Gorgon Gas Development
Marine Environmental Quality Management Plan

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1 Introduction

Chevron Australia Pty Ltd (CAPL) is the proponent and the person taking the action for the Gorgon Gas Development on behalf of the following companies (collectively known as the Gorgon Joint Venturers), pursuant to Ministerial Statement No. 800 (MS 800, Ref. 1):

- Chevron Australia Pty Ltd
- Chevron (TAPL) Pty Ltd
- Shell Development (Australia) Pty Ltd
- Mobil Australia Resources Company Pty Limited
- Osaka Gas Gorgon Pty Ltd
- Tokyo Gas Gorgon Pty Ltd
- JERA Gorgon Pty Ltd.

1.1 Project

CAPL is developing the gas reserves of the Greater Gorgon Area. The gas will be processed in a gas treatment plant on Barrow Island, which is located off the Pilbara coast, 85 km north-north-east of Onslow in Western Australia (WA) (Figure 1-1).

Subsea gathering systems and pipelines deliver feed gas from the Gorgon and Jansz–Io gas fields to the west coast of Barrow Island. The underground feed gas pipeline system then traverses Barrow Island to the east coast where the Gas Treatment Plant (GTP) is located. The GTP includes natural gas trains that produce liquefied natural gas (LNG) as well as condensate and domestic gas (DomGas). Carbon dioxide, which occurs naturally in the feed gas, is separated during the production process and injected into deep rock formations below Barrow Island. The LNG and condensate is loaded onto tankers from a jetty and then transported to international markets. Gas for domestic use is exported by pipeline from Barrow Island to the domestic gas collection and distribution network on the WA mainland.

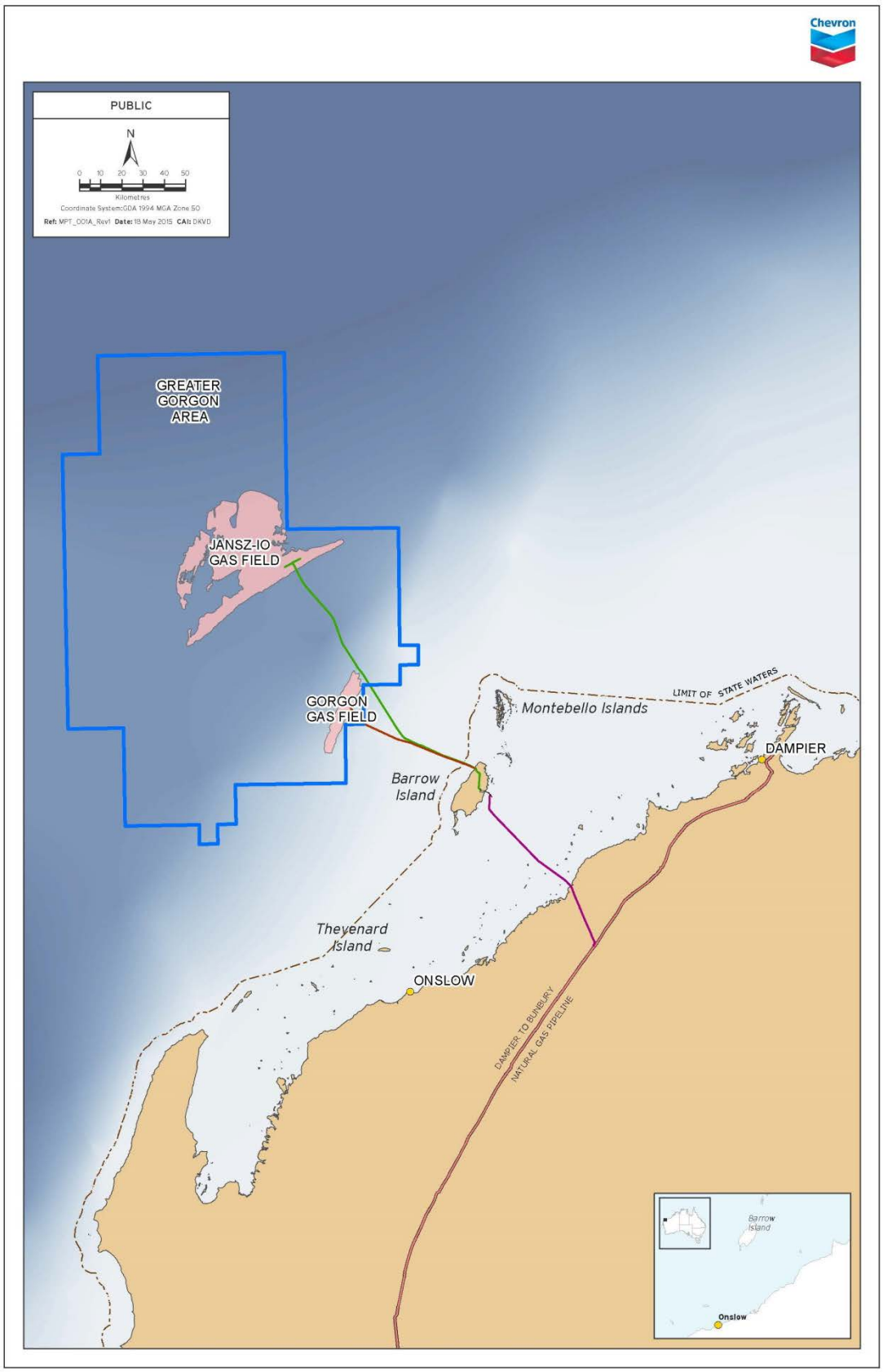

Figure 1-1: Regional Location of Barrow Island and the Greater Gorgon Area

1.2 Environmental Approvals

The initial Gorgon Gas Development was assessed through an Environmental Impact Statement/Environmental Review and Management Programme assessment process (Ref. 2; Ref. 3).

On 10 August 2009 the WA Minister for the Environment issued MS 800 (Ref. 1), granting approval for the Revised and Expanded Gorgon Gas Development. MS 800 provides approval for both the initial Gorgon Gas Development and the Revised and Expanded Gorgon Gas Development, which together are known as the Gorgon Gas Development.

Since the Revised and Expanded Gorgon Gas Development was approved, further minor changes have been made and/or approved to the Gorgon Gas Development.

1.3 Purpose of this Plan

1.3.1 Requirement for this Plan

1.3.1.1 State Environmental Approval Requirements

The Gorgon Gas Development Marine Environmental Quality Management Plan (MEQMP; 'this Plan') is required under Condition 23A.1 of MS 800:

> *Prior to the shipment of products from the Proposal the Proponent shall submit to the Minister a Marine Environmental Quality Management Plan (the Plan) that shall apply to the operation of the proposal that meets the objectives set out in Condition 23A.2 and the requirements of Condition 23A.3, as determined by the Minister.*

This Plan is not required under EPBC Reference: 2003/1294 and 2008/4178 and therefore does not address any requirements of Commonwealth approvals. Any matter specified in this Plan is relevant to the Gorgon Gas Development only if that matter relates to the specific activities or facilities associated with that particular development.

1.3.1.2 Other Legislation, Codes, Standards, and Guidelines

When developing this Plan, these guidelines were taken into account:

- WA's State Water Quality Management Strategy (SWQMS; Ref. 4), which provides for the establishment of Environmental Values (EVs) and Environmental Quality Objectives (EQOs) for all significant State water resources, via a consultative process involving community stakeholders.
- Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives (Ref. 5), which outlines the agreed interim EVs and EQOs, and the recommended Levels of Ecological Protection (LEPs) for the marine waters of the Pilbara (including the Barrow Island area) following extensive stakeholder consultation undertaken between September and November 2004.
- Technical Guidance: Protecting the Quality of Western Australia's Marine Environment (Ref. 6), which describes the structure of the Environmental Quality Management Framework (EQMF) and how it is to be applied by the WA Environmental Protection Authority (EPA) through environmental impact assessment to maintain a high level of quality in WA's marine waters.

This Plan builds on these documents by implementing the EQMF (Section 2) for State Coastal Waters at Barrow Island (except Marine Conservation Reserves) where activities associated with operation of the Gorgon Gas Development occur, as required by MS 800.

1.3.2 Objectives of this Plan

The objectives of this Plan, as specified in MS 800, Condition 23A.2, are to:

- establish and spatially define a set of EVs, EQOs, and associated levels of ecological protection for marine waters of the Barrow Island Port area and any other areas of State Coastal Waters (with the exception of waters within gazetted Marine Conservation Reserves where Management Plans are in place and interim EVs, EQOs, and LEPs have been endorsed by the EPA), where there is potential for the operation of the Proposal to affect marine environmental quality; and
- to protect the EVs, and achieve EQOs and associated levels of ecological protection for marine waters defined in Condition 23A.2 for the life of the Proposal.

1.3.3 Contents of this Plan

Explicit requirements of this Plan are specified in Condition 23A.3 of MS 800 and listed in Table 1-1. In summary, this Plan describes:

- the relationship and interaction of this Plan with other regulatory instruments and management measures (Sections 2 and 3.2)
- the risk-based strategy for implementing the EQMF to the Gorgon Gas Development (Section 3), including the screening process to determine which marine facilities and activities should be monitored based on the residual risk of those activities affecting EVs
- EVs and EQOs applicable to operation of the Gorgon Gas Development (Section 3.1)
- The existing environment (Section 4)
- Marine facilities and activities monitored via this Plan (Section 5)
- the spatial allocation of LEPs around Barrow Island (Section 6)
- Environmental Quality Criteria (EQC; limits of acceptable change) and triggers for management responses when criteria are not met (Section 7)
- the monitoring program to assess environmental quality indicators against the EQC (Section 8)
- environmental performance standards (Section 9)
- reporting and responses to an exceedance of an environmental performance standard (Section 10).

Table 1-1: Requirements of this Plan

Condition No.	Requirement	Section Reference in this Plan
23A.1	Prior to the shipment of products from the Proposal the Proponent shall submit to the Minister a Marine Environmental Quality Management Plan (the Plan) that shall apply to the	Sections 1.3

Condition No.	Requirement	Section Reference in this Plan
	operation of the proposal that meets the objectives set out in Condition 23A.2 and the requirements of Condition 23A.3, as determined by the Minister	
23A.2.i	Establish and spatially define a set of EVs, EQOs, and associated levels of ecological protection for marine waters of the Barrow Island Port area and any other areas of State Coastal Waters (with the exception of waters within gazetted Marine Conservation Reserves where Management Plans are in place and interim EVs, EQOs, and levels of ecological protection have been endorsed by the EPA), where there is potential for the operation of the Proposal to affect marine environmental quality	Sections 1.3.2, 1.4, Table 2-1, Sections 3.1 and 6
23A.2.ii	To protect the EVs, and achieve EQOs and associated levels of ecological protection for marine waters defined in Condition 23A.2 for the life of the Proposal	Sections 1.3.2 and 9
23A.3.i	A set of EVs and EQOs and associated levels of ecological protection for marine waters of the Barrow Island Port area and any other areas of State Coastal Waters (with the exception of waters within gazetted Marine Conservation Reserves where Management Plans are in place and interim EVs, EQOs and levels of ecological protection have been endorsed by the EPA), where there is potential for the operation of the Proposal to affect marine environmental quality	Table 2-1, Sections 3.1 and 6
23A.3.ii	The application of waste minimization principles where practicable (avoid, minimize, reduce and rectify) to the Proposal	Section 3.2
23A.3.iii	Recognition of the inherent environmental values of the marine environment surrounding Barrow Island, and the EPA-endorsed interim EVs, EQOs and levels of ecological protection that have been assigned to State coastal marine waters throughout the Pilbara, including Barrow Island (DoE, 2006; Ref. 5)	Sections 1.3.1.2, 1.4, 2, 4, and 6
23A.3.iv	A description of the consultation conducted on the proposed EVs, EQOs, and associated levels of ecological protection	Section 1.4
23A.3.v	Spatially accurate maps showing the EVs, EQOs and levels of ecological protection and their spatial allocation assigned with consideration to the outcomes of consultation	Section 6
23A.3.vi	An environmental quality monitoring program to determine whether the objectives in Condition 23A.2.ii are being achieved	Section 8
23A.3.vii	The indicators that will be monitored, a schedule detailing the locations and frequency for monitoring and the numerical and narrative EQC, including Environmental Quality Guidelines and Environmental Quality Standards	Sections 7 and 8
23A.3.viii	Standard operating procedures for conducting monitoring	Section 8
23A.3.ix	Decision schemes for evaluating monitoring data against the Environmental Quality Guidelines and Environmental Quality Standards referred to in Condition 23A.3.vi above	Section 7 and Appendix C
23A.3.x	Performance Standards against which achievement of the objectives of this condition can be determined	Section 9
23A.3.xi	Reporting procedures and protocols that shall apply	Section 10
23A.4	The Proponent shall implement the Plan	Sections 3 to 10 details how CAPL plans to implement this Condition

Condition No.	Requirement	Section Reference in this Plan
23A.5.i	If monitoring shows that an Environmental Quality Standard has been exceeded, the Proponent shall: Notify the CEO of the exceedance within two business days	Sections 7 and 10 detail how CAPL plans to implement this Condition
23A.5.ii	If monitoring shows that an Environmental Quality Standard has been exceeded, the Proponent shall: Prepare and submit an Environmental Quality Management Report within one month of detecting the exceedance that details management action(s) to be implemented to rectify the cause of the exceedance, including time frames for implementation and reporting of performance, as determined by the Minister	Sections 7 and 10 detail how CAPL plans to implement this Condition
23A.6	The Proponent shall implement management action(s) in accordance with the Environmental Quality Management Report required by Condition 23A.5ii above	Sections 7 and 10 detail how CAPL plans to implement this Condition

1.4 Stakeholder Consultation

This Section describes the stakeholder consultation process for this Plan, specifically the EVs, EQOs, and LEPs assigned to the marine waters of the Barrow Island Port area (also known as the Port of Barrow Island). Consultation with stakeholders is required under the SWQMS (Ref. 4), and is a condition of approval (Condition 23A.3.iv of MS 800).

The SWQMS (Ref. 4) provides for the establishment of interim EVs and EQOs as the goals for protecting the environment from the effects of anthropogenic activities. The SWQMS requires public consultation to establish EVs and EQOs before their submission to the EPA for review and endorsement; consultation guides environmental impact assessment and natural resources management (Ref. 4).

Comprehensive public consultation was undertaken in 2004 when the EVs, EQOs, and LEPs were developed for the greater Pilbara coast, which included the waters surrounding Barrow Island. This process resulted in a robust and publicly approved basis for the establishment of an interim Environmental Quality Plan (EVs, EQOs, and LEPs) for the waters surrounding Barrow Island; the outcomes of this consultation were published in 2006 (Ref. 5). Although the consultation process defined the spatial extent of the high and maximum LEPs in the waters surrounding Barrow Island, no specific recommendations were made for the spatial extent of the moderate and low LEPs. The intent was that the spatial extent of these lower LEPs would be defined once the footprint and discharge sources of the Gorgon Gas Development were defined. This Plan builds on these outcomes by refining the Environmental Quality Plan for areas associated with operation of the Gorgon Gas Development in the Port of Barrow Island (Section 6).

In accordance with Condition 23A.3.iv of MS 800, this Plan was prepared in consultation with Department of Water and Environmental Regulation (DWER; previously the Office of the [Western Australian] Environmental Protection Authority [OEPA] and (where relevant) the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA; previously the Department of Parks and Wildlife [Parks and Wildlife] and Department of Environment and Conservation [DEC]), as follows:

- CAPL informed OEPA and Parks and Wildlife of its intention to apply the interim EVs and EQOs, and to define the LEPs (in more detail) during the

development of this Plan. Return correspondence received from OEPA on 4 January 2013 confirmed the approach was supported, with several recommendations (Appendix A).

- CAPL briefed OEPA and Parks and Wildlife on 23 October 2014 regarding the proposed implementation of the EQMF to the Gorgon Gas Development, including the proposed EVs, EQOs, and LEPs associated with Gorgon marine facilities. The presentation material was provided electronically to OEPA and Parks and Wildlife after the briefing.
- A draft of this Plan was submitted to OEPA for review on 23 June 2015. OEPA provided comments on the Plan on 8 September 2015. Responses to comments were provided by CAPL on 21 October 2015, with a further consultation briefing on 13 November 2015 and email clarification correspondence on 20 November 2015.
- Revision 1.2 of this Plan was approved by the OEPA on 25 January 2016, on condition that some minor requirements were addressed in the next revision of the Plan (Revision 1.3). A follow-up meeting was held on 18 February 2016 to discuss and clarify the requirements to be addressed. Revision 1.3 was submitted for review on 30 August 2016. Revision 1.4 (submitted 9 March 2017) addressed the OEPA's comments on previous revisions.

CAPL regularly consulted the Barrow Island Port Captain and Port Superintendent throughout this Plan's development. The WA Department of Transport were advised of the outcomes of those consultations and that the Plan would not affect operation of the Port or the ability of CAPL to meet the obligations of the *Shipping and Pilotage Act 1967* (WA). The Department of Transport was invited to comment on this Plan either directly with CAPL or through consultation with DWER.

Outcomes of these consultations have been incorporated into this Plan, where practicable.

2 Environmental Protection Authority's Environmental Quality Management Framework for Protecting the Quality of Western Australia's Marine Environment

The SWQMS[1] (Ref. 4) provides a framework for establishing EVs and EQOs as the environmental management goals for protecting the environment from the effects of waste inputs and pollution (Ref. 5). The EQMF adopted by the EPA for State Waters is based on, and consistent with the SWQMS.

The intent of the EQMF is that, for each significant water body in WA, a series of EVs, EQOs, LEPs, and EQC are selected and applied based on specific uses (ecosystem, social, and industrial uses) of that water body, and on the risks posed by the operational activity. The consultation process for establishing appropriate EVs and EQOs for the marine waters of the Barrow Island Port area, as required under Condition 23A.3.iv, is described in Section 1.4.

This Section briefly describes the elements of the EQMF; the relationship between these elements is shown in Figure 2-1. Implementation of the EQMF for operation of the Gorgon Gas Development is described in Section 3.

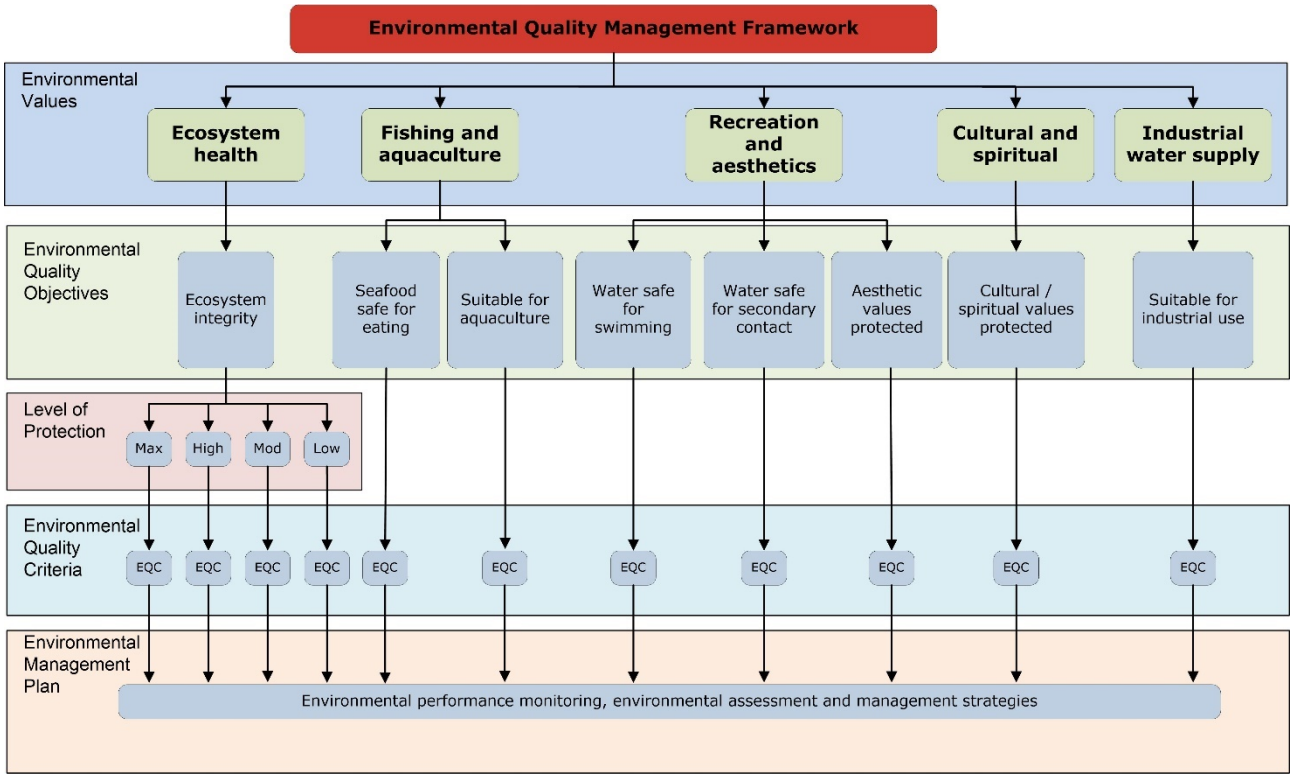

Figure 2-1: Environmental Quality Management Framework for WA Marine Waters

2.1 Environmental Values and Environmental Quality Objectives

EVs refer to a particular value or use of the marine environment that is important for a healthy ecosystem, or that is important for public benefit, welfare, safety, or health, and that requires protection from the effects of pollution, environmental harm, waste discharges, and waste deposits (Ref. 7). EQOs are high-level

[1] The SWQMS is underpinned by the National Water Quality Management Strategy (Ref. 7), which is based on the principles of the National Strategy for Ecologically Sustainable Development (Ref. 8).

management objectives that describe what must be achieved to protect the EVs (Ref. 6).

Five EVs and associated EQOs were identified for WA marine waters (Table 2-1), and apply to all Pilbara waters (Ref. 5) including the waters surrounding Barrow Island, except for small areas immediately surrounding specific discharges where it may not be possible for all EVs to be met due to the nature of the discharges (Ref. 6).

Table 2-1: EVs and EQOs for WA Marine Waters

Environmental Values	Environmental Quality Objectives
Ecosystem Health (ecological value)	Maintain ecosystem integrity – maintaining the structure (e.g. the variety and quantity of life forms) and functions (e.g. the food chains and nutrient cycles) of marine ecosystems
Fishing and Aquaculture (social use value)	Fishing – seafood (caught or grown) is of a quality safe for eating
	Aquaculture – water quality is suitable for aquaculture purposes
Recreation and Aesthetics (social use value)	Primary contact recreation – water quality is safe for primary contact recreation (e.g. swimming and diving)
	Secondary contact recreation – water quality is safe for secondary contact recreation (e.g. fishing and boating)
	Aesthetic values of the marine environment are protected
Cultural and Spiritual (social use value)	Cultural and spiritual values of the marine environment are protected
Industrial Water Supply (social use value)	Water quality is suitable for industrial supply purposes

Source: Ref. 5

2.2 Levels of Ecological Protection

The first EQO—maintain ecosystem integrity—is unique in that it encompasses four LEPs, each representing a different environmental quality condition (Table 2-2).

The acceptance of different LEPs recognises that other societal uses must be considered when managing environmental quality. Due to competing interests, it is acknowledged that not all areas can achieve (or retain) high to maximum LEPs, and that some areas need to be given moderate or low ecological protection status because of historical or future uses (Ref. 9) with corresponding limits of acceptable change to environmental quality. It is also recognised that:

> *'these LEPs should be applied to each part of the ecosystem in such a way that the general integrity of the ecosystem is maintained. This allows for management of conservation values and multiple uses (some with localised effects) while still maintaining the broad structure and function of the ecosystem. Clearly, setting a Moderate or Low LEP over large areas would not protect ecosystem integrity overall. Conversely, it would be unreasonable to propose an area of Maximum LEP adjacent to major existing development or population nodes.'* (Ref. 5).

LEP designations for the Barrow Island Port area are detailed in Section 6.

Table 2-2: LEPs Linked to the EQO for Maintain Ecosystem Integrity

Level of Ecological Protection	Environmental Quality Conditions (Limit of Acceptable Change)		
	Contaminant Concentration Indicators	Biological Indicators	Typical Example of where this LEP would Apply
Maximum	Contaminant levels and other measures remain within the limits of natural variation (no detectable change)	No detectable changes to ecosystem processes, biodiversity, abundance, biomass, or quality of biota beyond the limits of natural variation	Areas with a declared high conservation value (e.g. a Marine Park), but not generally within 5 km of a development
High	Very low contaminant levels, small measurable changes to water and sediment quality		Most of the State's coastal waters where a low, moderate, or maximum LEP has not been designated
Moderate	Elevated contaminant levels that do not exceed specified criteria	Small changes to abundance, biomass, and rates of ecosystem process, but no detectable change to biodiversity or types of ecosystem processes at local and regional scale	Relatively small areas within inner ports and adjacent to heavy industry premises where pollution from current and/or historical activities may preclude a high LEP. May also be used for marinas and harbours to account for accumulation of contaminants from antifoulant coatings, typically extending 250 m from berths or turning basins
Low	High contaminant levels – substantial changes beyond natural variation	Large changes to abundance, biomass, and rates of ecosystem process from natural variation. Types of ecosystem processes should remain unchanged and regional biodiversity should remain unaffected	Small as reasonably practicable and limited to the initial dilution zone around specific wastewater discharges. Located within a moderate ecological protection area (MEPA) where practicable

2.3 Environmental Quality Criteria

The EQC provide benchmarks against which environmental quality is measured. Unlike the EVs and EQOs, which are largely qualitative and described narratively, the EQC are more quantitative and are described numerically (Ref. 9). An important aspect of the EQMF is that the EQC define the limits of acceptable change to the measured environmental quality indicators. They do not represent pollution levels that trigger enforcement action if exceeded (i.e. they are not compliance triggers), nor do they infer it is acceptable to load up the ecosystem to these levels. The key to successful marine environmental performance under the EQMF is to maintain environmental quality within the bounds of the EQC. If the EQC are met, then it is assumed that the EQOs and EVs are protected.

There are two levels of EQC, comprising Environmental Quality Guidelines (EQGs) and Environmental Quality Standards (EQSs):

- **EQGs:** These are relatively simple and easy-to-measure investigative triggers that, if met, indicate there is a high degree of certainty that the associated EQO has been achieved. If the guideline is not met, there is uncertainty as to whether the associated EQO has been achieved and a more detailed assessment against the EQS is triggered.

- **EQSs:** These are threshold numerical values or narrative statements that indicate a level beyond which there is a significant risk (with increasing certainty) that the associated EQO has not been achieved and a management response is likely required. The response would normally focus on identifying the cause (or source) of the exceedance and then reducing the loads of the contaminant of concern; remedial work may also need to be undertaken in extreme circumstances. EQSs are generally equivalent to the water quality objectives described by the Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ; Ref. 7).

These two types of criteria, and their framework for application (Figure 2-2), are used in this Plan to assess whether the EQOs have been met and thus EVs are being protected. The specific EQC developed for operation of the Gorgon Gas Development are detailed in Section 7.

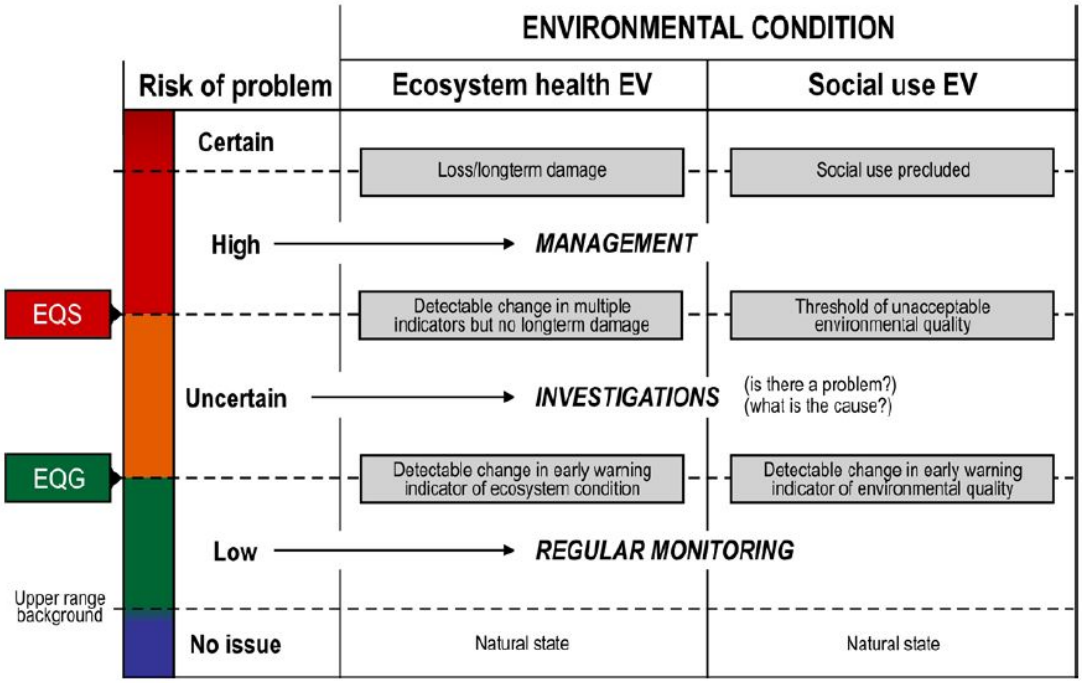

Figure 2-2: Conceptual Framework for Applying the EQGs and EQSs

Notes: Conceptual diagram (source: Ref. 6) showing the relationship between the two types of EQC (EQG and EQS, on the left) with the associated environmental condition (on the right). The diagram shows that the intensity of the response triggered depends on which type of EQC has not been met, which in turn reflects the level of risk of whether or not there is an environmental problem.

3 Implementation of the Environmental Quality Management Framework for Operation of the Gorgon Gas Development

This Section outlines CAPL's strategy for implementing the EPA's EQMF for operation of the Gorgon Gas Development, including the screening process used to determine the marine facilities and associated operational activities that require monitoring to achieve the EQOs.

3.1 Environmental Values and Environmental Quality Objectives for Operation of the Gorgon Gas Development

The stakeholder consultation process (Section 1.4) determined that the interim EVs and EQOs described by the Pilbara Coastal Water Quality Consultation Outcomes (Ref. 5) apply to the marine waters within the scope of this Plan. None of the stressors resulting from operation of the Gorgon Gas Development would preclude EQOs from being maintained; therefore, all EVs and EQOs identified in Table 2-1 apply to the waters of the Barrow Island Port and other State Coastal Waters where operational activities occur, with no exclusions.

3.2 Waste Minimisation Principles and Related Documents

Although the overall objective of the EQMF is to protect the EVs from the effects of pollution, waste discharges, and waste deposits, the EQMF functions within the broader principle of waste minimisation (Ref. 6). Waste avoidance and minimisation strategies are the primary ways to protect the EVs; the EQMF works in tandem with these strategies by assessing the overall long-term quality of the marine environment receiving wastes, and therefore the overall effectiveness of the waste minimisation approach.

Figure 3-1 shows the Gorgon Gas Development waste management documentation hierarchy within which this Plan exists; the following sections summarise of those documents.

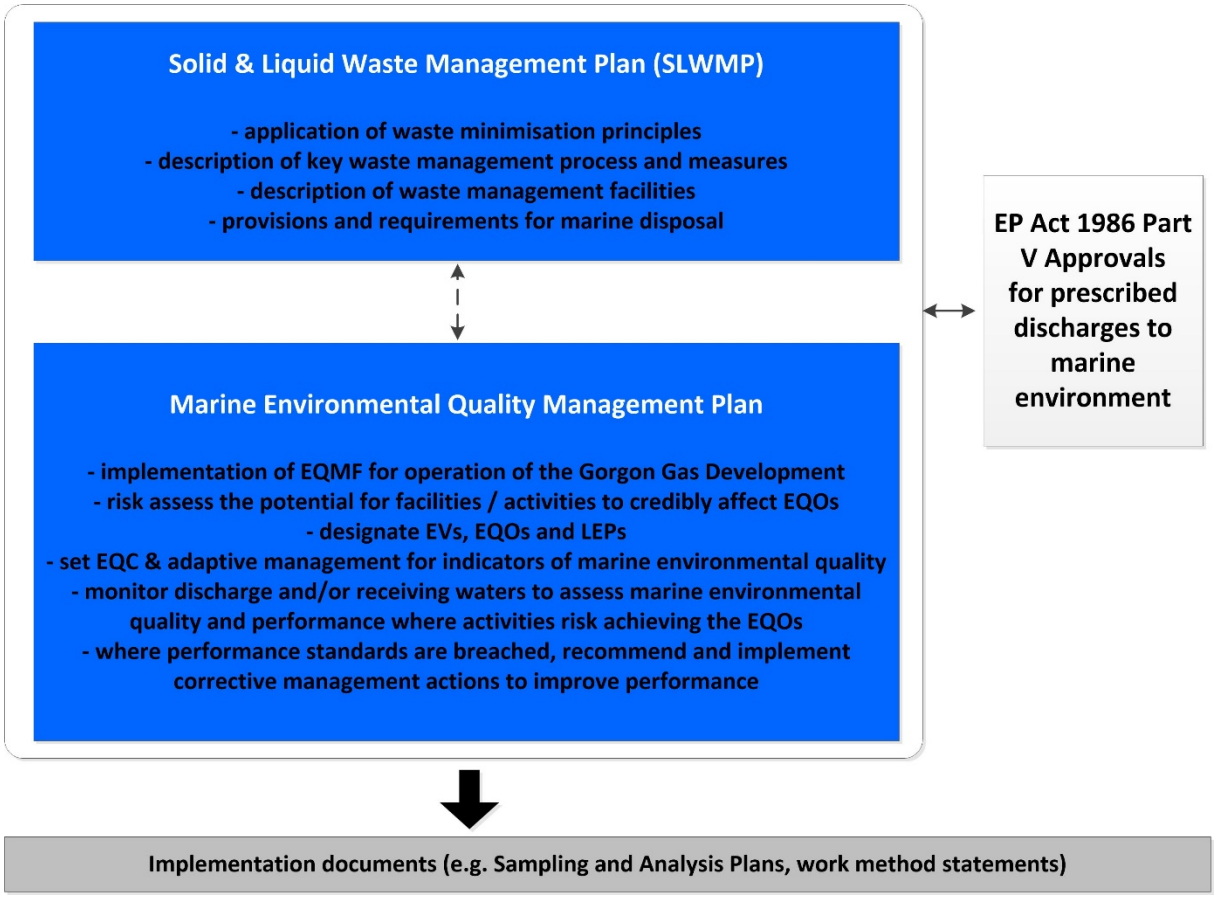

Figure 3-1: Hierarchy of Waste Management Documentation Relevant to this Plan

3.2.1 Gorgon Gas Development Ministerial Plans

Management of wastes from Gorgon operations is outlined in the Solid and Liquid Waste Management Plan (SLWMP; Ref. 10), which is underpinned by a waste minimisation hierarchy where disposal of wastes to the marine environment is the least preferred option.

This Plan is related to the SLWMP, in that any management actions initiated from processes described in Section 7 (e.g. reduction of a waste stream) are likely to be practicably implemented via the SLWMP or related internal processes.

3.2.2 *Environmental Protection Act 1986* Part V Licences and Other Related Licences

Part V of the Western Australian *Environmental Protection Act 1986* (EP Act) is administered by DWER; it relates to applications for prescribed premises and works approvals licences (and registrations) for premises with significant potential to cause emissions and discharges to air, land, or water.

The GTP operates under Licence L9102/2017/1, issued under Part V of the EP Act. The Licence includes conditions regarding the management of air emissions and liquid waste discharges to the terrestrial environment.

The GTP is also required to be licensed and operated in compliance with the Dangerous Goods Safety (Storage and Handling of Non-Explosives) Regulations 2007 and the Dangerous Goods Safety (Major Hazard Facilities) Regulations 2007. This requires a Dangerous Goods licence(s) to cover the

storage of chemicals classified as dangerous goods (depending on quantities) and a Major Hazard Facility Licence for operation of the GTP and export of LNG.

3.3 Screening and Risk Assessment of Marine Facilities and Activities Related to Operation of the Gorgon Gas Development

3.3.1 Overview

The scope of this Plan includes all activities related to operation of the Gorgon Gas Development with the potential to affect marine environmental quality (Section 1.3.2). Although each of the marine facilities and associated activities are generally considered to pose a low risk to the EVs of the Barrow Island marine environment, the potential of any of the activities to affect marine environmental quality and consequently risk achieving the EQOs was comprehensively assessed using a staged screening and risk-assessment process. The approach was risk-based, with the intention to result in a fit-for-purpose monitoring program that focuses on key pressures to marine environmental quality from operation of the Gorgon Gas Development, at time scales relevant to the stressors.

Based on the degree of risk to marine environmental quality, the outcomes of the risk assessment were used to determine the requirement for monitoring to confirm achievement of EQOs.

Activities with the potential to measurably affect marine environmental quality require monitoring, only where the potential effects pose a credible risk to achieving the EQOs and the designated LEPs. EQC and environmental monitoring requirements specific to the activities meeting the above definition—categorised as ‘Tolerable if monitored’ (Section 3.3.3)—are specified in this Plan.

Activities identified as having the potential to affect marine environmental quality but where those effects are trivial, inconsequential, not persistent, and therefore do not inherently pose a credible risk to achieving the EQOs (‘Negligible – inherent’), are not monitored via this Plan as there is a high confidence that EQOs and designated LEPs will be maintained (Appendix B). Similarly, activities already effectively managed and/or monitored through other regulatory or internal instruments to the extent that the residual risk (accounting for safeguards) to EQOs and LEPs is negligible (‘Negligible – mitigated’) are not further assessed or monitored via this Plan (Appendix B); where practicable, activities monitored via other instruments may be compared against the EQC defined in this Plan.

The following sections (as summarised in Figure 3-2) describe each step of the process used to determine which marine facilities and activities required monitoring and/or management to ensure that the EQOs are achieved.

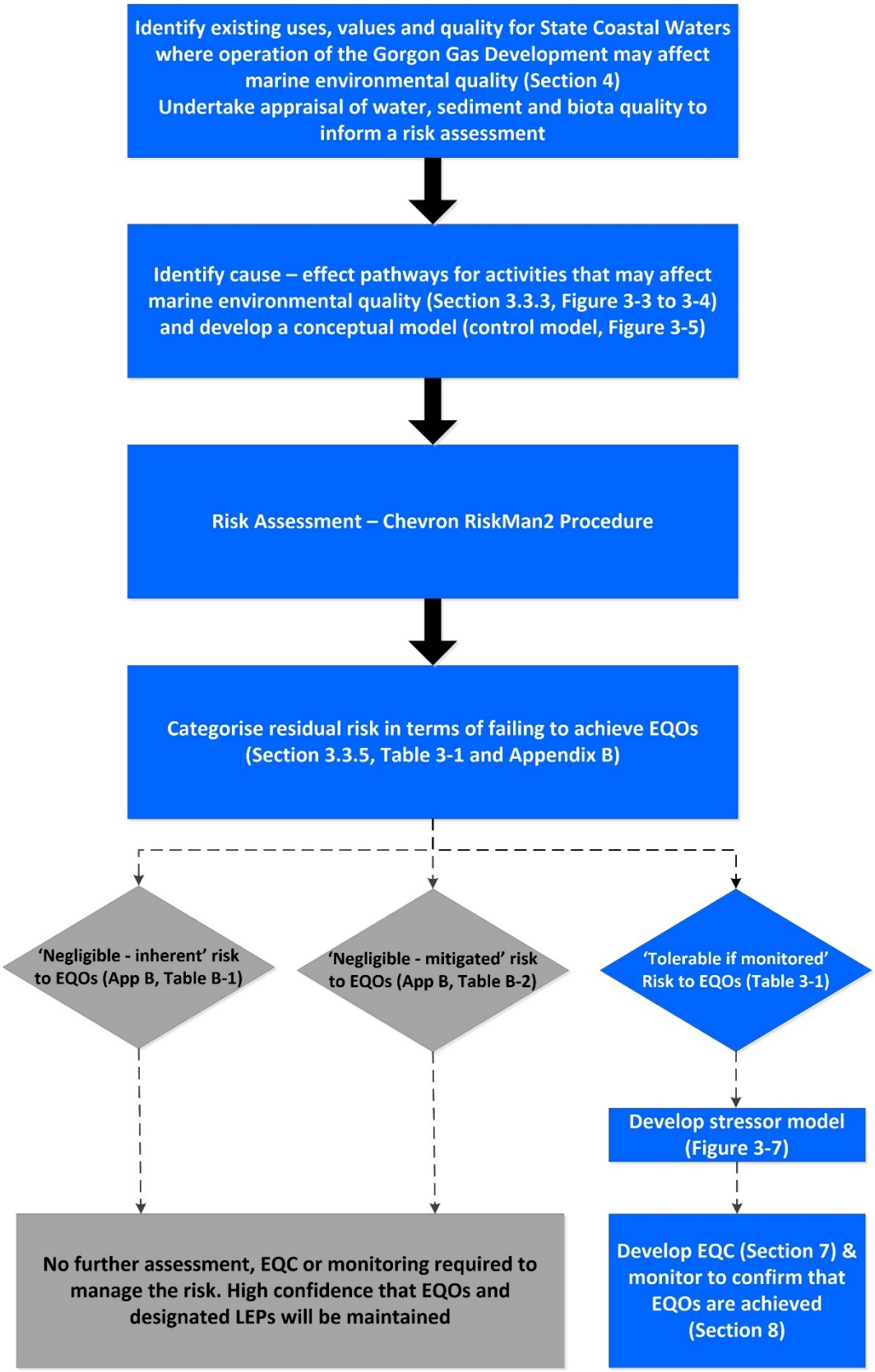

Figure 3-2: Screening Process to Determine the Marine Facilities and Activities Monitored via this Plan

3.3.2 Identification of Environmental Values and Environmental Quality Objectives for Operation of the Gorgon Gas Development

The first step in the screening process was to identify the existing uses, values and quality of State Coastal Waters where operation of the Gorgon Gas Development may affect marine environmental quality. Section 4 describes the marine environment surrounding Barrow Island.

3.3.3 Identification of Cause–Effect Pathways

The second step in the screening process was to identify potential pathways for impacts to marine environmental quality. Cause–effect (also known as stressor–response) models draw together relevant empirical and theoretical knowledge of the ecosystem. Stressors and contaminants most likely to result from facilities and activities in the broader Barrow Island area (shown in Figure 3-3 and Figure 3-4) were identified by reviewing all relevant Gorgon Gas Development environmental documentation, and holding dedicated workshops that were attended by external consultants and technical experts from CAPL.

The outcome of the review and workshops was a conceptual model, modified from Gross (Ref. 11). The complex model of cause–effect pathways (control model, Figure 3-5) is a conceptualisation of the actual controls and interactions responsible for system dynamics. The Control model developed for the waters surrounding Barrow Island is hierarchical, with the stressors and their sources shown in the upper sections of the model, and the indicators (receptors) and effects shown in the lower sections. The stressors included in the Control model are both natural and anthropogenic and the objective was to capture all known interactions between elements to consider the cumulative effects to marine environmental quality. Although the control model is the most comprehensive of the conceptual models, it remains relatively simple in that it does not account for synergistic effects or the severity of the disturbance (i.e. the model makes no attempt to account for the magnitude and/or the duration of the stress).

Although the intent of the EQMF is to protect the EVs from the effects of pollution, waste discharges, and waste deposits, as per Condition 23A.2.i of MS 800, the scope of this Plan includes any operational activity where there is potential for operation of the Gorgon Gas Development to affect marine environmental quality. Therefore, the risk screening process included activities CAPL considered to be beyond the intent of the EQMF (e.g. effects to coastal processes); however, these activities are not shown in the control model.

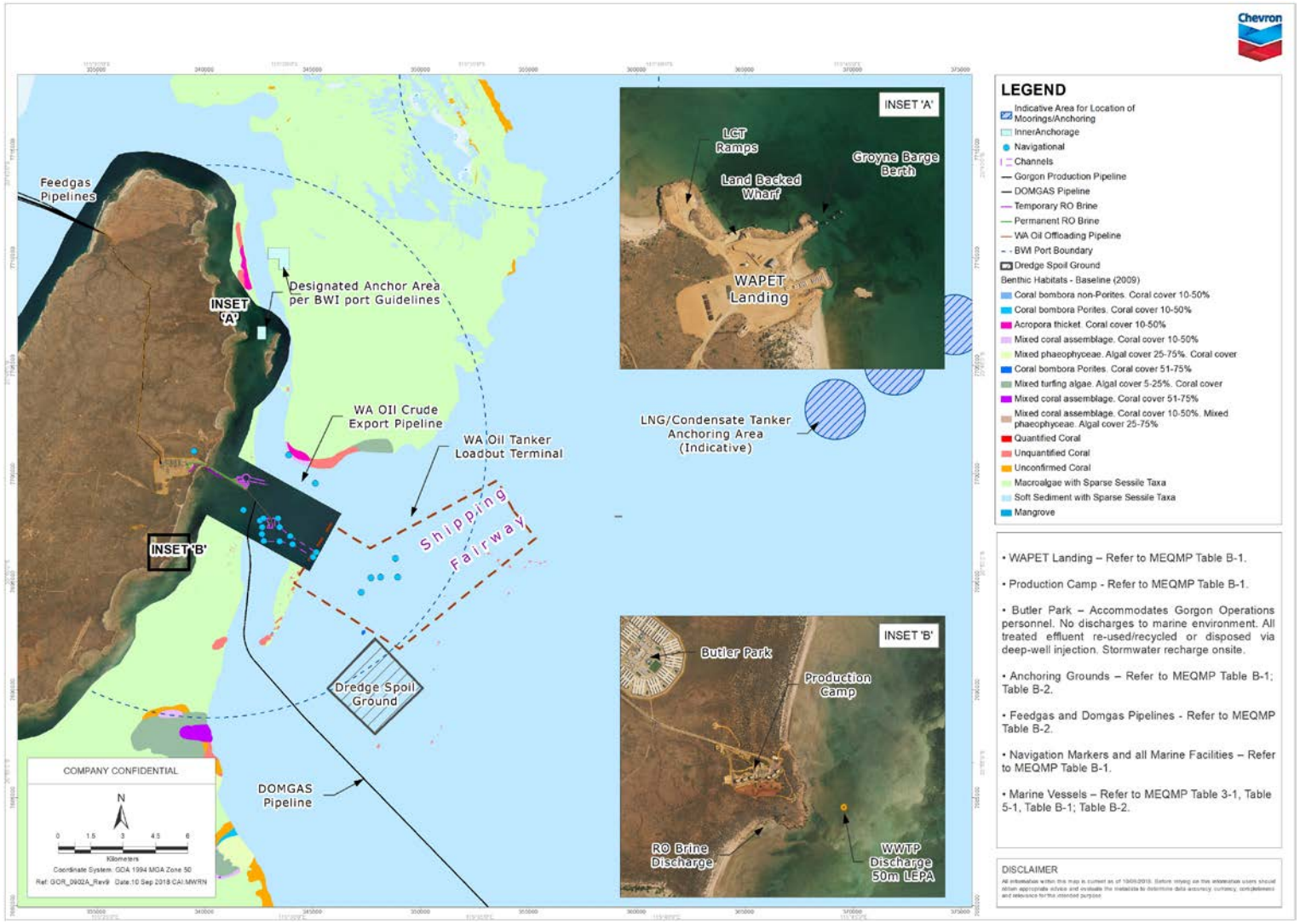

Figure 3-3: Overview of Key Facilities and Activities in the Barrow Island Area

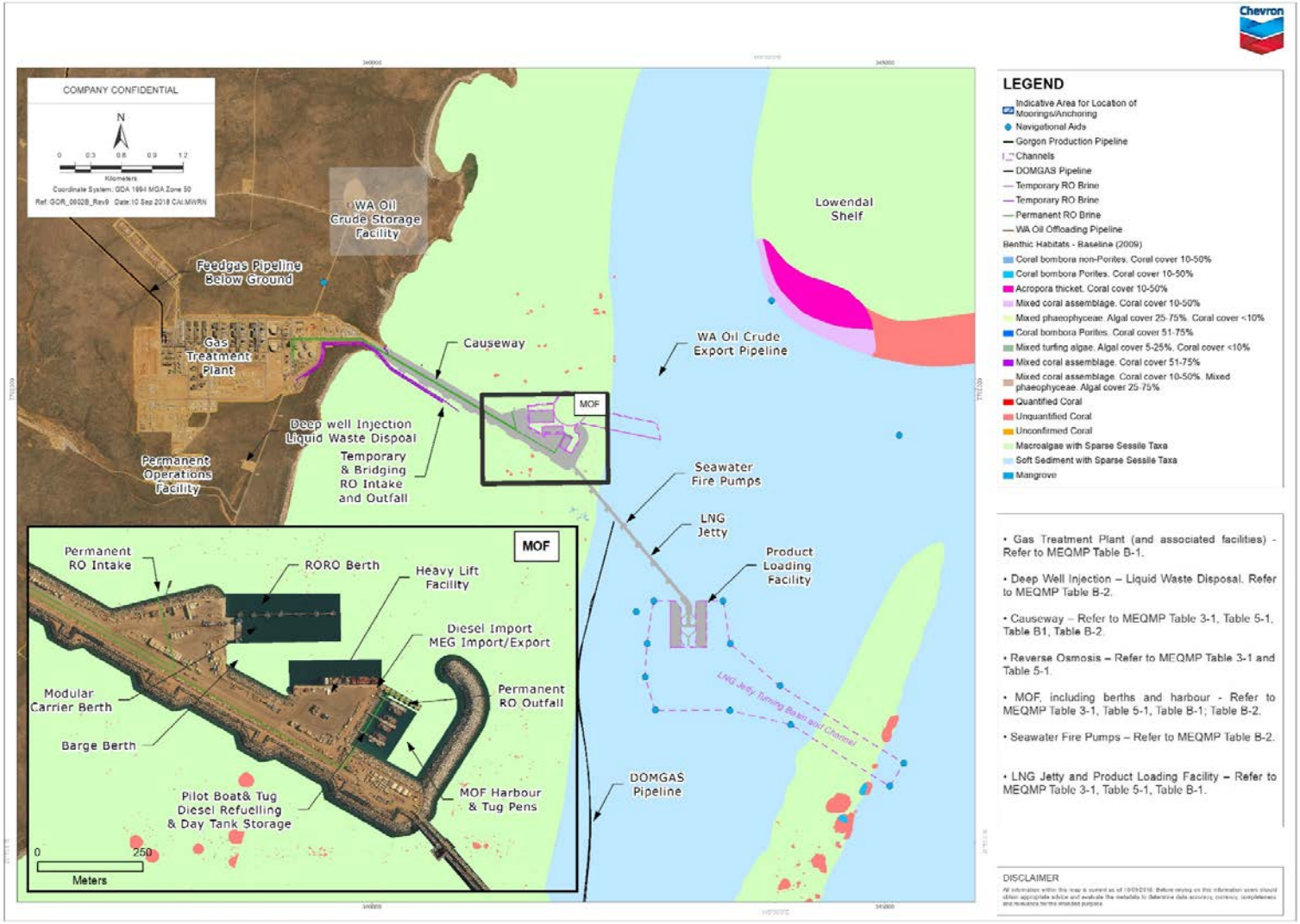

Figure 3-4: Key Facilities and Activities around Gorgon Gas Development Facilities

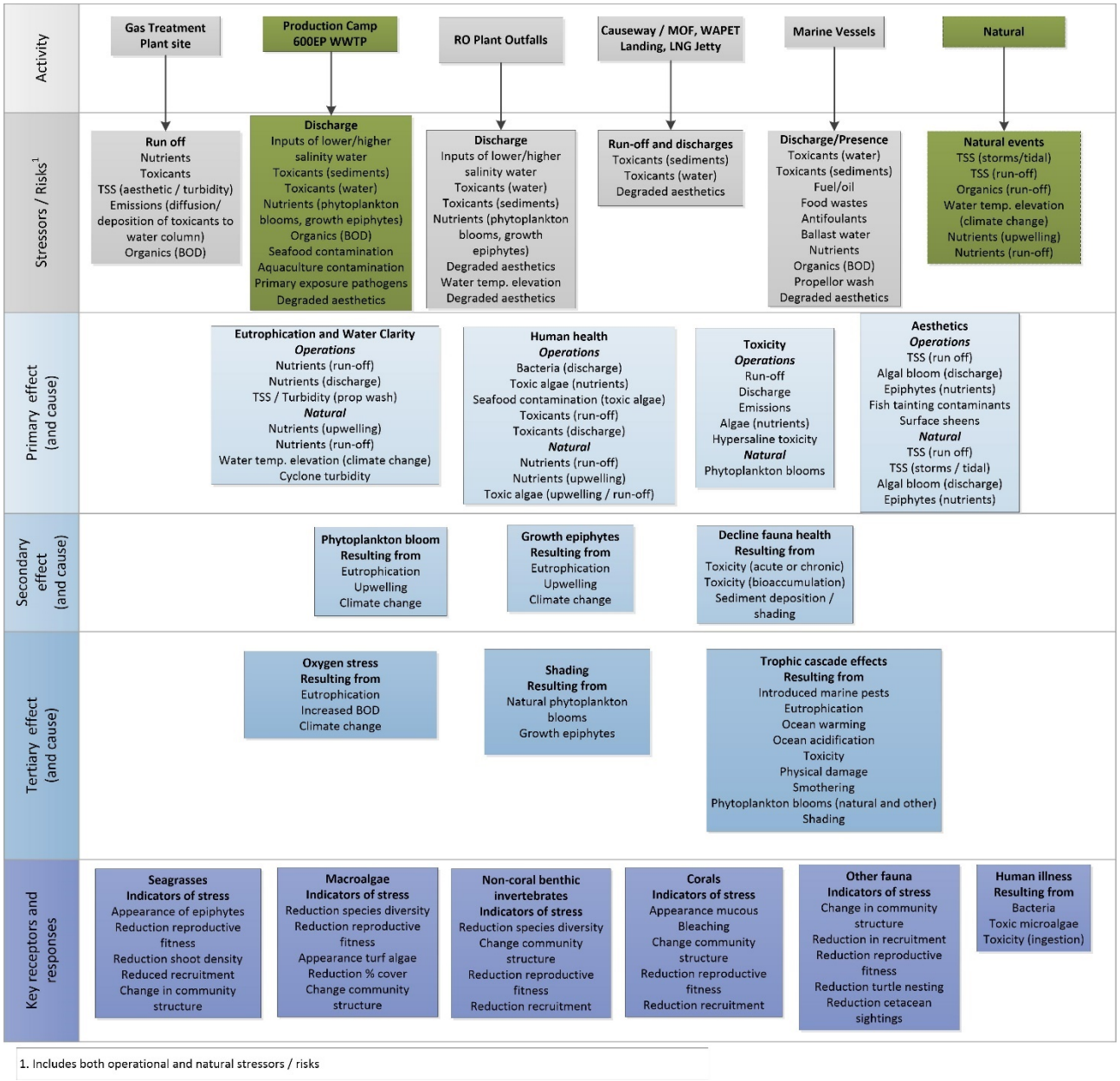

Figure 3-5: Control Model Depicting Potential Stressors, Effects, and Key Receptors from Key Facilities and Activities in the Barrow Island Area

Note: Stressors not related to operation of the Gorgon Gas Development (shaded green) are included in the Control model to enable consideration of cumulative effects to marine environmental quality.

3.3.4 Risk Assessment and Categorisation

Each of the activities/facilities and identified cause–effect pathways were systematically assessed for their potential to affect marine environmental quality, and then categorised according to the risk of that effect compromising the EQOs. Assessment was guided by the CAPL Health, Environment, and Safety (HES) Risk Management Process (Ref. 12) and determined:

- the potential extent and magnitude of the effects to marine environmental quality (consequence)

- the extent to which some (or all) of the effects may be minimised via design or mitigation measures already in place during operations (safeguards)
- the probability of the consequence occurring, given the safeguards (likelihood)
- the subsequent residual risk ranking.

The risks were assessed in the context of the operational activities, known environmental conditions (Section 4) and likely responses (informed by the potential effects and receptors identified in the Control model), local restrictions to be applied during Gorgon operations, and the social considerations specific to Barrow Island.

The ranking outcomes of Chevron Corporation's RiskMan2 Procedure (Ref. 13) were then translated to the EQMF by categorising the residual risk ranking in terms of compromising the EQOs (and thus failing to protect the EVs). Three categories of residual risk were used:

- **Negligible – inherent**: There is negligible risk of the stressors from the facility/activity to the EQOs due to minimal presence (or absence) of relevant and measurable stressors, and/or the inherent design/engineering of Gorgon Gas Development infrastructure, and/or recreational/commercial use of Barrow Island waters. Monitoring is not required to confirm that EVs are protected.
- **Negligible – mitigated**: There is high certainty that the potential for the facility/activity to affect marine environmental quality and threaten the EVs is adequately managed by environmental management and mitigation measures already in place for operation of the Gorgon Gas Development, such that the residual risk to achieving EQOs is negligible. Monitoring is not required to confirm that EVs are protected.
- **Tolerable if monitored**: The potential to affect marine environmental quality and risk of compromising the EQOs is deemed acceptable (and is as low as reasonably practicable [ALARP]), but the effects require designation of specific LEPs and monitoring of EQC to ensure that EQOs are maintained and EVs are protected.

3.3.5 Outcomes

CAPL may review the risk assessment as required (e.g. in response to new information; as a result of a significant change to the Gorgon Gas Development that results in increased and significantly changed discharges to the marine environment; or substantial increased recreational/commercial use of the waters surrounding Barrow Island). However, revising this Plan is only required if the revised risk assessment results in amended monitoring regimes, or new monitoring through (re)categorisation of an activity to 'Tolerable if monitored'.

3.3.5.1 Ecosystem Health EV

In most cases, risks to the Ecosystem Health EV were categorised as 'Negligible – inherent' or 'Negligible – mitigated'; however, the risk from four specific groups of activities/stressors occurring at the Materials Offloading Facility (MOF) and LNG Jetty facilities were categorised as 'Tolerable if monitored', as summarised in Table 3-1. Further description of the marine facilities and associated activities/key stressors resulting in a 'Tolerable if monitored' risk is provided in Section 5.

Based on the risk-assessment outcomes, designation of specific LEPs and monitoring against EQC in this Plan is limited to waters within the Barrow Island Port area. The operational activities occurring beyond these waters were considered to:

- pose no credible risk to achieving EQOs from effects to marine environmental quality (Negligible – inherent); or
- be adequately managed through existing management frameworks (Negligible – mitigated); or
- be spatially transient (e.g. shipping routes), and therefore it would not be reasonably practicable to spatially define EVs, EQOs, and associated LEPs for those particular areas of State Coastal Waters (if the potential for affecting marine environmental quality warranted a reduced LEP).

Appendix B summarises the risk-assessment outcomes for activities categorised as 'Negligible – inherent' or 'Negligible – mitigated'.

3.3.5.2 Social Use EVs

Risks to Recreation and Aesthetics, Cultural and Spiritual, and Industrial Water Supply EVs from all identified facilities/activities were categorised as 'Negligible – inherent' or 'Negligible – mitigated', with the existing safeguards in place (Appendix B). EQC (and monitoring) specific to the Fishing and Aquaculture EV are specified in this Plan, due to activities/stressors occurring at the MOF facilities that were categorised as 'Tolerable if monitored' (Table 3-1). Note: Maintenance of the Ecosystem Health EV (Section 3.3.5.1) protects the structure and function of the marine ecosystem (including constituent fauna, flora, water quality, sediment quality, and biogeochemical processes), and thus provide extra protection to Social Use EVs.

The Fishing and Aquaculture EV is aimed at ensuring facilities/activities do not affect shellfish intended for human consumption. Maintaining aquatic life for safe human consumption is primarily concerned with harvesting and consuming raw shellfish (i.e. filter-feeding bivalve molluscs such as oysters, mussels, clams, pipis, scallops, cockles, and razor clams), but not other forms of seafood. The WA Department of Health discourages the public from taking wild shellfish, recommending instead that shellfish are only consumed if harvested commercially and under strict monitoring programs (Ref. 14). Regardless, EQC (and monitoring) specific to Fishing and Aquaculture is included in this Plan. Note: 'the prohibition of these activities within an area is not a reason for excluding the EV of Fishing and Aquaculture and allow the uncontrolled discharge of some contaminants to the point where it could be unsafe to consume seafood from the area if the Restricted Zone were lifted in the future' (Ref. 6).

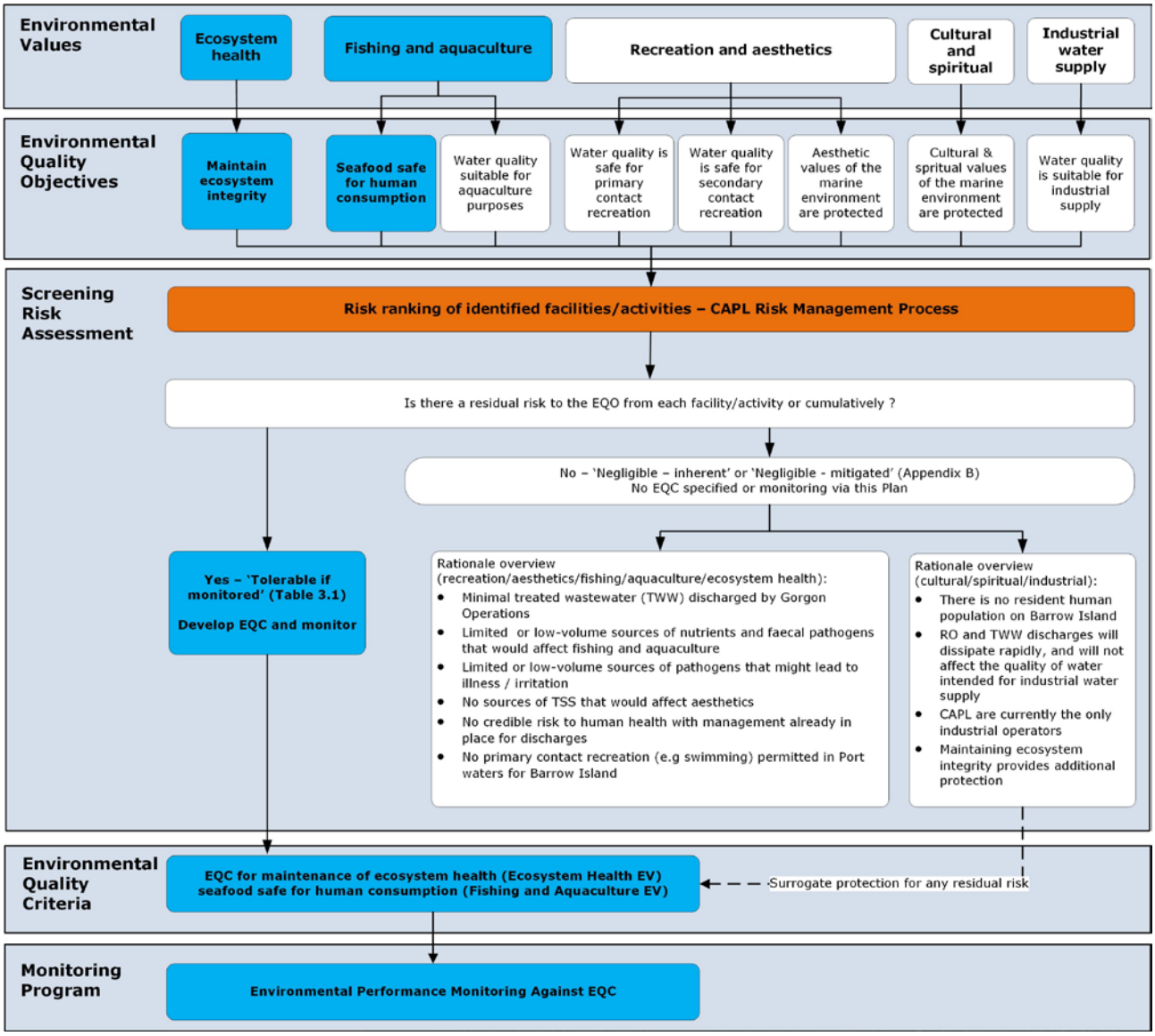

Figure 3-6: Summary of Screening Risk-Assessment Outcomes

Note: Blue shaded cells represent the EVs monitored under this Plan.

Table 3-1: Summary of Gorgon Gas Development Operational Activities Categorised as 'Tolerable if monitored'

Marine Facility	Activity and Key Stressor	Safeguards – Design Features and Management Measures	EV at Risk	EQC Defined in this Plan
MOF and Turning Basin (including the tug pen)	Cumulative incidents of contaminated run-off and/or direct leaks from marine facilities with the potential to result in accumulation of toxicants in marine sediments, particularly in lower flushing environments such as the tug pen	**Design features**: • Storage vessels and higher-risk leak points (e.g. bowsers, flanges, valves) are contained within bunds or kerbed containment areas, and where appropriate, are equipped with sumps to facilitate emptying. • All waste transported via the MOF is containerised. • Management measures – regulatory: • Management of wastes from Gorgon operations is defined in the SLWMP (Ref. 10) • Management measures – internal: • Bulk transfers to/from marine vessels supporting Gorgon operations comply with the Australian Business Unit (ABU) Offshore Cargo Handling Procedures (Ref. 15), specifically requirements for dry and wet transfers (including bulk hydrocarbons) near the marine environment. • Operational procedures specifying that areas are to be maintained clean, requiring immediate clean-up of spills, routine inspections for damaged or leaking equipment, pre/post rainfall inspections and cleanout, dewatering of sumps and bunds, and scheduled preventive maintenance programs. • No permanent or transit chemical storage areas on the Causeway/MOF Jetty, unless ALARP risk is demonstrated.	Ecosystem Health Fishing and Aquaculture	EQC for toxicants in sediments Section 7.1.1 EQC for toxicants in marine water – Section 7.1.2 EQC for toxicants in biological (oyster) tissue – Section 7.2.1
	Leaching of antifoulants (containing toxicants, e.g. copper and zinc) from the hulls of marine vessels, and/or direct leaks from vessels with the potential to result in elevated concentration of toxicants in water and accumulation of toxicants in marine biota and sediments, particularly in lower flushing environments such as the tug pen	**Management measures – external and internal**: • Marine vessels must be registered with the International Maritime Organization (IMO), which prohibits antifoulants containing tributyltin (TBT). • Internal Marine Operational Excellence (OE) inspections verify that vessels are IMO-registered, which confirms that the antifoulants are TBT-free. **Comments**: • Assessment conservatively assumes toxic antifoulant coatings are used for the life of the Gorgon Gas Development, i.e. no further technological advances in antifoulant coatings towards lower or non-toxic options (for non-target organisms). The assessment considers inputs of contaminants when adjacent to marine facilities, not in open water. CAPL considers the tug pen is the highest risk area.		

Marine Facility	Activity and Key Stressor	Safeguards – Design Features and Management Measures	EV at Risk	EQC Defined in this Plan
		• TBT is not considered a risk factor for Gorgon operations due to the external and internal management controls prohibiting its use.		
LNG Jetty, Product Loading Facility, and Turning Basin	Cumulative incidents of contaminated run-off and/or direct leaks from marine facilities with the potential to result in accumulation of toxicants in marine sediments	**Design features**: • Storage vessels and higher-risk leak points (e.g. bowsers, flanges, valves) are contained within bunds or kerbed containment areas, and where appropriate, are equipped with sumps to facilitate emptying. **Management measures – regulatory**: • Management of wastes from Gorgon operations is defined in the SLWMP (Ref. 10) **Management measures – internal**: • Bulk transfers to/from marine vessels supporting Gorgon operations comply with the ABU Offshore Cargo Handling Procedures (Ref. 15), specifically requirements for dry and wet transfers (including bulk hydrocarbons) near the marine environment. • Operational procedures specifying that areas are to be maintained clean, requiring immediate clean-up of spills, routine inspections for damaged or leaking equipment, pre/post rainfall inspections and cleanout, dewatering of sumps and bunds, and scheduled preventive maintenance programs.	Ecosystem Health	EQC for toxicants in sediments – Section 7.1.1
Reverse osmosis (RO) facilities supporting operation of the Gorgon Gas Development	Discharge of hypersaline RO reject water with the potential to affect water quality through changes to salinity and associated physiological stress. Whole Effluent Toxicity (WET) testing of simulated effluents found that elevated concentrations of salinity was the key stressor in brine, with process chemical additives having no additional measurable effect upon the toxicity of the effluent	**Design features**: • RO outfall diffusers are designed to achieve the required dilutions to meet 99% species protection (calculated via ecotoxicity testing) in the initial (near-field) dilution zone. • Diffuser performance has been verified by sustained field measurements. **Management measures – regulatory**: • Condition 30.2.ii of MS 800 requires authorisation from the Minister for discharges from any wastewater treatment plant (WWTP), RO plant, or other process water to the environment unless disposed of via deep well injection. The SLWMP (Ref. 10) describes the waste management facilities on Barrow Island and options for disposal, including to the marine environment. Marine disposal of RO brine discharges has been authorised by the Minister. **Management measures – internal**:	Ecosystem Health	EQC for physicochemical stressors – Section 7.1.3

Marine Facility	Activity and Key Stressor	Safeguards – Design Features and Management Measures	EV at Risk	EQC Defined in this Plan
		• Operator procedures for operating plant according to manufacturers' specifications, including monitoring system performance. **Comments**: • The process and justification for selecting water supply, treatment, and brine disposal options, the characteristics of the selected option, risk, and environmental impact assessment of brine disposal, is described in the Reverse Osmosis Brine Disposal via Ocean Outfall Environmental Management and Monitoring Plan (ROBDOOEMMP Ref. 16). Ongoing monitoring of the RO discharges in an operational setting is addressed in this Plan.		

3.3.6 Stressor Model

Lastly, based on the outcomes of the risk assessment and categorisation process, a Stressor model (Figure 3-7) was developed to show the relationship between the key stressors, effects (which also double as indicators), and receptors from facilities/activities that may require monitoring and/or management. The intent of the Stressor model was to isolate a subset of relevant indicators from which EQC were developed to establish monitoring and assessment protocols against those EQC.

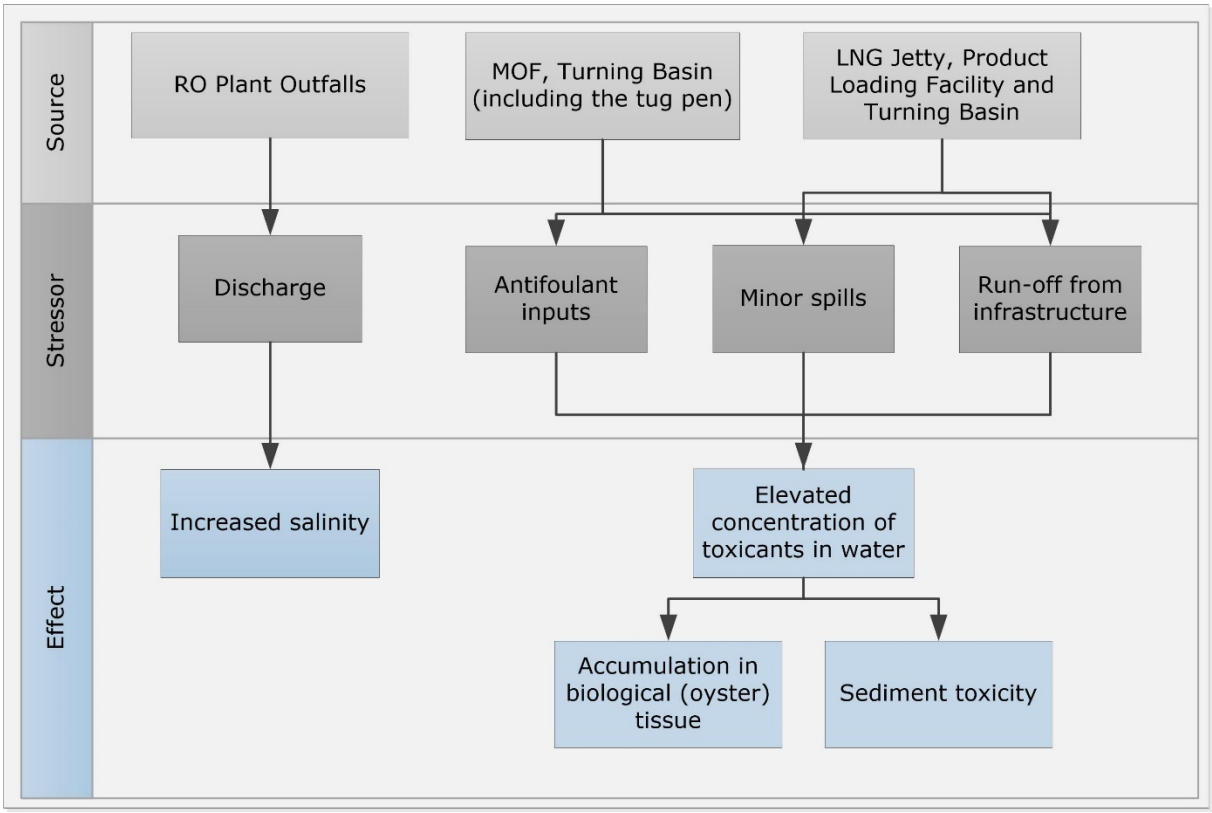

Figure 3-7: Stressor Model Depicting the Major Cause–effect Pathways from Potential Key Stressors Originating from Marine Facilities and Activities Related to Operation of the Gorgon Gas Development

4 Description of the Environment

This Section outlines the existing uses, values, and quality of the marine waters surrounding Barrow Island in the context of the EVs described in Section 2.1.

4.1 Ecosystem

The Barrow Island marine and terrestrial environments have been the subject of extensive scientific investigation, both before (Coastal and Marine Baseline State and Environmental Impact Report [CMBSEIR]; Ref. 17) and after the dredging and dredge spoil disposal phases (Post-Development Surveys 1, 2, and 3 [PDS1, PDS2, and PDS3]; Ref. 18; Ref. 19; Ref. 20) of the Gorgon Gas Development. Further studies were undertaken to inform development of this Plan and risk assessment of activities supporting operation of the Gorgon Gas Development (Ref. 21; Ref. 22). Thus, this summary of EVs is supported by a detailed, contemporary understanding of the physicochemical and biological components of the Barrow Island marine ecosystem, and its interaction with existing social and industrial infrastructures. Note: Natural events (e.g. thermal bleaching, cyclones) can rapidly and drastically alter the composition, health, and abundance of biological assemblages (Section 4.1.1.3, Ref. 20).

4.1.1 Benthic Habitats

The central east coast of Barrow Island is a sheltered, relatively low-energy environment comprising sandy beaches, small rocky headlands, and a broad fringing intertidal/subtidal rock platform. The subtidal environment, and especially the fringing rock platform, is characterised by sparse assemblages of macroalgae, seagrasses (largely ephemeral species), non-coral benthic macroinvertebrates (NCBMs), and sporadic coral colonies or the occasional small bombora field (Figure 5-1). Exposed areas of rock (e.g. on the slopes of the natural channel adjacent to the fringing platform) tend to have a higher abundance of sessile taxa. The loadout facilities of the LNG Jetty, situated in deeper water and on soft sediment, are also characterised by sparse sessile taxa.

For most activities and facilities described in this Plan (Section 5), the receiving environment is the fringing intertidal and subtidal rock platform, which is widespread across the east coast of Barrow Island. Although more extensive coral communities are present in the offshore environment, all are located more than 3 km from the nearest applicable marine facilities, and none are expected to be adversely affected by the activities described in this Plan.

4.1.1.1 Macroalgae and Seagrass

Macroalgal communities are common on the fringing subtidal rock platform of Barrow Island. PDS1 identified 95 different taxa represented equally by the red, brown, and green algae (Ref. 23).

Generally, seagrasses are sparsely distributed and commonly co-occur with macroalgae; however, natural spatial and temporal variability in seagrasses is significant in Barrow Island marine waters (Ref. 24). At the completion of PDS1, seagrasses on the fringing rock platform were generally dominated by *Halophila ovalis* and *H. spinulosa*. Lower numbers of *Cymodocea serrulata*, *H. decipiens*, *Syringodium isoetifolium*, and *Halodule* species were also reported (Ref. 24).

4.1.1.2 Non-coral Benthic Macroinvertebrates

NCBMs are a common and widespread element of the eastern intertidal and subtidal fringing environments of Barrow Island (Ref. 2). At the completion of PDS3, the sessile NCBM taxa of eastern Barrow Island were dominated by colonial ascidians, sea whips, sponges, and *Turbinaria* spp. Other fauna such as anemones, bivalves, crinoids, gastropods, gorgonians, sea cucumbers, and sea urchins have also been observed (Ref. 25). There are also differences in NCBM assemblages between hard and soft substrates, with Zoanthids dominant on hard substrates and Hydroids dominant on the available hard substrates within areas of mostly soft substrate (Ref. 25). The high diversity and abundance of NCBMs is consistent with previous findings that the waters of the Montebello/Barrow Islands are species-rich (Ref. 26; Ref. 2; Ref. 27).

4.1.1.3 Corals

The corals of Barrow Island and the greater Pilbara marine waters are typically dominated by *Acropora* (especially plate *Acropora*), *Porites*, *Pavona*, and *Turbinaria*, with a mixed assemblage of faviids, and other scleractinian corals being less dominant (Ref. 28); however, dominance of taxa can change dramatically in response to natural climatic events.

At Barrow Island, CMBSEIR surveys identified 48 genera (196 species) of hard coral and eight genera of soft coral (Ref. 17) with Faviidae, Poritidae, and Acroporidae families the dominant families. In 2014, five years on from the CMBSEIR surveys, the Faviidae and Poritidae families remain the dominant/subdominant coral families on the east coast of Barrow Island (Ref. 29). A bleaching event in early 2013 resulted in a dramatic reduction in live coral cover between PDS2 and PDS3 (more so than occurred as a result of dredging activities), particularly across the *Acropora* (Ref. 29). Although recovery of Barrow Island coral communities is expected over time, the recovery trajectory depends on the extent and frequency of future disturbances (Ref. 29).

4.1.2 Water Quality

4.1.2.1 Temperature and Salinity

Surface water temperatures around Barrow Island typically vary between 21 °C in winter and 32 °C in late summer, but can be higher for short periods. The sea water is generally well mixed with uniform temperatures throughout the water column (Ref. 2). Generally, temperature stratification of nearshore waters is infrequent and there is little evidence of salinity stratification at any of the nearshore sites monitored on the east or west coasts of Barrow Island (Ref. 30; Ref. 31). However, rainfall events are expected to cause localised salinity stratification in coastal waters adjacent to discharging watercourses.

4.1.2.2 Toxicants

Broadscale water quality studies (to inform the engineering design of the RO plants) were undertaken before starting dredging and construction activities. These data represent preconstruction water quality and are likely to reflect background concentrations of toxicants in the Barrow Island area. Water samples were collected on nine occasions in 2008, at three sites on the east coast of Barrow Island: immediately south of the MOF, ~1 km south of the LNG Jetty, and ~25 km east of the MOF and LNG Jetty infrastructure.

Samples were analysed by the Commonwealth Scientific and Industrial Research Organisation using specialist ultra-trace methods and provided clear results that, except for cobalt, concentrations of metals (aluminium, arsenic, barium, calcium, cadmium, total chromium, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, strontium, tin, vanadium, and zinc) were consistently below the ANZECC/ARMCANZ (Ref. 31) guideline trigger values for 99% species protection. Naturally occurring background concentrations of cobalt were well above the 99% species protection value (Ref. 31).

In an earlier study of the North West Shelf using comparable ultra-trace methods Wenziker *et al.* (Ref. 32) reported concentrations of cadmium, chromium, copper, mercury, lead, and zinc below the 99% species protection trigger values. For cobalt, Wenziker *et al.* (Ref. 32) reported that the 99% species protection guideline trigger value is excessively conservative and that, where a very high level of ecological protection is sought, cobalt concentrations in north-west waters should be assessed against the 95% species protection guideline value.

4.1.2.3 Nutrients

The nearshore waters on the east coast of Barrow Island are generally oligotrophic, with temporal fluctuations in nutrients (Ref. 31); Nutrient concentrations were generally below the ANZECC/ARMCANZ (Ref. 7) default trigger values (nutrient enrichment) for tropical Australia, with occasional fluctuations of ammonia, nitrite+nitrate, and orthophosphate well above guideline values (Ref. 31). The natural variation in these parameters suggest that the default guideline trigger values are too low for the marine waters off the east coast of Barrow Island.

4.1.2.4 Light and Turbidity

Surveys undertaken to produce the CMBSEIR included measurements of turbidity, sedimentation, and light at the seabed. Higher turbidity levels and light attenuation coefficients indicate that the shallow waters close to Barrow Island are naturally more turbid than deeper offshore waters (Ref. 30). In the waters off the east coast of Barrow Island, turbidity and concentrations of suspended sediments were generally low (<5 mg/L) and indicative of clear water environments, although there was considerable variability amongst monitoring sites. Very low levels of net sediment deposition were observed during the CMBSEIR (generally below the limits of instrument detection) and any deposition that did occur was temporary and rapidly resuspended by waves and tidal flow (Ref. 17).

Wave activity was found to be a significant contributor to local resuspension of sediments and this was most noticeable on the east coast of Barrow Island during periods of strong easterly winds that dominate the weather pattern in winter. Extreme events, such as tropical cyclones, also strongly influenced turbidity and light attenuation (Ref. 17). Sediment vertical particle flux, as recorded by sediment traps, was strongly linked to turbidity; the highest fluxes were recorded during periods that coincided with persistent strong easterly winds or passing cyclones (Ref. 17).

4.1.3 Sediment Quality

Comprehensive sediment sampling encompassing multiple sites around marine facilities was conducted in early 2014 and late 2015 to inform development of this Plan. Sampling included marine facilities used for operation of the Gorgon Gas Development and around facilities used to support construction activities.

Sampling was undertaken at 16 sites around WAPET Landing (including three reference sites), 38 sites around the MOF, 11 sites around the LNG Jetty and turning basin, and 18 common reference sites (Ref. 21; Ref. 22). Sample analyses included total organic carbon (TOC), total metals, bioavailable metals (subset of sites), polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPHs), benzene, toluene, ethylbenzene and xylene (BTEX, subset of sites), organotins (subset of sites), and particle size analysis (PSA).

PSA analysis for samples taken in 2014 indicated that sediments were mainly composed of sand (total sand, 63.6% to 96.4%). TOC content in sediment samples was low with all samples from 2014 and 2015 containing <1% organic content, typical of sandy sediment found in shallow open coastal waters (0.2% to 10% TOC; Ref. 33).

Except for nickel in one reference site sample (Ref. 22), total metal concentrations of all sediment samples were below respective laboratory limits of reporting (LoR) and/or Interim Sediment Quality Guideline (ISQG)-Low trigger values (Ref. 7). The total concentration of nickel at the single reference site was 30.2 mg/kg, above the 21 mg/kg ISQG-Low criteria but below the ISQG-High trigger level of 52 mg/kg.

TPH and Total PAH concentrations were all below the LoR in 2014 and at very low concentrations in 2015 samples (with a much lower LoR). Once normalised for (very low) organic carbon (OC) content, six samples from 2015 were above ISQG-Low concentrations for benzo(a)pyrene, but well below the ISQG-High concentrations.

Sediment TBT concentrations were all below the laboratory LoR and the ISQG-Low trigger value, except for one sample in each of the 2014 and 2015 surveys. Although the concentration of TBT at these two locations exceeded the ISQG-Low trigger value (once corrected for very low OC content), the concentrations were well below the ISQG-High trigger value. Dibutyltin (DBT) was recorded in one of the samples at concentrations marginally above the LoR, suggesting that some breakdown of the TBT may have occurred.

The generally low levels of contaminants in sediments adjacent to the marine facilities is indicative of high sediment quality that affords a high level of ecological protection.

4.2 Social

4.2.1 Fishing and Aquaculture

The Barrow/Montebello/Lowendal waters intersect with commercial fisheries managed by State and Commonwealth departments. Nine State-managed fisheries and three Commonwealth-managed fisheries intersect the area between Barrow Island and the mainland. Waters potentially affected by Gorgon operations represent a very small proportion of available fisheries.

No aquaculture activities occur in the waters surrounding Barrow Island, although there are aquaculture leases along the mainland coast of the Pilbara. Pearling leases have been issued for the sheltered waters of the Montebello and Lowendal Islands; however, these sites are well clear of any potential effects from Gorgon operations activities.

The State-managed fisheries are (Ref. 34):

- **Beche-de-mer Fishery**. Beche-de-mer—also known as sea cucumbers or trepang—are in the Phylum Echinodermata, Class Holothuroidea. This fishery

is primarily based in the northern half of WA, extending from Exmouth Gulf to the Northern Territory border. Beche-de-mer may only be harvested by hand or diving by licensed commercial fishers; there is a small amount of fishing by wading. None of the six licensed vessels fished for beche-de-mer in 2013, and fishing activity within the WA fisheries is in a resting phase. The fishing fleet is based in the Northern Territory, therefore future engagement or interaction with Gorgon operations activities is considered highly unlikely.

- **Mackerel Managed Fishery**. Area 2 of this fishery (Pilbara) overlaps with the waters surrounding Barrow Island. Target species—Spanish Mackerel (*Scomberomorus commerson*) and Grey Mackerel (*S. semifasciatus*)—are fished by near-surface trolling and handline. Thirteen boats operated in 2013, with four vessels operating in the Pilbara Management Area. Most of the catch from this fishery is taken from Area 1, located in the Kimberley region well north of Barrow Island waters.
- **Marine Aquarium Fish Managed Fishery**. This fishery operates in WA State Waters from the Northern Territory border to the South Australian border. Primarily a dive-based, hand-net fishery operating from small boats up to 8 m long, its fishing activities are impacted by adverse weather conditions, water depth, and distance from shore. There are 12 licenses in the fishery, of which ten were in operation in 2013. Due to the predominantly coastal collection of the fishery species, it is unlikely that Gorgon operations will interact with this fishery.
- **Onslow Prawn Managed Fishery**. Fishers operate along the western part of the North West Shelf targeting Western King Prawns (*Penaeus latisulcatus*), Brown Tiger Prawns (*P. esculentus*), and Endeavour Prawns (*Metapenaeus endeavouri*). For 2013, limited commercial fishing was undertaken because of resource ventures in the region. The installation of pipelines, platforms, and wharf facilities for the Wheatstone Development increased the uncertainty of fishing viability in Area 1, the most productive area in this fishery. Barrow Island is located well clear of Area 1 and therefore activities from Gorgon operations are not expected to interact with Onslow Prawn licence holders should they choose to re-enter this fishery.
- **Pearl Oyster Managed Fishery**. This fishery is separated into four zones. The waters surrounding Barrow Island overlap Zone 1, which extends from North West Cape (including Exmouth Gulf) to longitude 119°30′ E; there are five licence holders in Zone 1. It is a quota-based, dive fishery, operating in shallow coastal waters along the North West Shelf. The harvest method is drift diving, where six to eight divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legal-sized oysters by hand. The key species targeted is *Pinctada maxima*. Pearl oyster shell fishing has not been reported in Zone 1 since 2008.
- **Pilbara Development Crab Fishery**. This fishery targets Blue Swimmer Crab (*Portunus armatus*). It is centred largely on the inshore waters from Onslow to Port Hedland, with most commercial activity occurring in and around Nickol Bay. Nickol Bay is not near the waters surrounding Barrow Island. Note: Onslow Prawn fishers also retain crab as a by-product.
- **Pilbara Line Fishery**. This fishery can operate anywhere within Pilbara waters. Catches are dominated by Ruby Snapper (*Etelis carbunculus*) and Goldband Snapper (*Pristipomoides multidens*). The fishery encompasses a very large area and none of the targeted species are unique to the waters

surrounding Barrow Island. Nine licence holders are currently permitted to fish for any five-month period within a year.

- **Pilbara Trap Fishery**. As with the Pilbara Line Fishery, this fishery encompasses a very large area. Major species taken by the fishery in 2013 were Goldband snapper (*P. multidens*), Red Emperor (*Lutjanus sebae*), Rankin Cod (*Epinephelus multinotatus*), Bluespotted Emperor (*Lethrinus punctulatus*), and Crimson Snapper (*Lutjanus erythropterus*). There are six licences consolidated onto three vessels.
- **Specimen Shell Managed Fishery**. This fishery includes all State Waters between the high water mark and the 200 m isobath. This is a limited entry fishery with 32 licences, 18 of which are active. No more than two divers per licence are allowed in the water at any one time and specimens may only be collected by hand. Because most collection is along the coast, it is unlikely that the Gorgon operations will interact with this fishery.

The Pilbara Fish Trawl Fishery does not overlap with the waters surrounding Barrow Island. This fishery is divided into two zones: Zone 1 (currently closed to trawling), which is south and west of the Barrow Island area; Zone 2 operates in waters well north of the Barrow and Montebello Islands, with the waters close to these islands not open to the fishery.

The Commonwealth-managed fisheries are (Ref. 35):

- **Southern Bluefin Tuna Fishery**. No commercial or recreational fishing for Southern Bluefin Tuna occurs in WA. However, the WA coast is a key migration route for the tuna; young fish (1–4 years) move from the spawning ground in the north-east Indian Ocean into the Australian Fishing Zone and southwards along the WA coast.
- **Western Tuna and Billfish Fishery**. This fishery targets large pelagic species such as Broadbill Swordfish (*Xiphias gladius*), Yellowfin Tuna (*Thunnus albacares*), Bigeye Tuna (*T. obesus*), and Albacore Tuna (*T. alalunga*). In 2012–2013, 95 fishing permits were issued, but only four longline vessels operated. In recent years, effort has concentrated off south-west WA. No activity occurred in the waters surrounding Barrow Island in 2013.
- **Western Skipjack Tuna Fishery**. Although this fishery has access to Barrow Island waters, no Australian vessels fished in 2012 or 2013, and no catch or effort has occurred since the 2008–2009 fishing season. Fishing is opportunistic and highly dependent on fish availability and the domestic cannery market. Currently, no domestic cannery has active contracts for Skipjack Tuna.

4.2.2 Recreation

Because of the isolation from major mainland centres, industry presence, and lack of visitor facilities, visitation levels to the broader Barrow/Montebello/Lowendal area have historically been low, but are increasing.

The broader area is becoming an important location for nature-based tourism, with charter boats taking tourists to the Montebello Islands to participate in recreational activities such as fishing, diving, wildlife viewing, island exploring, and surfing. These charter or private ventures may transit through Barrow Island waters; however, the recreational activities are centred on the Montebello Islands area because of its diversity of environments and available activities within a smaller

geographic area, and its relative shelter from prevailing weather conditions compared with Barrow Island waters.

Other recreational values include shore- and boat-based fishing opportunities targeting various pelagic and reef finfish species, mud crabs, and other edible invertebrates. Most recreational fishing occurs in mainland coastal waters with very few recreational fishers visiting the offshore region; those who do visit mostly visit the waters off the north-eastern end of Trimouille Island and south of the Montebello Islands.

Restrictions on activities in Barrow Island Port waters apply to operational workers on Barrow Island (Ref. 36). Land-based recreational fishing is permitted at limited locations on the east coast of Barrow Island (including Port waters), and at Ledge and Chair beaches on the west coast, which are distant from any sources of discharge. Swimming and snorkelling are restricted to specific areas beyond the Port waters; recreational boating is prohibited. These restrictions may be revisited from time to time.

4.2.3 Cultural

Aboriginal occupation of north-western Australia dates back at least 30 000 years. Barrow Island was once connected to the mainland and offered important resources for Aboriginal people in the past. Rising sea levels flooded mainland access to Barrow Island about 7000 years ago, preventing its continued use by Aboriginal people. Barrow Island appears to have been uninhabited until American whalers and pearlers arrived in the early to mid-1800s.

CAPL has an Aboriginal Cultural Heritage Management Plan (Ref. 37) that guides how cultural heritage on Barrow Island is managed and protected. To prepare the plan, CAPL consulted with three Aboriginal traditional owner groups with an interest in Barrow Island:

- Thalanyji People
- Yaburara and Coastal Mardudhunera People
- Kuruma Marthudunera People.

Non-Aboriginal cultural heritage sites, including coastal locations, have been identified on Barrow Island, and are managed in conjunction with DBCA. The known coastal sites are concentrated in the Bandicoot Bay area and are distant from the marine facilities and activities described in this Plan.

4.2.4 Industry and Tenure

The Gorgon Gas Development is located on Barrow Island and its immediate surrounds, which are within the Shire of Ashburton. There is no resident human population on Barrow Island and no Native Title claims over Barrow Island or its surrounding waters. Access to Barrow Island is restricted to personnel associated with petroleum activities and DBCA personnel.

Oil and gas exploration crews first operated on Barrow Island in 1957 and drilled the successful Barrow No. 1 well in 1964. In 1966, the WA Government granted a Petroleum Lease (L1H) to West Australian Petroleum Pty Ltd (WAPET). The lease is currently held by CAPL, Santos Offshore, and Mobil Australia Resources Company (the Barrow Island Joint Venture, otherwise known as ‘WA Oil’) and covers all but two small exploration areas (EP 61 and EP 62), which are held solely by CAPL.

Personnel involved with operating the WA Oil oilfield are accommodated at the Production Camp. Facilities at the Production Camp are authorised for use by Gorgon Gas Development personnel through a common use facility agreement with WA Oil and the existing Barrow Island Lessee Camp Licence, issued in accordance with the *Barrow Island Act 2003* (WA) and the *Land Administration Act 1997* (WA). The Licence term is for 60 years with expiry in 2069 and allows for a number of uses including 'the use, sharing and maintenance with the Barrow Island lessee of the Barrow Island lessee's services, facilities and infrastructure on the Licence Area'. Some personnel involved in construction and commissioning of the Gorgon Gas Development were accommodated at the Production Camp; all personnel involved in operating the Gorgon Gas Development are accommodated at Butler Park. Marine discharges from the Production Camp include tertiary treated effluent from the Production Camp 600 Equivalent Persons Wastewater Treatment Plant (600EP WWTP)—a licensed prescribed premises (L8817/2014/1) under Category 54 of Schedule 1 of the Environmental Protection Regulations 1987—and discharge of RO reject water from the Production Camp Brackish RO Plant.

Under the *Conservation and Land Management Act 1984* (WA) Barrow Island is designated as a Class A nature reserve for the purposes of 'Conservation of Flora and Fauna'. However, the *Barrow Island Act 2003* (WA) and related State Agreement allows for the implementation of the Gorgon Gas Development and makes provision for land on Barrow Island to be used for gas processing purposes.

A large area off the east coast of Barrow Island is a designated port—the Port of Barrow Island, which was created under the *Shipping and Pilotage Act 1967* (WA) and is vested under the *Marine and Harbours Act 1981* (WA) in the Minister for Transport. The marine facilities on the eastern side of Barrow Island are contained entirely within the Port area. Access to Port waters is restricted and all vessels (both commercial and recreational) are required to comply with the Port of Barrow Island – Port Operating Requirements and act in accordance with the Port of Barrow Island – Port Information Guide (Ref. 36).

Aside from the shared facilities at the Production Camp listed above, CAPL (WA Oil) also operates crude oil export facilities within the Port area and shipping activities at WAPET Landing. Logistics vessels servicing construction activities of the Gorgon Gas Development used WAPET Landing; but the MOF is now the primary logistics facility.

Non-CAPL infrastructure in the Barrow Island area is limited to petroleum infrastructure associated with Quadrant Energy's operations base on Varanus Island. Quadrant Energy's facilities include platforms, a domestic natural gas pipeline, crude oil export facilities, and port infrastructure.

Commercial shipping in the State Waters off the east coast of Barrow Island is generally limited to that associated with CAPL operations (Gorgon Gas Development and WA Oil). Because numerous shallow reefs occur around the east coast, other commercial ships use either the deeper waters west of Barrow Island or defined routes well to the east (e.g. Mary Anne Passage), thus avoiding the Southern Barrow Shoals and Lowendal Shelf.

4.2.5 Marine Protected Areas

Except for the area defined by the Port, the waters around Barrow Island are part of the Montebello/Barrow Island Marine Conservation Reserve. Most of the conservation area is zoned as a Marine Management Area, inclusive of the

Western Barrow Island Sanctuary Zone. The conservation reserves also comprise the Barrow Island Marine Park and Bandicoot Bay Conservation Area, located adjacent to the west and south coasts of Barrow Island, respectively (Figure 6-1). The Barrow Island marine area is listed on both the State Register of Heritage Places and the Commonwealth Register of the National Estate. Marine Conservation Reserves are vested in the State Marine Parks and Reserves Authority (MPRA) and managed by DBCA in accordance with the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017 (Ref. 27), which defines the permissible activities within each zone.

No known shipwrecks occur in the waters surrounding Barrow Island.

5 Description of Marine Facilities, Activities, and Key Stressors

Each of the marine facilities and associated activities/key stressors resulting in a 'Tolerable if monitored' risk category (Section 3.3.5) and monitored via this Plan are shown in Figure 5-1 and described in Table 5-1.

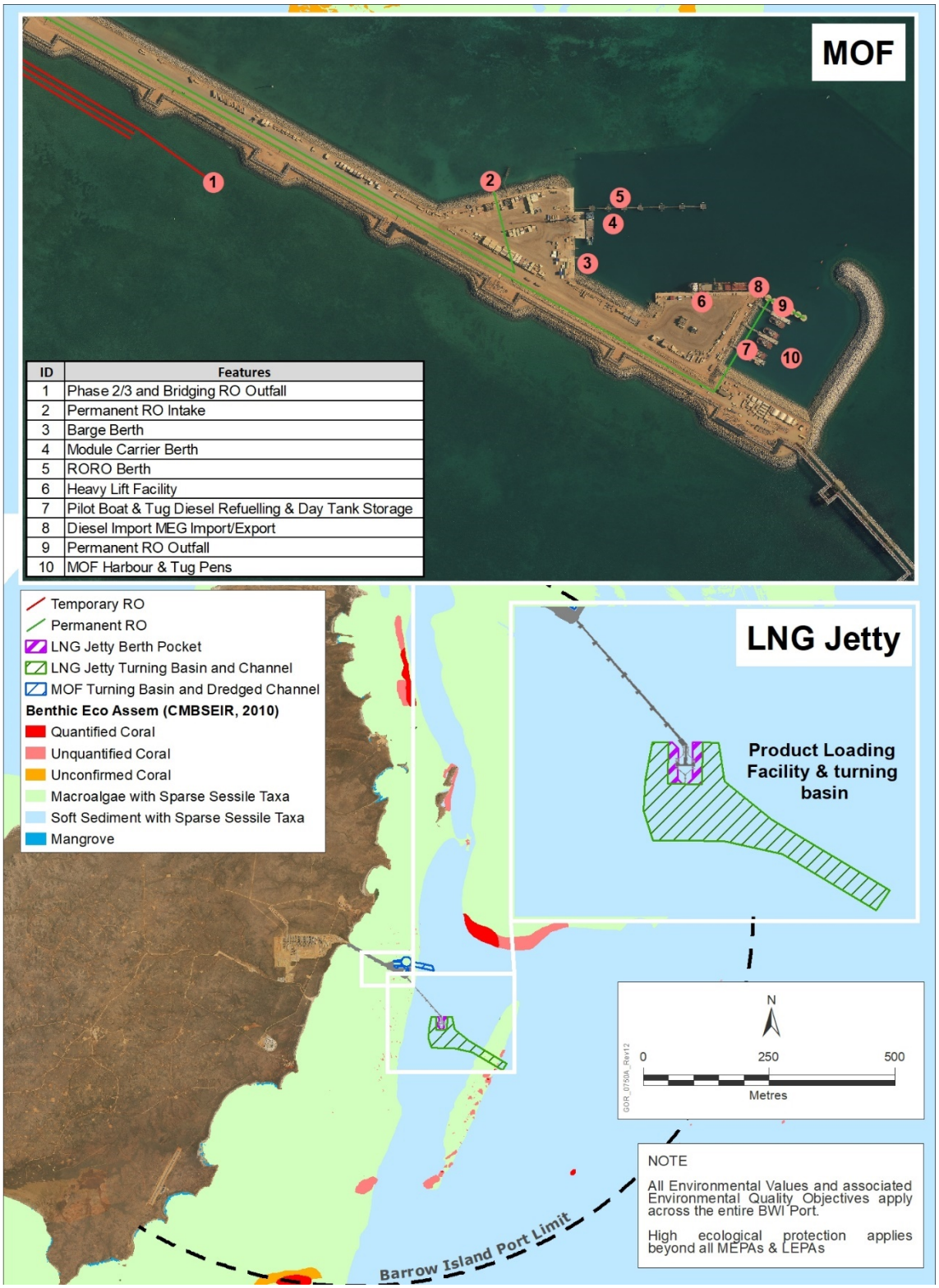

Figure 5-1: Gorgon Gas Development Marine Facilities Monitored by this Plan

Table 5-1: Marine Facilities, Activities, and Key Stressors Requiring Monitoring and/or Management via this Plan

Marine Facility Description	Activity	Key Stressors
MOF and turning basin: The Causeway and MOF form a contiguous solid structure, extending ~2.1 km east-south-east from Town Point on the east coast of Barrow Island. The Causeway provides road access to the MOF and the base support for the shipping loadout (hydrocarbon product) pipe infrastructure. The MOF extends seaward from the Causeway, forming a breakwater to protect tug pen moorings, other berths, and a heavy lift facility. The MOF turning basin is a dredged pocket adjacent to the MOF that allows vessels to manoeuvre on approach to MOF berthing facilities.	The MOF (and its connecting Causeway) is the primary import/export facility and harbour for the Gorgon operations supply chain. Specific activities include: • import/export of materials, including solid and liquid wastes • harbouring and movement of support vessels; i.e. tugs, logistics vessels (barges, landing craft), pilot vessels • movement of light and heavy land-based vehicles • fuel transfer and storage • chemical import/export via dedicated lines. Activities identified as having higher potential for contamination include: • long-term presence of marine vessels within the tug pen • temporary laydown and transfer of wastes • diesel transfer and storage for refuelling tugs and pilot vessels.	• Cumulative incidents of: • Run-off (from MOF only) containing entrained toxicants e.g. hydrocarbons and chemicals • Input of toxicants from antifoulants on marine vessels to water, sediments, and accumulation in biological (oyster) tissue • Direct (minor) inputs, leaks and spills to water from fuel/hydrocarbons and chemicals potentially accumulating in sediments.
LNG Jetty, Product Loading Facility, and turning basin: The LNG Jetty is an open structure ~2.1 km long, comprising gravity-base concrete caissons that support the steel jetty superstructure. The loadout facility is at the end of the LNG Jetty and includes loading platforms with hydraulic loading arms for transfer of LNG and condensate, and a maintenance warehouse. Diesel transfer and storage is provided for emergency seawater firewater pumps. Breasting and mooring dolphins and other minor supporting infrastructure are located along the LNG Jetty. The LNG turning basin is a dredged pocket surrounding the LNG Jetty loadout facility that allows manoeuvring of LNG and condensate tankers on approach to the loadout facility.	• Movement of vessels (LNG, condensate, and support vessels) • Transfer of LNG and condensate to tanker vessels via hydraulic loading arms • Diesel transfer and storage for seawater firewater pumps	Cumulative incidents of: • direct (minor) inputs, leaks and spills to water from fuel/ hydrocarbons and chemicals • input of toxicants from antifoulants on marine vessels potentially accumulating in sediments.

Marine Facility Description	Activity	Key Stressors
Reverse Osmosis Facilities RO facilities servicing operation of the Gorgon Gas Development include the Phase 2/3, Bridging, and Permanent RO package plants. <u>Phase 2/3 and Bridging RO</u> The sea water intake is located south of the MOF, ~700 m from shore, and is secured to the seabed. RO processing occurs at the GTP site and can produce up to 4800 m^3/day of fresh water. RO reject water is sent to the outfall, located ~900 m from shore, south of the MOF (Figure 5-1). <u>Permanent RO</u> The sea water intake is located within a caisson installed within the MOF structure ~1.3 km from shore (Figure 5-1). RO processing occurs at the GTP site and RO reject water is sent to the outfall, located ~2 km from the shore (Figure 5-1). The plant is configured with three modular trains, each train is capable of producing ~700 m^3/day of freshwater in standalone operation.	<u>Phase 2/3 and Bridging RO</u> • Discharge of brine and backwash water via an ocean outfall comprising two diffusers. The outfalls are secured 1 m above the seabed and are designed to achieve 40 dilutions in the near-field (within metres of the outfall) at shallowest water depths. • Maximum brine discharge volume (during peak use) is estimated at nominally 6667 m^3/day (6.67 ML/day). • Minimum brine discharge volume (when the facility is in care and maintenance mode) is estimated at nominally 210 m^3/day. <u>Permanent RO</u> • Discharge of brine and backwash fluids via ocean outfall comprising two diffusers facing open waters on caissons adjacent to the tug pen berths. The diffusers are designed to discharge near the surface of the ocean at lowest astronomical tide and achieve at least 100 dilutions in the near-field (metres from the outfall) under minimum and maximum operating conditions. • Maximum brine discharge volume (during peak use) is estimated at nominally 1700 m^3/day (1.7 ML/day) and 2550 m^3/day (2.55 ML/day) for two and three trains, respectively.	• discharge of brine • WET testing of simulated effluents found that elevated concentrations of salinity was the key stressor in brine, with process chemical additives having no additional measurable effect upon the toxicity of the effluent (Ref. 16).

6 Levels of Ecological Protection for Operation of the Gorgon Gas Development

The EQO 'maintain ecosystem integrity' is unique because it requires the spatial definition of up to four LEPs—maximum, high, moderate, and low—as described in Section 2.2. Broadscale definition of LEPs has already been developed for the waters surrounding Barrow Island (Figure 6-1; Ref. 5) and this Plan does not alter the LEPs for waters beyond the Barrow Island Port boundary. Finer-scale allocation of LEPs associated with operation of the Gorgon Gas Development within the Barrow Island Port area are defined in this Plan (Figure 6-2). LEPs have not been defined/altered in this Plan for any other State Waters beyond the waters surrounding Barrow Island (refer to Section 3.3.5), such as mainland supply bases or transit routes.

The rationale for designating LEPs within the Barrow Island Port area is based on the reasonable expectation that operation of the Gorgon Gas Development may reduce marine environmental quality in localised areas, such that a high LEP (the desired level of protection for State Waters unless otherwise specified) may not be achievable immediately adjacent to some operational infrastructure. Therefore, limited areas adjacent to MOF and LNG Jetty infrastructures have been designated as a moderate or low LEP—determined by the characteristics of the waste inputs—where there is potential for moderate to high levels of contaminants and small to large changes in biological indicators (Table 2-2). No designated maximum LEPs are defined within the Barrow Island Port area as it is unreasonable to apply this LEP to areas adjacent to industrialised ports (Ref. 6).

Designation of moderate or low LEPs around specific infrastructure considered introduction of contaminants from all known potentially polluting activities, individual and cumulative (potential), over the life of the Gorgon Gas Development. Specific consideration was given to potential effects of those activities/stressors categorised as 'Tolerable if monitored'.

For activities/stressors categorised as 'Negligible – inherent' and 'Negligible – mitigated', the potential cumulative effects from those activities did not warrant or contribute to the designation of reduced LEP or EV exclusion zones. Although small detectable changes in water or sediment quality may occur from these activities/facilities, any changes are not expected to result in measurable or persistent biological effects. Similarly, historical use of the waters surrounding Barrow Island during construction of the Gorgon Gas Development or other industrial activities did not warrant designation of reduced LEPs (Section 4.1.3).

The spatial extent and rationale for each moderate ecological protection area (MEPA) is described in Section 6. In general, the size of the MEPAs is based on EPA expectations (Appendix A; Ref. 6) and accepted precedents (e.g. Wheatstone Project; Ref. 38), as the activities and expected impacts of these precedent cases are of a similar nature and scale to operation of the Gorgon Gas Development. Areas of low ecological protection (LEPAs) relating to the discharge of brine from the Gorgon RO plants that support operations are based on field-verified dilution modelling.

The specific infrastructure and LEP boundaries are shown in Figure 6-2.

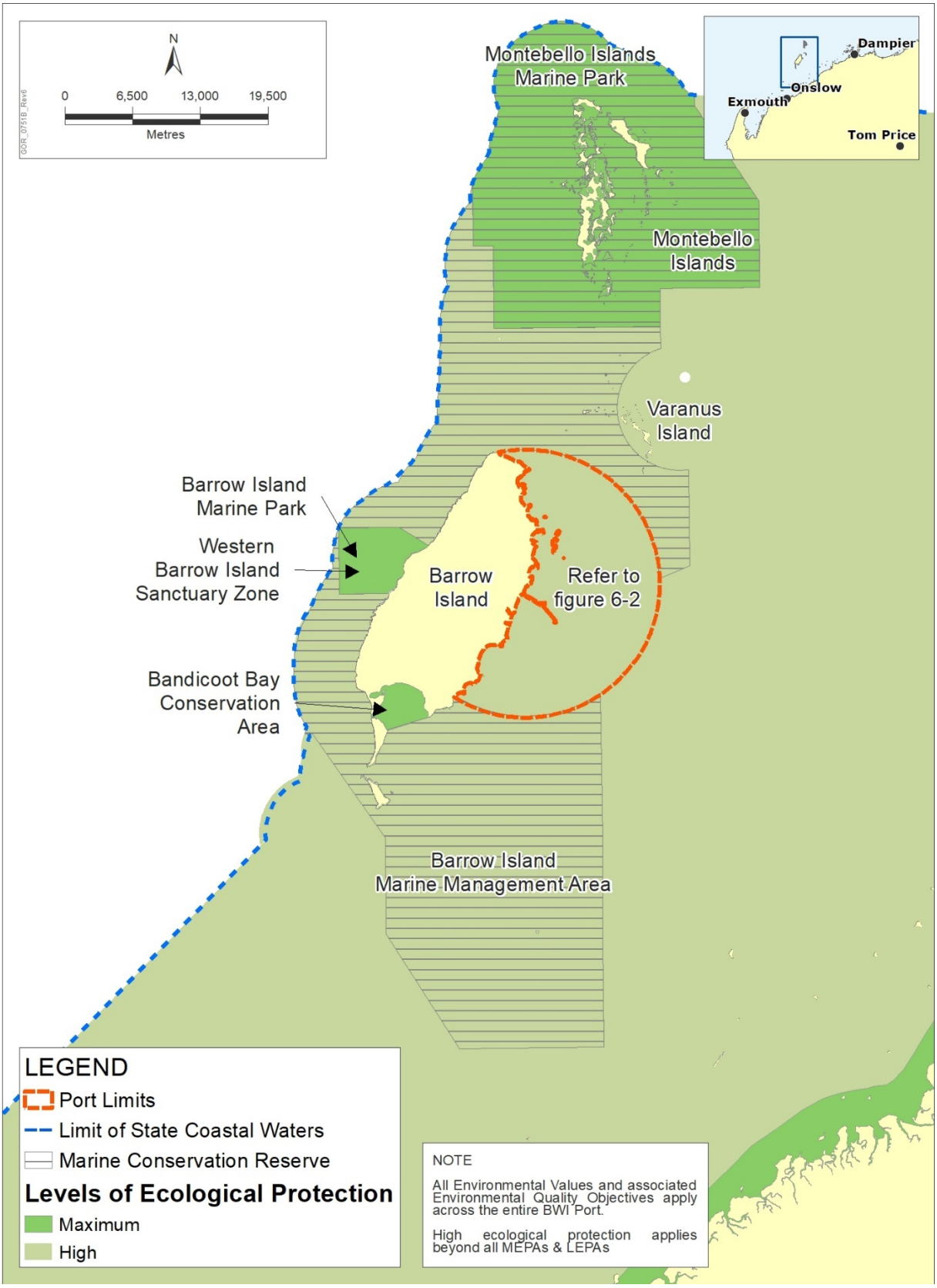

Figure 6-1: Areas of Maximum and High Ecological Protection around Barrow and Montebello Islands Resulting from the Pilbara Coastal Water Quality Consultation Outcomes

Source: Ref. 5

6.1 MOF and Turning Basin

Operational activities associated with the MOF and turning basin are summarised in Table 5-1. Waste minimisation and control strategies (including spill containment) are in place for activities occurring on the MOF (and connecting Causeway) to prevent contamination to the marine environment; however, the cumulative effects from minor events over the life of the Gorgon Gas Development may result in marine environmental impacts through lower quality of sediments and/or marine waters, and subsequent affects to resident biological indicators (oysters).

Contamination may also be introduced by vessels, through shedding of antifoulant coatings. Tugs and pilot vessels are stationed within the MOF harbour; generally, the sheltered nature of this area is expected to contain any persistent contamination of sediments originating from within the harbour; therefore, it is considered a separate defined sampling area for monitoring compliance against relevant EQC (Section 7). Outside the harbour, moving and positioning larger vessels using the bulk berths at the MOF is likely to result in some localised redistribution of potentially contaminated sediments through propeller wash.

Waters potentially affected by these activities have been designated a moderate LEP, recognising that the water may contain elevated levels of contaminants resulting in accumulation of toxicants in sediments and biological (oyster) tissue (Ref. 6).

The dimensions of the MEPA surrounding the MOF represents a 250 m buffer around the outer boundary of the MOF (Figure 6-2); it is expected that high ecological protection is maintained beyond this area, including immediately adjacent to the Causeway. There is no MEPA south of the Causeway/MOF as stormwater is designed to drain north of the facility and therefore contaminant inputs from run-off are not expected south of the facility.

6.2 LNG Jetty, Product Loading Facility, and Turning Basin

The LNG loadout facility receives LNG and condensate tankers for export of product. Loadout equipment and supporting infrastructure at the facility includes spill prevention measures and appropriate bunding; however, incremental small releases may accumulate over time and result in sediment contamination.

As with the MOF, tankers and support vessels may introduce contamination through antifoulant shedding and permitted discharges. Tankers approaching and departing the facility are manoeuvred by tugs and their propeller wash is likely to resuspend and redistribute potentially contaminated sediments.

The MEPA around the LNG loadout facility extends 250 m from the boundary of the dredged turning basin and the nearby section of the approach channel where tugs commence/cease manoeuvring activities (Figure 6-2).

6.3 Reverse Osmosis Facilities

WET testing of simulated brine (which included chemical additives from backwashing and cleaning) conservatively determined that 40 dilutions would provide 99% species protection, equivalent to a high level of ecological protection (Ref. 16). Hydrodynamic modelling was used in the design of the outfall diffusers so that they achieve a minimum of40 dilutions in the near-field under a range of ambient conditions while operating concurrently (Ref. 16). Delineation of LEPAs (mixing zones) around Gorgon RO facility ocean outfall(s) are based on field-verified dilution modelling, with a small buffer applied.

6.3.1 Phase 2/3 and Bridging RO

The two Phase 2/3 and Bridging RO outfall diffusers were designed to achieve a minimum of 40 dilutions in the near-field. The outfall is positioned 1 m above the seabed and the near-field dilution area is limited to within metres of the outfall.

Monitoring of receiving waters occurred over three years under the ROBDOOEMMP (Ref. 16), concluding in March 2013 when it was established that the dilution modelling had been verified and the signature of brine discharges was limited to a small area around the outfall.

The LEPA has been set at 30 m radius around the outfall to provide a small but appropriately conservative buffer around the joint initial dilution zone. High ecological protection is expected to be achieved at the boundary of the LEPA more than 95% of the time. If the Phase 2/3 and Bridging RO plants are decommissioned and the outfall is removed, the LEPA will no longer apply as residual effects to marine environmental quality are not expected to occur once discharges cease.

6.3.2 Permanent RO

The outfall for the Permanent RO Plant comprises two diffusers located ~15 m apart and just below the water surface at lowest astronomical tide. The diffusers were designed to achieve 100 dilutions in the near-field mixing zone, which equates to ~8 m from the source under maximum flow conditions. Extended in situ monitoring of the receiving waters around the diffusers verified the modelling predictions and confirmed that rapid dilution is achieved upon discharge (Ref. 39).

Meaningful effects to salinity, dissolved oxygen (DO), and temperature due to RO discharges were not observed at monitoring sites close to the outfall, and natural variation (daily and seasonal) in these parameters was much higher than any differences that could be attributed to brine discharge. No build-up of salinity concentrations within the tug pen was observed, even under benign metocean conditions, indicating that natural flushing is effective under all conditions.

The LEPA has been set at a radius of 30 m around a central point between the two diffusers. The LEPA for the Permanent RO outfall is contained within the MEPA established for activities at the MOF (Figure 6-2). Discharges from RO ocean outfall(s) are not expected to result in sediment contamination or accumulation of contaminants in resident shellfish and are therefore unlikely to affect interpretation of sediment and biota monitoring data around the MOF.

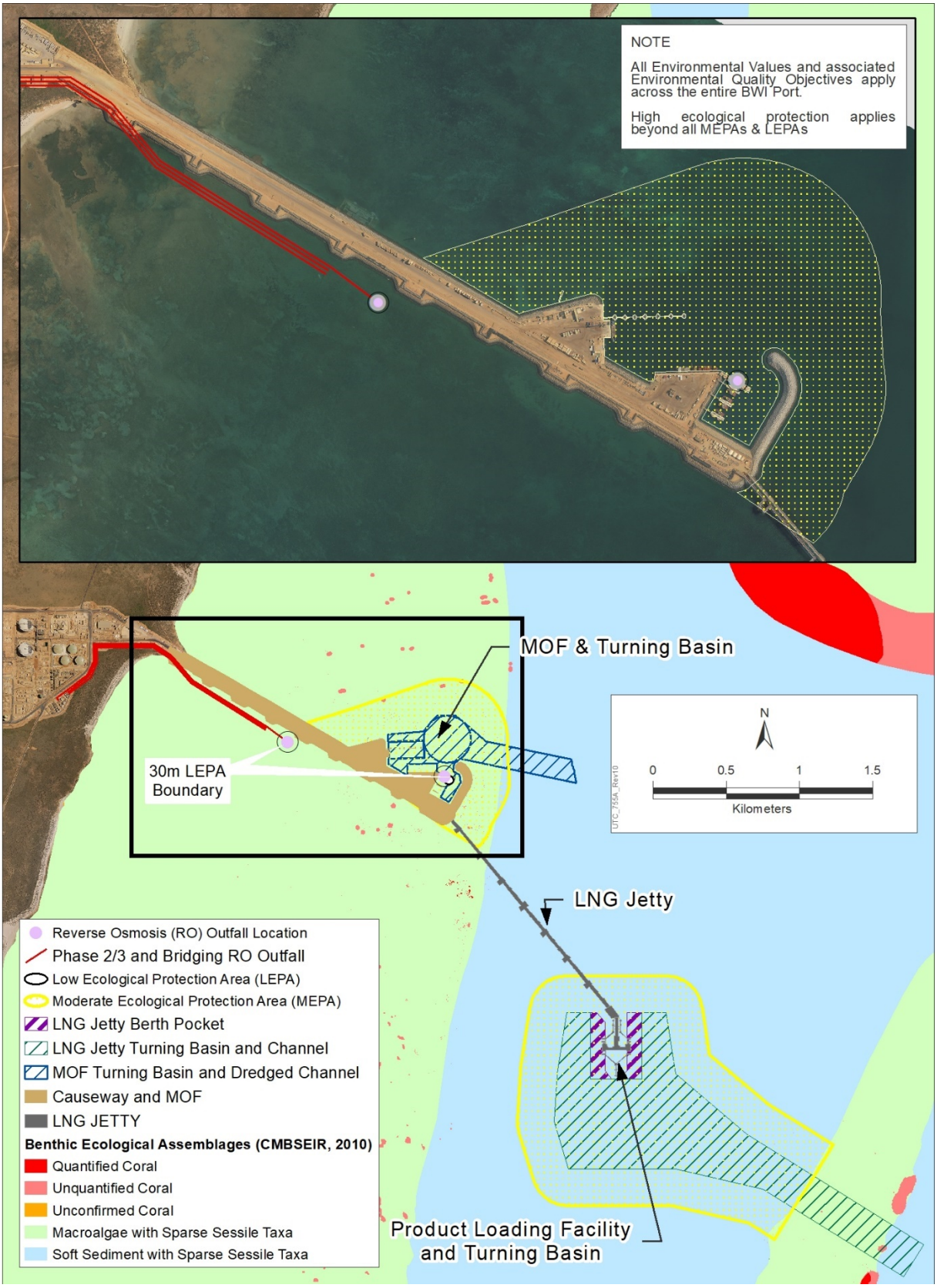

Figure 6-2: MOF and LNG Jetty showing LEPA and MEPA Boundaries

6.4 Alignment with the Management Objectives of the Barrow Island Marine Conservation Reserves

The Port of Barrow Island is partially encircled by the Barrow Island Marine Management Area, most of which is 'unclassified' according to the marine zonation system (Ref. 27). As per the recommendations of the Pilbara Coastal Water Quality Consultation Outcomes (Ref. 5) and Section 5 of the Technical Guidance for Protecting the Quality of Western Australia's Marine Environment (Ref. 6), a high level of ecological protection is required across the unclassified parts of the Marine Management Area to align with the MPRA's long-term targets for water and sediment quality. Because all adjacent areas within the Barrow Island Port along the common boundary are also zoned for high ecological protection in this Plan, the MPRA's long-term targets are unlikely to be compromised by activities related to operation of the Gorgon Gas Development.

Nearby, the Montebello Islands, Barrow Island Marine Park, and the Bandicoot Bay Conservation Area require the maximum LEP to meet the MPRA's long-term targets. Each of these areas are distant from the activities and facilities addressed in this Plan and therefore are not expected to be affected by operation of the Gorgon Gas Development.

7 Environmental Quality Criteria for Operation of the Gorgon Gas Development

Marine environmental quality is measured by monitoring specific indicators that are relevant to the identified key stressors; EQC are the benchmarks that marine environmental quality indicators are measured against. Indicators and their related EQC were derived based on their conceptual relevance, response variability, feasibility of monitoring, interpretability, utility (i.e. ease of use), and nature of the stressor.

EQC have been developed according to the approach defined by the EPA (Ref. 41), and are designed to be initiated sequentially. Meeting the EQG provides high certainty that the associated EQO is being achieved. Conversely, failing to meet an EQG is a trigger for further investigation against EQS tests, as the EQO may be at risk. Investigations may follow a risk-based approach that can consider hierarchical (and multiple) lines of evidence and integrate compliance monitoring results.

Under the screening process used to implement the EQMF for the Gorgon Gas Development (Section 3.3), EQC (and monitoring) specific to the EVs of Ecosystem Health and Fishing and Aquaculture are specified in this Plan, as the risks to other EVs are either not credible, are sufficiently managed, and/or are adequately protected by specified EQC for protecting Ecosystem Health.

If stressors monitored via this Plan exceed an EQS and trigger an adaptive management response, the potential impacts to Social Use EVs (not monitored) and EQOs may be considered in any further investigations as these EVs may no longer be maintained under an EQS exceedance scenario.

Both numerical and narrative EQC are included in this Section. Decision scheme diagrams are also included where relevant and are intended to guide users through the implementation (and assessment of) the EQGs and EQSs, and to show the tests involved. Narrative decision schemes are provided in Appendix C; these list definitive details at each test and are designed to be read in conjunction with the scheme diagrams and text below.

As per EPA guidance (Ref. 40), CAPL may choose to initiate adaptive management at an earlier stage if any EQC is not met. Similarly, CAPL may choose to selectively skip EQC tests in favour of more stringent and informative EQC tests, due to cost, logistical, or other operational considerations deemed relevant by CAPL. Adoption of either scenario would result in a more conservative approach where management, if required, would be initiated earlier than anticipated if all steps were followed.

7.1 Ecosystem Health EQC

Certain activities associated with the MOF and LNG Jetty were deemed to pose a ‘Tolerable if monitored’ risk to the EV for Ecosystem Health and MEPA zones were designated around these facilities to account for their potential effects to sediment and water quality (Section 6). EQC have been developed for these activities to assess the surrounding marine ecosystems for the effects of toxicants in sediments and marine water, based on the stressors listed in Table 5-1. The EQC only include toxicants potentially introduced by relevant Gorgon operational activities, as informed through the risk-assessment process, conceptual models and investigative sampling (Section 3.3).

Local EQC may be developed if monitoring results consistently show that ambient concentrations at reference sites (background concentrations) are above the EQC in Table 7-1 and Table 7-2. Parameters for establishing new EQC are provided in the narrative decision scheme (Appendix C); however, formally establishing and implementing revised EQC would require revising this Plan.

For the Ecosystem Health EV and associated EQO for 'maintenance of ecosystem integrity', EQC related to toxicants were developed for each LEP designated in this Plan. The EQC triggers increase in sensitivity with increasing LEPs; the most conservative triggers are applied to High Ecological Protection Areas (HEPAs).

The EQC tests are designed to be initiated sequentially. If the EQS A/B test is exceeded, an adaptive management action is triggered (as per Condition 23A.5 of MS 800)—at this stage there is higher likelihood of actual direct biological effects, whereas EQG tests only indicate potential biological effects, with less certainty. Further tests may be initiated as part of an adaptive management response; these tests may follow a risk-based approach that can consider hierarchical (and multiple) lines of evidence and integrate more refined measures of the surrogate indicators (e.g. bioavailable contaminant concentrations) with more direct measures of the EQO (e.g. toxicity testing or in situ biological effects).

7.1.1 Toxicants in Sediments

7.1.1.1 Initial Assessment Against the EQG

Once routine sediment sampling is completed (Section 8.1), median concentration of toxicants in sediment is calculated by pooling data collected for each analyte within each ecological protection area (MEPA and HEPA) and facility (MOF and LNG Jetty) (i.e. EQG A; Table 7-1); the tug pen is designated as a separate defined area within the MOF MEPA for compliance assessments. If median concentrations within the defined sampling areas meet relevant guideline values listed in Table 7-1, then no further assessment is required until the next routine monitoring event, provided that the EQG B is also met.

Total concentration of toxicants in sediment obtained at individual sampling sites (EQG B) are compared against guideline Values listed in Table 7-1. If individual sampling sites fail to meet relevant EQGs, then the contaminated area may need to be defined and characterised through additional sampling, in accordance with Appendix C. Monitoring data obtained from efforts to define the contaminated area are assessed against guideline Values defined in Table 7-1.

7.1.1.2 Decision Schemes and Defined Management Reponses for Further Assessment Against the EQS

If the criteria for EQG B is not met, then further assessment against the EQS tests for the relevant sampling area proceed following the narrative decision scheme in Appendix C and with reference to Figure 7-1, Table 7-1, and Table 7-2. Sites on the common MEPA/HEPA boundaries are assessed against the EQS for high ecological protection. This may require further field sampling.

If monitoring shows EQS A/B have been met, then the environmental quality is deemed acceptable, no further investigation and assessment is required, and routine monitoring is to continue as per Section 8.1. However, separate to the requirements of this Plan, CAPL may choose to further investigate the cause of elevated contaminants and implement proactive management measures to

prevent or minimise further accumulation of contaminants to levels that could result in biological effects.

For bioaccumulating / biomagnifying toxicants, an exceedance of the EQG B criteria results in adaptive management response without further predefined tests against EQS.

In parallel with the procedure in Figure 7-1, CAPL may also review the data in the context of non-operational activities (i.e. activities beyond the scope of this Plan), which may be influencing the measured parameters.

7.1.1.3 Adaptive Management Action

If monitoring shows that EQS A/B (or EQG B for bioaccumulating / biomagnifying toxicants) has been exceeded, then adaptive management action is triggered. For an exceedance of EQS A/B, reporting requirements under Conditions 23A.5.i and 23A.5.ii is also triggered (Section 10). If an exceedance of EQG B for bioaccumulating / biomagnifying toxicants occurs, reporting requirements and timing will be determined on a case-by-case basis, in consultation with DWER.

Where practicable, the overall intention of any adaptive management action is to ensure there is no irreversible or long-term damage to key biological receptors. The action would normally focus on identifying the cause (or source) of the exceedance and then reducing the loads of the contaminant of concern (i.e. source control).

Management actions may include further investigations to characterise the scale and nature of the contamination, the resulting biological effects, and the significance of those effects in the context of natural variation and the environmental setting. Example options for further investigations include (in order of increasing certainty of biological impacts):

- sediment elutriation or pore-water analysis
- bioaccumulator organism (or surrogate) tissue analysis
- indirect biological measures (e.g. ecotoxicity testing)
- direct biological and ecological measures.

Risks to Social Use EVs may also be considered in a management response because the increase in toxicants may also have potential to affect maintenance of Social Use EQOs.

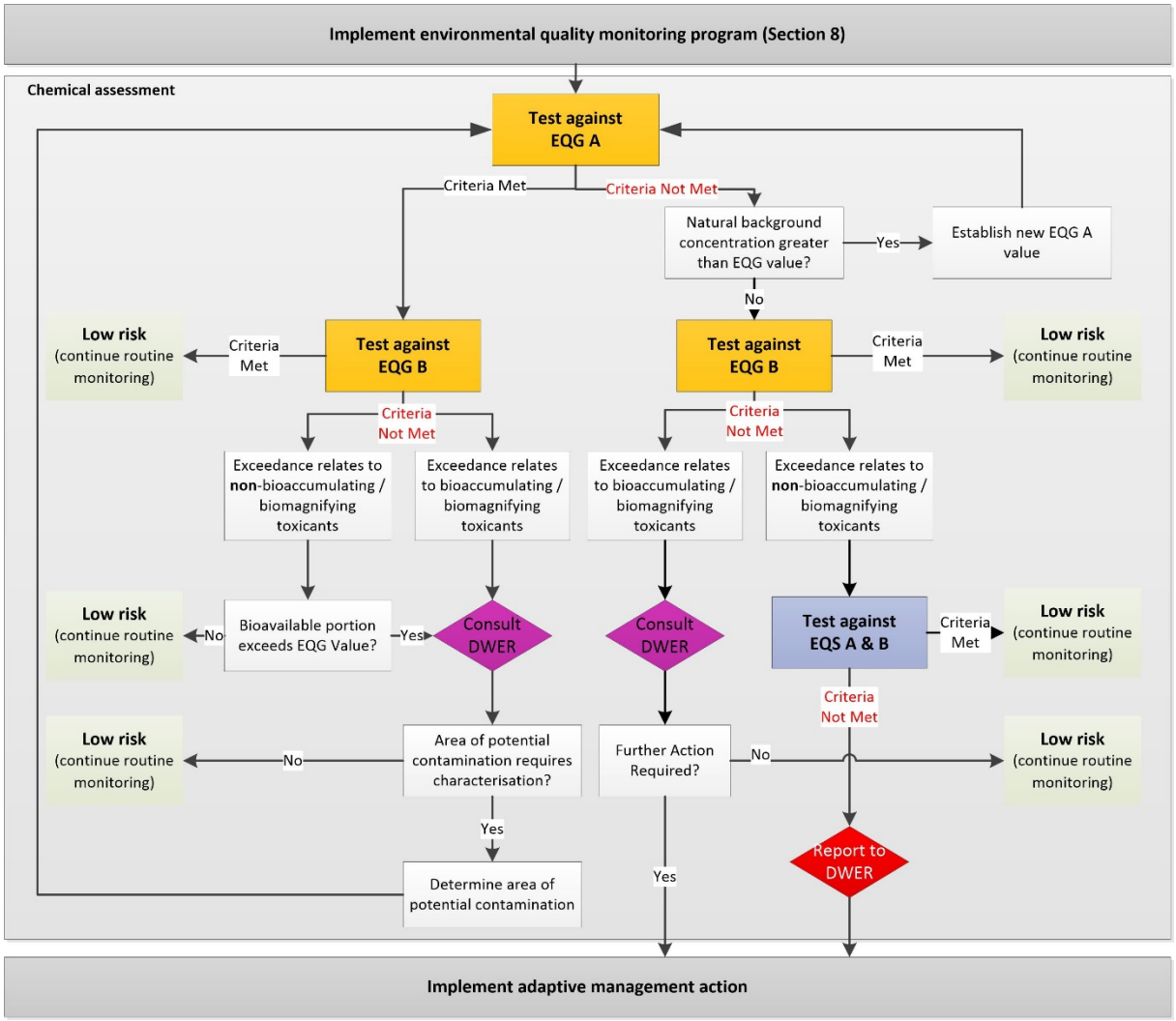

Figure 7-1: Decision Scheme for Applying the EQC for Toxicants in Marine Sediments

Table 7-1: EQG for Protecting Environmental Values from the Effects of Toxicants in Marine Sediments

Environmental Quality Guideline					
A) Median sediment total contaminant concentration* from a defined sampling area should not exceed the EQG value for the relevant ecological protection area. B) Total contaminant concentration at individual sample sites should not exceed the EQG resampling trigger (if so, a new sampling area may be defined to assess the extent of contamination).					
Chemical	**Value (high and moderate protection)**	**Resampling Trigger**	**Chemical**	**Value (high and moderate protection)**	**Resampling Trigger**
Metals and Metalloids (mg/kg dry weight)					
Arsenic	20	70	Mercury[A]	0.15	1
Cadmium[A]	1.5	10	Nickel	21	52
Chromium	80	370	Silver	1	3.7
Copper	65	270	Zinc	200	410
Lead	50	220			

Environmental Quality Guideline					
Organics (µg/kg dry weight)					
Acenaphthene	16	500	Benzo(a)pyrene[A]	430	1600
Acenaphthalene	44	640	Dibenzo(a,h)anthracene	63	260
Anthracene[A]	85	1100	Chrysene	384	2800
Fluorene	19	540	Fluoranthene[A]	600	5100
Naphthalene	160	2100	Pyrene	665	2600
Phenanthrene[A]	240	1500	High Molecular Weight PAHs[A]	1700	9600
Low Molecular Weight PAHs[A,B]	552	3160	Total PAHs[A]	4000	45 000
Benzo(a)anthracene	261	1600			

Notes:

* *Contaminant concentrations in sediments should be reported as dry weight. For initial assessment of sediment metal concentrations against the EQG, a strong acid digestion (e.g. nitric acid/perchloric acid mixture) should be used.*

A *Substances that may adversely bioaccumulate or biomagnify (Log $_{10}$ Octanol-Water Partition Coefficient [Kow] values >4 and <7)*

B *Low molecular weight PAHs are the sum of concentrations of acenaphthene, acenaphthalene, anthracene, fluorene, naphthalene, and phenanthrene; high molecular weight PAHs are the sum of concentrations of benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, and pyrene.*

Table 7-2: EQS for Protecting Environmental Values from the Effects of Toxicants in Marine Sediments

Environmental Quality Standard	
High Protection	**Moderate Protection**
Bioavailable Measures	
A) The 80th percentile of bioavailable metal or metalloid concentrations[A] (e.g. dilute acid extractable metals, Simultaneous Extracted Metals [SEM] / Acid-volatile Sulfide [AVS] analysis[B]) from the defined sampling area should not exceed the EQG A value or B) The median bioavailable concentration for non-metallic contaminants[A] (e.g. OC normalisation[C]) from the defined sampling area should not exceed the EQG A value.	A) The median bioavailable metal or metalloid concentrations[A] (e.g. dilute acid extractable metals, SEM/AVS analysis[B]) from the defined sampling area should not exceed the EQG A value. or B) The 40th percentile of bioavailable concentrations for non-metallic contaminants[A] (e.g. OC normalisation[C]) from the defined sampling area should not exceed the EQG A value.

Notes:

A *See Ref. 7*

B *SEM/AVS analysis appropriate for divalent transition metals that react with sulfide to form insoluble precipitates (e.g. cadmium, copper, mercury, nickel, lead, zinc)*

C *Normalised to 1% OC.*

7.1.2 Toxicants in Marine Waters

7.1.2.1 Initial Assessment Against the EQG

Once all routine water sampling is completed for the year (Section 8.2), compliance against EQG A is determined by comparing the 95th percentile of total toxicant concentrations in water from a defined sampling area and year to the relevant LEP guideline in Table 7-3. The 95th percentile is calculated by pooling data collected from defined sampling areas within the MOF; sites adjacent to the MOF are separate to those in the tug pen (Section 8.2). In instances where there are ≤20 samples from a defined sampling area the individual results of toxicant concentrations will be compared to the relevant LEP guideline. Sites on the common MEPA/HEPA boundary are assessed against the EQG for high ecological protection..

Compliance against EQG B is determined by calculating the total toxicity of the mixture (TTM) from the defined sampling areas adjacent to the MOF (all samples within the annual assessment period). If the TTM exceeds 1 using the TTM formula in Table 7-3, and includes the key antifoulant constituents (copper, nickel, and zinc), then bioavailable (i.e. filtered) concentrations of metals and metalloids are compared to EQS A and B[2] (Section 7.1.2.2). If EQG A and EQG B are met, then no further assessment is required until the next routine monitoring event.

7.1.2.2 Decision Schemes and Defined Management Reponses for Further Assessment Against the EQS

If the criteria for EQS A/B are not met, then assessment against EQS C for direct toxicity testing using relevant species may proceed following the narrative decision scheme in Appendix C and with reference to Figure 7-2. This may require further field sampling.

If monitoring shows that criteria have been met for EQS B/C, then the environmental quality is deemed acceptable, no further investigation and assessment is required, and routine monitoring is to continue as per Section 8.2. However, separate to the requirements of this Plan, CAPL may choose to further investigate the cause of elevated contaminants and implement proactive management measures to prevent or minimise further accumulation of contaminants to levels that could result in biological effects. Therefore, adaptive management may be instigated before assessment against EQS C.

In parallel with the procedure in Figure 7-1, CAPL may also review the data in the context of non-operational activities (i.e. activities beyond the scope of this Plan) that may be influencing the measured parameters.

7.1.2.3 Adaptive Management Action

If monitoring shows that EQS C has been exceeded, then adaptive management action and reporting requirements under Conditions 23A.5.i and 23A.5.ii of MS 800 are triggered (Section 10).

Where practicable, the overall intention of any adaptive management action is to ensure there is no irreversible or long-term damage to key biological receptors. The action would normally focus on identifying the cause (or source) of the exceedance and then reducing the loads of the contaminant of concern (i.e. source control) where possible and practicable. Management actions may include

[2] CAPL may initially assess bioavailable concentrations of metals (EQS)

further investigations to characterise the scale and nature of the contamination, the resulting biological effects, and the significance of those effects in the context of natural variation and the environmental setting. Example options for further investigations include:

- bioaccumulator organism (or surrogate) tissue analysis (also refer to Section 7.2)
- direct biological and ecological measures.

Risks to Social Use EVs may also be considered in a management response because the increase in toxicants may also have potential to affect maintenance of Social EQOs.

Results of the assessment against the Fishing and Aquaculture EV may also be considered as a multiple lines of evidence approach to determine the source of the exceedance and appropriate adaptive management actions (Section 7.2).

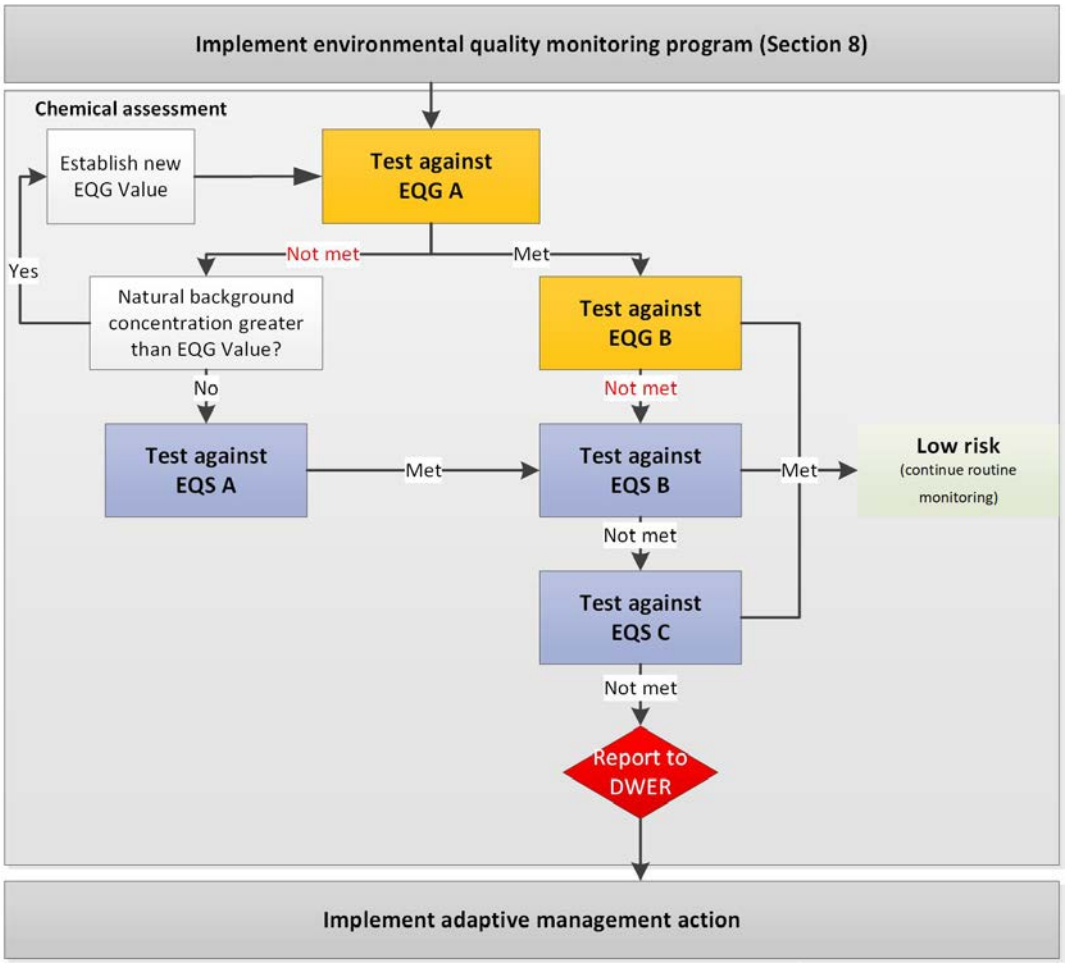

Figure 7-2: Decision Scheme for Applying the EQC for Toxicants in Marine Waters Adjacent to the MOF

Notes:

EQG and EQS may be applied to individual site or a broader defined area of concern.

Table 7-3: EQG for Protecting Environmental Values from the Effects of Toxicants in Marine Waters Adjacent to the MOF

Environmental Quality Guidelines*		
A) The 95th percentile of the sample concentrations from the area of concern should not exceed the EQG value. B) TTM should not exceed 1 for chemical mixtures using total contaminant concentrations from a single site or for a defined area over a 12-month sampling period[D].		
Chemical	**High protection**	**Moderate protection**
Metals and Metalloids (µg/L)		
Cadmium[B]	0.7	14[C]
Chromium III	7.7	49
Chromium VI	0.14	20[C]
Copper	0.3	3[C]
Lead	2.2	6.6[C]
Mercury (inorganic)[B]	0.1	0.7[C]
Nickel	7	200[A]
Zinc	7[C]	23[C]

Notes:

* *EQG may be applied to an individual site or a broader defined area of concern*

A *Value may not protect key test species from acute and chronic toxicity (see Ref. 9)*

B *Chemical for which possible bioaccumulation and biomagnification effects should be considered (Log $_{10}$ Kow values >4 and <7)*

C *Value may not protect key test species from chronic toxicity (see Ref. 9)*

D *TTM = Σ(Ci / EQGi) where Ci is the concentration of the 'i'th component in the mixture and EQGi is the guideline for that component. If TTM exceeds 1, the mixture has exceeded the water quality guideline. ANZECC/ARMCANZ (Ref. 7) only recommends using this formula on mixtures with up to 5 contaminants of concern until further scientific study confirms its relevance to more complex mixtures. The effect of different contaminants on biota can be synergistic, antagonistic, as well as additive depending on several factors, including the species being tested. Direct toxicity assessment (DTA) usage is recommended for toxicant mixtures of >5 components or of uncertain mixture effects. Where the effect of the different contaminants on each other is unknown, and DTA is not a viable alternative, the assumption that all contaminants have additive toxicity is acceptable.*

Table 7-4: EQS for Protecting Environmental Values from the Effects of Toxicants in Marine Waters Adjacent to the MOF

Environmental Quality Standard*
Moderate Protection Narrative
Bioavailable Measures
A) The 95th percentile of the bioavailable contaminant concentration in the test samples should not exceed the EQG value (Table 7-3) **and** B) TTM should not exceed 1 for chemical mixtures using median bioavailable contaminant concentrations from a single site or for a defined area over a 12-month sampling period[A].
Indirect Biological Measures

Environmental Quality Standard*
Moderate Protection Narrative
C) When using DTA procedures on ambient waters, there should not be a statistically significant effect ($p<0.05$) on lethal acute endpoints, or >50% on sublethal chronic endpoints, for any species, compared with the reference/control water.

Notes:

* *EQS may be applied to individual site or a broader defined area of concern.*

A *TTM = Σ(Ci / EQGi) where Ci is the concentration of the 'ith component in the mixture and EQGi is the guideline for that component. If TTM exceeds 1, the mixture has exceeded the water quality guideline. ANZECC/ARMCANZ (Ref. 7) only recommends using this formula on mixtures with up to 5 contaminants of concern until further scientific study confirms its relevance to more complex mixtures. The effect of different contaminants on biota can be synergistic, antagonistic, as well as additive depending on a number of factors, including the species being tested. DTA usage is recommended for toxicant mixtures of >5 components or of uncertain mixture effects. Where the effect of the different contaminants on each other is unknown, and DTA is not a viable alternative, the assumption that all contaminants have additive toxicity is acceptable.*

7.1.3 Physicochemical Stressors – RO Discharges

RO discharges were deemed to pose a 'Tolerable if monitored' risk to the EV for Ecosystem Health; small LEPAs are designated around these facilities to account for their potential effects to water quality. Previous monitoring of receiving waters around each RO outfall confirmed that adequate dilution is achieved in the near-field mixing zone; therefore, routine monitoring against the EQG is focused on inline monitoring of the discharge stream to ensure that the RO plant is operating within expected tolerances and the bounds of modelled discharge conditions.

Monitoring of receiving waters at the boundary of the LEPA mixing zones against the EQS occurs if discharge quality is consistently beyond the EQG. If the EQS is exceeded, then an adaptive management action is triggered (as per Condition 23A.5 of MS 800). Further tests may be initiated as part of an adaptive management response; these tests may follow a risk-based approach that can consider hierarchical (and multiple) lines of evidence and integrate direct measures such as toxicity testing.

7.1.3.1 Initial Assessment Against the EQG

Once routine monitoring is completed (Section 8.3), the median conductivity is calculated for each month and for each RO plant. Median concentrations are compared against the EQG A listed in Table 7-5. If EQG A is met, then no further assessment is required until the next month.

If EQG A is not met, then the monitoring frequency is increased to daily for the following month (high-frequency monitoring). Retesting occurs at the end of the month by comparing the median conductivity for that month against EQG A. If the high-frequency monthly assessment meets the EQG A criterion, then routine monitoring resumes.

7.1.3.2 Further Assessment Against the EQS

If the criteria for EQG A are not met at the end of that high-frequency period, then daily monitoring of the discharge stream continues and assessment of receiving water quality against the EQS A criteria is initiated within one month (where practicable), as per Table 8-3.

Monitoring of receiving waters at the boundary of the LEPA aims to determine the influence of the elevated salinity upon receiving waters and confirm adequate

dilution is occurring upon discharge. Monitoring is focused on the bottom one metre of the water column because RO discharges are negatively buoyant compared to receiving waters.

If monitoring shows that EQS A criteria have been met, then the environmental quality is deemed acceptable and no further investigation and assessment is required. Routine monitoring is to resume as per Table 8-3.

After recommencing routine monitoring, if discharge water quality exceeds EQG A criterion within the next three months (i.e. a consistent trend of exceeding the EQG A appears evident), then re-escalation to monitoring of receiving waters and retesting against the EQS A only occurs if the median conductivity of discharge waters is 2.5 mS/cm (or more) greater than the previous EQG A exceedance event; this prevents unnecessary reassessment of receiving waters when water quality is unlikely to have significantly changed.

If the increased conductivity is a result of RO system process efficiency gains (i.e. greater recovery of freshwater), then the EQG A may be revised through consultation with DWER and revision of this Plan.

Separate to the requirements of this Plan, CAPL may choose to further investigate the cause of elevated conductivity and implement proactive management measures to prevent or minimise ongoing elevations at levels that could result in biological effects.

7.1.3.3 Adaptive Management Action

If monitoring shows that the EQS A is exceeded for any receiving water sampling event, then adaptive management action and reporting requirements under Conditions 23A.5.i and 23A.5.ii of MS 800 is triggered (Section 10).

Where practicable, the overall intention of any adaptive management action is to ensure there is no irreversible or long-term damage to key biological receptors. The action would normally focus on identifying the cause (or source) of the elevated conductivity and rectifying the issue through process system adjustments.

Management actions may include further investigations to characterise the scale and nature of the elevated conductivity, the resulting biological effects, and the significance of those effects in the context of natural variation. Example options for further investigations include:

- integrity inspections of outfall diffusers to determine if degradation, damage, or fouling may be contributing to reduced dilution
- revising dilution modelling to account for altered discharge parameters
- indirect biological measures (e.g. ecotoxicity testing).

Risks to Social Use EVs may also be considered in a management response; however, only gross increases in salinity would have potential to affect maintenance of Social Use EQOs.

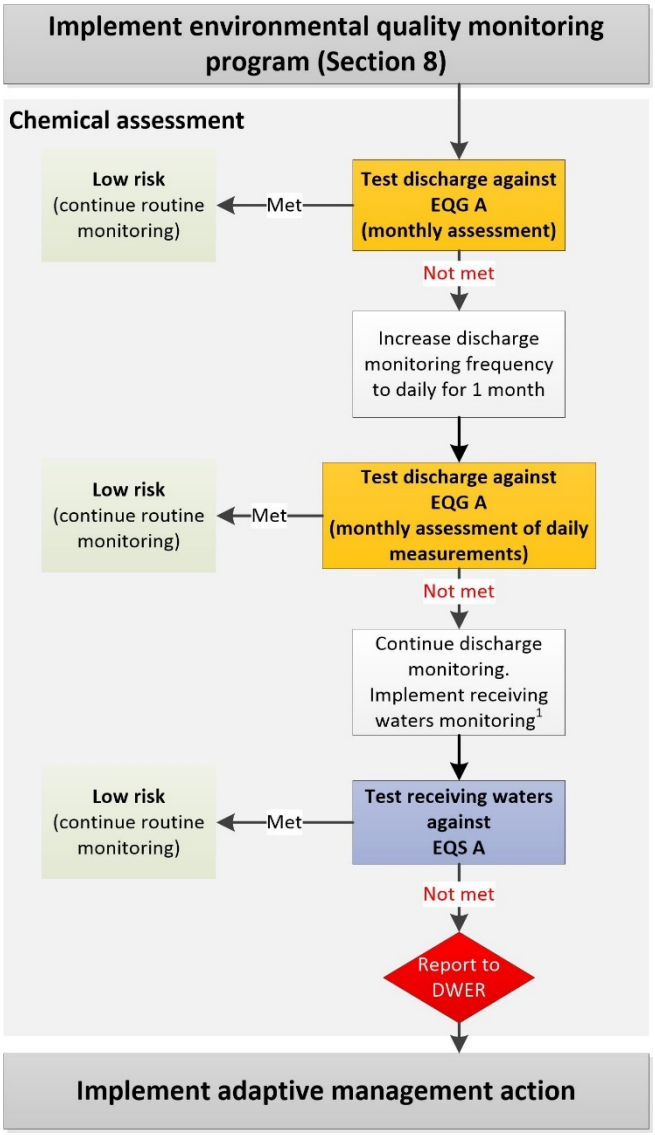

Figure 7-3: Decision Scheme for Applying the EQC for Physicochemical Stressors

Note:

1. *For repeated exceedances of EQG A, only recommence monitoring receiving waters if median discharge conductivity is >2.5 mS/cm than a previous exceedance within the previous 3 months. Refer to Table 7-5.*

Table 7-5: EQG for Protecting Environmental Values from the Effects of Physicochemical Stressors

Environmental Quality Guideline – Discharge Water Quality
A) The median conductivity of discharge waters for the prescribed period should not exceed 100 mS/cm. When comparing routine monitoring data against the EQG A in the period immediately following monitoring of receiving waters, the EQG A is temporarily modified to 2.5 mS/cm above the average conductivity that initiated the monitoring of receiving waters. This temporary EQG A only applies for a three-month period immediately following recommencement of routine monitoring. For example, if the average discharge conductivity during the four-week high-frequency monitoring period against the EQG A was 102 mS/cm and subsequent receiving water monitoring against EQS A met the criterion, then the temporary EQG A upon restart of routine monitoring is 104.5 mS/cm (102 + 2.5 mS/cm) for a three-month period. After that time, the EQG A resets to 100 mS/cm.

Table 7-6: EQS for Protecting Environmental Values from the Effects of Physicochemical Stressors in Marine Waters

Environmental Quality Standard – Receiving Water Quality
A) The median conductivity of receiving waters from the lower 1 m of the water column profile at one or more monitoring locations on the LEPA boundary, calculated over no more than one week, is <2.0 mS/cm greater than suitable nearby reference sites.

7.2 Fishing and Aquaculture EQC

Certain activities associated with the MOF were deemed to pose a 'Tolerable if monitored' risk to the Fishing and Aquaculture EV, and the MOF is designated as a MEPA to account for the potential for toxicants to accumulate in biological (oyster) tissue (Section 3). EQC have been developed to determine the risk associated with contaminants of concern resulting from activities associated with the MOF and turning basin. The EQC only include toxicants potentially introduced by relevant Gorgon operational activities, as informed through the risk-assessment process, conceptual models and investigative sampling.

For the Fishing and Aquaculture EV and associated EQO for 'seafood safe for eating', EQC related to the accumulation of chemical toxicants were developed for the MOF MEPA designated in this Plan. These EQC have been developed in conjunction with the Ecosystem Health EQC (Section 7.1), in recognition that these EQC do not necessarily protect fish and aquaculture species (Ref. 9).

7.2.1 Toxicants in Biological (Oyster) Tissue

7.2.1.1 Initial Assessment Against the EQG

Once routine sampling is completed (Section 8.4), the median toxicant concentration at each site is compared against the EQG A values in Table 7-7. If the criteria for the EQG is met, then no further assessment is required until the next routine monitoring event.

7.2.1.2 Adaptive Management Action

If monitoring shows that the EQG A has been exceeded, then adaptive management action is triggered. Reporting requirements resulting from an exceedance of EQG are determined on a case-by-case basis, in consultation with the DWER.

Results of the assessment against the Ecosystem Health EV may also be considered as a multiple lines of evidence approach to determine the source of the exceedance and appropriate adaptive management actions (Section 7.1).

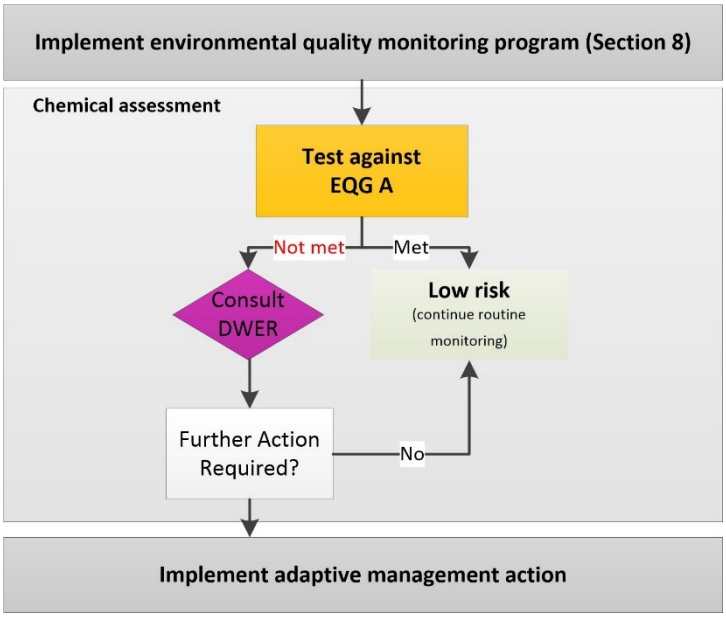

Figure 7-4: Decision Scheme for Applying the EQC for Toxicants in Biological (Oyster) Tissue

Table 7-7: EQG for Protecting Environmental Values from the Effects of Toxicants in Biological (Oyster) Tissue

Environmental Quality Guidelines	
A) Median chemical concentration in biological (resident oyster) tissue should not exceed the environmental quality guideline.	
Chemical	**Value**
Copper	30*
Zinc	290*

Note:

* *Adopted Generally Expected Levels (GELs) for metal contaminants; additional guidelines to maximum levels in Standard 1.4.1 – Contaminants and Natural Toxicants July 2001 (Ref. 42). Adopted GEL for copper in molluscs and zinc in oysters.*

8 Monitoring Program

This Section of the Plan summarises the sampling and analysis approach (program design, sampling frequency, parameters, analysis etc.) for routine monitoring and compliance assessment against the EQC defined in Section 7. CAPL will undertake monitoring according to the sampling requirements specified in Table 8-1 to Table 8-4.

Detailed sampling procedures are defined in the MEQMP Sampling and Analysis Plan (Ref. 43). Where applicable and practicable, the methods outlined in the EPA guidelines (Ref. 44) were used to inform the sampling approach and procedures in this Plan and accompanying documents.

The sampling and analysis approach, operating procedures, and methods for sampling undertaken as part of an adaptive management response are not specified in this Plan and are to be undertaken on a case-by-case basis, in consultation with the DWER, where specified.

8.1 Toxicants in Sediments

Table 8-1: Minimum Routine Sampling and Analysis Parameters for Sediment Sampling

Sampling / Analysis Parameter	Minimum Requirement
Method	At each sampling site, surficial sediments (approximately the top 10 cm of the sediment) are to be collected using a method capable of surface sediment collection (e.g. grab sampler). To ensure local variability of sediment characteristics is accounted for, at least five subsamples from the same site are to be collected and homogenised to form a composite sample. Where practicable, sediment subsamples from a sampling site should be within 40 m of each other. Sampling locations are to be recorded at the time of sampling.
Location and Sampling Density	The minimum number of sampling sites for each ecological protection area are described below. CAPL may sample additional targeted locations if results of previous sampling events indicate localised accumulation of contaminants. **MOF Area:** • HEPA – Six sites north and east of the MOF along the common MEPA/HEPA boundary and two sites along the Causeway • MOF MEPA – 16 sites, comprising six sites immediately adjacent to MOF facilities, six within the MOF tug pen, and four positioned mid-zone (not adjacent to facilities) or on the boundary between LEPA/MEPAs **LNG Area:** • LNG HEPA – Four sites surrounding the LNG Jetty turning basin along the common MEPA/HEPA boundary • LNG MEPA – Seven sites, comprising three sites immediately adjacent to the LNG Jetty loadout facility and four positioned mid-zone (not adjacent to facilities) within the LNG Jetty MEPA **Reference Sites (for contextual purposes only, not routinely assessed against EQC):** Six locations, selected to be representative of potential impact sites and according to these guidelines: • bathymetry, substrate, and hydrodynamics similar to test sites • located away from the influence of pressures from historical activities or those related to operation of the Gorgon Gas Development. Indicative locations of sampling sites are shown in Figure 8-1 and Figure 8-2. Target sites within the tug pen are located in depositional areas; however, selection of the final location largely depends on the availability of recoverable surficial sediments at the target sampling location (Section 8.5).

Sampling / Analysis Parameter	Minimum Requirement
Frequency	For the first three years of MEQMP implementation, one sampling event within each 12-month period following shipment of first product, then a default frequency of every three years unless there is a demonstrated (from monitoring results) trend of accumulation of contaminants such that there is a high likelihood of exceeding an EQG within the default three-year sampling interval. If a trend of accumulation of contaminants towards an EQC is evident, monitoring at the affected locations may occur more frequently without necessarily affecting the monitoring frequency of unaffected areas. Routine monitoring frequency may be assessed by CAPL after each routine monitoring event to determine if the default frequency is appropriate, or if more frequent monitoring is warranted at any location. DWER is to be consulted after the third year of sediment sampling, before reducing to the default frequency.
Laboratory Analyses	For initial assessment against the EQGs, surficial sediment samples are to be analysed for: • TOC (to facilitate OC normalisation) metals and metalloids – including aluminium, arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc • organics – including PAHs Analyses will be undertaken by analytical laboratories with National Association of Testing Authorities accredited methods. Where possible, LoR will achieve or exceed the guidelines set out in Table 7-1.
Quality Assurance/ Quality Control (QA/QC)	Three types of QA/QC samples are to be collected for each routine monitoring event: • Replicates: At 10% of sampling sites, or at least two sampling sites, replicate samples are to be taken to assess local variation within a sampling site; both replicates are to be analysed by the same laboratory. Analysis is to include metals, organic matter content, and organic contaminants only. • Splits: At 5% of sampling sites, or at least two sampling sites, a composite sample is to be split into two separate portions; the first portion is analysed at the primary laboratory and the second portion analysed by a second (reference) laboratory to assess inter-laboratory variation. Analysis is to include metals, organic matter content, and organic contaminants only. • Blanks: Field blanks and transport blanks measure the potential contamination of samples during the sampling and transport process. Blanks are to be treated in the same way as sediment samples by exposing them to the same sampling and transport environment as normal samples.
Data Analysis	**Normalisation:** As TOC is the main binding constituent for organic substances in marine sediments, the ANZECC/ARMCANZ (Ref. 7) guidelines require organics (TPHs and PAHs) to be normalised to 1% TOC. The normalised results provide a measure of the bioavailability of the organic analytes for comparison against bioavailable EQC (Section 7.1.1). When TOC is significantly >1%, the additional binding capacity results in organics being less biologically available and therefore normalisation reduces the measured value proportionally (the reverse also applies). Normalisation is only appropriate over a TOC range of 0.2–10%. For TOC <0.2% or TOC >10%, the maximum and minimum values of 0.2 and 10% TOC are used for normalisation, respectively. For TOC in the range of 0.2–10%, a normalisation factor is calculated using the equation: *Normalisation Factor = 1/TOC (%)* The final value for comparison against the EQS B values is determined by multiplying the laboratory-reported analyte concentration by the normalisation factor. **Concentrations below the LoR:** Analytical results below the laboratory LoR (also referred to as the detection limit) are represented in graphs as half the LoR (LoR/2). In tables, all analytical results that are below the LoR will be presented as such.

Sampling / Analysis Parameter	Minimum Requirement
Data QA/QC	Results of the field QA/QC sampling are analysed by calculating the relative percent difference (RPD) for split and replicate samples. The RPD is calculated as: $\text{RPD (\%)} = \frac{\text{(difference between splits/replicates)} \times 100}{\text{(average of splits/replicates)}}$ The splits should agree within an RPD of ±35%. If the RPD for a measured analyte falls outside these limits, the values of the measured analyte are flagged as estimates rather than precise values. The replicate samples should agree within an RPD of ±50%.
Compliance Assessment	Compliance assessment is undertaken for each monitoring event. Refer to Section 7.1.1 for compliance assessment steps.

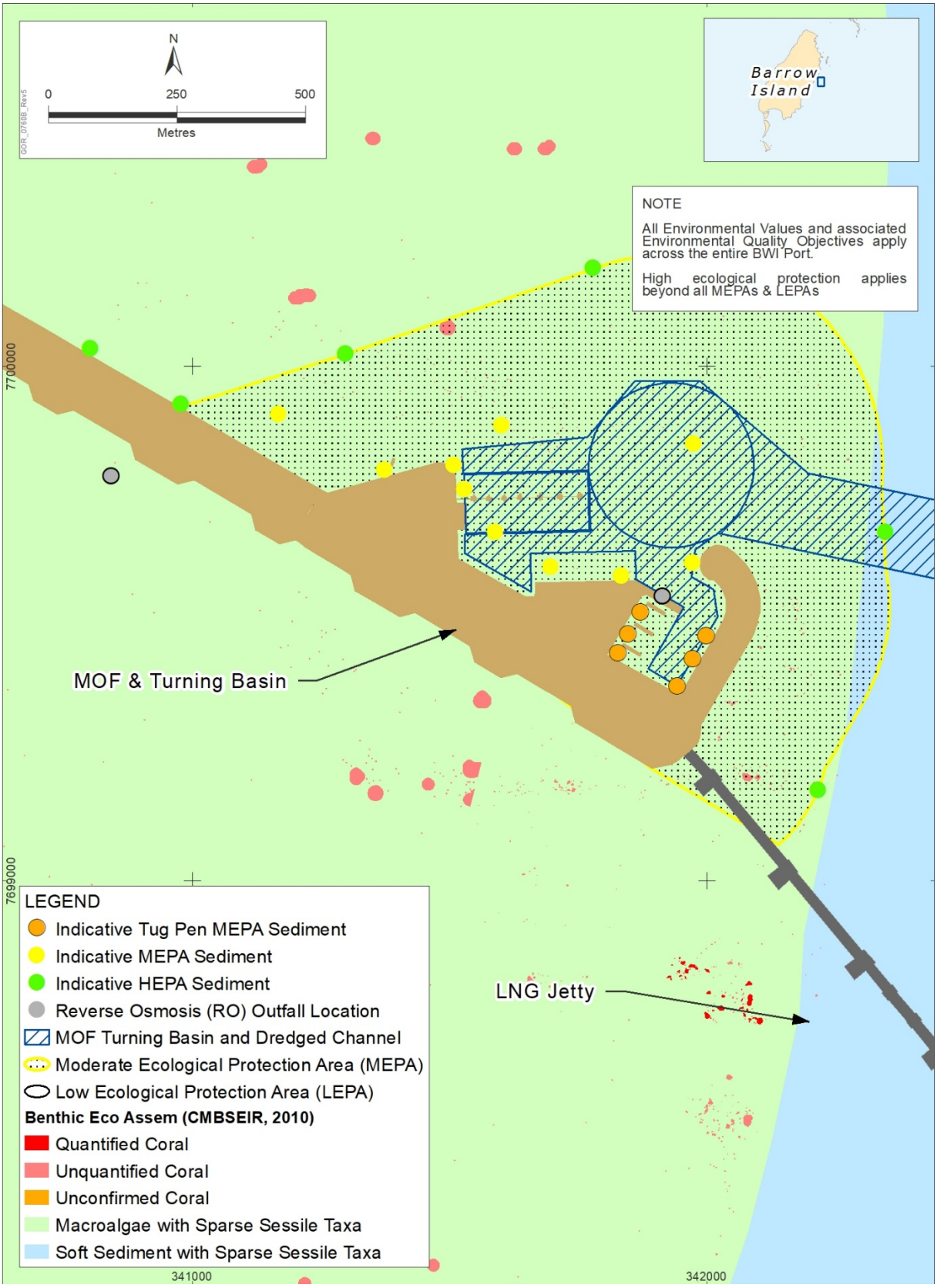

Figure 8-1: Indicative Locations of Routine Sediment Sampling Sites at the MOF

Note: Reference sites are not shown; locations are selected using the guidelines in Table 8-1

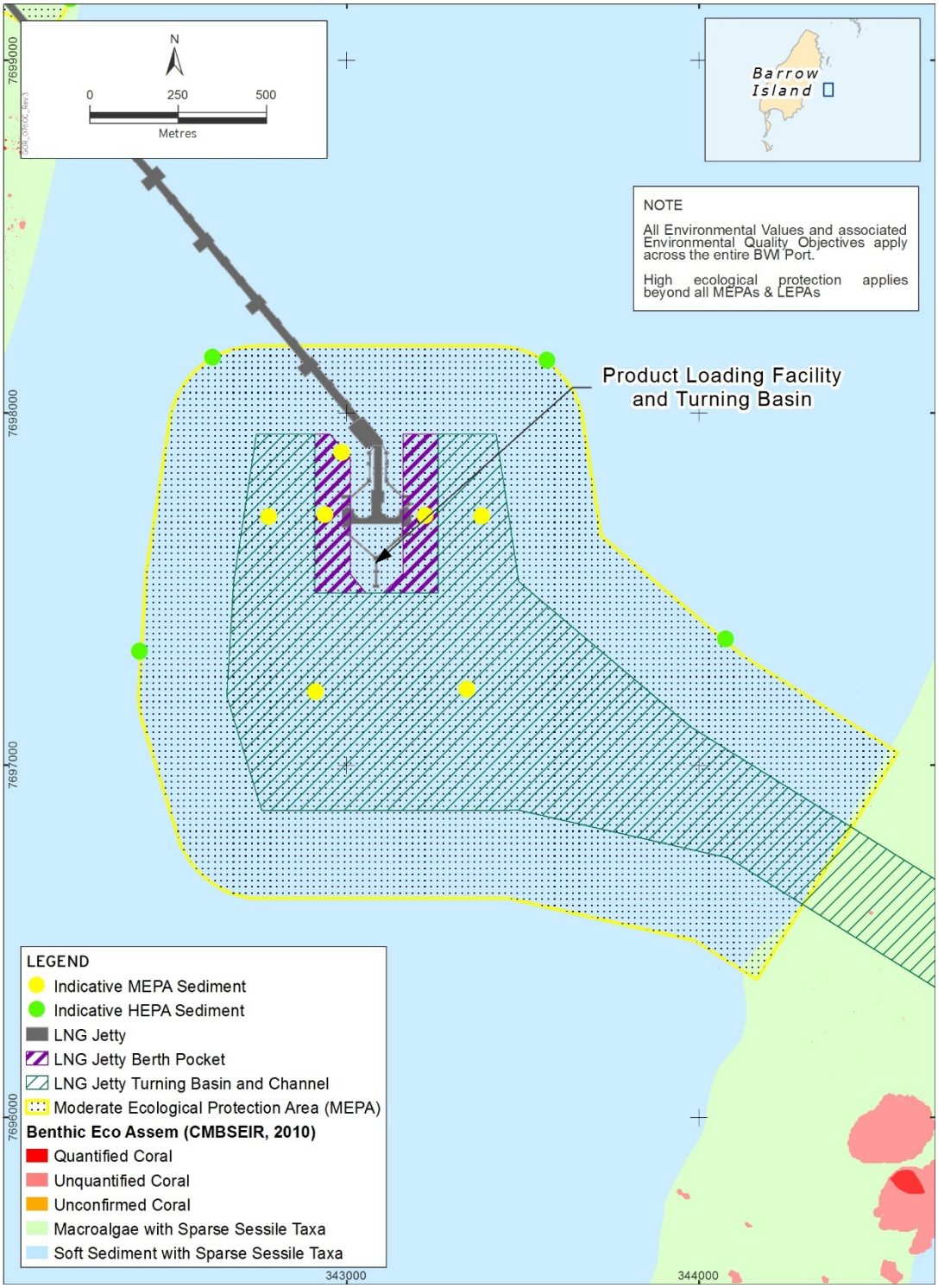

Figure 8-2: Indicative Locations of Routine Sediment Sampling Sites at the LNG Jetty

Note: Reference sites are not shown; locations are selected using the guidelines in Table 8-1

8.2 Toxicants in Marine Waters

Table 8-2: Minimum Routine Sampling and Analysis Parameters for Marine Waters Adjacent to the MOF

Sampling / Analysis Parameter	Minimum Requirement
Method	Aligned with AZ/NZS 5667.1:1998 (Ref. 44), Water quality sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples and AZ/NZS 5667.9:1998, Water quality sampling Part 9 (Ref. 45). At each sampling site, water is collected near the surface (~1 m depth) and ~0.5 m from the bottom of the water column using a Niskin bottle (or equivalent).
Location and Sampling Density	The minimum number of sampling sites for each discrete area within the MOF MEPA are: • five sites adjacent to the MOF • fifteen sites within the tug pen • three sites along the common MEPA/HEPA boundary (for contextual purposes only; not routinely assessed against EQC). Indicative sampling locations of are shown in Figure 8-3. CAPL may sample additional targeted locations if results of previous sampling events indicate localised contamination.
Frequency	Two sampling events within each 12-month period, for three consecutive years, then a default frequency of once per annum. Routine monitoring frequency may be assessed by CAPL after each routine monitoring event to determine if the default frequency is appropriate, or if more frequent monitoring is warranted at any location. • DWER is to be consulted after the third year of water sampling, before reducing to the default frequency.
Laboratory Analyses	For assessment against the EQG A/B and EQS A/B, water samples are analysed for concentrations of aluminium, cadmium, chromium (III and VI), copper, lead, mercury, nickel, and zinc. For assessment against EQS C, direct toxicity testing is completed on local indicator species. Adaptive management may be instigated before assessment against EQS C. Secondary indicators, not assessed against EQC, may also be recorded for contextual purposes.
QA/QC	The following QA/QC of samples applies to each sampling event: • Field blank: samples (usually a clean matrix similar to that of the test sample) that are processed and analysed in the same way as the submitted samples. They are used to detect contamination arising in the laboratory as a result of sample preparation, extraction, or analysis. In this case, blanks are to be prepared using the methods for field sampling, but the containers are to be filled with laboratory distilled water. • Sample splits: 10% of samples (randomly selected) are to be sampled as splits. A single sample is collected and split into two separate samples in the field and each sample analysed individually (all analytes) to examine the consistency of their analytical methods. An additional (third) split is collected and sent to a secondary laboratory to examine inter-laboratory consistency.
Data Analysis	**Data Aggregation** The 95th percentile is calculated by pooling data collected from defined sampling areas over a 12-month period. In instances where there are ≤20 samples from a defined sampling area the individual results of toxicant concentrations will be compared to the relevant LEP guideline. **Concentrations below the LoR:** Analytical results below the laboratory LoR (also referred to as the detection limit) are represented in graphs as half the LoR (LoR/2). In tables, all analytical results that are below the LoR will be presented as such.
Data QA/QC	Results of the field QA/QC sampling are analysed by calculating the RPD for split samples. The RPD for split samples is calculated as:

Sampling / Analysis Parameter	Minimum Requirement
	$$\text{RPD (\%)} = \frac{\text{(difference between splits)} \times 100}{\text{(average of splits)}}$$ The splits should agree within an RPD of ±35%. If the RPD for a measured analyte falls outside these limits, the values of the measured analyte are flagged as estimates rather than precise values. TTM is calculated based on the additive effects of copper, zinc, and nickel, which are the three contaminants identified as most likely to cause toxicity effects from antifouling paints.
Compliance Assessment	Compliance assessment is undertaken annually, using pooled data from all monitoring events within a 12-month period. Refer to Section 7.1.2 for compliance assessment steps.

Figure 8-3: Indicative Locations of Routine Water and Biota Quality Sampling Sites Adjacent to the MOF

8.3 Physicochemical Stressors

Table 8-3: Monitoring Parameters for RO Discharges

Sampling / Analysis Parameter	Minimum Requirement
Method	**Routine monitoring against EQG A:** Routine monitoring of RO discharges measures conductivity—the key discharge water quality stressor / indicator. Monitoring points are to be chosen as close to the end of the processing stream as practicable, to maximise representativeness of discharge quality. Monitoring may be done using inline instruments (manual or automatic recording) or by physical collection of water sample(s). **Triggered monitoring against EQS A**: At each sampling location, a water quality probe capable of measuring conductivity within 1 m of the seabed is used. Sampling locations and relevant metadata are to be recorded for the time of sampling.
Location and Sampling Density	**Routine monitoring against EQG A:** Monitoring within the discharge stream, either using inline instruments or physical collection of water samples. One stabilised measurement required from each operating RO discharge stream. **Triggered monitoring against EQS A**: Monitoring of receiving waters surrounding the outfall at the boundary of the LEPA mixing zone, and suitable nearby reference sites: • five separate sampling locations targeting the LEPA boundary • two reference sites located beyond the influence of RO discharges
Frequency	**Routine monitoring against EQG A:** For routine monitoring, weekly recording/measurements are required with results tested against EQG A each month. **High-frequency monitoring against EQG A**: If the criterion for EQG A is not met for a particular month, monitoring frequency increases to daily for the following month. The median (of daily measurements) for that month is tested against EQG A; the frequency returns to routine monitoring once EQG A is met. If EQG A for the high-frequency monitoring period is not met, then daily recording/measurement of discharge conductivity is to occur for the duration of the EQS A monitoring period. **Triggered monitoring against EQS A**: Three discrete sampling events completed within a one-week period, within a month of being notified of the high-frequency monitoring EQG A exceedance, where practicable. **Notes**: • Monitoring only occurs if the RO plant is consistently and actively in service. If an RO plant is running in stand-by mode for an extended period (e.g. more than one week), is rarely discharging, or has been decommissioned, then sampling is not required. • If a trend of water quality indicators towards an EQC is evident at one particular RO plant, monitoring at the affected RO plant may, at CAPL's discretion, occur more frequently without necessarily affecting the monitoring frequency of unaffected RO plants. • Routine monitoring frequency may be reassessed by CAPL at any stage to determine if the default frequency is appropriate, or if more or less frequent monitoring is warranted at any RO plant. DWER is to be consulted before reducing the frequency of monitoring at any RO plant.

Sampling / Analysis Parameter	Minimum Requirement
Water Quality Indicators	Conductivity is the primary indicator for assessment against the EQG and EQS. • Secondary indicators, not assessed against EQC, may be recorded for contextual purposes, including temperature and pH.
Data Analysis	**Triggered monitoring against EQS A:** Only the bottom one metre of the water column data should be used for assessment against the EQS A. Data from more than one metre above seabed should be separated and not used for calculations of median conductivity. Outliers should also be removed before analysis. At least five stabilised measurements are required at each site. The median is calculated for each site using data pooled from the three sampling events within the EQS sampling period.
QA/QC	Inline measurement is subject to QA/QC measures related to operating the RO plants according to manufacturers' specifications, therefore this Plan does not set any further QA/QC requirements for inline sampling. The measurement device for physicochemical water characteristics is calibrated and operated according to manufacturers' recommendations, where practicable. The operator should allow the device to stabilise before recording measurements.

8.4 Toxicants in Biological (Oyster) Tissue

Table 8-4: Minimum Routine Sampling and Analysis Parameters for Toxicants in Biological (Oyster) Tissue Adjacent to the MOF

Sampling / Analysis Parameter	Minimum Requirement
Method	Oysters attached to marine facilities (natural or artificial substrates) are collected to achieve a target wet oyster flesh weight of 5 g for each replicate sample.
Location and Sampling Density	Seven sites adjacent to the MOF/tug pen and three reference sites. Three replicate samples (approximately 5 oysters per replicate) are collected from each site. Reference site data are recorded for contextual purposes only, and not routinely assessed against EQC. Indicative sampling locations of are shown in Figure 8-3. CAPL may sample additional targeted locations if results of previous sampling events indicate localised contamination.
Frequency	One sampling event within each 12-month period (from the date of approval of this Revision). Routine monitoring frequency may be assessed by CAPL after each routine monitoring event to determine if the default frequency (annual) is appropriate, or if an altered frequency is warranted at any location. DWER will be consulted before reducing the frequency.
Indicators	For assessment against the EQG, biological (oyster) tissue is analysed for total concentrations of copper and zinc. Secondary indicators (including aluminium, arsenic, cadmium, chromium, lead, nickel, mercury), not assessed against EQC, may be recorded for contextual purposes.
QA/QC	Biota samples are collected in triplicate at each sampling sites. All efforts should be made to sample oysters of roughly the same size/maturity level, and from roughly the same depth/level of exposure on the substrate.
Data Analysis	**Concentrations below the LoR:** Analytical results below the laboratory LoR (also referred to as the detection limit) are represented in graphs as half the LoR (LoR/2). In tables, all analytical results that are below the LoR are presented as such.

Sampling / Analysis Parameter	Minimum Requirement
Data QA/QC	Results of the field QA/QC sampling are analysed by calculating the RSD of replicate samples. The RSD for replicate samples should agree within an RSD of ±50% and is calculated as: $\text{RSD (\%)} = \frac{\text{(standard deviation of replicate)} \times 100}{\text{(average of replicate)}}$
Compliance Assessment	Refer to Section 7.2 for compliance assessment steps.

8.5 Limitations

Monitoring is to be implemented in a way that meets the objectives of this Plan, while retaining operational flexibility to accommodate local variations in conditions, abnormal conditions, and/or events beyond CAPL's control. The survey areas occur in a region that experiences extreme weather events—there may be times when it is not possible to implement or complete a sampling program; if this occurs, CAPL will take measures and/or reprioritise its monitoring programs to ensure the objectives of this Plan are met.

The benthic habitats east of Barrow Island are variable, with many areas characterised by hard substrate or only a thin veneer of sediments overlying hard substrate. Further, sediment sampling sites may be difficult to access if construction or operational programs are underway in the immediate vicinity of the sites. If insufficient sediment is available for a representative sample to be collected or if access is restricted, alternative locations will be sampled within the requirements of Table 8-1. For sites on the boundary of ecological protection areas, alternative locations along the same boundary will be selected, where practicable.

9 Performance Objectives and Standards

Environmental performance is 'the measurable results of an organisation's management of its environmental aspects' (Ref. 47). CAPL measures environmental performance through:

- **Environmental performance objectives** – the environmental goals that CAPL sets itself to achieve
- **Environmental performance standards** – the measures CAPL uses to assess whether or not it is meeting its environmental performance objectives, comprising:
- **Performance measures** – indicators that provide information about CAPL's performance against an objective (e.g. percentage of employees who complete an induction)
- **Performance targets** – the level that CAPL is aiming for (e.g. 100% of employees complete an induction).

In accordance with Condition 23A.3.x of MS 800, Table 9-1 lists the environmental performance objective and standards that were developed to enable CAPL to assess environmental performance for marine environmental quality. The performance objective is linked to the second objective of this Plan (Condition 23A.2.ii); no performance standards have been defined for the first objective of this Plan (Condition 23A.2.i) as the information contained in this Plan is the only valid measure of achieving that objective.

Under the EQMF, environmental performance against the EQOs is measured by assessing monitoring data against the EQC; therefore, the targets are fundamentally linked to the EQC.

The target in Table 9-1 was developed specifically for assessing performance, not compliance. Failure to meet the target does not represent a breach of this Plan; rather, it indicates that a performance objective may not have been met and there may be a need for management action or review of the environmental performance objectives and standards.

Table 9-1: Objectives and Performance Standards

Facility	Objective	Performance Standards	
		Description	Target
MOF, LNG Jetty, and Turning Basins	Protect the EVs, and achieve EQOs and associated LEPs for marine waters defined in Condition 23A.2 for the life of the Gorgon Gas Development	Number of exceedances of EQC and associated LEPs that lead to adaptive management for marine waters adjacent to the MOF and LNG Jetty marine facilities	Zero
RO Plants	Protect the EVs, and achieve EQOs and associated LEPs for marine waters defined in Condition 23A.2 for the life of the Gorgon Gas Development	Number of exceedances of EQC and associated LEPs that lead to adaptive management for marine waters adjacent to RO discharge outfalls	Zero

10 Reporting and Response

Table 10-1 lists the environmental reporting procedures and protocols that shall apply, specific to this Plan, as per Conditions 23A.5.i and 23A.5.ii of MS 800.

Table 10-1: Reporting Requirements

Event	Report to	Timing
Exceedance of an EQS that requires management action	Chief Executive Officer (CEO) (of DWER, or a person approved by the CEO to receive the report)	Within two business days of CAPL receiving verified results confirming the exceedance

Within one month of detecting a exceedance (via verified results), CAPL will prepare and submit an Environmental Quality Management Report (EQMR) that details management action(s) to be implemented to rectify the cause of the exceedance, including time frames for implementation and reporting of performance, as determined by the Minister. CAPL will implement the agreed management action(s) in accordance with the EQMR.

Before submission, agreement, and implementation of the EQMR, CAPL may continue to take management action, which may include investigating the reason for the exceedance; reviewing the risks associated with the changed parameter with the aim of trying to understand and mitigate the cause of the change; further field monitoring; and/or additional management or mitigation measures.

11 Terminology

Terms, definitions, acronyms, and abbreviations used in this document are listed in Table 11-1. These align with the terms, definitions and abbreviations defined in Schedule 2 of MS 800.

Table 11-1: Terminology

Term	Definition
~	Approximately
<	Less than; fewer than
>	Greater than; more than
µg/L	Micrograms per litre
600EP	600 Equivalent Persons
ABU	Australian Business Unit
ALARP	As low as reasonable practicable
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AVS	Acid-volatile Sulfide
Bioaccumulation	The increase in concentration of one or more substances (typically toxins) in an organism or a part of that organism
Bioavailability	The extent to which a drug or other substance is taken up by a specific tissue or organ after administration
Biomagnification	The increase in concentration of a substance (typically toxins) in a food chain, not an organism
BOD	Biological Oxygen Demand
BTEX	Benzene, toluene, ethylbenzene, and xylene compounds
CAPL	Chevron Australia Pty Ltd
CEO	Chief Executive Officer of DWER, or equivalent
cm	Centimetre
CMBSEIR	Coastal and Marine Baseline State and Environmental Impact Report
Construction	Construction includes any Proposal-related (or action-related) construction and commissioning activities within the Terrestrial and Marine Disturbance Footprints, excluding investigatory works such as, but not limited to, geotechnical, geophysical, biological, and cultural heritage surveys, baseline monitoring surveys, and technology trials.
DBCA	Western Australian Department of Biodiversity, Conservation, and Attractions (from 1 July 2017; formerly Department of Parks and Wildlife [Parks and Wildlife]) (DBCA dates: from 1 Jul 2017 to [ongoing])
DBT	Dibutyltin
DEC	Former Western Australian Department of Environment and Conservation, then split into Department of Environment Regulation and Department of Parks and Wildlife [Parks and Wildlife]. Now Department of Biodiversity, Conservation, and Attractions (DBCA; from 1 July 2017) and Department of Water and Environmental Regulation (DWER; from 1 July 2017). (DEC dates: 1 Jul 2006 to 30 Jun 2013; was an amalgamation of Department of the Environment and Department of Conservation and Land Management)
DO	Dissolved Oxygen

Term	Definition
Dolphin (structure)	A fixed man-made marine structure that extends above the water level and is not connected to shore. Typical uses include extending a berth (a berthing dolphin) or providing a point to moor to (a mooring dolphin). Dolphins are also used to display regulatory information like speed limits, navigation information, lighted aids to navigation, etc.
DomGas	Domestic Gas
DTA	Direct Toxicity Assessment
DWER	Western Australian Department of Water and Environmental Regulation (formerly Department of Environment Regulation and Office of the [WA] Environmental Protection Authority [OEPA]) (from 1 July 2017 to [ongoing])
Ecotoxicity	The potential for biological, chemical or physical stressors to affect ecosystems
Elutriation	A method for separating particles (using liquid or air) based on their size, shape, and density
EMP	Environmental Management Plan
EP Act	Western Australian *Environmental Protection Act 1986*
EPA	Western Australian Environmental Protection Authority
EPBC Reference: 2003/1294	Commonwealth Ministerial Approval (for the Gorgon Gas Development) as amended or replaced from time to time.
EPBC Reference: 2005/2184	Commonwealth Ministerial Approval (for the Jansz Feed Gas Pipeline) as amended or replaced from time to time.
EPBC Reference: 2008/4178	Commonwealth Ministerial Approval (for the Revised Gorgon Gas Development) as amended or replaced from time to time.
EQC	Environmental Quality Criteria. Numerical values or narrative statements that serve as benchmarks to determine whether a more detailed assessment of environmental quality is required (these criteria are termed Environmental Quality Guidelines [EQGs]), or whether a management response is required (termed Environmental Quality Standards [EQSs]).
EQG	Environmental Quality Guideline. A threshold numerical value or narrative statement that, if met, indicates there is a high degree of certainty that the associated Environmental Quality Objective (EQO) has been achieved.
EQMF	Environmental Quality Management Framework. The environmental management framework developed and adopted by the EPA for managing the quality for the marine environment to meet the EPA's objectives and the community and stakeholders long-term desires.
EQMR	Environmental Quality Management Report
EQO	Environmental Quality Objective. A specific management goal for a part of the environment; it is either ecologically based by describing the desired level of health of the ecosystem or socially based by describing the environmental quality required to maintain specific human uses.
EQS	Environmental Quality Standard. A threshold numerical value or narrative statement that indicates a level beyond which there is a significant risk that the associated EQO has not been achieved. A management response is triggered upon exceedance of the final EQS.
EV	Environmental Values. As per the definition in the *Environmental Protection Act 1986* (WA): a beneficial use; or an ecosystem health condition. In the context of the EQMF: Particular value or use of the marine environment that is important for a healthy ecosystem or for public benefit, welfare, safety, or health, and that requires protection from the effects of pollution, waste discharges, and waste deposits.

Term	Definition
g	Gram
GEL	Generally Expected Level
GGD	Gorgon Gas Development
Gorgon Gas Development	The Gorgon Gas Development as approved under MS 800 and EPBC Reference: 2003/1294 and 2008/4178 as amended or replaced from time to time.
GTP	Gas Treatment Plant
ha	Hectare
HEPA	High Ecological Protection Area. A designated area requiring a High LEP, where contaminant concentration indicators may demonstrate a small detectable change beyond limits of natural variation but no resultant effect on biota.
HES	Health, Environment, and Safety
IMO	International Maritime Organization
ISO	International Organization for Standardization
ISQG	Interim Sediment Quality Guideline
Jansz Feed Gas Pipeline	The Jansz Feed Gas Pipeline as approved in MS 769 (Ref. 48) and EPBC Reference: 2005/2184 (Ref. 49) as amended or replaced from time to time.
JHA	Job Hazard Analysis
kg	Kilogram
KL	Kilolitre
km	Kilometre
L	Litre
LEP	Level of Ecological Protection. In relation to the EQO for 'maintain ecosystem integrity', four LEPs are recognised (Maximum LEP, High LEP, Moderate LEP, and Low LEP) that may be applied to separate areas of an ecosystem, with intent to protect the integrity of the ecosystem overall.
LEPA	Low Ecological Protection Area. A designated area requiring a Low LEP, where contaminant concentration indicators may demonstrate high levels of contaminants and biological indicators may exhibit large changes from natural variation.
LNG	Liquefied Natural Gas
LoR	Limit of Reporting (also known as the detection limit)
m	Metre
m^3	Cubic metre
Macroalgae	Algae that can be seen easily, without using a microscope; includes large seaweeds.
Marine Disturbance Footprint	The area of the seabed to be disturbed by construction or operations activities associated with the marine facilities listed in Condition 14.3 of MS 800 (excepting that area of the seabed to be disturbed by the generation of turbidity and sedimentation from dredging and dredge spoil disposal) as set out in the Coastal and Marine Baseline State Report required under Condition 14.2 of MS 800.

Term	Definition
Marine facilities	In relation to MS 800, the marine facilities are the: • Materials Offloading Facility (MOF) • LNG Jetty • Dredge Spoil Disposal Ground • Offshore Feed Gas Pipeline System and marine component of the shore crossing • Domestic Gas Pipeline. For the purposes of MS 800, marine facilities also include: • Marine upgrade of the existing WAPET Landing.
MARPOL	The International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. Also known as MARPOL 73/78.
MEG	Monoethylene glycol
MEPA	Moderate Ecological Protection Area. A designated area requiring a Moderate LEP, where contaminant concentration indicators may demonstrate elevated levels of contaminants and biological indicators may exhibit moderate changes from natural variation.
MEQMP	Marine Environmental Quality Management Plan, as defined by Condition 23A of MS 800.
Metocean	Meteorological and oceanographic conditions
mg	Milligram
MGA94 Zone 50	Map Grid of Australia Zone 50 (WA); projection based on the Geocentric Datum of Australia 1994.
ML	Megalitre
MMA	Mermaid Marine Australia
MOF	Materials Offloading Facility
MPRA	Western Australian Marine Parks and Reserves Authority
MS	(Western Australian) Ministerial Statement
mS	Microsiemen (a Siemen [S] is a unit of electrical conductivity); the conductivity of water is measured within a certain distance (e.g. S/cm or mS/cm)
MS 769	Western Australian Ministerial Statement No. 769 (for the Jansz Feed Gas Pipeline) as amended from time to time.
MS 800	Western Australian Ministerial Statement No. 800 (for the Gorgon Gas Development) as amended from time to time.
N/A	Not applicable
NCBM	Non-coral Benthic Macroinvertebrate
Negligible – Inherent Risk	For the purposes of this Plan: There is negligible risk of the stressors from the facility/activity to the EQOs due to minimal presence (or absence) of relevant and measurable stressors, and/or the inherent design/engineering of Gorgon Gas Development infrastructure, and/or recreational/commercial use of Barrow Island waters. Monitoring is not required to confirm that EVs are protected.
Negligible – Mitigated Risk	For the purposes of this Plan: There is high certainty that the potential for the facility/activity to affect marine environmental quality and threaten the EVs is adequately managed by environmental management and mitigation measures already in place for operation of the Gorgon Gas Development, such that the residual risk to achieving EQOs is negligible. Monitoring is not required to confirm that EVs are protected.

Term	Definition
Niskin bottle	A plastic cylinder with stoppers at each end to seal the bottle; used to take water samples at a desired depth without mixing with water from other depths.
nm	Nautical mile
OC	Organic carbon
OE	Operational Excellence
OEPA	Former Office of the (Western Australian) Environmental Protection Authority (now Department of Water and Environmental Regulation [DWER] [from 1 July 2017])
Oligotrophic	An ecosystem or environment that offers little to sustain life; commonly used to describe bodies of water or soils with very low nutrient levels
Operations (Gorgon Gas Development)	In relation to MS 800, for the respective LNG trains, this is the period from the date on which the Gorgon Joint Venturers issue a notice of acceptance of work under the Engineering, Procurement and Construction Management contract, or equivalent contract entered into in respect of that LNG train of the Gas Treatment Plant; until the date on which the Gorgon Joint Venturers commence decommissioning of that LNG train. For the purposes of this Plan, operations for the marine facilities monitored by this Plan occurs upon first shipment of products.
PAH	Polycyclic Aromatic Hydrocarbon
Parks and Wildlife	Former Western Australian Department of Parks and Wildlife (previously DEC; now DBCA [from 1 July 2017]) (Parks and Wildlife dates: 1 July 2013 to 30 June 2017)
PDS1, PDS2, etc.	Post-Development Survey: Year 1, Year 2, etc.
Percentile	A measure used in statistics indicating the value below which a given percentage of observations in a group of observations fall (e.g. the 90th percentile is the value [or score] below which 90% of the observations may be found)
Performance Standards	Matters that are developed for assessing performance, not compliance, and are quantitative targets, or where that is demonstrated to be not practicable, qualitative targets, against which progress towards achievement of the objectives of conditions can be measured.
pH	Measure of acidity or basicity of a solution
Physicochemical	Physicochemistry (also called physical chemistry) is the explanation of macroscopic, microscopic, atomic, subatomic, and particulate phenomena in chemical systems in terms of physical concepts; sometimes using the principles, practices, and concepts of physics like thermodynamics, quantum chemistry, statistical mechanics, and dynamics.
Pore Water	Water occupying the interstitial spaces between sediment particles. Contaminants in the interstitial water and in the solid phase are expected to be at thermodynamic equilibrium
PPA	Pilbara Ports Authority
Practicable	Practicable means reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge.
PSA	Particle Size Analysis
p-value	In statistical hypothesis testing, the probability of obtaining a result at least as extreme as the one that was actually observed, assuming that the null hypothesis is true
QA/QC	Quality Assurance/Quality Control
QMS	Quarantine Management System

Term	Definition
RO	Reverse Osmosis
ROBDOOEMMP	Reverse Osmosis Brine Disposal via Ocean Outfall Environmental Management and Monitoring Plan
RORO	Roll-on, roll-off
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SCM	Supply Chain Management
SEM	Simultaneous Extracted Metals
Sessile	Permanently attached directly to the substratum by its base (i.e. immobile), without a stalk or stem.
SLWMP	Solid and Liquid Waste Management Plan
State Coastal Waters	It forms a boundary of the scope of the Plan. So where the document refers back to Ministerial Statement requirements, we use 'State Coastal Waters', but for all other instances just use 'State Waters'. They are effectively the same thing.
State Coastal Waters	For the purposes of this Plan, is equivalent to State Waters and is used interchangeably
State Waters	The marine environment within three nautical miles of the coast of Barrow Island or the mainland of Western Australia
Stressor	An environmental condition or influence that stresses (i.e. causes stress for) an organism.
Surficial	Of or pertaining to the surface.
SWQMS	State Water Quality Management Strategy
T	Tonne
TAPL	Texaco Australia Pty Ltd
TBT	Tributyltin
TN	Total Nitrogen
TOC	Total Organic Carbon
Tolerable Risk	For the purposes of this Plan: The potential to affect marine environmental quality and the risk of compromising the EQOs is deemed acceptable (and is ALARP), but the effects require designation of specific LEPs and monitoring of EQC to ensure that EQOs are maintained and EVs are protected.
Toxicant	A toxic substance introduced into the environment
TP	Total Phosphorus
TPH	Total Petroleum Hydrocarbons
TSEPP	Terrestrial and Subterranean Environment Protection Plan
TSS	Total Suspended Solids
TTC	Thermotolerant Coliforms
TTM	Total toxicity of the mixture
Turbidity	The cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a test of water clarity.
WA	Western Australia

Term	Definition
WA Oil	Western Australia Oil Operations by Chevron Australia Pty Ltd, including Barrow Island oil field production operations (distinct from the Gorgon Gas Development).
WAPET	West Australian Petroleum Pty Ltd.
WAPET Landing	Proper name referring to the site of the barge landing existing on the east coast of Barrow Island prior to the date of MS 800.
Waters Surrounding Barrow Island	Refers to the waters of the Barrow Island Marine Park and Barrow Island Marine Management Area (~4169 ha and 114 693 ha respectively) as well as the Port of Barrow Island representing the Pilbara Offshore Marine Bioregion.
WET	Whole Effluent Toxicity
WWTP	Wastewater Treatment Plant

12 References

The following documentation is directly referenced in this document.

Table 12-1: References

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Appendix A Correspondence between OEPA and CAPL regarding Environmental Values and Environmental Quality Objectives

Appendix B Risk-assessment Summary of Gorgon Gas Development Operational Activities not Requiring Monitoring Against EQC

Activities identified as having the potential to affect marine environmental quality but where those effects are trivial, inconsequential, not persistent, and therefore do not inherently pose a credible risk to achieving the EQOs ('Negligible – inherent'), are not monitored via this Plan as there is a high confidence that EQOs and designated LEPs will be maintained. Similarly, activities already effectively managed and/or monitored through other regulatory or internal instruments to the extent that the residual risk (accounting for safeguards) to EVs is negligible ('Negligible – mitigated') are not further assessed or monitored via this Plan.

A summary of risk assessment, categorisation outcomes, and justification for activities categorised as 'Negligible – inherent' or 'Negligible – mitigated' is provided in Table B-1 and Table B-2, respectively. The risks were assessed in the context of the operational activities, known environmental conditions and responses, local restrictions to be applied during Gorgon operations, and the social considerations specific to Barrow Island.

Table B-1: Summary of Gorgon Gas Development Operational Activities Categorised as 'Negligible – inherent' Risk

Item	Marine Facility	Activity / Key Stressor, Potential Effect to Marine Environmental Quality, and EV at Risk	Safeguards – Design Features and Management Measures	Comments / Justification
1.	Causeway	**Activity /Stressor**: • Contaminated run-off and/or direct leaks from the Causeway **Potential Effect**: • Accumulation of toxicants in marine sediments. **EV at risk**: • Ecosystem Health	**Management measures – regulatory**: • Management of wastes from Gorgon operations is defined in the SLWMP (Ref. 10).	• The Causeway provides access to the MOF only. There are no permanent facilities along the Causeway that support operation of the Gorgon Gas Development and no storage of wastes or other materials that may cause impacts to the marine environment during run-off events. • Sediment sampling around marine facilities in 2014 and 2015 (Section 4.1.3; Ref. 21; Ref. 22) confirmed that the sediments adjacent to the Causeway are representative of a high level of ecological protection.
2.	Causeway, MOF, LNG Jetty, turning basins, WAPET Landing	**Activity /Stressor**: • Run-off from marine facilities containing elevated total suspended solids (TSS) during rainfall events • Discharge of sediments through MOF sidewall **Potential Effect**: • Shading, smothering, or clogging of marine biota resulting from increased TSS **EV at risk**: • Ecosystem Health	**Design features**: • MOF design incorporates erosion and sediment control devices to minimise sediment carryover to marine environment.	• Sediment load in run-off from marine facilities would be less than natural watercourses discharging to the marine environment. • The likelihood of high loads of fine sediments discharging through sidewalls is very low. • MOF contains some sealed surfaces, limiting the sediment load in run-off from that facility. • Sediment load has reduced with completion of construction.
3.	Causeway, MOF, LNG Jetty, turning basins, WAPET Landing	**Activity /Stressor**: • Diffuse inputs of nutrients from marine facilities **Potential Effect**: • Nutrient enrichment, increased phytoplankton biomass **EV at risk**: • Ecosystem Health	**Management measures – regulatory**: • Management of wastes from Gorgon operations is defined in the SLWMP (Ref. 10).	• No known sources with the potential to stimulate algal growth – no cause–effect pathway.
4.	Causeway, MOF, LNG Jetty, turning basins, WAPET Landing	**Activity /Stressor**: • Inputs of toxicants, nutrients, bacteria, and microalgal biotoxins **Potential Effect**: • Impacts to fishing and aquaculture, primary and secondary contact recreation, and aesthetic values, resulting from: thermotolerant coliforms (TTC), toxicants in seafood flesh, microalgal biotoxins, physicochemical changes, nutrient enrichment, increased phytoplankton biomass **EV at risk**: • Fishing and Aquaculture • Recreation and Aesthetics	**Management measures – regulatory**: • Management of wastes from Gorgon operations is defined in the SLWMP (Ref. 10).	• No operational sources of TTC that might lead to illness from ingesting seafood. • No operational sources of nutrients with potential to stimulate microalgae. • Low risk of toxicants being assimilated by seafood, other than shellfish (refer to Table 3-1 and Table 5-1 • No edible filter-feeding shellfish (except small rock oysters) in vicinity of treated effluent discharges. • Department of Health advises against collecting shellfish around ports and harbours. • No operational sources of bacteria that may lead to illness from ingestion. • Negligible risk of in-water toxicants leading to poisoning (ingestion / primary contact) or irritation (secondary contact). • No irradiated contaminants. • Very limited public visitation to area. • Fishing or harvesting of shellfish by workforce, or recreational activities within Barrow Island Port waters is prohibited (Section 4). • No aquaculture in waters surrounding Barrow Island. • No risk of fish tainting. • No risk of affecting visual indicators / aesthetics.

Item	Marine Facility	Activity / Key Stressor, Potential Effect to Marine Environmental Quality, and EV at Risk	Safeguards – Design Features and Management Measures	Comments / Justification
5.	WAPET Landing	**Activity /Stressor**: • Contaminated run-off and/or direct leaks from facilities and marine vessels at WAPET Landing • Leaching of antifoulants (containing toxicants) from the hulls of marine vessels **Potential Effect**: • Accumulation of toxicants in marine sediments. **EV at risk**: • Ecosystem Health	**Management measures – regulatory**: • Management of wastes from Gorgon operations is defined in the SLWMP (Ref. 10). • Marine vessels are required to be registered with the IMO, which prohibits antifoulants containing TBT. **Management measures – internal**: • Marine vessels operating within the Barrow Island Quarantine Limited Access and Controlled Access Zones comply with requirements of the Barrow Island Quarantine Management System (QMS; Ref. 50), specifically: – vessel wetside quarantine compliance in accordance with the requirements of the QMS (including antifouling coating, inspections, and/or cleaning/treatments, if required). • Internal Marine OE inspections verify that vessels are IMO registered, which confirms that the antifoulants are TBT-free. • Bulk transfers to / from marine vessels, supporting Gorgon Operations, comply with the ABU Offshore Cargo Handling Procedures (Ref. 15), specifically requirements for dry and wet transfers, including bulk hydrocarbons, near the marine environment. • Diesel storage at WAPET Landing managed under an EP Act Part V License.	• Sediment sampling at 16 sites around WAPET Landing (including three reference sites) was undertaken in early 2014 and late 2015 to inform development of this Plan (Ref. 21; Ref. 22). Samples were analysed for TOC, total metals, PAHs, TPHs, organotins (monobutyltin, DBT, TBT) and PSA. • PSA analysis indicated that medium and coarse sand dominated the sediment composition within the WAPET Landing area. TOC content in sediment samples was low—<1% at all sites. • Metal concentrations of sediment samples were all below respective LoRs and/or ISQG-Low trigger values (Ref. 7). • TPH and Total PAH concentrations were all below the LoR in 2014 and at very low concentrations in 2015 samples (with a much lower LoR). All samples were below ISQG-Low criteria concentrations. • Sediment TBT concentrations were all below the laboratory LoR and the ISQG-Low trigger value, except for one sample in each of the 2014 and 2015 surveys. Although the concentration of TBT in these two samples exceeded the ISQG-Low trigger value (once corrected for OC content), the concentrations were well below the ISQG-High trigger value. DBT was recorded in one of the samples at concentrations marginally above the LoR, suggesting that some breakdown of the TBT may have occurred. TBT is not considered a risk factor for Gorgon operations due to existing management controls; no further accumulation will occur. • The low levels of contaminants in sediments adjacent to the WAPET Landing marine facilities indicates high sediment quality, despite a 40-year history of activity at WAPET Landing. Additionally, the 2014 and 2015 sampling programs were undertaken at the end of the peak Gorgon construction period after shipping activity at WAPET Landing had been at a sustained high level for almost six years (January 2010 to December 2015) at multiple berths, with no significant accumulation of contaminants in the sediments around the facility. Shipping activity at WAPET Landing is now minimal as the MOF is fully available. Steady-state use by Gorgon Operations is a fraction of the activity level sustained during construction and is restricted to occasional (backup) use by Landing Craft Tankers. • Monitoring data demonstrates a negligible risk of contamination from operational activities accumulating at WAPET Landing that would risk achieving the EQOs.
6.	Production Camp 600EP WWTP	**Activity /Stressor**: • Discharge of tertiary treated wastewater containing toxicants, nutrients, bacteria, and altered physicochemical properties **Potential Effect**: • Contamination of water and sediments, resulting from increased toxicants in water and sediments, physicochemical changes (temperature, TSS, DO, salinity), nutrient enrichment, and increased phytoplankton biomass, TTC, toxicants in seafood flesh, microalgal biotoxins, toxic microalgae, and pathogens, toxicants (poisoning and irritation), fish tainting chemicals, visual/ aesthetic changes **EV at risk**: • Ecosystem Health • Fishing and Aquaculture • Primary and Secondary Recreation • Aesthetic	**Management measures – regulatory**: • Production Camp 600EP WWTP managed under an EP Act Part V Licence to meet sewage discharge criteria (Ref. 51). **Design features:** • Tertiary treated effluent with nutrient reduction.	Gorgon operational personnel are not accommodated at the Production Camp under routine operating conditions. Any Gorgon operations personnel occasionally accommodated at the camp would contribute an insignificant proportion of the discharge compared to the other camp occupants (mainly WA Oil personnel). If this changes and operational personnel are routinely accommodated at the Production Camp in significant numbers, the risk assessment may be revised; if the risk is assessed as 'Tolerable if monitored', then EQC will be developed, and assessed through monitoring, via a revision to this Plan or a separate Plan (meeting the requirements of MS 800 Condition 23A). **Notes on existing discharge**: • Treated wastewater is discharged to the marine environment via an ocean outfall ~250 m offshore from Camp Point. Discharge has occurred at this location under varying levels of treatment (different treatment plants) since 1996, with no evidence of long-term impacts. • Quarterly discharge monitoring undertaken since commissioning has shown that concentrations of all measured parameters required by the Licence (pH, biological oxygen demand [BOD], TSS, total nitrogen [TN], total phosphorus [TP], *Escherichia coli* [*E. coli*]) are consistently well within the discharge target criteria, indicating that the WWTP is well maintained and running efficiently. • Tertiary treatment ensures that pathological agents in the discharge water are well controlled; monitoring during 2013 and 2014 (approximately weekly) did not detect pathological agents (TTCs, *E. coli*, *Strongyloides* and hookworms, somatic coliphages, sulfite-reducing Clostridia, *Clostridium perfringens*) above laboratory LoRs *in the discharge stream*. • Discharge volumes are small (maximum 231 KL per day = 10 000 L per hour). Daily discharge is equivalent to 10% of the volume of an Olympic-sized swimming pool [2500 KL]). • Modelling predicted a 100 m LEPA under worst-case dilution scenarios; however, monitoring of receiving waters (Ref. 52) on three occasions confirmed that adequate dilution to meet HEPA criteria for toxicants in water was achieved ~50 m from the outfall, even under conditions of low mixing (low tidal height, weak currents). Studies (Ref. 52) found no sediment contamination evident around the outfall despite years of operation at this location, confirming that the area is well-flushed. • Discharge point is >4 km from nearest Gorgon operations discharge.

Item	Marine Facility	Activity / Key Stressor, Potential Effect to Marine Environmental Quality, and EV at Risk	Safeguards – Design Features and Management Measures	Comments / Justification
				• No visual indication of the discharge plume is evident under any tidal condition. **Comments**: • No edible filter-feeding shellfish (except small rock oysters) in the vicinity of treated effluent discharges. • No aquaculture in waters surrounding Barrow Island. • No credible risk to human health with the management already in place for discharges. • No risk of fish tainting. • No primary contact recreation or shellfish collection permitted in Port waters for Barrow Island personnel. • Based on the above, the risk to EQOs from the activity that is attributable to Gorgon operations personnel would be negligible.
7.	Production Camp RO outfall	**Activity /Stressor**: • Discharge of brackish RO reject water containing toxicants, nutrients, and altered physicochemical properties **Potential Effect**: • Contamination of water and sediments, resulting from increased toxicants in water and sediments, physicochemical changes (temperature, TSS, DO, salinity), nutrient enrichment and increased phytoplankton biomass, toxicants (poisoning and irritation), fish tainting chemicals, visual / aesthetic changes **EV at risk**: • Ecosystem Health • Fishing and Aquaculture • Primary and Secondary Recreation • Aesthetic	No identified safeguards that would affect the risk ranking.	The RO Plant is not a Prescribed Premise under EP Act Part V – the discharge was previously determined to be a non-significant, low-risk discharge via the DWER Part V Licence (for Barrow Island) Environmental Assessment Report process [Ref. 53]. The facility is managed in accordance with internal procedures. **Notes on discharge**: The Production Camp RO Plant produces freshwater for domestic use from brackish water, which is sourced from groundwater wells on Barrow Island. The RO Plant discharges RO reject water to the supratidal limestone pavement via a pipe located ~150 m south of the Production Camp. The reject water is discharged above the high-tide line and flows across the supratidal limestone pavement under gravity to mix with the ocean at the shore. The receiving environment is intertidal—during low tides it is an exposed lagoon; during mid-high tide it is flooded. The lagoon is exposed ~10 hours (total) per day during spring tides; less in neaps. The RO Plant is operated intermittently on a demand basis, for ~12 hours per day (at maximum production). The average discharge rate is 3400 L/hour (or 0.041 ML/day, ~1 residential swimming pool per day). The RO Plant operates at maximum capacity (and has done so for a long time). **Discharge characteristics**: • concentrated groundwater (brackish); salinity ~5 parts per thousand (1/7th concentration of sea water) • copper and zinc, with concentrations exceeding receiving water guidelines, are the main constituents of potential concern along with nutrients; copper concentrations ranged from 2 to 4 µg/L, compared with the 99% species protection of 0.3 µg/L) Monitoring of ambient waters and sediments occurred on three occasions in March/April 2014 (Ref. 52) to inform the risk assessment; samples were collected when the intertidal pool was isolated from ocean (worst-case conditions), and sampling methods were based on the Cockburn Sound guidelines (Ref. 44). **Results**: • Discharge plume only detectable when discharge is occurring to the isolated pool (low tide); undetectable when the tide breaches the pool (most of the day) due to a high-energy mixing environment. • Copper concentrations were detected marginally above the 99% species protection guideline (0.3 µg/L) at sites close to the discharge only when the tidal pool was exposed and the outfall was discharging. Maximum concentration recorded was 0.5 µg/L. • No evidence of accumulation of contaminants within sediments.

Item	Marine Facility	Activity / Key Stressor, Potential Effect to Marine Environmental Quality, and EV at Risk	Safeguards – Design Features and Management Measures	Comments / Justification
8.	Production Camp stormwater	**Activity /Stressor**: • Discharge of stormwater from Production Camp containing elevated levels of toxicants and suspended sediments **Potential Effect**: • Contamination of water and sediments in vicinity of outfalls • Shading, smothering, or clogging of marine biota resulting from increased TSS • Aesthetic changes from increased TSS **EV at risk**: • Ecosystem Health • Aesthetics	Run-off/stormwater is captured and enters recharge basins. No direct discharge to marine environment.	No cause–effect pathway as there is no direct discharge to marine environment.
9.	GTP	**Activity /Stressor**: • Run-off / stormwater from the GTP containing elevated levels of toxicants and suspended sediments **Potential Effect**: • Contamination of water and sediments in vicinity of outfalls • Shading, smothering, or clogging of marine biota resulting from increased TSS • Aesthetic changes from increased TSS **EV at risk**: • Ecosystem Health • Aesthetics	**Design features**: • As detailed in the Terrestrial and Subterranean Environment Protection Plan (TSEPP) (Ref. 54), the surface water drainage system is designed to: – segregate, intercept, treat, and/or dispose of streams of potential contamination from the GTP – collect uncontaminated stormwater and redistribute it to the groundwater aquifer and to the surrounding terrestrial environment in a manner that minimises channelisation and erosion – no run-off (even uncontaminated) is allowed to flow directly to the marine environment from the GTP. **Management measures – regulatory**: • TSEPP (Ref. 54) describes management of stormwater • Stormwater run-off is managed as detailed in the EP Act Part V Licence and work approvals for the GTP.	No cause–effect pathway as there is no direct discharge to marine environment (Ref. 55).
10.	GTP	**Activity /Stressor**: • Atmospheric emissions from the GTP depositing into the marine environment **Potential Effect**: • Accumulation of toxicants in marine sediments. **EV at risk**: • Ecosystem Health	**Design features:** • Environmental Basis of Design (Ref. 55) and Greenhouse Gas Abatement Program (Ref. 56) **Management measures – regulatory**: • Management of emissions to air is addressed in the Air Quality Management Plan (Ref. 57) and Greenhouse Gas Abatement Program (Ref. 56). The EP Act Part V Licence issued for the GTP includes emissions targets for the various emission sources.	**Comments**: • Marine ecological risk assessments for air emissions (Ref. 58) established that air emissions are a very low risk of contaminating the marine environment, based on modelling of all emission sources. • If air quality monitoring results show significant deviations from modelling estimates, marine ecological risk assessments may be reviewed.
11.	Marine vessels	**Activity /Stressor**: • Discharges of treated wastewater containing altered physicochemical properties (elevated TSS, reduced DO, temperature, salinity) • Exhaust emissions **Potential Effect**: • Contamination of water and sediments, resulting from increased toxicants in water and sediments, physicochemical changes (TSS, DO, temperature, salinity) **EV at risk**: • Ecosystem Health • Fishing and Aquaculture	**Management measures – regulatory**: • Discharges from marine vessels are managed under MARPOL requirements, as detailed in the SLWMP (Ref. 10). **Management measures – internal**: • Vessels chartered or operating on behalf of Gorgon Operations and/or its contractors comply with MARPOL, as per the ABU Offshore Cargo Handling Procedures (Ref. 15). **Management measures – external**: • Applicable vessels (>400 T) have International Air Pollution Certificate showing MARPOL compliance. **Surrogates**: • Accumulation of contaminants adjacent to marine facilities (e.g. MOF tug pen) would be detected via this Plan's sampling program, as detailed in Section 8.	• Small volumes of discharge, minor differences in physicochemical characteristics between ambient water and discharge, good mixing and flushing of receiving waters. • Ecosystem integrity is not at risk from atmospheric emissions generated by marine vessels.

Item	Marine Facility	Activity / Key Stressor, Potential Effect to Marine Environmental Quality, and EV at Risk	Safeguards – Design Features and Management Measures	Comments / Justification
		• Primary and Secondary Recreation • Aesthetic		
12.	Marine vessel movements associated with shipping of product	**Activity /Stressor**: • Shipping movements resuspending surficial sediments **Potential Effect**: • Shading, smothering, or clogging of marine biota resulting from increased TSS **EV at risk**: • Ecosystem Health	No identified safeguards that would affect the risk ranking.	Modelling (Ref. 59) and evidence (Ref. 20) suggests that it is highly likely that negligible impact to sensitive receptors (e.g. coral) will result from resuspension of sediments by shipping, particularly when considering impacts already sustained during dredging and spoil disposal activities. Any impacts that would occur would be contained within the dredged channel and turning basins or immediately adjacent (Ref. 59)—areas that are already completely disturbed. Modelling of sediment resuspension generated by LNG / condensate shipping activities predicts that most resuspended sediment fractions resettle within the dredged channel; minor deposition of medium-sized fractions was predicted to settle beyond the channel and berth pockets, at rates not anticipated to impact sensitive receptors (Ref. 59). Finer fractions (very fine sands, silts, and muds) may be dispersed beyond the shipping channel and berth pockets by currents; however, these turbid plumes are likely to be temporary (hours), transient, and spatially confined. Additionally, the concentrations of suspended sediments in these transient plumes are predicted to be well within the tolerance limits of corals in terms of light reduction or sedimentation effects.
13.	Minor marine infrastructures (e.g. navigation markers)	**Activity /Stressor**: • Inputs of toxicants from minor marine infrastructures **Potential Effect**: • Contamination of sediments resulting from increased toxicants in water **EV at risk**: • Ecosystem Health	No identified safeguards that would affect the risk ranking.	Smaller marine infrastructure such as navigation aids and moorings have limited potential for contamination.
14.	All marine facilities with cathodic protection	**Activity /Stressor**: • Inputs of toxicants from marine infrastructures through degradation of cathodic protection **Potential Effect**: • Contamination of sediments resulting from increased toxicants in water **EV at risk**: • Ecosystem Health	No identified safeguards that would affect risk ranking. **Surrogates**: Any accumulation of contaminants in enclosed waters (e.g. within MOF tug pen) would be detected via this Plan's sampling program, as detailed in Section 8.	Sacrificial anodes do not pose a threat to water quality due to their slow dissolution rates and high levels of flushing at each of the marine facilities.
15.	All marine facilities and activities	**Activity /Stressor**: • All activities **Potential Effect**: • Impacts to cultural and spiritual values, and industrial water supply values **EV at risk**: • Cultural and Spiritual • Industrial Water Supply	**Surrogates**: Where at risk, the EQC prescribed for protecting ecosystem health are used as surrogates to protect cultural and spiritual values and industrial water supply values.	**Cultural and Spiritual**: Despite no resident human population on Barrow Island, cultural and spiritual values of the Barrow Island area align with the pristine quality of the region, including the diversity and abundance of marine fauna and flora. This Plan includes EQC for assessing the EQO 'maintain ecosystem integrity', which are conservative; by maintaining ecosystem integrity it is expected that the EQO for Cultural and Spiritual values are also achieved. Therefore, the risk to Cultural and Spiritual values is considered manageable. **Industrial Water Supply**: CAPL is the operator of two petroleum activities (Gorgon Gas Development and WA Oil, also known as the Barrow Island Joint Venture) on Barrow Island, on behalf of the respective joint venture participants. Many of the marine facilities are shared and Gorgon activities are managed to not compromise the amenity and access to the marine environment for the Barrow Island Joint Venture. In addition, all current operational sea water intakes are located sufficiently distant from marine discharges such that the quality of the intake water is not compromised. By maintaining the quality of sea water to achieve the EQO 'maintain ecosystem integrity', the EQO for Industrial Water Supply is expected to be achieved and therefore the risk is considered manageable.

Table B-2: Summary of Gorgon Gas Development Operational Activities Categorised as 'Negligible – mitigated' Risk

Item	Marine Facility	Activity / Key Stressor, Potential Effect to Marine Environmental Quality, and EV at Risk	Safeguards	Comments / Justification
1.	Causeway, MOF, LNG Jetty, and turning basins	**Activity /Stressor**: • Contaminated run-off and/or direct leaks **Potential Effect**: • Acute or chronic effects to water quality **EV at risk**: • Ecosystem Health	• Design features: • Storage vessels and higher-risk leak points (e.g. bowsers, flanges, valves) are equipped with kerbed containment and sumps. Bunds on LNG Jetty (remote from drainage system) are fully self-contained. • All waste transported via the MOF is containerised. • Management measures – regulatory: • Management of wastes from Gorgon operations is defined in the SLWMP (Ref. 10). • Management measures – internal: • Bulk transfers to/from marine vessels supporting Gorgon operations comply with the ABU Offshore Cargo Handling Procedures (Ref. 15), specifically requirements for dry and wet transfers, including bulk hydrocarbons, near the marine environment. • Operational procedures specifying that areas are to be maintained clean, requiring immediate clean-up of spills, routine inspections for damaged or leaking equipment, pre/post rainfall inspections and cleanout, dewatering of sumps and bunds, and scheduled preventive maintenance programs. • No permanent or transient chemical storage areas on the Causeway/MOF Jetty, unless ALARP risk is demonstrated.	Water quality is reasonably expected to meet HEPA criteria >95% of the time, except at highly localised areas immediately around discharges/inputs during the times that discharges occur. Designation of a MEPA around the MOF is based on localised impacts to water quality from antifoulant impacts, and long-term (30+ years Gorgon Gas Development life) potential for certain contaminants to accumulate in sediments. Safeguards are expected to be very effective and contaminants entering the marine environment from the MOF will be minor and episodic/infrequent in nature. In addition to being infrequent, inputs will be of low loads, spatially limited, and the dissolvable and/or suspended portions will not persist as they will be rapidly flushed and diluted/dispersed away from the MOF by tidal currents. Aside from the RO discharges and dissolution of sacrificial anodes, release of antifoulant coatings would be the only chronic discharge to the marine environment in the vicinity of the MOF. Although chronic, the rate of biocidal release is slow (by design) and the low loads of biocide released will be well diluted by tidal flushing within the tug pen; effects are expected to be localised to the tug pen.
2.	Marine vessels	**Activity /Stressor**: • Run-off from marine vessels (e.g. deck-wash) containing toxicants • Discharges of treated effluent containing toxicants, elevated nutrients, and bacteria **Potential Effect**: • Contamination of water and sediments, resulting from increased toxicants in water and sediments, nutrient enrichment and increased phytoplankton biomass, TTC, toxicants in seafood flesh, microalgal biotoxins, toxic microalgae and pathogens, toxicants (poisoning and irritation), fish tainting chemicals, visual / aesthetic changes **EV at risk**: • Ecosystem Health • Fishing and Aquaculture • Primary and Secondary Recreation • Aesthetic.	**Management measures – regulatory**: • Discharges from marine vessels are managed under MARPOL requirements, as detailed in the SLWMP (Ref. 10). **Management measures – internal**: • Vessels chartered or operating on behalf of Gorgon Operations and/or its contractors comply with MARPOL, as per the ABU Offshore Cargo Handling Procedures (Ref. 15). **Surrogates**: • Accumulation of contaminants adjacent to marine facilities (e.g. MOF tug pen) would be detected via this Plan's sampling program, as detailed in Section 8.	The risk assessment focused on tugs and pilot boats as the highest risk pathways. During LNG/condensate tanker visits to Port, one tug is manned 24 hours per day by three crew, otherwise crew are accommodated ashore. The tugs are stationed within the semi-enclosed (but well-flushed) MOF harbour. **Permitted to discharge within the tug pen**: • treated effluent, only from IMO-approved WWTP [discharge parameters: mean TTC <100 TTC/100 mL, mean TSS <35 mg/L, pH 6–8.5, BOD_5 <25 mg/L, Chemical Oxygen Demand <125 mg/L, no visible floating solids or discolouration]. • greywater (preference is to treat greywater via the WWTP first), cooling water, RO brine (if a treatment system is present). **Not permitted to discharge within the tug pen** [square brackets indicate where it *is* permitted]: • food waste (macerated or unmacerated). [Macerated <25 mm = 3 nm west of Barrow Island, unmacerated = 12 nm west of Barrow Island] • disinfected or untreated sewage (including sludge or solids). [Disinfected = 3 nm west of Barrow Island, untreated = 12 nm west of Barrow Island] • any other solid waste [elsewhere in accordance with MARPOL Annex V] • discharge from IMO-approved oily water separator [vessel must be underway for this; thus, can discharge within the Port, but not when stationary in the tug pen] **Comments**: • Discharge of treated effluent and run-off are infrequent events, occurring <5% of the time. • Although tugs are permitted to discharge treated effluent within the tug pen, in most circumstances they discharge in open waters when underway. • <10 dilutions required for treated effluent to meet EQC (faecal pathogens in water) for maintenance of seafood consumption. • Treated effluent discharge meets primary and secondary contact recreation EQC (faecal pathogens in water) at the source (no dilutions required).
3.	Maintenance dredging	**Activity /Stressor**: • Resuspension of surficial sediments • Removal of habitat	N/A	Maintenance dredging requirements not yet known. Once known, activities are to be managed on a case-by-case basis to meet the requirements of Condition 23A of MS 800 and other applicable regulatory and internal requirements.

Item	Marine Facility	Activity / Key Stressor, Potential Effect to Marine Environmental Quality, and EV at Risk	Safeguards	Comments / Justification
		• Deposition (to spoil ground) of potentially contaminated sediments		
4.	Feed Gas Pipelines and DomGas Pipeline	**Activity /Stressor**: • Operation and maintenance activities associated with Gorgon Feed Gas and DomGas pipelines (within State Waters), including vessel operations.	**Management measures – regulatory**: • Wastes and discharges associated with pipelines are managed as detailed in the DomGas Pipeline Environment Plan – Commissioning, Start-Up and Operation (Ref. 60) and Gorgon and Jansz Feed Gas Pipelines and Wells Operations Environment Plan (Ref. 61)	Routine operation of the Feed Gas and DomGas pipelines (i.e. movement of gas through the pipe) has minimal potential to affect marine environmental quality and is of negligible risk to EQOs (no cause–effect pathway). Maintenance activities by survey/inspection vessels are transient, benign, and wholly managed through separate Environment Plans as per WA and Commonwealth petroleum legislation and regulations. These measures ensure that maintenance activities would not affect marine environmental quality to the extent that EQOs may be compromised.
5.	Activities beyond Barrow Island Port area at Supply Bases	**Activity /Stressor**: All activities associated with marine supply bases: • Contaminated run-off, direct leaks, leaching of antifoulant from marine facilities and vessels with the potential to result in accumulation of toxicants in marine sediments, particularly in lower flushing environments • Discharges containing toxicants, nutrients, bacteria, and microalgal biotoxins **Potential Effect**: • Contamination of water and sediments, impacts to fishing and aquaculture, primary and secondary contact recreation, and aesthetic values resulting from: increased toxicants in water and sediments, nutrient enrichment and increased phytoplankton biomass, TTC, toxicants in seafood flesh, microalgal biotoxins, toxic microalgae and pathogens, toxicants (poisoning and irritation), fish tainting chemicals, visual / aesthetic changes **EV at risk**: • Ecosystem Health • Fishing and Aquaculture • Primary and Secondary Recreation • Aesthetic • Cultural and Spiritual • Industrial Water Supply	**Management measures – regulatory**: • Discharges from marine vessels are to be in accordance with MARPOL, as detailed in the SLWMP (Ref. 10). • *Port Authorities Act 1999* (WA) – defines a core function of a Port Authority 'to protect the environment of the Port and minimise the impact of Port operations on the environment'. The Act establishes the Pilbara Ports Authority (PPA) and Fremantle Port Authority • PPA Environmental Management Plan (Ref. 62) – applies to Dampier Supply Base. Management/monitoring of water quality transitioning towards an EQMF. • PPA marine and stormwater quality monitoring program – applies to Dampier Supply Base. • EP Act Part V ministerial conditions, and/or EP Act Part V licences and development approval requirements specific to each facility or operator within Pilbara Ports. **Management measures – internal**: • Vessels chartered or operating on behalf of Gorgon Operations and/or its contractors comply with MARPOL, as per the ABU Offshore Cargo Handling Procedures (Ref. 15). • MMA, as service provider to CAPL, must have an HES Management Plan that documents how they will meet CAPL requirements, including environmental regulatory requirements. **Management measures – external**: • Leaseholder EMPs and development approvals – specific requirements specified by PPA and applicable to Dampier Supply Base	CAPL is a customer of Mermaid Marine Australia (MMA), which leases and operates the shore-based facility in the Port of Dampier (known as the Dampier Supply Base). The MMA Dampier Supply Base supports a range of operators and activities including, but not limited to, BHP and Quadrant. Activities at Dampier Supply Base are ongoing during Gorgon Operations. However, activities with the potential to affect marine environmental quality are already managed under frameworks that apply broadly to these multiuser facilities, and specifically to MMA's activities. Effective environmental management of CAPL's activities at MMA Dampier Supply Base within the Pilbara Ports is achieved in these ways: • Whole-of-port environmental management by the PPA – including ambient water and stormwater monitoring • Activity-, operator-, location-specific environmental requirements specified by the PPA, or individual Part IV and/or Part V EP Act requirements • Contractor-specific environmental management plans (EMPs) required by CAPL. Implementation of the PPA's EMP and EQMF is outside CAPL's influence, as is the implementation of MMA's Part V licence(s).
6.	Activities beyond Barrow Island Port area, not including supply bases	**Activity /Stressor**: • All marine-based activities resulting in inputs of toxicants e.g. shipping activities on transit routes **Potential Effect**: • Contamination of water and sediments **EV at risk**: • Ecosystem Health	**Management measures – regulatory**: • Discharges from marine vessels are to be in accordance with MARPOL requirements, as detailed in the SLWMP (Ref. 10). **Management measures – internal**: • Vessels chartered or operating on behalf of Gorgon Operations and/or its contractors comply with MARPOL, as per the ABU Offshore Cargo Handling Procedures (Ref. 15).	This Plan applies to 'any other areas of State Coastal Waters where there is potential for the Proposal to affect marine environmental quality' and requires spatially defined EVs, EQOs and LEPs (Condition 23A.2.I of MS 800). It is not reasonably practicable to spatially define EVs, EQOs, and monitor against EQC where the activities are sporadic, transient, and not persistent (i.e. where there is no ongoing Gorgon Gas Development operational presence). For this reason, activities in State Waters beyond the Barrow Island Port (and away from supply bases) are not monitored via this Plan. Regardless, the activities that could lead to effects on marine environmental quality are effectively managed by the nominated safeguards such that the risk to EQOs is negligible.
7.	Marine vessels	**Activity /Stressor**: Marine vessel movements supporting Gorgon operations activities – introduction of invasive marine species	**Management measures – regulatory**: The Barrow Island QMS (Ref. 50) manages the risk of affecting marine environmental quality from the introducing invasive marine species from vessels servicing the Gorgon Gas Development.	
8.	All marine facilities and activities	**Activity /Stressor**:	**Management measures – regulatory**: • Pipeline activity-specific Environment Plans / Oil Pollution Emergency Plans	There are limited options for managing and monitoring unplanned events once they have occurred (Ref. 6); the focus for such events is prevention, and ensuring appropriate response capability specific to the activity (see the Safeguards column). Although EQC have not been specified in this Plan for spill

Item	Marine Facility	Activity / Key Stressor, Potential Effect to Marine Environmental Quality, and EV at Risk	Safeguards	Comments / Justification
		Large spills or product releases resulting in contamination of water and sediments (and subsequent responses)	• MARPOL Annex 1 – Shipboard Oil Pollution Emergency Plans required for all vessels **Management measures – internal**: • CAPL's suite of emergency management documents • Management measures – external: State Emergency Management Plan for Marine Oil Pollution (WestPlan-MOP; Ref. 63)	scenarios, this Plan may be used to inform remediation completion criteria in the event of a spill, based on acceptable environmental conditions within the defined LEP areas. Monitoring related to spills are addressed in the ABU Operational and Scientific Monitoring Plan (Ref. 64). This Plan is adaptable to a wide range of scenarios and includes initiation criteria for different studies; post-spill, pre-impact monitoring is specified where feasible.
9.	Causeway / MOF	**Activity /Stressor**: Modification of coastal profile and subsequent effects	**Management measures – regulatory**: Management and monitoring of coastal processes are effectively addressed by the Coastal Stability Management and Monitoring Plan (Ref. 65) such that effects to marine environmental quality do not compromise the EQOs.	
10.	Wastewater deep well injection	**Activity /Stressor**: Deep well injection of liquid wastes	**Management measures – regulatory**: • Deep well injection of Gorgon Operations liquid wastes is managed as detailed in the SLWMP (Ref. 10), TSEPP (Ref. 54), and EP Act Part V Licence for the liquid waste facility. • Groundwater monitoring program would detect any unexpected migration of a liquid waste plume before it reaches the marine environment.	Where effluent and process water cannot be re-used on Barrow Island it may be disposed of via deep well injection via a facility dedicated to disposal of liquid wastes (Ref. 10). Wastes disposed of via this method have no migration pathway to the marine environment as the formation is geologically isolated and more than 1000 m below the land surface.
11.	Emergency fire pumps on LNG Jetty	**Activity /Stressor**: • Discharge of chlorinated sea water from the five emergency fire (water) pumps located on the LNG Jetty. **Potential Effect**: • Contamination of water resulting from increased toxicants in water **EV at risk**: • Ecosystem Health	**Management measures – regulatory**: Discharges to the marine environment is managed as detailed in SLWMP (Ref. 10). **Management measures – internal**: • Study of chlorine dosing to firewater pumps to control biofouling while maintaining ALARP environmental impact. • Operator procedures for adjusting dosing regimes.	Hypochlorite dosing of seawater fire pumps stilling wells is to be undertaken to ensure that pumps are always ready for use in the event of a serious fire at the GTP. Hypochlorite dosing is commonly used throughout the industry to control biofouling on permanently immersed marine structures, including high-volume discharges such as cooling water. A study was commissioned to ensure that the (unavoidable) dosing of firewater pumps was appropriate to control biofouling and was not excessive (ALARP). This included modelling the decay of hypochlorite within the closed system and degradation/dilution upon release to the environment. Effects on water quality and biota are likely to be minimal and limited to immediately around the discharge, because: • Daily release volumes and loads are extremely low compared to other industrial outfalls (e.g. cooling water systems, which have significantly higher loads) where limited chronic effects are recorded. • Release rates are very slow. • Initial plume is very thin and narrow. Likely to be mixed quickly through turbulent mixing. • Hypochlorite consumption (through oxidant demand) in the receiving environment is likely to be very high. Oxidants will be rapidly consumed. • Fire pumps are located in a non-sensitive area and released mid-water. Receptors are limited to planktonic/pelagic species in mid-water. Benthic habitats are unlikely to be exposed. • Mobile fauna (e.g. fish, adult turtles, mammals) are easily able to avoid the small plumes. Surface swimmers (e.g. turtle hatchlings) will not be exposed. • Dosing is to be adjusted based on observed rate of fouling and decay of hypochlorite.

Appendix C Narrative Decision Schemes for Environmental Quality Criteria

Narrative decision scheme for applying the EQC for toxicants in sediments

Blue text corresponds with decision scheme text in Figure 7-1.

1. ***Implement environmental quality monitoring program*** as per this Plan and the MEQMP Sampling and Analysis Plan (Ref. 43) and go to step 2.

2. ***Test against EQG A.*** Has the EQG A been met for each toxicant? Compare the median concentration of each toxicant against the EQG A value in Table 7-1 [high or moderate protection]). The median is calculated by pooling the data from analysis of composite samples within each discrete monitoring area:

[N] – go to step 4

[Y] – go to step 3

3. ***Test against EQG B***. Have the EQG B criteria for each toxicant been met at each site? Compare the composite sample from each site against the EQG B criteria:

[N] – go to step 6a or 6b depending on whether the exceedance relates to bioaccumulating/biomagnifying or non-bioaccumulating/non-biomagnifying toxicants

[Y] – no toxicity problem (if EQG A also met), go to step 1

4. For naturally occurring toxicants, determine whether the ***natural background contaminant concentration exceeds the EQG value*** (unlikely in most cases; note that test site and reference site should have comparable grain sizes):

[N] – ***EQG A triggered***; go to step 5, then go to step 8

[Y] – establish the 90th percentile of background concentration as the new EQG value then go to step 2

5. Have the EQG B criteria for each toxicant been met at each site? Compare the composite sample from each site against the EQG B criteria. (***Test against EQG B***):

[N] – go to step 6a or 6b depending on whether the exceedance relates to bioaccumulating/biomagnifying or non-bioaccumulating/non-biomagnifying toxicants

[Y] – no toxicity problem, go to step 1

The EQG is exceeded, triggering a more intensive investigation. Ambient quality is now monitored and assessed against the Environmental Quality Standard.

6a. If the exceedance relates to non-bioaccumulating or non-biomagnifying toxicants, does the bioavailable portion exceed the EQG value in Table 7-1?

[N] – no toxicity problem, go to step 1

[Y] – consult DWER and determine whether to characterise the area of potential contamination:

a. [N] – no toxicity problem, go to step 1

b. [Y] – go to step 7

6b. If the exceedance relates to bioaccumulating or biomagnifying toxicants (i.e. is the contaminant cadmium, mercury, anthracene, phenanthrene, benzo(a)pyrene, fluoranthene, total low molecular weight PAHs, total high molecular weight PAHs, total PAHs?), consult DWER and determine whether and what further action is required:

[N] – no toxicity problem, go to step 1

[Y] – go to step 7

7. Determine area of potential contamination at site/s where the composite sample failed the EQG B criteria. Requires non-routine targeted resampling. In consultation with DWER, design a sampling program for this area and test the median of pooled samples against EQG A. *Typically, this would involve sampling a perimeter of two concentric rings of 20 m and 50 m radius around the centre of the area of elevated contamination.* Go to step 2 (***Test against EQG A***).

8. Has the contaminant of concern been identified as having the potential to adversely bioaccumulate or biomagnify? (i.e. is the contaminant cadmium, mercury, anthracene, phenanthrene, benzo(a)pyrene, fluoranthene, total low molecular weight PAHs, total high molecular weight PAHs, total PAHs?):

[N] – go to step 9

[Y] – consult DWER and determine appropriate course of action.

9. Resolve bioavailable concentrations (as far as possible) for relevant contaminants and determine whether EQS A **and** B have been met for each toxicant (***EQS Test A and B Bioavailable measures***):

[N] – EQS has been exceeded – report and respond as per Section 10.

[Y] – environmental quality acceptable, go to step 1

Narrative decision scheme for applying the EQC for toxicants in marine water

Blue text corresponds with decision scheme text in Figure 7-2.

1. ***Implement environmental quality monitoring program*** as per this Plan and MEQMP Sampling and Analysis Plan (Ref. 43) and go to step 2.

2. ***Test against EQG A.*** Has the EQG A been met for each toxicant? Compare the 95th percentile of total toxicant concentrations in water from a defined sampling area to the relevant LEP (moderate and high) EQG values in Table 7-3:

   [N] – go to step 3

   [Y] – go to step 4

3. For naturally occurring chemicals, determine whether the ***natural background contaminant concentration exceeds the EQG value*** (unlikely in most cases; note that test site and reference site should have comparable grain sizes):

   [N] – ***EQG A triggered***; go to step 5

   [Y] – establish the 80th or 95th percentile (high and moderate, respectively) of background concentration as the new EQG value then go to step 2

4. ***Test against EQG B***. Has the EQG B criteria for TTM been met i.e. a TTM <1 calculated with total concentrations of key antifoulant constituents (copper, nickel, and zinc)?:

   [N] – go to step 5

   [Y] – no toxicity problem (if EQG A also met), go to step 1

The EQG is exceeded, triggering a more intensive investigation. Ambient water quality is now monitored and assessed against the Environmental Quality Standard.

5. ***Test against EQS A***. Has the EQS A been met for bioavailable concentrations of relevant toxicants? 95th percentile of bioavailable toxicant concentrations in water from a defined sampling area to the relevant LEP (moderate and high) EQG values in Table 7-3?:

   [Y/N] – go to step 6

6. ***Test against EQS B***. Has the EQS B criteria for TTM been met i.e. a TTM <1 calculated with bioavailable concentrations of key antifoulant constituents [copper, nickel and zinc]?

   [N] – go to step 7 (or consult DWER and determine appropriate course of action)

   [Y] – no toxicity problem, go to step 1

7. ***Test against EQS C***. Undertake DTA using relevant species and determine whether EQS C has been met:

   [N] – EQS has been exceeded – report and respond as per Section 10.

[Y] – no toxicity problem, go to step 1

Narrative decision scheme for applying the EQC for toxicants in biological (oyster) tissue

Blue text corresponds with decision scheme text in Figure 7-4.

1. ***Implement environmental quality monitoring program*** as per this Plan and MEQMP Sampling and Analysis Plan (Ref. 43) and go to step 2.

2. ***Test against EQG A.*** Has EQG A has been met for each toxicant? Compare the median concentration of each toxicant at each sampling site against the EQG A value in Table 7-7:

[N] – consult DWER and determine appropriate course of action. Consider management action to reduce the level of contamination below the EQG

[Y] – no toxicity problem, go to step 1

Appendix D Compliance Reporting Table

Section No.	Actions	Timing
7.1.1.1	Once routine sediment sampling is completed (Section 8.1), median concentration of toxicants in sediment is calculated by pooling data collected for each analyte within each ecological protection area (MEPA and HEPA) and facility (MOF and LNG Jetty) (i.e. EQG A; Table 7-1); the tug pen is designated as a separate defined area within the MOF MEPA for compliance assessments. If median concentrations within the defined sampling areas meet relevant guideline values listed in Table 7-1, then no further assessment is required until the next routine monitoring event, provided that the EQG B is also met. Total concentration of toxicants in sediment obtained at individual sampling sites (EQG B) are compared against guideline Values listed in Table 7-1. If individual sampling sites fail to meet relevant EQGs, then the contaminated area may need to be defined and characterised through additional sampling, in accordance with Appendix C. Monitoring data obtained from efforts to define the contaminated area are assessed against guideline Values defined in Table 7-1.	Upon receiving laboratory results from routine sediment sampling
7.1.1.2	If the criteria for EQG B is not met, then further assessment against the EQS tests for the relevant sampling area proceed following the narrative decision scheme in Appendix C and with reference to Figure 7-1, Table 7-1, and Table 7-2. Sites on the common MEPA/HEPA boundaries are assessed against the EQS for high ecological protection. This may require further field sampling. If monitoring shows EQS A/B have been met, then the environmental quality is deemed acceptable, no further investigation and assessment is required, and routine monitoring is to continue as per Section 8.1. However, separate to the requirements of this Plan, CAPL may choose to further investigate the cause of elevated contaminants and implement proactive management measures to prevent or minimise further accumulation of contaminants to levels that could result in biological effects.	Upon receiving laboratory results from routine sediment sampling
7.1.1.2	For bioaccumulating / biomagnifying toxicants, an exceedance of the EQG B criteria results in adaptive management response without further predefined tests against EQS.	Upon receiving laboratory results from routine sediment sampling
7.1.1.3	If monitoring shows that EQS A/B (or EQG B for bioaccumulating / biomagnifying toxicants) has been exceeded, then adaptive management action is triggered. For an exceedance of EQS A/B, reporting requirements under Conditions 23A.5.i and 23A.5.ii is also triggered (Section 10). If an exceedance of EQG B for bioaccumulating / biomagnifying toxicants occurs, reporting requirements and timing will be determined on a case-by-case basis, in consultation with DWER.	Upon exceeding EQS A/B, or EQG B for bioaccumulating / biomagnifying toxicants
7.1.2.1	Once all routine water sampling is completed for the year (Section 8.2), compliance against EQG A is determined by comparing the 95th percentile of total toxicant concentrations in water from a defined sampling area and year to the relevant LEP guideline in Table 7-3. The 95th percentile is calculated by pooling data collected from defined sampling areas within the MOF; sites adjacent to the MOF are separate to those in the tug pen (Section 8.2). In instances where there	Upon receiving laboratory results from all routine water sampling events within the year

Section No.	Actions	Timing
	are ≤20 samples from a defined sampling area the individual results of toxicant concentrations will be compared to the relevant LEP guideline. Sites on the common MEPA/HEPA boundary are assessed against the EQG for high ecological protection.. Compliance against EQG B is determined by calculating the total toxicity of the mixture (TTM) from the defined sampling areas adjacent to the MOF (all samples within the annual assessment period). If the TTM exceeds 1 using the TTM formula in Table 7-3, and includes the key antifoulant constituents (copper, nickel, and zinc), then bioavailable (i.e. filtered) concentrations of metals and metalloids are compared to EQS A and B[3] (Section 7.1.2.2). If EQG A and EQG B are met, then no further assessment is required until the next routine monitoring event.	
7.1.2.2	If the criteria for EQS A/B are not met, then assessment against EQS C for direct toxicity testing using relevant species may proceed following the narrative decision scheme in Appendix C and with reference to Figure 7-2. This may require further field sampling. If monitoring shows that criteria have been met for EQS B/C, then the environmental quality is deemed acceptable, no further investigation and assessment is required, and routine monitoring is to continue as per Section 8.2.	Upon receiving laboratory results from all routine water sampling events within the year
7.1.2.3	If monitoring shows that EQS C has been exceeded, then adaptive management action and reporting requirements under Conditions 23A.5.i and 23A.5.ii of MS 800 are triggered (Section 10).	Upon exceeding EQS C
7.1.3.1	Once routine monitoring is completed (Section 8.3), the median conductivity is calculated for each month and for each RO plant. Median concentrations are compared against the EQG A listed in Table 7-5. If EQG A is met, then no further assessment is required until the next month. If EQG A is not met, then the monitoring frequency is increased to daily for the following month (high-frequency monitoring). Retesting occurs at the end of the month by comparing the median conductivity for that month against EQG A. If the high-frequency monthly assessment meets the EQG A criterion, then routine monitoring resumes.	Upon completion of routine RO discharge monitoring for each month
7.1.3.2	If the criteria for EQG A are not met at the end of that high-frequency period, then daily monitoring of the discharge stream continues and assessment of receiving water quality against the EQS A criteria is initiated within one month (where practicable), as per Table 8-3.	If the criteria for EQG A are not met at the end of a high-frequency monitoring period
7.1.3.3	If monitoring shows that the EQS A is exceeded for any receiving water sampling event, then adaptive management action and reporting requirements under Conditions 23A.5.i and 23A.5.ii of MS 800 is triggered (Section 10).	Upon exceeding the EQS A for any receiving water sampling event
7.2.1.1	Once routine sampling is completed (Section 8.4), the median toxicant concentration at each site is compared against the EQG A values in Table 7-7. If the criteria for the EQG is met, then no further assessment is required until the next routine monitoring event.	Upon completion of routine biota monitoring
7.2.1.2	If monitoring shows that the EQG A has been exceeded, then adaptive management action is triggered. Reporting requirements resulting from an exceedance of EQG are	Upon exceeding the EQG A

[3] CAPL may initially assess bioavailable concentrations of metals (EQS)

Section No.	Actions	Timing
	determined on a case-by-case basis, in consultation with the DWER.	
8	CAPL will undertake monitoring according to the sampling requirements specified in Table 8-1 to Table 8-4	Variable for each monitoring program
Table 10-1	Exceedance of an EQS that requires management action will be reported to the CEO (of DWER, or a person approved by the CEO to receive the report) within two business days of CAPL receiving verified results confirming the exceedance.	Upon exceedance of an EQS that requires management action
10	Within one month of detecting a exceedance (via verified results), CAPL will prepare and submit an EQMR that details management action(s) to be implemented to rectify the cause of the exceedance, including time frames for implementation and reporting of performance, as determined by the Minister. CAPL will implement the agreed management action(s) in accordance with the EQMR.	Upon exceedance of an EQS that requires management action