

09 ■ Risk Assessment Process

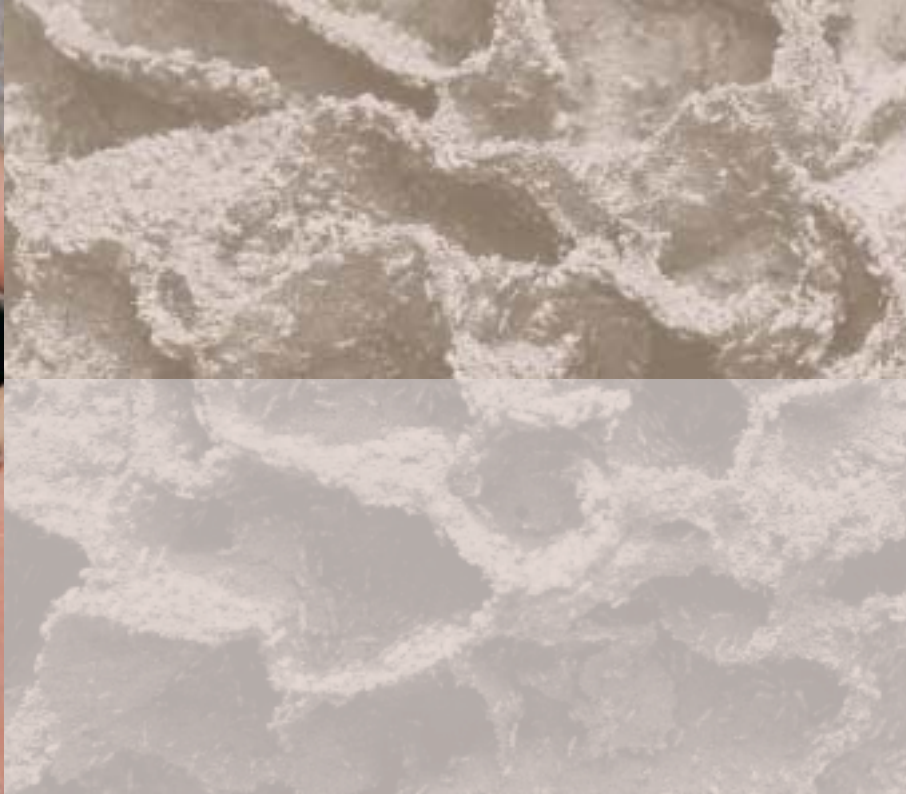


Environmental risk assessment is a process that evaluates the likelihood and consequence of adverse environmental impacts occurring as a result of exposure to one or more stressors. One of the advantages of this process over a more traditional environmental impact assessment approach is that it allows potential environmental hazards or threats to be considered on the basis of level of potential risk to the environment. This subsequently assists in prioritising development of management measures to achieve an overall acceptable level of risk.

Risk assessments have been undertaken in accordance with: AS/NZS 4360:2004, Risk management; SAA Handbook 203:2004, Environmental risk management – Principles and process; and AS/NZS 3931:1998, Risk analysis of technological systems – Application guide.

Risk assessments initially involved identification of stressors through a series of hazard identification workshops. Examples of stressors include light, noise and clearing and earthworks. This was followed by definition of consequence categories for groups of environmental factors. Prior to risk characterisation, ecological specialists identified groups of receptors (species or communities) which were considered to be sensitive to stressors associated with the Development (e.g. protected fauna, restricted flora and vegetation communities). Within each group of receptors, key receptor species were identified which were considered to be particularly sensitive to stressors and hence protective of the wider biological group. Risk levels (low, medium, high) were then estimated for each stressor and associated key receptor/s through an assessment of consequences and likelihood.

Risk assessments, including definition of consequences and identification of stressors and receptors, were undertaken by technical specialists with recognised expertise in a broad range of environmental fields. This included specialists with a long-standing knowledge and experience of working on Barrow Island.



9.1 Introduction

This chapter outlines the methodology used to assess risks associated with the proposed Gorgon Development. The methodology has been consultatively developed with specialist environmental and risk consultants (refer to Acknowledgements). The procedure was developed in accordance with the principles and guidelines contained in:

- AS/NZS 4360:2004, Risk management
- SAA Handbook 203:2004, Environmental risk management – Principles and process
- AS/NZS 3931:1998, Risk analysis of technological systems – Application guide.

The risk assessment methodology has been used primarily to assess the environmental risks associated with the proposed Development. Results and management strategies for the terrestrial and marine environment are presented in chapters 10 and 11. Where practicable, a risk-based approach was also applied to potential negative social and economic impacts. However, beneficial social and economic impacts must also be considered in the assessment process. Where beneficial impacts could not be assessed adequately using a risk-based approach, more traditional assessment approaches were applied as described in chapters 14 and 15.

One of the advantages of this process over a more traditional environmental impact assessment approach is that it allows potential environmental hazards or threats to be systematically identified and considered on the basis of potential risk to the environment. This subsequently assists in prioritising development of management measures to achieve an overall acceptable level of risk. This ability to focus on higher risk issues is particularly useful in assessing the implications of the Gorgon Development, which is a large and complex proposal that may have a multitude of potential impacts in an area of recognised conservation value.

9.2 Methodology

Environmental risk assessment is a process that evaluates the likelihood that adverse environmental impacts may occur as a result of exposure to one or more stressors (US EPA 1998). The overall environmental risk assessment process is shown in Figure 9-1 and broadly comprises the following steps:

- establishment of a risk assessment framework (definition of consequences and likelihood and establishment and validation of risk matrix)
- systematic identification of potential stressors (i.e. hazards or threats)
- identification of key receptor species or communities

- initial characterisation of environmental risks based on familiar management practices
- subsequent identification of additional management options to meet expectations for best practice environmental management, as required (i.e. elimination, substitution, reduction, engineering controls and management controls)
- analysis of residual risks based on additional management options, which reduce likelihood and/or potential consequences
- identification of preferred management option/s which will be adopted to reduce risks to acceptable levels.

Throughout the environmental risk assessment process the Joint Venturers have engaged specialists with recognised expertise in a broad range of environmental, social and economic fields. Risk assessments, including definition of consequences and identification of stressors and receptors, were undertaken by technical specialists with recognised expertise in a broad range of environmental fields (refer to Acknowledgments). This included specialists with a long-standing knowledge and experience of working within the proposed Development area, and on Barrow Island in particular.

An explanation of risk assessment terms used throughout this chapter and chapters 10 and 11 is provided in Table 9-1.

Figure 9-1:

Outline of Risk-based Environmental Assessment Process (after AS/NZS 4360:2004)

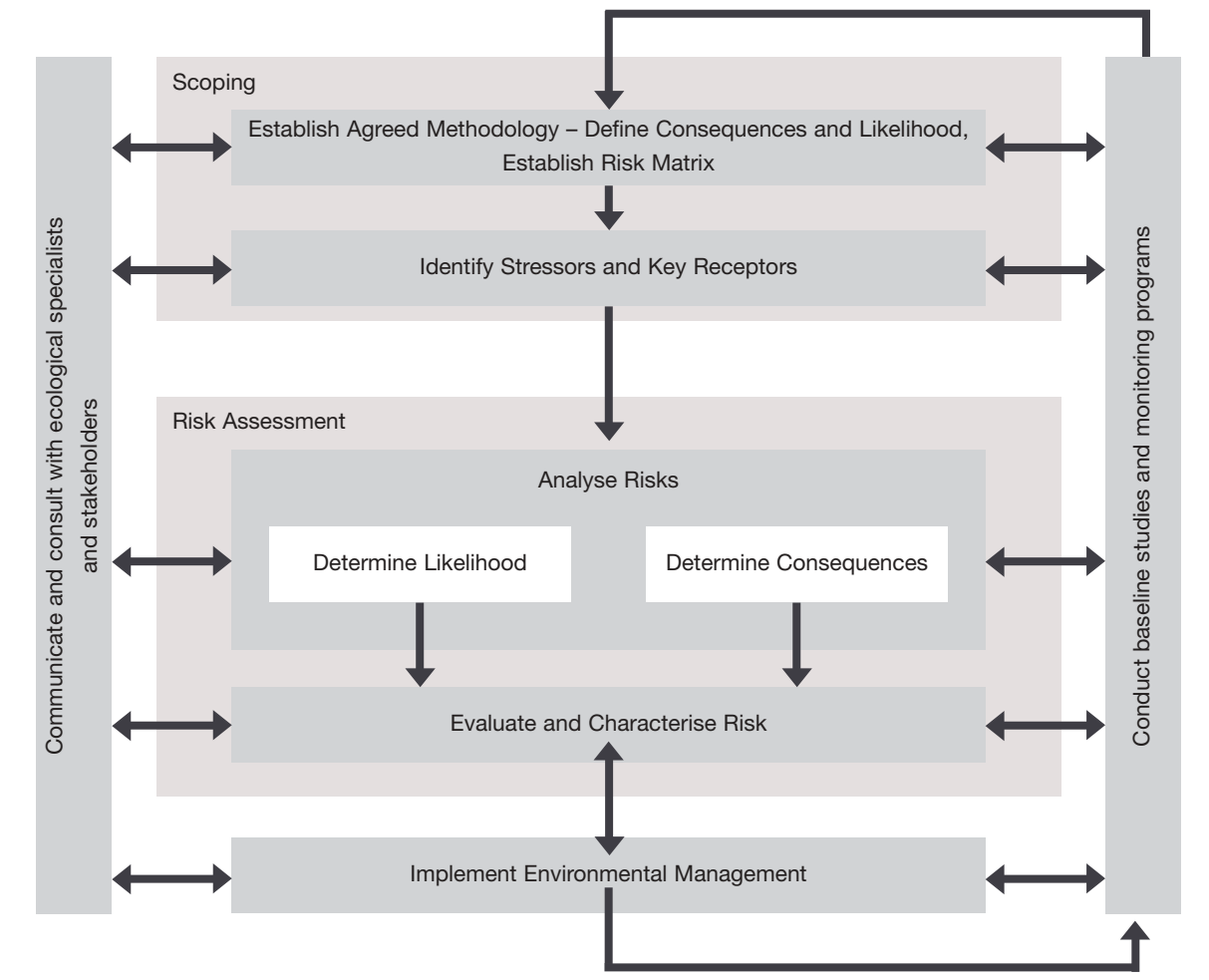


Table 9-1:

Risk Assessment Terminology

Term	Definition
Behavioural impact	Disruption of established behavioural patterns affecting reproductive or survival success.
Consequence	The implication of the impact (as defined).
Decrease in abundance	Loss of individual animals/plants.
Disruption	Interruption to the flow or continuity of biological processes and/or behaviour.
Hazard	A source of potential harm, or a situation with a potential to cause loss or adverse effect. Hazard has the same meaning as 'threat'.
Impact	Direct interaction of a stressor with the environment.
Impact on population	Decrease in abundance beyond natural variation in population size.
Immediate region	For aspects of the Development on Barrow Island or within the marine conservation reserves: Barrow Island, Lowendal Islands and Montebello Islands. For aspects of the Development offshore of Barrow Island: Pilbara Offshore Region. For aspects of the Development between Barrow Island and the mainland: Pilbara Nearshore Region. For aspects of the Development on the mainland: Pilbara.
Likelihood	The probability of a stressor impacting on the key receptors.
Local	Impacts restricted to the area directly affected by the Development and the immediate vicinity of the Development.
Long-term	Greater than five years.
Population	A group of organisms of the same species occupying an area.
Population viability	The ability of a group of organisms (occupying an area) to survive in that area.
Receptor	An ecological entity (e.g. species, population, community, and habitat) exposed to a stressor.
Reduced viability	Reduced ability of population to persist through time.
Region	Pilbara.
Short-term	Less than five years.
Species viability	The ability of the species to persist through time.
Stressor	A source of potential harm, or a situation with a potential to cause loss or adverse effect.
Widespread	Impacts extending to areas well-outside the direct impact zone from the Development.

9.2.1 Identification of Stressors

Potential stressors (hazards or threats) associated with the proposed Development were systematically identified through a number of HAZID (hazard identification) workshops. The main focus of the HAZID workshops was to identify credible threats to environmental values of the Development area as a result of planned activities. Workshops were also used to develop a shared understanding of the range of consequences that should be considered, so that consequence levels could be categorised for later risk assessment (Section 9.2.3).

The HAZID and risk assessment process relied on the expertise of workshop participants to identify hazards for specific activities under consideration. Therefore

specialists with recognised expertise in a broad range of fields, knowledge of the proposed project and the environment within the development area were involved in the HAZID workshops. In addition, an environmental risk assessment expert facilitated the process, recorded outcomes, and maintained the integrity of the approach.

A comprehensive list of stressors associated with Development activities was prepared in advance of the risk assessment workshops with input from participants (Table 9-2). This list was used by environmental specialists to prompt consideration of the characteristics of various stressors in their assessment of potential consequences and likelihood of consequences.

Table 9-2:
List of Stressors Associated with Proposed Development Activities

Stressor	Associated development activities/facilities	Components
Atmospheric		
Light	<ul style="list-style-type: none"> marine vessels gas processing facility (construction/ operations) construction village marine facilities (MOF, LNG loadout, jetty) pipeline construction flaring 	<ul style="list-style-type: none"> direct light diffuse glow
Combustion emissions	<ul style="list-style-type: none"> construction equipment power generation (electrical and mechanical) flare 	<ul style="list-style-type: none"> particulates NO_x, SO_x VOC BTEX
Fugitive emissions	<ul style="list-style-type: none"> condensate tanks condensate loading valves and flanges 	<ul style="list-style-type: none"> VOC BTEX
Dust	<ul style="list-style-type: none"> construction (earthworks, vehicles, stockpiles, land clearing) vehicles (operations) 	
CO ₂ discharge	<ul style="list-style-type: none"> failure of CO₂ re-injection pipeline/well reservoir leak/failure (fault structures, abandoned wells, etc) 	<ul style="list-style-type: none"> primarily CO₂ minor VOC minor BTEX minor H₂S
Heated air	<ul style="list-style-type: none"> air coolers flare 	

Table 9-2: (continued)

List of Stressors Associated with Proposed Development Activities

Stressor	Associated development activities/facilities	Components
Terrestrial		
Clearing and earthworks	<ul style="list-style-type: none"> • gas processing facility • construction village • airport extension • road re-alignment • pipelines • utility corridors • CO₂ monitoring (seismic and/or wells) • MOF/ jetty approaches 	
Liquid and solid waste disposal	<ul style="list-style-type: none"> • grey-water for dust suppression (construction only) • system failure (all wastewater injected) • produced water (injected) • sewage (injected) • reverse osmosis brine (ocean discharge) • hydrotest water • domestic wastes • construction wastes • drilling waste 	<ul style="list-style-type: none"> • BOD, COD • hydrocarbons • chemical additives • salinity • bacteria • heavy metals
Leaks or spills	<ul style="list-style-type: none"> • diesel storage and handling • condensate storage and handling • MEG, TEG storage and handling • aMDEA storage and handling • chemical storage and handling • pipelines 	<ul style="list-style-type: none"> • BOD, COD • persistence/ biodegradability • toxicity • heavy metals • hydrocarbons • chemical additives
Fire	<ul style="list-style-type: none"> • construction and operation of facilities • vehicle exhaust • flare 	<ul style="list-style-type: none"> • smoke • heat • nutrients • habitat modification
Noise and vibration	<ul style="list-style-type: none"> • built plant operations (turbines, air coolers, pressure letdown valves, pumps, etc) • blasting and earthworks • flaring • vehicles and equipment • drilling 	
Physical interaction	<ul style="list-style-type: none"> • vehicle traffic • operation of equipment and machinery • workforce activities 	<ul style="list-style-type: none"> • road kill • interaction/ disturbance

Table 9-2: (continued)

List of Stressors Associated with Proposed Development Activities

Stressor	Associated development activities/facilities	Components
Terrestrial		
Light and shading/ heat and cold	<ul style="list-style-type: none"> • pipeline • gas processing facility • construction village 	
Dust	<ul style="list-style-type: none"> • vehicle and machinery movements 	
Physical presence	<ul style="list-style-type: none"> • gas processing facility • construction village • sealed roads 	
Marine		
Seabed disturbance	<ul style="list-style-type: none"> • dredging and blasting • dumping of dredge spoil • construction of marine facilities (MOF, causeway, LNG loadout, jetty, pipelines, optical fibre cable, subsea gathering system) • anchoring of drill rigs, pipelay vessels and dredge vessels 	<ul style="list-style-type: none"> • habitat disturbance (benthic primary producers) • turbidity • smothering
Physical presence	<ul style="list-style-type: none"> • permanent presence of infrastructure (MOF, causeway, LNG loadout, jetty, pipelines, optical fibre cable, subsea gathering system) 	<ul style="list-style-type: none"> • local flow change • habitat modification
Liquid and solid waste disposal	<ul style="list-style-type: none"> • hydrotest water • domestic waste and treated sewage • waste chemicals and oil • drilling waste (cuttings and drilling fluids) • produced formation water • reverse osmosis brine • stormwater runoff 	<ul style="list-style-type: none"> • BOD, COD • persistence/biodegradability • chemical additives • hydrocarbons • heavy metals
Leaks or spills	<ul style="list-style-type: none"> • storage and transport of chemicals, fuels or other hazardous material • MOF loading/unloading • vessel collision or grounding • failure of equipment or pipelines 	<ul style="list-style-type: none"> • BOD, COD • persistence/biodegradability • toxicity • hydrocarbons • chemical additives
Discharges	<ul style="list-style-type: none"> • marine construction vessels • dredge spoil • hydrotest water • drilling fluids • stormwater 	<ul style="list-style-type: none"> • turbidity • anti-fouling leachate • chemicals

Table 9-2: (continued)

List of Stressors Associated with Proposed Development Activities

Stressor	Associated development activities/facilities	Components
Marine		
Physical interaction	<ul style="list-style-type: none"> • operation of vessels and barges • dredging of shipping channels • presence of construction workforce 	<ul style="list-style-type: none"> • grounding • collision
Noise and vibration	<ul style="list-style-type: none"> • vessel movements • drilling (subsea facilities) • dredging (MOF, shipping channel, causeway) • pipelay (pipelines) • blasting (MOF, shipping channels) • piling (jetty) • HDD (west coast shore crossing) • operation of subsea gathering system 	<ul style="list-style-type: none"> • disturbance • physiological effects
<i>Note: all acronyms and abbreviations are provided in the supplementary information section of this document.</i>		

9.2.2 Identification of Receptors

Prior to undertaking risk assessments ecological specialists identified groups of receptors (species or communities) which were considered to be sensitive to stressors associated with the Development (e.g. protected fauna (listed/threatened species), restricted flora and vegetation communities) (Table 9-3). Within each group of receptors, key receptor species were identified which were considered to be particularly sensitive to stressors and hence protective of the wider biological group. Key receptors identified for protected fauna (listed/ threatened species) and general fauna are shown in Table 9-4. Similar information has been documented for all groups of receptors and is included in relevant sections of chapters 10 and 11.

9.2.3 Definition of Consequences

To describe the type and duration of potential impacts associated with the Development, definitions for five categories of consequences (minor, moderate, serious, major, critical) were developed. Specific scales of consequence were defined using criteria that were relevant to different groups of receptors, presented in Table 9-5. For example, in the case of a protected fauna species, consequences are analysed in terms of species behaviour and population size and viability, whereas consequences to soils and landform were defined in terms of soil contamination, soil characteristics and changes to landform.

Table 9-3:
Groups of Receptors and Associated Consequence Criteria

Groups of Receptors	Consequence Criteria
Terrestrial Environment	
Soils and landform	<ul style="list-style-type: none"> • soil contamination • soil characteristics • landform
Water quality (surface and groundwater)	<ul style="list-style-type: none"> • water quality • groundwater recharge
Air quality	<ul style="list-style-type: none"> • local air quality • regional air quality
Restricted flora and vegetation communities	<ul style="list-style-type: none"> • impact to species or community (abundance or distribution) • loss of species or community
General flora and communities	<ul style="list-style-type: none"> • impact to species or community (abundance or distribution) • loss of species or community
Protected fauna (listed/threatened species)	<ul style="list-style-type: none"> • species behaviour • population size and viability
General fauna (not listed/threatened)	<ul style="list-style-type: none"> • species behaviour • population size and viability
Subterranean fauna	<ul style="list-style-type: none"> • species behaviour • population size and viability
Marine Environment	
Water quality	<ul style="list-style-type: none"> • water quality
Seabed (subtidal and intertidal) Foreshore	<ul style="list-style-type: none"> • sediment contamination • benthic substrate characteristics
Benthic primary producers and significant communities	<ul style="list-style-type: none"> • impact to species or community • loss of species or community
General taxa and communities (flora)	<ul style="list-style-type: none"> • impact to species or community • loss of species or community
Listed species or evolutionary significant units	<ul style="list-style-type: none"> • species behaviour • population size and viability
General species and communities (not listed/threatened)	<ul style="list-style-type: none"> • species behaviour • population size and viability

Table 9-4: Key Receptor Species for Listed and General Terrestrial Fauna Species		
Key Receptor	Reason for Selection	Additional Species Represented by Receptor
Listed Threatened Species		
Euro, <i>Macropus robustus isabellinus</i>	Listed; largest marsupial on Barrow Island	
Black-flanked rock wallaby, <i>Petrogale lateralis</i>	Listed; low population size; significant issue on west coast	
Spectacled hare wallaby, <i>Lagorchestes conspicillatus conspicillatus</i>	Listed; non-burrowing; medium-sized marsupial	
Burrowing bettong, <i>Bettongia lesueur</i>	Listed; burrowing marsupial; site restricted	
Golden bandicoot, <i>Isodon auratus barrowensis</i>	Listed; readily adapts to human presence	
Barrow Island chestnut mouse, <i>Pseudomys nanus ferculinus</i>	Listed; small mammals	Small mammals: <i>Zyzomys</i> sp., <i>Planigale</i> sp., <i>Pseudantechinus</i> sp.
White-winged fairy wren, <i>Malurus leucopterus edouardi</i>	Listed; restricted to Barrow Island; abundant	Landbirds
General fauna (evolutionary significant units)		
Land snail, <i>Rhagada</i> sp.	Short-range endemic	Land snails
Scorpion, <i>Urodacus</i> sp. nov. 'barrow'	New species restricted to Development site	Scorpions, pseudoscorpions, insects, arachnids, other invertebrates
Northern brush-tailed possum, <i>Trichosurus vulpecula arnhemensis</i>	Resident of rock holes and termite mounds	Small mammals
Termites, <i>Nasutitermes tridodia</i>	Important ecological component; mound builders	Detritivores
Mygalomorph spiders	Burrowing spider; possible short-range endemic; susceptible to ground level impacts	Burrow-dwelling invertebrates
Spinifexbird, <i>Eremiornis carteri</i>	Abundant landbird	Landbirds
Leopard skink, <i>Ctenotus pantherinus acripes</i>	Restricted to Barrow Island in Western Australia	Skinks and other terrestrial reptiles
Perentie, <i>Varanus giganteus</i>	Major predator; largest terrestrial reptile on island	Monitors

Table 9-5:
Consequence Definitions for Risk-based Environmental Assessment

Consequence Category	Minor	Moderate	Serious	Major	Critical
Protected fauna species (listed/threatened)	<i>Individual level effects</i>				
	Local, short-term behavioural impact.	Local, long-term or widespread, short-term behavioural impact.	Widespread, long-term behavioural impact.		
	<i>Population level effects</i>				
	Local, short-term decrease in abundance. No lasting effects on local population.	Local, long-term or widespread, short-term decrease in abundance. Loss of small number of individuals without reduction in local population viability.	Local, long-term or widespread, short-term decrease in abundance. Loss of individuals leads to reduction in viability of local population. No reduction in viability of race on Barrow Island.	Local, long-term or widespread, short-term impact leads to loss of local population/s and reduced viability of the race on Barrow Island.	Widespread, long-term impact on population. Extinction of Barrow Island race.
General fauna communities and species (not listed/threatened)	<i>Individual effects</i>				
	Local, long-term or widespread, short-term behavioural impact.	Widespread, long-term behavioural impact.			
	<i>Population level effects</i>				
	Local, long-term or widespread, short-term decrease in abundance. Loss of small number of individuals without reduction in local population viability.	Local, long-term or widespread, short-term decrease in abundance. Loss of individuals leads to reduction in viability of local population. No reduction in viability on Barrow Island.	Local, long-term or widespread, short-term impact leads to loss of local population/s and reduced viability on Barrow Island.	Widespread, long-term impact on population. Extinction on Barrow Island.	Loss from immediate region.

9.2.4 Definition of Likelihood

The likelihood of an interaction between a stressor and a receptor causing a particular impact was defined based on a nominal Development lifecycle of 60 years. Five categories of likelihood were developed for the risk assessment, as shown in Table 9-6.

9.2.5 Characterisation of Risk

Risk levels were estimated for each stressor and associated key receptor/s through an assessment of consequences and likelihood. A qualitative scoring system was used to assess likelihood of consequences as described in Table 9-6. Likelihood relates to the probability of a stressor impacting on key receptors and does not equate to the probability of a stressor itself eventuating.

Based on the scoring of likelihood and consequences, risk was characterised as high, medium or low as illustrated in the matrix shown in Figure 9-2. A risk is considered acceptable if it falls in the low category without any further mitigation measures, and ‘tolerable’ if it falls in the medium risk category and is managed to reduce the risk to a level ‘as low as reasonably practicable’ (ALARP) (SAA HB 436:2004). Risk reduction measures must be applied to reduce high risks to tolerable levels. Taken together, these risk levels and corresponding requirements for risk treatment are the standards for acceptable risk to flora and fauna.

Table 9-6:
Likelihood Definitions for Risk-based Environmental Assessment

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

9.2.6 Risk Management

Ecological and environmental specialists finalised the risk assessment and provided advice to the Gorgon Development Team with options for managing risk. The Gorgon Development Team considered whether recommendations for reducing or eliminating high and medium risks were feasible. In the case of medium risk, they also considered whether the costs would balance the benefits derived from them.

Figure 9-2:
Gorgon Development Environmental Risk Matrix

		Consequence category				
		Minor	Moderate	Serious	Major	Critical
Likelihood category	Almost certain					
	Likely					
	Possible					
	Unlikely					
	Remote					

Legend Low Risk Medium Risk High Risk

As specific management measures were developed, high and medium risks were re-assessed to determine whether they were reduced to meet standards for acceptable risk (Section 9.2.5). In the case of medium risks, management measures were developed until no further practicable measures could be applied to reduce risk any further. In the case of high risks, ecological specialists were consulted to ensure that all possible management measures were considered.

Risk assessment results and management strategies for the terrestrial and marine environment are presented in chapters 10 and 11.

9.3 Uncertainty

Uncertainty in estimates of consequences and likelihood were approached in a precautionary manner. Generally, for planned activities, there was little uncertainty in the mechanisms of an exposure scenario. Even for unplanned accidents involving spills or leaks, scenarios are described on the basis of well-understood exposure mechanisms. However, it is widely recognised that the consequences of exposure can be more difficult to predict in complex ecological systems. Once a range of possible consequences was established, the more serious consequences were selected for estimating risk and proposing management measures to ensure that the 'lack of full scientific certainty was not used as a reason for postponing measures to prevent environmental degradation' (United Nations Environment Programme 1992). The same approach was applied to judgments of likelihood when some uncertainty existed, and the more frequent choice of likelihood was selected as a precautionary measure.

Where there was uncertainty in the judgments made during the risk analysis, it was handled in a manner which would not understate the overall risk. As such, in the case of high and medium risks, robust management strategies were proposed to reduce risk and prevent serious environmental impacts from occurring. Environmental monitoring will measure the actual impacts of development activities, and confirm whether management strategies are comprehensive enough to allow for the precautionary approach taken in the risk estimates.

9.4 Conclusion

Adoption of a risk-based environmental assessment process and identification of the most significant risks to the conservation values of the Development area are fundamental to the Joint Venturers' approach to this Draft EIS/ERMP. This process has been undertaken in accordance with Australian Standards for risk management and best practices in environmental risk assessment. By systematically identifying all stressors to conservation values and engaging ecological specialists to assist in the development of risk-based management strategies, potential environmental and socio-economic impacts will be reduced to meet standards for acceptable risk, or in some cases avoided altogether.

