasible, and it remains the intent of the Joint Venturers to proceed with this proposal as an integral component of the Gorgon Development.

22.310 In the event of approval of this proposal, sequestration opportunities that have conservation and salinity benefits should be required to be undertaken to offset the net remaining emissions after geosequestration.

The Gorgon Joint Venturers acknowledge that there are opportunities to offset greenhouse gas emissions through revegetation and rehabilitation plantations. Such offsets have the additional benefit of improving the conservation values and assisting in the management of dry land salinity. These issues were considered as part Joint Venturers assessment of alternative greenhouse gas abatement options (Chevron Australia 2005; p 601).

State Government greenhouse gas emissions policy, as documented in EPA Guidance Note 12, p 9 (EPA 2002) requires that proponents of major projects 'Consider a wide range of carbon sequestration options and include intended measures for research and adoption. Options include:

- Forestry or other revegetation;
- Geological re-injection;
- Chemical methods;
- Soil uptake; and
- Re-use.'

Note that proponents are only required to consider these actions and that the policy does not require any particular option to be undertaken. In complying with this policy, the Gorgon Joint Venturers have elected to exceed the requirements of the policy and undertake a significant geological injection program. The reasoning behind the selection of CO₂ injection over the alternatives is outlined on p 601 of the Draft EIS/ERMP (Chevron Australia 2005).

If regulators were to require additional measures (organic offsets) to be undertaken to offset the remaining emissions from the proposed Development, this would indicate a significant change in State Government policy. It would also fail to recognise the measures that the Gorgon Joint Venturers have already committed to in excess of that required by current policy.

Also refer to 18.31 Section 2.2.

13.3 Gorgon Development Greenhouse Gas Emissions

22.46 Page iv Foreword – GJV gas is not particularly clean when the full life cycle emissions associated with the development are considered. Note that emissions have been underestimated and that the annual emissions for the project have increased markedly since the ESE.

The Gorgon Joint Venturers have provided data in the Draft EIS/ERMP in relation to the lifecycle emissions compared to competing energy fuels and benchmarked greenhouse efficiency performance against a number of comparable LNG developments (Chevron Australia 2005; pp 600 and 615). These data show that the manufacture of LNG by the Joint Venturers will be amongst the most greenhouse gas emission-efficient in the world and that LNG has significant lifecycle greenhouse gas emissions benefits when compared to competing energy fuels. It is also well recognised that natural gas has additional advantages over competing fuels such as coal and fuel oil in areas such as particulate and sulphur emissions. Combined, these data show that energy provided by the Gorgon Joint Venturers will have one of the lowest greenhouse gas emission footprints with less sulphur and particulate emissions compared to other major energy sources.

The anticipated annual greenhouse gas emissions as stated in the Draft EIS/ERMP (Chevron Australia 2005; p 609) are higher than stated in the ESE Review (ChevronTexaco Australia 2003; p 157). The primary reason for this is the emissions estimates contained in the Draft EIS/ERMP are based on a reference case that includes a number of high emissions scenarios, including an assumption around the volume of reservoir CO₂ vented rather than injected. It should be noted that the Gorgon Joint Venturers have also put forward a number of planned actions and performance targets (Chevron Australia 2005; p 678) with the intent of delivering annual greenhouse gas emissions below those contained in the reference case and below those stated in the ESE Review (ChevronTexaco Australia 2003).

13.3.1 Greenhouse Gas Emissions Efficiency Improvements

No submissions received on this section of the Draft EIS/ERMP.

13.3.2 Emissions Estimation Methodology

No submissions received on this section of the Draft EIS/ERMP.

13.3.3 Emissions During Construction and Commissioning

22.179 Construction-related emissions are de-emphasised here, as compared to operational emissions – does this mean they have been disregarded/not analysed?

Construction activities such as dredges, cranes, trucks, earth moving equipment, barges, etc, will result in emissions as noted in the Draft EIS/ERMP in Section 7.2.1. The Joint Venturers acknowledge that emissions can be reduced by appropriate planning such as mentioned in the Draft EIS/ERMP Framework EMP, Technical Appendix A1, Section 3.11, which states: 'Modular construction techniques shall be employed to the extent practical to reduce net emissions from construction machinery'. Also, Chapter 13 shows indicative greenhouse gas emission levels during the construction phase (Table 13.5) and the operational phase (Figure 13.6). These emphasise the relative emissions, namely in the order of 2 million tonnes CO₂e from the entire construction and commissioning phase, but 4 MTPA for the life of the Development from the operational facility.

13.3.4 Emissions from Operations

22.64 Page 11 – Table 1.2: Annual emissions with sequestration are up 700,000 hectares [sic] as compared to the ESE!

It is presumed here that the submitter is referring to the increase in estimated annual greenhouse gas emissions in the Draft EIS/ERMP compared with the ESE Review.

The anticipated annual greenhouse gas emissions as stated in the Draft EIS/ERMP (Chevron Australia 2005; p 609) are higher than stated in the ESE Review (ChevronTexaco Australia 2003; p 157). The primary reason for this is the emissions estimates contained in the Draft EIS/ERMP are based on a reference case that includes a number of high emissions scenarios, including an assumption that some volume of reservoir CO₂ vented rather than injected. It should be noted that the Gorgon Joint Venturers have also put forward a number of planned actions and performance targets (Chevron Australia 2005; p 678) with the intent of delivering annual greenhouse gas emissions below those contained in the reference case and below those stated in the ESE Review.

13.3.5 Greenhouse Gas Emissions during Decommissioning

No submissions received on this section of the Draft EIS/ERMP.

13.3.6 Benchmarked Greenhouse Gas Emission Performance

22.77 Page 17: The proponent lists ten sustainability principles, most of which the proponent fails to meet even at the most basic level. Principle 6. Efficient Resource Use – until the issue of geosequestration is resolved, this principle cannot be met. Even if geosequestration is feasible, the amount of greenhouse gas emissions generated from this proposal will be extremely large.

It is unclear here what is meant by ‘the geosequestration issue’ to be resolved before the principle of efficient resource use can be met.

By adopting currently applied best practice in plant design and implementing a policy of no routine flaring or venting of hydrocarbons the Gorgon Joint Venturers are ensuring that the maximum amount practical of natural gas will be exported as LNG and domestic gas rather than being used as fuel or flared. This is substantiated by the comparative benchmarking data contained in the Draft EIS/ERMP (Chevron Australia 2005; p 615).

22.138 Page 108: Given that the estimated emissions associated with the project are massive (even if geosequestration is successful), every possible effort to reduce emissions should be taken. The Submitters consider it unacceptable that CO₂ is released to the atmosphere when the re-injection compressor stops – that gas should be stored until re-injection is re-started.

The design of the gas processing facility incorporates currently applied best practice in the areas of subsea development, LNG technology selection and waste heat recovery, which are the major contributors to the Development greenhouse gas emissions. In addition, the Joint Venturers have adopted a policy of no routine flaring or venting of hydrocarbons such that these gas streams will be redirected back into the process system. The commitment to reduce the Development’s greenhouse gas emissions by the injection of reservoir CO₂ into the Dupuy Formation exceeds the actions that are required by current government policy. Further, injection of CO₂ is an activity that is not being undertaken by our LNG competitors, some of which have higher levels of CO₂ in their gas. These actions will result in the Gorgon Development being one of the world’s most greenhouse gas efficient LNG projects as documented in the Draft EIS/ERMP under comparative benchmarking of greenhouse gas efficiency (Chevron Australia 2005; p 615).

The Joint Venturers' commitment to inject reservoir CO₂ is qualified as discussed on p 597 of the Draft EIS/ERMP. The Joint Venturers have committed to constructing the injection system using injection equipment sized to handle the expected rate of CO₂ removed from the incoming gas stream to the gas processing facility. Venting of reservoir CO₂ will be required during periods of maintenance and equipment downtime associated with the injection equipment or for reservoir constraints. The requirement to vent reservoir CO₂ in these circumstances was identified in the ESE Review (ChevronTexaco Australia 2003).

As very large storage tanks would be required, the Submitter's suggestion that the CO₂ should be stored somehow during periods when the CO₂ compressors are offline is impractical as it would involve additional land clearing on Barrow Island. The Gorgon Joint Venturers are however studying opportunities to improve compressor reliability by using multiple smaller compressors rather than a single large compressor.

13.4 Disposal of Reservoir Carbon Dioxide by Injection into the Dupuy Formation

11.1.1 The Australian Government is spending significant amounts of money on research into geosequestration as a method of greenhouse gas emissions abatement. The research being funded is primarily basic research into the behaviour of CO₂ when pumped underground, methods for selecting the best sites and the best risk management and monitoring methods. Most of these research projects are still in their infancy. There are only two possible conclusions we can draw from this: 1 – the Government is spending millions of dollars researching questions we already know the answers to or; 2 – the GJV proposes to conduct the largest geosequestration project in the world underneath an irreplaceable Class A nature reserve while many of the basic questions about the implementation, safety and efficacy of geosequestration remain unanswered.

The Intergovernmental Panel on Climate Change as part of their recent report on Carbon Capture and Storage (CCS) (IPCC 2005, Summary for Policy Makers, p 7) published a table that documents the current maturity of carbon capture and storage system components. This table demonstrates that there are many areas of the carbon capture and storage system that are in an early stage of research and demonstration phases of maturity. However geological storage in saline formations, as proposed by the Gorgon Joint Venturers, is at a maturity where it is feasible under specific economic conditions.

The Gorgon Joint Venturers have been active participants in the research and development of geosequestration technologies since the inception of this line of research (refer Box 13-3 of the Draft EIS/ERMP) (Chevron Australia 2005) and, as such, are well placed to lead with the application of these technologies on a commercial scale.

It should be noted that commercial scale CO₂ injection projects have been in operation at Sleipner since 1996 and more recently at In Salah since 2004. Both these large-scale CO₂ injection projects have associated research and development programs. It is reasonable to anticipate that the Gorgon Joint Venturers' commitment to public disclosure of monitoring data associated with the Gorgon Development will also be use to support continuing research.

The Gorgon Development CO₂ injection project has, and will continue to undergo, review by independent consultants commissioned by government so that government has independent advice upon which to assess the proposals being put forward.

Refer to Table 11.1.1

Table 11.1.1
Maturity of Carbon Capture and Storage Technologies.

CCS component	CCS technology	Research phase ¹³	Demonstration phase ⁷	Economically feasible under specific conditions ⁵	Mature market ⁶
Capture	Post-combustion			X	
	Pre-combustion			X	
	Oxyfuel combustion		X		
	Industrial separation (natural gas processing, ammonia production)				X
Transportation	Pipeline				X
	Shipping			X	
Geological storage	Enhanced Oil Recovery (EOR)				X
	Gas or oil fields			X	
	Saline formations			X	
	Enhanced Coal Bed Methane recovery (ECBM)		X		
Ocean storage	Direct injection (dissolution type)	X			
	Direct injection (lake type)	X			
Mineral carbonation	Natural silicate minerals	X			
	Waste materials		X		
Industrial uses of CO ₂					X

² CO₂ injection for EOR is a mature market technology, but when this technology is used for CO₂ storage, it is only 'economically feasible under specific conditions'

11.2 Critically, despite espousing the benefit of the geosequestration aspect of the project, the proponent's state simply that should it prove economically or technically unviable, the CO₂ will simply be vented into the atmosphere. Little is said about what the threshold test for economic viability will be.

The following statement qualifying the economic viability of the CO₂ injection project was provided in the Draft EIS/ERMP. Qualifiers dealing with CO₂ injection uncertainty have been provided to manage what are anticipated to be remote outcomes and should not be interpreted as reflecting the expected performance of the CO₂ injection project.

As noted on p 597 of the Draft EIS/ERMP (Chevron Australia 2005):

'In common with the subsurface uncertainties encountered in the oil and gas industry, there remains an element of cost and technical uncertainty with the CO₂ injection proposal. This uncertainty is associated with the performance of the injection wells and the behaviour of the CO₂ once injected.'

The Gorgon Joint Venturers have committed to a range of activities, such as the drilling of a data well (which has been the subject of its own approval) and to an ongoing reservoir monitoring and management program to further reduce and manage these uncertainties. In the unlikely event that the proposed CO₂ injection should prove technically infeasible or cost prohibitive, such as if it is determined that a large number of additional injection wells are required, the Gorgon Joint Venturers will consult with government with the intent of maximising the injection of CO₂ within the commercial constraints of the Gorgon Development¹.

Any decision to construct a facility to inject less than the anticipated volume of reservoir CO₂ would have to be made in consultation with government. Further, this decision would have to be fully supported by economic data that clearly demonstrate that constructing a facility to inject the full volume of reservoir CO₂ would jeopardise the viability of the Gorgon Development.

14.3 Although it is desirable to sequester as much greenhouse gas as possible during the use of fossil fuels, the Conservation Commissions questions whether the production of gas with an overall CO₂ content of some 7% should require reinjection and therefore on Barrow Island Nature Reserve.

There are many drivers in addition to the opportunity to dispose of reservoir CO₂ that make Barrow Island the preferred location for the Gorgon Development. For example, the increased cost of raw gas pipelines and the likely need for an offshore platform if the Development was to be situated on the mainland. Barrow Island would remain the preferred location for the Gorgon Development even if the reservoir CO₂ injection was not part of the project scope.

Locating the Gorgon Development on Barrow Island provides the additional environmental benefit to significantly reduce the Development's greenhouse gas emissions by enabling the injection of reservoir CO₂. It would not be possible to achieve this reduction in greenhouse gas emissions if the Gorgon Development was located elsewhere.

16.59 Dirty gas. CO₂ levels in the Gorgon gas are unacceptably high. Extraction is dependant on the ability to inject the CO₂ deep into the geological strata. Geo-sequestration is too new to give assurance that it is safe and reliable. Waste disposal problems are being passed on to WA and to future generations.

As a general rule, all gas fields contain a certain percentage of CO₂. Table 22.75 and 16.59 provides some examples of naturally occurring CO₂ in a number of competing LNG developments and Australian domestic gas suppliers. Note this is not an exhaustive list and while there are many fields with very low CO₂ contents, there are also fields with what could be considered very high CO₂ contents. The giant Natuna gas field in South China Sea has a reservoir CO₂ content of over 70%.

There is currently no law or government policy in Australia that prohibits the development of gas fields containing high levels of CO₂. For example the BassGas development, which is currently being commissioned, has approximately 15% reservoir CO₂, the majority of which is vented to atmosphere during gas processing.

The Gorgon Joint Venturers have provided data in the Draft EIS/ERMP in relation to the lifecycle emissions compared to competing energy fuels and benchmarked greenhouse efficiency performance against a number of comparable LNG developments (Chevron Australia 2005; pp 600 and 615). This data show that the manufacture of LNG by the Gorgon Joint Venturers will be amongst the most greenhouse gas emission-efficient in the world and that LNG has significant lifecycle greenhouse gas emissions benefits when compared to competing energy fuels. It is also well recognised that natural gas has additional advantages over competing fuels such as coal and fuel oil in areas such as particulate and sulphur emissions. Combined these data show that energy provided by the Gorgon Joint Venturers will have one of the lowest greenhouse gas emission footprints with less sulphur and particulate emissions compared to other major energy sources.

Geosequestration is not new with commercial scale CO₂ injection operations commencing at Sleipner in the Norwegian North Sea since 1996.

In relation to the submission that CO₂ injection will result in 'problems being passed onto WA and to future generations', refer to 16.46 Section 13.4.12.

Table 22.72 and 16.59 (Page 356).

22.5 The Submitters are not necessarily averse to carbon dioxide capture and storage (CCS)/ geosequestration in the longer term and is a signatory to the Climate Action Network Australia Position Paper on geosequestration (see www.cana.net.au).

The Climate Action Network Australia (CANA) position paper on geosequestration identifies a number of key issues to be addressed by informed public debate: limited coverage, timeframe, permanence, liability, ecological impacts, diversion of resources and cost. Of these, only the issues of permanence, liability and ecological impact are relevant to the proposal by the Gorgon Joint Venturers and are addressed below. The remaining issues are essentially matters for government policy.

Permanence – CANA has expressed concern that leakage from geosequestration sites will add to global warming and lead to other environmental risks such as asphyxiation. Modelling undertaken by the Gorgon Joint Venturers (Chevron Australia 2005; p 645), shows that it takes just under one thousand years for the injected CO₂ to reach the first effective barrier to migration, the base Barrow Group Shale. During this time, a large amount of the CO₂ has become permanently trapped within the Dupuy Formation. Should the CO₂ penetrate this barrier, it will have to migrate through an additional 2000 m of geologic section in order to reach the surface. As it migrates through this section, the remaining CO₂ is likely to become permanently trapped.

Monitoring of the CO₂ behaviour in the subsurface is integral to the proposal to inject CO₂ and will enable deviations from the expected migration paths to be assessed and managed in accordance with the projects uncertainty management plans. These plans will continually be updated and approved by government as an integral part of the CO₂ Injection Operations Management Plan.

Liability – CANA has called for the establishment of a 'stringent legal framework for regulating geosequestration that ensures that the proponents of geosequestration assume complete legal liability for the full economic, environmental and social costs of leakage over the lifetime of the storage'. The Gorgon Joint Venturers maintain that the long-term issues (and any potential liability) that are likely to result from geosequestration are not dissimilar to those that arise from activities currently undertaken in the oil, gas and mining sectors and that existing statutory regulation and common law provide appropriate mechanisms for managing these liabilities (Chevron Australia 2005; p 676).

Ultimately the most effective way to reduce liability is through diligent site selection, and operational oversight by government. The Western Australian Government has already commissioned a number of independent reviews of the work undertaken by the Gorgon Joint Venturers. The Joint Venturers welcome this level of review and anticipate it continuing through the operational and post operational phases of the project.

Ecological Impact – CANA has expressed concern over the potential 'risk of negative ecological impacts on subterranean biodiversity and water supplies from geosequestration.' The Gorgon Joint Venturer, through the Draft EIS/ERMP, assessed the likelihood of negative impacts on subterranean fauna to be remote with a medium level of residual risk. The residual risk to terrestrial vegetation from a leak of injected CO₂ is considered low (Chevron Australia 2005; pp 388 and 334). A significant component of the planned monitoring program is aimed at detecting surface leaks before they can pose a risk to the environment (Chevron Australia 2005; p 648).

22.93 Page 34: As the Joint Venturers well know, the opportunity for geosequestration is in no way unique to Barrow (if indeed it is possible there, which remains unproven).

The Gorgon Joint Venturers have identified Barrow Island as the preferred injection location due to the combination of favourable technical attributes for permanently trapping CO₂ and where the cost of injection (derived as a function of distance from the CO₂ source and whether onshore or offshore) can be undertaken without overly impacting the cost competitiveness of the proposed Development. Injection of reservoir CO₂ at a location distant from Barrow Island would make the opportunity to significantly reduce greenhouse emissions by CO₂ injection cost prohibitive.

While other CO₂ injection locations may exist in proximity to the Gorgon Development, they are either less favourable from a technical perspective or cost prohibitive due to distance (and being offshore) from the gas processing facility.

13.4.1 Assessment of Potential Carbon Dioxide Injection Sites

8.30 Section 13.4.2, Figure 13-9: Were any of the existing disused Dupuy wells considered as potentially suitable sites to use as onshore injection drill centres for directional drilling. This would reduce the amount of land to be disturbed for this aspect of the project.

The location of the CO₂ injection wells shown in the Draft EIS/ERMP Figure 13-9 (Chevron Australia 2005) is a representation of the anticipated layout of the CO₂ injection well drill centres and the bottom-hole locations. The Gorgon Joint Venturers are continuing to study the number and location (surface and bottom hole location) of the required CO₂ injection wells. The objective is to reduce the number of injection wells to the lowest number possible while still providing capacity to inject the expected rate of reservoir CO₂. It is anticipated that the number of injection wells and drill centres will be the same or less than that identified in the Draft EIS/ERMP.

The Gorgon Joint Venturers have undertaken an assessment of existing well penetrations to assess if each well is appropriately completed or decommissioned for service in a CO₂ environment (Chevron Australia 2005; p 651). This study has indicated that these wells are unsuitable for conversion to injection wells, although some may have utility as observation wells once appropriately remedial actions have been undertaken.

In considering potential sites for the location of the CO₂ injection well drill centres all sites of previous disturbance, including old drill pads, will be assessed. It is unlikely that the existing Dupuy Formation wells pads will provide suitable locations due to their location along the central axis of the island which is distant from the preferred injection location on the central east coast.

8.31 Section 13.4.2, pg 626: Reference is made to the central west coast location as an area that might provide an area for supplementary injection in the event that injectivity proves to be inadequate at the preferred location. To what extent has this location been investigated – has a reservoir simulation of the CO₂ plume migration for injection at this site been completed?

The central west coast onshore location was fully evaluated in the ranking process which led to the selection of the central east coast location as the preferred area for CO₂ injection. A reservoir simulation of the CO₂ plume migration for the central west coast location has been completed and it shows an acceptable aerial extent over time, similar to that for the central east coast. The combination of mainly central east coast and supplemental west coast injection has also been modelled.

- 8.32 Section 13.4.4, pg 638, last paragraph: Reference is made to the need to drill a data well to determine the injectivity of the Dupuy sands. In the response to submissions it would be useful to provide the following information with respect to the proposed data well:
- (i) its location;
 - (ii) how will the findings from these studies affect decision making in implementing geosequestration for the Gorgon Project; and
 - (iii) how will these findings be communicated to stakeholders?

Location:

Since the Draft EIS/ERMP was written, the location of the proposed data well has been decided and is shown on the attached map of Barrow Island. Also shown on the map are the existing Dupuy Formation wells, and the predicted 5-year, 40-year and 1000-year CO₂ plume migration. Note that the surface location has been selected slightly to the north of the planned bottom-hole location so as to place the drill pad in an area of previous land disturbance.

How the findings from these studies will affect decision-making in implementing the project:

It is anticipated that the drilling of the data well will confirm the Gorgon Joint Venturers' expectation of the reservoir properties within the Dupuy Formation. That is, the data well will act to narrow the range of uncertainty about a particular expectation value. This will improve the confidence that the Joint Venturers have in the number of injection wells required to dispose of the full volume of reservoir CO₂ without the risk of developing excessive reservoir pressure. In the unlikely event that the data well provides a totally unexpected result, indicating that the Joint Venturers existing understanding of reservoir properties is inaccurate, then additional studies will be required to be undertaken to incorporate these new data in the geologic and reservoir simulation models.

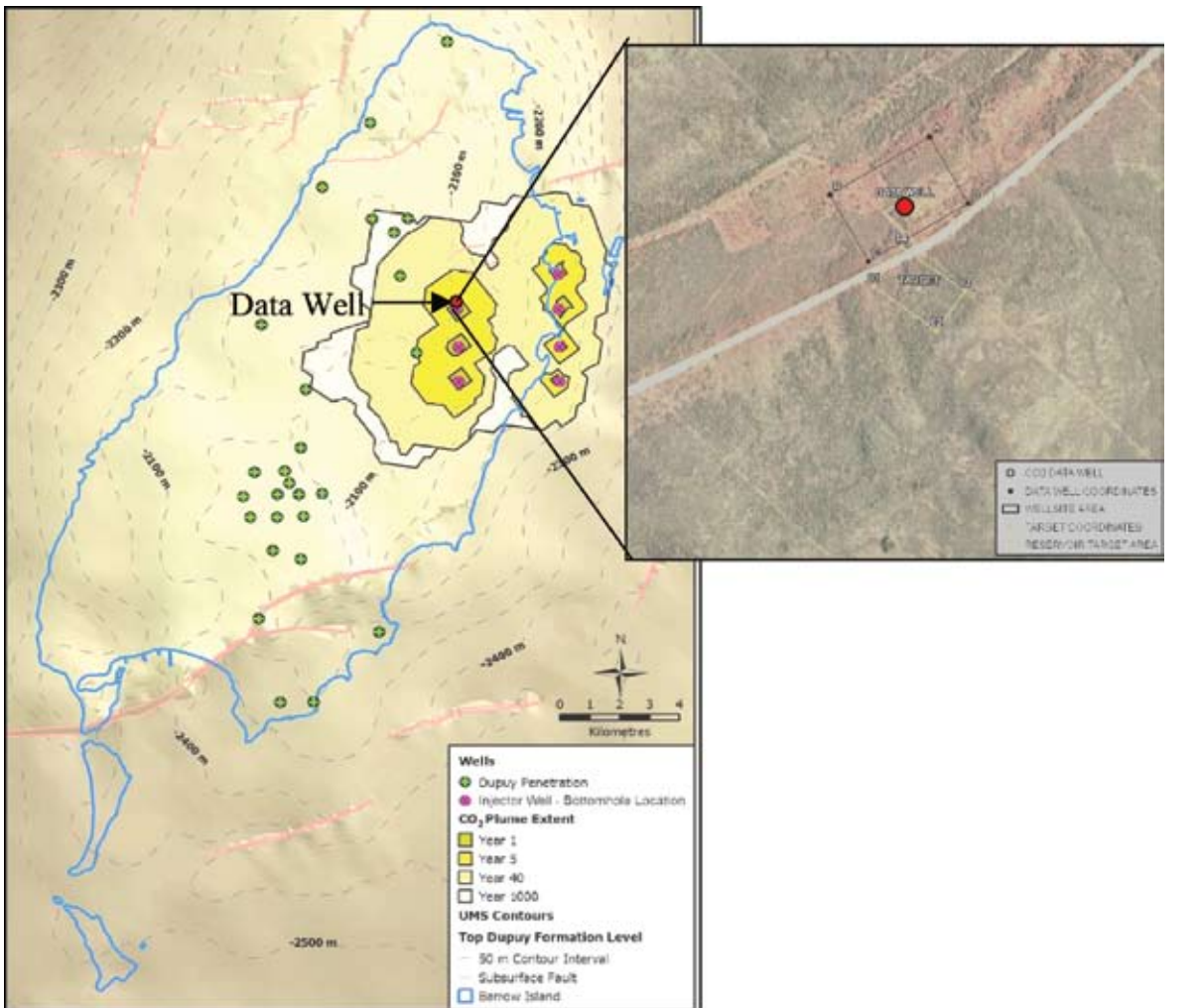
Communication of data well results to stakeholders:

It is anticipated that information on the progress of the data well will be made available to DoIR in the same manner as currently applies to the drilling of petroleum wells. Additionally the information from the data well will be incorporated into the documents required to be submitted to support the Ministerial consideration of approval of the CO₂ injection project under the provisions of the *Barrow Island Act 2003*. The Gorgon Joint Venturers are currently discussing with government the opportunity to make these documents publicly available, however no decision on the public release of these documents has been made at this time.

Refer to Figure 8.32.

Figure 8.32

Location of the CO₂ Data Well to be drilled in Early 2006.



22.4 The IPCC Special Report on Carbon Dioxide Capture and Storage Summary for Policy Makers, released in October 2005, states that “With appropriate site selection based on available subsurface information, a monitoring programme to detect problems, a regulatory system and the appropriate use of remediation methods to stop or control CO₂ releases if they arise, the local health, safety and environmental risks of geological storage would be comparable to the risks of current activities such as natural gas storage, EOR and deep underground disposal of acid gas”¹ It is crucial to note that none of these risk-reduction criteria have been met by the GJV proposal.

The Joint Venturers have been investigating suitable sites for the injection of CO₂ since 1998. A summary of this work was contained in the ESE Review (ChevronTexaco Australia 2003; p 163) where a number of alternative sites within several hundred kilometres of Barrow Island were assessed. This work highlighted that the Dupuy formation below Barrow Island is the best reservoir for CO₂ injection. One of the drivers for selecting the Dupuy Formation was the level of subsurface information available in the area around Barrow Island. Building upon this work, a more detailed assessment on sites within the Dupuy Formation was undertaken and reported on in the Draft EIS/ERMP (Chevron Australia 2005; p 624).

Importantly, the Western Australian Government has commissioned consultants to undertake an independent technical review of the Gorgon Joint Venturers’ studies so that government has independent advice upon which to assess the proposals being put forward. The findings and recommendations from the most recent of these studies are available on the DoIR web site (DoIR 2005). In part these studies concluded that:

- The Dupuy reservoir appears to have adequate capacity to contain the approximately 125 million tonnes of CO₂ that will be potentially available for sequestration over the full life of the Development.

The *Barrow Island Act 2003* contains the world’s first specific legislation dealing with the subsurface injection of CO₂ in order to reduce greenhouse gas emissions. This legislation is supported by extensive work in the area of regulation of geosequestration undertaken by the Ministerial Council of Minerals and Petroleum Resources (MCMPR 2005) and which has involved widespread community consultation).

The Gorgon Joint Venturers have outlined their approach to the management of CO₂ injection risk in the Draft EIS/ERMP under the heading Carbon Dioxide Injection Uncertainty Management (Chevron Australia 2005; p 650). This approach identifies: the nature of the uncertainty; what the worse-than-expected outcome might be; the signposts and reservoir surveillance technologies to identify if this worse-than-expected outcome is developing; and a series of management actions that can be implemented to mitigate the risk. To enable the understanding of risk to the environment from CO₂ injection operations, a comprehensive failure modes and effects study has been undertaken to assess the impact of likely failure modes and the impact of safeguards, mitigation or management measures.

22.142 Page 114 and 115: The level of detail provided about CO₂ re-injection is disappointing. Why hasn’t alternative sites work like that done for the terrestrial feed gas pipeline been done?

This comment relates to the level of detail provided under Chapter 6: Development Description. A comprehensive discussion of the CO₂ injection proposal is contained in Chapter 13 of the Draft EIS/ERMP. Chapter 13 includes a discussion on the location of carbon dioxide injection sites on Barrow Island (Chevron Australia 2005; p 624).

22.311 Regarding the process undertaken by GJV to ascertain the best site for underground storage of CO₂ waste, the CCWA is concerned that some candidate sites were deemed to be unsuitable due to the risk to currently producing oil and gas fields. If certain sites would be superior once oil and gas fields are depleted, it would be preferable to delay the GJV project until the best sites are available, rather than using the less preferable site of the Dupuy Massive Sands under Barrow Island.

The Joint Venturers have been investigating suitable sites for the injection of CO₂ since 1998. A summary of this work is provided in the ESE Review (ChevronTexaco Australia 2003; p 163) where a number of alternative sites within several hundred kilometres of Barrow Island were assessed. These sites were selected using a range of criteria including the risk to currently producing oil and gas fields (Chevron Australia 2005; p 620). The attributes that make the Dupuy Formation the preferred injection location are listed on p 622 of the Draft EIS/ERMP (Chevron Australia 2005).

It should be noted that depleted oil and gas fields as potential CO₂ injection sites are not without risk. These depleted fields often have a significant number of existing well penetrations and the change in reservoir pressure during the depletion of the field can stress the overlying barrier lithologies. Many of the oil fields in proximity to Barrow Island do not have the size to contain the proposed volumes of injected CO₂.

22.312 The Submitters are concerned that GJV has adopted an approach of selecting a less than optimal site for the proposed reinjection of reservoir CO₂ in order to hasten the development of the Gorgon gas field, despite the attendant risks of using a site that, if unsuitable poses massive risks to the sensitive ecosystem of Barrow Island.

The Joint Venturers maintain that the tortuous nature of the Dupuy Formation and the resulting higher potential for permanent trapping of the injected CO₂ (Chevron Australia 2005; p 638), along with the multiple baffles and barriers between the Dupuy Formation and the surface, make the Dupuy Formation below Barrow Island an ideal location for CO₂ injection.

Importantly, the Western Australian Government has commissioned consultants to undertake independent technical review of the Gorgon Joint Venture studies so that government has independent advice upon which to assess the proposals being put forward. The findings and recommendations from the most recent of these studies are available on the DoIR web site (DoIR 2005). In part these studies concluded that:

- The Dupuy reservoir appears to have adequate capacity to contain the approximately 125 million tonnes of CO₂ that will be potentially available for sequestration over the full life of the Development.

Also refer to response to submission 22.311 Section 13.4.1.

13.4.2 Location of Carbon Dioxide Injection on Barrow Island

No submissions received on this section of the Draft EIS/ERMP.

13.4.3 Geology of Barrow Island

No submissions received on this section of the Draft EIS/ERMP.

13.4.4 Carbon Dioxide Behaviour in the Subsurface

22.48 Page 3 – 1.1: As the Joint Venturers well know, the injection of CO₂ associated with oil recovery has little to do with the kind of geosequestration proposed for this project. This section should be re-written to reflect reality.

Enhanced oil recovery operations provide valuable experience, such as in the: compression and pumping of CO₂; CO₂ pipeline construction and operation; injection well design and maintenance; and the subsurface behaviour of the injected CO₂. For example, it is experience gained with enhanced oil recovery that has highlighted the importance of ensuring existing well penetrations are fit for CO₂ service. Worldwide there are over 3100 km of CO₂ pipelines in service transporting over 45 million tonnes of CO₂ per year. Data from these operations has been incorporated into the design of the injection system and the Gorgon Joint Venturers understanding of risk and uncertainty management.

In relation to the subsurface behaviour of injected CO₂, enhanced oil recovery operations have been instrumental in developing an understanding of trapping mechanisms and implementing the required upgrades to tools such as reservoir simulators so that they accurately model CO₂ behaviour.

Oil and gas research has led to the understanding of trapping mechanisms. For the Gorgon Development, residual gas trapping is the primary mechanism by which the injected CO₂ will become permanently trapped in the subsurface. Residual gas trapping also applies to oil and gas field developments. For example, in oil and gas production operations a residual, or irreducible, oil or gas saturation exists. Residual gas trapping in a natural gas reservoir is analogous to residual CO₂ trapping associated with CO₂ injection. Thus, the understanding of residual trapping comes primarily from the oil and gas industry.

Since CO₂ is naturally occurring in many oil and gas reservoirs, and CO₂ has been used in enhances oil recovery, the physical properties of CO₂ in the reservoir and its interaction with water and hydrocarbons have been extensively studied and are well-known.

13.4.5 Reservoir Simulation

No submissions received on this section of the Draft EIS/ERMP.

13.4.6 Deviations from Simulation Predictions

No submissions received on this section of the Draft EIS/ERMP.

13.4.7 Monitoring of Injected Carbon Dioxide

8.33 Section 13.4.7, pg 649, 1st paragraph: It is stated that experience from CO₂ injection operations has shown that a combination of observation wells and time-lapse seismic data provides the best possible means to track the progress of migrating CO₂ through the subsurface. What evidence is there of this?

The Intergovernmental Panel of Climate Change as part of their recent report on Carbon Capture and Storage (CCS) (IPCC 2005, Chapter 5, pp 50 and 51) published information on 'Direct techniques for monitoring CO₂ migration' and 'Indirect techniques for monitoring CO₂ migration. This information highlighted the importance of monitoring in wells for the direct detection of CO₂ (or introduced tracers) and the use of repeat seismic surveys for indirect measurement of the injected CO₂. This discussion also looks at non-seismic techniques such as gravity and electrical/electromagnetic methods for indirect observation but concludes that 'gravity will not have the same level of resolution as seismic' and that electrical/ electromagnetic techniques 'will require more work to determine its resolution and overall effectiveness'.

8.34 Section 13.4.7, page 648: It is stated that the Gorgon Joint Venture continues to study the most appropriate technique to monitor the injected CO₂ and that demonstrating the integrity of the CO₂ injection project through monitoring the behaviour of the injected CO₂ will be integral to gaining community support. Once the Gorgon Joint Venture has selected the technique/s will information on the techniques be made available to the public?

Monitoring activities on Barrow Island will continue to evolve as new technologies become available and information is obtained on the behaviour of the CO₂ in the subsurface. In the Draft EIS/ERMP, the Gorgon Joint Venturers have outlined a reference-case monitoring program based on the technology available today. Repeat seismic surveys and observations wells form a major component of this monitoring approach. It would be inappropriate to require that future monitoring also be based on this approach as that would preclude the use of technologies that may become available. Importantly the Gorgon Joint Venturers have outlined a set of objectives for monitoring and verification activities (Chevron Australia 2005; p 648).

The Gorgon Joint Venturers have committed in the Draft EIS/ERMP to 'make information available to the public with regard to the ongoing monitoring program' (Chevron Australia 2005; p 619). Information on the techniques being selected will be included in this release of data.

18.54 Alternative seismic acquisition technologies must continue to be investigated during the life of the project.

Monitoring activities on Barrow Island will continue to evolve over time as new technologies become available and information is obtained on the behaviour of the CO₂ in the subsurface. In the Draft EIS/ERMP, the Gorgon Joint Venturers outlined a monitoring program based on the technology available today. Repeat seismic surveys and observation wells form a major component of this monitoring approach. Importantly the Gorgon Joint Venturers have also outlined a set of objectives for monitoring and verification activities (Chevron Australia 2005; p 648) by which the application of future technological developments will be assessed.

The advances in seismic imaging technology and acquisition practices over the last 20 years demonstrate that these technologies are rapidly evolving.

22.12 It is now apparent that at least 10,000 pieces of equipment involved with seismic monitoring will expose the Island to quarantine risk.

This submission is referring to the likely use of 'less than 10,000 individual geophone elements' (Chevron Australia 2005; p 118). Many hundreds of geophone elements are normally incorporated into one geophone cable.

The mobilisation of land-based seismic crews to Barrow Island will be undertaken in accordance with the quarantine procedures in place to prevent the introduction of non-indigenous species to Barrow Island. It should be noted that these types of surveys have been previously undertaken on Barrow Island without any identifiable species introduction attributable to those surveys.

22.144 Page 115: Yet another aspect of the project – this time re-injection monitoring – has yet to be designed!

Monitoring activities on Barrow Island will continue to evolve over time as new technologies become available and information is obtained on the behaviour of the CO₂ in the subsurface. In the Draft EIS/ERMP, the Gorgon Joint Venturers have outlined a monitoring program (reference case) based on the technology available today. Repeat seismic surveys and observation wells form a major component of this monitoring approach. Importantly the Gorgon Joint Venturers have also outlined a set of objectives for monitoring and verification activities (Chevron Australia 2005; p 648) by which the application of future technological developments will be assessed.

The advances in seismic imaging technology and acquisition practices over the last 20 years demonstrate that these technologies are rapidly evolving.

22.144.1 Page 118: The Submitters note that the lowest impact monitoring activity here still seems to involve 10,000 pieces of equipment, each with their attendant quarantine risk. While the discussion focuses on the fact that other options with heavier impacts might be avoided, again we should emphasise that the regulators should be exclusively concerned with absolute impacts, not relative ones!

The Gorgon Joint Venturers concur that that the absolute impact needs to be considered by regulators, but in order to minimise the level of absolute risk it is necessary to compare the relative impacts of a range of alternatives.

This submission is referring to the likely use of 'less than 10 000 individual geophone elements' (Chevron Australia 2005; p 118). Many hundreds of geophone elements are normally incorporated into one geophone cable.

The mobilisation of land-based seismic crews to Barrow Island will be undertaken in accordance with the quarantine procedures in place to prevent the introduction of non-indigenous species to Barrow Island. It should be noted that these types of surveys have been previously undertaken on Barrow Island without any identifiable species introduction attributable to those surveys.

Also refer to 22.12 Section 13.4.7.

22.324 There is far too little information provided in the Draft EIS/ERMP to assess the effectiveness or environmental impacts of the monitoring regime that will be required to track the movement of CO₂ in the subsurface and to detect any leaks of CO₂.

22.325 Given that there is little uncertainty regarding the ability of the proponent to reinject CO₂ into the subsurface, the monitoring of the CO₂ following reinjection is arguably the most important design aspect of the geosequestration system. It is unacceptable to expect to be granted environmental approval of an unproven technology such as geosequestration on an unprecedented scale prior to the development of a monitoring programme and confirmation of its viability.

Monitoring activities on Barrow Island will continue to evolve as new technologies become available and information is obtained on the behaviour of the CO₂ in the subsurface. In the Draft EIS/ERMP, the Gorgon Joint Venturers outlined a reference case monitoring program based on the technology available today. Repeat seismic surveys and observation wells form a major component of this monitoring approach. It is inappropriate to require that future monitoring will be based on this approach as that would preclude the use of technologies that may become available. Importantly, the Gorgon Joint Venturers have also outlined a set of objectives for monitoring and verification activities (Chevron Australia 2005; p 648).

It is the intent of the Gorgon Joint Venturers to maintain the level of environmental impact at, or below, that associated with the reference case monitoring program outlined in the Draft EIS/ERMP. All matters dealing with monitoring of the injected CO₂ would be undertaken in accordance with a Carbon Dioxide Injection Operations Management Plan which would be agreed by regulatory authorities. Refer to Section 13.4.8 of the Draft EIS/ERMP (Chevron Australia 2005; p 649). The Gorgon Joint Venturers have committed in the Draft EIS/ERMP to 'make information available to the public with regard to the ongoing monitoring program' (Chevron Australia 2005; p 619).

13.4.8 Carbon Dioxide Injection Operations Management Plan

8.29 The suspension of CO₂ injection operation should be done in consultation with the relevant government agencies.

It is the intent that all matters dealing with operational management of CO₂ injection, including criteria by which the operations would be suspended, will be undertaken in accordance with a Carbon Dioxide Injection Operations Management Plan. This Plan will be agreed and endorsed by regulatory authorities. Refer Section to 13.4.8 of the Draft EIS/ERMP (Chevron Australia 2005; p 649).

8.35 Section 13.4.8, pg 652, 3rd paragraph: It is stated that during operations appropriate arrangements will be made with Barrow Island Joint Venture to ensure that all wells in the path of the migrating CO₂ are assessed and if required, worked over, such that they are fit for service in a CO₂ environment. The assessment/work over should be done in consultation with the relevant government agencies.

It is the intent that all matters dealing with operational management of CO₂ injection, including management of existing well penetrations, would be undertaken in accordance with a Carbon Dioxide Injection Operations Management Plan which would be agreed and endorsed by regulatory authorities. Refer Section 13.4.8 of the Draft EIS/ERMP (Chevron Australia 2005; p 649).

18.169 Given the values of Barrow Island possibly at threat due to potential failure of CO₂ reinjection to the Dupuy Formation, it is imperative that the proponent adopts a precautionary approach so that all potential risks of failure are minimized to an acceptable level.

It is the intent that all matters dealing with the ongoing operational management of CO₂ injection, including management response to high formation pressures, unpredicted migration, management of existing well penetrations and criteria by which the operations would be suspended, would be undertaken in accordance with a Carbon Dioxide Injection Operations Management Plan. This Plan would be agreed and endorsed by regulatory authorities. Refer Section 13.4.8 of the Draft EIS/ERMP (Chevron Australia 2005; p 649).

The Gorgon Joint Venturers have outlined their approach to the management of CO₂ injection risk in the Draft EIS/ERMP under the heading Carbon Dioxide Injection Uncertainty Management (Chevron Australia 2005; p 650). This approach identifies: the nature of the uncertainty; what the worse-than-expected outcome might be; the signposts and reservoir surveillance technologies to identify if this worse-than-expected outcome is developing and a series of management actions that can be implemented to mitigate the risk. To enable the understanding of risk to the environment from CO₂ injection operations, a comprehensive failure modes and effects study has been undertaken to assess the impact of likely failure modes and the impact of safeguards, mitigation or management measures.

The Gorgon Joint Venturers have stated that ‘...if at any time the Joint Venturers consider that the injection of reservoir CO₂ represents an unacceptable risk to the environmental values of Barrow Island, or a safety risk, then CO₂ injection operations would be suspended and the remaining reservoir CO₂ vented to the atmosphere’. That is, the Joint Venturers ‘will place the safety of the workforce on Barrow Island and the environmental values of Barrow Island above the mitigation of increased atmospheric greenhouse gas emissions.’ (Chevron Australia 2005; pp 597 and 599).

22.6 The CCWA considers that this project should be delayed until the uncertainties regarding the application of geosequestration technology are reduced and an alternative site for the processing plant is agreed upon.

The Gorgon Joint Venturers have undertaken extensive studies into uncertainty associated with the injection of CO₂ and to reduce the level of uncertainty to a level where it is manageable. The results of this work are captured in the discussion around uncertainty management in the Draft EIS/ERMP (Chevron Australia 2005; p 650). This work has been, and will continue to be, scrutinised by government as it considers approval of CO₂ injection under the *Barrow Island Act 2003*, and through continued supervision of CO₂ injection through the agreed Injection Operations Management Plan.

22.298 The GJV proposal relies heavily on the use of geosequestration to reduce its greenhouse gas emissions from an estimated almost 7 million tonnes per annum (Mtpa) CO₂e to 4 Mtpa CO₂e. While geosequestration may prove a useful technology in the mitigation of greenhouse gas emissions from energy-intensive projects in the future, there are too many uncertainties regarding its application at the proposed location, including unresolved monitoring, liability and regulatory issues. Furthermore, GJV have made it clear that, if the proposed geosequestration proves technically or financially prohibitive then they would continue operations with venting of CO₂ to the atmosphere. Thus, there is no certainty within this proposal as to the exact amount of additional CO₂ emissions will result.

The Gorgon Joint Venturers have adopted a greenhouse gas management strategy for the Gorgon Development that incorporates many initiatives aimed at the reduction of greenhouse gas emissions. The adoption of currently applied best practice, such as the use of waste heat recovery, has resulted in a greenhouse emissions efficiency improvement of 0.34 tonnes CO₂e per tonne LNG when compared to the Gorgon Development concept in 1998. By comparison, the proposal to inject reservoir CO₂ results in an improved greenhouse emissions efficiency of 0.20 tonnes CO₂e per tonne LNG (Chevron Australia 2005; p 604).

The Gorgon Joint Venturers would not propose the CO₂ injection project if they did not believe that the residual uncertainty associated with the proposal to inject CO₂ is justified by the ability to achieve a significant reduction in the Development's greenhouse gas emissions. Importantly, the Joint Venturers have developed plans for managing the level of residual risk and these have been outlined in the Draft EIS/ERMP under the heading Carbon Dioxide Injection Uncertainty Management (Chevron Australia 2005; p 650).

The approach the Joint Venturers have taken to monitoring is not unresolved. The Draft EIS/ERMP (Chevron Australia 2005; p 115) contains a description of a reference case based on the monitoring technologies available using today's technology. Repeat seismic surveys form a major component of this monitoring approach. It should be recognised that monitoring activities will continue to evolve over time as new technologies become available and information is obtained on the behaviour of the CO₂ in the subsurface. Importantly, the Gorgon Joint Venturers have also outlined a set of objectives for monitoring and verification activities (Chevron Australia 2005; p 648) by which the application of future technological developments will be assessed.

The Joint Venturers commitment to inject reservoir CO₂ is qualified as discussed on p 597 of the Draft EIS/ERMP and the Submitters are correct in stating that 'there is no certainty within this proposal as to the exact amount of additional CO₂ emissions'. The inclusion of these qualifiers should not be interpreted as the Joint Venturers not planning to proceed with the injection of CO₂. These qualifiers mean that there may be unlikely circumstances where the Joint Venturers are unable to inject the full volume of reservoir CO₂.

The Gorgon Joint Venturers note that matters of regulation and liability are effectively a matter for government and are not necessarily matters that relate to the assessment of the Developments environmental impact. However in the spirit of an informed debate the Joint Venturers make the following points.

The *Barrow Island Act 2003* contains the world's first specific legislation dealing with the subsurface injection of CO₂ in order to reduce greenhouse gas emissions. This legislation is supported by extensive work in the area of regulation of geosequestration undertaken by the Ministerial Council of Minerals and Petroleum Resources and which has involved wide spread community consultation (MCMPR 2005).

The Gorgon Joint Venturers maintain that the long-term issues (and any potential liability) that are likely to result from geosequestration are not dissimilar to those that arise from activities currently undertaken in the oil, gas and mining sectors and that existing statutory regulation and common law provide appropriate mechanisms for managing these liabilities (Chevron Australia 2005; p 676). Further, the Joint Venturers note that the Ministerial Council on Mineral and Petroleum Resources, recommended (MCMPR 2005; p 46) that 'Liability should be based on existing regulatory arrangements and common law' and that 'Current regulatory principles and common law should continue to apply to liability issues for all stages of CCS projects'.

Ultimately the most effective way to reduce liability is through diligent site selection, and operational review by government. The Western Australian Government has already commissioned a number of independent reviews of the work undertaken by the Gorgon Joint Venturers.

22.326 GJV's statements throughout the draft EIS/ERMP that both general greenhouse mitigation opportunities and even geosequestration itself will only be undertaken if it is economically feasible means that it is reasonably likely that either insufficient monitoring will take place in order to reduce costs, or geosequestration with an adequate monitoring component will prove technically or cost-prohibitive and the high levels of CO₂ will be vented into the atmosphere.

All matters dealing with monitoring of the injected CO₂ would be undertaken in accordance with a Carbon Dioxide Injection Operations Management Plan which would be agreed by regulatory authorities. Refer to Section 13.4.8 of the Draft EIS/ERMP (Chevron Australia 2005; p 649).

22.327 There is no information regarding the frequency of seismic testing.

It is likely that the initial surveys will be acquired at intervals of two-to-three years after the commencement of injection. If the behaviour of the CO₂, as shown by those surveys, closely matches the behaviour predicted by reservoir modelling it is possible that further surveys may be more widely spaced. If the CO₂ migration shows deviations from that expected by modelling, then further surveys will most likely be acquired as shorter intervals.

All matters dealing with monitoring including the duration between surveys will be undertaken in accordance with a Carbon Dioxide Injection Operations Management Plan which would be agreed by regulatory authorities. Refer to Section 13.4.8 of the Draft EIS/ERMP (Chevron Australia 2005; p 649).

The Gorgon Joint Venturers have committed in the Draft EIS/ERMP to 'make information available to the public with regard to the ongoing monitoring program' (Chevron Australia 2005; p 619). This will enable independent researchers to assess the appropriate frequency of acquiring seismic data.

22.330 A close examination of Tables 13-17, 13-18, 13-19 and 13-20 (pages 668 to 674) shows that the column headed "Safeguards, Mitigation or Management Measures" contains very few measures that could be considered remediation. Rather, the points either attempt to downplay the likelihood of each event or discuss preventative measures.

The tables form part of a discussion around failure modes and effects, undertaken to enable the resulting environmental impacts of such failures to be assessed. As it is possible to implement safeguards or management actions to guard against many of these failure modes, it was prudent to highlight these prior to discussing the residual risk of such a failure. This level of residual risk was then used in other parts of the Draft EIS/ERMP to determine the risks to the environment of Barrow Island.

Table 13-14 (Chevron Australia 2005; pp 653 to 661) contains data on management actions available to manage uncertainty in relation to the CO₂ injection operations. It is these tables that contain identified management actions (remediation measures).

13.4.9 Environmental Impact of Carbon Dioxide Injection Infrastructure

No submissions received on this section of the Draft EIS/ERMP.

13.4.10 Potential Failure Modes Related to Carbon Dioxide Injection

22.333 Insufficient information has been provided regarding GJV's risk assessment methodology regarding geosequestration, particularly with regard to the necessary complete independence of the person/persons or entities undertaking the risk assessment and the proponents.

The Gorgon Joint Venturers believe that the process for assessing the environmental risk of the proposed CO₂ injection project on Barrow Island is clear. The process is based on a failure modes and effects assessment to understand the nature and likelihood of possible failure modes. This data was then provided to the ecologists undertaking the ecological risk assessment to assess the likely impact upon the flora and fauna of Barrow Island. This process is documented in the Draft EIS/ERMP commencing on p 663 (Chevron Australia 2005).

In order to adequately assess the nature and likelihood of failure, it is necessary to engage experts in the field under review. Refer to Australian Standard for Risk Analysis of Technological Systems (AS/NZS 1998). In the area of CO₂ injection this will likely involve experts working in the field of geosequestration, such as Andy Rigg from the Cooperative Research Centre for Greenhouse Gas Technologies. The Gorgon Joint Venturers rely upon the integrity of the organisations and the individuals involved in such processes to provide impartial advice.

22.334 The CSIRO publication *The Large Scale Injection of CO₂ into Subsurface Geological Formations in Australia: Getting the Risk Assessment Framework Right Addressing the Socio-Political Needs of Stakeholders*, is attached and outlines that new risk assessment methodologies are required for 'mega-projects' such as the GJV proposal. Yet no indication is given that emerging risk assessment methodologies have been considered or implemented by GJV despite the fact that this publication was released in 2003 by the Australian Petroleum Resources Research Centre's GEODISC program which was at the forefront of geosequestration research.

The Gorgon Joint Venturers have considered emerging risk assessment methodologies. Page 664 of the Draft EIS/ERMP identifies that the failure modes and effects study was based on a list of events developed during the GEODISC program and published in 2004 by the employees of its successor organisation, the Cooperative Research Centre for Greenhouse Gas Technologies (Bowden and Rigg 2004). One of the authors of this landmark paper participated in the failure modes and effects workshop and is acknowledged as a leading expert in the area of geosequestration subsurface risk analysis.

13.4.11 Approach to Long-term Responsibilities

No submissions received on this section of the Draft EIS/ERMP.

13.4.12 Approach to Long-term Responsibilities

16.46 Benefits to Western Australia appear to be relatively small as it appears that most financial benefits will go to the Commonwealth Government. Yet geosequestered CO₂ would become a very costly, high risk problem to our State and would turn the region into a rubbish dump for future generations to worry about long after Gorgon has abandoned the site.

The Gorgon Joint Venturers maintain that the long-term issues that are likely to result from geosequestration are not dissimilar to those that arise from activities currently undertaken in the oil, gas and mining sectors and that existing statutory regulation and common law provide appropriate mechanisms for managing risk (Chevron Australia 2005; p 676). Ultimately the most effective way to reduce the risk or environmental damage is through diligent site selection, and operational review by government. The Western Australian Government has already commissioned a number of independent reviews of the work undertaken by the Gorgon Joint Venturers. The Joint Venturers welcome this level of oversight and anticipate it continuing through the operational and post operational phases of the project.

The Gorgon Joint Venturers have adopted site closure criteria contained in the Principles for Carbon Dioxide Geosequestration (Chevron Australia 2005; p 676). The principles propose that site closure should occur once government is satisfied to a high degree of certainty that:

- future land use objectives defined at the time of project approval have been met
- the residual risks of leakage and resulting liabilities are acceptably low
- the ongoing costs associated with the site are acceptably low or are otherwise appropriately managed.

The Gorgon Joint Venturers support the use of these criteria in agreeing site closure of the Gorgon CO₂ injection project with government (Chevron Australia 2005; p 676).

Clearly government will not agree to the closure of the Gorgon CO₂ injection site until the Gorgon Joint Venturers have demonstrated to the government's satisfaction that the risk of leakage (and resultant liability) is low, such that the government is willing for the Joint Venturers day-to-day involvement in the site to end. The third in the site closure criteria recognises that there may be a scenario where site closure is desirable (by government) but that there are some identifiable ongoing costs. In this scenario, site closure can only be agreed if appropriate arrangements regarding ongoing funding have been put in place.

22.315 The draft EIS/ERMP is incorrect in stating that the Draft Regulatory Principles for Carbon Dioxide Geosequestration 'have been put forward for the various federal and state governments to consider.'

The Draft Principles to which the draft EIS/ERMP refers were approved "in principle" by the June 2004 meeting of the Ministerial Council for Mineral and Petroleum Resources (MCMPR), subject to stakeholder consultation. The Draft Principles were revised by a Stakeholder Reference Group during 2005 and the new version has been considered by the Standing Committee of Officials and will be considered by MCMPR on 25 November, 2005.

The Gorgon Joint Venturers note that matters of regulation are effectively a matter for government and are not necessarily matters that relate to the assessment of the Developments environmental impact.

The Draft Regulatory Principles received 'in principle' support in June of 2004. Advice from DoIR (Smith 2004) was that this does not signify that MCMPR had approved the Regulatory Principles. The principles have undergone subsequent revision prior to formal approval at the MCMPR meeting on November 25, 2005. The Joint Venturers understand that the Regulatory Principles were approved at the November 25 meeting. At the date the Draft EIS/ERMP was published the principles were being considered by the MCMPR and had yet to be approved.

22.316 GJV is correct when it states that there is no requirement for jurisdictions to implement the Regulatory Principles, however given the consultative nature of their development, the application of these principles would seem warranted in any legislative development. The Submitters are concerned that GJV should make the point that there is no need to abide by the proposed regulatory principles. Presumably a national approach is in the best interests of all stakeholders in the case of geosequestration technology, and a robust and stringent model with broad stakeholder support would also seem appropriate.

This statement was included in the Draft EIS/ERMP at the request of DoIR (Smith 2004) as it was felt that the Gorgon Development should not imply that the Regulatory Principles were binding on the respective Australian governments.

A nationally consistent approach to the regulation of geosequestration is in the best interests of all stakeholders. The Joint Venturers state on p 676 of the Draft EIS/ERMP that 'The Gorgon Joint Venturers support the use of these criteria to managing and agreeing site closure of the Gorgon CO₂ injection project with government'.

While the Regulatory Principles are not binding upon individual jurisdictions, the Gorgon Joint Venturers anticipate that the Western Australian Government will carefully consider the principles when it determines the 'conditions and restrictions' that it will apply to the approval to inject CO₂ under the provisions of the *Barrow Island Act 2003* (Article 13(6)). Recognising the importance of the Regulatory Principles (albeit in draft form at the time of writing the Draft EIS/ERMP), the Gorgon Joint Venturers have adopted a number of the principles in documenting how a number of issues will be dealt with. Some example of the adoption of the principles in the Draft EIS/ERMP include:

- the principle of site closure after a post injection phase of operations
- criteria to be met in order to agree site closure
- objectives to be met by any monitoring program.

22.329 Given that GJV will intend to hand over management of the injection site to government to manage as soon as possible after closure of the gas processing facility, more information regarding the costs to the public purse of ongoing monitoring of this remote site and the environmental impacts over the long-term must be provided.

The Gorgon Joint Venturers have adopted the site closure criteria contained in the Principles for Carbon Dioxide Geosequestration (see response to submission 22.315 and 22.316) (Chevron Australia 2005; p 676). It is proposed in those principles that site closure should occur once government is satisfied to a high degree of certainty that:

- future land use objectives defined at the time of project approval have been met
- the residual risk of leakage and resulting liabilities are acceptably low
- the ongoing costs associated with the site are acceptably low or are otherwise appropriately managed.

The Gorgon Joint Venturers support the use of these criteria to managing and agreeing site closure of the Gorgon CO₂ injection project with government (Chevron Australia 2005; p 676).

Government will not agree to the closure of the Gorgon CO₂ injection site until the Gorgon Joint Venturers have demonstrated to the government's satisfaction that the risk of leakage is low, such that the government is willing for the Joint Venturers day-to-day involvement in the site to end. Having demonstrated that the residual risk is acceptably low, the requirement for ongoing monitoring and management should also be low such that it could be expected that there will not be a 'cost to the public purse'. The third in the site closure criteria recognises that there may be a scenario where site closure is desirable (by government), but that there are some identifiable ongoing costs. In this scenario, site closure can only be agreed if appropriate arrangements regarding ongoing funding have been established.

22.331 The crucial issue in this situation is that the Western Australian community is being expected to accept a project without knowing if they will incur a major long-term liability. This is clearly unacceptable. (re: pages 668–674)

This response relates to a question of whether responsibility (and liability) resides with the Western Australian or Commonwealth Governments.

The Gorgon Joint Venturers note that issues around the management of liability are matters for government and are not necessarily matters that relate to the assessment of the Development's environmental impact.

13.5 Greenhouse Gas Management Plan

22.304 The Greenhouse Gas Management Strategy has many shortcomings and is insufficient as a guiding document for the management of greenhouse emissions from such a significant proposal.

The Gorgon Joint Venturers released their Greenhouse Management Strategy in 2003 (ChevronTexaco Australia 2003) as a strategic document mapping out how the Development would approach greenhouse gas management. The strategy should not be confused with a greenhouse management plan more commonly associated with major projects and released later in the maturity of the project. The publication of such a strategy early in the conceptual design for a major project is highly unusual initiative with the Joint Venturers unaware of any other major project that has done so.

Importantly, the strategy has provided clear guidance to the various Development Teams in: undertaking their design work and delivering on the primary objectives of current best practice in thermal efficiency and greenhouse emissions control; and the reducing greenhouse gas emissions by subsurface injection of reservoir CO₂. Success in delivering upon these strategies has resulted in the significant improvement in projected greenhouse gas emissions efficiency compared to earlier designs for this Development and emissions efficiency compared similar LNG developments (Chevron Australia 2005; pp 603 and 615). These data suggest that the early adoption (and publication) of the Gorgon Development Greenhouse Gas Management Strategy has been successful in delivering improved greenhouse gas emissions outcomes.

25.28 At present the EIS discusses this aspect of the proposal from a view point that assumes geosequestration will be undertaken and will be successful. It would be appropriate for the alternative scenarios (to the subsurface injection of reservoir CO₂) to be discussed in the EIS as well; firstly that geosequestration is not undertaken (noting that it is an option rather than a firm commitment at this stage); secondly that it is undertaken but fails in some way. The potential venting of all the carbon dioxide from the proposed Gorgon project and the likely environmental consequences at local, regional and global levels needs to be addressed in the EIS.

The opportunity to reduce the proposed Development's greenhouse gas emissions through alternatives such as organic sequestration was presented in the Draft EIS/ERMP as part of the Joint Venturers' assessment of alternative greenhouse gas abatement options (Chevron Australia 2005, p 601).

The commitment to significantly reduce the Gorgon Development's greenhouse gas emissions by the subsurface injection of reservoir CO₂ removed during gas processing is qualified as discussed in the Draft EIS/ERMP (Chevron Australia 2005, p 597). These qualifiers have been provided to manage what are anticipated to be remote outcomes and should not be interpreted as reflecting the expected performance of the CO₂ injection project.

If the Joint Venturers were unable to continue to inject reservoir CO₂, or were only able to inject a portion of the reservoir CO₂, then the implication would be that the greenhouse gas emissions for the Gorgon Development would increase from 4 MTPA to potentially as high as 6.7 MTPA. It is worth noting that with these increased levels of greenhouse gas emissions the greenhouse efficiency benchmark (Chevron Australia 2005, p 615) would increase from 0.35 tonnes CO₂e per tonne LNG to 0.55 tonnes CO₂e per tonne LNG, which would be comparable to the soon to be commissioned Darwin LNG plant. The lifecycle greenhouse gas emissions from the Gorgon Development without the injection of reservoir CO₂ would still have significant benefits over alternative fuels such as coal and fuel oil. Also refer to 22.301 Section 13.1.3.

The impact of this increased level of greenhouse gas emissions at local, regional and global scales has not been assessed as it is outside the agreed scope of the EIS/ERMP as documented in the Guidelines for an Environmental Impact Statement and Environmental Scoping Document for an Environmental Review and Management Program for the Proposed Gorgon Development (ChevronTexaco Australia 2004).

13.5.1 Membership of Government Programs

No submissions received on this section of the Draft EIS/ERMP.

13.5.2 Planned Actions to Reduce Greenhouse Gas Emissions

24.69 In event that defined performance targets (such as those in Table 13-21) are not achieved within the timeframes, what approach will the Gorgon Joint Venturers take to meet them?

The Gorgon Joint Venturers note that the greenhouse gas emissions estimates provided in the Draft EIS/ERMP are based on a series of reference case assumptions (Chevron Australia 2005; p 610) based on high emissions scenarios where either engineering design work is still to be completed (for example selection of power generation technology) or to allow for uncertainty in relation to the injection of reservoir CO₂.

The longer term performance target provided in Table 13.21 have been provided to reflect the actual level of greenhouse emissions the Joint Venturers believe the Gorgon Development is capable of achieving. The Joint Venturers have outlined a number of planned actions that they will undertake in reducing the Development's greenhouse gas emissions below those used in the Draft EIS/ERMP reference case (Chevron Australia 2005; p 678). In addition, Chevron's Operational Excellence Management System requires the regular review of energy efficiency measures and emissions performance and plans to be developed to improve these.

The Gorgon Joint Venturers have also undertaken to participate in government programs (Chevron Australia 2005; p 677) aimed at the voluntary reduction of greenhouse gas emissions and to fully comply with laws such as those proposed for Energy Efficiency Assessments. These actions will assist in continuing to reduce the Gorgon Development's greenhouse gas emissions.

13.5.3 Greenhouse Gas Emissions Performance Indicators and Targets

No submissions received on this section of the Draft EIS/ERMP.

13.6 Compliance with EPA Guidance Notes

19.20 The Department would also like clarification from the proponent or the EPA on the requirements for deep injection of carbon dioxide, which has potential to change the acidity of receiving ground water, thus changing the subsurface physical conditions. No such information has been made available through the ERMP and should be addressed as changes in subsurface physical conditions may have the potential to impact on the environment of Barrow Island.

19.45 The Environmental Regulation Branch is asked to seek clarification from the EPA regarding its [EPAs] requirements for deep injection of carbon dioxide into an aquifer, which has potential to change the acidity of receiving groundwater, thus changing the subsurface physical conditions.

The Submitters have requested advice from the proponent or the EPA. In making this response the Gorgon Joint Venturers are not responding on behalf of the EPA.

EPA Guidance Note No. 4 on the use of deep wells for the injection for disposal of industrial waste provides a relevant policy statement under which the proposed disposal of reservoir CO₂ should be assessed. The Gorgon Joint Venturers compliance with this policy statement is discussed on p 680 of the Draft EIS/ERMP (Chevron Australia 2005). The Gorgon Joint Venturers note that the objective of this policy statement is 'the protection of ground water resources which might be impacted by the subsurface injection of industrial waste'. The Joint Venturers also note that the definitions of industrial waste do not include CO₂, but 'consider it appropriate to apply the objectives of the guidance note to the proposed CO₂ injection project' (Chevron Australia 2005; p 680).

The Gorgon Joint Venturers agree that there is 'potential to change the acidity of receiving ground water', indeed this is almost inevitable. These changes will be localised to the waters in contact with the CO₂ plume, some 2300 m below the surface of Barrow Island. Modelling undertaken by the Gorgon Joint Venturers (Chevron Australia 2005; p 645), shows that it takes just under one thousand years for the injected CO₂ to reach the first effective barrier to migration, the base Barrow Group Shale. During this time, a large amount of the CO₂ has become permanently trapped within the Dupuy Formation. Should the CO₂ penetrate this barrier, it will have to migrate through an additional 2000 m of geologic section in order to reach the surface. As it migrates through this section, the remaining CO₂ is likely to become permanently trapped.

The Gorgon Joint Venturers have documented in some detail the physical risks and impacts that might arise from the CO₂ injection proposal and the steps they will take to manage and mitigate uncertainty (Chevron Australia 2005; p 650). Based on an assessment of possible failure modes, the Gorgon Joint Venturers have assessed the likelihood of negative impacts on subterranean fauna to be remote with a residual risk of medium. The residual risk to terrestrial vegetation from a leak of injected CO₂ is considered low (Chevron Australia 2005; pp 388 and 334).

14 Social and Cultural Environment

14 Social and Cultural Environment.....	383
14.1 Introduction and General Submissions on Social and Cultural Environment	384
14.2 Social Factors Requiring Assessment	384
14.3 Government Policy and Plans	384
14.4 Local Communities	384
14.5 Livelihoods and Lifestyle.....	384
14.6 Land and Sea Use and Tenure	385
14.7 Native Title	386
14.8 Cultural Heritage	386
14.8.1 Indigenous Archaeology	386
14.8.2 Maritime Heritage – Subsea	387
14.9 Landscape and Aesthetics.....	387
14.10 Workforce and Public Health and Safety.....	387
14.11 Public Risk Assessment.....	388

14.1 Introduction and General Submissions on Social and Cultural Environment

No submissions received on this section of the Draft EIS/ERMP.

14.2 Social Factors Requiring Assessment

No submissions received on this section of the Draft EIS/ERMP.

14.3 Government Policy and Plans

24.70 Will a rezoning for the development be required under the Shire of Ashburton TPS 7? This may have implications to the EPA in view of referral requirements under the *Environmental Protection Act*.

The Gorgon Joint Venturers do not expect there to be any requirement for rezoning, under the Shire of Ashburton Town Planning Scheme (TPS 7), for the Gorgon Development. Under the Shire of Ashburton Town Planning Scheme, Barrow Island is zoned as a 'Conservation, Recreation and Natural Landscape' reserve, which is 'intended to accommodate a broad range of natural and modified land uses and developments and may, subject to relevant approvals, include extractive or resources processing industries and infrastructure' (Department of Planning and Infrastructure 2005).

14.4 Local Communities

17.1 While the documents sighted make reference to a traffic management plan in the Dampier area, there is little comment on the impact of additional road train activity on the North west Coastal Highway from Perth to the Pilbara. Given the: – significant increase in construction activity forecast for the North West, – the increasing use of road tankers for petroleum from the mid west to Perth, and the limited number of heavy haulage routes from the Australian Marine Complex at Kwinana to Northwest coastal highway, then all parties should give additional consideration to reducing the reliance on road haulage (particularly on the NW Coastal Highway).

Access of this type is a state and Commonwealth issue to support the development opportunities offered by abundant natural resources in Australia and especially Western Australia. The State Government of Western Australia has just spent \$22 million on upgrading the wide load corridor from Kwinana to the Kewdale area which will support the Gorgon Development and the North West Shelf Venture's Train 5 construction (refer to Sound Telegraph, 16-11-2005, p 12). Once the Materials Offloading Facility (MOF) is in place at Barrow Island, the Joint Venturers will be considering direct shipments from the Perth area to Barrow Island, but quarantine aspects will be a critical input to this decision.

14.5 Livelihoods and Lifestyle

5.8 This lifestyle only facilitates social problems and wrecks relationships. The development does not give jobs to North-West towns. It does not create community.

The Draft EIS/ERMP, Section 14.5.5, Summary of Benefits and Risks to Livelihoods and Lifestyles and Table 14-4 and Table 14-5 document the expected number of local jobs. The target is 10% of total workforce sourced from the region.

22.75 Principle 4. Social Equity and Community Well-being Enhancement – it is highly questionable whether economic activity based on resources exploitation is a sound basis for community well-being. In addition, the further proliferation of fly-in fly-out work patterns will not lead to the development of strong, cohesive communities.

The Joint Venturers highlight the position of the Government of Western Australia expressed in the Keating Report that: 'Industry and resource development in Western Australia is a key economic driver for this State. If resource development were to cease, it would have a devastating social impact on the State, and on the employment opportunities and quality of life of its citizens.' (Independent Review Committee 2002)

The Joint Venturers recognise the potential issues associated with a fly-in fly-out (FIFO) workforce. As such, the Joint Venturers will adopt industry guidelines for work and rotation schedules as well as adopt measures, such as providing appropriate communications facilities and modifying procedures to reduce potential social impacts. Social impacts will be monitored and reported on through the Social Impact Management Plan process (refer to Draft EIS/ERMP, Table 14-3, p 692).

22.236 How is it asserted that the location of the construction village has been modified when the location of the construction village has not yet been finalised?

A site for the construction village has been selected after extensive evaluation of the range of available sites indicated in the Draft EIS/ERMP. The Joint Venturers propose to establish the construction village at a site approximately 2.6 km south-west of the gas processing facility and approximately 800 m west from the nearest accommodation building at the existing Chevron operations camp. The site is a combination of locations CVX1 and CVX2 (Figure 6-17) nominated in the Draft EIS/ERMP. The environmental, social and economic factors applicable to this selection provide greater benefits than the base case (gas processing facility) site. Detailed flora and fauna surveys have been undertaken within the site of the village and a surrounding buffer zone during the peak period of the year for such surveys. This has confirmed that the biodiversity and environmental factors prevailing on that site are similar to the base case (gas processing facility) site. In addition, there are a number of social (health, safety, amenities) factors that favour the new preferred location.

14.6 Land and Sea Use and Tenure

23.9 The Department cannot expend the resources required to analyse in detail the impacts of projects on fisheries but is able to provide expert comment on the adequacy of the assessment documentation. This is not possible in the case of this ERMP because, disappointingly for such a lengthy document, the fisheries impacts are not well documented. In fact the presence of pearl farms at the Lowendale Islands (operated by Fantome Pearls to the north and north west of Varanus Island), and the operation of trap fishing to the west and north of Barrow Island is not documented

23.11 The project involves the installation of extensive pipelines both to Barrow Island and from the Island to the mainland. The former does not raise any fisheries issues because there are no active trawl fisheries in the area to be traversed

23.12 However the pipeline to the coast will cross through trawl grounds utilised by fishes in the Onslow prawn fishery. The documentation indicates an alignment adjacent to existing pipelines and this is supported because in this way loss of trawl ground will be minimised. It is noted however that detail of the pipeline installation is not available and the potential to mitigate disruption to the fishing fleet is not discussed.

Recommendation; Alignment of pipelines in trawl areas should limit impact on fisheries by closely following existing installations, and impact on fisheries should be addressed.

In the Draft EIS/ERMP, refer to Section 8.4.5 Land and Sea Tenure and Use and Section 14.6.4 Sea Use and Table 14.6.

24.170 The proponent must consider the impacts of the proposal on aquaculture activities which occur in the Montebello/Barrow Islands region, including aquaculture activities in the MCRs.

The Joint Venturers are aware of aquaculture activities in the region and have assessed the risks posed by the Development to such activities as low (refer to Draft EIS/ERMP, Sections 14.6.4 and 14.6.5). Management measures will be adopted that reduce sediment plumes from dredging and reduce potential conflict with other users in the region. The Joint Venturers will continue to consult with land and sea users in the region to ensure management issues are appropriately considered in the preparation and implementation of construction and operations Environmental Management Plans.

14.7 Native Title

No submissions received on this section of the Draft EIS/ERMP.

14.8 Cultural Heritage

3.1 It is recommended that Chevron undertake comprehensive archaeological and ethnographic surveys of the areas to be affected by the project. The reports of these surveys should be submitted to DIA.

As part of the Cultural Heritage Assessment for the EIS/ERMP approval process, registered historical and cultural heritage sites were located within and adjacent to the Gorgon Development. Archaeological surveys were also undertaken within the proposed Development areas to identify any new cultural heritage sites. No sites were found to be impacted upon by the proposed Development. Further detailed archaeological studies will be undertaken prior to construction within the proposed Gorgon Development area. If any new sites are discovered, they will be managed in accordance with the Cultural Heritage Management Plan (CHMP). For more information please refer to the draft CHMP as provided in Appendix E1 in the Draft EIS/ERMP (Chevron Australia 2005).

3.2 A copy of the Cultural Heritage Management Plan (CHMP) should be provided to DIA.

Two full copies of the Draft EIS/ERMP, which include technical appendices where provided to the DIA. The draft Cultural Heritage Management Plan is found in Technical Appendix E1. Two further copies of the Draft EIS/ERMP (which includes Technical Appendix E1) have been submitted to the DIA for review.

14.8.1 Indigenous Archaeology

13.28 There is no reason given for the proposed 50% figure for archaeological survey or how and on what basis it would be achieved.

The archaeological surveys (which include Indigenous, Historic and Marine) of the proposed Development area will be conducted according to the draft cultural heritage management plan (CHMP) which outlines a comprehensive plan to manage any sites discovered within the proposed Development area. The CHMP recommends that detailed surveys be conducted by qualified archaeologists with a minimum of 50% coverage, with an emphasis on high-potential archaeological areas. For example, Coastal and Clay Pan areas. The 50% figure is used as a minimum figure for detailed surveys of this nature and is considered sufficient for management purposes. Further assessment and identification of potential sites will be carried out by a cultural heritage officer both prior to and during construction phase.

24.72 How consistent are the following targets, in Table 14-8:

- No impact to indigenous heritage sites, and
- Where sites cannot be avoided, sites only disturbed in accordance with procedures specified in CHMP?

As part of the Cultural Heritage Assessment for the Draft EIS/ERMP approval process, registered historical and cultural heritage sites were located within and adjacent to the Gorgon Development. Archaeological surveys were also undertaken within the proposed Development areas to identify any new cultural heritage sites.

No sites were found to be impacted upon by the proposed Development. Thus, both targets are applicable, i.e. that no impact to indigenous sites is possible. Further detailed studies which will be undertaken prior to construction, if a new site/s are discovered, they will be managed in accordance with procedures as outlined in the Cultural Heritage Management Plan.

14.8.2 Maritime Heritage – Subsea

- 13.29 In relation to the above statement we would ask who undertook that review, what was the level of knowledge and expertise of that person in relation to identifying submerges cultural heritage and what was the process of review. Until these questions are clarified, all review work undertaken by maritime archaeologists remains preliminary.
- 13.30 The potential nature of wreck sites, especially wooden vessels and sea bed topography make it difficult for remote sensing surveys to clearly delineate sites. Before any construction work begins on a submerged pipeline, a full survey and review of the sea-bed should be undertaken.

Review of underwater video surveillance, side-scan sonar and bathymetry surveys of the proposed Development areas was undertaken by professional subsea experts (Fugro 2003) as part of an overall assessment of subsea terrain and site suitability. This data was inspected by a qualified maritime archaeologist, whose experience includes Maritime Archaeological Assessments and Management. See Technical Appendix E1, Section 4.3 of the Draft EIS/ERMP for further discussion. From the data inspected no evidence of shipwrecks was apparent. However, to further reduce the possibility of impacting a shipwreck or heritage site, detailed marine surveys will be reviewed by a maritime heritage archaeologist/historian at the time the pipeline and optical fibre routes and disturbance areas are being finalised. Refer to Draft EIS/ERMP, Chapter 14.8.4 for further discussion.

- 13.31 The executive summary is misleading in that it suggests that the review has already been completed.

The executive summary of the Draft EIS/ERMP contains the essence of the archaeologist's findings. However the process of review is ongoing and is further discussed in the Draft EIS/ERMP in Section 14.8.4. Please also refer to 13.29 Section 14.8.3. The assessment found no presence of maritime heritage sites in the areas studied.

14.9 Landscape and Aesthetics

No submissions received on this section of the Draft EIS/ERMP.

14.10 Workforce and Public Health and Safety

- 17.2 The aspect of cyclone evacuation is not sufficiently explained and it is our view that the document underemphasises the significance of this issue. Given that the maximum manning on site may be in the order of 3000 persons and the previous maximum planned evacuation involved only about 1500 persons there will be some significant work required in this regard.

The Joint Venturers acknowledge the significance of cyclones, is working this issue, and is committed to involving relevant stakeholders (including DOCEP) in the review of proposals.

- 17.3 The risk associated with the CO₂ pipeline has in our view been given superficial treatment. The Risk Assessment Conclusions (pg 27 and 39 of the Technical Appendix E3) states that CO₂ “would not displace oxygen in the air to a degree where asphyxiation would occur”. It is agreed that such an event is unlikely however CO₂ is heavier than air and may form “ponds” in hollows if there was to be a significant leak during times of calm conditions. The CO₂ pipelines may extend up to 15 km from the plant. It should be noted that fog in the hollows is a regular sight on parts of BWI before sunrise when personnel are travelling to worksites. Where fog can lie then potentially so can CO₂ and therefore personnel driving into a hollow could be at risk as would possible unwary rescuers. Such personnel are more likely to be WA Oil Asset personnel rather than Gorgon personnel. It is our view that this issue requires further consideration.

Preliminary risk assessments have been undertaken to support the Draft EIS/ERMP. This work will be further developed and included in the development of Pipeline Safety Management Plans (for the CO₂ injection pipeline) for approval by the relevant authorities.

17.5 Given the future Major Hazard Facility status of the development there is now a need to ensure that the Major Hazard Facilities Safety Branch of DOCEP are involved in further development and consideration of the safety cases for the facility particularly during the FEED phase of the project.

The Joint Venturers acknowledge the significance of the Major Hazard Facility status of the gas processing facility and is committed to involving DOCEP in the review of proposals.

14.11 Public Risk Assessment

22.143 Why hasn't more work been done about the prospect of "pipeline release"? The sentence "Measures taken to protect people will also generally protect flora and fauna" raises more concerns than it answers!

Measures taken to protect people from a CO₂ release (such as the design integrity of the pipeline, testing, maintenance, etc) also protect the natural environment, such as fauna. Refer also to Chapter 14 (Section 14.11) of the Draft EIS/ERMP.

15 Economic Environment

15 Economic Environment	389
15.1 Introduction and General Submissions on Economic Environment	390
15.2 Economic Analysis	390
15.3 Impacts on the Domestic Gas Market	390
15.4 Local Content	390
15.5 Capacity Building	390
15.6 Expansion of the Development	390

15.1 Introduction and General Submissions on Economic Environment

No submissions received on this section of the Draft EIS/ERMP.

15.2 Economic Analysis

22.73 Principle 2. Economic Benefit Delivery – as outlined below we believe that the benefits to the State (as distinct from the Commonwealth) are very low given the size of the project.

As a national resource, the Gorgon Development returns substantial benefits to the people of Australia. The residents of Western Australia share in those benefits in the same way that other Australians do through both direct and indirect employment and easing of the tax burden.

15.3 Impacts on the Domestic Gas Market

No submissions received on this section of the Draft EIS/ERMP.

15.4 Local Content

No submissions received on this section of the Draft EIS/ERMP.

15.5 Capacity Building

No submissions received on this section of the Draft EIS/ERMP.

15.6 Expansion of the Development

No submissions received on this section of the Draft EIS/ERMP.

16 Environmental Management Framework

16 Environmental Management Framework	391
16.1 Introduction and General Submissions on the Environmental Management Framework	392
16.2 Key Elements of the Environmental Management System.....	393
16.2.1 Policy	393
16.2.2 Objectives and Targets	393
16.2.3 Leadership and Commitment.....	393
16.2.4 Organisation Structure and Responsibility	393
16.2.5 Operational Control	393
16.2.6 Documentation and Reporting	393
16.2.7 Training, Awareness and Competence.....	393
16.2.8 Monitoring.....	393
16.2.9 Auditing.....	394
16.2.10 Non-Conformance and Corrective Action.....	394
16.2.11 Emergency Preparedness and Response	394
16.2.12 Incident Reporting	395
16.2.13 System Review	395
16.3 Environmental Management Plans	395

16.1 Introduction and General Submissions on the Environmental Management Framework

8.1 ...it is suggested that a schedule or matrix of approvals be developed to outline which agencies are to be involved at various stages and identify where unnecessary duplication exists.

The Joint Venturers are, in consultation with the appointed Front End Engineering and Design (FEED) contractors, developing a matrix of all approvals required at the various stages of the proposed Development and identifying the government agencies involved. The Gorgon Joint Venturers are always seeking to avoid duplication particularly in this complex area of government approvals.

14.23 The Conservation Commission notes that Chevron has proposed an adaptive approach to environmental management, and in particular to the management of quarantine risks. This is an acceptable and welcome approach.

Comment noted and appreciated.

16.2 The proposed would have major, cumulative environmental impacts that would impose unacceptable, serious risks to the unique, fragile and threatened arid-land ecosystems of Barrow Island, as well as to the surrounding marine environment

Predicted environmental impacts have been evaluated during the Joint Venturers' risk assessment process. The Joint Venturers applied appropriate rigour to ensure a high level of accuracy in predictions of environmental impacts and in the development of environmental management measures. Specific Environmental Management Plans are currently being collated in conjunction with appropriate ecological experts and government agencies. These Plans will refine management measures outlined in Chapters 10-15 of the Draft EIS/ERMP and the Framework EMP.

18.7 If the Gorgon gas development does proceed, there will be a significant requirement on regulators to review and approve management plans relevant to the project. This will place significant resource demands on agencies. There is a need for Government to consider the requirements for resources to be allocated to agencies to meet these demands.

The Joint Venturers are cognisant of the potential workloads faced by regulatory agencies associated with the planning and approval of the Gorgon Development. While the Joint Venturers recognise that the provision of adequate resources is a matter for government, they will work closely with relevant agencies to ensure that matters under their control are conducted in a manner that assists agencies and fulfils the Joint Venturers' responsibilities efficiently.

18.29 It is understood that the proposed Gorgon gas development will operate separately to the current oilfield operation. However, it is essential for environmental management on Barrow Island to adopt a whole-of-island approach across both the oilfield and gas processing operations.

Although the proposed Gorgon Development and current Barrow Island Oil operations are owned by separate joint ventures, Chevron Australia is the operator for each; and will ensure both operations are managed in a consistent manner to protect the conservation values of Barrow Island. Establishment of the Barrow Island Coordination Council (BICC) is an obligation under the Gorgon State Agreement, which will provide a single point of contact in relation to the management of issues related to emergency response, quarantine, environmental monitoring and reporting for the petroleum operations on Barrow Island.

18.4 CALM is concerned at the lack of specificity of many of the development proposals mentioned in the ERMP in terms of their environmental footprint and precise impacts, and the ERMP is considered inadequate for a development plan in such a sensitive environment.

The Draft EIS/ERMP documents produced by the Joint Venturers are the most comprehensive environmental studies of any project in Australia. Many millions of dollars have been spent by the Joint Venturers on the studies to date. More than 100 independent experts – recognised nationally and internationally for their work – have contributed scientific data, studies, observations and advice to the process. This work has given the Gorgon Joint Venturers confidence that the impacts are well understood and can be managed and mitigated to acceptable levels. Further studies will be undertaken as necessary as the design of the LNG processing plant and associated infrastructure is further defined.

16.2 Key Elements of the Environmental Management System

22.237 Leaks and spills have also occurred as result of non-compliance with procedures! Please refer again to the overview and relevant Parliamentary questions in Appendix 1, and we would also commend the regulators to consider the report conducted by Harry Butler (Appendix 7), in particular the paragraphs indicated at pages 54 to 59.

A gas processing facility is a very clean facility. As mentioned in the Draft EIS/ERMP, Section 6.2.10 and 6.3.6, the Gorgon Joint Venturers will use AS1940 as a minimum for storing oils and similar materials. Environmental management processes are discussed in detail in the Draft EIS/ERMP, Chapter 16, in particular, note the reference to ISO14001 in Section 16.1.

16.2.1 Policy

No submissions received on this section of the Draft EIS/ERMP.

16.2.2 Objectives and Targets

No submissions received on this section of the Draft EIS/ERMP.

16.2.3 Leadership and Commitment

No submissions received on this section of the Draft EIS/ERMP.

16.2.4 Organisation Structure and Responsibility

No submissions received on this section of the Draft EIS/ERMP.

16.2.5 Operational Control

No submissions received on this section of the Draft EIS/ERMP.

16.2.6 Documentation and Reporting

No submissions received on this section of the Draft EIS/ERMP.

16.2.7 Training, Awareness and Competence

14.22 The Commission considers that induction concerning environmental responsibilities on Barrow Island will be an essential component of any development on the island. It is pleasing to see that there is a clear commitment to conduct orientations and inductions prior to people commencing work on the site. Also the proposal is supported that compliance with HES requirement will be a condition of employment and contracts. As mentioned earlier managed 'experiences' of the environment of Barrow Island could well assist in achieving compliance with environmental responsibilities.

Comments noted and appreciated.

16.2.8 Monitoring

18.176 Consequential management changes following audits should be adopted to the requirements of the Minister for the Environment on the advice of the Department of Environment and CALM.

Environmental auditing and monitoring will form an integral part of Development construction and operations. Detailed auditing and monitoring programs will be developed in consultation with the Barrow Island Coordination Council (BICC), DoE, CALM and the Conservation Commission of Western Australia. Any consequential management changes will be addressed by Chevron Australia and incorporated into the overall Environmental Management System for both construction and operational phases of the Development. See Chapter 16 of the Draft EIS/ERMP for further detail.

16.2.9 Auditing

18.173 Independent audits should be required every 5 years to the requirements and satisfaction of the Department of Environment and CALM.

An environmental audit program will be developed with the Environmental Audit Branch of DoE, and in consultation with CALM. This program will set up both internal and external auditing arrangements for the project which will include all aspects of environmental management. For further details refer to Chapter 16.2.9 in the Draft EIS/ERMP.

18.174 Annual audits of the operations should be undertaken by regulatory authorities to ensure compliance of the proponent with environmental conditions.

The Joint Venturers will assess the adequacy and effectiveness of the environmental management system annually during construction and during the first few years of operation. This will include annual auditing and reporting procedures as developed in consultation with the Environmental Auditing Branch of DoE and CALM to ensure compliance with the environmental conditions set.

24.4 In addition, project commitments should be reviewed to improve their auditability for compliance monitoring.

The Gorgon Joint Venturers will work with the Audit Branch of the DoE to ensure that the commitments made are auditable.

16.2.10 Non-Conformance and Corrective Action

No submissions received on this section of the Draft EIS/ERMP.

16.2.11 Emergency Preparedness and Response

10.6 The inevitable oil pollution that will result from the ships berthing on the proposed jetty is also a serious cause for concern.

The Gorgon Joint Venturers do not accept that oil spills are inevitable as 'Over 1000 tanker loadings and 300 million barrels of crude oil have been exported without incident from the east coast of Barrow Island in the last 35 years.' (Chevron Australia 2005; p 509). The Gorgon Joint Venturers are committed to maintaining such a record, and approach the issue of potential spills in two main ways: firstly and most importantly, through prevention (refer to the Draft EIS/ERMP, Section 7.9, p 188); and secondly, spill contingency planning as mentioned in the Draft EIS/ERMP, Sections 7.9.2 and 16.2.11. The assessment in the Draft EIS/ERMP is conservative (i.e. represents a worst case) as it did not take into account implementing response measures. A comprehensive assessment of spill risks is provided in Chapters 10 (terrestrial) and 11 (marine) of the Draft EIS/ERMP.

19.49 The LWQB has found that due to logistical difficulties in mobilising equipment because of isolation, quarantine requirements and restrictions of access to parts of the island, as well as an inability to operate in the vicinity of operating infrastructure, the time that Chevron is able to respond to contamination issues is often well after an incident has occurred and therefore has limited success in implementing any active remediation methods

The Joint Venturers will ensure that spill contingency planning as outlined in the Draft EIS/ERMP, Technical Appendix A1, Framework EMP, Section 3.19, takes into account realistic response times.

16.2.12 Incident Reporting

No submissions received on this section of the Draft EIS/ERMP.

16.2.13 System Review

8.3 In section 16.2.13 the system review outlines assessment of the adequacy and effectiveness of the management system ‘annually during construction and the first few years of operations.’ The ongoing review and assessment of the project would be expected to continue throughout the life of the project.

The Joint Venturers agree that the adequacy and effectiveness of the environmental management system will be assessed at regular intervals throughout the life of the Development in accordance with the Chevron OEMS.

16.3 Environmental Management Plans

8.2 Arrangements should be made available for review by all interested parties and agreed prior to settling of Ministerial Conditions which will also detail requirements for further EMP's.

The concept of further EMPs being prepared, after ministerial conditions are set, as suggested by DoIR, is supported by the Joint Venturers. As committed to in Draft EIS/ERMP, Section 16.3.2, EMPs will be developed in consultation with relevant agencies and made available to the public.

8.7 It is recommended to develop and agree on general expectations and likelihood of success of the mangrove rehabilitation programme prior to project commencement.

The Joint Venturers will include completion criteria and contingency plans (for example, in the event of unexpectedly poor rehabilitation success) in EMPs.

13.3 Recommendation: Baseline marine biodiversity studies and long-term monitoring strategies need to be developed to supplement and improve the existing limited information base, so that potential impacts and risks to biological systems through the Gorgon Development can be managed to an acceptable level.

The Joint Venturers are in the process of scoping a Marine Survey to address biodiversity. The results will be used to assist in the monitoring of impacts resulting from the Gorgon Development. Environmental monitoring will be undertaken during marine-based construction activities. Strategies used for this monitoring will be governed by the final design of development components and the construction methods used. Information in regard to the planned Environmental Management Plans is currently provided in Chapter 16 of the Draft EIS/ERMP.

14.7 Establishment of the Gorgon Development on Barrow Island will lead to further developments with associated cumulative impacts that have the potential to substantially diminish Barrow Island's biodiversity conservation values and extend the duration of industrial occupation with associated risks for the foreseeable future. These further developments may be difficult to regulate environmentally should the need to avoid commercial advantages for some developers over others become an issue.

The Conservation Commission of Western Australia will be consulted during the preparation of the detailed EMPs, as will relevant state and Commonwealth regulatory agencies. This EIS/ERMP addresses the scope of work for the Gorgon Development that is known to date. Any further developments resulting from market opportunities will be addressed in accordance with State and Commonwealth Government environmental approvals processes by the proponent.

14.24 Recommendation 11: The Conservation Commission recommends that any approvals are subject to ensuring that adequate provision is made for community and agency involvement in ongoing adaptive environmental management decisions.

Barrow Island's Class A Nature Reserve status has been maintained while being home to Australia's largest operating onshore oilfield during the past 40 years. A gas processing facility on Barrow Island will allow additional resources to be directed to managing the Island's conservation values for decades. The Gorgon Development has been deliberately sited to avoid areas of particular conservation significance and will not impair the conservation values of the island. Environmental Management Plans will be developed and documented through a systematic and consultative process to address environmental factors and risks identified during the environmental impact assessment. The plans will be prepared by the Joint Venturers with technical input from a variety of sources including the design and construction contractor, comment from relevant regulatory agencies, and conditions of approval.

Environmental Management Plans will be developed and documented through a systematic and consultative process to address environmental factors and risks identified during the environmental impact assessment. The plans will be prepared by the Joint Venturers with technical input from a variety of sources including the design and construction contractor, comment from relevant regulatory agencies, and conditions of approval.

16.72 No evidence is supplied to show that, in such a harsh environment, the vegetation can adequately recover from so much clearing and fragmentation.

Natural revegetation of disturbed areas is slow but effective on Barrow Island. The Vegetation Clearing IMS will include procedures for active rehabilitation of cleared areas as appropriate during the decommissioning stage of the Development.

16.89 Ingestion of plastic rubber, fishing line and hooks, tar, cellophane, rope and string, wax, Styrofoam, charcoal, aluminium cans and cigarette filters make floating debris a death trap for sea turtles. With the proposed major increase in work-force numbers on Barrow Island during the construction phase this is likely to become an added problem here too.

Environmental Management Plans for construction and operation of the Development will include waste disposal systems to ensure these materials are properly disposed of and do not end up in the sea. Education campaigns will be run to inform workers of the conservation values of the Barrow Island area and the potentially serious impacts on marine fauna associated with littering. Also refer to Technical Appendix A1, Sections 3.15 and 3.1 of the Draft EIS/ERMP.

18.69 Chevron Australia should develop a clearing audit process to accurately determine existing clearing and track all future clearing annually. This process could be developed using GIS and high resolution air photography, but should also include direct measurement of representative disturbed areas, in consultation with and to the satisfaction of CALM.

Recommendation noted. The proposed Gorgon Development will be managed to limit vegetation clearing and ground disturbance as per the Barrow Island Act. Clearing will be monitored via an auditable land use register, which will be regularly reviewed to ensure compliance. A comprehensive series of environmental management plans for construction activities will be produced to mitigate and manage impacts, which include protocols for clearing and earthworks activities. Aerial surveys have been undertaken to provide baseline, high-resolution photography. Similar high-resolution surveys will be undertaken as necessary during the construction phase to ensure compliance with ministerial conditions and lease requirements.

18.85 Protocols should be developed for dealing with injured, sick, orphaned and dead animals, including the humane euthanasia of animals injured during earthworks, recording data on animals killed or injured during earthworks, and vouchering specimens where necessary.

Protocols are being developed as part of the Interaction Management Strategy within the Construction Environmental Management Plan encompassing euthanasia, treatment and museum vouchering of dead specimens.

18.116 Tier 2 management actions need to be determined and committed to prior to project commencement to the satisfaction of the EPA on the advice of CALM and the Department of Environment.

The Dredging and Spoil Disposal Management Plan will be finalised in consultation with the dredging contractor, EPA, CALM and DoE, prior to the dredging operation commencing. This will include commitment to all management responses to monitoring triggers.

18.121 There needs to be record keeping of turtles or dugongs killed as a result of the proposed development with immediate reporting to CALM and a commitment to vary works if the level of mortality reaches a point identified in a fauna impact management plan to be prepared by Chevron.

The Fauna Interaction IMS for the Construction and Operations EMPs, covering marine activities, will include safeguards to prevent these outcomes, but also a register of megafauna injuries and mortalities that will be reported to CALM. The IMS will describe how work methods or timing will be modified in response to any breaches of pre-agreed acceptable levels of megafauna injury and death. Refer also to Technical Appendix A1, Section 3.19 of the Draft EIS/ERMP (p 34) 'Wildlife Incidents', and Section 4.2 and Section 6.2.

18.170 Management plans are required for potential stressors including the design and management of lighting, drainage design, and the management of fire, dust, and noise and vibration.

18.171 All management plans relating to impacts on the terrestrial and marine environments should be prepared to the requirements and satisfaction of the Department of Environment and CALM.

A comprehensive series of detailed Environmental Management Plans will be written in consultation with CALM and DoE. These EMPs will deal with all aspects and components of the Gorgon Development. Refer to Technical Appendix A1 (Framework Environmental Management Plan) of the Draft EIS/ERMP for further details. These EMPs will be developed for all aspects of the development including design, construction, commissioning and operational phases. Particular environmental stressors, including effects from light, drainage, fire, dust, noise and vibration will be addressed in respective Impact Mitigation Strategies (IMS), which will provide stringent measures and controls to minimise impacts to acceptable levels.

18.172 All environmental monitoring undertaken on Barrow Island must be to the requirements and satisfaction of the Department of Environment and CALM.

All environmental monitoring programs will be designed in consultation with CALM, DoE and DEH.

19.11 In the event that site works are conducted in contaminated areas the Department suggests that the EPA require an appropriate management plan be put in place and remediation of the contamination as part of construction works

19.12 There may be potential for contaminated ground to be disturbed with the linking of the new development to facilities already existing on Barrow Island.

As noted, there is no known contamination in areas to be developed. The EMP for earthworks will include measures for responding to contamination, should it be identified during construction.

22.190 Is it intended that draft spill contingency plans be the subject of community consultation, as is the case with the BHP Billiton and Woodside projects above?

Oil Spill Contingency Planning is best managed via the Barrow Island Coordination Council (BICC) as mentioned in the Draft EIS/ERMP (p 32) which states 'The BICC will:

- provide a single point of contact and interaction between CALM and the operators on Barrow Island
- liaise with CALM on the environmental management of the island
- establish, monitor and review quarantine procedures
- plan and coordinate emergency response and remediation for quarantine breaches, spills and fires.'

Spill contingency plans, as with all relevant Environmental Management Plans, will be made available to interested stakeholders.

22.243 What measures are proposed to reduce deaths associated with trenching?

A Fauna IMS is being developed that will be included in the Construction Environmental Management Plans for all parts of the development requiring earthworks. The IMS will include management measures such as daily inspection and clearing of fauna trapped in open trenches and fauna 'ladders'.

22.250 The quality of the Dredging and Spoil Disposal Management Plan will heavily influence the size of environmental impact of this proposal, if it is approved. This Plan should, therefore, be developed with further public input and before the overall proposal is finally considered for environmental approval.

22.265 The Gorgon Development Spill Contingency Plan should be developed with further public input and before the overall proposal is finally considered for environmental approval.

A comprehensive series of detailed Environmental Management Plans will be written in consultation with CALM and DoE. These EMPs will deal with all aspects and components of the Gorgon Development. Refer to Technical Appendix A1 (Framework Environmental Management Plan) of the Draft EIS/ERMP for further details. These EMPs will be developed for all aspects of the development including design, construction, commissioning and operational phases. The Dredging and Spoil Disposal EMP will be developed in consultation with relevant agencies in accordance with an agreed program and schedule; approved by government and made available to the public.

22.328 Both on and offshore seismic monitoring can have significant impacts on marine and terrestrial animals.

Petroleum legislation and regulations require specific environmental management plans for these activities. The potential impact of the activities on marine and terrestrial fauna will be addressed in these plans and the potential impacts (and mitigation measures) will be included in the designing, scheduling and management of these activities.

24.50 The Draft EIS/ERMP indicates that there are a number of surveys that have yet to be undertaken or completed which will inform design and management. Examples include vegetation in the CO₂ injection area, CO₂ seismic survey, hydrological, geotechnical surveys, fauna surveys, quarantine barrier selection, the Dupuy well. Many of these will provide information that is crucial knowledge about impacts. How will the outstanding information from outstanding surveys be provided in a timely and transparent way so that they can be considered during the assessment of the proposal?

The concept of further EMPs being prepared after ministerial conditions are set, as suggested by DoIR, is supported by the Joint Venturers. As committed to in the Draft EIS/ERMP, Section 16.3.2, EMPs will be developed in consultation with relevant agencies and made available to the public.

24.52 Table 10-2 (as an example) provides a list of targets which management measures are intended to deliver. Without details of the management measures, on what basis can the proponent's give assurance that each of the targets will be met in full, and what are the consequences to the proposal if they are not? For example:

- no soil erosion or sedimentation outside of Development footprint
- no disturbance to significant geological features (eg caves)
- no measurable impact on groundwater
- no measurable impact on groundwater regime (recharge and quality)?

Environmental Management Plans will be developed and implemented such that procedures adopted aim to reduce foreseeable environmental impacts. It is the aim of the Joint Venturers to meet all targets stated in the Draft EIS/ERMP. As committed to in Draft EIS/ERMP, Section 16.3.2, EMPs will be developed in consultation with relevant agencies and made available to the public.

24.56 There needs to be an explanation about the predicted effect of continued fire exclusion for another 60 years on top of past 40 years, especially on Spinifex and acacias which make up much of the habitat. This was specifically flagged in EPA Bulletin 1101E.

Recent reviews (e.g. Casson 2003) of the potential impacts of the current fire management regime on Barrow Island have recommended the development of a patch-burn strategy for the island. A fire management program will be developed by the Barrow Island Coordination Council (BICC) in consultation with CALM and DoIR.

10.12 The ERMP/EIS undertakes that prior to the commencement of dredging and spoil disposal activities they will prepare a comprehensive Dredging and Spoil Disposal Management Plan (DSDMP) (section 11.2.1, pg 406). However, this should be done before the development is given the go-ahead, as the impacts of dredging could be significant and unavoidable on the turtle populations, and this should be part of an overall assessment of this development's impact on the local environment

24.73 The Draft EIS/ERMP does not contain detailed management plans. For the assessment to proceed to decision-making without key EMPs having not been reviewed as part of the project assessment leaves any approval open to legal challenge. Ch 16.3.2 indicates that draft EMPs will be prepared prior to development approval, with final EMPs incorporating relevant conditions from the approval process. This therefore envisages that the draft EMPs will be available before the WA and Commonwealth Ministers for Environment determine conditions of approval.

Critical EMPs for review in the pre-approval stage are likely to be:

- Offshore & Onshore Feed gas Pipeline
- Gas Processing Facility, Camp and associated Infrastructure
- Port facilities (Materials Offloading and LNG Jetty)
- Dredging and Spoil Disposal
- CO₂ Injection System (Pipelines and Wells)
- Quarantine Management

The need for public review and comment on draft EMPs will need to be considered and allowed for in timeframes.

The Draft EIS/ERMP contains extensive management measures proposed by the Joint Venturers to address potential environmental impacts that may result from the design, construction, operation and decommissioning of the Gorgon Development. These have been presented in two forms: on a factor-stressor basis in the Main Report (to assist assessment agencies in considering proposed management of environmental aspects such as birds or vegetation); and on a Development activity basis in the a Framework EMP in Technical Appendix A1 (to allow consideration of proposed measures to deal with each construction activity in a progressive manner, such as earthworks). In addition, in regard to the key issue of quarantine management, the Joint Venturers have documented key barriers (or management measures) on the three key pathways relevant to quarantine.

The Joint Venturers consider documentation provided in the Draft EIS/ERMP is consistent with the approved Scoping Document (ChevronTexaco Australia 2004), meets the requirements outlined in the EP Act, Environmental Impact Assessment (Part IV) Administrative Procedures 2002, and Guidelines for Preparing a PER/ERMP.

As outlined in the Draft EIS/ERMP, the Joint Venturers will develop detailed EMPs progressively in the lead-up to specific activities taking place. Section 16.3.2 of the Draft EIS/ERMP does not indicate, nor is it the Joint Venturers' intention, for approved EMPs to be a pre-requisite for Development approval. The Joint Venturers concur that EMPs for the following development components are of most importance during this phase:

- feed gas pipeline
- gas processing facility, camp and associated infrastructure
- port facilities
- dredging and spoil disposal
- CO₂ injection system
- quarantine management.

These will be developed in consultation with, and approved by, relevant agencies. The program for development of the remaining detailed plans will be agreed with DEH and EPA.

25.46 The Draft EIS/ERMP does not contain detailed management plans and management plan commitments are on the whole limited to broad objectives. It is indicated that detailed plans will be prepared prior to development approval but these should be made available for public comment and should be factored into timeframes.

The Draft EIS/ERMP contains extensive management measures proposed by the Joint Venturers to address potential environmental impacts that may result from the design, construction, operation and decommissioning of the Gorgon Development. These have been presented in two forms: on a factor-stressor basis in the Main Report (to assist assessment agencies consider proposed management of environmental aspects such as birds or vegetation); and on a Development activity basis in the Framework EMP in Technical Appendix A1 (to allow consideration of proposed measures to deal with each construction activity, such as earthworks). In addition, in regard to the key issue of quarantine management, the Joint Venturers have documented key barriers (or management measures) on the three key pathways relevant to quarantine.

The Joint Venturers consider documentation provided in the Draft EIS/ERMP is consistent with the approved Scoping Document (ChevronTexaco Australia 2004), meets the requirements outlined in the EP Act, Environmental Impact Assessment (Part IV) Administrative Procedures 2002, and Guidelines for Preparing a PER/ERMP.

The Joint Venturers also consider that the model adopted is consistent with EPA's expectations that 'new benchmarks' are set as the scope and level of detail provided on proposed management measures exceeds those provided in recent ERMPs in Western Australia.

As outlined in the Draft EIS/ERMP, the Joint Venturers will develop detailed EMPs progressively in the lead-up to specific activities taking place. Section 16.3.2 of the Draft EIS/ERMP does not indicate, nor is it the Joint Venturers' intention, for approved EMPs to be a pre-requisite for Development approval.

EMPs will be developed in consultation with, and approved by, relevant agencies. These Plans will be made available to the public. The program for developing the remaining detailed plans will be agreed with DEH and EPA.

17 Conclusion

17 Conclusion	401
17.1 Conclusion	402
17.1.1 Gorgon Development Sustainability Principles	402
17.2 Outcomes of the Environmental Impact Assessment of the Proposed Gorgon Development.....	402
17.3 Stakeholder Engagement and Way Forward	403

17.1 Conclusion

17.1.1 Gorgon Development Sustainability Principles

13.2 That the proponents develop a clear Sustainability Policy of framework based on the definition of sustainability in the State Sustainability Strategy and in consultation with the community, that the principals of 'sustainable management' are clarified and that the use of the word 'sustainable' as an adjective is minimized.

The Joint Venturers approach to sustainability was developed in recognition of current approaches in Western Australia, nationally and internationally. Further, the Joint Venturers consider this approach to be consistent with the State Sustainability Strategy for Western Australia. The model was presented to the community formally in the ESE Review (ChevronTexaco Australia 2003).

The Joint Venturers developed ten sustainability principles and 32 measurement criteria during the ESE Review process to reflect the fundamental values and tenets of sustainability relevant to the proposed Development. It is not intended to prepare additional documentation in the form of a Sustainability Policy.

16.57 Significant cumulative impacts ignored: Cumulative environmental impacts would be considerable and carry high risks, especially given the 60 year period over which the project is anticipated to operate. Cumulative impacts have not been considered in the EIS and ERMP yet these are wholly implicit in the development proposal.

16.78 Cumulative impacts have not been assessed.

Cumulative impacts are addressed in the Cumulative Risk sections within the terrestrial flora and fauna sections (Chevron Australia 2005; Section 10.3.5, pg 334 and Section 10.4.6, pg 365). The cumulative risks to marine benthic habitats and marine fauna are addressed also (Chevron Australia 2005; Section 11.4, pg 462–480 and Section 11.5.6, pg 511–513).

18.79 Given the information provided in the ERMP, it is CALM's view that Chevron Australia has not adequately considered the potential impacts of the proposed development on the overall conservation status of threatened fauna that occur on Barrow Island. On this basis, consideration of the proposed Gorgon gas development on Barrow Island should be delayed until the information is provided

It is the Gorgon Joint Venturers' view that sufficient information has been provided for the assessment as it has followed available guidelines and the field programs have been subject to ongoing review by government agencies. Any gaps in information have been treated with the precautionary approach where the worst case scenario was assumed and the proponent committed to undertake further work to fill in those gaps.

17.2 Outcomes of the Environmental Impact Assessment of the Proposed Gorgon Development

18.1 Notwithstanding additional material contained within the ERMP, it is CALM's view that it has not been proven with confidence that the risks of the project are either acceptable or manageable.

The Joint Venturers have outlined management measures throughout the Draft EIS/ERMP (specifically in Chapters 10–15 and Technical Appendix A1, the Framework EMP) which will reduce environmental risks to acceptable levels and thereby protect the conservation of Barrow Island and the surrounding environments.

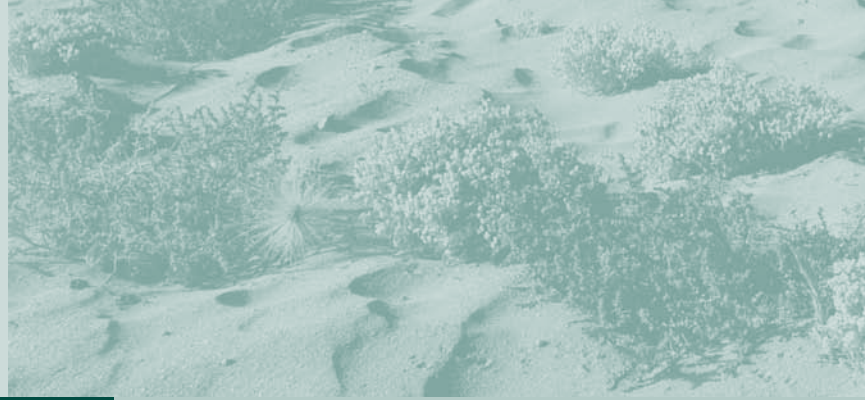
17.3 Stakeholder Engagement and Way Forward

23.4 Recommendation; that the EPA determine a mechanism for public involvement in the environmental assessment of components of the Gorgon project that are not yet finalised.

For components of the Gorgon Development which are yet to be finalised, the Joint Venturers will develop a public reporting process to inform stakeholders of the status and progress of key environmental issues. Also, a series of detailed EMPs for construction and operational components will be used to further manage and minimise impacts from the Development. Further mechanisms of public involvement will be determined in consultation with the EPA.

15.10 In summary, the MPRA has grave concerns as to the scale and location of this proposed development. Specifically there are three impacts of concern: 1) Impacts of the dredging plume and causeway construction on marine communities. 2) Effects on rare and endangered flatback turtles and on-going necessity for light management. 3) Introduced Marine Pests risks.

Refer to Chapter 7 for light mitigation strategies and Chapter 11 for an assessment of potential impacts. Dredge plume modelling has been completed, with model validation data published in the Draft EIS/ERMP Additional Information Package. Introduced marine pest risks are being addressed through the same risk-based assessment process that has been used for the three priority pathways (refer to the Additional Information Package, Part 2). Substantial progress has been made to date in four IMEA and PBA workshops (refer to Table 12-3 in the Draft EIS/ERMP), to identify threats of introduction and suggestions for quarantine barriers that would be effective to address each threat. Proposed barriers for the marine vessel pathways will be tested for effectiveness in a QHAZ workshop by independent experts, with special reference to the status of the Montebello/Barrow Islands Marine Conservation Reserves.



Part C

Technical Report on the
Outcomes of Additional
Dredge Modelling to
Inform Impact Prediction

Final Environmental Impact Statement/
Response to Submissions on the Environmental
Review and Management Programme for the
Proposed Gorgon Development

GORGON DEVELOPMENT ON BARROW ISLAND
TECHNICAL REPORT ON THE OUTCOMES OF
ADDITIONAL MODELLING TO INFORM
IMPACT PREDICTION

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Executive Summary

Hydrodynamic modelling of sedimentation and turbidity plumes and health criteria, representing potential responses of BPP to these stressors, were used to predict the environmental impacts associated with the proposed Gorgon dredging programme on the east coast of Barrow Island. This impact assessment was presented in the Draft EIS/ERMP for the Gorgon Development. Additional information was provided in the Additional Information Package (AIP) released in October 2005. Since the release of the Draft EIS/ERMP, engineering for the Gorgon Development has progressed the design of the marine facilities and the dredging programme has been refined. Improved meteorological and bathymetric data and the reassessment of the BPP health threshold criteria used to delineate zones of potential impact have necessitated re-modelling the effects of the turbidity and sedimentation associated with the proposed dredging. This report has been written to provide additional information to the EPA to better inform the assessment of the Gorgon Development.

The new meteorological and bathymetric data used within the revised hydrodynamic model has increased the accuracy of impact prediction over that presented in the Draft EIS/ERMP. Design changes for the marine facilities have had little effect on the predicted impacts from dredging and spoil disposal. Reassessment of the BPP health threshold criteria to incorporate cumulative impacts has resulted in a new set of cumulative criteria that are even more conservative than the consecutive criteria modelled in the Draft EIS/ERMP. The additional conservatism has had little effect on the predicted extent of impacts. The Draft EIS/ERMP is considered to be adequately conservative in its assessment of possible impacts relating to dredging and spoil disposal.

Predicted long-term impacts to marine BPP are generally restricted to within 1–2 km of the MOF, LNG access channel and spoil ground, although some turbidity related effects may occur further afield. TSS concentrations are predicted to rarely exceed 25 mg l^{-1} during dredging, even in relatively close proximity to operations. Coarse sediments will accumulate in close proximity to the dredged areas and the spoil ground. Outside of these areas, the sedimentation rate is low in comparison to background levels. Interannual variation in the number of easterly and westerly wind anomalies is predicted to have limited effect of the predicted zones of impact and influence.

Fine particles produced during dredging will be continuously re-suspended and exported from the area through the action of wind, waves and currents. Fine sediments on the seabed are predicted to be removed within 12 weeks. The larger particles at the spoil ground will be relatively stable. The seabed in the spoil ground will be permanently modified, resulting in a change in BPPH.

Hydrodynamic model sensitivity tests indicate that changes in the proportions of fines produced during dredging have a moderate effect of the predicted impact zones. The majority of these impacts will be in close proximity to Barrow Island and the proposed marine facilities and could potentially affect regionally significant coral reefs. Reactive management, such as real time measurement of fines production to inform impact prediction and reducing the amount of fines discharged at any site will aid in the protection of these important BPP communities.

A comparison of the newly developed cumulative BPP criteria with both the previously modelled consecutive criteria presented in the Draft EIS/ERMP and more conservative criteria suggested by the DoE (double cumulative criteria time period) revealed only very small differences in the location and scale of predicted impacts, indicating that both the previously modelled

consecutive criteria in the Draft EIS/ERMP and the newly developed cumulative criteria presented in this report can be considered adequately conservative in their assessment of possible impacts related to dredging and spoil disposal.

Changes to the dredge schedule have the capacity to affect the location of impact zones as a result of changes in the dominant meteorology during dredging. Commencing the dredging operation in October (spanning two summers and one winter, as in the Draft EIS/ERMP) leads to different impact predictions to a start in April (two winters and one summer – this report). These two dredging periods are likely to have the most extreme effects on turbid plumes. Predicted impacts to marine BPP from dredging and spoil disposal tend to occur to the south of operations, particularly in nearshore waters, when dredging starts in April. This is related to the predominance of north and north-easterly events during the winter months. The reverse is true for an October start to operations, when summer 'southerlies' push turbid plumes to the north, resulting in impacts to BPP to the north of operations, particularly on the Lowendal Shelf.

Contents

Executive Summary	409
1 Background	414
2 Background Data	416
2.1 Water Quality Data	416
2.2 Benthic Habitat Mapping	418
2.3 Baseline Marine Monitoring Programme	418
2.3.1 Approach	419
2.3.2 Objectives	419
2.3.3 Key Elements	419
2.3.4 Relating TSS, Turbidity, Sedimentation and Light Attenuation	419
3 Current Development Plan	421
4 New Model Input Data	422
4.1 Meteorology	422
4.2 Bathymetry	422
4.3 Dredge Spoil Ground	422
4.4 Dredge Log	423
4.4.1 MOF Access Channel	423
4.4.2 LNG Access Channel	423
4.5 Particle Size	424

5	Modelling.....	425
5.1	Model Sensitivity Tests	425
5.1.1	Scheduling.....	425
5.1.2	Particle Size (Extra Fines).....	426
5.1.3	Interannual Variation	426
5.2	Current Model Scenarios and Comparisons	426
5.2.1	Interannual Variation	426
5.2.2	Persistence of Sedimentation Loads.....	426
5.2.3	Double Proportion of Fine Particles	426
5.2.4	Test of Threshold Conservatism.....	426
5.2.5	Comparison with Draft EIS/ERMP.....	426
6	Interpreting the Model.....	427
7	Impacts to Benthic Primary Producers.....	428
7.1	Coral Health Criteria and Other BPP	428
7.2	Recolonisation and Recovery of Coral Reefs	429
7.3	Timescales of Recovery.....	430
7.4	Sedimentation and Turbidity Threshold Criteria	432
7.4.1	Consecutive Criteria	432
7.4.2	Cumulative Criteria	432
7.5	Zones of Impact.....	434
8	Model Results	435
8.1	Interannual Variation.....	435
8.1.1	'Normal' Meteorology	435
8.1.2	'More Easterly Events' Scenario.....	436
8.1.3	'More Westerly Events' Scenario.....	439
8.2	TSS Pulses and Sediment Accumulation	440
8.3	Stability of Dredged Material	440
8.4	Greater Contribution of Fines	446
8.5	Double 'Rolling' Time Period	448
8.6	Consecutive vs Cumulative Criteria.....	450
8.7	Seasonal Variation.....	451
8.8	BPPH calculations	453
8.8.1	Background	453
8.8.2	Revised BPPH Assessment.....	454
9	References	459
	Appendix A.....	463

List of Tables

Table 1:	Predicted Impacts to Marine BPPH in the High Impact Zone and Moderate Impact Zone	431
Table 2:	Cumulative and Consecutive Coral Health Threshold Criteria	433
Table 3:	Location of Sites for Times Series Plots.....	440
Table 4:	‘Double Rolling Time Period’ Cumulative Coral Health Threshold Criteria	449
Table 5:	BPPH Assessment Under Revised Dredge Plume Modelling and Prediction of Impact Zones using Cumulative Impact Criteria	456

List of Figures

Figure 1:	Water Quality Sites.....	417
Figure 2:	Towed Video Survey Routes	418
Figure 3:	The Anticipated Area of Impact (Base Case) Associated with Dredging and Spoil Disposal Under ‘Normal’ Meteorology	436
Figure 4:	A Detailed View of the Anticipated Area of Impact Near the Proposed Marine Facilities Under the ‘Normal’ Meteorology (Base Case) Scenario.....	437
Figure 5:	The Anticipated Area of Impact Associated with Dredging and Spoil Disposal During ‘More Easterly Events’.....	438
Figure 6:	The Anticipated Area of Impact Associated with Dredging and Spoil Disposal During ‘More Westerly Events’.....	439
Figure 7:	The Location of the Four Individual Sites Modelled to Produce Time Series Plots of TSS and Sedimentation	441
Figure 8:	Time Series Plots of Predicted TSS at Four Sites Under ‘Normal’ Meteorological Conditions	442
Figure 9:	Time Series Plots of Predicted Sedimentation at Three Sites Under ‘Normal’ Meteorological Conditions	443
Figure 10:	The Anticipated On Bottom Sediment Load at the End of Dredging (0 Weeks).....	444
Figure 11:	The Anticipated On Bottom Sediment Load 12 Weeks After the End of Dredging	445
Figure 12:	The Anticipated On Bottom Sediment Load 24 Weeks After the End of Dredging	446
Figure 13:	The Anticipated On Bottom Sediment Load 48 Weeks After the End of Dredging	447
Figure 14:	The Area of Impact (TSS) Predicted to Occur Under Base Case Assumptions (Solid Lines) and if Double the Amount of Fines are Produced During Dredging and Spoil Disposal (Dashed Line).....	448
Figure 15:	The Area of Impact Predicted to Occur Under ‘Base Case’ Assumptions (Solid Lines) and the Cumulative Criteria ‘Rolling’ Time Period is Doubled (Dashed Line)	450
Figure 16:	The Area of Impact Predicted to Occur Under ‘Base Case’ Assumptions (Solid Lines) and if the Consecutive Criteria Used in the Draft EIS/ERMP are Employed (Dashed Line)	451
Figure 17:	A Comparison of the Predicted Areas of Impact from Dredging and Spoil Disposal if Dredging Starts in April (Base Case – Solid Line) and October (Dashed Line).....	452
Figure 18:	BPPH Management Units and ‘Base Case’ Impact Zones.....	458

1 Background

Hydrodynamic modelling and Benthic Primary Producer (BPP) health criteria were used to predict the environmental impacts associated with the proposed dredging programme on the east coast of Barrow Island. This impact assessment was presented in the Draft EIS/ERMP (Chevron, 2005a) for the Gorgon Development. Technical reports that were unavailable at the time of release of the Draft EIS/ERMP, which included field validation studies of the dredge plume modelling, were subsequently released for public comment as an Additional Information Package (AIP) (Chevron, 2005b). The Gorgon Development is currently undergoing formal assessment by the Western Australian Environmental Protection Authority (EPA) and Department of Environment and Heritage (DEH). This technical report comprises the final input into the assessment process.

Since the release of the Draft EIS/ERMP, engineering for the Gorgon Development has progressed the design of the marine facilities and the dredging programme has also been refined. The possibility of delays to the commencement of dredging works has highlighted the need to consider the consequences of changes in the dredge schedule. These changes, improved meteorological and bathymetric data and ongoing examination of the hydrodynamic model's sensitivity to changes in other parameters and assumptions, have necessitated re-modelling the behaviour of the turbidity and sedimentation associated with the proposed dredging.

The re-modelling and preliminary feedback on the BPP health criteria have led to reassessment of the BPP health threshold criteria used to delineate zones of potential impact. In the Draft EIS/ERMP, the prediction of 'high' and 'moderate' impact zones and the 'zone of influence' were based on coral sensitivity criteria derived from published data on coral responses to natural and artificial sedimentation and turbidity stress. However, there are no data for northern Western Australian corals that can be used to accurately predict the response of corals at Barrow Island to turbidity and sedimentation stress. In the absence of directly relevant data, very conservative sensitivity criteria were adopted for impact prediction. These criteria were based on the responses of sensitive coral taxa to persistent sedimentation and turbidity and are detailed in Section 11.3 of the Draft EIS/ERMP (Chevron, 2005). The current assessment examines 'pulse' events as well as the 'consecutive' events described in the Draft EIS/ERMP.

The purpose of this technical report is to update and clarify issues relating to the dredge program predictive modelling, as raised by the Western Australian Department of the Environment (DoE) Marine Branch as part of the Submissions process (submissions received in regard to the Draft EIS/ERMP and Additional Information Package). This report will be published as 'Part C' of the Final EIS/Response to Submissions on the Draft EIS/ERMP document and will therefore be available to submitters and the public (via the Gorgon website).

This technical report examines the sensitivity of the model to changes in the main parameters, examines 'pulse' events as well as the 'press' events described in the Draft EIS/ERMP and presents new baseline water quality data collected since the release of the Draft EIS/ERMP and AIP.

2 Background Data

2.1 Water Quality Data

Background water quality data were collected during the first baseline marine monitoring survey in August/September 2005. This survey was the first of the surveys planned for the Baseline Marine Monitoring Programme (BMMP) for the Gorgon Development. Subject to project approval, the current draft BMMP will be revised to incorporate the latest development plan, dredge scenario and impact predictions. The BMMP would form the basis for the ongoing monitoring programme during construction. The plan will be finalised in consultation with the Western Australian EPA, DoE, CALM and the Commonwealth DEH. Details of the proposed BMMP are contained in the following section. The full data set will be presented in a progress report for the BMMP. A summary of the data are presented below.

Water quality measurements included vertical profiling of the water column and collection of water samples from the surface and bottom for the analysis of Total Suspended Solids (TSS). Water quality measurements were undertaken at 23 sites between Thevenard Island and the Montebello Islands over a period of 14 days (Figure 1). Six sediment trap arrays, each containing six replicate traps, were deployed in and around the proposed dredging and dredge spoil area to provide an indication of the natural (background) level of sediment deposition. Sediment trap arrays were set for 7-9 days over the tidal cycle.

Water quality was profiled using a high accuracy Seabird SBE19 CTD profiler with calibrated YSI sensors. TSS samples were collected in a Niskin sampler. Three litres of seawater from the surface and 0.5 m above the seabed were filtered and washed for subsequent laboratory analysis.

Mean turbidity throughout the vertical profile ranged from 7.69 – 9.79 nephelometric turbidity units (NTU) and was highest at the Double Island moorings and the Barrow Island tide gauge (Appendix A). The majority of water quality sites were located in shallow water, so PAR readings should be treated with caution due to surface reflection. The water column was well mixed, with no apparent haloclines or thermoclines (Appendix A).

TSS concentrations ranged from 2.0 - 5.4 mg l⁻¹ with an overall mean concentration of 3.2 mg l⁻¹. TSS concentrations were highest at Double Island (5.4 mg l⁻¹) and off the south-east coast of Barrow Island (5.3 mg l⁻¹).

Figure 1:
Water Quality Sites



Sedimentation rates off the east coast of Barrow Island ranged from 1.06 to 6.76 mg cm⁻² d⁻¹ with a mean of 4.15 mg cm⁻² d⁻¹. Collected sediment generally comprised less than 10% (by weight) of organic material. Sedimentation rates were lowest on the subtidal pavement reef just south of the proposed LNG channel and highest at the eastern end of the proposed MOF. Sedimentation and TSS concentrations were generally highest in the nearshore waters off the east coast of Barrow Island and lower further offshore.

2.2 Benthic Habitat Mapping

Benthic Habitat mapping was conducted during the August/September 2005 baseline marine monitoring survey to resolve some questions of coral distribution, particularly around the Lowendal Islands. This survey is described in the AIP.

Towed video methods were used to cover large areas of the seabed during the survey. The extent of the video survey of unconfirmed coral habitats on the Lowendal Shelf and along the north-eastern coastline of Barrow Island is shown in Figure 2.

Mapping revealed that there is little coral in the predicted impact area to the south of the Lowendal Islands. The large expanses of 'unconfirmed coral' on the Eastern Lowendal Shelf have been reclassified as limestone pavement supporting variable cover of macroalgae and scattered corals. Unconfirmed coral communities to the north of Double Island, offshore of Ant Point, have been confirmed as an extensive *Acropora* thicket. The 'base' benthic habitat map has been revised to incorporate these changes.

2.3 Baseline Marine Monitoring Programme

It is anticipated that the final BMMP will follow on from the initial survey and will follow the approach and comprise the elements described below.

The baseline studies of coral habitat distribution, coral health and reproduction and water quality proposed in the BMMP will quantify the pre-impact status of the coral communities and waters that may be affected by construction and operation of the marine facilities associated with the Gorgon Development. These baseline data will provide the basis of the ongoing monitoring programme and provide a temporal and spatial reference against which to assess the impacts of dredging and drilling through a Before-After Control and Impact (BACI) design.

Figure 2:
Towed Video Survey Routes



2.3.1 Approach

As suggested by both the DoE and the EPA, the approaches outlined in the proposed BMMP are based on recommendations in EPA Bulletin 1116, Dampier Port Authority – Port Expansion and Dredging Program (EPA, 2003). The proponents of the Dampier dredging project were required to prepare, implement and maintain a number of different coral and water quality monitoring programmes for the duration of the dredging comprising the following key elements:

- Port-wide coral reef field surveys and mapping;
- Coral Health Monitoring Plan (CHMP);
- Coral Habitat Monitoring and Management Plan (CHMMP); and a
- Water Quality Monitoring Plan (WQMP).

Relevant information, techniques and procedures used in the proposed BMMP will be consistent with other coral and water quality monitoring programmes in the region, such as the WA Oil Thevenard Island Region Marine Environmental Monitoring Program and other dredging developments in Australia, such the Nelly Bay Harbour Development on Magnetic Island, Queensland, and the Townsville Port Authority Capital Dredging Works.

2.3.2 Objectives

The broad objectives of the field programme and analyses contained within the proposed BMMP are to:

- Establish a baseline monitoring program, including permanent sites that can continue to be monitored during construction and operations.
- Characterise the baseline (un-impacted/background) status of water quality and coral community health and diversity at each monitoring site against which to compare possible impacts.

2.3.3 Key Elements

The following key elements of the BMMP will be:

- Collect seasonal baseline water quality and coral health data at predicted impact and reference sites prior to dredging.
- Establish remote logging stations to relay 'real time' water quality data.
- Compare field measurements of TSS vs turbidity relationships with laboratory results to calibrate 'real time' data.
- Determine timing of peak in spawning activity for March and October mass coral spawning events.

2.3.4 Relating TSS, Turbidity, Sedimentation and Light Attenuation

TSS concentrations cannot be easily and quickly determined in the field. Transportation to a laboratory and analysis are time-consuming and costly and therefore direct TSS measurement is not practical for reactive monitoring in an area as remote as Barrow Island. Purported TSS loggers measure turbidity and estimate TSS via an algorithm that assumes knowledge of the optical properties of the suspended material.

Turbidity is relatively easy to measure quickly and can also be monitored remotely, as nephelometers can be deployed on moored telemetry buoys. TSS is a measure of the total weight of particles in suspension, and is a direct function of the number, size and specific gravity of the particles. Turbidity is a direct function of the number, surface area, and refractive index of the particles, but is an inverse function of their size. Turbidity (NTU) can only be used as an index of suspended solids concentration if the optical properties of the suspension are understood.

Laboratory tests for deriving a correlation curve between TSS and turbidity must be suspension specific, not just site-specific. If the suspension to be represented is the product of dredging or drilling, in which a sediment suspension is modified by settling, the best way to approximate the suspension is by subjecting sediment samples to a comparable period of settling. The procedure for conducting such a test is described below, and is based on that employed by the United States Environmental Protection Agency (USEPA) and the United States Army Corp of Engineers (USACE). Further details of this methodology can be found in Thackston and Palermo (2000).

In the case of dredging, dredge spoil disposal and drilling, the larger, heavier solids will settle near the source, i.e. close to the dredge cutter head or overflow point from the barge, and only the finer particles will be present at distance from the activity. A laboratory settling column test is proposed to be employed, using material from geotechnical cores obtained from the site of proposed dredging. The material within the geotechnical cores will be ground to a variety of particle sizes and the range of sizes will be similar to those produced by the dredging of hard limestone by a cutter suction dredge during the Geraldton Port Expansion Project. The particle size distribution will be based on samples from the Geraldton hopper barges and subsequently analysed by the CSIRO Division of

Minerals. Grinding of the majority of material to very small sizes for some column tests may also provide some conservatism within correlations.

The ground material is mixed with seawater to a slurry concentration approximating the dredge discharge concentration, based on advice from the dredge manager and contractor regarding cutting and pumping rates for the selected dredge. The slurry is then transferred to a settling column 180 cm high.

As the slurry settles, 50 mL aliquots are taken from sampling ports just below the water surface. Light penetration and sediment settling rates will also be established through the use of light loggers and modified sediment traps within the column.

Linear or non-linear 'lines of best fit' are fitted to the data to derive a relationship between TSS and NTU. The relationships between grain size, sedimentation rates and light attenuation will also be explored. These relationships will be constantly revised using field data collected during construction.

3 Current Development Plan

As the Front End Engineering and Design (FEED) phase of the Gorgon Project progresses, additional work, including modelling of shipping movements and further geotechnical studies, has led to changes to the layout of the marine facilities. These are described fully in Part A of the Final EIS/ Response to Submissions on the ERMP and include:

- Extending the Materials Offloading Facility (MOF) from 325 m to 520 m, with a slight change in orientation. The length of the causeway at Town Point (800 m) remains unchanged.
- Lengthening the dredged access channel to the MOF from the 1.3 km initially modelled to approximately 1.6 km in length. The width (120 m) and depth (6.5 m below chart datum) remain unchanged. The total volume of material dredged at this location will increase from 0.8 Mm³ to 1.1 Mm³. The majority of the dredge spoil from dredging the MOF access channel will be used to construct the MOF and causeway. The duration of dredging remains unchanged at approximately 21 weeks.
- Decrease in the length of the piled LNG jetty from 3.1 km to 2.7 km.
- Dual berth configuration for the tanker turning basin to be dredged to 14 m below chart datum.
- Decrease in volume of material dredged from the LNG channel and ship berths from the initially proposed 7.0 Mm³ to 6.5 Mm³. Although there has been a slight change in orientation, the overall length (~2 km), width (300m) and depth (14 m below chart datum) of the LNG access channel remains unchanged.

4 New Model Input Data

Basic assumptions of the revised model are clarified in the following sections, with particular reference to changes in assumptions previously used in the Draft EIS/ERMP.

4.1 Meteorology

The 3D hydrodynamic model was verified using 3-hourly gridded data from the BOM operational forecast model (LAPS – Limited Area Prediction System). Details of model verification can be found in Part 1 of the AIP (Chevron, 2005b). In the current modelling, LAPS data rather than Barrow Island observations were used to represent the meteorology, as the LAPS data represent the winds over the region far better than the single point Barrow Island. Data for the six year period from 1999 to 2005 were taken as representative of the range of weather patterns around Barrow Island.

Meteorological data for 2001 represents the ‘normal’ meteorology of the area in terms of fewer anomalies to easterly or westerly wind patterns. The year 2000 was chosen to represent a year with more ‘easterly’ anomalies and 2002 to represent the year with more ‘westerly’ anomalies (see Technical Appendix B5 of the Draft EIS/ERMP for further detail). The model runs were conducted on a continuous 16 month time series, with the model starting in April of the appropriate year, i.e. for a ‘normal’ year the model starts in April 2001 and finishes in July 2002.

4.2 Bathymetry

The 3D bathymetric data used in the Draft EIS/ERMP has now been augmented by recently flown LADS data (Laser Airborne Depth Survey). These new data provide high resolution bathymetry for the east coast of Barrow Island that greatly improves the accuracy of the hydrodynamic model in shallow coastal areas.

4.3 Dredge Spoil Ground

The location and layout of the 1500 ha dredge spoil ground remains unchanged since the Draft EIS/ERMP. At its closest point, the spoil ground is approximately 10 km off the east coast of Barrow Island.

Initial dredge plume modelling for the Draft EIS/ERMP did not include the disposal of fine dredged material at the spoil ground, since it was conservatively assumed that 50% of fine particles released during dredging will be released at the cutter head and 50% from the tail water discharge (barge overflow). Consequently, under the previous hydrodynamic model, no fine particles were transported to the spoil ground and they did not contribute to sedimentation and turbidity at this site.

Impacts associated with the disposal of dredged material at the spoil ground in the Draft EIS/ERMP were assessed on the assumption that there would be minimal sedimentation and turbidity beyond the nominal buffer zone that allowed for rock roll, benthic sediment disturbance and a small amount of fines produced during transit and dumping.

However, one possible management response to prolonged exceedance of coral health or water quality criteria during dredging will be to reduce the amount (time) of barge overflow. Reducing the time for which the barges overflow will result in a higher proportion of fines remaining in the barges. These fine particles will be transported to the spoil ground and will contribute to turbidity and sedimentation when dumped at the spoil ground. The revised hydrodynamic model examines the effect of transporting 20% of the fine material generated during dredging to the spoil ground. The remaining 80% is assumed to be liberated equally from the cutter head (40%) and tail water discharge (40%).

4.4 Dredge Log

Additional information on the way the dredging operation will run and the assumptions used in both the current modelling and the Draft EIS/ERMP modelling is presented below.

4.4.1 MOF Access Channel

For the model simulation of the dredging required for the MOF access channel with a Cutter Suction Dredge (CSD) the following assumptions were made:

- A bund wall in the MOF outline will be filled with dredge spoil pumped directly from the CSD.
- The volume of cut and fill is estimated to be 1 Mm³ (Draft EIS/ERMP volume was 0.8 Mm³).
- Geotechnical data indicate the material to be dredged is crystalline limestone with a capping of calcarenite.
- The characteristics of the spoil are anticipated to be similar to that generated at Geraldton (i.e. a high proportion of fines/flour and coarse limestone rubble).
- The rock is believed to be slightly harder on average than that encountered at Geraldton and may create more fines during CSD operations.
- The dredging/reclamation program will run for approximately 18 weeks plus 2 (or more) weeks weather downtime.
- A mean dredge work rate of 84 hours of dredging per week (actual rate will vary depending on hardness of rock).

- The dredge will stop and change teeth every few hours (more frequently in harder rock) and stop for maintenance or refuelling.
- The dredge will start at outer end of the access channel and gradually work towards the shore creating a 6.5m deep channel (LAT).
- There will be shutdowns each 7 to 14 days in harder material and less frequently in softer materials.
- The dredge will refuel every four to six weeks for approximately 2 days.
- It is assumed that 5% of total material cut will be smaller than 75 microns diameter and that the distribution of these particle sizes will be similar to the distribution of particle sizes generated during dredging at Geraldton.
- It is assumed that 40% of these fines will be released at the cutter head and 40% from the 'dewatering' discharge from the MOF. The remaining 20% of fines is assumed to be retained inside the MOF bund.

4.4.2 LNG Access Channel

For the simulation of the dredging of the LNG access channel and turning basin using a Trailer Suction Hopper Dredge (TSHD) and CSD on the eastern side of Barrow Island the following assumptions were made in developing the simulated dredge log.

- The total volume to be dredged is estimated to be 6.5 Mm³.
- Roughly 40% (2.6 Mm³) of the total volume to be dredged in the LNG access channel and turning basin areas is unconsolidated sandy sediment which can be removed by a TSHD.
- The TSHD dredging and disposal cycle period will be approximately 2.5 hrs (based on 90 minutes of dredging, 1 hour of travel to and from spoil ground including 10 minutes for dumping at the spoil ground).
- TSHD's are less weather dependent than CSD's and will be able to deliver about 134 hours production per week which equates to 53 loads per week on average.
- Assuming an average load of 5,000 m³, giving a rate of approx. 250,000 m³ per week, the sands can be removed in approximately 10 to 12 weeks.
- In general, maintenance will be undertaken whilst travelling to and from the spoil grounds but the TSHD will cease operations for two days every 4 to 6 weeks to refuel and undertake major maintenance.

- The TSHD will overflow for the last 60 minutes of the dredging cycle.
- Overflow water will be released under the keel of the TSHD at a depth of approximately 6 m below surface.
- Overflow discharge will be approximately 8 m³/sec (2 x 4 m³ /sec dragheads).
- Fines within the sediments may be released.
- The sands are coarser than the 'rock flour' and the particle size distribution used in this part of the simulation is based on laboratory analyses of field samples taken from the Development area.
- The harder material will be removed by a large CSD pumping directly into one of two self-propelled hopper barges that will transport the material to the spoil ground.
- CSD dredge behaviour and production rates are anticipated to be similar to those for the MOF access channel dredging rates described earlier (effective production of 84 hours/week).
- CSD dredging is anticipated to continue for 48 weeks.
- 40% fines will be generated at the CSD cutter head and 40% released from the hopper barge overflow which will be beneath the keel of the barge, the remaining 20% will be transported to the spoil ground.

4.5 Particle Size

The action of the dredge cutter head creates sediment and the vessel(s) propellers mobilize natural sediments. Fine particles settle more slowly and are deposited in quiescent zones further from the dredging site. Coarse particles settle rapidly close to the source. The major focus in the dredge modelling was on the liberation of fine particles into the water column producing turbidity and some far-field sedimentation. The near-field sedimentation of heavier particles was not modelled as these particles are assumed to settle very close to the dredged areas and as they are too heavy to be resuspended they need not be modelled.

Only particles with a diameter less than 150 µm were included in the hydrodynamic modelling. The range of particle sizes used in modelling the dredging of sands by the TSHD was considerably coarser than the particles used in the modelling the behaviour of 'rock flour' generated by the CSD.

The dumping of material at the spoil ground however was simulated using the full distribution of particle sizes assumed to be in the barge hoppers.

5 Modelling

5.1 Model Sensitivity Tests

The dredge modelling was carried out by Global Environmental Modelling Systems (GEMS) in two steps. Firstly the 3-dimensional ocean circulation of the region from Northwest Cape to north of the Montebello Islands was predicted for 16 months using GCOM3D. Then the total dredge program was simulated over 465 days using DREDGETRAK which simulates the half-hourly behaviour of the dredge(s) based on an estimated dredge log.

Modelling relied on the best available meteorology and bathymetry and model assumptions were based on other recent dredging programs in Western Australia. Where there was uncertainty in model parameters, conservative values were chosen such that the model would tend to overestimate the impact. The 'base case' modelling started in April, with pauses during coral spawning, and extended through two winters (more north-easterly winds) and one summer (more southerly winds). In order to facilitate comparisons with the information presented in the Draft EIS/ERMP, an additional model scenario was run with an October start date.

Modelling predicted the distribution of particles generated by the dredging that caused plumes of TSS and sedimentation on the seabed at hourly intervals over the total dredge program (approximately 465 days). Turbidity and sedimentation data were computed hourly for each 1 m layer of the water column of the study area. The hourly output was analysed to derive periods of exposure to turbidity and/or sedimentation in relation to a prior defined BPP health thresholds.

Model sensitivity tests involved varying key parameters and assumptions and examining the resultant effects on the model output. Changes in model output were assessed by comparison of the size, shape and location of the BPP impact zones.

5.1.1 Scheduling

Dredge plume modelling undertaken for the Draft EIS/ERMP assumed an October start for the dredging of the access channels for the Materials Offloading Facility (MOF) and Liquefied Natural Gas (LNG) loading facilities. The likelihood of a six month delay in commencing the dredging has been addressed by using an April start date for the revised dredging model. The potential ramifications of the rescheduling are discussed in later sections.

5.1.2 Particle Size (Extra Fines)

It is assumed in the hydrodynamic model that under 'normal' operating conditions 5% of total material cut by the CSD will be below 75 µm and that the distribution of these fine particle sizes will be similar to the distribution of particle sizes generated during dredging at Geraldton.

However, the rock to be dredged on the east coast of Barrow Island may be slightly harder on average than that encountered at Geraldton. It is currently unknown whether harder limestone rock will actually decrease the amount of fines produced during dredging, through greater fracturing, or increase the amount of fines due to greater 'crumbling' of the rock.

In the absence of directly relevant data, doubling the amount of fines produced during dredging by the CSD was considered to be a highly conservative scenario that would provide an indication of the sensitivity of the model to increased fines production. It is worth noting that due to the very small size of the fines produced (<75µm) under this scenario, this material is not expected to settle on the seabed and is assumed to contribute only to TSS and not to sedimentation. Resultant outputs are therefore based only on TSS threshold criteria.

5.1.3 Interannual Variation

Variations in the meteorology, especially changes in dominant wind patterns, will produce variations in the spatial and temporal distribution of sediment plumes. Potential interannual variability has been addressed by modelling three separate time periods that represent the likely scale of meteorological scenarios that may occur during dredging.

The meteorological data for 2001 was chosen to represent the 'normal' meteorology of the area, primarily because of fewer anomalies to easterly or westerly wind patterns. The previous year, 2000, was a year with a greater number of 'easterly anomalies' and was chosen to represent a period with more easterly events. The year 2002 displayed more 'westerly anomalies' and the meteorology from this year was chosen to represent a period of more westerly winds on the predicted behaviour of sediment plumes (see Technical Appendix B5 of the Draft EIS/ERMP for further detail).

All model runs included continuous 16 month time series of meteorological data, with the assumption that dredging starts in April of the appropriate year, i.e. for a 'normal' year the modelled dredging began in April 2001 and finished in July 2002.

5.2 Current Model Scenarios and Comparisons

A 'Base Case' model scenario was established using the anticipated scheduling and the newly developed cumulative coral threshold criteria (see Section 7.4.2).

5.2.1 Interannual Variation

Interannual variation was assessed by comparing the 'Base Case' or 'normal' year with 'atypical' years. The three years were:

- A 'normal meteorology' year (April 2001 to July 2002) – 'Base Case'.
- A 'more westerly events' year (April 2002 to July 2003).
- A 'more easterly events' year (April 2000 to July 2001).

5.2.2 Persistence of Sedimentation Loads

The 'Base Case' was continued with 'normal meteorology' for a further 48 weeks to investigate the stability of dredged material that had been deposited on the seabed. This scenario characterises the potential for recovery of physical benthic habitats that have been altered through sediment deposition and accumulation. Recovery of the physical habitats is necessary for recovery of the associated BPP communities.

5.2.3 Double Proportion of Fine Particles

A 'normal meteorology' year (April 2001 to July 2002) that assumes that twice as much fine material (<75 µm) is produced during dredging.

5.2.4 Test of Threshold Conservatism

A 'normal meteorology' year (April 2001 to July 2002) with more conservative cumulative threshold criteria as recommended by the DoE.

5.2.5 Comparison with Draft EIS/ERMP

The modelling presented in the Draft EIS/ERMP was based on dredging starting in October. The prediction of impact zones was based on 'consecutive' BPP health criteria.

Impact zones generated by 'Base Case' modelling using 'consecutive' BPP health criteria were compared with the same zones generated using the new cumulative criteria.

The effects of changes to the dredge schedule were examined by comparing impact zones generated from an October start with the same zones generated from an April start, with both scenarios modelled using 'normal' meteorology.

6 Interpreting the Model

The figures showing the zones of high and moderate impact and the zone of influence should be interpreted on the basis of the following:

- All plots show elevated TSS or sedimentation due to dredging. The 'above background' levels do not include natural turbidity or sedimentation.
- All potential sources of turbidity and sedimentation have been included in the simulations, including direct release by the dredge and suspension due to propeller wash.
- The TSS concentrations represent the highest TSS concentrations within any 1 m depth bin through the water column. The plots therefore show the maximum turbidity and are not 'depth-averaged'.
- It was assumed that particles greater than 150 microns settle quickly, remain within the vicinity of the dredged areas and are not resuspended.
- The behaviour of particles greater than 150 microns liberated during dredging was therefore not simulated in order to focus on the more active, smaller particles.
- Sedimentation impact zones generated from the modelling did not include the impacts in areas adjacent to the dredging areas due to heavier particles. These zones have been estimated on the basis of experience with previous dredging operations (GEMS, pers. comm., 2006) and include a substantial precautionary buffer. The areas receiving particles >150 microns are completely encompassed by the area of deposition of smaller particles.
- The full range of particle sizes expected to be released at the spoil ground was simulated in order to study spoil ground stability over time.
- The model incorporates the best available data for parameters and assumptions, but no model can perfectly simulate the behaviour of water-borne particles in space and time. The output of the model, including the impact zone figures, provide a 'best estimate' of potential impacts from the dredging program. Changes in operation of the dredge, weather patterns or particle characteristics will affect the actual plume behaviour and associated environmental impacts.

7 Impacts to Benthic Primary Producers

7.1 Coral Health Criteria and Other BPP

Conservative coral health criteria were selected to predict the effects of dredging and other construction activities on this component of the ecosystem. Coral reefs are the most highly valued component of the marine ecosystem from many perspectives, principally related to their high ecological diversity, longevity and relative stability in the absence of impacts. The high value of coral communities in the Barrow Island region is reflected in the Indicative Management Plan for the proposed Montebello/Barrow Islands Marine Conservation Reserves where the Barrow Island Marine Park has been established to protect coral communities. This is in contrast with other marine BPP, such as seagrass and macroalgae which have been given no special protection apart from inclusion within the multiple use area of the Marine Management Area (CALM, 2004).

The consequence of the loss of well developed coral assemblages is considered more serious than the loss of other marine BPP as they may take decades to fully recover. Other BPP communities in the impact zones, for example the seagrasses and macroalgae are able to rapidly recolonise disturbed areas.

Cyclone Vance devastated large areas of *Halophila* seagrass meadows in Exmouth Gulf in March 1999. Within eight months of the cyclone, the seagrass had begun to re-establish and by 2001 the areal extent and species richness of the seagrass community had increased greatly. The average seagrass cover increased from 0.15% to 41.9% and biomass values rose to 70 gm⁻², which is capable of supporting a high abundance of juvenile tiger prawns (Loneragan *et al.*, 2003). The re-establishment of seagrass in Exmouth Gulf has been accompanied by increased sightings of Dugong (Loneragan *et al.*, 1998).

Algal turf communities are relatively resilient and have impressive rates of recolonisation when compared with corals. Airoldi (1998) found that algal turf was relatively impervious to disturbance and high rates of vegetative reproduction provided the capability to resist further disturbance and to compete for space against larger macroalgae. During a study on successional patterns on an artificial reef in the Philippines, Pamintuan *et al.* (1994) observed that the initial coloniser of the artificial reef was turf algae which appeared within two weeks of reef establishment. Bailey-Brock (1989) also reported that algal turf species were rapid colonisers, colonizing an artificial reef in Hawaii within 2 weeks. Fabricius and De'ath (2001) reported dead corals being colonised by filamentous turf algae within days in all reef environments, and McVey (1970) recorded the colonization of five species of algae on concrete pipes within 12 hours (Bailey-Brock, 1989).

Succession from turf algae to crustose coralline algae (CCA) assemblages generally occurs within a few months when environmental conditions are suitable (Fabricius & De'ath, 2001). Bailey-Brock (1989) observed in Hawaii that the change from filamentous algae to CCA occurred after two months, and that after a year there was a larger proportion of CCA to fleshy species of algae, with the succession being most conspicuous during the summer months.

Fleshy-macroalgae also rapidly recolonise denuded or new substrates. Experimental studies looking at the recolonisation of *Sargassum*, which is one of the dominant brown macroalgae in the waters around Barrow Island, found that in tropical habitats they recolonise bare substrate in the space of 3-4 months (Ang, 1985). On the Great Barrier Reef, Vuki & Price (1994) found new recruits of *Sargassum* in cleared quadrats three months after the clearing of the substrate, when the substrate was cleared during the reproductive season. The life history characteristics of *Sargassum* promote rapid recolonisation capabilities in this genus. In tropical regions most *Sargassum* species are fertile for five months of the year, generally over summer (Ang, 1985; Vuki & Price, 1994). This long reproductive season coupled with the characteristically high fecundity of marine alga, enables effective recolonisation of cleared or open substrata in marine environments (Paine, 1979). It is anticipated that sedimentation may lead to loss of fleshy thallus, but the plants will regenerate from persistent stipes attached to the underlying rock (Umar *et al.*, 1998).

The invertebrate epifauna associated with marine BPP communities can also recover very rapidly from high magnitude disturbances. Martin-Smith (1994) reported that some taxa were present within 6 hours of complete defaunation and within two weeks, the re-established epifaunal communities were indistinguishable from controls. A study of the recovery rates of copepod assemblages in a temperate seagrass habitat after an anoxic event demonstrated that recolonisation started quickly after the end of the disturbance and within 5 days the abundance and diversity of copepods in the previously disturbed areas had reached an equilibrium with the control plots (Cristoni *et al.*, 2004). These small macrofauna are an important trophic link between the macrophytes and the larger fauna usually associated with them.

Populations of large invertebrate fauna, a significant contributor to coral reef diversity, are also able to recover rapidly after impacts. For example, within 2 years of dredging at Heron Island on the Great Barrier Reef, gastropod numbers had recovered to pre-dredging levels (Catterall *et al.*, 1992). A study of colonization rates of an artificial reef in Hawaii by Bailey-Brock (1989), reported that within two weeks many invertebrates had colonised the substrate, the dominant ones being the rock oysters, tubeworms and encrusting bryozoans. This author also reported that similar invertebrate taxa were among the most frequent recruits in studies on the Great Barrier Reef, the Red Sea and in Hawaii.

Some coral assemblages may recover rapidly from disturbance (Brown *et al.*, 2002). In contrast, some well developed coral assemblages may take years to decades, or longer, to recover fully (Connell *et al.*, 1997). Thus, the protection of coral habitat is of paramount importance in protecting coral reef assemblages. Protection of coral assemblages is considered a conservative means of protecting ecosystem diversity and function because shallow water coral assemblages are generally more sensitive to sedimentation and turbidity.

7.2 Recolonisation and Recovery of Coral Reefs

Corals are affected by the direct impacts of dredging, e.g. removal, and the indirect impacts, such as turbidity and sedimentation stress. Long term studies (~30 years) of coral reef recovery after disturbance have shown that time scales of recovery depend upon the type and scale of damage (Connell *et al.*, 1997). For example, in the shallow subtidal communities on Heron Island, Great Barrier Reef, a long term study of the effects of cyclones showed that when the substrate was not directly affected by disturbance, the time scale of recovery was up to a decade (Connell *et al.*, 1997). In contrast, when the physical environment was directly altered by disturbance recovery was related to the time scale of recovery of the benthic habitat (Connell *et al.*, 1997).

Corals have the ability to compartmentalize sedimentation stress. Philipp and Fabricius (2003) demonstrated that the photosynthetic activity from tissues directly underneath the sediment declined, while the activity in the adjacent clean tissues did not. Furthermore, only colony parts directly exposed to large amounts of sediment died and other parts of the colony remained healthy. If a dredging event damaged but did not kill entire colonies, much of the recovery may be from regrowth of the survivors (Connell *et al.*, 1997). In comparison, if most individuals are killed by an extreme disturbance, recovery will depend almost entirely upon recruitment from elsewhere, and the recovery of the coral assemblage and associated fauna will be slower.

A long term monitoring program of reef flats in Thailand between 1983-2000 (Brown *et al.*, 2002) afforded an opportunity to study the recovery of the reef flat after dredging took place in 1986-1987. The reef flats largely recovered from the dredging impacts in approximately 12 months (Brown *et al.*, 2002). Coral cover and diversity values returned to former levels only 22 months after dredging began (Brown *et al.*, 1990). This was attributed to the fact that the reef flats were dominated by massive coral species, whose morphology exposed only the upper surfaces of the colonies to sedimentation and only the polyps on the upper surface died. The polyps on the shaded edges and sides of the colonies survived and recolonised the upper surface. In addition, the recruitment and survival of juvenile corals was relatively unaffected by dredging activities (Brown *et al.*, 2002).

Massive species are also resilient to sublethal impacts, such as bleaching. For example, in the Maldives, differential recovery after bleaching led to many reefs being dominated by massive corals such as *Porites* and *Astreopora* (McClanahan, 2000). Branching corals did not recover as well as massive species. After 12 months, branching and encrusting species such as *Acropora*, *Montipora* and *Pocillopora* had started recruiting, suggesting that there may be future changes in the species composition of these reefs (McClanahan, 2000). Acroporids grow rapidly but may not recruit to disturbed areas effectively. Recruitment of *Acropora* four years after widespread mortality in the Western Indian Ocean was low (but increasing) in comparison with faviids (Sheppard and Obura, 2005).

The coral assemblage at Dugong Reef, approximately 5 km south east of Barrow Island was severely affected by a natural stress event in 1991, during which large areas of tabular and branching *Acropora* died. This widespread coral mortality was attributed to water column hypoxia following mass coral spawning in combination with high temperature stress (LeProvost Environmental Consultants, 1992). By 1994, coral recovery in areas of large scale mortality was minimal. This contrasted with a small reef closer to Barrow Island where *Acropora* were similarly affected but a variety of genera, such as *Acropora*, *Porites*, *Pectinia* and *Echinopora* had recruited (Bowman Bishaw Gorham, 1994). Coral habitat mapping for the Gorgon Project in 2005 revealed that sections of Dugong Reef previously dominated by *Acropora* and killed in 1991 and large areas of dead branching *Acropora* on nearby Batman Reef had still not recovered (RPS BBG, unpublished data, 2005).

7.3 Timescales of Recovery

With the exception of well developed coral assemblages, the majority of marine BPP and BPPH within high and moderate impact zones are expected to recover within the first 5 years following dredging. If BPP and BPPH are estimated to take longer than 30 years to recover, they have been identified as loss in the BPPH assessment.

Predicted impacts to marine BPPH in the high impact zone and moderate impact zone are described in Table 1. The concentration of TSS and rate of sedimentation outside of the zone of moderate impact and within the zone of influence is not expected to have a measurable effect on BPP and no impacts are predicted to occur in this zone.

Recovery of non coral BPP, such as macroalgae and seagrass communities within high and moderate impact zones is expected to occur within 2 to 5 years. Coral communities are expected to recover within 5 years in moderate impact zones if reefs are dominated by massive coral species, such as *Porites*.

The highly conservative long term 30 year recovery period allows for a further 25 to 28 year time frame after the initial recolonisation/regrowth of massive coral species for the recovery of populations of rare taxa that might only recruit infrequently.

Table 1: Predicted Impacts to Marine BPPH in the High Impact Zone and Moderate Impact Zone									
Benthic Habitat Type	Key Receptor	Reason for Selection	High Impact Zone			Moderate Impact Zone			
			Predicted effects	Presence in zone	Recovery time frame	Predicted effects	Presence in zone	Recovery time frame	Recovery time frame
Coral communities – more resilient species – Large bomboora	<i>Porites lobata</i>	Large colonies; widespread; important ecologically; resilient but slow growing	High mortality (up to 100%)	Yes (MU 4 & 8)	Permanent loss (>30 yr recovery)	Some mortality (up to 30%)	Yes	Temporary loss, recovery in 2-5 yrs	
Coral communities – more sensitive species – coral thickets	<i>Acropora</i> spp.	Small colonies; large thicket on southern Lowendal Shelf; sensitive but fast growing	High mortality (up to 100%)	No	NA	High mortality (possibly to 100%)	No	NA	
Macroalgae (limestone reef)	<i>Sargassum</i> spp.	Most widespread and abundant genus on hard substrates	High mortality (up to 100%)	Yes (MU 4, 7 & 8)	Temporary loss, recovery in 2-5 yrs	High mortality (possibly to 100%)	Yes	Temporary loss, recovery in 2-5 yrs	
Subtidal reef (low relief) and sand with seagrass	<i>Halophila ovalis</i>	Most abundant and widespread genus; ephemeral	High mortality (up to 100%)	Yes (MU 4, 8, 9, 10 & 11)	Temporary loss, recovery in 2-5 yrs	High mortality (possibly to 100%)	Yes	Temporary loss, recovery in 2-5 yrs	

7.4 Sedimentation and Turbidity Threshold Criteria

7.4.1 Consecutive Criteria

High turbidity and sedimentation stress over extended periods has been shown to have detrimental effects on corals and other BPP. The literature reports the effects of persistent stress, or 'press' impacts rather than intermittent or 'pulse' impacts.

Preliminary modelling suggested that persistent plumes are predicted to last for weeks in close proximity to dredging operations, rather than short pulses of a few days. The greatest effects of sedimentation and elevated TSS on corals are likely to be due to a continuous reduction in the light climate and/or continuous sediment deposition because the corals have no recovery time to remove sediments or to photosynthesise. The effects of continuous stress were represented by threshold criteria comprising elevated TSS or sedimentation over a number of consecutive days in the Draft EIS/ERMP.

Impacts of increased and persistent sedimentation and suspended solid concentrations on corals and other BPP were assessed by setting highly conservative threshold criteria for coral responses to 'press' stressors and using these to predict the range of effects due to the proposed dredging and drilling programs. Both the length of time corals are exposed to increased suspended sediment loads and the amount of suspended and deposited sediment were assumed to affect the severity of the impacts to any coral or marine BPP. The criteria incorporate a high level of conservatism to account for possible additive effects of increased TSS and sedimentation events that occur together. A detailed description of the previously modelled consecutive coral threshold criteria can be found in Section 11.3.1 of the Draft EIS/ERMP and are provided in Table 2.

However, pulses of elevated TSS or sedimentation every few days may have cumulative effects on corals and other BPP if there is not sufficient 'recovery' time between the pulses. Following the release of the Draft EIS/ERMP and the AIP, concern was raised over the potential cumulative impacts of TSS and sedimentation to corals and other marine BPP that would not be accounted for using consecutive criteria. In order to resolve this issue, cumulative coral health threshold criteria that take into account both the intensity and duration of stressors over given time periods have been developed and are described [below](#).

7.4.2 Cumulative Criteria

Cumulative threshold criteria have been designed to account for the intensity and duration of the sediment plume within a longer 'rolling' time period. By design, previously modelled consecutive criteria will be contained within the new cumulative criteria. For example, consecutive coral health threshold criteria modelled in the Draft EIS/ERMP, e.g. the zone of high impact due to acute stress of $\geq 25 \text{ mg cm}^{-2} \text{ d}^{-1}$ of sediment above background levels for five consecutive days is encompassed by the new and more conservative cumulative coral health threshold criterion of $\geq 25 \text{ mg cm}^{-2} \text{ d}^{-1}$ above background for any five days in a 15 day period. The five days of exceedance within the 15 day period may or may not be consecutive, but regardless of whether they are consecutive or cumulative will trigger, the high impact criterion.

While there is very limited relevant literature on cumulative effects the cumulative criteria are based on a one third exposure time vs two thirds recovery time to allow for a minimum recovery time between pulse events. This was based on the available published material, including laboratory and field observations. Great Barrier Reef corals exposed to high sediment loads ($79\text{-}234 \text{ mg cm}^{-2}$) for 24 hours needed 36 to 48 h to recover (Philipp and Fabricius, 2003). Studies on sediment rejection by 22 species of Australian scleractinian corals by Stafford-Smith (1993) showed that most species cleared a 200 mg cm^{-2} dose of sediment within 2 days (48 h) and that fine sediment ($<250 \mu\text{m}$) was removed faster than coarse sediment ($>500 \mu\text{m}$).

The cumulative levels set for this assessment are considered to be highly conservative since other research suggests corals can withstand prolonged periods of sedimentation and turbidity. For example, Rogers (1983) showed that *Acropora cervicornis*, *Montastraea anularis* and *Diploria stitigosa* survived extreme sedimentation at $200 \text{ mg cm}^{-2} \text{ d}^{-1}$ for 45 continuous days without extensive damage. In another experiment, complete shading of a coral reef by Rogers (1979) to simulate extreme turbidity revealed that 9 out of 10 coral species showed few deleterious effects after three weeks of darkness, with only *A. cervicornis* showing extensive bleaching after 21 days.

Consistent with the consecutive criteria in the Draft EIS/ERMP, the cumulative effects of increased TSS on corals are assumed to be dominated by daytime effects and the coral health threshold criteria are based on a TSS concentration above background which

exceeds set values for at least half of the daylight hours (6 out of 12 hours) in any day. The zone of influence represents TSS concentrations of 2 mg l^{-1} above background in any hourly period at any depth during the entire dredging programme.

Sedimentation may affect the feeding efficiency of corals at night and the cumulative threshold criteria are therefore based on a daily load (24 h) to account for possible smothering, abrasion, energetic depletion and reduced feeding efficiency during the day and night. Sedimentation impact criteria are based on daily sedimentation rates as presented in Table 2. Cumulative impact criteria represent specified daily sediment loads for a specific number of days in a

defined period, e.g. for 5 days in a 'rolling' 15 day period. The zone of influence represents sedimentation $\geq 1 \text{ mg cm}^{-2}$ above background at any time during the entire dredging programme.

As a conservative measure, the sedimentation criteria assume that all material that settles will accumulate and does not account for re-suspension.

Details of cumulative coral health threshold criteria are contained in Table 2. Previously modelled consecutive coral health threshold criteria are also provided for comparative purposes. For a detailed description of the derivation of concentration thresholds, see Section 11.3.1 of the Draft EIS/ERMP.

Table 2:
Cumulative and Consecutive Coral Health Threshold Criteria

Zone of High Impact			
Variable	Timeframe	Concentration	Time (consecutive days)
TSS	Short	$\geq 25 \text{ mg l}^{-1}$	5
	Medium	$\geq 10 \text{ mg l}^{-1}$	20
	Long	$\geq 5 \text{ mg l}^{-1}$	80
Sedimentation	Short	$\geq 25 \text{ mg cm}^{-2} \text{ d}^{-1}$	5
	Medium	$\geq 10 \text{ mg cm}^{-2} \text{ d}^{-1}$	20
	Long	$\geq 5 \text{ mg cm}^{-2} \text{ d}^{-1}$	40
Zone of Moderate Impact			
Variable	Timeframe	Concentration	Time (cumulative days)
TSS	Short	$\geq 25 \text{ mg l}^{-1}$	5 in 15
	Medium	$\geq 10 \text{ mg l}^{-1}$	20 in 60
	Long	$\geq 5 \text{ mg l}^{-1}$	80 in 240
Sedimentation	Daily	$\geq 100 \text{ mg cm}^{-2} \text{ d}^{-1}$	1
	Short	$\geq 25 \text{ mg cm}^{-2} \text{ d}^{-1}$	5 in 15
	Medium	$\geq 10 \text{ mg cm}^{-2} \text{ d}^{-1}$	20 in 60
	Long	$\geq 5 \text{ mg cm}^{-2} \text{ d}^{-1}$	40 in 120
Zone of Moderate Impact			
Variable	Timeframe	Concentration	Time (consecutive days)
TSS	Short	$\geq 25 \text{ mg l}^{-1}$	2
	Medium	$\geq 10 \text{ mg l}^{-1}$	7
	Long	$\geq 5 \text{ mg l}^{-1}$	20
Sedimentation	Short	$\geq 25 \text{ mg cm}^{-2} \text{ d}^{-1}$	2
	Medium	$\geq 10 \text{ mg cm}^{-2} \text{ d}^{-1}$	7
	Long	$\geq 5 \text{ mg cm}^{-2} \text{ d}^{-1}$	20

Table 2:
Cumulative and Consecutive Coral Health Threshold Criteria (continued)

Zone of Moderate Impact (continued)			
Variable	Timeframe	Concentration	Time (cumulative days)
TSS	Short	$\geq 25 \text{ mg l}^{-1}$	2 in 6
	Medium	$\geq 10 \text{ mg l}^{-1}$	7 in 21
	Long	$\geq 5 \text{ mg l}^{-1}$	20 in 60
Sedimentation	Daily	$\geq 50 \text{ mg cm}^{-2} \text{ d}^{-1}$	1
	Short	$\geq 25 \text{ mg cm}^{-2} \text{ d}^{-1}$	2 in 6
	Medium	$\geq 10 \text{ mg cm}^{-2} \text{ d}^{-1}$	7 in 21
	Long	$\geq 5 \text{ mg cm}^{-2} \text{ d}^{-1}$	
Zone of Influence			
Variable	Concentration		Time
TSS	$\geq 2 \text{ mg l}^{-1}$		In any daylight period
Sedimentation	$\geq 1 \text{ mg cm}^{-2}$		During any 24 hr period

7.5 Zones of Impact

Consistent with the impact assessments in the Draft EIS/ERMP, two zones of differing levels of impact and one zone of influence were established. These zones were defined on the basis of both sediment load and exposure time above background levels, taking into account published values for acute (short-term), medium-term and chronic (long-term) responses to both sedimentation and elevated total suspended solids (TSS). See Section 11.3.1 of the Draft EIS/ERMP for further detail. The same approach has been undertaken for this assessment using the cumulative criteria and the updated model assumptions for each model scenario. Three zones have been delineated:

- The 'zone of high impact' with possible high to total mortality of corals, macroalgae and seagrasses.
- The 'zone of moderate impact' with potential for significant losses of sensitive coral species and macrophytes, and partial loss of resilient species.
- The 'visible plume and extent of sedimentation' where turbid water plumes and/or sedimentation will occur, but are not expected to have a measurable impact upon benthic primary producers.

The predicted impacts to the main BPP communities within the two impact zones are presented with expected recovery times in Table 1. Conservatism built into each criterion and the definition of each zone means that a range of potential impact levels are plausible within each zone. For example, in the high impact zone, effects may range from total mortality of all corals to mortality of specific coral taxa, mortality of individual colonies or partial death of colonies. The impact assessment assumes total loss of all BPP in the high impact zone.

These zones of impact and influence have been plotted over the revised Development Plan and the regional benthic habitat database to indicate which benthic habitats lay within each impact zone.

8 Model Results

The results of the hydrodynamic modelling and analyses of the model output to determine zones of impact based on BPP health criteria are presented in the following sections. Sections 8.1 to 8.7 describe the results of the tests of the model's sensitivity to changes in key parameters and the effect of different model scenarios on the size and shape of the impact zones. The environmental impacts to BPPH, associated with the 'Base Case', are described in section 8.8.

8.1 Interannual Variation

8.1.1 'Normal' Meteorology

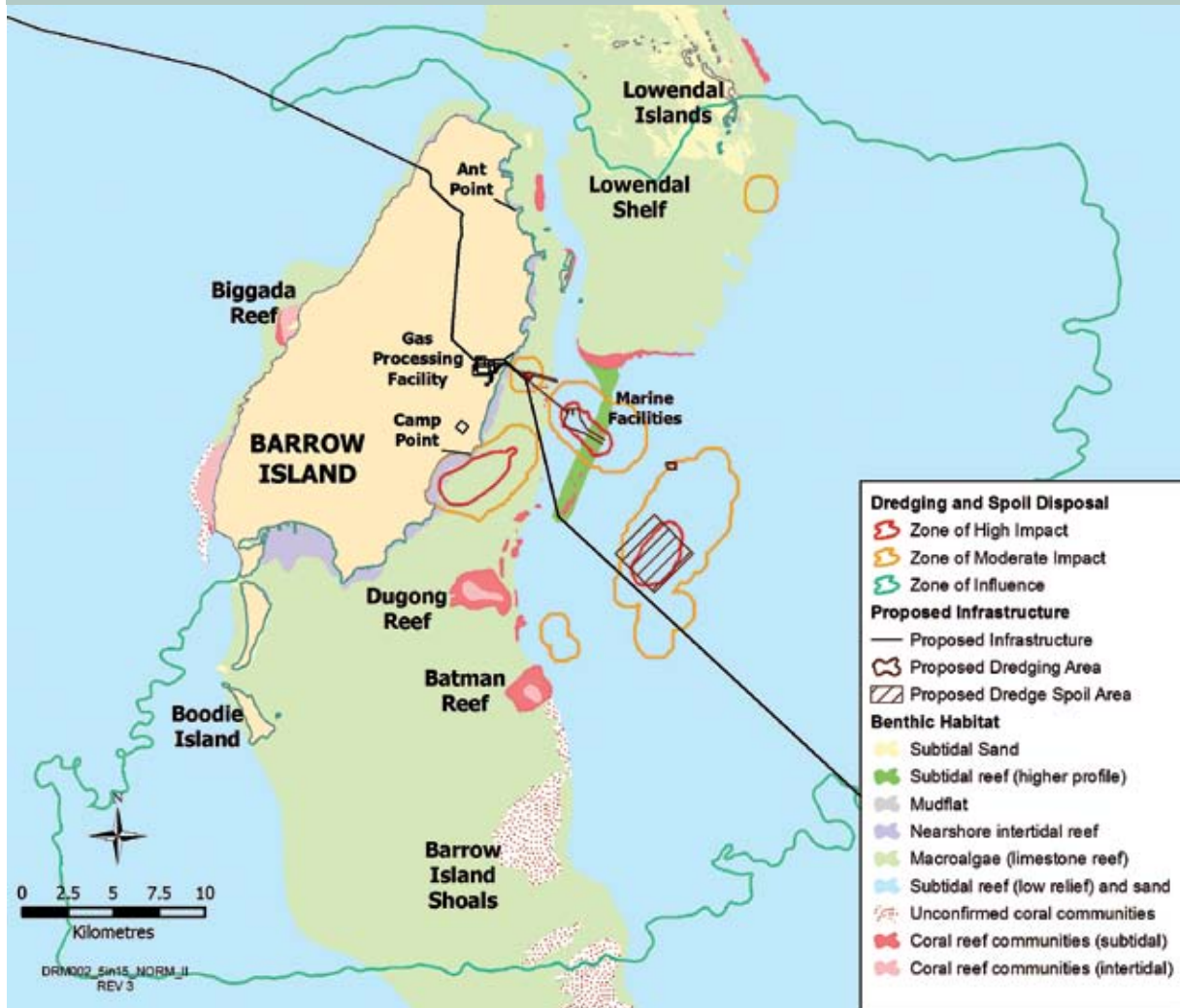
The 'normal' meteorology scenario (Figures 3 & 4) represents the areas of seabed most likely to be influenced by TSS and sedimentation from the proposed Development. This scenario is considered to be the 'Base Case'. Zones of high impact, moderate impact and influence have been delineated based on the standard cumulative coral sensitivity criteria and hydrodynamic modelling described in previous sections.

High impact zones are generally restricted to the vicinity of the MOF and extend up to a maximum of approximately 1 km from the proposed LNG access channel, turning basin and spoil ground (Figure 4). An additional high impact zone is predicted to occur close to the island near Shark Beach, south of Camp Point (Figure 4). This is due to persistent and elevated TSS concentrations in the area as a result of local circulation patterns.

The zones of moderate impact associated with dredging on the east coast of Barrow Island generally surround the zones of high impact indicating a cline of TSS concentrations and sedimentation rates. The moderate impact zone extends a further 1 km from the high impact zone around the MOF and up to a further 2 km from the high impact zone around the LNG loading facilities and turbid plume south of Camp Point (Figure 4). The moderate impact zone around the spoil ground is also predicted to spread further north-east and south than the high impact zone with an additional zone of moderate impacts predicted to occur to the north of Batman Reef and another just south of the Lowendal Islands on the eastern Lowendal Shelf (Figure 4).

The zone of influence, where transient and very low levels of TSS and sedimentation may occur during dredging, stretches for up to 40 km from the dredging and spoil disposal locations (Figure 3). The levels of TSS and sedimentation in this zone are very low and are not expected to have a measurable impact on marine BPP or their habitats.

Figure 3:
The Anticipated Area of Impact (Base Case) Associated with Dredging and Spoil Disposal Under 'Normal' Meteorology



No regionally significant coral assemblages or well developed assemblages of sensitive *Acropora* corals are predicted to be affected by dredging under the 'Base Case' scenario. The scattered *Porites* bombara within the high impact areas around the MOF and LNG channel may be severely affected and if they suffer total mortality would take more than 30 years to recover. Scattered coral communities on nearshore pavement, such as *Turbinaria*, may suffer effects ranging from bleaching of individual colonies to partial mortality (<30%) of some individuals in moderate impact zones. The main BPP seabed communities in the high and moderate impact zones, macroalgae dominated pavement and seagrass dominated sand, will recover relatively rapidly, (<5 years) in areas not permanently modified following the cessation of dredging activities.

8.1.2 'More Easterly Events' Scenario

The impact zones generated under the 'more easterly events' meteorology scenario (Figure 5) represent the areas of seabed most likely to be influenced by TSS and sedimentation if dredging is undertaken during a period of more easterly wind anomalies (more easterly winds than in an average year).

In general, easterly winds tend to push turbid plumes closer to Barrow Island, exacerbating impacts in nearshore waters. High impact zones are predicted to occur in similar locations to those under 'normal' meteorological conditions, with the exception of an additional, but small, high impact zone south-east of the spoil ground and another larger high impact zone south of the MOF (Figures 3 & 5).

Figure 4:

A Detailed View of the Anticipated Area of Impact Near the Proposed Marine Facilities Under the 'Normal' Meteorology (Base Case) Scenario

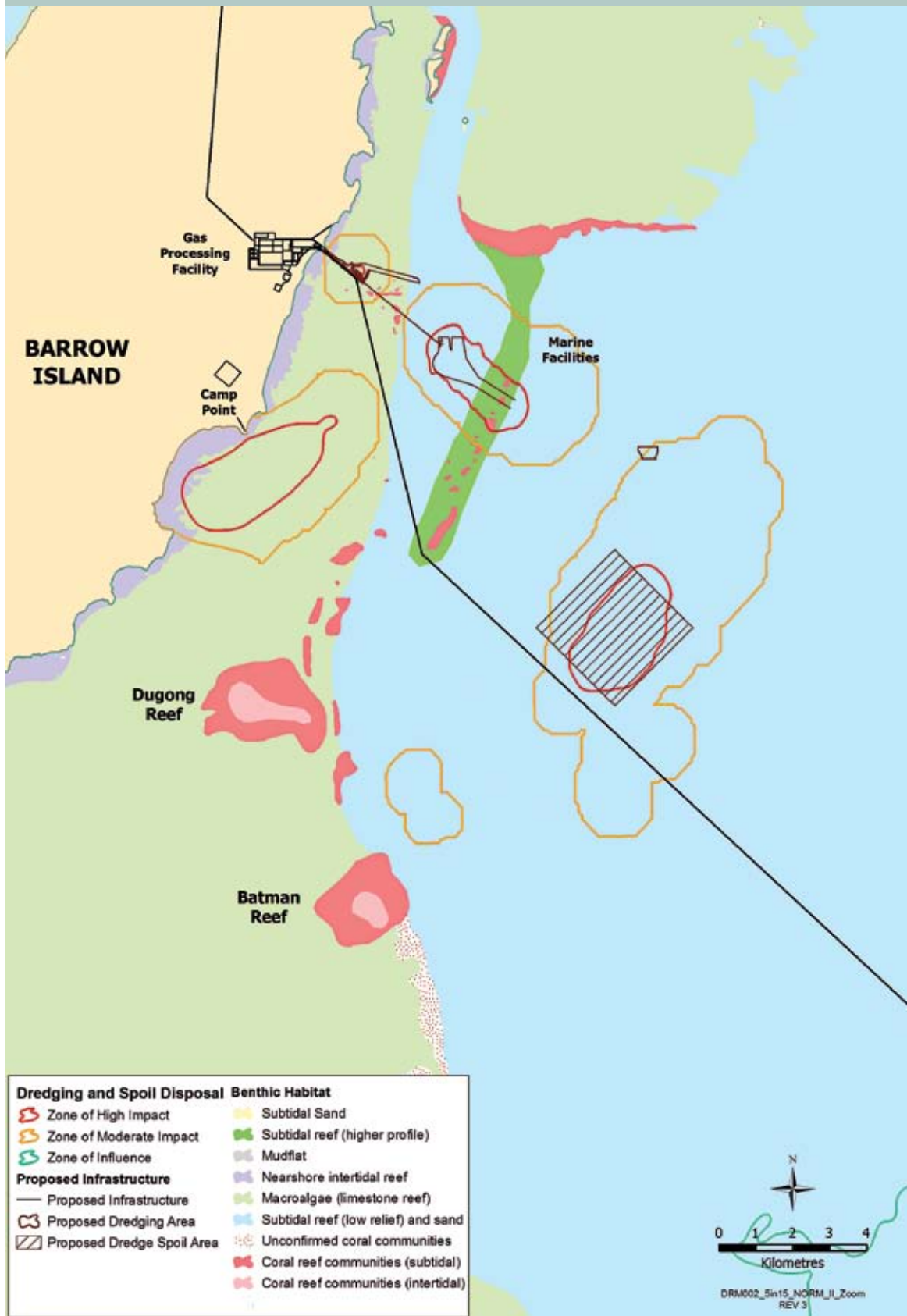
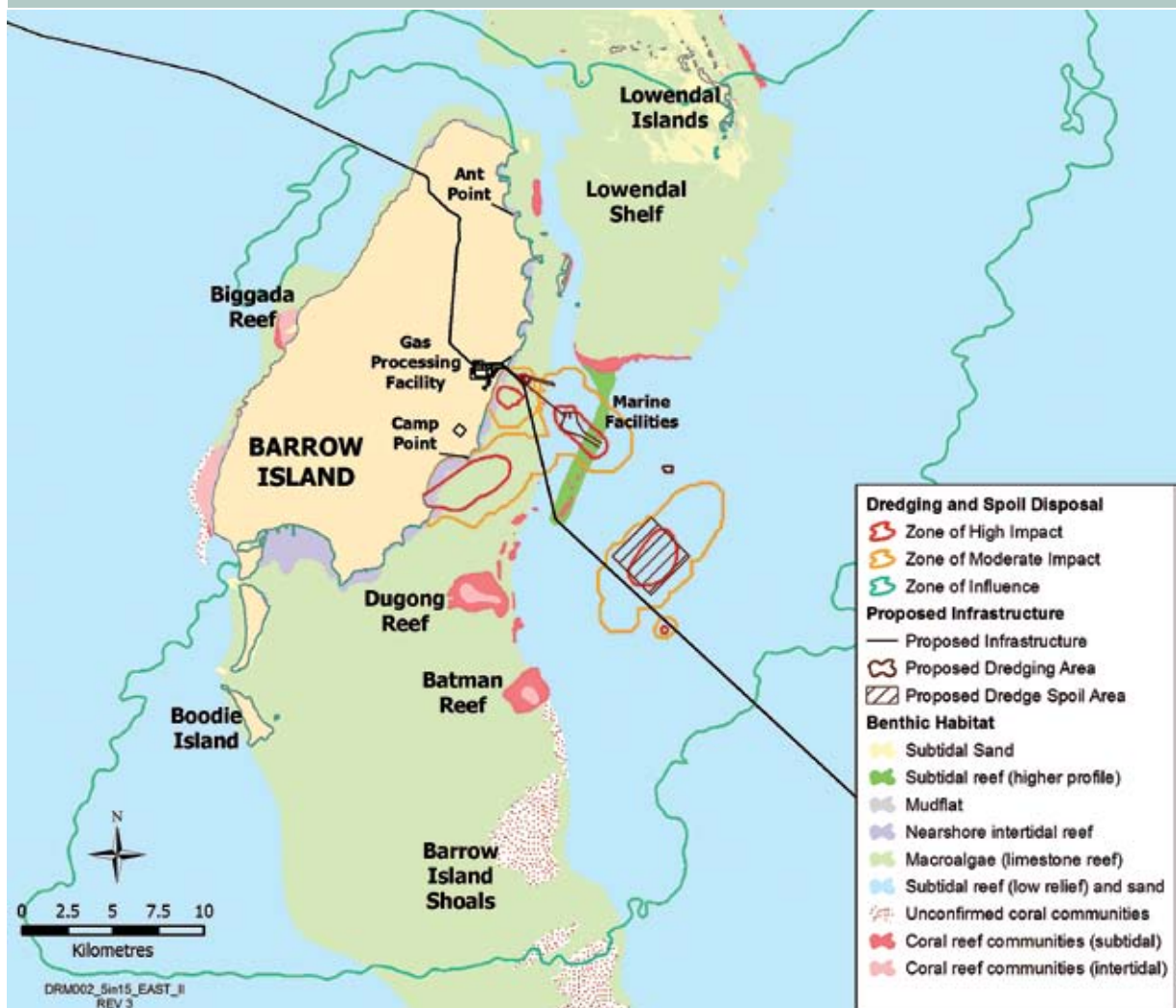


Figure 5:
The Anticipated Area of Impact Associated with Dredging and Spoil Disposal During 'More Easterly Events'

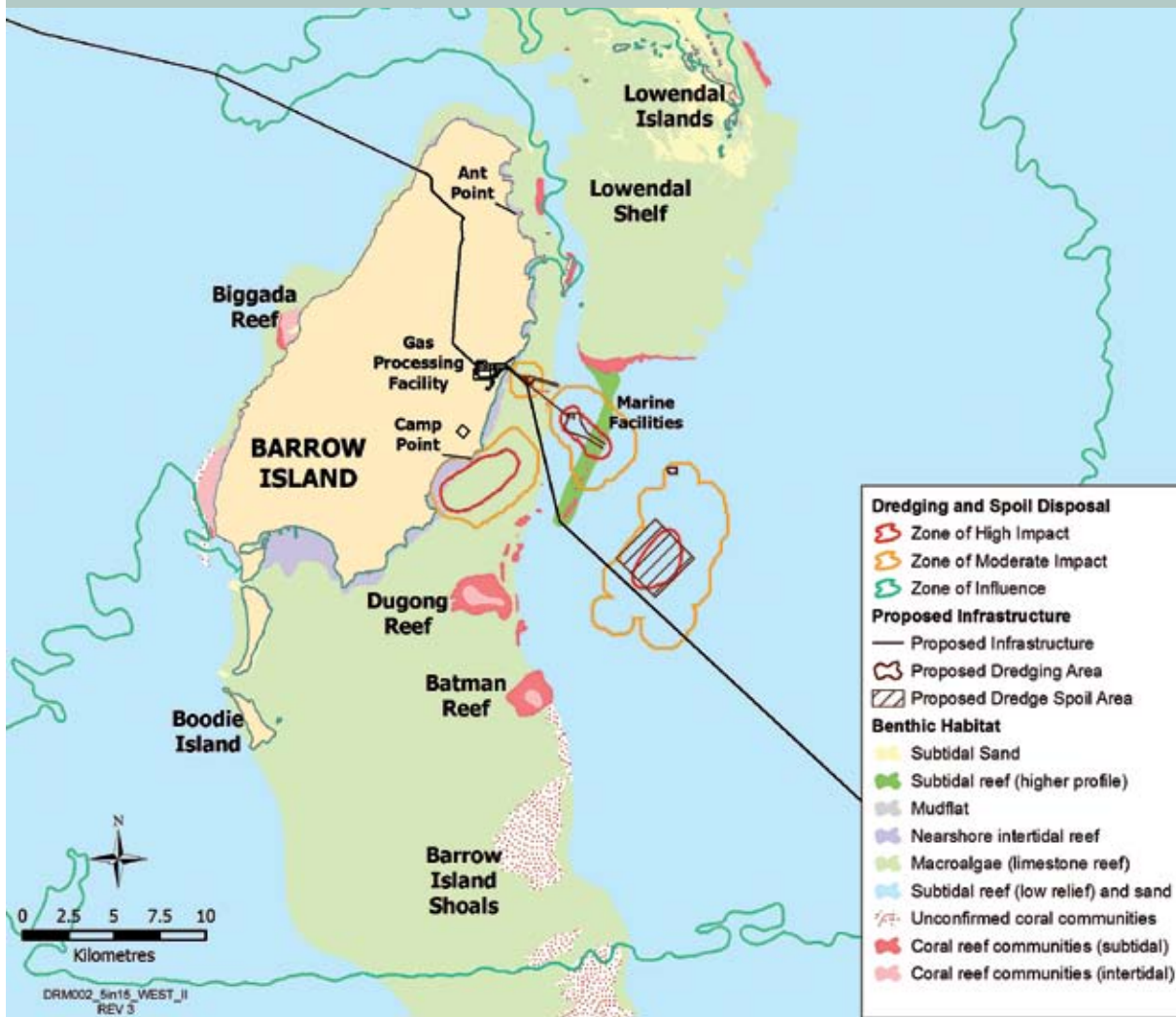


Moderate impact zones are also similar to those produced under 'normal' meteorological conditions, although they tend to be slightly larger with separate moderate impact zones 'joining' in nearshore waters to create larger zones of moderate impact (Figure 5). No moderate impacts on the Lowendal Shelf are predicted with more easterly winds.

Easterly wind anomalies tend to restrict the movement of the zone of influence to the west of Barrow Island, possibly due to enhancing dilution of the plume to $<2 \text{ mgL}^{-1}$. However this zone extends further to the north of the island than under 'normal' meteorological conditions (Figures 3 & 5). No impacts to BPP within the zone of influence are expected.

No regionally significant coral assemblages or known areas of sensitive *Acropora* corals are predicted to be affected by dredging during a 'more easterly events' period. *Porites bombora* within the high impact areas around the MOF and LNG channel will be similarly affected under this scenario as under the 'normal' scenario. The larger moderate impact zones in nearshore waters may include a greater number of scattered coral communities on nearshore pavement, such as *Turbinaria*, but does not include well developed *Acropora* communities. Impacts to corals in the moderate impact zone, apart from well developed *Acropora* thickets, are considered a short term impact as these corals will rapidly recolonise affected areas.

Figure 6:
The Anticipated Area of Impact Associated with Dredging and Spoil Disposal During ‘More Westerly Events’



8.1.3 ‘More Westerly Events’ Scenario

The ‘more westerly events’ meteorology scenario (Figure 6) represents the areas of seabed most likely to be influenced by TSS and sedimentation if dredging is undertaken during a period with more westerly wind anomalies.

Overall, more westerly wind anomalies have only a small effect on turbid water plumes compared to the ‘normal’ meteorology scenario. High impact zones are predicted to be very similar to those under ‘normal’ meteorological conditions and moderate impact zones, whilst showing small differences, are also of a very similar scale to those in a ‘normal’ year (Figures 3 & 6). During more ‘westerly events’, there is the

possibility that a greater number of *Porites bombora* will suffer moderate impacts as this zone stretches further south along the high profile subtidal reef than under the ‘normal’ meteorological scenario. The effects on *Porites* colonies in this zone would range from bleaching of individual colonies to partial (<30%) mortality of individual *bombora*. Small colonies of more sensitive coral species are likely to suffer very high mortality in this zone, although this is considered to be a short term impact as these corals will rapidly recolonise affected areas. No regionally significant coral assemblages or known areas of sensitive *Acropora* corals are known to occur in either the high or moderate impact zones under this scenario.

The zone of influence under the ‘more westerly’ scenario is also very similar to that predicted under ‘normal’ conditions, although it tends to extend further to the west and south (Figures 3 & 6). Marine BPP in this zone are unlikely to suffer any measurable effects due to dredging.

8.2 TSS Pulses and Sediment Accumulation

In order to explore any possible impacts to marine BPP from large spikes in TSS concentrations or the accumulation of sediment during the proposed dredging programme the behaviour and intensity of sediment plumes at selected sites were plotted (Figures 8 & 9). Details of the four locations for which time series plots have been presented are detailed in Table 3 and Figure 7.

Maximum daily TSS (mg l^{-1}) and on bottom sediment load (mg cm^{-2}) above background at each site is presented graphically for the 66 weeks of the proposed dredging programme (Figures 8 & 9).

At each site, TSS is predicted to vary markedly over short temporal scales, primarily due to the strong currents and tides in the waters offshore of the east coast of Barrow Island which rapidly dilute and disperse the turbid plumes. TSS is rarely expected to exceed 25 mg l^{-1} and no long term, persistent turbid pulses or very high levels of TSS are predicted to occur, even at sites close to dredging operations, e.g. Town Point Reef (Figure 8). Cumulative coral health threshold criteria at this site are ‘triggered’ by low levels of TSS for long periods, rather than short, high TSS pulses over several days.

Elevated TSS at Dugong Reef and on the Southern Lowendal Shelf is predicted to occur as a result of dredging and spoil disposal operations, although not a level that is predicted to have a measurable effect on local marine BPP. TSS at these sites is not expected to

exceed two or three times background levels on more than a small number of occasions. Further north, close to the Lowendal Islands, turbid plumes are expected to occur sporadically throughout the proposed dredging programme (Figure 8).

The time series sedimentation plots (Figure 9) show the daily accumulated sediment load at each of the modelled locations over the dredging programme. Rises in the graph indicate sediment settling on the seabed and contributing to on bottom sediment load. Declines in the time series plot indicate that a greater proportion of sediment is resuspended during that 24 hour period, reducing overall on bottom sediment load.

Very low levels of sedimentation are expected to occur in areas more than several hundred metres to 1 km from dredging and spoil disposal operations. Larger, heavier particles will tend to settle very close to dredging operations and will not resuspend under normal conditions. Fine material is predicted to continually settle and then resuspend, slowly diluting and dispersing into deeper, offshore waters.

Only very low levels of fine sediment are anticipated to accumulate on the seabed at the modelled locations, and then only at three of the four sites (Figure 9). The predicted levels of sediment accumulation at each site are far below those that are expected to have a negative effect on marine BPP. No large ‘pulses’ of sedimentation are predicted to occur under normal meteorological conditions (Figure 9).

8.3 Stability of Dredged Material

The 3-D hydrodynamic model was run for a further 48 weeks after the cessation of dredging to track the movement of particles liberated during dredging and spoil disposal. The model run was based on a ‘normal’ meteorology year (2001 start) and ‘snapshots’ of bottom sediment load (mg cm^{-2}) were output quarterly, starting immediately after dredging finished.

Table 3:
Location of Sites for Times Series Plots

Sites – Time Series Plots	Site Number	Easting	Northing
Town Point Subtidal Pavement Reef (South)	1	344225	7694674
Southern Lowendal Shelf Reef	2	345479	7700574
Dugong Reef	3	340179	7687827
Lowendal Islands Patch Reef	4	354578	7709154

Four 'snapshots' of bottom sediment load were output from the model, corresponding to the periods immediately following the cessation of dredging (week 0) and at 12, 24 and 48 week intervals after dredging (Figures 10, 11, 12 & 13, respectively).

It is important to note that the near-field sedimentation from larger, heavier particles (>150 µm) was not modelled, except at the spoil ground, as these particles are assumed to remain within the vicinity of the dredged areas. It is anticipated that this coarse material will be restricted to within several hundred metres of dredged channels and will only be mobilised in extreme weather conditions, such as during cyclones.

In practice this meant that for the dredging of the MOF, turning basin and access channel only particles of diameter less than 150 µm were included in the particle distribution. However, the dumping of material at the

spoil ground was simulated using the full distribution of particle sizes assumed to be pumped into the hopper barges. As a conservative measure, it was also assumed that 20% of fines produced during dredging would be transported to the spoil ground.

At the cessation of dredging (week 0) the hydrodynamic model predicted that the bottom sediment load at the spoil ground will be in the order of 100 to 10,000 mg cm⁻² (Figure 10). Thin veneers of sediment are expected to have accumulated on the seabed (1 to 20 mg cm⁻²) directly to the east and south-east of the LNG access channel and in patches to the south-west of the dredging and dredge spoil sites towards Boodie Island (Figure 10). Sediment load on the seabed beyond the spoil ground is very low (maximum of 20 mg cm⁻²) and is not predicted to have any measurable effect on marine BPP or BPPH.

Figure 7:

The Location of the Four Individual Sites Modelled to Produce Time Series Plots of TSS and Sedimentation

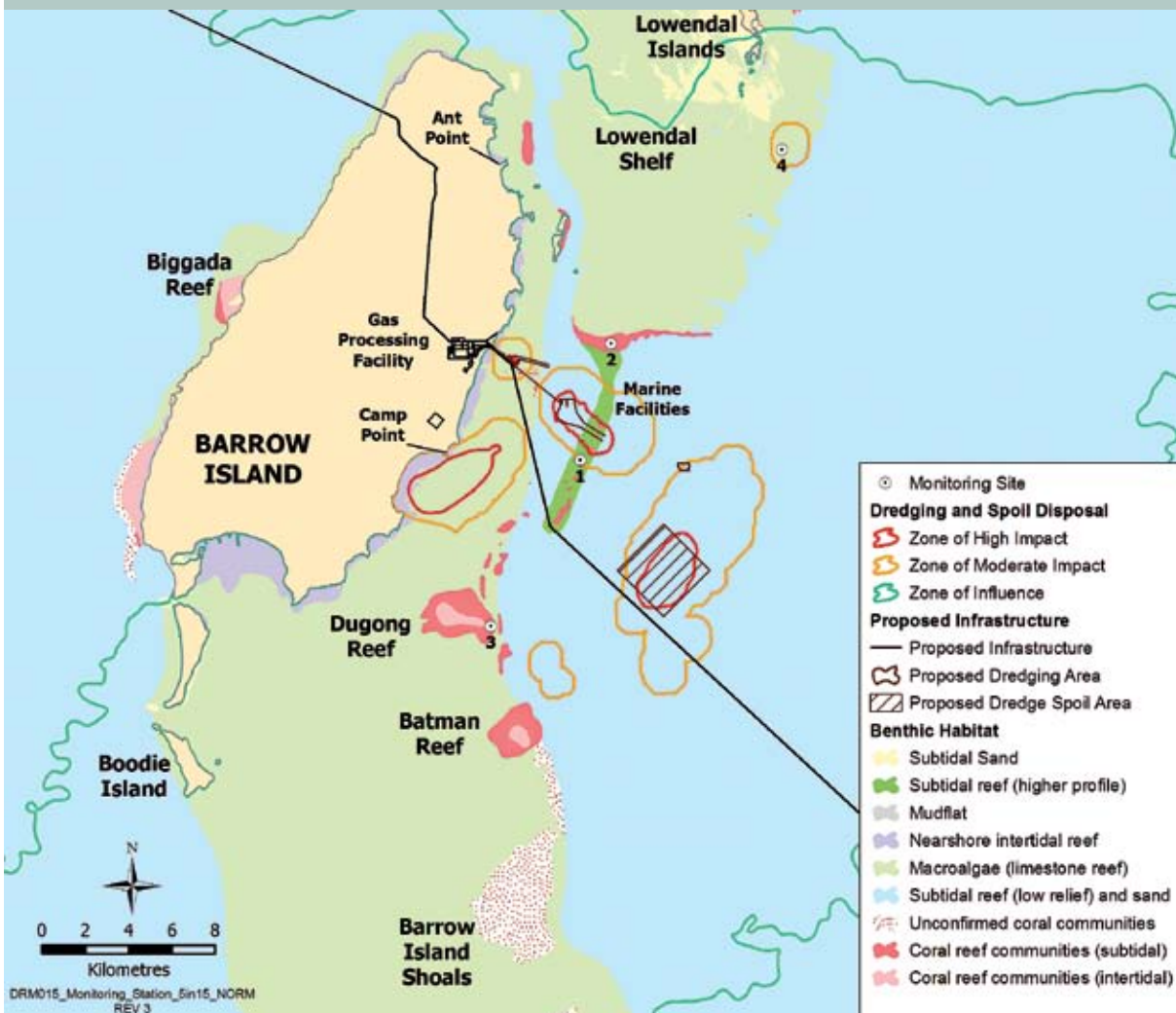


Figure 8:

Time Series Plots of Predicted TSS at Four Sites Under 'Normal' Meteorological Conditions

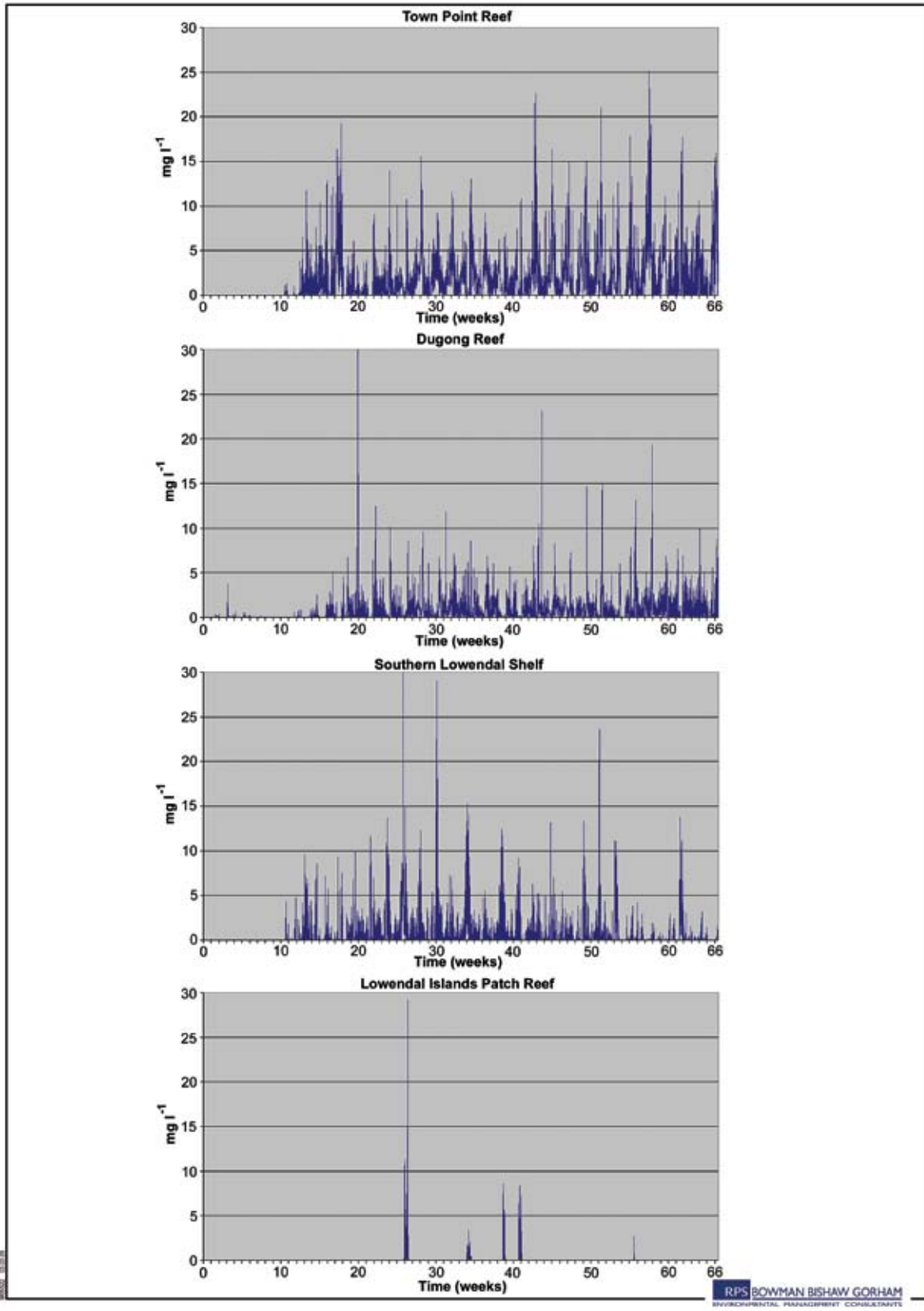


Figure 9:

Time Series Plots of Predicted Sedimentation at Three Sites Under 'Normal' Meteorological Conditions

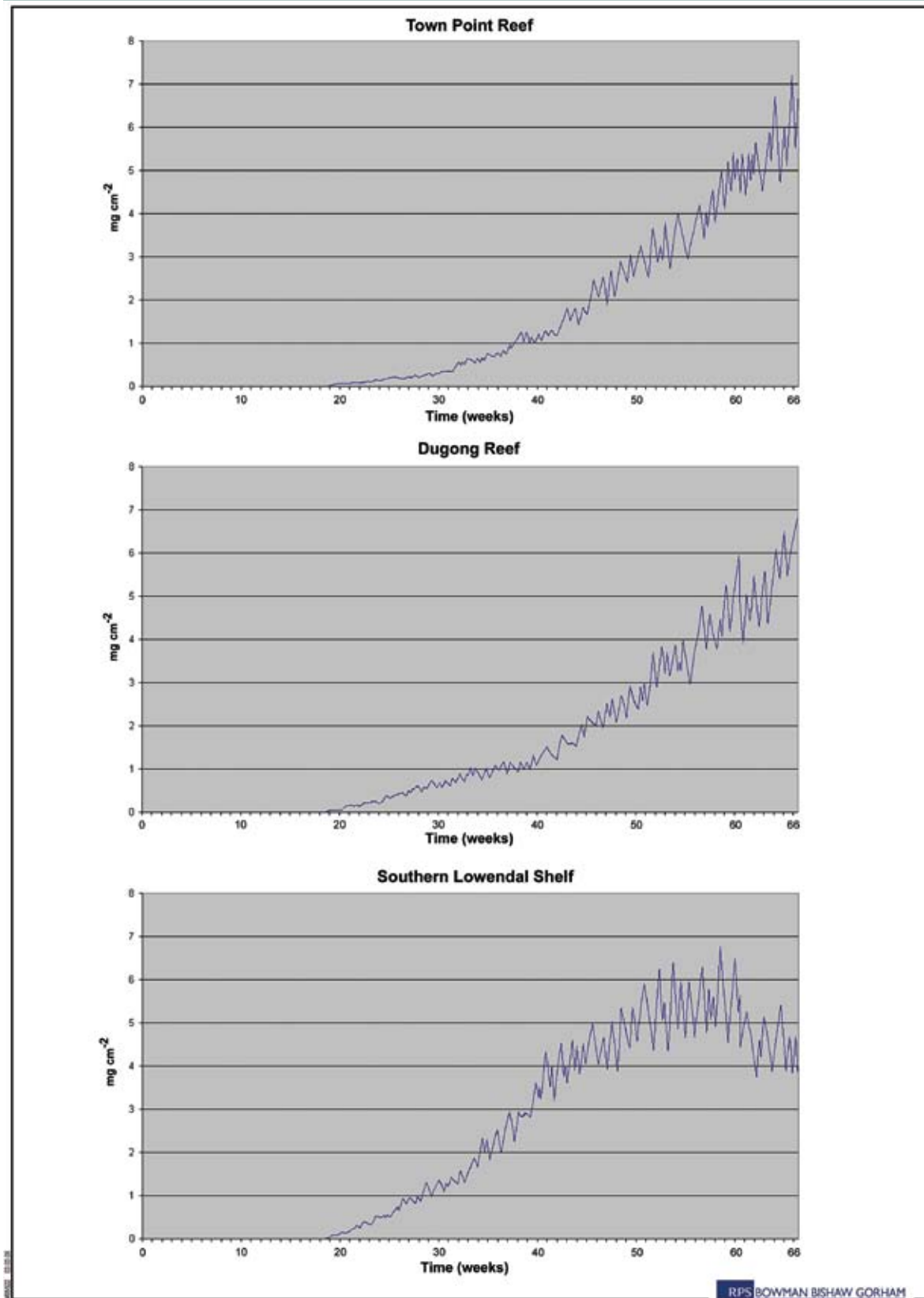
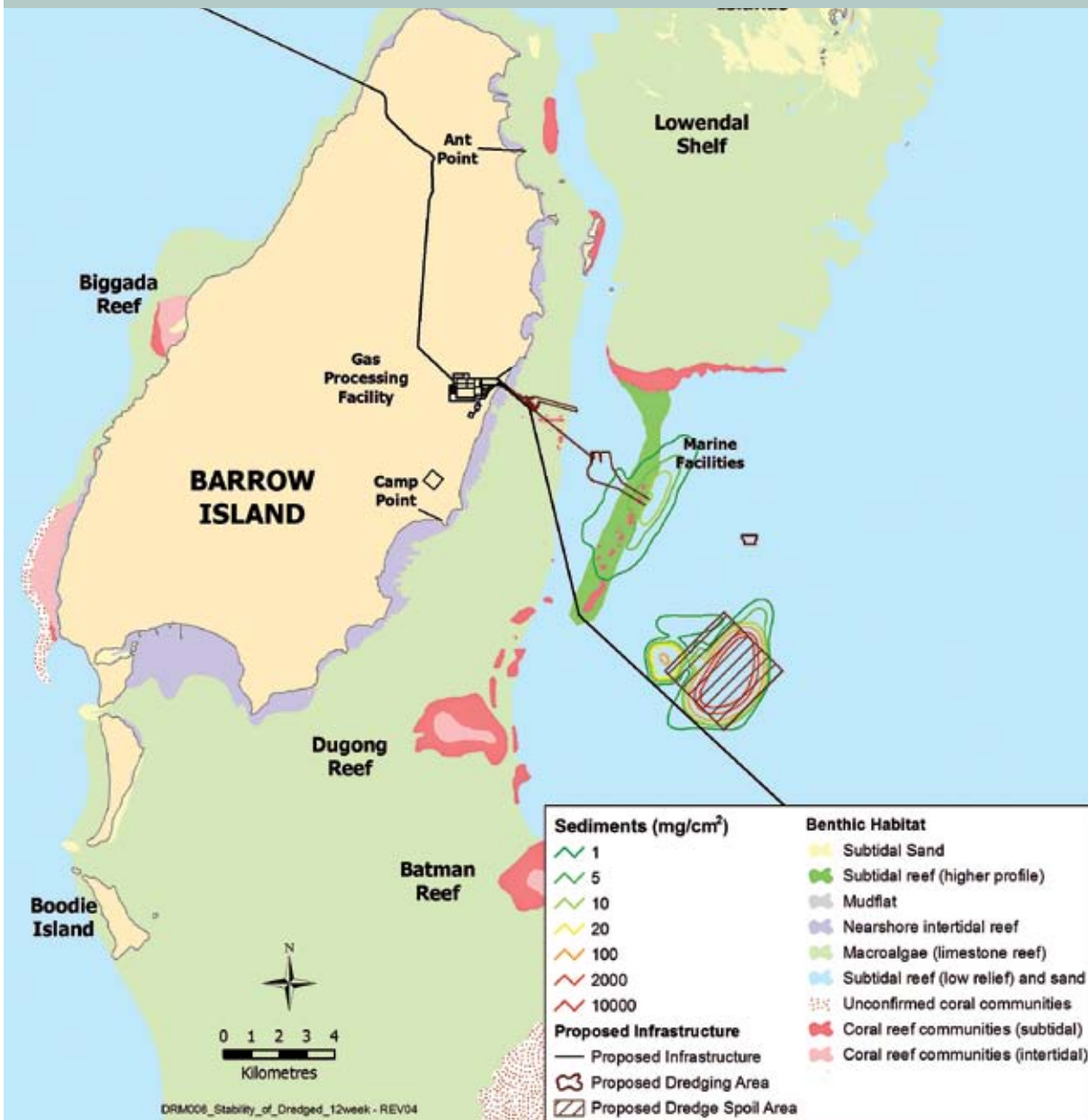


Figure 10:
The Anticipated On Bottom Sediment Load at the End of Dredging (0 Weeks)



Figure 11:

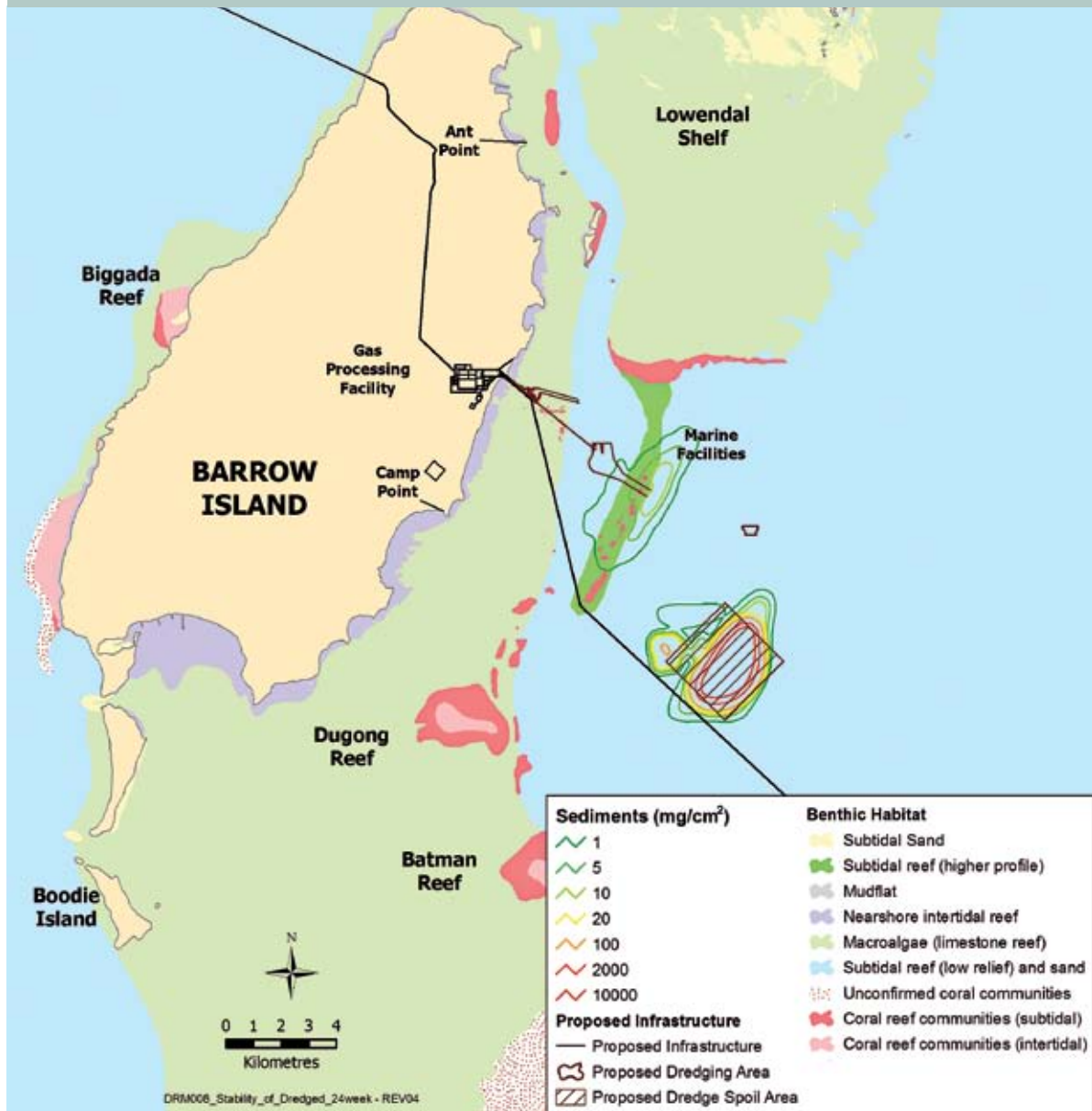
The Anticipated On Bottom Sediment Load 12 Weeks After the End of Dredging



The hydrodynamic model predicts that the spoil ground will be stable with only small movements of material around the periphery of the site over the 48 weeks following dredging. The fine sediment that accumulates on the seabed at the eastern end of the dredged LNG access channel will also persist at approximately 1-10 mg cm⁻². This area of deposited sediments only slightly decreases in size over 48 weeks (Figures 10 to 13). This sediment load is predicted to have no measurable impacts to marine BPP although increased turbidity in the area may reduce the recovery rate of impacted BPP in close proximity.

While the spoil ground is considered a loss of BPPH under the BPPH assessment due to permanent habitat modification, it is expected that turf and macroalgae will colonise the spoil ground rapidly (2-5 years), with the establishment of a diverse macroalgae community in the longer term.

Figure 12:
The Anticipated On Bottom Sediment Load 24 Weeks After the End of Dredging



8.4 Greater Contribution of Fines

The 'Base Case' modelling assumes the proportion of fine particles generated during dredging of hard limestone at Barrow Island will be similar to the proportion generated at Geraldton. It is possible, however, that the limestone at Barrow Island is harder.

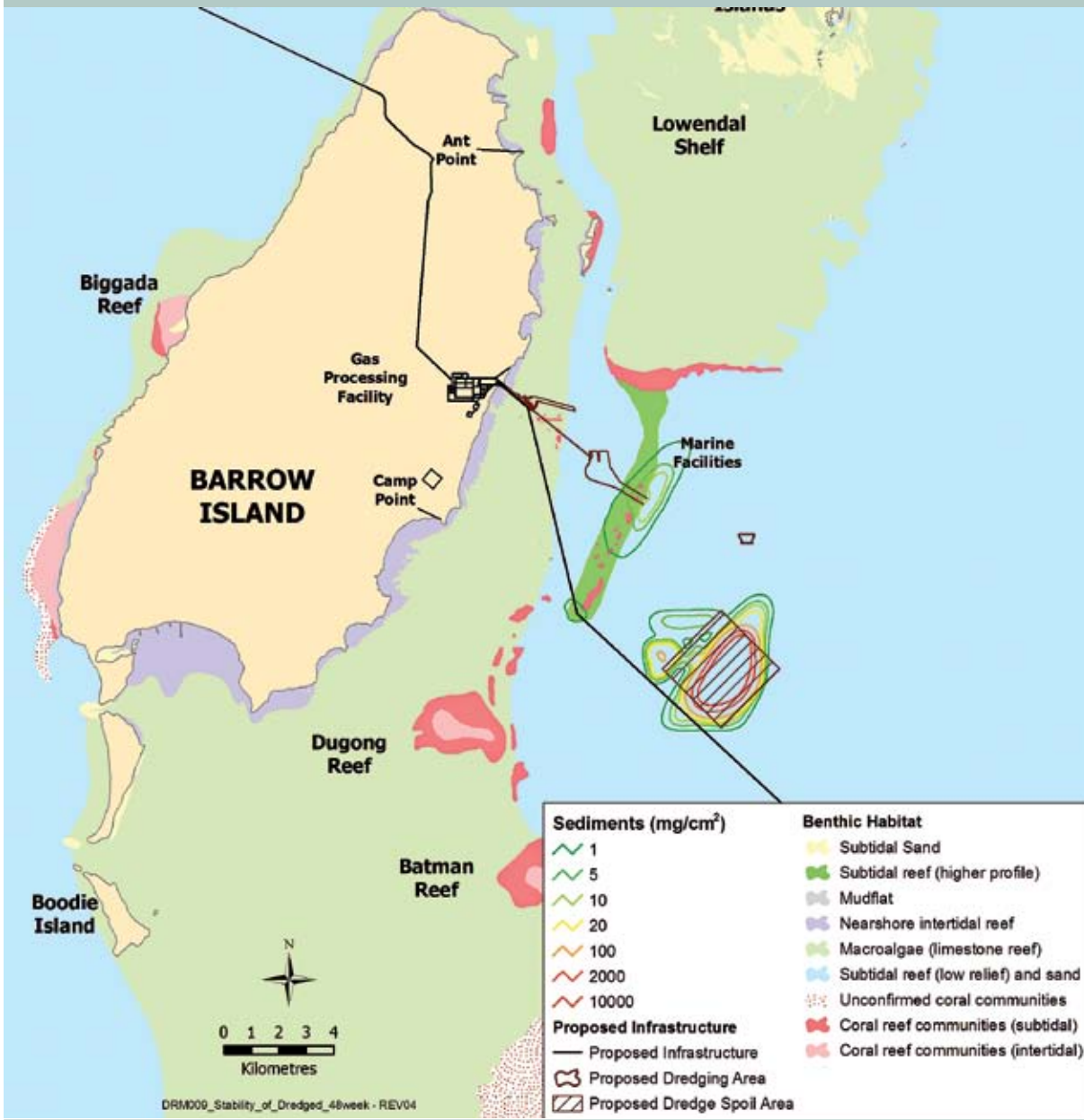
It is currently unknown how the hardness of the limestone will affect the amount of fines produced during dredging. If dredging the limestone at Barrow Island produces a higher proportion of fines, this will increase the mass of fine particles and create larger turbid plumes. Doubling the proportion of fines produced was considered to be a highly conservative

test of the effects of this parameter on the model results in the absence of directly relevant data. Due to the very small size of the fines produced (<75µm), this material is not expected to settle on the seabed and is thus assumed to contribute only to TSS and not to sedimentation.

The 'double fines' scenario was modelled using a 'normal' meteorology year and the zones of impact and influence derived using the standard cumulative threshold criteria described in previous sections. Impact zones under the 'double fines' scenario were plotted over the zones for the 'Base Case' scenario for comparative purposes (Figure 14).

Figure 13:

The Anticipated On Bottom Sediment Load 48 Weeks After the End of Dredging

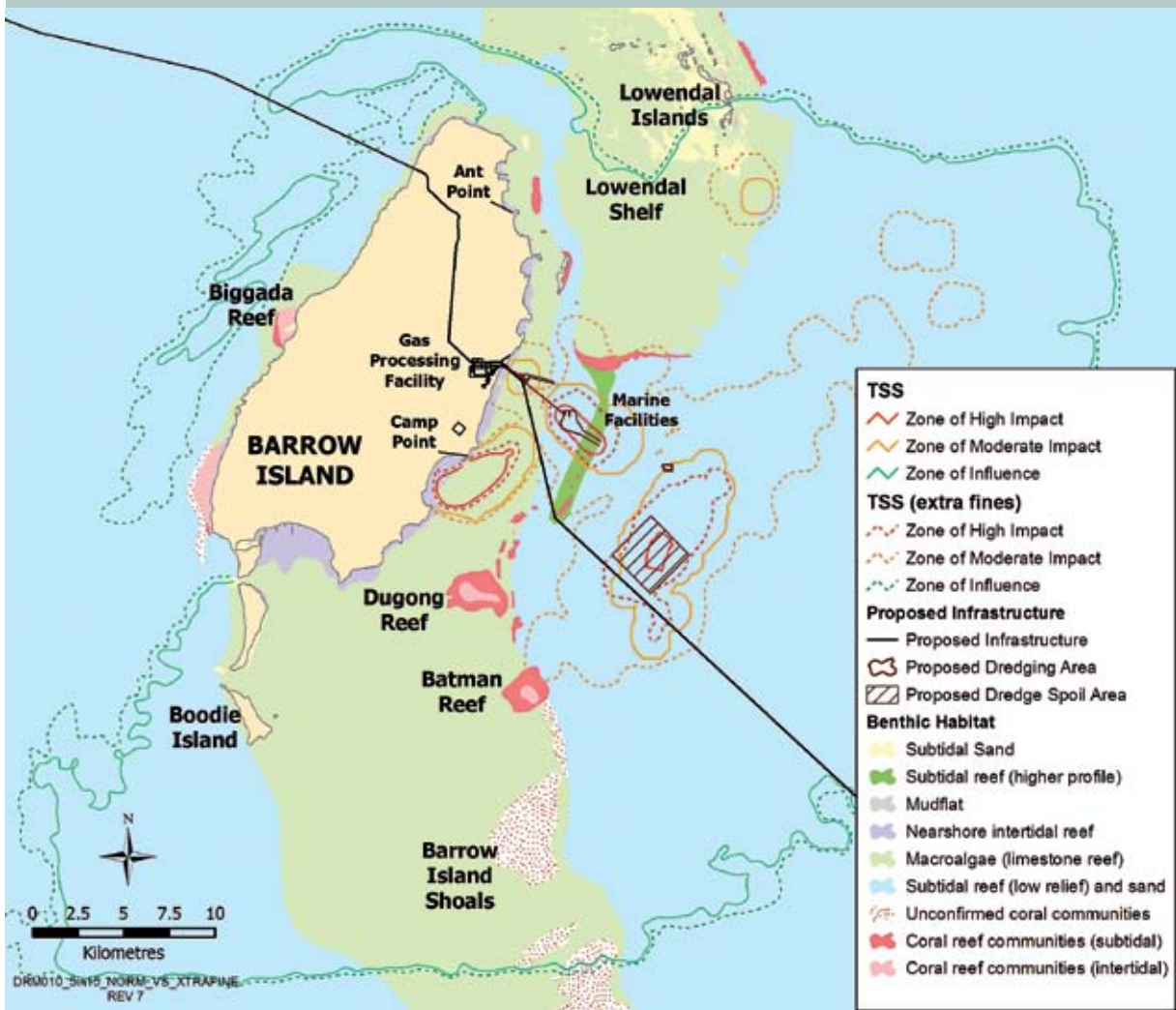


The zone of high impact produced from extra fines tends to extend the zones produced under normal particle size and volume predictions. The zone of high impact around the LNG channel from extra fines is approximately double that under the anticipated fines production. The predicted high impact zone from extra fines around the spoil ground is also much larger than that under normal conditions, covering approximately twice the area of the spoil ground, running in a general north-east, south-west direction (Figure 14). While the areas of high and moderate impacts are much larger, the zone of high impacts from turbidity associated with doubling the fines production during dredging, does not affect any regionally significant coral assemblages.

The 'double fines' moderate impact zone is appreciably larger than that under the 'Base Case' encompassing most of the area around the proposed marine facilities including a large area offshore and to the north of the spoil ground (Figure 14). Under this highly conservative scenario, moderate impacts to marine BPP from elevated TSS are predicted to occur on the southern and eastern margins of the Lowendal Shelf and possibly as far south as Batman Reef. This may have serious effects on the well-developed Acroporid assemblages in these areas.

Figure 14:

The Area of Impact (TSS) Predicted to Occur Under Base Case Assumptions (Solid Lines) and if Double the Amount of Fines are Produced During Dredging and Spoil Disposal (Dashed Line)



Potential impacts under this 'double fines' scenario should be considered to be a significant overestimate of impacts from turbidity related stress, with levels set artificially high to test the sensitivity of the model to changes in basic assumptions. Real time monitoring of fines production during dredging operations will allow the model assumptions to be tested, the results of which will enable spatial and temporal differences in the turbid plumes due to fines production to be effectively managed. Management responses will be detailed in the Dredging Management Plan.

The visible plume under both normal and extra fines conditions are of a similar magnitude, with double the amount of fines producing only a marginally larger zone of influence (Figure 14).

8.5 Double 'Rolling' Time Period

Zones of impact generated using the cumulative coral health threshold criteria represent areas affected by a series of 'pulses' of high TSS or sedimentation. The closer the 'pulses' are together, or the shorter the time period within which they occur, the greater the stress on the corals and other BPP. The cumulative criteria set a threshold of a certain number of days of high TSS or sedimentation within a given 'rolling' time period. The cumulative criteria are explained in detail in Section 7.4.2.

At the suggestion of the DoE and EPASU, the 'rolling' time period was doubled to test the effects on the impact zones. The longer 'rolling' period results in significantly more conservative criteria than those originally proposed and on which the base case is modelled. It should be noted that these criteria are not based on the published literature and are only be

used to gauge the sensitivity of the model to changes in threshold limits. They should be considered in this context to be a significant overestimate of possible impacts to marine BPP from dredging activities.

A summary of the more conservative cumulative threshold criteria for the sensitivity analysis is presented in Table 4. The zones of impact under the double 'rolling' time during a 'normal' meteorology year were overlaid on the base case scenario for comparative purposes (Figure 15).

The zones of high impact near the marine facilities produced from doubling the 'rolling' time period are the same, or very similar, to those produced using the standard cumulative criteria (Figure 15).

However, the predicted high impact zone around the spoil ground is larger than under the base case, covering approximately twice the area of the spoil ground, with a new small high impact zone approximately 2 km south of the spoil ground (Figure 15).

The moderate impact zones around the MOF and spoil ground are significantly larger than that under 'standard' modelling conditions, but only slightly larger around the LNG channel, the impact zone south of Camp Point and on the eastern Lowendal Shelf. The moderate impact zone around the spoil ground is also significantly larger (Figure 15). No regionally significant coral assemblages would be affected within the moderate impact zone.

Table 4:
'Double Rolling Time Period' Cumulative Coral Health Threshold Criteria

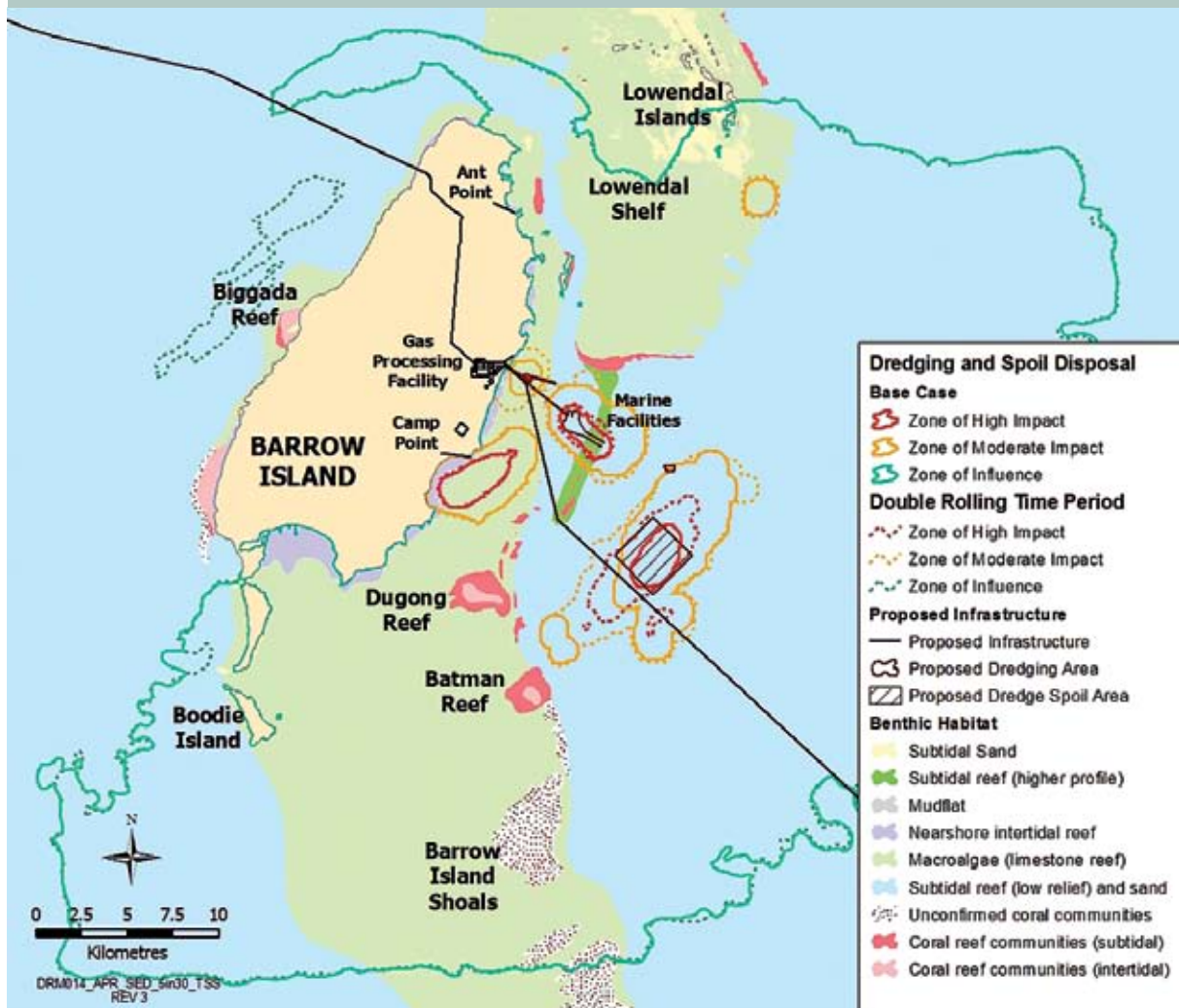
Zone of High Impact			
Variable	Timeframe	Concentration	Time (cumulative days)
TSS	Short	$\geq 25 \text{ mg l}^{-1}$	5 in 30
	Medium	$\geq 10 \text{ mg l}^{-1}$	20 in 120
	Long	$\geq 5 \text{ mg l}^{-1}$	80 in 480
Sedimentation	Daily	$\geq 100 \text{ mg cm}^{-2} \text{ d}^{-1}$	1
	Short	$\geq 25 \text{ mg cm}^{-2} \text{ d}^{-1}$	5 in 30
	Medium	$\geq 10 \text{ mg cm}^{-2} \text{ d}^{-1}$	20 in 120
	Long	$\geq 5 \text{ mg cm}^{-2} \text{ d}^{-1}$	40 in 240

Zone of Moderate Impact			
Variable	Timeframe	Concentration	Time (cumulative days)
TSS	Short	$\geq 25 \text{ mg l}^{-1}$	2 in 12
	Medium	$\geq 10 \text{ mg l}^{-1}$	7 in 63
	Long	$\geq 5 \text{ mg l}^{-1}$	20 in 180
Sedimentation	Daily	$\geq 50 \text{ mg cm}^{-2} \text{ d}^{-1}$	1
	Short	$\geq 25 \text{ mg cm}^{-2} \text{ d}^{-1}$	2 in 12
	Medium	$\geq 10 \text{ mg cm}^{-2} \text{ d}^{-1}$	7 in 63
	Long	$\geq 5 \text{ mg cm}^{-2} \text{ d}^{-1}$	20 in 180

Zone of Influence		
Variable	Concentration	Time
TSS	$\geq 2 \text{ mg l}^{-1}$	In any daylight period
Sedimentation	$\geq 1 \text{ mg cm}^{-2}$	During any 24 hr period

Figure 15:

The Area of Impact Predicted to Occur Under 'Base Case' Assumptions (Solid Lines) and the Cumulative Criteria 'Rolling' Time Period is Doubled (Dashed Line)



The zone of influence under both normal and double the rolling time period criteria are of a similar magnitude, with the double criteria producing only a marginally larger zone of influence with an extra zone on the west coast of the island, offshore from Biggada Reef (Figures 3 & 15). Turbidity at this concentration will not affect BPP within the Barrow Island Marine Park.

Doubling the time period had only a minor effect on the extent and type of environmental impacts, confirming that the standard cumulative criteria used for the 'base case' are sufficiently conservative.

8.6 Consecutive vs Cumulative Criteria

Following the release of the Draft EIS/ERMP, concern was raised over the potential cumulative impacts due to 'pulses' of TSS and sedimentation to corals and other marine BPP that would not be accounted for

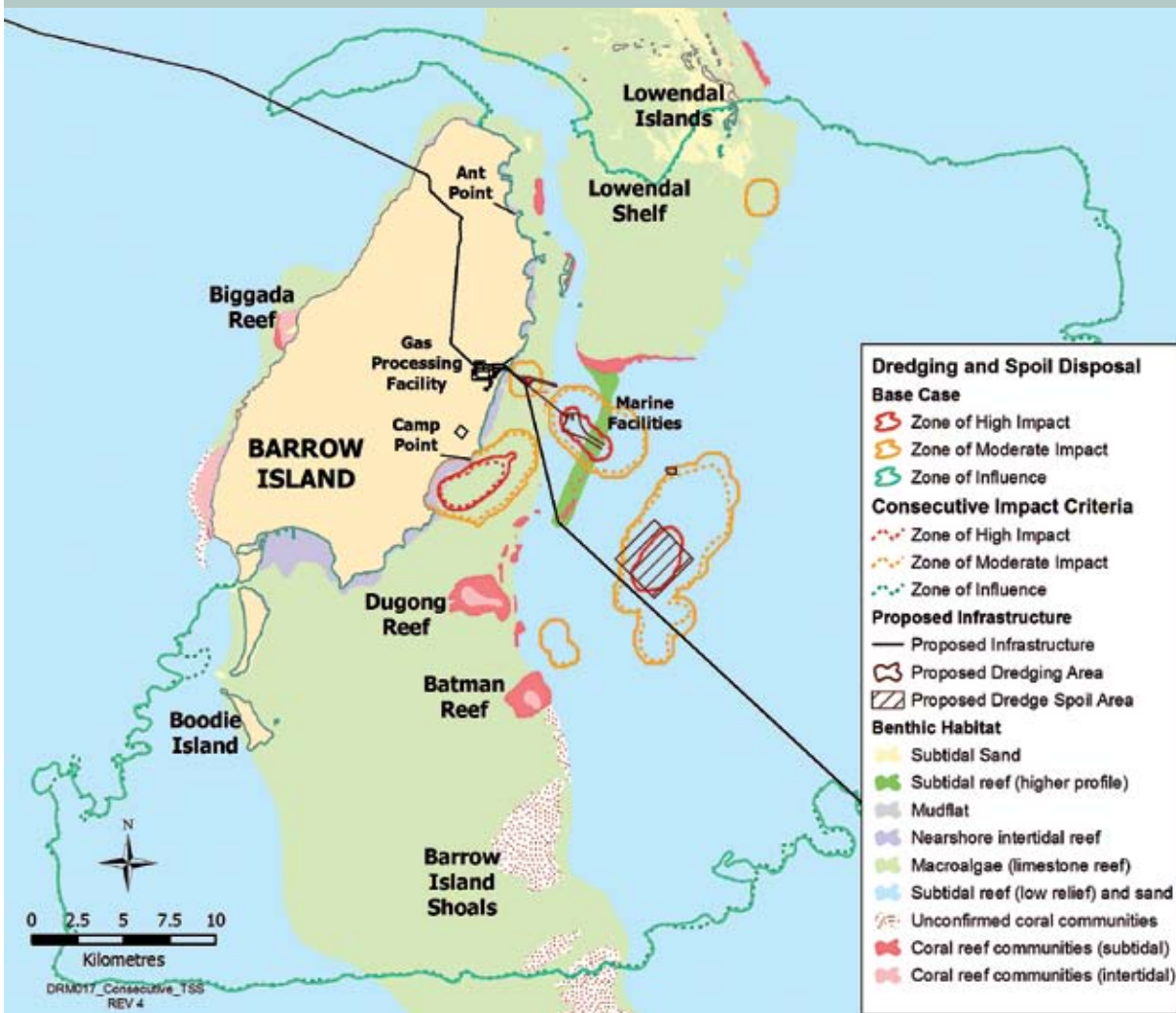
using 'press' consecutive criteria. In order to resolve this issue, cumulative coral health threshold criteria that take into account both the intensity and duration of stressors over given time periods have been developed and used to derive impact zones (see Section 7.4.2).

Comparison of the previously modelled consecutive coral criteria and the newly developed cumulative coral threshold criteria facilitates comparison of the current impact assessment with that provided in the Draft EIS/ERMP. It also provides a sensitivity analysis of the new cumulative criteria in relation to their ability to predict potential impacts that were not identified using the consecutive criteria.

The cumulative criteria are based on time periods and concentrations defining the consecutive coral threshold criteria and are therefore more conservative

Figure 16:

The Area of Impact Predicted to Occur Under 'Base Case' Assumptions (Solid Lines) and if the Consecutive Criteria Used in the Draft EIS/ERMP are Employed (Dashed Line)



than the consecutive criteria. Thus, cumulative impacts predicted within any model scenario will always be larger than those predicted under the consecutive criteria. The scale of that difference provides an indication of the sensitivity of the impact assessment to using these different types of criteria for predicting impact zones.

Zones of impact derived using the cumulative and consecutive criteria during a year of 'normal' meteorology are shown in Figure 16.

Overall, there were only slight differences in the impact and influence zones produced by the cumulative (base case) and consecutive criteria. This indicates that impacts to BPP from dredging and spoil disposal are generally the result of elevated and persistent TSS and sedimentation levels which occur for several consecutive days, rather than a series of 'pulse' events.

Under both the consecutive criteria scenario and the base case (cumulative) criteria scenario, no regionally significant coral assemblages or well-developed *Acropora* assemblages are predicted to be affected by dredging.

8.7 Seasonal Variation

Dredge plume modelling presented in the Draft EIS/ERMP was based on the expected schedule at that time commencing in October. From October, the 16 month dredging programme extended through two summers, which are dominated by southerly winds, and one winter, with predominantly north-easterly winds. The overall result of this scenario was that sediment plumes displayed a tendency to be driven north from the dredging locations by the predominantly southerly flow. Possible impacts to marine BPP were predicted to occur almost exclusively in close proximity to dredging operations or to the north of operations,

with potential impacts some distance onto the Lowendal Shelf (See Figure 11-5).

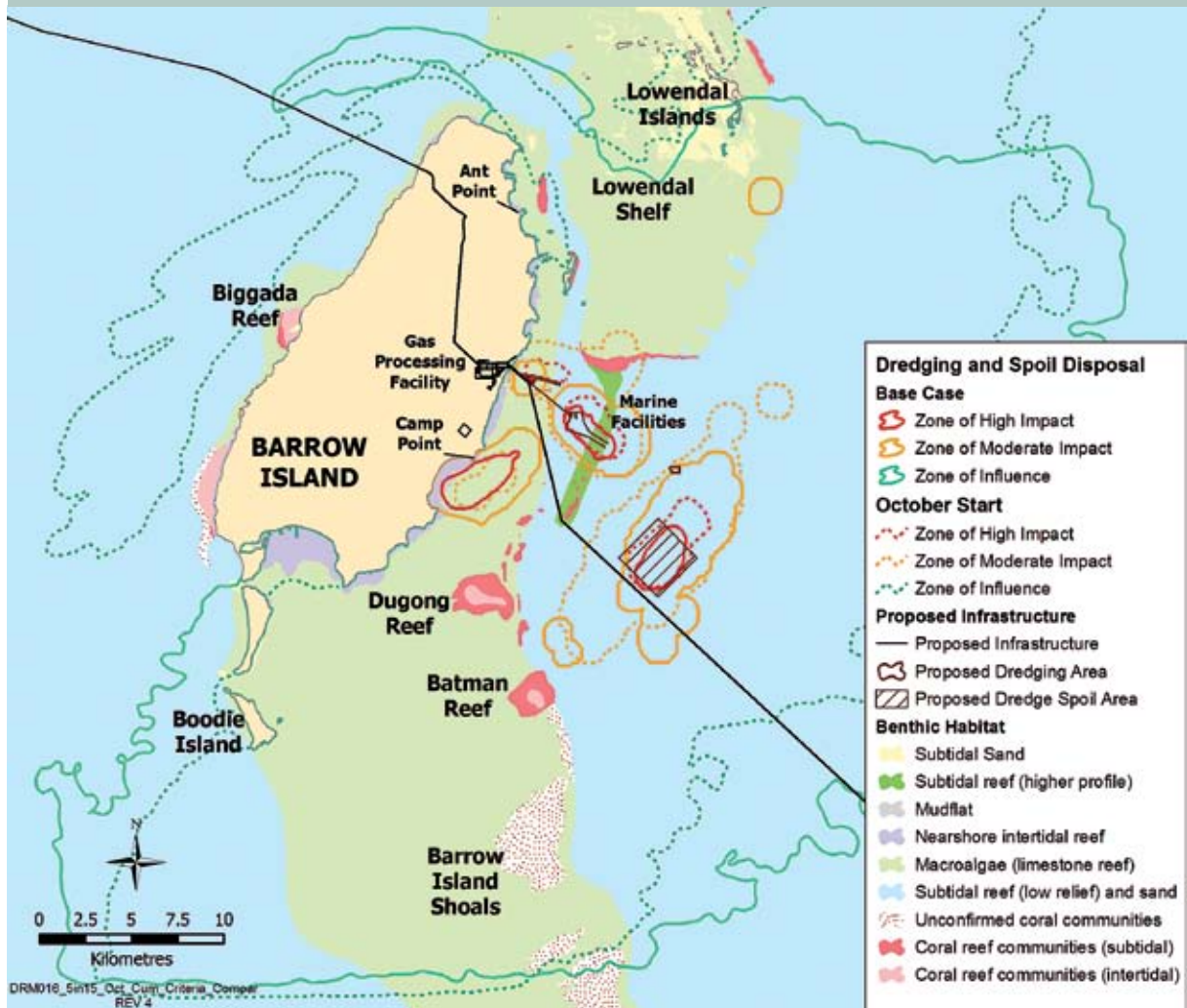
The schedule has since been revisited to account for probable delays and an April start date has been assumed for this revised dredging assessment. The consequence of starting the proposed 16 month dredging programme in April is that dredging will take place over two winters and only one summer, in contrast to the two summer and one winter previously modelled. This results in a significant change in the dominant wind patterns during dredging from the previously southerly dominated pattern to a north-easterly pattern. This change means that the two schedule scenarios that are likely to have the greatest differences in predicted impacts have now been modelled.

To test the sensitivity of the impact prediction to changes in the dredging schedule, both the April start (Base Case) and October start scenarios have been modelled for a 'normal' meteorology year and standard cumulative coral threshold criteria. The October start scenario (dashed line) has been overlaid on the April base case scenario (solid line) in Figure 17. Zones of impact derived from the October start modelling are not directly comparable with the Draft EIS/ERMP zones (Sections 11.3 & 11.4) as the new model incorporates changes to the development plan, spoil ground, meteorology, bathymetry and distribution of particles.

Under both schedule scenarios, the main impacts to marine BPP are in close proximity to dredging operations (Figure 17). However, the predominance of

Figure 17:

A Comparison of the Predicted Areas of Impact from Dredging and Spoil Disposal if Dredging Starts in April (Base Case – Solid Line) and October (Dashed Line)



southerly winds after an October start tend to push sediment plumes further north in nearshore waters, which results in larger and more northerly zones of high and moderate impacts around the MOF, LNG channel and spoil ground. The high impact zone south of the proposed marine facilities at Camp Point is not present under the October start scenario (Figure 17).

The northward flow following the October schedule scenario causes a large zone of moderate impact to form over the east coast marine facilities and extend up onto the southern Lowendal Shelf (Figure 17). Moderate impacts in nearshore waters south of Camp point are reduced from those predicted for an April start and no impacts to the eastern Lowendal Shelf are anticipated. The moderate impact zone surrounding the spoil ground extends further northeast under the October start scenario (Figure 17).

The moderate impact zone under the October start scenario covers part of the regionally significant *Acropora* community on the south western corner of the Lowendal Shelf. Potentially high mortality in this area would lead to long-term impacts to a regionally significant BPP assemblage. This would increase the residual risk of unacceptable impacts.

8.8 BPPH calculations

8.8.1 Background

Benthic primary producer habitats comprise both benthic primary producer communities and the substrates that support these communities. Examples of benthic primary producer habitats in the Pilbara region include coral reefs, seagrass meadows, macroalgae beds and mangrove forests as well as the intertidal and subtidal substrates that support them. Benthic primary producers are important as they are a key source of energy (primary production) in marine ecosystems, provide substrate and shelter for other marine organisms and increase substrate stability (EPA 2004).

The EPA has developed a Guidance Statement aimed at protecting benthic primary producer habitat (EPA 2004). This Statement specifically applies to development proposals that may result in removal or destruction of, or damage to, benthic primary producer habitats. The guidelines provide for the protection and maintenance of ecosystem integrity by applying a risk-based environmental protection framework which includes quantitative cumulative loss thresholds (EPA 2004).

Consistent with the EPA guidance (EPA 2004), unavoidable impacts to benthic primary producer habitats have been assessed as either 'permanent loss' or 'temporary change'. A thirty year recovery period has been selected as the basis for distinguishing between permanent loss of BPPH and temporary damage to BPPH. 'Permanent loss' indicates loss of the functionality of the benthic primary producer habitat such that it is no longer able to support the same benthic primary producer communities or that the damage to the BPP community persists for greater than 30 years, e.g. *Porites bombora* in high impact zones. A permanent change in the substrate type is also treated as benthic primary producer habitat loss, although there is frequently a mitigating shift to another benthic primary producer habitat type, such as that predicted to occur at the spoil ground.

'Temporary damage' to benthic primary producer habitat indicates temporary or sublethal impacts that may reduce or remove the current standing crop of benthic primary producers, but that the substrate will retain its ecological function as benthic primary producer habitat and the benthic primary producer communities are predicted to recover fully within 30 years. Full recovery indicates the recovery of the biomass of BPP and the full diversity of marine life associated with the original BPP community. Macroalgae dominated limestone reefs, subtidal limestone reef platforms with macroalgae and scattered corals and reef platform/sand with scattered seagrass within high and moderate impacts zones are considered to be temporarily affected as full recovery of these communities is anticipated within five years of the disturbance.

Impacts to benthic primary producer habitats from the proposed Development are expected to comprise direct loss by removal (dredged areas) or burial (infrastructure, dredge spoil) and temporary damage (anchor scars, sedimentation, increased turbidity). Most of the damaged areas are expected to recover fully during the post-construction period when water quality and sedimentation return to within their natural range. Much of the permanent loss of benthic primary producer habitat will be offset by colonisation of new hard substrates created by the Development, for example the causeway, jetty piles and dredge spoil ground.

Direct and permanent removal of BPPH by excavation or replacement by infrastructure, permanent modification of BPPH type and loss of BPP communities that

may take greater than 30 years to recover have been assessed as loss against the cumulative loss threshold criteria (EPA 2004). Impacts due to temporary loss from sedimentation, direct disturbance (anchoring), and turbidity have been assessed as damage from which full recovery is predicted within 30 years. Sedimentation and turbidity (TSS) impacts are considered as loss only if they lead to total mortality of a BPP assemblage or serious damage to a BPPH that would not recover within 30 years, e.g. death of an extensive *Acropora* thicket or large *Porites* bomбора.

8.8.2 Revised BPPH Assessment

The assessment of impacts to BPPH in this section provides an update of the BPPH assessment conducted for the Draft EIS/ERMP to incorporate changes to the development plan, new model input data, the revised dredging schedule and the new cumulative threshold criteria. The assessment is based on the revised marine benthic habitat map as described in the Additional Information Package and shown in all figures in this report. Only the management units for which there have been changes since the Draft EIS/ERMP assessment have been re-assessed. The original BPPH assessment can be found in Sections 11.3 & 11.4 of the Draft EIS/ERMP.

Seven of the east coast management units defined in the Draft EIS/ERMP (Section 11.4) are predicted to suffer impacts to BPPH, based on the results of the revised hydrodynamic dredge plume model and the existing HDD plume model. These management units 3, 4, 7, 8, 9, 10, and 11. A summary of the area of different benthic primary producer habitat types within these seven management units and the total cumulative losses of each benthic primary producer habitat expected in each unit, including permanent and temporary change is presented in Table 5.

Predicted losses and damage within each management unit are described in the following.

Management Unit 3 – South of Lowendal Islands

Benthic primary producer habitats around the Lowendal Islands (MU3 – Figure 18), to the north-east of Barrow Island, include macroalgae dominated reefs, seagrass communities and sparse coral assemblages. Management unit 3 lies within the multiple use area of the Barrow Island Marine Management Area and has a cumulative loss threshold of 2%. The revised dredge plume modelling indicates that a small plume of elevated TSS may persist in the vicinity of the

Lowendal Islands. This is predicted to have moderate impacts on BPPH. There are no known areas of BPPH in this management unit that would take longer than 30 years to recover. These impacts are considered acceptable.

Management Units 4, 7 & 8 – East Coast Barrow Island

The main coastal components of the proposed Development are concentrated in the mid-east coast of Barrow Island at Town Point and include the causeway, MOF, dredged shipping channels, open-pile jetty and domestic gas pipeline. Revised dredge plume modelling predicts impacts from dredging and spoil disposal to BPPH in four of the existing management units (MU4, 7, 8 & 9) established within the Barrow Island Port Area (Figure 18). Management unit 9 is included in the subsequent section.

These management units lie within the Barrow Island Port Area, designated by the *Shipping and Pilotage Act 1967* and vested under the *Marine and Harbours Act 1981*. Under the benthic primary producer habitat Guidance Statement (EPA 2004), a port may be classified as a Development Area (Category E) with a cumulative loss threshold of 10%. The whole port area represents a higher management level at which the significance of the predicted cumulative benthic primary producer habitat losses can be assessed.

The port management units encompass a large proportion of the benthic habitats along the east coast of Barrow Island. They include nearshore reef platform adjacent to the east coast of Barrow Island, the southern Lowendal Shelf, the reef ridge running south from the Shelf and areas of deeper sand veneers over pavement reef (Figure 18).

Permanent loss within these management units is associated with proposed construction of the solid causeway and MOF, the dredged access channel for the MOF, domestic gas pipeline (30 m disturbance corridor), open-piled jetty (18 m disturbance corridor), dredged tanker turning/loading basin, dredged shipping channel and optical fibre cable (10 m corridor). Benthic primary producer habitats within the high and moderate impact zones are predicted to be temporarily damaged unless the zones include BPPH that may not recover to the same pre-disturbance benthic primary producer communities within 30 years. The predicted areas of moderate impact under the 'base case' do not include any benthic primary producer habitats that would take greater than 30 years to recover.

Permanent loss of coral BPPH is predicted to be greater than the CLT in MU4 and MU8 (Table 5). Scattered large *Porites* bombora on the rocky ridge running south from the Lowendal Shelf may take longer than 30 years to fully recover and are assessed as permanent loss. While these losses exceed the CLT (10%), they are considered sustainable as not all of the corals are long-lived *Porites* bombora and the affected *Porites* bombora are the smallest of those in the area. There are much better developed *Porites* bombora fields to the north and to the south of the dredge area that are not predicted to be affected. The physical structure of these bombora will continue to provide complex habitat for the faunal assemblages currently inhabiting the area.

Sedimentation and elevated TSS concentrations are predicted to cause temporary loss of BPPH in all of the port area management units (Table 5). The largest temporary losses are predicted for the management units adjacent the dredging sites. These areas will recover their function as BPPH when excess sediment and TSS have been reduced to the level that the substrates regain their ability to support the same benthic primary producer communities. Current modelling indicates that sediment deposits will only persist in the immediate vicinity of the dredged areas. In areas beyond the potential permanent sediment accumulation zone, all of the damaged benthic primary producer habitats supporting macrophytes on the east coast are predicted to fully recover in less than 30 years.

Management Units 9, 10 & 11 – Spoil Ground

The benthic primary producer habitats within the dredge spoil management units are characterised by deep sandy seabed with occasional emergent pavement reef which supports scattered seagrass meadows dominated by *Halophila*. The whole of this area is conservatively assumed to be capable of supporting seagrass and is considered as seagrass BPPH. The disposal of boulders and rubble at this site will lead to a change in the substrate type from sandy seabed to boulder reef. This is expected to be a permanent change to the characteristics of the benthic primary producer habitat in the area.

Management unit 9 covers the area within the Barrow Island port limits that would be affected by the spoil ground and the small area of additional dredging for the offshore part of the shipping channel (Figure 18). Management units 10 and 11 encompass the

area outside the Barrow Island port limits, which is proposed for the disposal of dredged material from the MOF access channel and LNG shipping turning basin and channel (Figure 18).

Management unit 9 lies within the Barrow Island port limits and has a cumulative loss threshold of 10%. Management unit 10 lies within the Marine Conservation Reserve boundary and has a cumulative loss threshold of 2%. Management unit 11 is outside the reserve and as a general coastal area has a cumulative loss threshold of 5%.

The proposed dredge spoil area, the offshore area to be dredged for the shipping channel and the domgas pipeline will permanently modify approximately 4, 5 and 11% of the seabed in management units 9, 10 and 11 respectively (Figure 18, Table 5). While the losses exceed the BPPH guidance cumulative threshold levels for the later two management units, they do not represent a threat to the ecological integrity of the surrounding benthic primary producer habitat or to the conservation values of the Barrow Island Marine Conservation Area. Macroalgae and small corals are expected to colonise parts of the spoil ground within 2-5 years and the area will regain function as benthic primary producer habitat. However, seagrasses are unlikely to successfully colonise the area and there will be a permanent shift in benthic primary producer community type. The area to be lost is a very small proportion of this habitat type in the waters off the east coast of Barrow Island and there are no other significant developments in the area.

The spoil ground is predicted to become macroalgae dominated benthic primary producer habitat and will support a diverse assemblage of associated fauna. The local biodiversity is expected to increase due to creation of a new habitat type in the area without affecting the persistence of ephemeral seagrasses in the general area. The permanent loss of the *Halophila* is not expected to effect local populations of turtles or dugong as these animals are highly mobile and forage over large areas, the small areas to be modified are expected to be less productive than shallower sandy areas and this BPPH type is very well represented in the region. No ecosystem function effects are anticipated as a result of the changes to the benthic habitats in these management units.

Table 5: (continued)

BPPH Assessment Under Revised Dredge Plume Modelling and Prediction of Impact Zones using Cumulative Impact Criteria

Benthic Primary Producer Habitat Type	Total area of BPPH before disturbance (ha)	Percentage of temporary BPPH change	Percentage of permanent BPPH loss	CLT ¹
Management Unit 3				
Macroalgae-dominated intertidal limestone reef platform	0	-	-	2%
Subtidal limestone reef platform with macroalgae and scattered corals	2425	10	0	2%
Reef platform/sand with scattered seagrass	1219	3	0	2%
Coral habitats	5	<1	0	2%
Management Unit 4				
Macroalgae-dominated intertidal limestone reef platform	435	9	<1	10%
Subtidal limestone reef platform with macroalgae and scattered corals	2690	11	<2	10%
Reef platform/sand with scattered seagrass	982	15	<1	10%
Coral habitats	157	22	11	10%
Management Unit 7				
Macroalgae-dominated intertidal limestone reef platform	509	56	0	10%
Subtidal limestone reef platform with macroalgae and scattered corals	4032	40	<1	10%
Reef platform/sand with scattered seagrass	331	6	<2	10%
Coral habitats	175	0	0	10%
Management Unit 8				
Macroalgae-dominated intertidal limestone reef platform	0	-	-	10%
Subtidal limestone reef platform with macroalgae and scattered corals	724	38	4	10%
Reef platform/sand with scattered seagrass	3424	24	4	10%
Coral habitats	61	4	21	10%
Management Unit 9				
Macroalgae-dominated intertidal limestone reef platform	0	-	-	10%
Subtidal limestone reef platform with macroalgae and scattered corals	0	-	-	10%

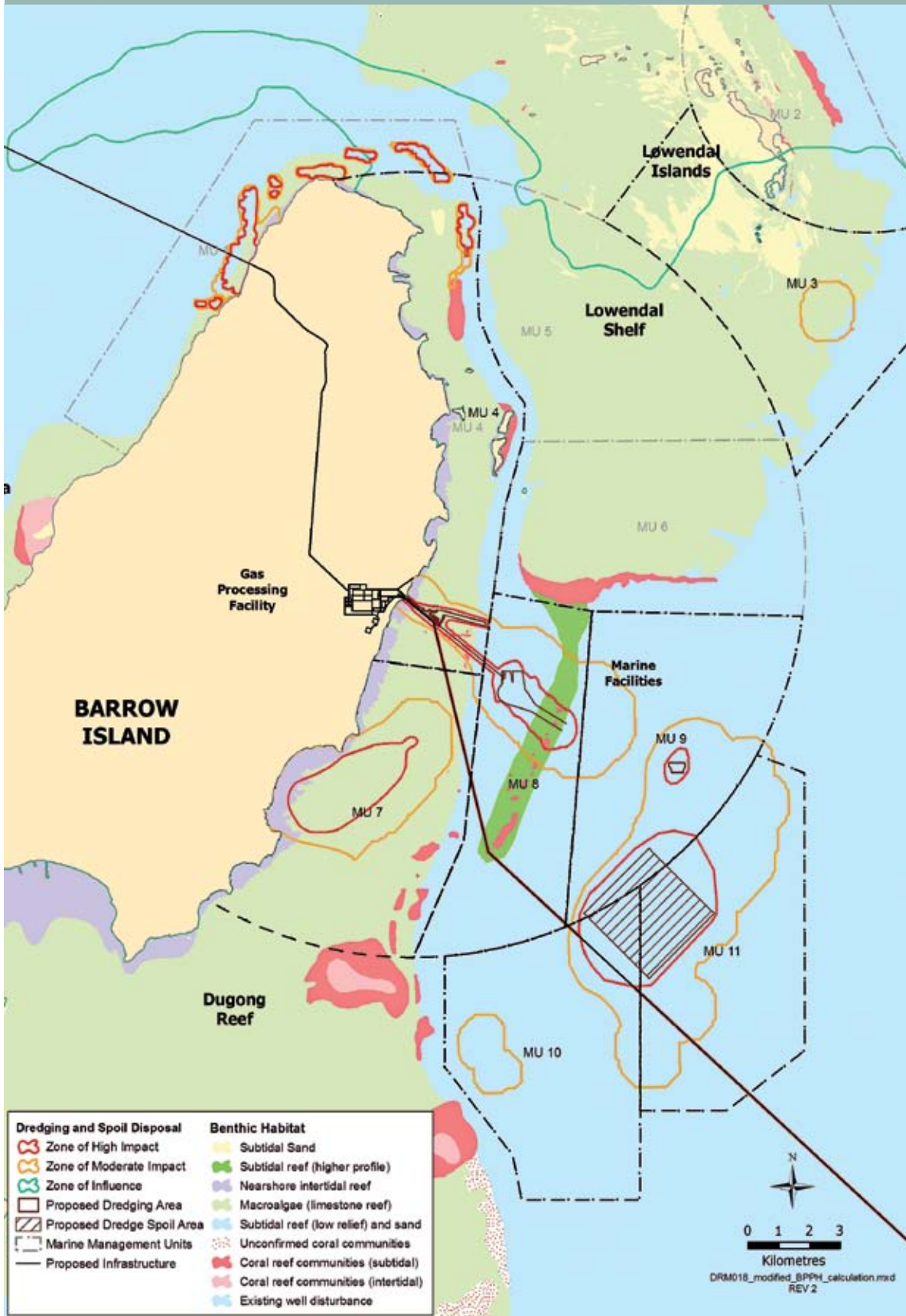
Table 5: (continued)

BPPH Assessment Under Revised Dredge Plume Modelling and Prediction of Impact Zones using Cumulative Impact Criteria

Benthic Primary Producer Habitat Type	Total area of BPPH before disturbance (ha)	Percentage of temporary BPPH change	Percentage of permanent BPPH loss	CLT ¹
Reef platform/sand with scattered seagrass	4941	37	4	10%
Coral habitats	0	-	-	10%
Management Unit 10				
Macroalgae-dominated intertidal limestone reef platform	0	-	-	2%
Subtidal limestone reef platform with macroalgae and scattered corals	0	-	-	2%
Reef platform/sand with scattered seagrass	4923	20	5	2%
Coral habitats	0	-	-	2%
Management Unit 11				
Macroalgae-dominated intertidal limestone reef platform	0	-	-	5%
Subtidal limestone reef platform with macroalgae and scattered corals	0	-	-	5%
Reef platform/sand with scattered seagrass	4760	42	11	5%
Coral habitats	0	-	-	5%

¹Cumulative loss threshold (EPA 2004)

Figure 18:
BPPH Management Units and 'Base Case' Impact Zones



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Appendix A

Vertical Water Quality Profiles

Table 1

Location of Water Quality Monitoring Sites – August/September 2006 (continued)

Site	Description	Location (WGS84, MGAz50)	
		Easting	Northing
WQ1	Barrow Island tide gauge, near Town Point	342492	7700030
WQ2	Barrow Island current metre deployment location, near Town Point	341803	7699456
WQ3	Near a Porites bombora field, offshore of Barrow Island	344601	7696020
WQ4	Location of settlement plate/sediment trap 1	348200	7692084
WQ5	Location of settlement plate/sediment trap 2	345051	7694513
WQ6	Location of settlement plate/sediment trap 5	343552	7696552
WQ7	Location of settlement plate/sediment trap 6	341963	7698562
WQ8	Near Thevenard Island	295404	7625040
WQ9	Barrow Island supply barge mooring, north-west of Double Island	342534	7704742
WQ10	South-west of the southern island at Double Island	342825	7706738
WQ11	Double Island Mooring location	342924	7706732
WQ12	Unconfirmed coral community off North East coast of Barrow Island	341855	7709577
WQ13	Batman Reef	342363	7681962
WQ14	Coral Reef off the south-east of Barrow Island (Backlip Reef)	341906	7692094
WQ15	Double Island Mooring location	342744	7706678
WQ16	Southern extent of Lowendal Shelf	348551	7701071
WQ17	Dugong Reef	340990	7687255
WQ18	Southern area of Barrow Island Shoals	346402	7670436
WQ19	Southern extent of Barrow Island Shoals	346883	7666030
WQ20	Near proposed Materials Offloading Facility	344597	7696395
WQ21	South of Abutilon Islands	352581	7707546
WQ22	Ah Chong Reef	350226	7731772
WQ23	Near Town Point – Barrow Island	339136	7695456

Figure 1:
Vertical Water Quality Profile at Site WQ1, 11 August 2005

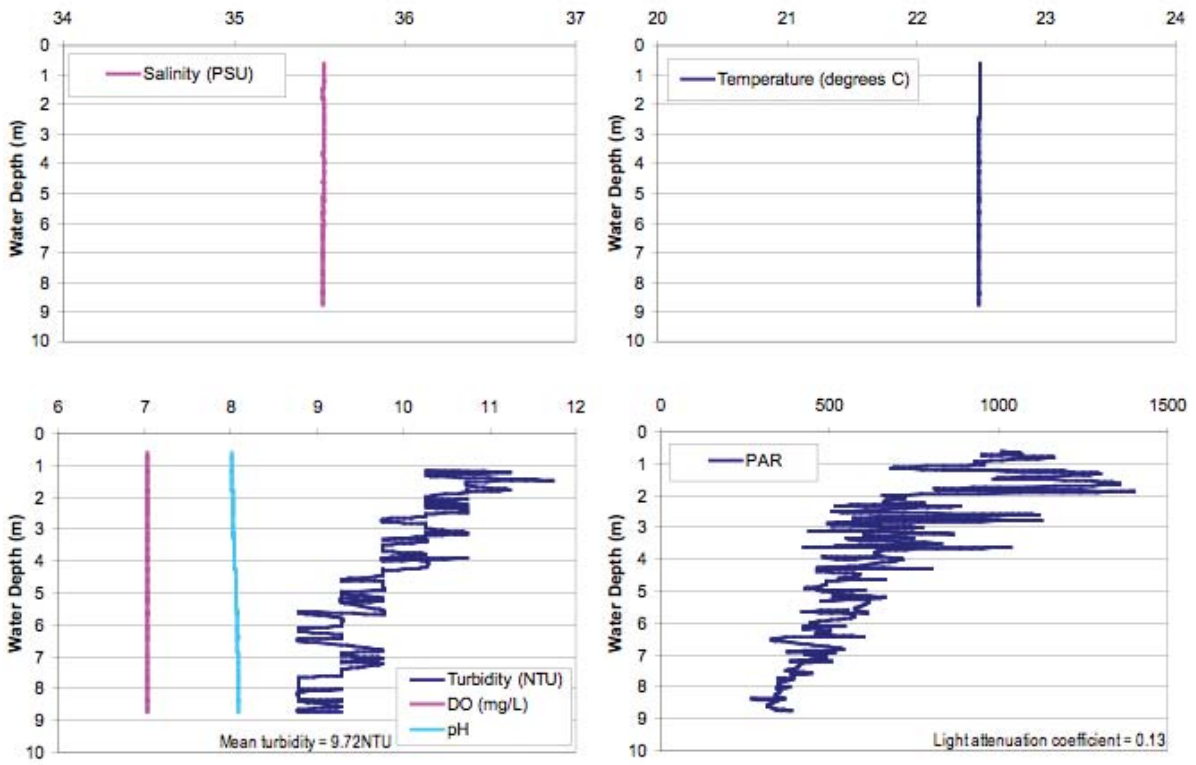


Figure 2:
Vertical Water Quality Profile at Site WQ2, 11 August 2005

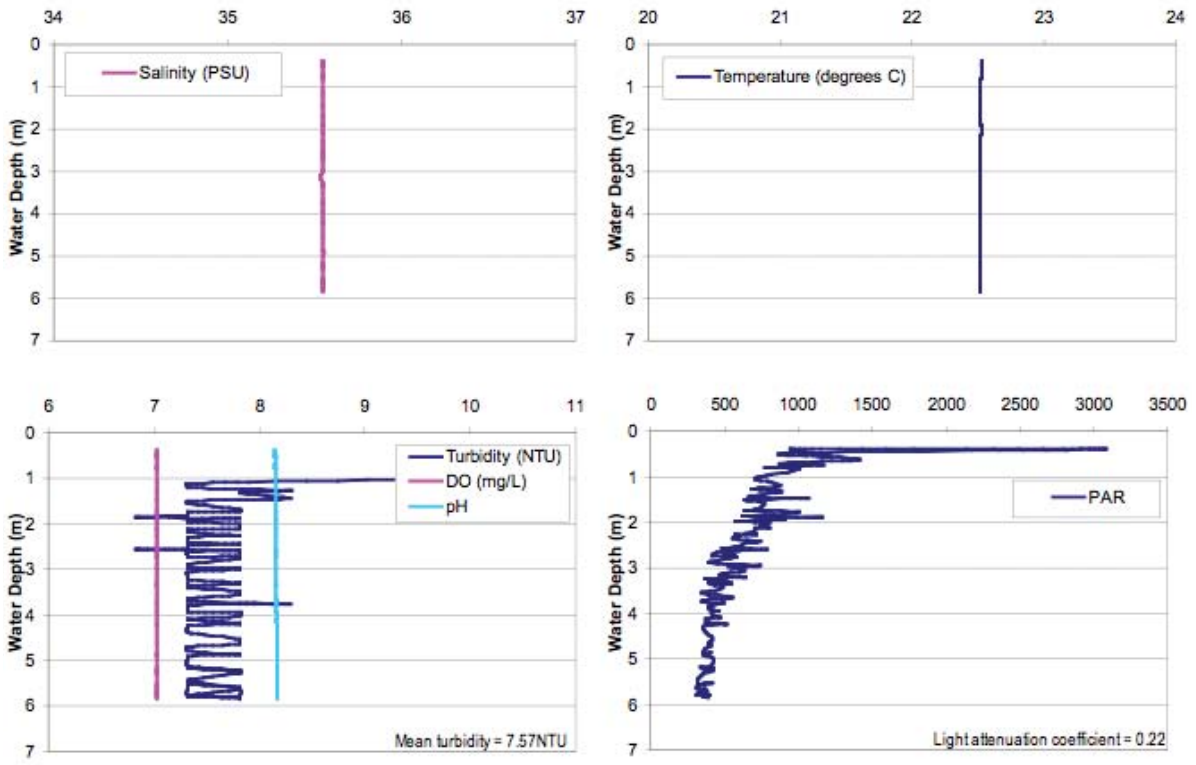


Figure 3:
Vertical Water Quality Profile at Site WQ3, 11 August 2005

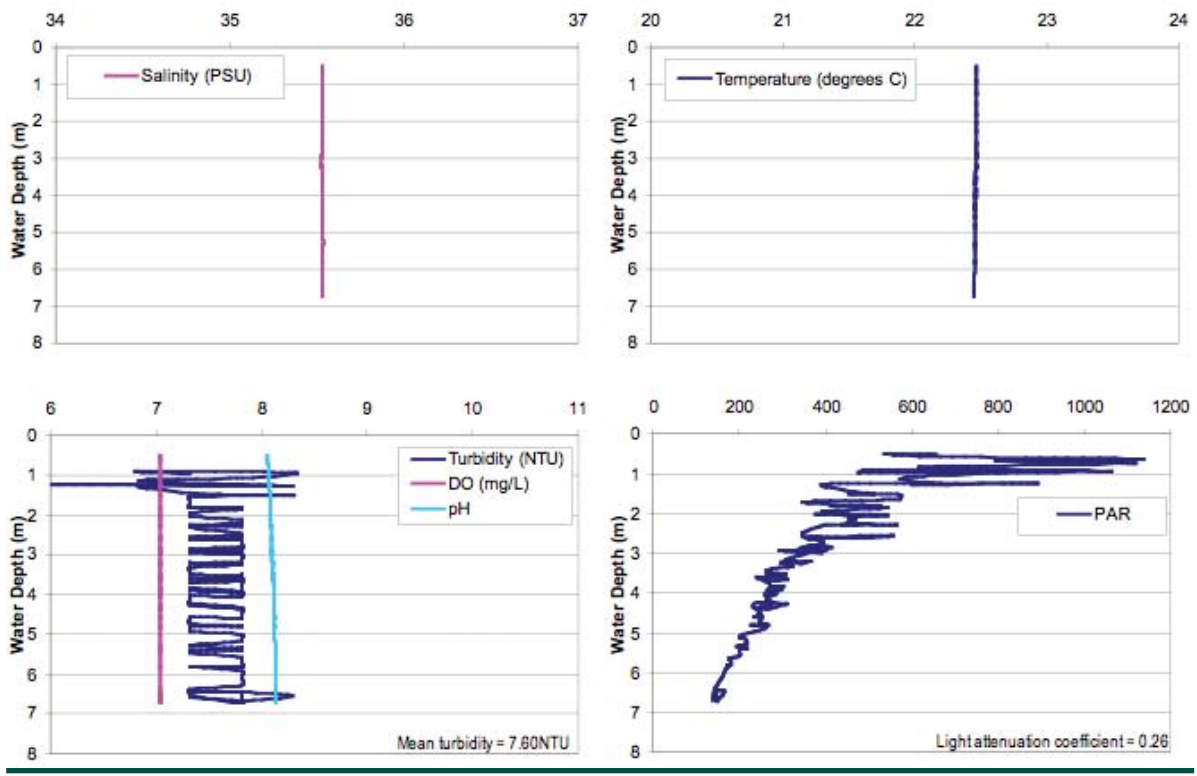


Figure 4:
Vertical Water Quality Profile at Site WQ4, 11 August 2005

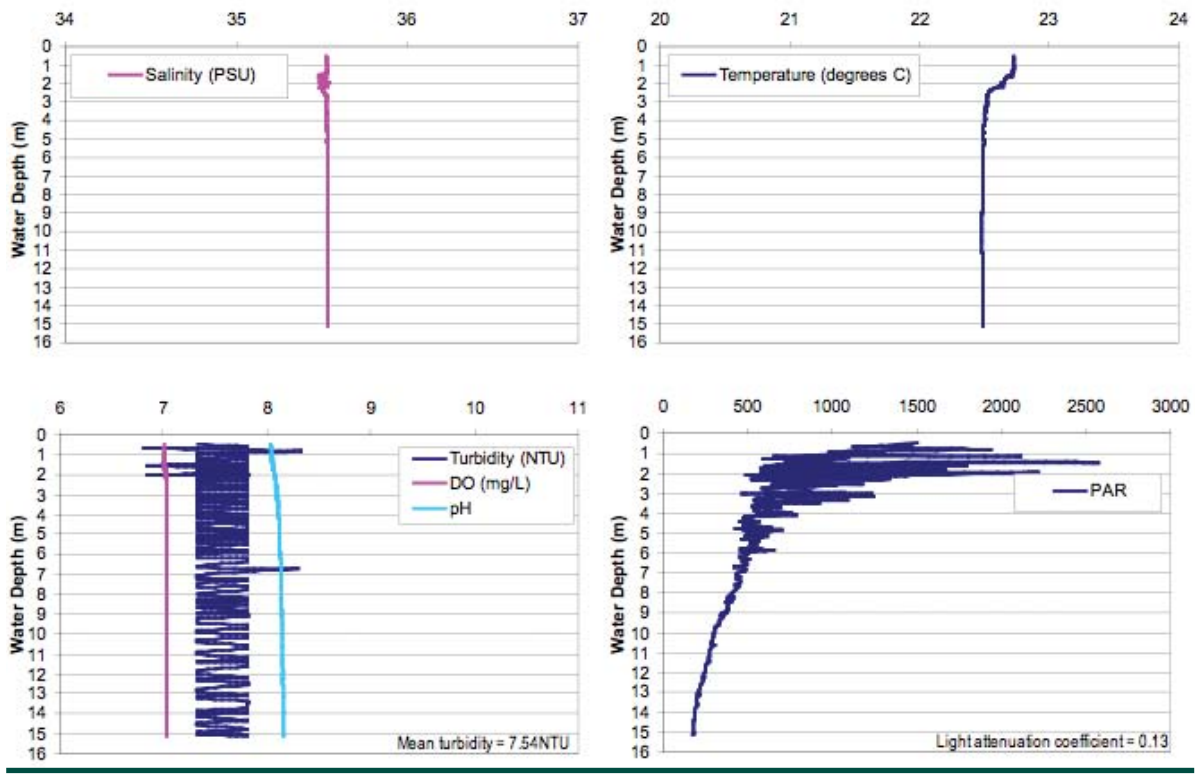


Figure 5:
Vertical Water Quality Profile at Site WQ5, 11 August 2005

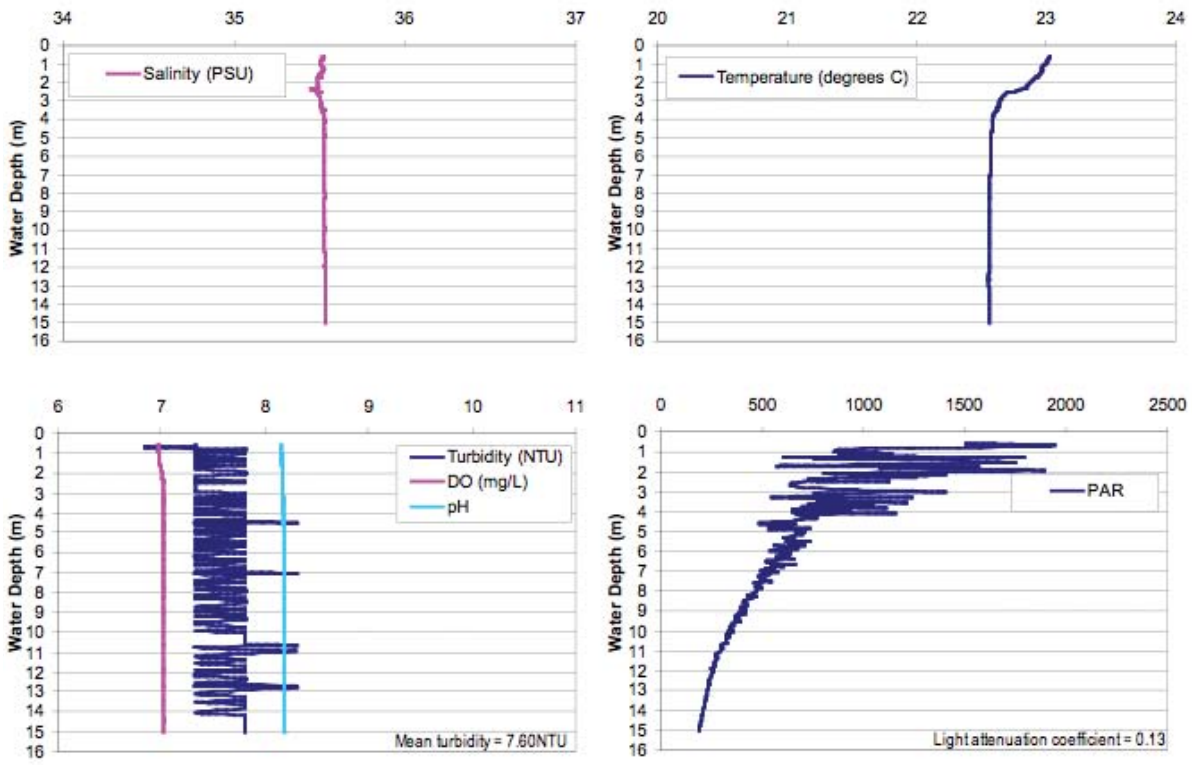


Figure 6:
Vertical Water Quality Profile at Site WQ6, 11 August 2005

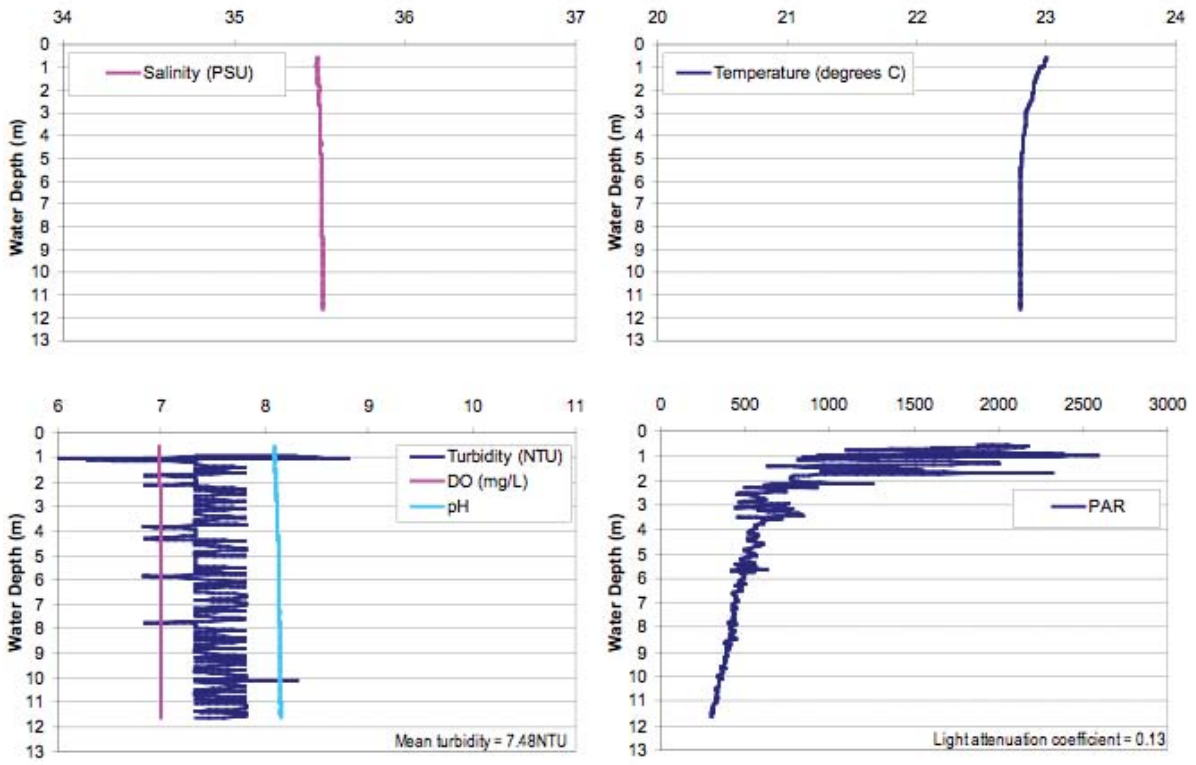


Figure 7:
Vertical Water Quality Profile at Site WQ7, 11 August 2005

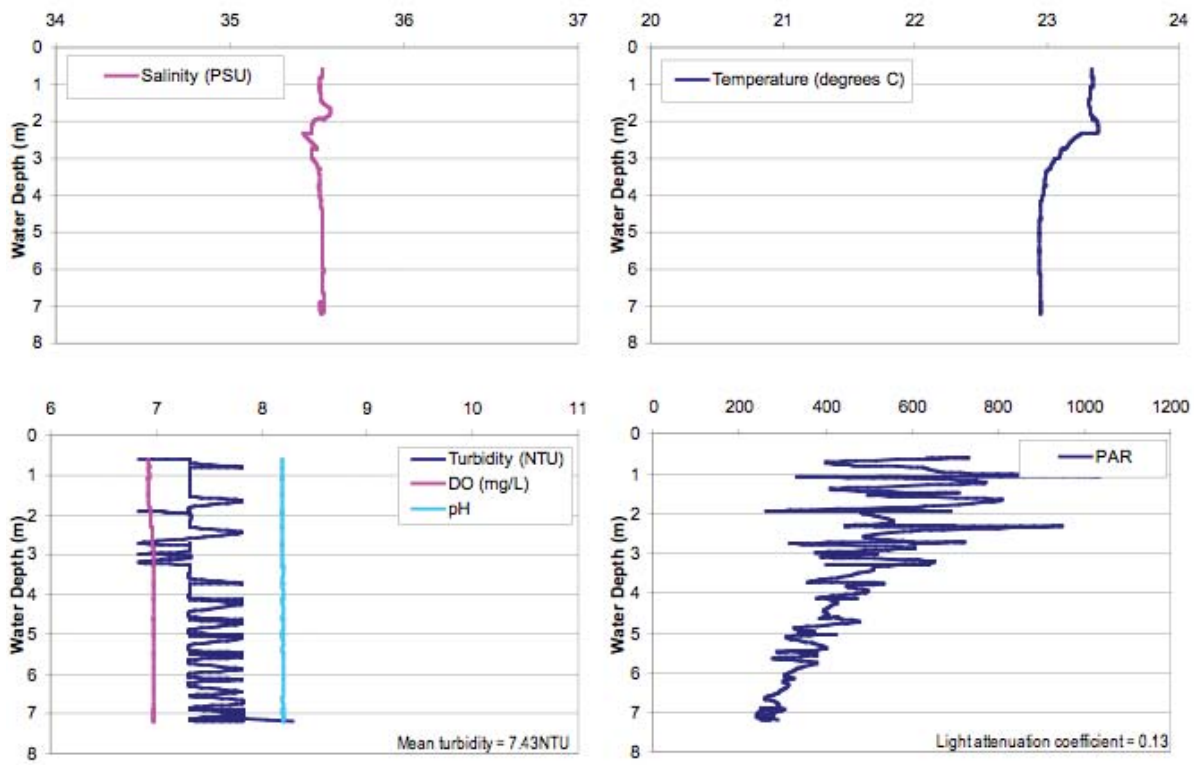


Figure 8:
Vertical Water Quality Profile at Site WQ8, 11 August 2005

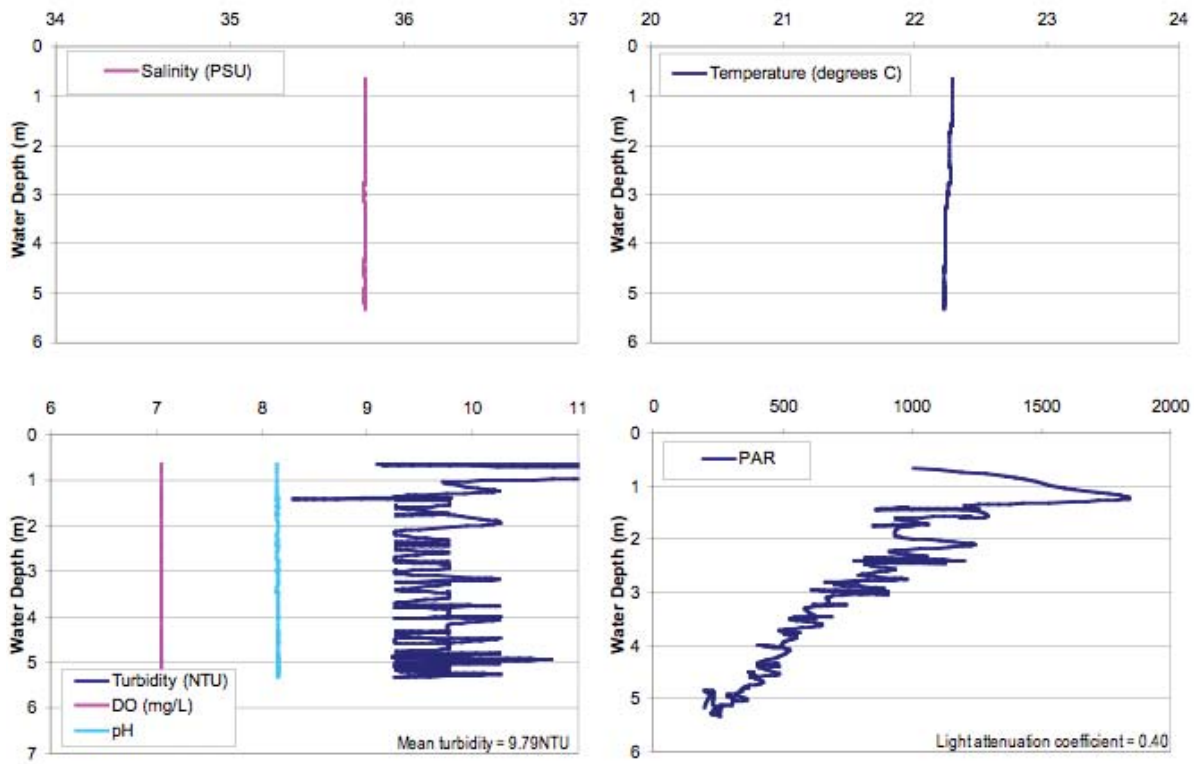


Figure 9:

Vertical Water Quality Profile at Site WQ9, 11 August 2005

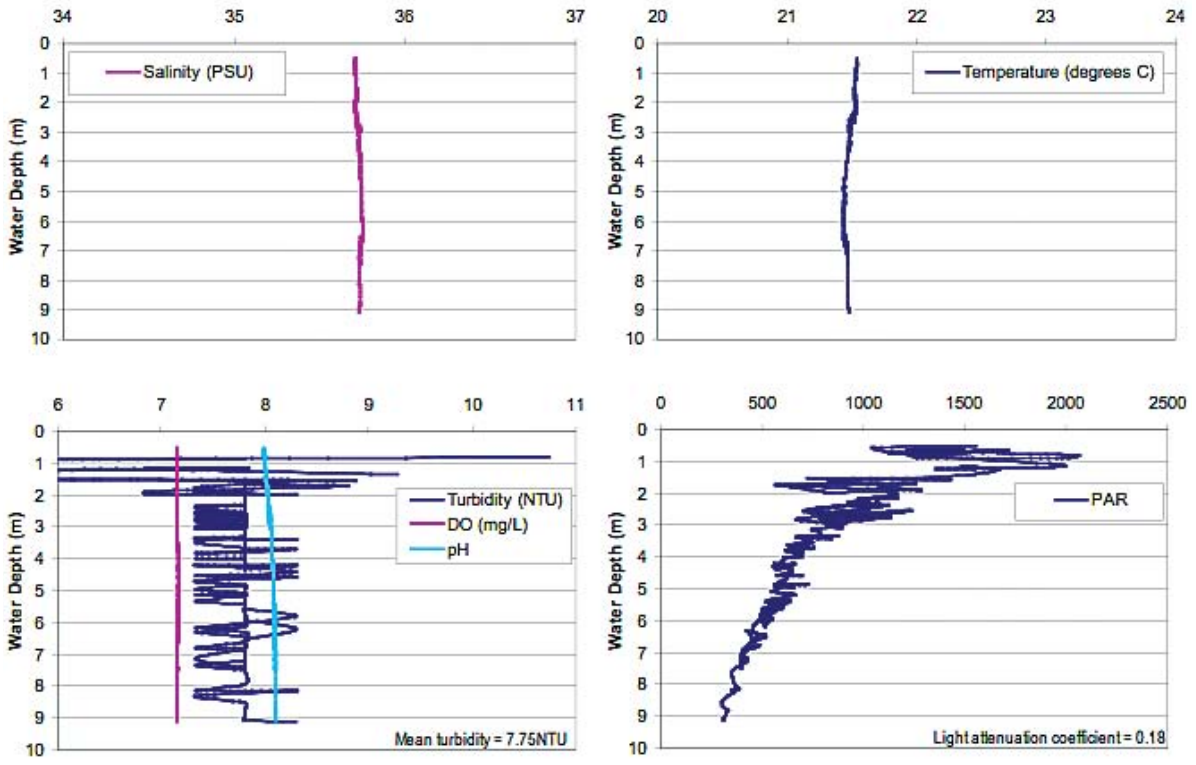


Figure 10:

Vertical Water Quality Profile at Site WQ10, 11 August 2005

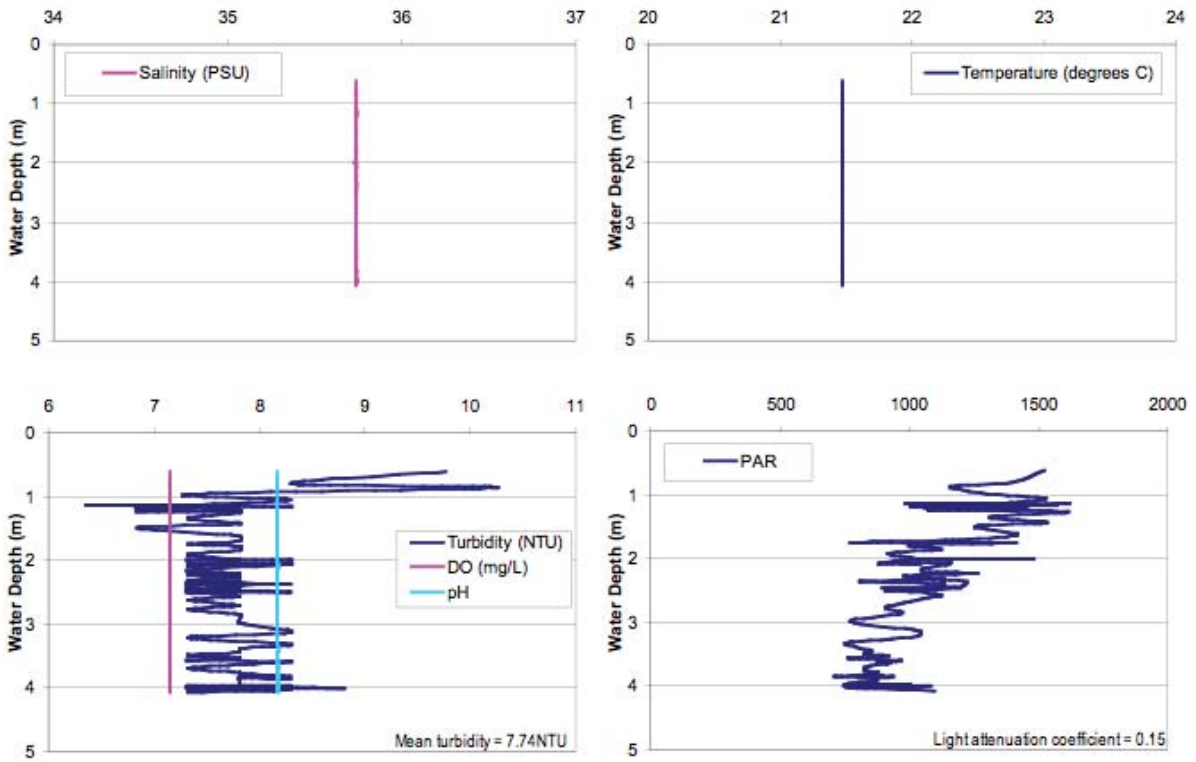


Figure 11a:
Vertical Water Quality Profile at Site WQ11, 9 September 2005

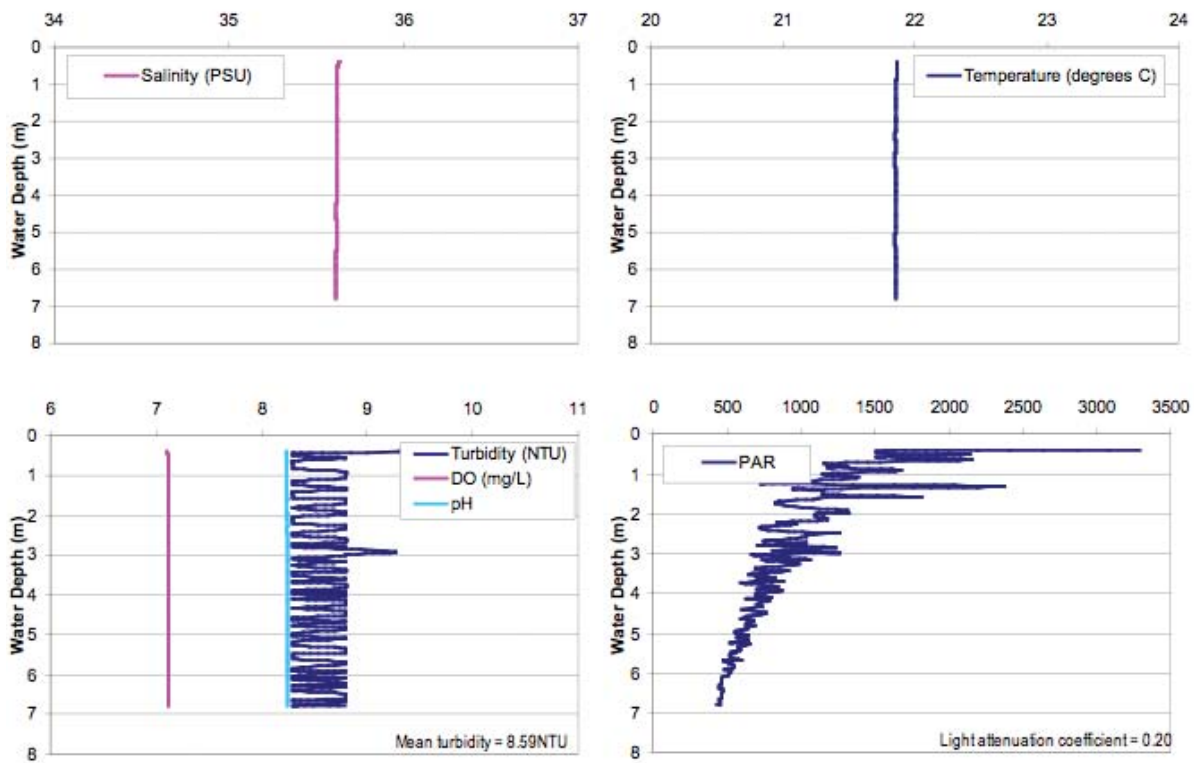


Figure 11b:
Vertical Water Quality Profile at Site WQ11, 9 September 2005

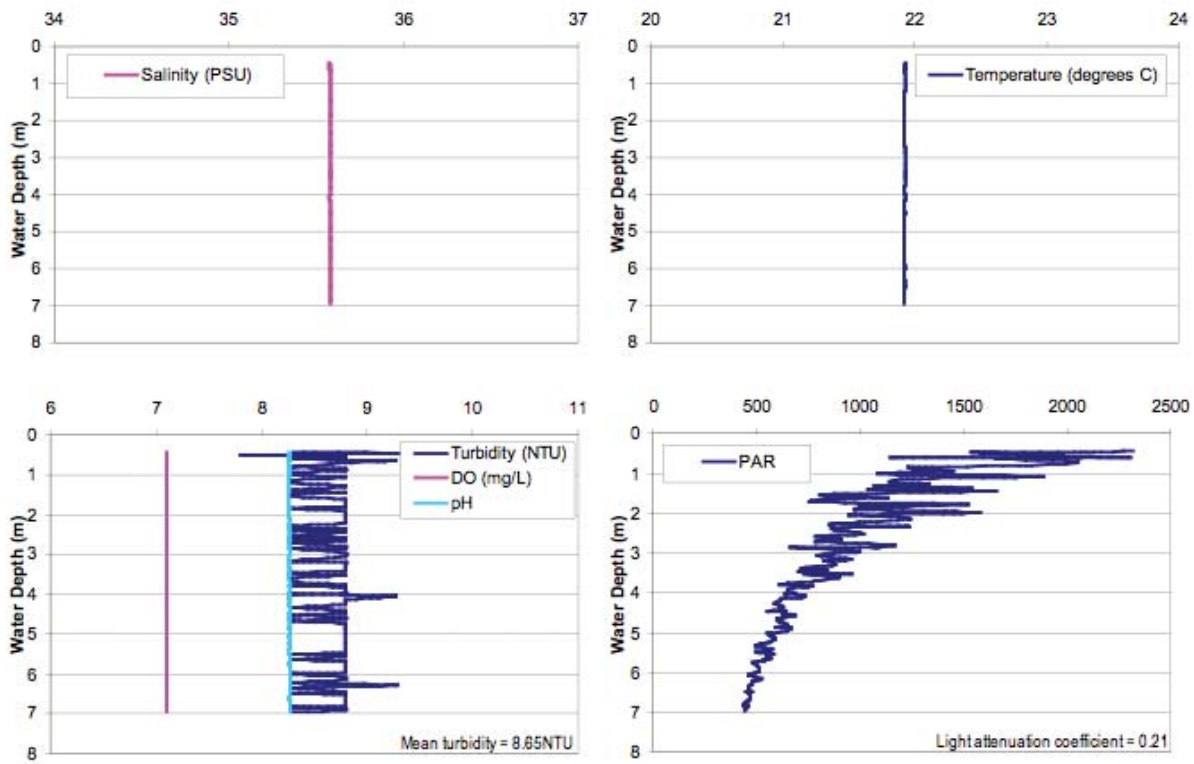


Figure 12:
Vertical Water Quality Profile at Site WQ12, 9 September 2005

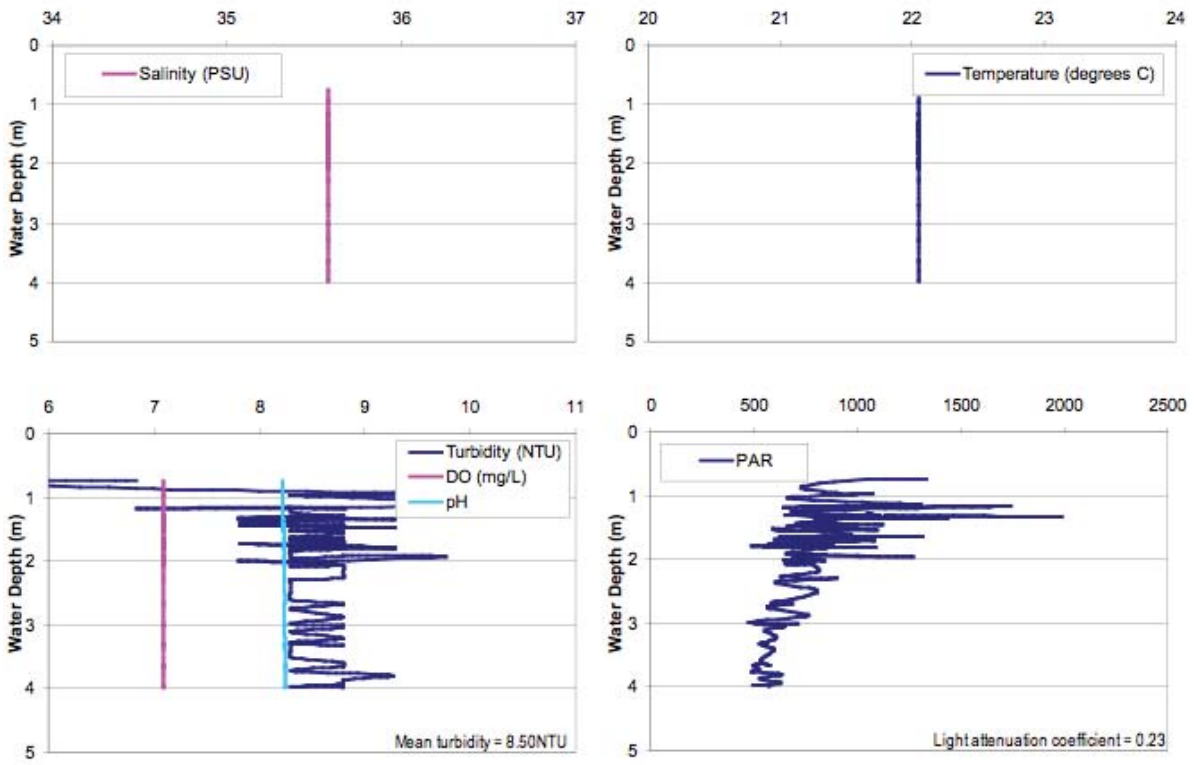


Figure 13:
Vertical Water Quality Profile at Site WQ13, 13 September 2005

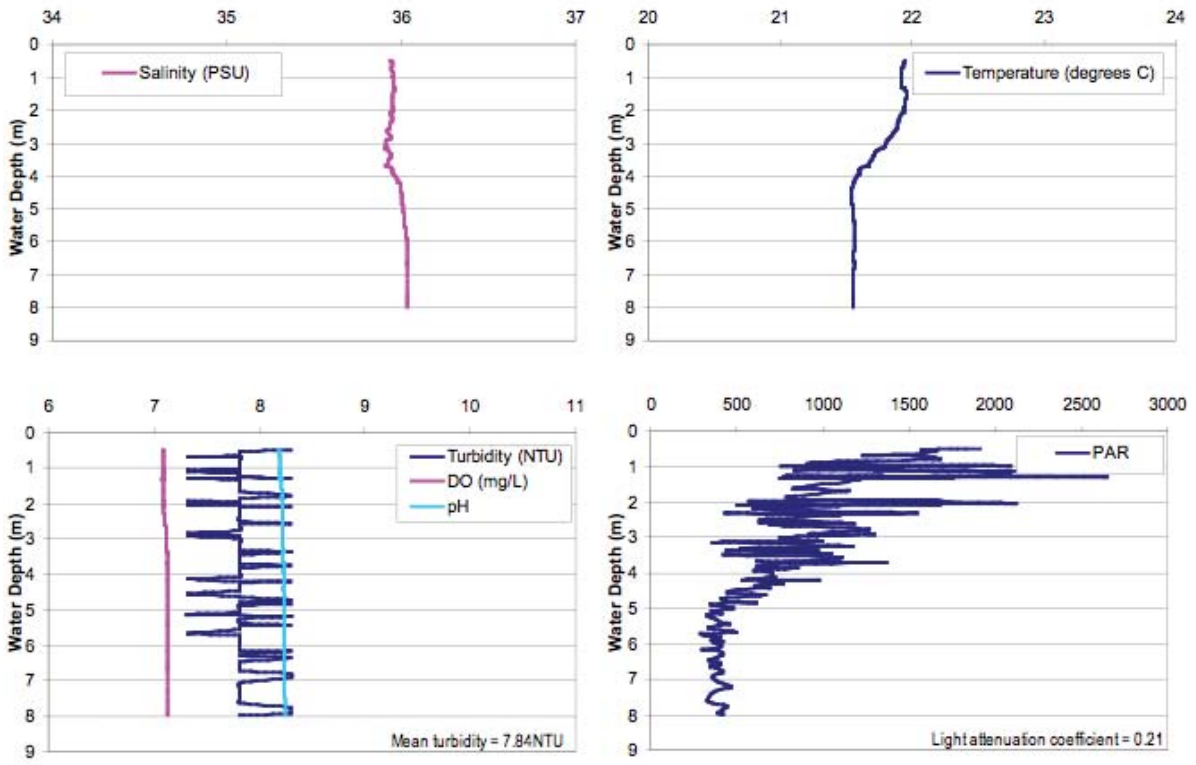


Figure 14:
Vertical Water Quality Profile at Site WQ14, 14 September 2005

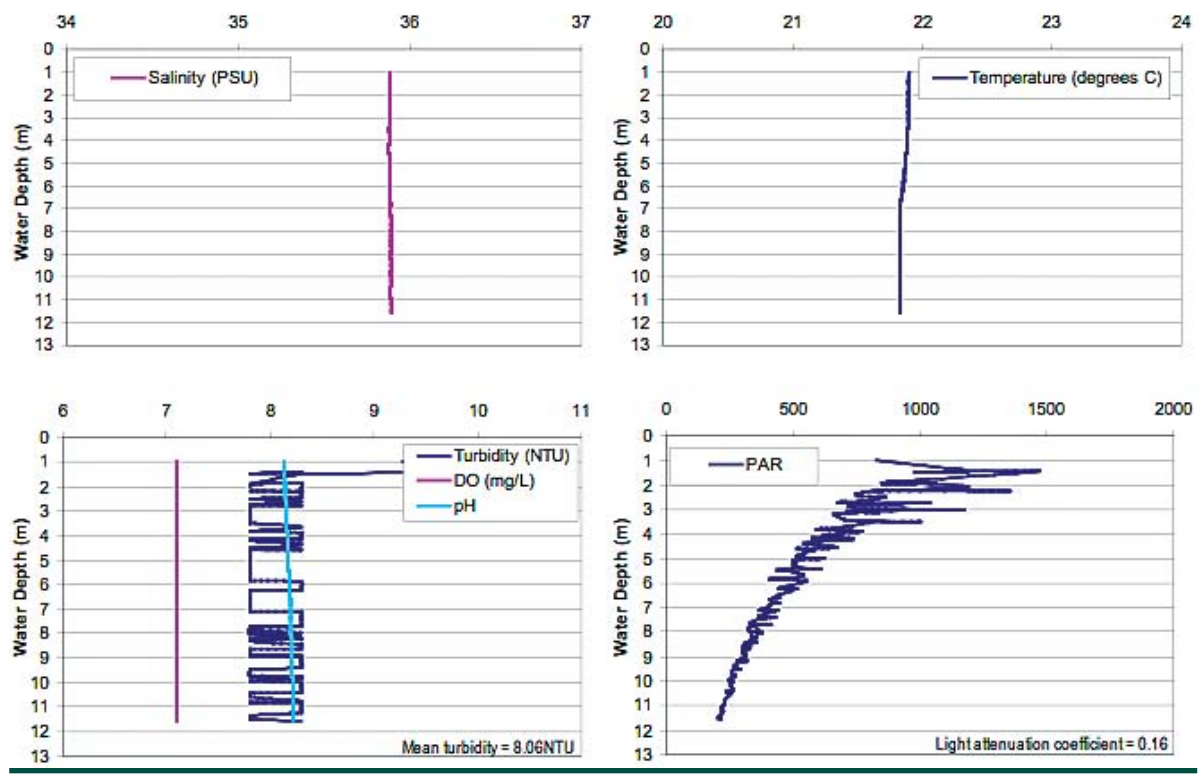


Figure 15:
Vertical Water Quality Profile at Site WQ15, 15 September 2005

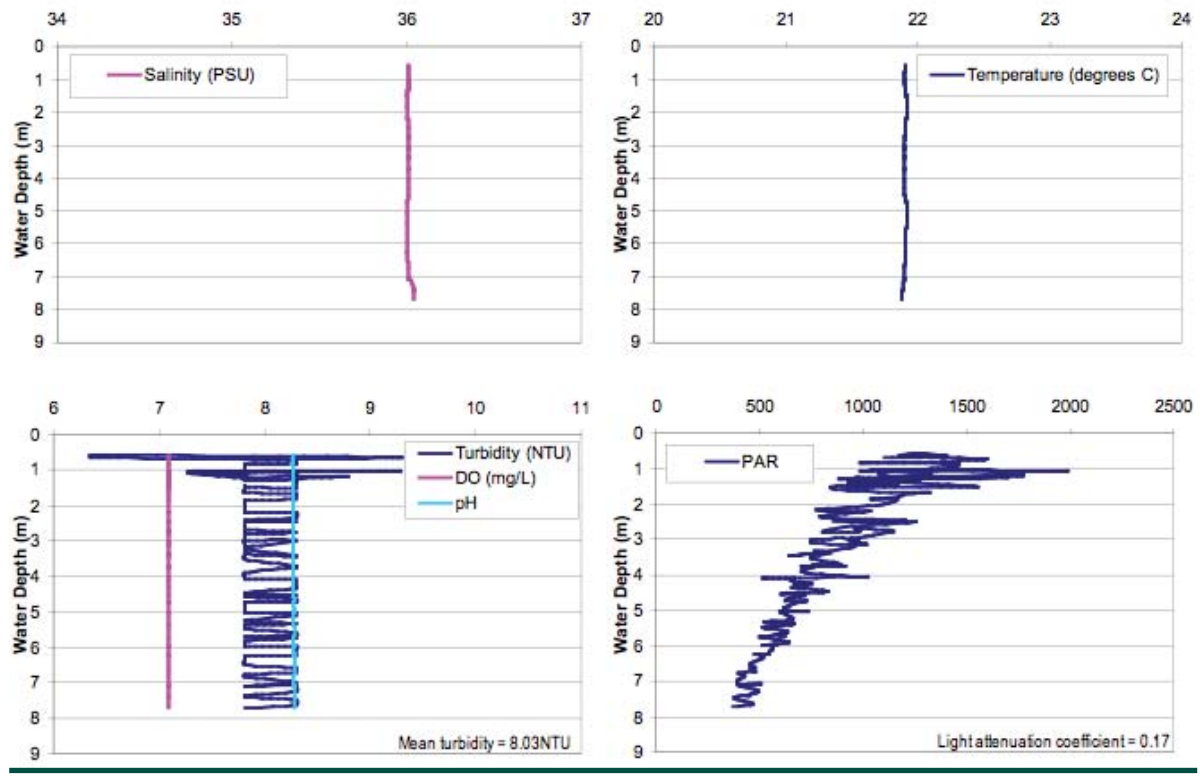


Figure 16:
Vertical Water Quality Profile at Site WQ16, 15 September 2005

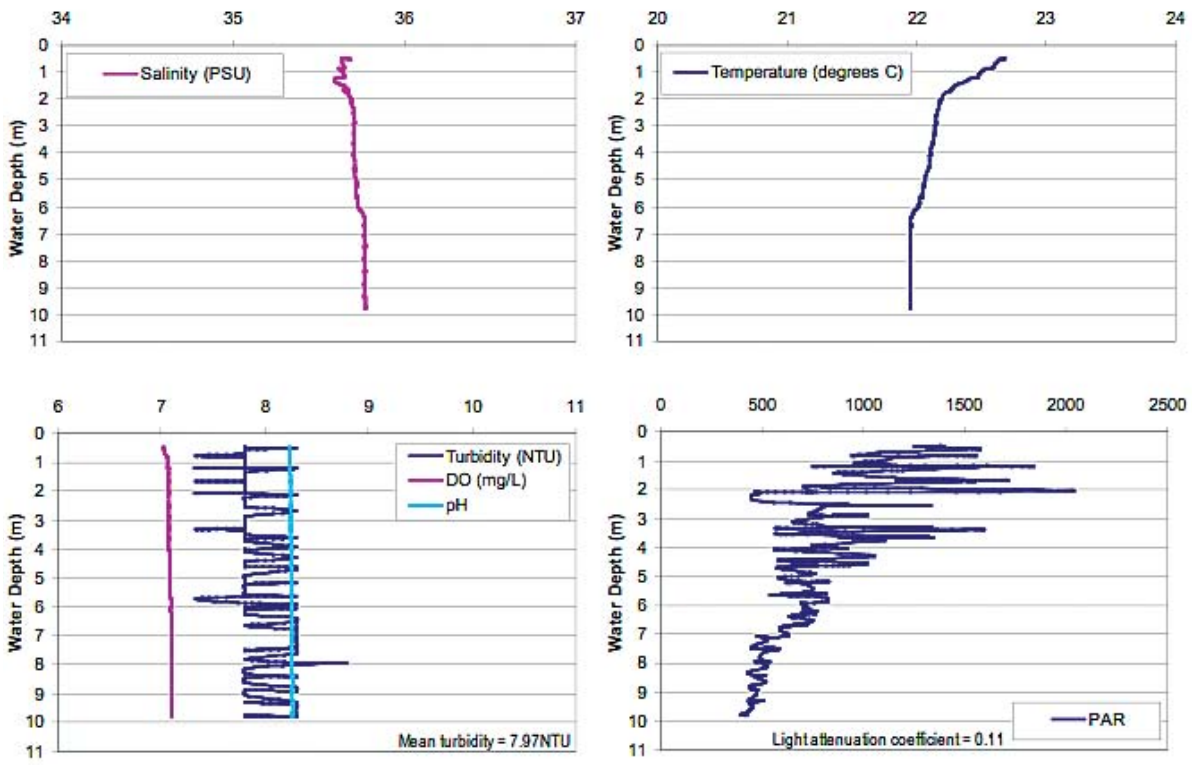


Figure 17:
Vertical Water Quality Profile at Site WQ17, 17 September 2005

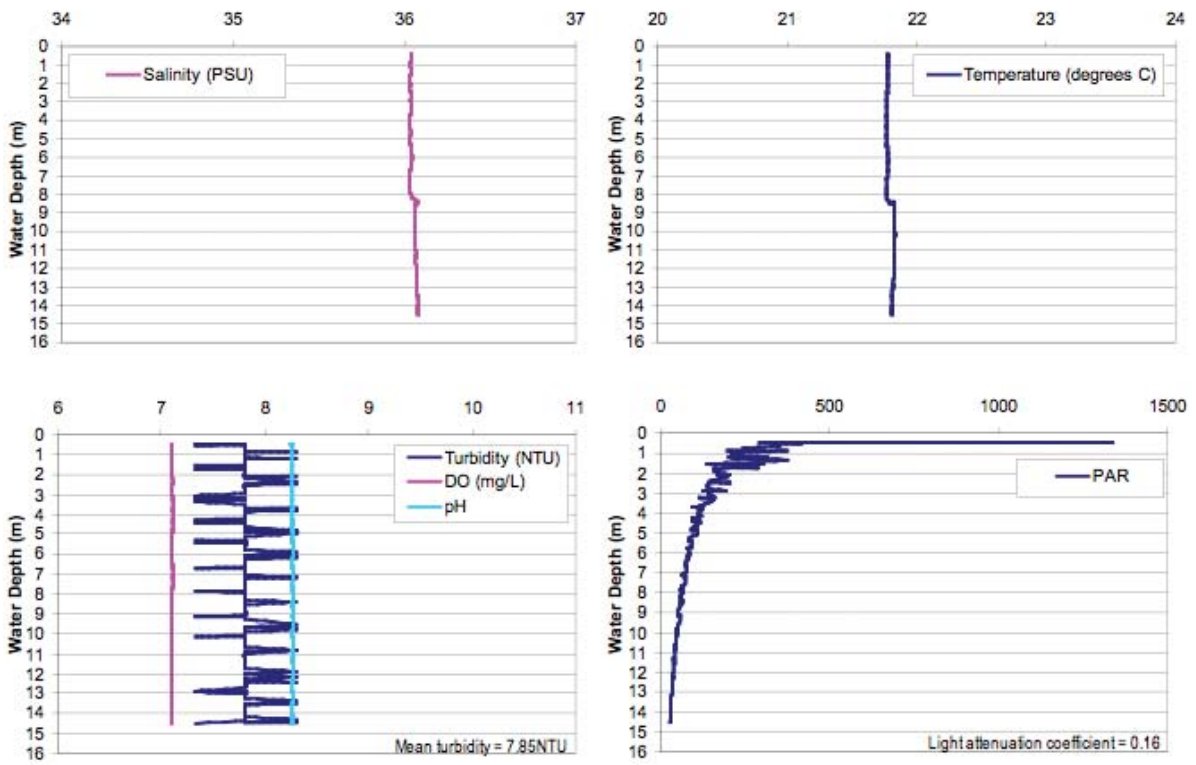


Figure 18:
Vertical Water Quality Profile at Site WQ18, 17 September 2005

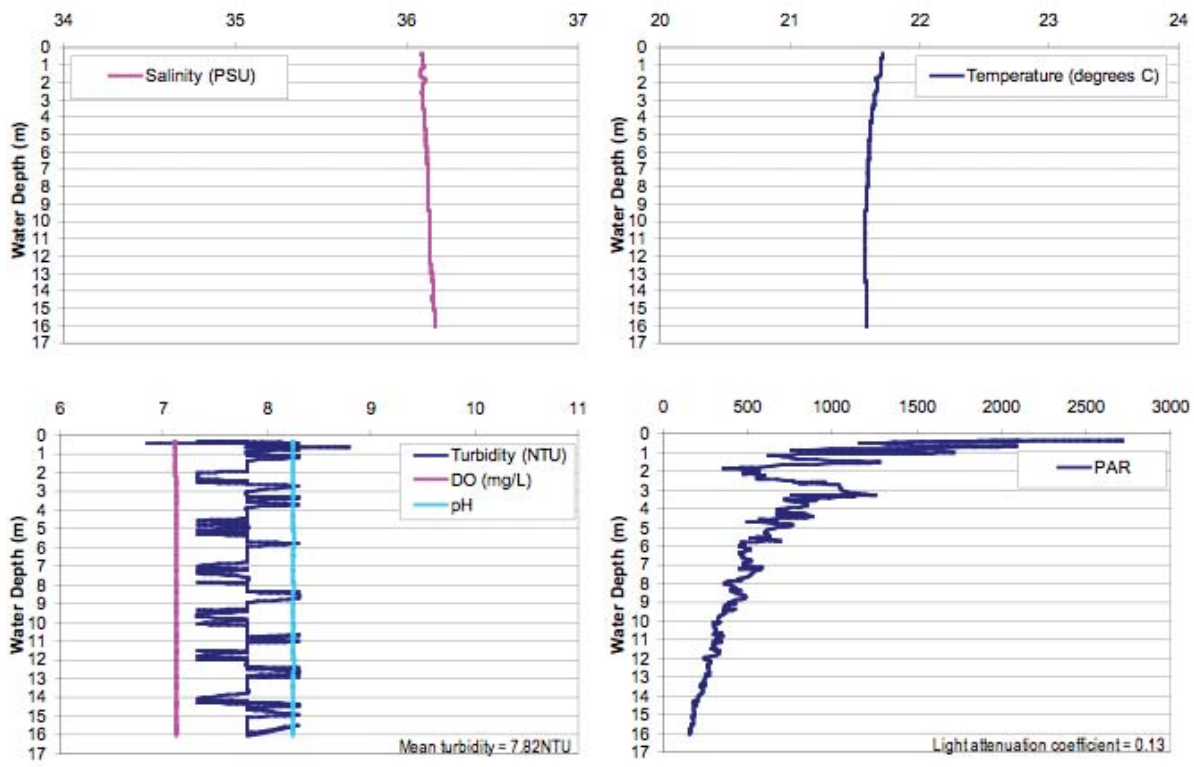


Figure 19:
Vertical Water Quality Profile at Site WQ19, 18 September 2005

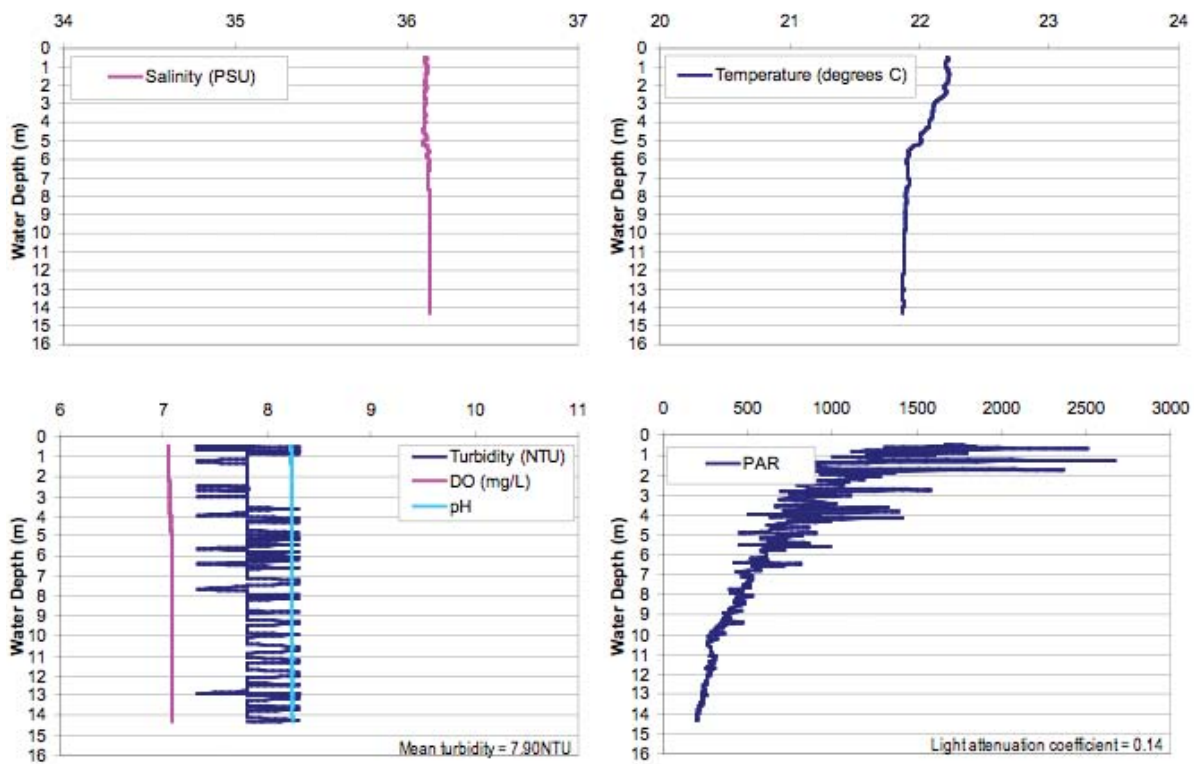


Figure 20:
Vertical Water Quality Profile at Site WQ20, 18 September 2005

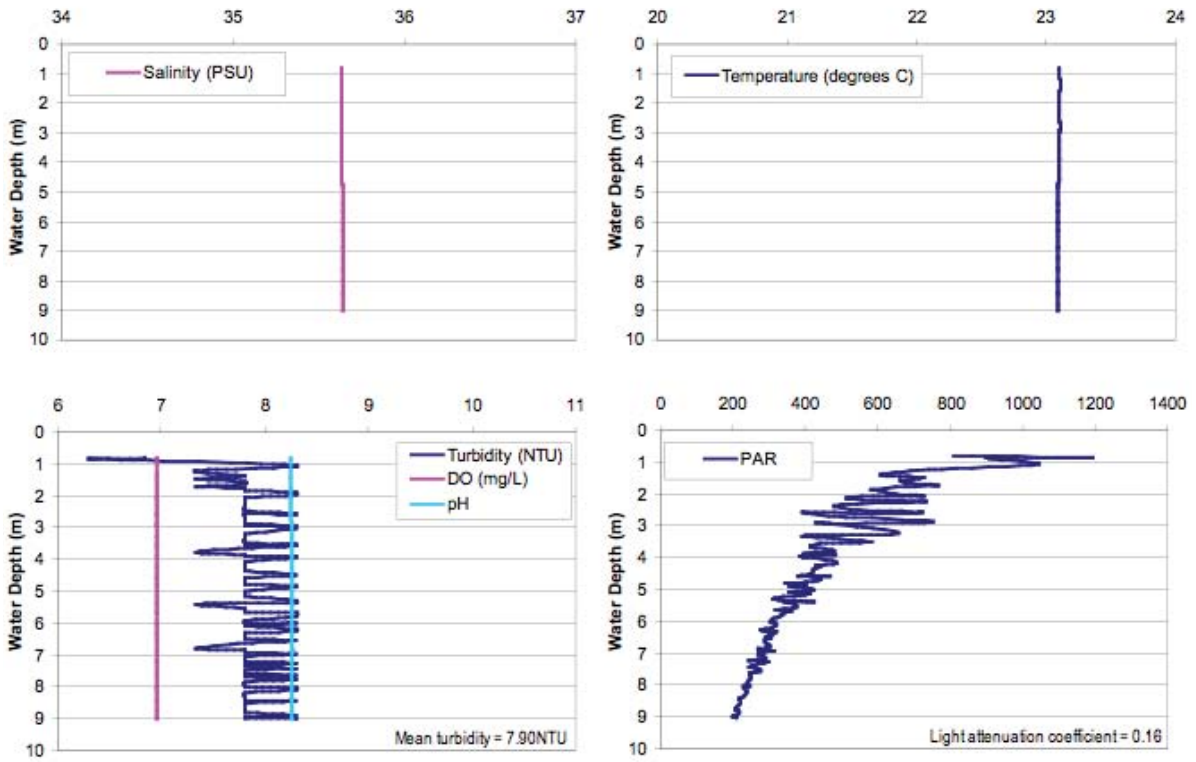


Figure 21:
Vertical Water Quality Profile at Site WQ21, 19 September 2005

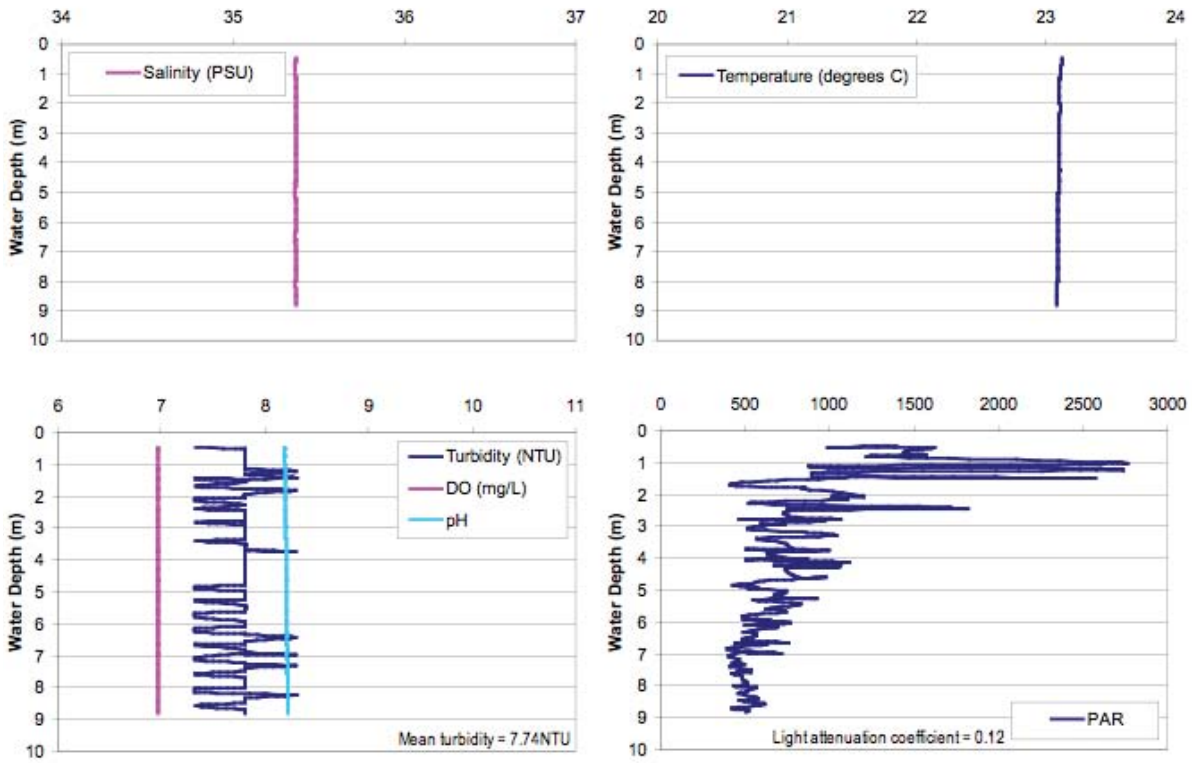
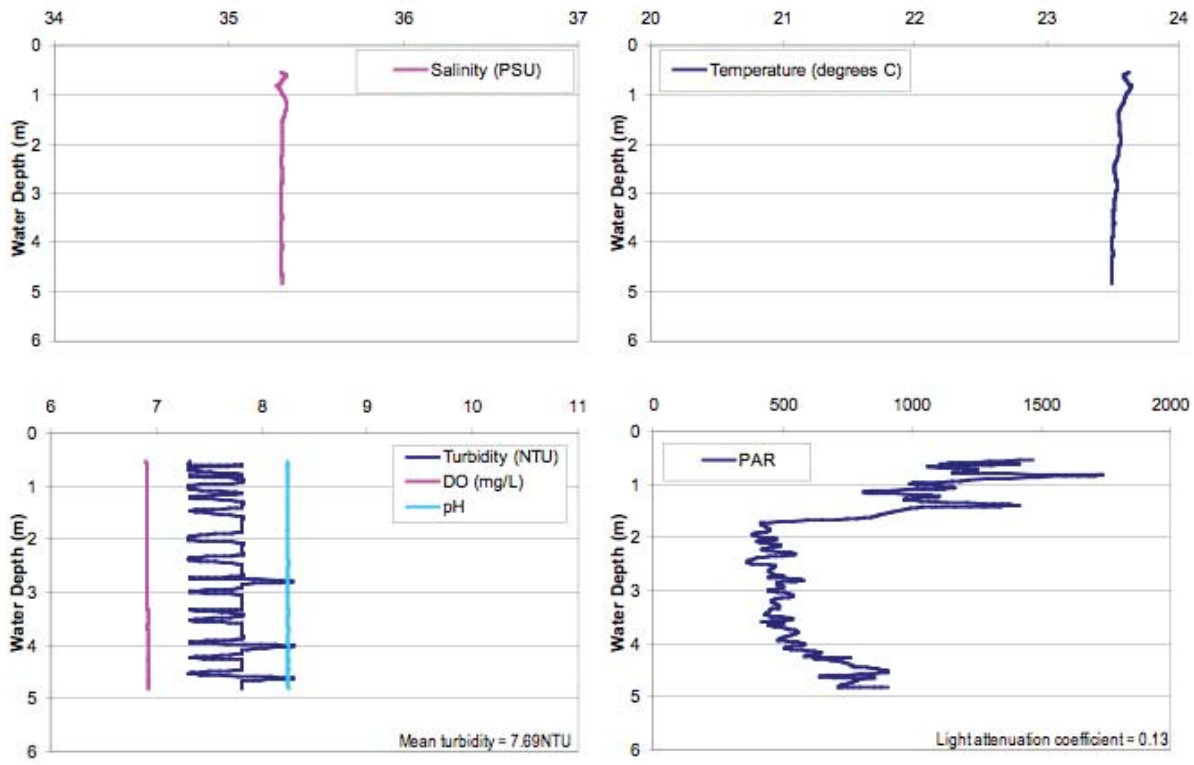


Figure 22:

Vertical Water Quality Profile at Site WQ22, 19 September 2005

**Figure 23:**

Vertical Water Quality Profile at Site WQ23, 20 September 2005

