Santos
GLNG

Operations Environmental Management Plan to Address Matters of National Environmental Significance and Environmental Authority Conditions for the LNG Facility and Marine Facilities

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1 INTRODUCTION

1.1 Background

Joint venture participants Santos, PETRONAS, Total and KOGAS are together developing their Queensland coal seam gas (CSG) resources in the Bowen and Surat Basins in the area between Roma and Emerald. These CSG resources and other gas purchased from third parties provides feed gas for the liquefied natural gas (LNG) liquefaction and export facility (LNG facility) on Curtis Island, near Gladstone, Queensland, owned by Santos GLNG Pty Ltd, PAPL (Downstream) Pty Limited, Total GLNG Australia and KGLNG Liquefaction Pty Ltd (together GLNG) and operated on their behalf by GLNG Operations Pty Ltd (GLNG OPL).

The operation of the LNG facility is authorised by Petroleum Facility Licence 10 (PFL 10).

The LNG facility is located within the Curtis Island Industry Precinct of the Gladstone State Development Area (GSDA) in the southwest section of Curtis Island. The facility meters, treats and liquefies the natural gas feedstock and stores and loads the resultant LNG onto LNG Carriers (LNGC) for export to global markets. Associated infrastructure to support the LNG facility includes a product loading facility (PLF), a materials offloading facility (MOF) and a haul road linking the MOF with the LNG facility. For the purpose of this document the PLF and MOF will be referred to as “associated marine facilities”. Refer to Figure 1-1 for the LNG facility and associated marine facilities site location.

Other components of the Project include mainland marine logistics facilities. These marine logistics facilities are used to access Curtis Island, and are mostly situated at Port Central and RG Tanna. Operation and environmental management of these mainland marine logistic facilities are not included within the scope of this Operations Environmental Management Plan (OEMP). Dredging has also been undertaken to facilitate LNGC access. These works are authorised by separate approvals and associated management plans held by Gladstone Ports Corporation (GPC), and fall outside the scope of this OEMP.

On 16 July 2007, the Coordinator-General declared the Project to be a ‘significant project’ for which an Environmental Impact Statement (EIS) is required under the *State Development and Public Works Organisation Act 1971* (SDPWO Act). On 31 March 2008, the Project was declared a ‘Controlled Action’ under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

During 2008 and 2009, an EIS and a Supplementary EIS (SEIS) were prepared for the Project under the State-Federal bilateral agreement. On 28 May 2010, the Coordinator General issued his report under the SDPWO Act. On 22 October 2010, the Project was granted federal approval under the EPBC Act, namely approvals EPBC No. 2008/4057 for the LNG facility on Curtis Island, and EPBC No. 2008/4058 for the associated marine facilities.

Construction of the LNG Facility commenced in April 2011, with production of LNG from the first train scheduled for the second half of 2015. Bechtel is the Principal Contractor appointed by GLNG for the engineering, procurement, construction and commissioning of the LNG facility and associated marine facilities on Curtis Island. A Construction Environmental Management Plan (CEMP) was developed and approved for the construction and commissioning of the LNG facility and associated marine facilities.

Bechtel will commission and operate the LNG Facility (Trains 1 and 2) until certification of practical completion. From practical completion of Train 1, operation of this train and associated utilities will pass to GLNG OPL. A similar process will occur for Train 2 in 2016. This OEMP and supporting management plans and procedures discussed herein will apply to the operations phase following practical completion of each respective Train, and upon assumption of Operator responsibilities by GLNG OPL.

1.2 Scope and Purpose of the OEMP

The scope of this OEMP applies to the normal operations of the LNG facility and associated marine facilities following completion of construction, commissioning and handover from Bechtel to GLNG. Environmental management of the facility during the construction and commissioning/start-up phases is conducted under the CEMP (Bechtel, 2014).

The OEMP has been prepared by GLNG to address the following conditions:

- Conditions 26 and 27 of approval EPBC No. 2008/4057 for the LNG facility on Curtis Island; and
- Conditions A9 and A10 of Environmental Authority EPPG00712213 (EA).

This OEMP applies to the Lots listed in Table 1-1.

Table 1-1. Real property descriptions for Petroleum Facility Licence (PFL) 10

Current Lot Descriptions	Description of Activities
Lot 1 on SP235007 Lot 4 on SP235007	LNG facility
Lot 1 on SP228184	PLF
Lot 4 on SP235936	Haul road
Lot 7 on SP239683	MOF

The objectives of the OEMP are to document the following:

- Details of operational activities;
- Environmental management roles and responsibilities;
- Evidence of practical and achievable plans to ensure that the Project's environmental requirements are complied with;
- An integrated plan for monitoring, assessing and controlling potential impacts;
- Evidence that the LNG facility and associated infrastructure development will be operated in an environmentally responsible manner.

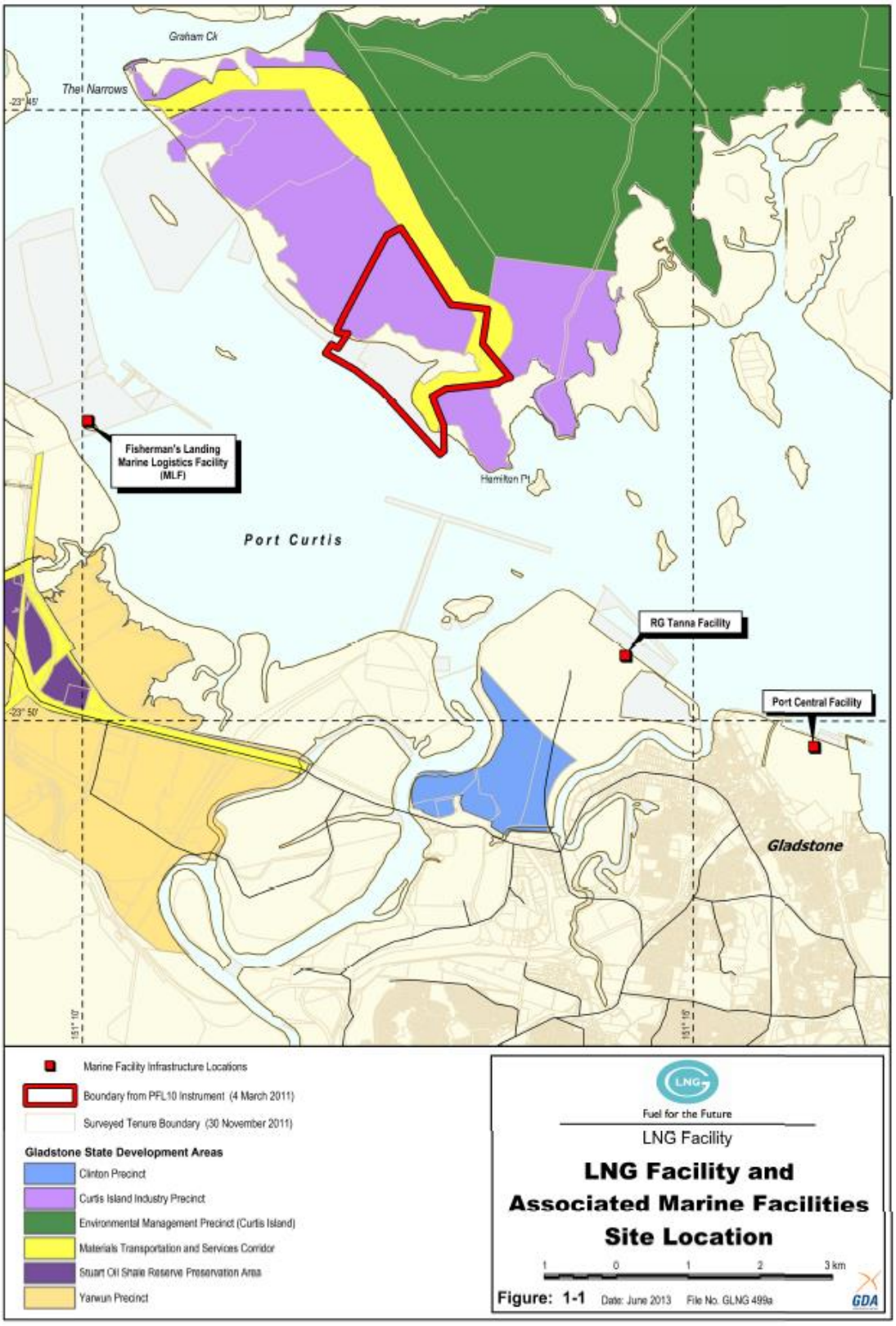

Figure 1-1. LNG Facility Locality Plan

1.2.1 Compliance with EPBC Referral No 2008/4057 Conditions

Cross-references to the relevant section(s) of this OEMP that address the relevant conditions from EPBC Referral No 2008/4057 are provided in Table 1-2.

Table 1-2. Compliance with EPBC Referral No 2008/4057 Conditions

Condition Number	Condition	Cross-Reference / Comment
26	Before commissioning the first LNG train, an Operational Environmental Management Plan (OEMP) must be prepared.	This OEMP covers the operation of the facility from Practical Completion of Train 1. Concurrent construction and commissioning of Train 2, up until Practical Completion of Train 2 in 2016, and decommissioning of temporary construction facilities are covered by the CEMP.
27	The OEMP must address the matters required to be included in the CEMP while incorporating changes and any additions the proponent believes are necessary to reflect the shift from construction phase to the operational phase. Requirements for the CEMP (under Condition 24) and applicable to the OEMP are as follows:	
	a) Plans showing the type and extent of the works;	Section 2 Figure 1-1
	b) Plans and maps showing discharge points and emission controls for operations stages;	Section 2 Figures 2-3 and 4-1
	c) an environmental monitoring and a sampling program which details baseline data collection and provides the basis for ongoing monitoring of specified parameters for the operational phase, including appropriate triggers for mitigation and cessation of works	Section 6
	d) any potential impacts or effects of the proposed works on the environment during the operational phase and the means by which adverse impacts will be avoided or mitigated;	Section 4
	e) details of the sewage treatment plant and desalination plant;	This section is not applicable to the OEMP as these facilities were only for construction purposes only. However, there is an Operations Water Treatment Plant and Oily Water Treatment Plant effluent from which discharges through WW1.
	f) details on plant, equipment or activities that — i) a description of the plant, equipment or activities;	Section 2, 4, 5 and 6

Condition Number	Condition		Cross-Reference / Comment
	involve emissions to the environment, including:	ii) design and operational performance information for plant, equipment or activities;	Section 2 Section 4
		iii) the potential for unforseen or accidental incidents and proposed responses to these incidents;	Sections 2.10 and 4; GLNG OPL Emergency Response Plan
	g) a detailed list of waste streams including their handling, treatment and disposal arrangements;		Section 5.1
	h) the environmental protection commitments proposed for the activities to protect the environmental values under best practice environmental management;		Sections 1.5, 4 and 5
	i) a rehabilitation program for land disturbed for construction of all infrastructure on Curtis Island;		Section 7
	j) details of a response plan, with appropriate triggers, which will be initiated in response to any significant impacts on the environment from the works		Section 4
	k) identification and characterisation of all wastes and emissions produced by the LNG Facility and its associated support infrastructure including its source, handling, treatment, disposal, or release to the environment.		Sections 4 and 5

1.2.2 Compliance with Environmental Authority EPPG00712213

Cross-references to the relevant section(s) of this OEMP that address the relevant conditions from the EA are provided in Table 1-3.

Table 1-3. Compliance with Environmental Authority EPPG00712213

Condition Number	Condition		Cross-Reference / Comment
A9	An Environmental Management Plan (EM plan) must be implemented that provides for the effective management of the actual and potential impacts resulting from the carrying out of the petroleum activities. Documentation relating to the EM plan must be kept.		This OEMP
A10	The EM plan required by condition (A9) must address, at least, the following:		
	(1) Describe each of the following:	(a) each relevant resource authority for the environmental authority;	Section 1.4

Condition Number	Condition		Cross-Reference / Comment
		(b) all relevant petroleum activities	Sections 1.8 and 2
		(c) the land on which the activities including associated accommodation and recreational activities are to be carried out	Section 1.2 Table 1-1
		(d) the environmental values likely to be affected by the activities including associated accommodation and recreational activities	Sections 3 and 4
		(e) the potential adverse and beneficial impacts of the activities including associated accommodation and recreational activities on the environmental values.	Section 4
	(2) State the environmental protection commitments the applicant proposes for the activities to protect or enhance the environmental values under best practice environmental management.		Section 1.5 and 4
	(3) Include a rehabilitation program for land proposed to be disturbed under each relevant resource authority for the application.		Section 7
	(4) State a proposed amount of financial assurance for the environmental authority as part of the rehabilitation program.		Section 7
	(5) Training staff in the awareness of environmental issues related to carrying out the petroleum activities, which must include at least:	(a) The environmental policy of the authority holder, so that all persons that carry out the petroleum activities are aware of all relevant commitments to environmental management.	Sections 1.5 and 1.9
		(b) Any relevant environmental objectives and targets, so that all staff are aware of the relevant performance objectives and can work towards these	Section 1.9
		(c) Control procedures to be implemented for routine operations for day to day activities including associated accommodation and recreational activities, to minimise the likelihood of environmental harm, however occasioned or caused	Sections 1.9 and 4
		(d) Contingency plans and emergency procedures to be implemented for non-routine situations to deal with foreseeable risks and hazards, including corrective responses to prevent and mitigate environmental harm (including any necessary site rehabilitation)	Section 4, GLNG OPL Emergency Response Plan
		(e) Organisational structure and responsibility to ensure that roles, responsibilities and authorities are appropriately defined to ensure effective management of environmental issues	Section 1.6

Condition Number	Condition		Cross-Reference / Comment
		(f) Effective communication procedures to ensure two-way communication on environmental matters between operational staff and higher management	Sections 1.6 and 1.9
		(g) Obligations with respect to monitoring, notification and record keeping obligations under the EM plan and relevant approvals	Sections 1.7, 1.10, 4 and 6.6
		(h) Monitoring of the release of contaminants into the environment including procedures, methods and record keeping.	Section 6
	(6) The conduct of periodic reviews of environmental performance and procedures adopted, not less frequently than annually		Section 1.10
	(7) A program for continuous improvement.		Section 1.11

This OEMP and supporting documents referenced in Section 1.3 provide strategies to be employed for environmental management of LNG facility operations. This OEMP will be a dynamic document, reviewed regularly and revised to reflect Project changes and new developments that may occur over the life of the Project.

1.3 Supporting Documentation

A number of studies and management plans have been prepared as a requirement of both State and Federal approval conditions with most required to be publically available including those listed in Table 1-4.

Table 1-4. Supporting Documentation

Plan Name	Web Address	Requirement / Comments
Environmental Impact Statement	http://www.santosglng.com	The EIS report was approved by the Coordinator- General (CG) for release for public and advisory agency comment from 20 June to 17 August 2009.
Supplementary Environmental Impact Statement	http://www.santosglng.com	The SEIS was delivered to the Department of Infrastructure and Planning (DIP) on 20 November 2009.
Construction Environmental Management Plan	http://www.santosglng.com	Condition 23, 24 and 25 (EPBC No. 2008/4057) Condition 11 and 12 (EPBC No. 2008/4058)
Migratory Shorebird Management Plan	http://www.santosglng.com	Condition 19 and 20 (EPBC No. 2008/4058)
GLNG Curtis Island Facility: Water Mouse Survey and Habitat Assessment	http://www.santosglng.com	Condition 32 and 33 (EPBC No. 2008/4057) Condition 17 and 18 (EPBC No. 2008/4058)

Plan Name	Web Address	Requirement / Comments
Shipping Activity Management Plan	http://www.santosglng.com	Condition 13, 14, 15 and 16 (EPBC No. 2008/4058)
GLNG LNG Facility Pre-clearance survey for EPBC-Listed Fauna and Flora Species, Migratory Species and Ecological Communities	http://www.santosglng.com	Condition 20, 21 and 22 (EPBC No. 2008/4057)
Long Term Turtle Management Plan	http://www.santosglng.com	Conditions 34, 35 and 36 (EPBC No. 2008/4057)
Biosecurity Management Plan and Quarantine Area Operations Manual	http://www.santosglng.com	Condition 30 and 31 (EPBC No. 2008/4057)

1.4 Planning and Environmental Approvals

Planning and approvals for the LNG facility operations are identified below in Table 1-4.

Table 1-5. Other Planning and Supporting Documentation

Other Approvals
Environmental Authority EPPG00712213 issued by DEHP under Section 242 of the *Environmental Protection Act 1994* (current version issued on 8 April 2015).
EPBC Approval 2008/4057 for the LNG Facility approved by DSEWPC (now DoTE) on 22 October 2010 under Sections 130(1) and 133 of the *Environment Protection and Biodiversity Conservation Act 1999*
EPBC Approval 2008/4058 for the Marine Facilities approved by DSEWPC (now DoTE) on 22 October 2010 under Sections 130(1) and 133 of the *Environment Protection and Biodiversity Conservation Act 1999*.
Coordinator General Report (Evaluation Report for Environmental Impact Statement – Gladstone Liquefied Gas Project), Approval Conditions, Appendix 4 – LNG Facility, May 2010.
Petroleum facilities Licence (PFL) 10 granted on 4 March 2011 by the Department of natural resources and Mines (DNRM) under Section 446(1) of the *Petroleum and Gas (Production and Safety) Act 2004*
A Material Change of Use (MCU) for the LNG facility plus other ancillary uses and associated infrastructure within the GSDA from the Department of State Development, Infrastructure and Planning on 14 March 2011 (MCH2011/009 which replaced MCU2011/009).
Development Approval No. 2011DB0082 approved on 8 April 2011 by the Department of Agriculture, Fisheries and Forestry (DAFF) under Section 376 of the *Sustainable Planning Act 2009* for Operational Works involving the removal, destruction or damage of marine plants associated with the construction of a Materials Offloading facility (MOF) (including dredging works), the Pioneer MOF and Haul Road.
Development Approval No. DA/603/2012 approved by Gladstone Regional Council on 24 July 2012 under Sections 334 and 335 of the *Sustainable Planning Act 2009* for prescribed tidal works involving removal, destruction or damage of marine plants for the Product Loading Facility (PLF).
Development Approval No. DA/634/2012 approved by Gladstone Regional Council on 05 July 2012 under Sections 334 and 335 of the Sustainable Planning Act 2009 for prescribed tidal works involving removal, destruction or damage of marine plants for the Area 15 Shore Protection Works.
Development Approval No. DA/264/2011 (Permissible Change) approved by Gladstone Regional Council on 14 May 2014 under Sections 334 and 335 of the *Sustainable Planning Act 2009* for prescribed tidal works for the MOF.
Development Approval No. DA/258/2010 approved by Gladstone Regional Council on 14 May 2014 under Sections 334 and 335 of the *Sustainable Planning Act 2009* for prescribed tidal works the temporary Pioneer Barge Ramp Facility.

Other Approvals
Major Hazard Facility Licence Number 10029) under the Queensland *Work Health and Safety Regulation 2011* (the WHS Regulation) granted by Workplace Health and Safety Queensland (WHSQ) on 2nd September, 2013 following submission of a 'Safety Case" earlier in 2013.

1.5 Environmental Policy

Operation of the LNG facvilitywill conform to the GLNG OPL Environmental Policy shown in Figure 1-2.

Santos
GLNG

Environmental Policy

Santos
GLNG Project

Our Environmental Vision

"We will continuously seek to find new ways to minimise our environmental impact across the lifecycle of our activities"

At GLNG Operations Limited (OPL) we adopt the principles of sustainable development. We recognise our responsibility to meet community expectations and we are committed to the continuous improvement of our environmental performance. We believe that environmental stewardship is both a management obligation and the responsibility of every individual.

To achieve this we will:

- Comply with and continuously improve the Environment, Health and Safety Management System (EHSMS) across the business.
- Proactively identify environmental hazards, assess their risk and eliminate or, if not possible, manage the risk to as low as reasonably practicable.
- Establish annual environmental objectives and targets, implement programs to achieve them, and review and report on environmental performance against those objectives and targets.
- As a minimum comply with relevant legal and other requirements.
- Ensure that we have the resources and skills necessary to achieve our environmental commitments.
- Include environmental performance in the appraisal of workers' performance.
- Implement strategies to minimise pollution, manage waste, use water and energy efficiently, and address relevant biodiversity issues.
- Formally monitor, audit, review and report annually on our environmental performance and EHSMS requirements against defined objectives.
- Require that companies providing contract services to GLNG implement environmental policies, systems and procedures in line with this policy.
- Positively influence the environmental performance of Joint Venture activities operated by others.

Rod Duke | *CEO – GLNG Operations Pty Ltd. (GLNG OPL)*

Figure 1-2. GLNG Environmental Policy

1.6 Roles and Responsibilities

GLNG OPL will have day to day responsibility for ensuring that this OEMP is implemented. The assignment of roles, responsibilities and accountability will be in accordance with the Santos Environment Health and Safety Management System (EHSMS).

GLNG OPL staff and contractors will be responsible for implementing the OEMP in a manner that complies with all relevant environmental standards, adheres to all legislative requirements, and ensures that all environmental objectives associated with the work are achieved.

All staff will be responsible for the environmental performance of their activities and for complying with the General Environmental Duty as outlined in the E*nvironmental Protection Act 1994*. Section 319 (1) of the *Environmental Protection Act 1994 states that 'a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to minimise the harm*'. Specific environmental responsibilities are detailed in Table 1-6.

Table 1-6. Roles and Responsibilities for the LNG facility and Associated Infrastructure

Role	Description
General Manager, Downstream Operations	The General Manager, Downstream Operations is responsible for the standard of management, including environmental management and communications to GLNG compliance management teams and project stakeholders. To assist in fulfilling this responsibility, the General Manager, Downstream Operations is supported by a number of specialised personnel.
Plant Manager	The Plant Manager is responsible for all operations activities, including planning, procedures approvals, and execution of works. The Plant Manager is responsible for ensuring adequate provision is made for compliance activities, and will direct work in a manner that complies with all relevant environmental procedures, adheres to legislative requirements, permits and approvals, and ensures that all environmental objectives associated with the project are achieved.
EHSS&T Manager	The EHSS&T Manager is responsible for ensuring compliance with environmental regulations, permits, licenses and approvals, and compliance with this OEMP. The EHSS&T Manager will coordinate and conduct training of personnel including Site Inductions and awareness training on environmental compliance and implementation of this OEMP; communicate incidences and non-compliances to the management team, and will initiate and participate in environmental incident investigations, and implement corrective actions in conjunction with the Senior Environmental Advisor.
Senior Environmental Advisor	The Senior Environmental Advisor is responsible for ensuring environmental monitoring and reporting are completed in accordance with this OEMP, applicable regulations, permits, licenses and approvals. The Senior Environmental Advisor is also responsible for implementation of programs for the continual measurement of the environmental performance of personnel and equipment, management of incidents and complaints, and implementation of programs for auditing, incidents and complaints management, implementation of corrective actions, and ensuring this OEMP and environmental plans are implemented and updated to ensure compliance with applicable environmental regulations, permits and approvals.
Marine and Stakeholder Manager	The Marine Manager is responsible for port and marine operations and ensuring compliance with the applicable legislation and regulations, permits, licenses and other approvals.

Role	Description
Downstream Operations Team Members	Follow management measures outlined in the OEMP. Report environmental incidents and complete any assigned preventative and corrective actions utilising the EHS Toolbox - Incident Management System (IMS). Undertaken any assigned inspections and actions utilising the Audit and Inspection Manager (AIM).

1.7 Emergencies, Incidents and Complaints

Regulatory agencies will be notified of any reportable environmental incident or non-conformance with statutory approvals in accordance with the relevant legislation and notification requirements of each approval.

1.7.1 Federal

GLNG OPL will report any non-compliance with any condition of EPBC Referral No 2008/4057 and remedial action in writing to the Department of the Environment (DoTE) within five (5) business days after first becoming aware of a non-compliance (condition 63(a)) and bring the matter into compliance within a reasonable timeframe agreed to, in writing by the Commonwealth (condition 63(b)) in accordance with the requirements of the approval conditions of EPBC 2008/4057.

1.7.2 State

GLNG OPL will notify DEHP after becoming aware of environmental harm or unauthorised release of contaminants and provide a report to DEHP detailing the incident or emergency in accordance with notification procedures and timeframes detailed in Schedule K of EA EPPG00712213.

1.8 Notifiable Activities

Notifiable activities listed under Schedule 3 of the *Environmental Protection Act 1994* (EP Act) relevant to operation of the LNG facility are as follows:

- 1 Abrasive blasting (may be required during maintenance shutdowns or overhauls)
- 7 Chemical Storage
- 29 Petroleum Product Storage

1.9 Training and Awareness (including the Environmental Code of Conduct)

All GLNG OPL personnel, contractors, their subcontractors and visitors will be required to undertake appropriate environmental training and induction programs. The training will incorporate all aspects required under Condition A10 of the EA and includes training on the Environmental Code of Conduct, which includes in subject the matters set out in Conditions 3 to 6 of EPBC No 2008/4057.

All managers and supervisors will be responsible for ensuring that personnel under their control have the requisite competencies, skills and training to carry out their assigned tasks in accordance with the requirements of the OEMP. They will also be responsible for identifying any additional training and competency requirements.

All GLNG OPL personnel, contractors, their subcontractors and visitors will complete a comprehensive project induction. The induction will include a comprehensive review of environmental requirements and standards, safety, access protocols and the Environmental Code of Conduct. The induction will include, at a minimum, information on the following:

- Description of the Curtis Island Environmental Management Precinct;
- Explanation of the environmental values of the World Heritage Area;
- Information on listed species and ecological communities and other native species that are found around the project site; and
- Explanation of the Rodds Bay Dugong Protection Area, and Great Barrier Reef Marine Park, Rodds Peninsula and the Capricorn Bunker group.

The Induction will confirm that no private motor vehicles or private watercraft are brought onto the Site or into waters within 100 metres of the Site boundary on Curtis Island as stated in the EPBC Approval for the facility. It also prohibits employees and visitors bringing animals and plants to site or onto Curtis Island and prohibits entry into the Curtis Island Environmental Management Precinct without authorisation.

All team leaders, superintendents and managers will have additional detailed training on the use and implementation of the OEMP.

All managers and supervisors will hold regular toolbox meetings with personnel to discuss issues associated with their scheduled work. This will include highlighting and discussing relevant environmental issues.

1.10 Auditing and Reporting

During operation activities, compliance audits will be conducted in accordance with the requirements of this OEMP as well as operations procedures, relevant legislation, licence and permit conditions and industry standards. To ensure appropriate stakeholders are adequately informed of relevant Environmental, Health and Safety (EHS) performance, reports (where necessary) will be prepared for internal and stakeholder review.

All inspection and audit reports of environmental performance will be stored in an electronic database that is used to enable corrective actions identified during the inspection/auditing process to be recorded, tracked and closed out. The information will be made available to the relevant regulatory authorities as required.

In addition to the monitoring and reporting requirements documented in the relevant sections of this OEMP, the following auditing regime will be implemented:

- During the operational phase of the LNG facility and associated infrastructure, internal audits of environmental compliance against statutory approvals will be undertaken on a regular basis.
- Third party audits will also be conducted as required under the EA or other approvals as part of the audit program developed for the LNG Facility.

Any environmental incident, hazard, near miss, non-conformance or third party complaint will be managed in accordance with this OEMP and recorded in the Incident Management System (IMS), an electronic notification and recording system. All non-conformances lodged are tracked and actioned by nominated personnel, which includes the investigation and implementation of corrective action where required.

Regulatory agencies will be notified of any reportable environmental incident or non-conformance with statutory approvals in accordance with notification requirements of each approval.

Relevant records supporting inspections and audits (in addition to monitoring and other critical aspects of the management system) will be generated and maintained. GLNG will report annually to the administering authorities as required by applicable approvals or statute. Condition 67 of EPBC Approval No 2008/4057, for example, requires that GLNG produce an Annual Environmental Return to address, amongst other things, compliance with the approval conditions and impacts on Matters of National Environmental Significance (MNES).

1.11 Review and Improvement

In addition to the monitoring and auditing of environmental performance discussed in Section 1.10, periodic review (not less than annually) of management plans and procedures will be conducted to assess the effectiveness of the programs and identify any changes required and aspects that may be improved. Based on the review, plans and procedures will be updated as appropriate to optimise operations and achievement of environmental performance objectives.

2 PROJECT DESCRIPTION

2.1 Overview

The LNG Facility comprises a LNG production and export facility located on Curtis Island, near Gladstone QLD and includes associated utilities and supporting infrastructure. The facility accepts gas feedstock from a network of upstream production fields in the Bowen and Surat Basins of Queensland and third parties via an approximately 420 kilometre Gas Transmission Pipeline (GTP). The facility meters, treats and liquefies the gas feedstock and stores and loads the resultant LNG onto LNG Carriers (LNGCs) for export to global markets.

At design capacity, the facility produces approximately 7.8 million metric tonnes per annum (Mtpa) of LNG via two liquefaction trains. With a single LNG train in operation, the LNG facility will load approximately one LNGC every five to seven days. With a second train operational (normal operations), an LNGC will be loaded approximately every two to three days.

The facility is planned to operate 24 hours per day, 365 days per year. Planned shutdowns for maintenance may occur in conjunction with upstream production outages or scheduled inspections undertaken for regulatory compliance. The on-site population during operations will be approximately 120 persons comprising management, administration, engineering, operations, maintenance, security and support services personnel. The battery limits of the LNG facility are from the GTP isolation valve (upstream limit) on the northern site boundary to the manifold of LNGC (downstream limit) berthed at the Product Loading Facility (PLF). The facility layout and boundaries are shown on attached Figure 1-1.

The facility operations and control systems are summarised below. The environmental setting of the LNG facility, environmental management and monitoring activities applicable to LNG facility's operations, and decommissioning and rehabilitation plans and requirements are discussed in subsequent sections of this OEMP.

2.2 LNG Process Description

The facility process employs ConocoPhillips (CoP) Optimized Cascade® liquefaction technology in a two-train-in-one configuration. Both trains have a design capacity of 3.9 Mtpa each at an ambient temperature of 27°C. At lower ambient temperatures, the facility will have additional capacity. The trains are independent and are capable of a complete shutdown for a maintenance turnaround and in-service inspection without impacting upon the other train.

As the gas feedstock supplied to the process is composed almost entirely of methane, the facility excludes the liquids removal or fractionation units typical of plants that treat a ‘rich’ feed gas stream containing higher amounts of hydrocarbons heavier than methane.

The CoP Optimized Cascade Process is shown schematically in Figure 2-1. Note that for simplicity, only a single Train and LNG storage tank are shown.

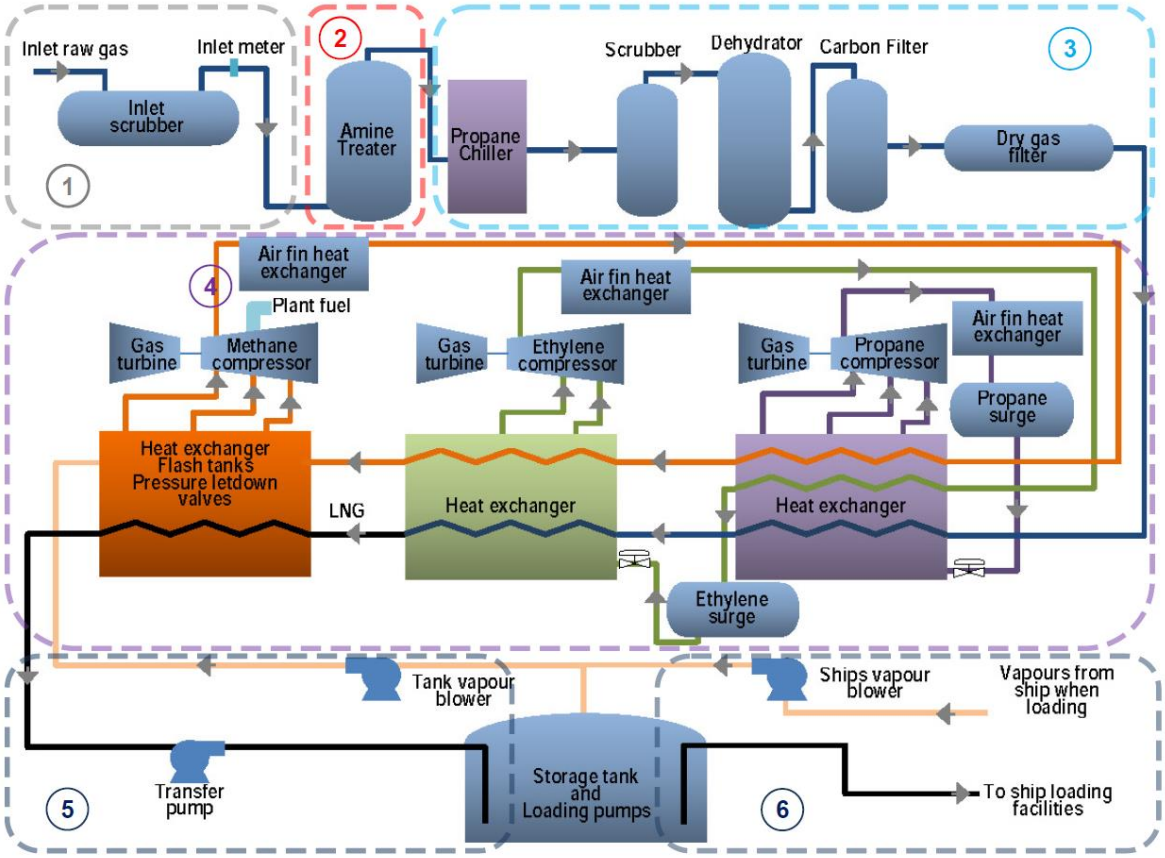

Figure 2-1. Schematic of ConocoPhillips Optimised Cascade LNG Process

An overview of the Optimized Cascade LNG Process stages corresponding to those shown above is set out in Table 2-1.

Table 2-1. Overview of the Optimised Cascade Process

Process Stage	Process Description
Feed Gas Arrival (outside the facility's battery limits)	Although not part of the GLNG Facility, the feed gas arrival narrative has been included here for completeness. Inlet gas arrives at the facility via the GTP, typically at 22°C. The expected normal feed pressure at the plant inlet is 6.5 megapascals gauge (MPag). The facility can be isolated from the pipeline (and hence, the upstream gas fields) by an emergency isolation valve. A Pig Receiver is provided upstream of the GTP/facility interface for receipt of maintenance/inspection pigs from the GTP.
1. Feed Gas Conditioning and Metering	This initial process stage removes liquid slugs, followed by solid particles and sized liquid droplets to avoid damage to or plugging of the control valves at the plant inlet. The feed gas is pre-heated as required to compensate for Joule-Thomson cooling effects, optimise carbon dioxide (CO_2) removal and prevent hydrate formation, and is then passed through a pressure control station and a feed gas metering package.

Process Stage	Process Description
2. Acid Gas Removal and Amine Regeneration	To avoid issues in the downstream liquefaction processes caused by the presence of the naturally occurring feed gas contaminants, CO_2 and traces of hydrogen sulphide (H_2S) (known as 'acid gases', both are corrosive to carbon steel, freeze out during feed gas liquefaction and reduce the calorific value of the exported LNG), the feed gas is treated to remove the acid gases (known as 'sweetening'). The acid gases are removed from the feed gas stream by contact with an aqueous amine solvent that binds and removes the contaminants. The solvent is fed into the top of a counter-current flow absorption column and flows downwards, absorbing the acid gases from the feed gas which is fed into and rises from the bottom of the column. The 'sweetened' feed gas exits the top of the column and is directed to further treatment while the solvent containing absorbed acid gases is regenerated by stripping of the acid gases and recirculated to repeat the absorption cycle.
3. Feed Gas Dehydration and Mercury Removal	The now 'sweetened' feed gas is saturated with water from contacting the aqueous amine and requires drying to remove water vapour that could freeze in the cryogenic sections of the downstream liquefaction trains. The feed gas is first chilled to just above the hydrate formation temperature to facilitate bulk water dropout and filtered to remove micron sized liquid and solid particles, then passed through water adsorbing molecular sieves, further reducing the water content in the feed gas to less than 0.05 parts per million (volume). After drying, the feed gas is passed through mercury removal beds which contain a mercury adsorbing material, to ensure the concentration of Mercury in the feed gas entering the downstream process is maintained below design limits of less than 10 nanograms per standard cubic metre (ng/Sm^3). This process is necessary as Mercury can corrode aluminium equipment in the downstream process and is included in the facility as a precautionary measure.
4. Feed Gas Liquefaction and Nitrogen Removal	Following dehydration and mercury removal, the treated, dried feed gas is passed through successive stages of refrigeration in which the temperature of the feed gas is progressively lowered to its dewpoint through heat exchange with refrigerants and depressurisation. Three refrigeration circuits are used, each employing two gas-turbine driven compressors arranged in parallel to compress the refrigerants: • Propane refrigeration circuit: chills the feed gas prior to liquefaction, condenses the ethylene refrigerant compressor discharge and de-superheats the methane refrigerant compressor discharge. • Ethylene refrigeration and liquefaction circuit: further chills and condenses the feed gas flowing from the propane refrigerant circuit and condenses the methane refrigerant compressor discharge. • Methane refrigeration and liquefaction circuit: flashes the condensed feed gas from the ethylene refrigerant circuit to lower pressures with the liquid from the last stage sent to LNG storage tanks. Nitrogen gas (N2) is rejected to atmosphere as part of the liquefaction process to meet both LNG export and fuel gas specifications. Additional process information on the refrigeration and liquefaction circuits and nitrogen rejection is deemed proprietary and confidential and therefore not included here.

Process Stage	Process Description
5. LNG Storage	Following liquefaction, the LNG product from both trains is stored in two, 140 000 m^3 LNG Storage Tanks which maintain LNG at cryogenic temperature (-162°C) via auto-refrigeration and at slightly above atmospheric pressure (5 kPag). The tanks are equipped with level gauging and level transmitters to prevent overfilling, pressure relief valves for overpressure protection, vents, temperature elements and other basic instrumentation as well as lightning protection. The tanks are equipped with external fire suppression measures including dry chemical extinguishing and fixed nitrogen snuffing systems at relief valve vents as well as flammable gas, fire and low temperature detectors provided on top of the tanks. The LNG storage tanks are a full-containment type comprising a nine percent nickel steel inner container and a prestressed-concrete outer container with a carbon steel lining. The inner nickel steel tank provides liquid containment and prevents ingress of LNG into the space between the inner and outer containers. The inner container is an open top design designed to hold the working capacity of 140 000 m^3. The inner tank is covered by a suspended deck supported from the outer tank roof designed to allow circulation of vapour between the inner and outer containers while preventing passage of thermal insulation material (Perlite) into the inner container. All liquid and vapour connections to the LNG tanks pass through the domed roof of the outer tank and suspended deck. There are no penetrations of the inner tank. The concrete outer tank container is a self-supporting structure designed for vapour containment and to hold the thermal insulation material that fills the space between the inner and outer containers. In the event of an inner tank leak, the outer container is designed to safely contain the gross LNG volume without leakage or uncontrolled release of vapour. An indicative illustration of a typical double-container LNG storage tank (described above) is provided below as Figure 2-1.

Process Stage	Process Description
6. LNG Loading	The LNG product is transferred by submersible pumps in the storage tanks through loading arms arrayed at the PLF and onto a LNGC. With a single train in operation, LNG off-takes occur approximately every five to seven days. With a second train in operation, LNGC loading occurs approximately every two to three days. LNG is pumped from the storage tanks through a 750 millimetre (nominal diameter) loading line to the LNG Loading Arms via eight column-mounted, submersible LNG Loading Pumps (four per tank) with a nominal combined pump capacity (in parallel) of 10 000 m^3/h. When ship loading is not occurring, the LNG loading line is maintained full of LNG and around the same temperature as the tank liquid via a LNG cool down line that delivers a slipstream of LNG from the LNG transfer pumps. The slipstream is fed into the loading line at the loading jetty and flows in the reverse direction up the loading line back to the LNG storage tanks. The Loading/Vapour Return Arms are capable of both ship loading and vapour return. Only two loading arms and one loading/vapour return arm in operation are necessary for uninterrupted loading. An LNG drain sump is provided at the PLF to recover liquid from the loading arms at cessation of loading operations. Collected LNG vaporises in the sump and is returned to the LNG storage tanks via the vapour return line. A 16 metre (width) by 18.5 metre (length) by 0.3 metre (depth) containment curb has been provided around the LNG Loading Arms to collect LNG from a potential release/spill. The curb slopes away to the rear of the loading arms to two separate drain locations, equipped with cryogenic detectors. Any release detected by two detectors will automatically initiate a shutdown of ship loading. The PLF is designed to handle LNGCs of both spherical and membrane containments, with a range of ship sizes and LNG capacities. LNGCs between 125,000 to 220,000 m^3 capacity range ('target ships') can be accommodated at the PLF.

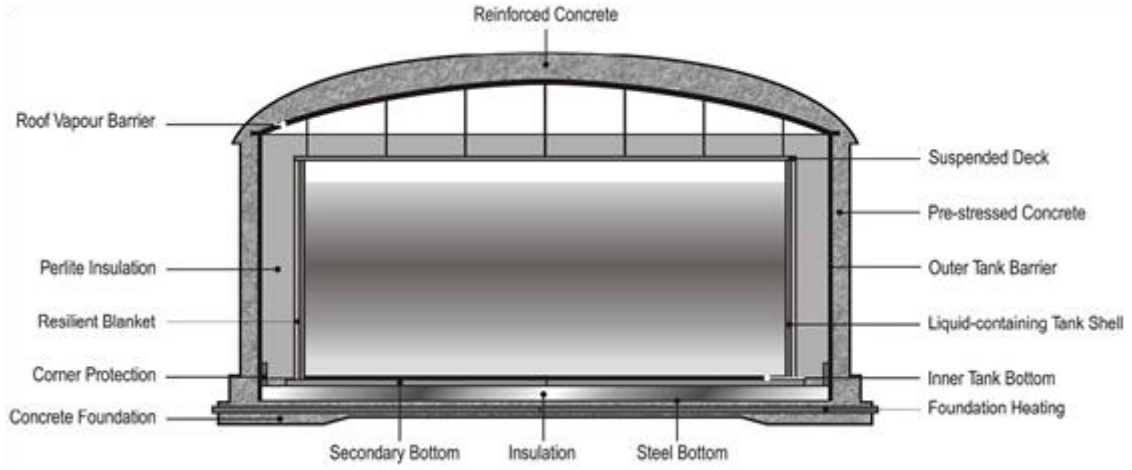

Figure 2-2. Typical LNG Full Containment Tank Configuration

2.3 Process Support Systems

Details are provided below on a number of process support systems that can impact/influence environmental management at the facility.

2.3.1 Flare/Vent System

The Flare/Vent System is designed to allow safe disposal of hydrocarbon streams and venting of waste gases. The Flare/Vent System comprises five separate stacks:

- **Wet Gas Flare**: designed to handle hydrocarbon streams saturated with water vapour and/or free liquid hydrocarbons or free liquid water as well as handling warm blowdown.
- **Dry Gas Flare**: designed to handle dry cryogenic hydrocarbons streams (vapour and liquid) and cold blowdown.
- **Wet/Dry Flare**: designed as a spare hybrid flare stack to handle streams from either the wet gas or dry gas flare systems; normally on standby and placed in service during maintenance of the wet or dry gas flare stacks.
- **Marine/Storage Flare**: designed to handle vapour from the LNG storage tanks and LNGC vapour return during loading operations in the event the boil-off gas compressors fail or the capacity of the compressors is exceeded.
- **Waste Gas Vent Stack**: designed to vent CO_2 generated at the CO_2 Absorber and N_2 from the Nitrogen Removal System; each train has a dedicated Waste Gas Vent Stack and associated Waste Gas Knockout Drum.

The flare systems include knockout drums (except the Marine/Storage Flare) to separate liquids from vapours before they are routed to the flare stacks. Liquids from the Wet Gas Flare are separated in the Wet Gas Flare Knockout Drum and pumped via Wet Gas Flare Knockout Drum Pump to a waste water tank for disposal.

The wet gas, dry gas flare stacks and spare wet/dry flare stacks are located side by side on the northern side of the facility at a safe exclusion zone from the main section of the plant and have independent, dedicated flame-front generators, aircraft warning beacons, junction boxes and derrick support structure. The Marine/Storage Flare is located near the LNG storage area. Each flare stack is equipped with pilots and electronic ignition systems and is smokeless during normal operations.

2.3.2 Refrigerant Storage System

The Refrigerant Storage System is provided to allow periodic make-up to the refrigerant circuits and refrigerant de-inventory (storage) from the process during maintenance of the trains. Storage for the methane refrigerant is not required as methane make-up is provided from the feed gas stream following treatment.

Ethylene is stored in three Ethylene Storage Drums which are horizontal double-wall, vacuum jacketed (Perlite) pressurised drums with a capacity of 267 m^3 (working volume of 225 m^3 each). Ethylene is loaded into the storage drums from ISO-containers and can also be loaded directly from the ISO-containers into the ethylene refrigeration circuit.

Propane is stored at ambient temperature in three Propane Storage Drums which are horizontal, pressurised drums with a capacity of 537 m^3 (working capacity of 461 m^3). Propane is loaded into the drums directly from ISO-containers via a manually operated, electrically-driven Propane Unloading Pump. An equalisation line between the container and the storage drums is provided. Excess vapour is vented under pressure control to the Dry Flare System.

The propane and ethylene storage drums are located within a paved area sloped to direct spills away from the vessels.

2.3.3 Diesel Fuel Storage

Diesel fuel is stored on-site to maintain a buffer supply for diesel end users. Diesel fuel is brought in tanker trucks and offloaded to the Diesel Storage Tank through a Diesel Filter by a dual-mode (pump in/pump out) Diesel Transfer Pump. The storage tank is an atmospheric tank with a capacity of 99 m^3 (working capacity of 68 m^3). Diesel fuel is transferred as required from the storage tank by the Diesel Fuel Transfer Pump to day tanks for the Diesel Firewater Pump Package, the Emergency Air Compressor Package and the three standby Diesel Generators that provide emergency power.

2.3.4 Water System

Potable water, service water, firewater and process water demand at the facility is met by potable water supplied via pipeline from the Gladstone Area Water Board, supplemented by water condensed during turbine inlet air chilling. When available, supply from the Turbine Inlet Air Chilling System (TIAC) will supplement supply from the Gladstone Area Water Board.

Water from the Gladstone Area Water Board pipeline and condensed water is stored in a Raw Water Surge Tank and then pumped to a Pre-Treatment System designed to remove colloidal and suspended solids. The system consists of filters and chemical injection units supplied from chemical tote tanks. Water from the Pre-Treatment System is pumped to a Demineraliser Package and a Chlorinator/Remineraliser Package.

The Demineraliser Package consists of a reverse osmosis/electro-deionisation (RO/ED) system that uses high pressure pumps and semi-permeable membranes to remove dissolved salts from the pre-treated water. One RO unit is provided as standby to facilitate cleaning and membrane replacement of the duty unit. A chemical cleaning system is provided for cleaning of membranes in place. The RO permeate is then passed through an electro-deionisation process to remove additional dissolved solids and the resulting demineralised water is stored in a demineralised water storage tank before being sent to end users. Demineralised water is used as make-up and wash water in the Acid Gas Removal System and as gas turbine blade wash water.

The Chlorinator/Remineraliser Package re-mineralises and treats demineralised water from the RO/ED package with sodium hypochlorite to produce potable water. The potable water is stored in a tank sized to meet 24 hours service at average daily flow. Waste streams (RO concentrate (ROC or brine) and blowdown) from the water pre-treatment package and demineraliser package are pumped to a seawater outfall (WWI diffuser). The RO

membranes are cleaned using a chemical cleaning solution and then thoroughly rinsed with clean water. The cleaning solution and rinse water generated by RO membrane cleaning is contained and disposed of off-site.

2.3.5 Turbine Inlet Air Chilling System

The TIAC cools gas turbine inlet air to prevent a reduction in efficiency at high ambient temperatures. The turbine inlet air is chilled via heat exchange with chilled water. The TIAC chills water using propane as a refrigerant and the chilled water cools the inlet air going to the compressor turbines through Air Chiller Coils.

Moisture condensed during air chilling is collected in pans and sent to a Condensed Water Collection Tank from where it is pumped by Condensed Water Transfer Pumps to the Raw Water Surge Tank to supplement supply from the Gladstone Area Water Board.

Following heat exchange, warmed water is passed through Refrigerant Evaporators which re-chill the water using propane as a refrigerant and the re-chilled water is recirculated to the Air Chiller Coils.

2.3.6 Nitrogen System

Gaseous Nitrogen (N_2) requirements are supplied from the Nitrogen Generation Package and the Liquid Nitrogen Package. End uses for N_2 include blanket gas for the LNG Storage Tanks, purge gas for the refrigeration circuit cold boxes, flares, loading arm swivel joint purges, compressor gas seals and buffer, and maintenance activities.

The Liquid Nitrogen Package is provided as a back-up when the Nitrogen Generation Package is not available. The Liquid Nitrogen Package comprises a liquid nitrogen tank equipped with a connection point for unloading of liquid nitrogen, a pressure building coil to create supply pressure and vapourisers to create gaseous N_2. As the Liquid Nitrogen Package is a standby unit, it is common to both trains.

2.4 Power Generation and Distribution

The LNG facility's power requirements are generated on-site by six gas turbine driven generators (GTGs) which are supplied with fuel gas from the Fuel Gas System. The facility's electrical system is a self-sufficient 'islanded' system with no external connections.

The electrical load for Train 1, common infrastructure facilities and ship loading operations is supplied by four GTGs with n+1 sparing philosophy. The peak electrical load (during ship loading at an ambient temperature of 32°C) is met by three operating GTG units with the fourth unit acting as a spare for both trains. If one GTG trips, the standby generator is brought into service. In order to meet emission control requirements (i.e. nitrogen oxides emissions), the GTGs are operated with a minimum 50 percent load. Two of the GTGs are equipped with waste heat recovery units supplying hot exhaust to the Train 1 Regeneration Gas Heaters.

Two GTGs supply Train 2 under peak operating condition. Normally, both GTGs are operating, each with a minimum 50 percent load to ensure compliance with emissions requirements. The Train 1 spare GTG also serves as spare for Train 2. Both of the Train 2 GTGs are equipped with waste heat recovery units supplying hot exhaust to the Train 2 Regeneration Gas Heaters. The GTG areas are bunded and oily waste water is sent to the Oily Water System for treatment and disposal.

The six GTGs have an output of approximately 11 MW each and generate power at 11 kilovolts (kV), 3-phase, 50 Hertz (Hz). Power management is performed by a Power Management System that ensures stable system voltage and frequency control, automatic transfer between GTG units and load shedding functions.

Three standby diesel-driven generators are provided to supply essential loads to support safe shutdown and to allow start-up of one of the GTGs. The standby system comprises three, 100 percent continuous service, diesel-driven generator sets, each with an output of 2.0 MW. The diesel-driven generators are rated to support vital power supplies (uninterruptible power supply (UPS) feeders), emergency lighting and critical heating and ventilation air-conditioning (HVAC) systems, electric-driven firewater pumps, GTG auxiliary supplies, start-up fuel gas heater and one GTG starter motor.

Redundant 230 Volt (V) alternating current UPS systems are provided to supply the DCS, safety systems (i.e. the fire and gas and emergency shutdown systems) and other equipment that requires no-break supply such as telecommunications (closed circuit television (CCTV), radios, public address/general alarm and telephones) and marine and aircraft navigational aids.

2.5 Firewater System

The facility, including both trains, utility and marine areas and buildings, is protected from fire events by a self-sufficient fire protection system designed to control or extinguish fires based on the worst case fire scenario (refrigerant storage area fire lasting four hours).

The Firewater System is charged with fresh water drawn from the Gladstone Area Water Board (GAWB). Firewater is stored in two atmospheric Firewater Tanks, each equipped with a pumper truck connection, atmospheric vent and overflow line draining to a safe location. The two tanks have a net capacity of 4700 m^3 each including a 100 m^3 allowance for utility water supply to the Potable Water Chlorinator/Remineraliser Package. The take-off line for utility water supply is located at a height that reserves 4400 m^3 for firewater service, based on a firewater service flow of 1100 m^3/h for four hours.

Firewater is distributed to the various firefighting devices through an extensive underground system comprising of high density polyethylene pipe. The firefighting devices include fire hydrants, firewater and foam hose reels, fixed and oscillating monitors, water mist systems and building sprinkler systems.

A single carbon steel firewater line is provided from the ring main to the PLF to feed fire hydrants, monitors and foam hose reels. Additional firefighting capability can be supplied by supporting tug boats.

2.6 Stormwater Management

Stormwater management at the LNG facility has three (3) components:

- Erosion control whereby cut and/or fill batters are protected from erosion by stabilising the exposed surface with vegetation or other cover (e.g. rock mulch, geotextile, erosion control matting);
- Runoff control where runoff from rainfall events are directed to stabilised drainage channels or other structures (channels stabilised by rock armouring/riprap); and
- Sediment control whereby measures, such as silt fences and sediment basins, are used to trap and retain sediment that is entrained in the water column due to an erosion event elsewhere.

During construction of the facility, diversion drains were constructed around the facility to divert upstream catchment runoff, largely from undisturbed areas, around the site. Drainage lines directing runoff off constructed cut batters as well as entry points for natural drainage lines were stabilised with rock armouring or other stabilisation materials. The entire invert of both the western and eastern diversion drain have been rock armoured.

Steep slopes, both cut and fill batters, constructed during the construction phase of the project have been stabilised to minimise erosion and sediment generation. Following a risk assement process, some exposed rock faces have been deemed competent and left largely untreated. Other faces comprising in part or in whole of dispersive material have been stabilised with geotextile overlain with rock mulch. More inaccessible batters have been stabilised using concrete blankets or covered with woven erosion control matting (e.g. Enviromat, jute matting) and seeded or hydromulched.

The entire perimeter of any outer fill batters facing or draining towards Port Curtis with the potential to be impacted by waves or storm surge have been rock armoured over their entire length. Most internal drains have been lined with concrete or riprap. Site drainage has been designed for a 25 year ARI storm event.

Buffer strips of vegetation were left intact between disturbed areas and wetlands or natural drainage lines to help protect water quality.

Within the plant area bounded by the western and eastern diversion drain, the site is broken up into 3 catchment areas with runoff from each catchment reporting to a dedicated sediment basin. These basins are known as Sediment Basins 1, 2 and 3.

During the construction phase, these sediment basins were constructed and operated as Type ‘D’ sediment basins (according to the design guidelines of the Australasian Best Practice Erosion and Sediment Control – International Erosion Control Association Australasia (IECA) 2008). This basin type is designed to capture the 85%ile rainfall event (42.1mm over a 5 day period for the Gladstone region). Even when the basin is full of water, sediment-laden stormwater runoff continues to be directed through the basin for continued settlement of coarse-grained particles contained in the flow.

Type ‘D’ sediment basins are typically designed for a maximum five (5) day cycle – filling, treatment and discharge within a maximum 5 day period. The basins operate as ‘wet’ basins which are designed to retain sediment laden water and allow adequate time for the settlement of suspended particles. This may be achieved by either gravitational means of through the addition of flocculants to aid the settlement of sediment out of suspension in the water column. Once the required water quality is achieved as stipulated in the Environmental Authority, the basin(s) can then be dewatered.

During the early stage of the operational phase of the facility, the intention is to retain the sediment basins as Type D sediment basins whilst the reporting catchment areas settle and consolidate and any sediment entrained within the system from the earlier construction phase are flushed through.

At some point in time, GLNG may decide to convert these sediment basins to Type ‘C’ (flow through) sediment basins.

The receiving environment for stormwater runoff and wastewater effluents at the LNG facility is Port Curtis. There are nine stormwater discharge monitoring points that either convey stormwater around the Site or release stormwater from the three (3) sediment basins on site. The discharge point for treated wastewater (from the Oily Water Treatment Plant (OWTP), the RO/ED water treatment plant (WTP) and the Process Area Spill Containment Sump (PASCS) from each Train) is the WW1 diffuser located at the PLF. The discharge points are shown on Figure 2-3.

The facility’s stormwater system outside the LNG process area is designed to direct water away from process and chemical handling/storage areas, and minimise potential erosion. The stormwater system comprises a series of diversion drains, and sediment basins which discharge to Port Curtis via authorised discharge points SW1 through SW9. In addition to stormwater, excess condensate water from the TIAC may be discharged via outlet SW3. The stormwater discharge locations system are illustrated on Figure 2-3.

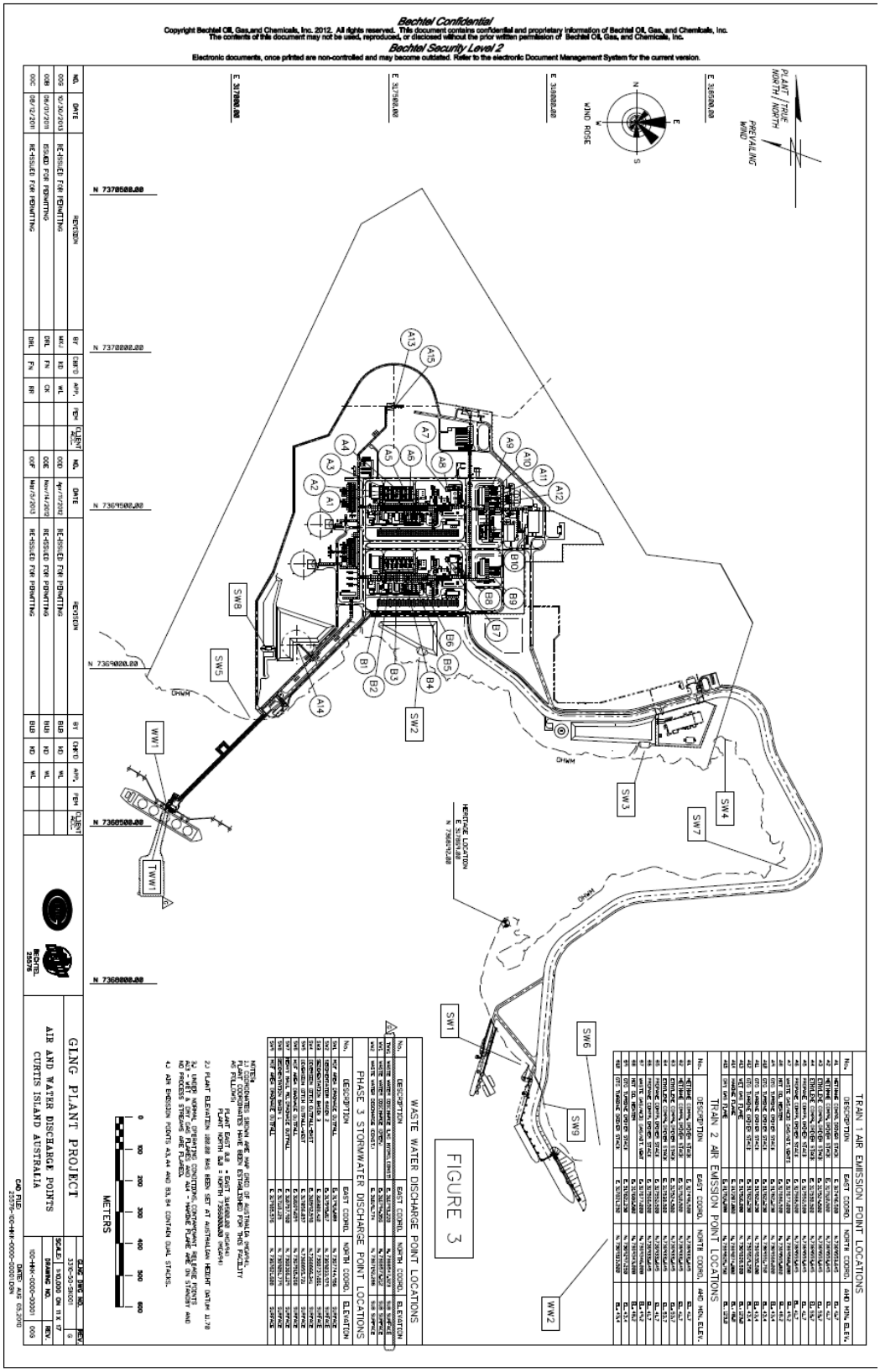

Figure 2-3. Water Discharge Points, Sediment Basins and Air Emission Points

Clean stormwater from undisturbed catchments is intercepted in diversion drains and directed around the perimeter of the facility and discharged via stabilised outlet structures into Port Curtis.

In undisturbed/ “Clean” (non-process) areas, stormwater is directed to one of the site sedimentation ponds (sediment basins), which overflow to Port Curtis.

The main liquefaction process areas are located on concrete slabs and drain to a Process Area Spill Containment Sump (PASCS). The PASCS receives surface water from the process area slab, including the first flush from a rain event. The sump is designed to store potentially contaminated runoff from the reporting catchment area resulting from a 12.7mm rainfall event. During sustained rain events, the PASCS is designed so that once the sump reaches capacity, it overflows via surface water drains to Sediment Basin 2. The PASCS is equipped with an oil skimmer package to collect and pump skimmed oil to the OWTP. The system is also equipped with pumps to send collected water to the OWTP or to the WW1 diffuser if it is of acceptable quality.

Other process and storage areas with potential for contamination are paved and bunded with an integral sump. Water collected in the bund sumps, including stormwater and utility water from cleaning operations or testing of firefighting equipment, is pumped to the OWTP for removal of oil, grease and suspended solids.

Following a rain event, impounded stormwater in the individual bunded areas will be visually inspected for contaminants. If the water is of acceptable quality (e.g. no visible sheen) it will be discharged to the facility stormwater drainage system and released to the receiving environment via discharge point SW2. Contaminated stormwater will be pumped to the OWTP for treatment.

Maintenance, utility and support facilities are covered and/or contained within bunded/curbed concrete slabs with integral sumps. Sump water from these areas is directed to the OWTP. Contaminated water from the hot oil and pig catcher area drains is pumped to the OWTP. Brine (ROC) and treated effluent is discharged to Port Curtis via diffuser WW1. Potentially contaminated water from the amine storage area is stored in a tank for removal and disposal offsite at a licensed waste management facility.

Chemical and fuel storage areas are bunded and equipped with vacuum truck connections to facilitate collection and off-site disposal of contaminated stormwater and deposited solids/sludge. Filling operations are supervised and if a spill occurs, spill response will be initiated immediately and the area will be remediated, and not flushed to sumps. Uncontaminated stormwater is released to the facility stormwater drainage system.

2.7 Effluent Treatment

The facility’s waste water and sanitary sewage collection systems are segregated from clean stormwater and comprise:

- Process/Oily Water Collection and Treatment System
- Contaminated (contact) Storm Water Collection System
- Sanitary Sewage Collection and Pumping System to Gladstone Regional Council (GRC) Waste Water Pipeline

Process area drains, oily water from knockout drums and potentially contaminated storm water from the process and utility areas are directed to the OWTP. Sanitary waste generated within the facility is routed to sanitary lift stations/holding tank and pumped to the GRC Waste Water Pipeline.

Drips and drains from the compressors are free-drained, collected in hubs and routed to the Compressor Area Collection Tank. Oily waste water is sent to the OWTP. Waste Water from the laboratory flows via gravity to the Laboratory Sump from where it is pumped under level control to the OWTP. Liquids from the Wet Gas Flare Knockout Drum are pumped to the Waste Water Tank or the OWTP.

Potentially contaminated storm water runoff from the process areas is collected in and routed via concrete lined ditches to the PASCS. The sump is designed as a first flush system to collect contaminated storm water and prevent oil from reaching the clean storm water system. The PASCS has an Oil Skimmer Package to skim and pump oily water to the Oily Water Treatment System. Clean water from the PASCS is pumped to the clean storm water outfall.

Potentially contaminated storm water from the hot oil tank curb/dike is gravity drained to the Hot Oil Tank Sump while potentially contaminated storm water from the inlet gas facility area is drained via gravity to the Pig Receiver Slab Sump and from the power generator area to the Oily Water Lift Station. Storm water from the hot oil/fired heater area flows to the Hot Oil/Fired Heater Oily Water Lift Station. Wash down water from the maintenance building wash down pad drains to the Wash Down Pad Sump while storm water from the amine storage area drains to the Waste Water Sump from where it can then be pumped out to a vacuum truck for offsite disposal. Clean storm water is discharged to surface drainage ditches while process spills are pumped to the Waste Water Tank under level control. Storm water runoff or process spills from the diesel oil storage tank containment area flow into a sump where clean water is directed to the clean storm water system. Diesel spills are removed via vacuum truck. Clean storm water runoff from the waste oil tank dike and the oily water treatment area are manually discharged by gravity to surface drainage ditches.

The OWTP is designed to remove free phase and emulsified hydrocarbons (oil) and suspended solids from process waste water and potentially contaminated stormwater and serves both Trains. The system comprises of a Corrugated Plate Interceptor (CPI) Oil/Water Separator, Dissolved Air Flotation (DAF) Separator and DAF Effluent Filters which are aboveground steel fabricated units.

The incoming stream comprises water with varying amounts of hydrocarbons and sediment. The CPI Oil/Water Separator separates free oil waste water and is provided with covers and conservation vents. Oil/water separation occurs in plate packs comprised of parallel corrugated fibre reinforced polymer plates. Concrete curbing is provided around the separator to contain oil spills. Solids deposited at the bottom of the CPI Separator are pumped to a sludge holding tank and periodically offloaded to a vacuum truck for off-site disposal. Slop oil is pumped to a Waste Oil Tank for storage. Treated water from the CPI Separator is gravity fed to the DAF Separator to remove dispersed and emulsified oil and fine particles. The DAF float is pumped to the Waste Oil Tank and settled solids are periodically disposed off-site at approved locations.

The Waste Oil Tank has a capacity of 200 m^3 and holds the waste oil/water mix from the CPI Oil/Water Separator. The tank is equipped with sampling ports to determine the oil/water interface. Water is drained and routed to an Oily Water Lift Station while waste oil is periodically removed via vacuum truck and disposed of or recycled off-site.

Treated water from the DAF unit is pumped through DAF Pressure Filters to produce an effluent suitable for discharge (compliant with applicable regulations). The treated water can either be sent to directly discharge via the WW1 diffuser at the PLF jetty or sent to the Treated Effluent Holding Tank.

During operations the OWTP will operate intermittently and have an average (based on 24-hour average) dry weather discharge rate of six cubic metres per hour (m3/h). During wet weather conditions, the OWTP discharge rate will be managed to ensure a maximum discharge rate of 58 m^3/h is maintained. This will require prioritisation of flows to the OWTP during periods of ongoing rainfall.

Sanitary sewage from facility buildings flows via underground lines to sanitary lift stations which are equipped with spared pumps operating in a duty/standby configuration under level control. Sewage from the sanitary sumps is pumped to the Sanitary Waste Water Pumping System where the collected sewage is pumped to the GRC Waste Water Pipeline for off-site treatment.

See Figure 2-4 for a simplified schematic of the waste water system.

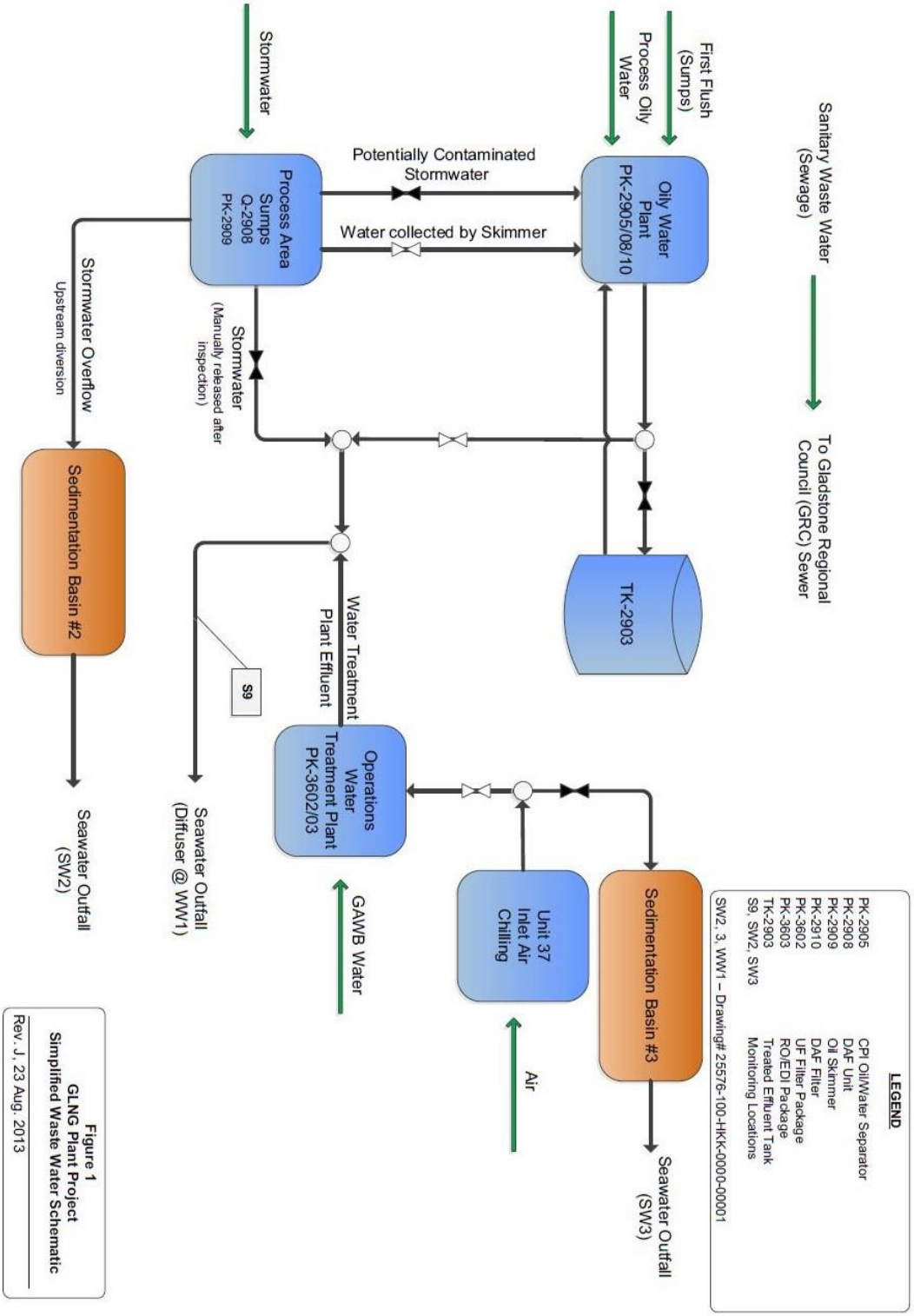

Figure 2-4. Simplified Waste Water Schematic

2.8 Control and Safeguarding Systems

The control and safety systems at the LNG Facility have been designed as an Integrated Control and Safety System (ICSS). The primary function of the ICSS is the automatic regulation of the process plant, utility systems and equipment packages to maintain their normal operation at the required operating pressures, temperatures, liquid levels and flow rates. The ICSS includes the following subsystems:

- Distributed Control System (DSC) which serves as the primary means to control and monitor the facility from a manned Central Control Room (CCR) and is the operator interface for control of process and utility operations. It forms the backbone of the ICSS and allows operators to view and control the entire facility from Operator Control Desks (OCD) in the CCR. In the event of an abnormal process and/or plant condition, the DCS, which receives inputs from the emergency shutdown, process shutdown and fire and gas systems, acts to isolate and thereby reduce hydrocarbon volumes that may be released, and to eliminate any potential ignition sources.
- Safety Instrumented System comprising:
    - Safety Shutdown System
    - Process Shutdown System

The Safety Instrumented System (SIS) provides automatic emergency shutdown, process shutdown and depressurisation functions for the facility and comprises of the discrete but intercommunicating Safety Shutdown System (SSS) and Process Shutdown System (PSD). The system is designed to allow the whole facility or sections of the facility to be brought to a safe and steady state from which it can be restarted or further shut down as warranted, isolate hydrocarbon inventories to limit potential releases and prevent the failure of plant equipment and vessels through overpressure.

The SSS acts as the highest level of protection (initiates ESDF; see below) and carries out the detection and logic to initiate emergency shutdown actions for the facility. The PSD System acts as the individual train level of protection and depressurisation (initiates ESDP, SDP and EDP; see below) required in emergency situations. In general, the PSD System protects and/or trips equipment applicable to the process units.

The shutdown systems are hierarchical – higher level shutdowns initiate lower levels. The ESD shutdown logic includes the following shutdown levels:

- **Emergency Shutdown Facility (ESDF)**: stops feed gas from the GTP entering the facility, is initiated either manually (hand switch in the CCR) or automatically (high-high level in the inlet separator) and will automatically cascade down to an emergency shutdown process (ESDP).
- **Emergency Shutdown Process (ESDP)**: shuts down the relevant train and stops all ingoing and outgoing streams by closing isolation valves, shuts down all major rotating equipment and heaters with open flames. An ESDP can be initiated automatically via cascade from an ESDF, a process upset or by activation of hand switches located throughout the facility.

- **Emergency Depressurisation (EDP)**: depressurises specific sections of the plant via manual hand switches located in the CCR. Individual valves, which depressurise a section of the plant, are operated by individual hand switches. Automatic depressurisation is initiated only by refrigeration compressor primary and/or secondary seal failure. Separate EDPs are provided for each train.
- **Shutdown Process (SDP)**: temporarily holds all process streams (stops liquefaction) and places major equipment in standby. The cold section of plant is isolated with the refrigerant compressors running on recycle. A SDP can be initiated automatically or via a hand switch in the CCR and allows for normal operations to be quickly restarted once the cause of the shutdown is removed.
- **Emergency Shutdown of Ship Loading (ESDL)**: stops LNGC loading and prepares for immediate vessel release/disconnection during actual or potential loading emergencies. The shutdown stops loading pumps, disconnects the loading arms and closes isolation valves. An ESDL can be automatically initiated via a mooring hook release signal from the LNGC or marine terminal or via actuation of manual hand switches located in the CCR and jetty area. An ESDL does not automatically affect plant production.
- **Shutdown Ship Loading (SDL)**: stops LNGC loading operations only and does not disconnect the loading arms from the vessel. A SDL can be initiated automatically or by manual actuation of hand switches located in the CCR and PLF.

The PSD System function is to protect the facility and equipment from abnormal operating conditions. The system detects any abnormal operating conditions that earlier corrective measures from the DCS have failed to control, and triggers automatic shutdown of process and utilities equipment if conditions escalate.

The EDP System is designed to quickly lower the pressure of specific sections of the plant from operating pressure to a specific threshold via depressurisation valves that discharge to the wet or dry flare header. Ultimate overpressure protection of equipment and piping systems is ensured by the provision of pressure relief devices.

Relief valve and flare system designs considered the worst upset conditions in determining the loading to size valves and flares, including:

- Blocked discharge
- Fire exposure
- Tube rupture
- Control valve failure
- Gas blow-by
- Thermal expansion
- Utility failure
- Emergency depressurisation

The shutdown and depressurisation systems fail to a safe position. In general, shutdown valves fail to a closed position and depressurising valves fail to an open position. Following

a shutdown, manual reset of the shutdown level from the ICSS in the CCR is required before normal operations can be resumed. The reset sequence is intended to prevent an uncontrolled plant re-start.

2.9 Other Ancillary Features

Other non-process LNG facility features and control systems are described below.

2.9.1 Haul Road and Plant Roads

The Haul Road provides vehicle access from the Materials Offloading Facility (MOF) where materials and personnel are offloaded to the LNG Facility site. The Haul Road is a dual-lane, sealed road with a nominal carriageway width of 35 metres. The Haul Road is provided with a security guardhouse on the eastern site boundary to control access to the facility.

Other sealed plant roads have been provided throughout the facility to allow all-weather access to the various process, utility and personnel facilities and are provided with road furniture including signage and drainage.

2.9.2 Materials Offloading Facility (MOF)

The MOF is located on the eastern side of China Bay and serves as the landing and departure point for personnel ferries and barges delivering materials, pre-assembled module units, equipment and vehicles and consumables to the facility. The MOF can accommodate a range of vessel types and comprises the following:

- Passenger ferry berth with capacity for simultaneous berthing of two, 400 passenger ferries;
- RoRo berth used primarily for receipt of materials and large equipment transported via rolling stock;
- LoLo berth used primarily for receipt of materials and equipment;
- Bulk aggregate berth used primarily for receipt of bulk materials such as aggregate, road base and structural fill;
- Barge ramp used for offloading of equipment and vehicles;
- Wharf structures, mooring and breasting dolphins; and
- Material, equipment and module laydown areas and vehicle manoeuvring areas.

2.10 Facility Design Considerations

Design of the facility was undertaken by Bechtel which has considerable experience in the design of LNG plants, in particular, facilities employing the CoP Optimized Cascade LNG process. The design philosophy of the facility incorporates inherently safe features including fire protection, plant layout, spill containment and hazardous area classification.

2.10.1 General Design Philosophy

The primary philosophy underlying the design of the facility is the prevention of personal injury, loss of life or physical damage to property or the environment. To achieve this goal, the use of mature and industry proven designs, technology, equipment and operating procedures have been adopted. So far as is reasonably practicable, responses to emergency situations have been automated so as to not leave the decision responsibility to workers.

Consistent with Australian and international standards and industry practice, the design of the facility has assumed that only a single major incident will occur at any given time ('single risk philosophy'). To ensure this is a valid premise; plant layout and control, safeguarding and containment systems have been provided and designed to meet relevant legislation, codes and Australian and international standards.

The most significant hazards at the facility are presented by the inventories of flammable, combustible and/or cryogenic materials such as LNG and the process refrigerants. To prevent and mitigate these hazards, a multi-element prevention and mitigation philosophy has been adopted as illustrated in Figure 2-5.

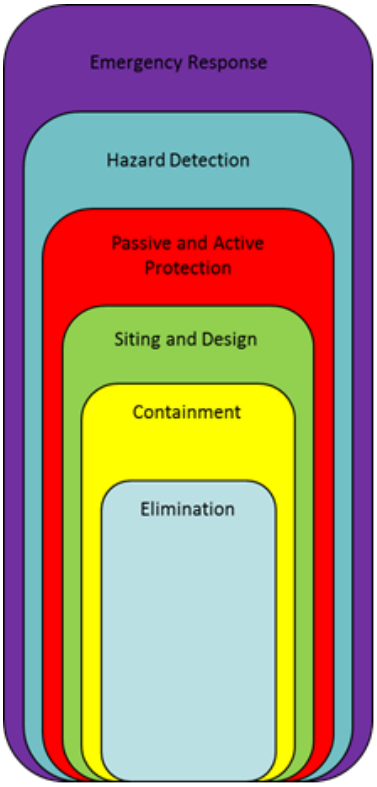

Figure 2-5. Hazard Prevention and Mitigation Philosophy

The underlying elements for hazard prevention and mitigation include:

- Rapid reaction by appropriately trained and equipped local and facility-based emergency responders;
- Early detection of hazardous conditions and the subsequent shutdown, isolation and depressurisation as appropriate for the situation;
- Active fire protection systems such as water spray systems and firewater hydrants at strategic locations to prevent escalation of fire events;
- Passive fire and cryogenic protection systems for structures;
- Separation and segregation of equipment and buildings;
- Protection of equipment and buildings through measures such as blast-resistant design;
- Protection of personnel through access control and location of manned buildings;
- Spill prevention and containment for areas storing or using flammable, combustible or toxic materials through measures such as impoundments, sloped paving and drainage systems; and
- Elimination of ignition sources through hazardous area classification and selection of appropriate equipment.

2.10.2 Emergency Response

The facility has undertaken a detailed fire and cryogenic hazard analysis to determine credible fire and cryogenic liquid release events and suitable prevention, detection and mitigation measures.

In emergency events, GLNG provides a first response team comprising of operations, maintenance and office-based workers trained and equipped to deal with credible events. The first response teams are relatively small, especially during night shift and are intended only to provide defensive operations to prevent event escalation. Further details of GLNG's planned approach to emergency response are contained in the LNG Facility Emergency Response Plan and the Environmental Contingency and Emergency Response Plan.

2.11 Schedule 15 and Other Hazardous Chemicals

The LNG Facility handles and stores a number of substances that are classified as hazardous chemicals under the *WHS Regulation* (Schedule 15, Tables 15.1 and 15.2) and as flammable or combustible under AS 1940 2004 (*The storage and handling of flammable and combustible liquids*). Other chemicals are present which are not classified as Schedule 15 chemicals, but due to their toxic, flammable or combustible properties are considered hazardous. Process and utility equipment at the facility, including marine and mainland facilities that contain or use hazardous chemicals have been specifically designed for the material, temperatures and pressures involved in that process. Receipt, storage, usage and disposal of hazardous materials are undertaken using approved equipment and procedures in line with GLNG requirements, industry best practice and Australian and international Standards and applicable regulations.

The facility's process is maintained within the design operating envelope by instrument control systems including emergency shutdown, process shutdown and pressure relief systems. In areas of the facility where explosive, combustible or toxic materials are received, stored, used or disposed of, there are extensive fire and gas detection and alarm systems to safeguard plant, personnel and the environment.

The Schedule 15 and other hazardous chemicals handled in support of or during operation of the facility are summarized in Table 2-2 and Table 2-3. Note that hazardous chemicals used in insignificant quantities, such as those employed in the facility's laboratory are excluded from the scope of this section.

Table 2-2. Hazardous Chemicals Listed Under Schedule 15 (Tables 15.1 and 15.2)

Hazardous Chemical	Quantity (t)	Physical Form (L, S, G)*	Largest Containment System		
			Quantity (t)	T (°C)	P (kPag)
Natural Gas, Refrigerated Liquid[1]	132,700	L	66 000	-161	5
Propane[2]	1300	L and G	263	27	920
Methane (Feed Gas)	230	G	127	30	6000
Ethylene	600	L and G	140	-78	313

Notes: * L = Liquid, S = Solid and G = Gas.
[1] Comprising LNG storage tanks (132,000 tonnes maximum combined inventory), LNG loading lines (300 tonnes) and Trains 1 and 2 (400 tonnes maximum combined inventory); [2] Comprising propane refrigeration circuit Train 1 and Train 2 (510 tonnes maximum combined inventory) and propane storage drums (789 tonnes maximum combined inventory).

Table 2-3. Other Hazardous Chemicals

Hazardous Chemical	Quantity	Physical Form (L, S)*	Largest Containment System		
			Quantity	T (°C)	P (kPag)
Therminol 55 (t)	425	L	425	27	Atm.
Refrigeration Compressor Lube Oils (t)	278.5	L	13	50	Atm.
Diesel Fuel (t)	81	L	81	27	Atm.
aMDEA (t)	855	L	471	27	Atm.
Hydrochloric Acid** (32%) (t)	0.9	L	0.9	27	Atm.
Sodium Hypochlorite** (t)	1.8	L	2.7	27	Atm.
Sodium Bisulfite** (t)	1.6	S	2.4	27	Atm.
Sodium Hydroxide** (t)	2.2	L	2.2	27	Atm.
Ferric Chloride** (t)	2.0	L	2.0	27	Atm.
Sulfuric Acid** (t)	3.0	L	1.5	27	Atm.
Nalco 2490** (t)	1.6	L	2.4	27	Atm.
Molecular Sieve Adsorbent (m^3)	636	S	318	-	-
Mercury Removal Absorbent (m^3)	122	S	61	-	-

Note: * Liquid (L), Solid (S);
** represents equal amounts in use and stored as reserve

3 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE - ENVIRONMENTAL VALUES

During 2008 and 2009, GLNG prepared an EIS and SEIS to identify MNES that would be potentially impacted by the GLNG project. Part of this process included conducting flora and fauna ground truthing surveys. Additional supporting surveys have since been conducted by GLNG to identify and mitigate potential impacts from the construction and operation of the LNG facility and associated LNG marine facilities. A summary of these additional surveys is provided in Table 3-1.

Table 3-1. Summary of Additional GLNG LNG Facility and Associated Marine Facilities MNES Surveys

Report Name	Target MNES	Date Undertaken	Future Surveys
Pre-clearance Survey	• Ecological communities; • Threatened species; • Migratory species; • Habitat for threatened and migratory species; and • Species contributing to the World Heritage and National Heritage values of the Great Barrier Reef World Heritage Area.	January 2011	N/A
Water Mouse Survey	Water Mouse (*Xeromys myoides*)	• November 2010 • April 2012	N/A
GLNG Curtis Island Marine Facilities Migratory Shorebirds Environmental Management Plan	Listed migratory shorebirds	• January 2011 • May 2011 • November 2011 • April 2012 • December 2012 • June 2013 • December 2013 • April 2014 • December 2014	Biannually for the duration of construction of the LNG marine facilities. These surveys are conducted under the CEMP

The LNG facility and associated marine facilities operations activities as identified in Section 2 have the potential to impact on the following MNES protected under the EPBC Act:

- World Heritage (Section 12, 15A);
- National Heritage Places (Section 15B, 15C);
- Listed Threatened Species and Communities (Section 18, 18A); and
- Listed Migratory Species (20, 20A).

Information on MNES gathered from the GLNG EIS, SEIS and supporting additional studies prepared to address both Queensland State and Commonwealth Conditions associated with the GLNG Project is summarised below.

3.1 World Heritage Area and National Heritage Places

3.1.1 Great Barrier Reef World Heritage Area and Great Barrier Reef Marine Park

The LNG facility site on Curtis Island and associated marine facilities located in China Bay, are both situated within the Great Barrier Reef World Heritage Area (GBRWHA). The GBRWHA is administered by the Great Barrier Reef Marine Park Authority (GBRMPA) in association with the Queensland Department of Environment and Heritage Protection (DEHP; formerly Department of Environment and Resource Management (DERM)). The boundary of the GBRWHA (heritage area) is set at the mean low water level on the mainland.

The GBRWHA is also listed as a National Heritage Place therefore the LNG facility and associated marine facilities are also located within a National Heritage Place.

Figure 3-1 shows the LNG facility and associated marine facilities in relation to the GBRWHA and Port Curtis.

The LNG facility is adjacent to Port Curtis, whilst the associated marine facilities are located within Port Curtis itself. Port Curtis is listed on the Directory of Important Wetlands in Australia. This area has been identified for its extensive range of marine wetlands encompassing seagrass beds, mangrove forest and intertidal mud flats that provide habitat for a range of significant migratory water birds, reptiles and mammals.

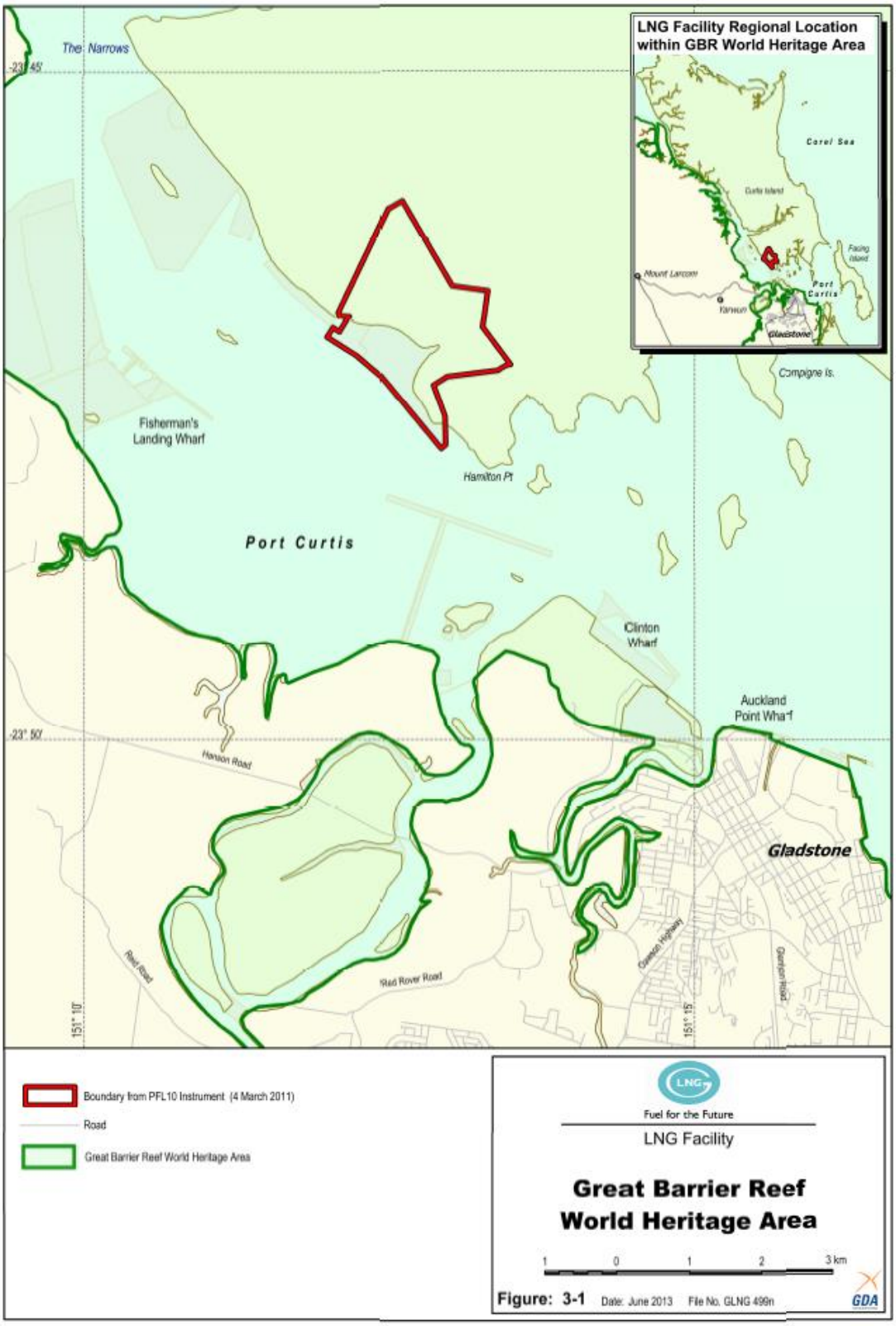

Figure 3-1. Great Barrier Reef World Heritage Area

3.1.2 Curtis Island Environmental Management Precinct

The Curtis Island Environmental Management Precinct has been created within the Gladstone State Development Area (GSDA) in order to recognise, protect and maintain significant ecological, environmental and heritage areas on the southern part of Curtis Island. It extends south from Graham Creek to, but excluding the South End community. The Precinct was established by the Queensland Government to offset the development of the LNG Industrial Park on Curtis Island. GLNG are making significant financial and other contributions to the management of the Precinct, including through a Management Committee.

East of the Curtis Island Environmental Management Precinct is the 290 hectare (ha) nature reserve and turtle nesting beach on the east coast of Curtis Island. Waters seaward of the nature reserve are included in the Great Barrier Reef Marine Park. The State Marine Park also encompasses Graham Creek and The Narrows (Ecofund, 2011).

Figure 3-2 shows the LNG facility and associated marine facilities in relation to the Curtis Island Environmental Management Precinct.

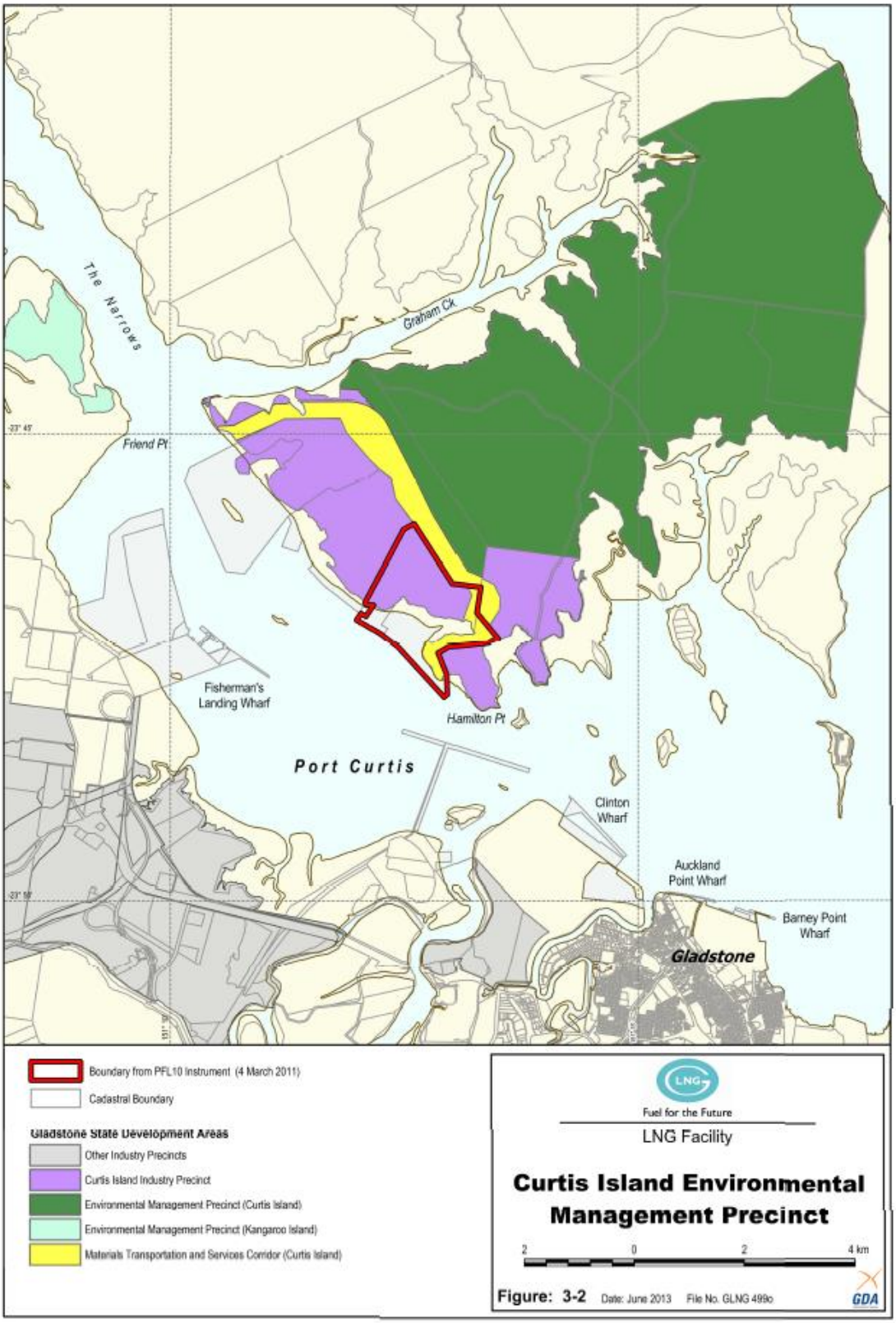

Figure 3-2. Curtis Island Environmental Management Precinct

3.1.3 Rodds Bay Dugong Protection Area

Port Curtis is wholly within the Rodds Bay Dugong Protection Area (DPA), prescribed under the *Fisheries Act 1994* and its subordinate legislation that regulates commercial fishing activities (URS, 2009a). The Rodds Bay DPA extends from Friend Point in the northwest to Rodds Peninsula in the southeast (refer to Figure 3-3).

In the GLNG EIS EPBC Controlled Action Assessment Report (refer to Appendix G of the EIS which can be found at http://www.santosglng.com) it is stated that studies prior to 2009 indicated that high numbers of dugong are found within Rodds Bay DPA that forage on seagrass meadows within the Port (GHD, 2009) and that dugongs display fine scale movements between localised bays (Marsh and Lawler, 2006). Grech and Marsh (2007) classed the area around Gladstone as low to medium conservation status on the basis of relative density of dugongs estimated from spatial modelling and frequency analysis taken from time series data over 19 years of aerial surveys. Evidence of dugong feeding activity has been observed on the majority of intertidal seagrass meadows surveyed in Port Curtis during the 2007 Department of Primary Industries and Fishery (DPI&F) long term monitoring program (Chartrand e*t. al.*, 2009). Refer to Section 3.3 for information on seagrass meadows around the LNG facility and associated marine facilities.

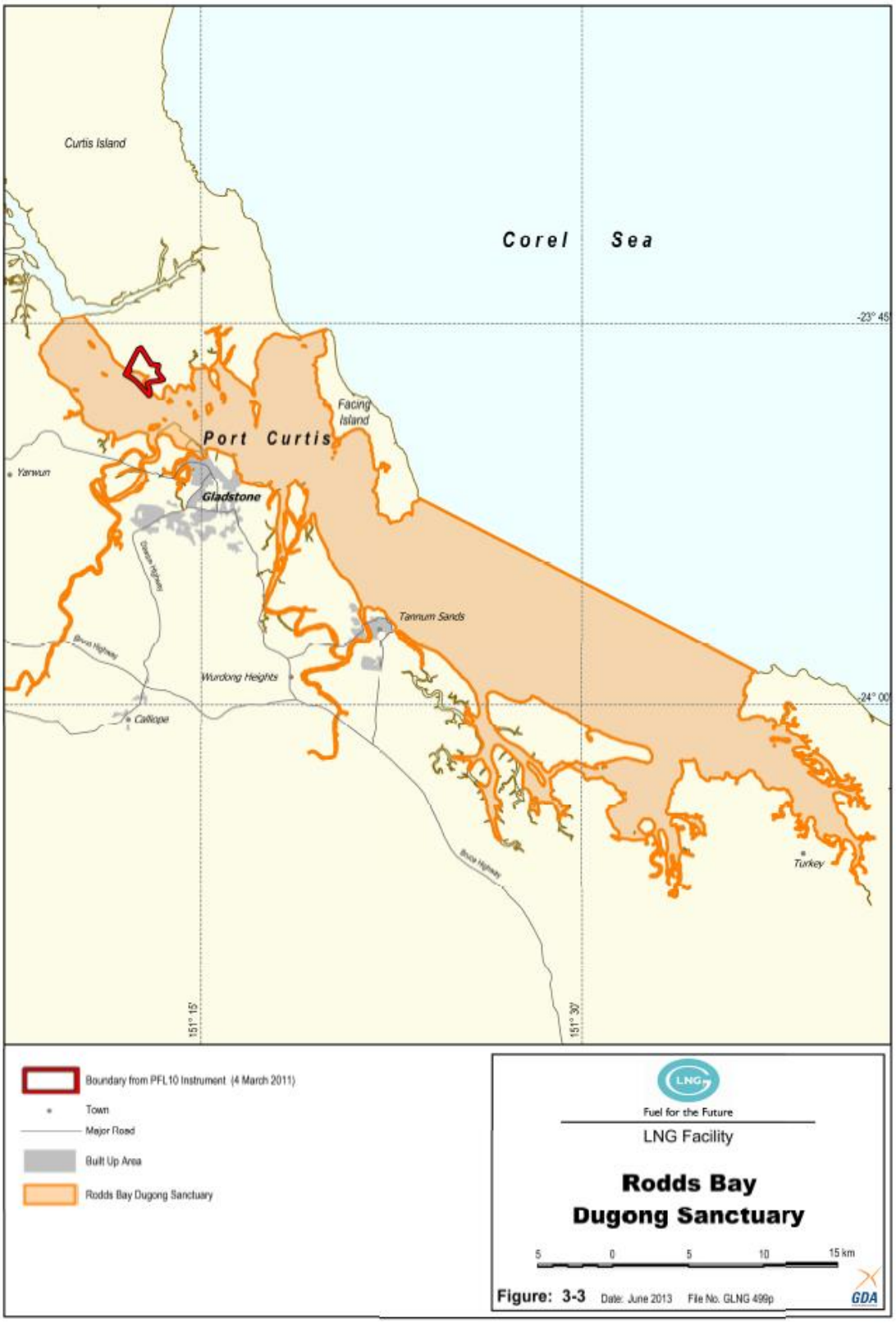

Figure 3-3. Rodds Bay Dugong Sanctuary

3.1.4 Capricorn Bunker Group

The Capricorn Bunker Group is located 60 to 100 km northeast of Gladstone. The islands have high natural values, notably breeding populations of seabirds, marine turtle and coral cay vegetation. The values of the area have been recognised in the declaration of the Capricornia Cays National Park and the Capricornia Cays National Park (Scientific) and surrounding State Marine Park and Great Barrier Reef Marine Park. Under the *Great Barrier Reef Park Act 1975*, the *Marine Parks Act 1982* and the *Nature Conservation Act 1992*, the responsible agencies are obliged to protect the natural and cultural values and ensure use is ecologically sustainable. The Capricornia Cays National Park is managed by the Queensland Parks and Wildlife Service (QPWS).

3.2 Threatened and Migratory Species and Communities for the LNG Facility

Below is a summary of ground truthing surveys for the LNG facility conducted during 2008 and 2009 from the GLNG EIS, SEIS and supporting surveys (refer to Table 3-1) to address GLNG's State and Commonwealth conditions. For a comprehensive assessment of threatened and migratory species and communities refer to GLNG EIS, Appendix G, EPBC Controlled Action Assessment Report (full report available at http://www.santosglng.com).

During ground truthing surveys undertaken in 2009 within the LNG facility site, no flora or fauna species of EPBC conservation significance were identified as being present (URS, 2009b).

During the January 2011 preclearance survey of the LNG facility and associated LNG marine facilities construction footprint conducted by URS, no EPBC listed flora or fauna species were encountered during the targeted searches (URS, 2011b). However, the following migratory species were observed within the marine facilities:

- Rainbow Bee-Eater (*Merops ornatus*);
- Eastern Curlew (*Numenius madagascarienisis*); and
- Whimbrel (*Numenius phaeopus*)

Full details concerning the preclearance survey can be found in the report '*GLNG LNG Facility Pre-clearance survey for EPBC-Listed Fauna and Flora Species, Migratory Species and Ecological Communities*' (full report available at http://www.santosglng.com).

3.2.1 Birds

Black Breasted Button – Quail and Squatter Pigeon

The GLNG EIS concluded that threatened EPBC species that may be impacted by construction of the LNG facility include the Black-Breasted Button-Quail (*Turnix melanogaster*) and the Squatter Pigeon (*Geophaps scripta scripta*). Although no individuals were recorded on Curtis Island in the vicinity of the LNG facility, suitable habitat for these

species is present at this location. It is considered unlikely that operation of the LNG facility will impact significantly on potential populations that may be present on Curtis Island (URS, 2009c). It should be noted that no sittings were recorded of the Black-Breasted Button-Quail or Squatter Pigeon during the January 2011 preclearance survey.

Migratory Wader Bird

Migratory water bird surveys were undertaken during three periods in 2008, April, June and December, as part of the GLNG EIS assessment. The surveys indicate that the LNG facility site does not act as core habitat for any of these species as similar vegetation communities and topography is found elsewhere in the region (URS, 2009c). It should be noted that no sightings were recorded of the migratory wader bird during the January 2011 preclearance survey.

Migratory Shorebirds

At the time of preparation of this OEMP, a total of ten (10) targeted migratory shorebird surveys have been undertaken by URS on behalf of GLNG (refer Table 3-1). It was identified that 26 migratory shorebird species may potentially be found within Port Curtis. A summary of shorebird species recorded within China Bay during the surveys is provided Table 3-2) and surveyed shorebird habitats at the GLNG LNG facility are shown on Figure 3-4.

Table 3-2. Shorebird Species Recorded within China Bay

Common Name	Scientific Name	Survey Period / # of Records										
		Jan 2011	May- Jun 2011	Nov 2011	April 2012	Dec 2012	Jun 2013	Dec 2013	April 2014	Dec 2014	Mar-Apr 2015	**Total**
Eastern Curlew[M]	*Numenius madagascariensis*	18	1	14	-	6	-	8	1	0	-	**57**
Whimbrel[M]	*Numenius phaeopus*	30	--	13	11	1	-	6	16	6	18	**101**
Australian Pied Oystercatcher[R]	*Haematopus longirostris*	4	2	2	-	5	-	8	6	2	2	**31**
Masked Lapwing[R]	*Vanellus miles*	9	3	2	13	2	-	10	8	13^	16	**76**
Beach Stone-Curlew[R]	*Esacus neglectus*	-	1	1	-	-	-	1	1	-	-	**4**
Total		**61**	**7**	**32**	**24**	**14**	**0**	**33**	**32**	**30**	**36**	

M = Migratory R = Resident species ^ = records consisted of a breeding pair and 3 fledged young

Overall the results of these surveys yielded a very low diversity when compared to the overall diversity of international migrants (26 species) known from Port Curtis. It is considered that China Bay does not currently act as significant shorebird habitat.

Observations of shorebird activity have shown that there is negligible impact on behaviour from site activities, and, on the basis of monitoring conducted to date, it appears that China bay has not acted as preferred shorebird habitat since studies in Port Curtis were initiated (URS, 2014a).

The significance of the habitats for wader birds within the project area is relatively low when compared to other marine/wader habitats in Queensland (e.g. Great Sandy Straights and Moreton Bay). Overall, the project area is of relatively low significance in the context of the Commonwealth's interests and responsibilities under the EPBC Act. The potential for significant impacts on wader bird habitat or migratory wader species is considered low during the LNG facility's operational phase (URS, 2011a).

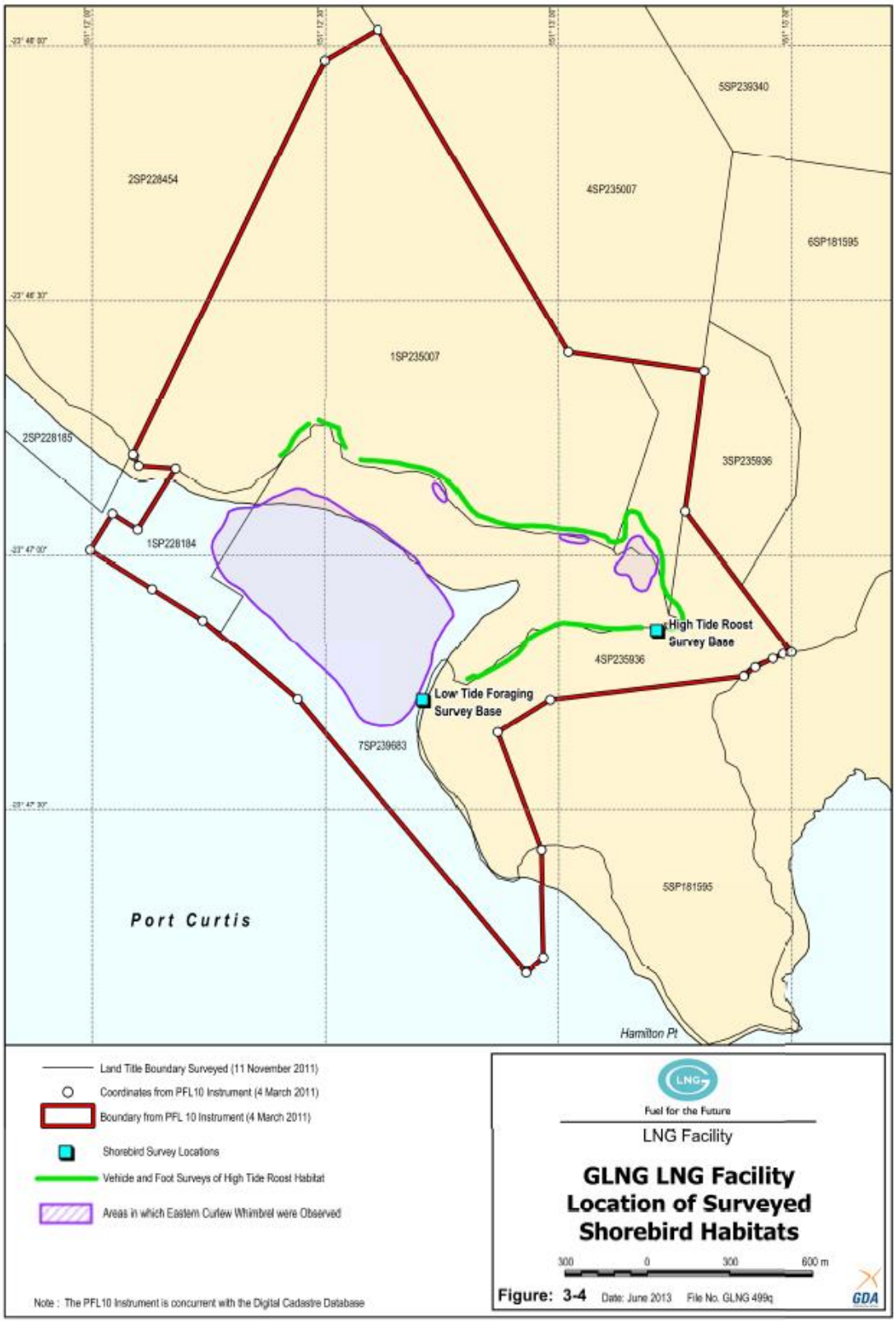

Figure 3-4. GLNG LNG facility Location of Surveyed Shorebird Habitats

Eastern Curlew and Whimbrel

The results of field surveys undertaken within China Bay, recorded the presence of only two species of international migratory shorebirds observed utilising intertidal habitat: the Eastern Curlew (*Numenius madagascariensis*) and the Whimbrel (*Numenius phaeopus*). Very low numbers of the Eastern Curlew and Whimbrel were observed using available habitat during the January 2011 pre-clearance surveys.

The Eastern Curlew is prevalent in the coastal regions of north-east and southern Australia. The species is associated with coastal mudflats, sandflats, mangroves, estuaries, sandspits, fresh/brackish lakes and grasslands near water (Pizzey and Knight 2003). At high tide the species relocates to saltpans, sand dunes and other open areas where they roost above the high water mark. This species is a summer (August - March) migrant to Australia (Pizzey and Knight 2003).

The Whimbrel is usually observed along tidal flats, estuaries, mangroves, coral cays, exposed reefs, flooded paddocks (floodplains), grasslands and sewerage ponds. The Whimbrel is usually a summer migrant to Australia (Pizzey and Knight 2003).

Rainbow Bee-Eater

The Rainbow Bee-Eater (*Merops ornatus*) was sighted on the hinterland margins of Curtis Island during the intertidal survey in June 2008 (URS, 2009b) and during the January 2011 preclearance survey small flocks of the Rainbow Bee-Eater were observed feeding at the ecotone between terrestrial and intertidal habitats at Hamilton Point during the migratory shorebirds survey. They were not observed within the LNG facility site itself, but would potentially utilise all areas of Curtis Island at times whilst seeking prey. No evidence of the species breeding within the LNG facility was observed, and inspections of exposed soil profiles (e.g. creek banks) showed that the stony soils present were unlikely to be preferred by this species for burrows. As this species is widespread and large areas of alternative suitable habitat exist and no evidence of breeding was recorded, potential impacts to this species are considered to be negligible (URS, 2011b).

Great Egret

The GLNG EIS, noted that the Great Egret (or white egret) (*Ardea alba*) was sighted on low tidal mudflats adjacent to Curtis Island. Great Egrets are listed in the China-Australia Migratory Bird Agreement (CAMBA) and Japan-Australia Migratory Bird Agreement (JAMBA) and are considered common throughout Australia (Birds Australia). This species was sighted on low tidal mud flats within Port Curtis during the intertidal survey in June 2008. Potential impacts to this species are considered negligible due to minimal disturbance to low tidal mudflats resulting from the operation of the LNG facility and the extent of mudflats dominating the lower intertidal habitats within Port Curtis. It is unlikely that significant impacts will occur to this species from the operation and decommissioning of the LNG facility (URS, 2009b). It is be noted that the Great Egret was not sighted in the January 2011 migratory shorebird survey.

White-bellied Sea Eagle

The White-bellied Sea Eagle (*Haliaeetus leucogaster*) is listed under the China-Australia Migratory Bird Agreement (CAMBA). The GLNG EIS, noted that this species is commonly found in coastal and near coastal areas of Australia and was sighted on low tidal mud flats, mangroves and rocky foreshore habitat of Curtis Island during field surveys conducted in June 2008 (URS, 2009b).

The White-bellied Sea-Eagle and the osprey were observed within 5 km of the LNG Facility within Port Curtis. However no evidence of nesting, roosting or exclusive uses of the China Bay area by the White-bellied Sea Eagle or Osprey was observed during the January 2011 Preclearance survey. As there will be negligible impact on these species from construction of the LNG facility, it was considered that a specific management plan for marine raptors was unwarranted (URS, 2011b).

3.2.2 Reptiles

Marine Reptiles (Turtles)

Several green turtles were seen by researchers during field surveys (2006) and it has been reported that The Narrows and the Calliope River mouth are major foraging areas (Connell Hatch, 2006). According to previous research, the Loggerhead Turtle (*Caretta caretta*) and flatback turtle (*Natator depressus*) utilise habitats in the outer harbour and occasionally move northward through Port Curtis into The Narrows (QDEH, 1994). The Leatherback Turtle (*Dermochelys coriacea*) has been recorded regionally although none have been sighted within Port Curtis.

Green Turtles

Green Turtles (*Chelonia mydas*) occur in seaweed-rich coral reefs and inshore seagrass pastures in tropical and subtropical areas of the Indo-Pacific region (Limpus, 2004). Green Turtles feed on small marine animals when they are young, but once they move to their adult foraging grounds green turtles mainly eat seagrass and seaweed (algae). They also feed on mangrove fruit, jellyfish and sponges.

Queensland has three distinct genetic breeding stock of Green Turtles with very little interbreeding occurring between these distinct populations (Dobbs, 2001). The southern Great Barrier Reef has 13 major rookeries, including North West Island, Wreck Island, Hoskyn Island, Heron Island and the Coral Sea cays.

Loggerhead Turtles

Loggerhead Turtles (*Caretta caretta*) feed mostly on shellfish, crabs, sea urchins and jellyfish (Limpus, 2004). Significant nesting areas in Australia occur on the southern Great Barrier Reef and adjacent mainland coastal areas, including Bundaberg, Wreck Island, Erskine Island, Tryon Island, Wreck Rock beach and Pryce Cay and in Western Australia including the Murion Islands and further south near Shark Bay. Females originally tagged

near the south east Queensland rookeries have been recaptured in Indonesia, Papua New Guinea, the Solomon Islands, New Caledonia, the Northern Territory, New South Wales and other parts of Queensland. The eastern Queensland Loggerhead population is genetically distinct from Loggerhead Turtles breeding in Western Australia (Dobbs, 2001).

Occasional nesting has been reported to occur on the ocean side of southern Curtis Island and Facing Island (Limpus, 1999) and have been recorded within the outer harbour of Port Curtis and moving north through The Narrows (QDEH, 1994).

Flatback Turtles

Flatback Turtles (*Natator depressus*) are only known to breed in Australia and is one of two species without a global distribution. They feed in the northern coastal regions of Australia, extending as far south as the Tropic of Capricorn. Their feeding grounds also extend to the Indonesian archipelago and the Papua New Guinea coast (DEWHA, 2003). Flatback Turtles have a preference for shallow, soft-bottomed sea bed habitats away from reefs.

Flatback turtles nest at major rookeries located on Curtis and Facing Islands, as well as the nearby Peak and Wild Duck Islands. Approximately 50 breeding females nest at Curtis Island each season (Hodge *et al*. 2006). Inter-nesting flatback turtles are likely to enter Port Curtis from time to time, but are unlikely to feed in the region (Sperling *et al*. 2010) and, based on tag recoveries, have foraging habitats further afield in the Great Barrier Reef lagoon (Limpus *et al*. 2002).

Terrestrial Reptiles

Yakka Skink

During the January 2011 preclearance survey it was noted that the habitats usually occupied by the Yakka Skink (*Egernia rugosa*) (i.e. poplar box, ironbark, brigalow, white cypress pine, mulga, bendee and lancewood woodlands and open forests) are largely absent at the LNG facility site. Curtis Island is also remote from the core area of habitation of the Yakka Skink which is found within the Mulga Lands and Brigalow Belt South Bioregions. The January 2011 preclearance survey verified the earlier results of the GLNG EIS and SEIS studies which did not record the presence of this species and concluded a low likelihood of it being present on Curtis Island (URS, 2011b).

3.2.3 Mammals

Terrestrial Mammals

No terrestrial mammals listed under the EPBC Act were recorded within the LNG facility and associated marine facilities area during surveys conducted during 2008 and 2009 as part of the EIS and SEIS. However, there is a low probability of the Water Mouse (*Xeromys myoides*) being present within or adjacent to the LNG facility and associated marine facilities sites.

Water Mouse

The Water Mouse is listed as vulnerable under the EPBC Act. It is a nocturnal, terrestrial carnivore which occurs in mangroves, saltmarsh, sedged lakes near foredunes and coastal freshwater swamps. A habitat assessment of the LNG facility's suitability for the Water Mouse was carried out by BAAM staff in December 2008. Mangrove habitat within China Bay and Port Curtis was considered to have low to moderate value for Water Mouse on the basis of low to moderate nesting site availability and past disturbance to potential habitats from an access track, refuse dumping and feral animal activity (BAAM 2009).

In addition to the 2008 survey, Water Mouse field investigations were carried out in November 2010 and in April 2012 (BAAM, 2012). The November 2010 survey was conducted over a period of four days and three nights. The survey included a combination of nocturnal trapping of preferred nesting habitat along the landward edge of mangroves and daytime searches for nest mounds and assessment of mangrove habitat values for the species, as recommended by EPBC guidelines for surveying Water Mouse habitat. No Water Mouse were trapped over a total of 445 trap nights, despite seven other rodents being trapped, comprising three Bush Rats (*Rattus fuscipes)* and four juvenile *Melomys* species. Furthermore, no signs of Water Mouse presence (nest mounds or prey middens) were observed during the daytime searches and habitat assessment surveys (BAAM, 2010; 2012).

The April 2012 survey was also conducted over a period of four days and three nights using combination of habitat assessment, daytime searching and Elliott trapping. No Water Mouse were trapped over a total of 300 trap nights. Furthermore, no obvious signs of Water Mouse presence (nest mounds or prey middens) were observed during the habitat assessment surveys. Refer to Figure 3-5 for potential Water Mouse habitat areas and habitat assessment sites in relation to the LNG facility. Water Mouse Survey Reports are available at http://www.santosglng.com.

Figure 3-5. Water Mouse Habitat Areas and Habitat Assessment Sites Indicated

Marine Mammals

Dugong

The Dugong (*Dugong dugon*), which is listed as Vulnerable under the Nature Conservation (Wildlife) Regulation 2006 and Migratory under the EPBC Act, is recorded to occur within the GLNG project area. Dugongs prefer shallow and sheltered areas where their primary food source, seagrass, occurs. The project area is located within the Rodds Bay Dugong Sanctuary. The Gladstone coastline and the Rodds Bay DPA are recognised as important habitat for Dugong populations despite being closely associated with commercial port activities.

A survey conducted in 2005 (Marsh and Lawler 2006) estimated that there were 183 (± 66) Dugongs in the Port of Gladstone area, with dugong feeding activity observed on the majority of intertidal seagrass meadows surveyed during a study of benthic habitats in the port. However, Grech and Marsh (2007) classed the area around Gladstone as low to medium conservation status on the basis of relative density of Dugongs estimated from spatial modelling and frequency analysis taken from time series data over 19 years of aerial surveys (URS, 2009b). A recent review by Sobtzick *et al.* (2013) concluded that the size of the dugong population at Gladstone is likely to be "in the low hundreds at the most".

Irrawaddy Dolphins

The EIS reported that although it is possible that Irrawaddy Dolphins utilise the Port of Gladstone region, the limited number of sightings indicates that the area is not a significant habitat for them. As such, it is concluded that potential impacts from shipping activities as a result of the LNG marine facilities operations are unlikely to have a significant impact on this species (URS, 2009b).

Snubfin Dolphins

Reports prior to 2009, recorded by the DERM (formerly called Environmental Protection Agency (EPA)), of dead Snubfin Dolphins at the mouth of the Calliope River, Fisherman's Landing and on the seaward beach of Facing Island indicate that this species is found within Port Curtis and utilise the area as a habitat. These reports however, allude to boat strike and entanglement in fishing gear and shark control nets as the most likely causes of death. The implementation of mitigation measures such as maintaining constant watch and reducing boat speed will reduce interactions with dolphins during all shipping and dredging activities.

3.2.4 Plants

Terrestrial Regional Ecosystems surveyed at the LNG Facility are shown on Figure 3-6.

No flora species listed under the EPBC Act have been recorded within the LNG marine facilities search area, including the MOF and PLF haul roads. Survey results are consistent with findings from the ecological studies undertaken for the GLNG EIS. The distribution of marine plants in Port Curtis are shown on Figure 3-7.

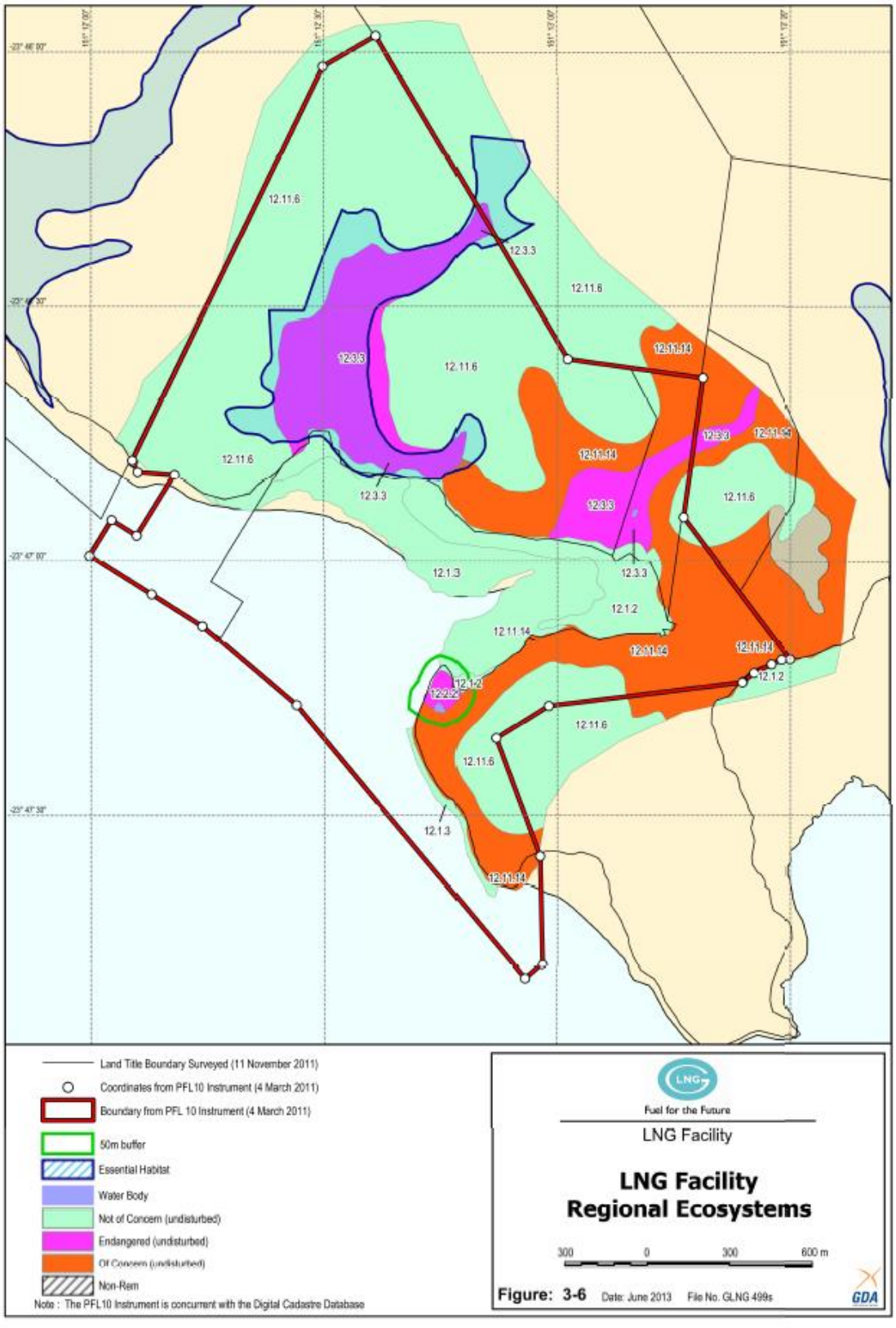

Figure 3-6. LNG Facility Regional Ecosystems

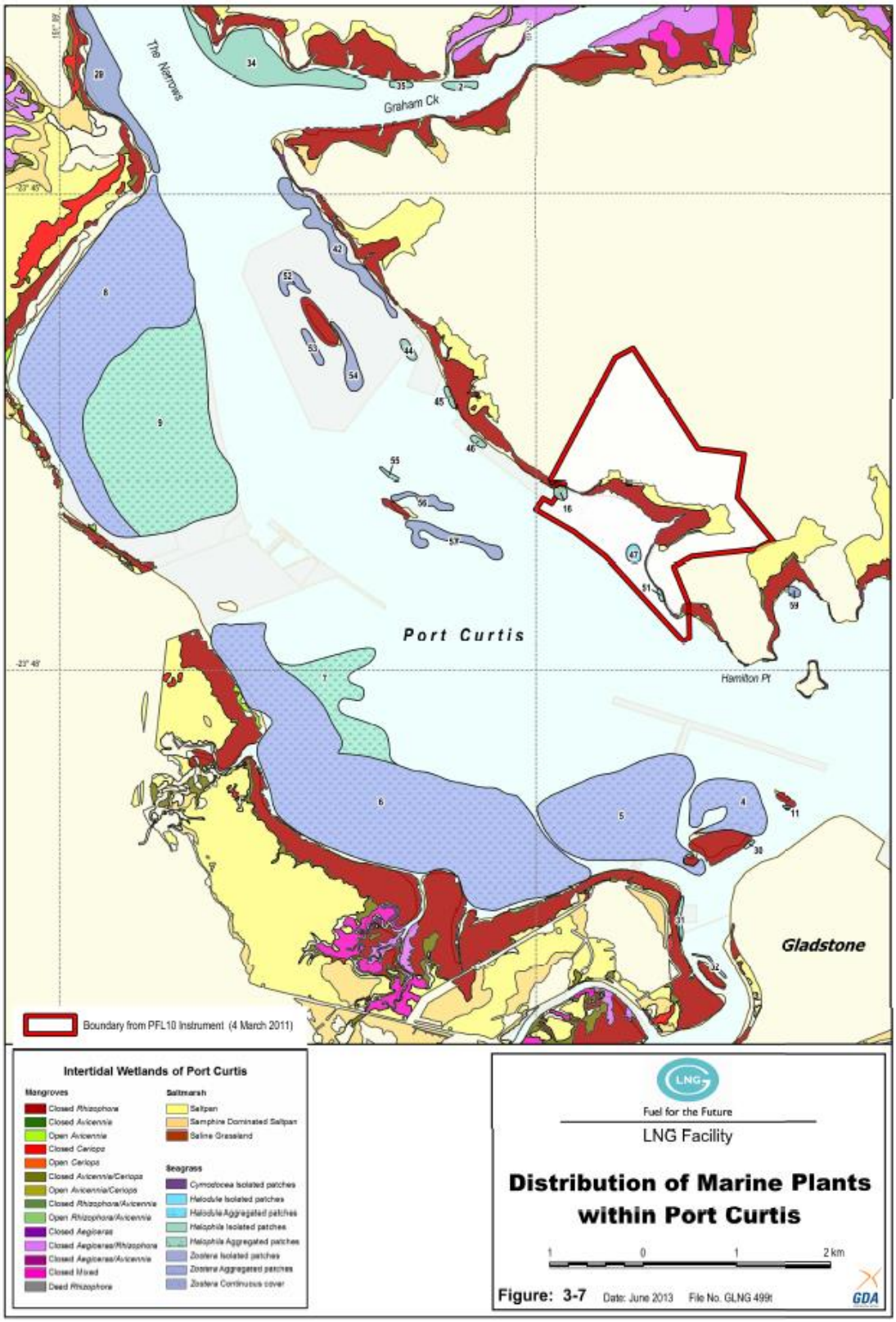

Figure 3-7. Distribution of Marine Plants Within Port Curtis

3.3 Threatened Ecological Communities

The results of assessment and evaluation of ecological communities in the project area are summarised below.

Semi-Evergreen Vine Thicket

A Semi-Evergreen Vine Thicket of the Brigalow Belt (North and South) and Nandewar Bioregions was identified within the MNES search area. However, this community is not found within the LNG marine facilities study area.

Coastal Vine Thicket of Eastern Australia

One endangered ecological community, Littoral Rainforest and Coastal Vine Thicket of Eastern Australia (RE 12.2.2 microphyll / notophyll vine forest) community was identified during field surveys undertaken during the EIS (2008 and 2009) within the proposed MOF haul road location. Subsequent boundary refinements to the LNG facility footprint resulted in minor adjustments to the footprint and amendments to areas of vegetation communities impacted. Of significance is the exclusion of any disturbance to RE 12.2.2 (microphyll / notophyll vine forest on beach ridges) from the revised footprint (URS, 2009c) (see Table 4 – 17).

During the January 2011 preclearance surveys of the Critically Endangered ecological community, Littoral Rainforest and Coastal Vine Thickets of Eastern Australia was confirmed at Hamilton Point. However, as discussed above this community is located outside the area of potential impact from the LNG facility and associated infrastructure. No other examples of this community were encountered during the field survey within the LNG facility site (URS, 2011b).

Seagrass Meadows

Seagrass meadows in Queensland are known to provide valuable nursery habitats for juvenile commercial and recreational fisheries species, as well as important food resources for endangered and threatened species such as dugong and turtles (Chartrand *et al.*, 2009). Seagrasses also show measurable response to changes in water quality making them ideal ecological communities for monitoring the “health” of port environments. The value of seagrasses in the Port Curtis area to Dugongs has been recognised by the declaration of the Rodds Bay DPA under the Queensland *Fisheries Act 1994* in 2002.

A total of 7,246 ha of intertidal (coastal) seagrass beds has been identified within the Port of Gladstone – Rodds Bay Dugong Protection Area (DPA), with an additional 6,332 ha in deep-water areas (>5 m Mean Sea Level) identified to the east and south of Facing Island (Rasheed *et al*. 2003; Rasheed *et al*. 2008). No deep-water seagrass communities have been reported within the inner-port area.

During a field study conducted in May 2008, no intertidal or sub-tidal seagrass was observed along the western side of Curtis Island or adjacent to North Passage and South Passage Island. This is contrary to results from baseline monitoring that reported the presence of ephemeral seagrass species dominated by *Zostera capricorni* with *Halophila ovalis* and some *Halophila decipiens* adjacent to South Passage Island and North Passage Island (Rasheed *et al.*, 2003), and isolated patches of *Zostera sp*. adjacent to China Bay (Danaher *et al.*, 2005). Seagrass meadows in 2009 consisted of isolated patches of *H. ovalis* and *Z. capricorni* adjacent to South Passage Island and North Passage Island. The three seagrass meadows identified adjacent to China Bay consisted of isolated patches of *H. ovalis* and *Halophila uninervis* with some mixed species. All seagrass meadows recorded in 2009 were of small area and biomass.

An additional seagrass survey requested by the Department of Employment, Economic Development and Innovation (DEEDI) was undertaken in November 2010 in localities adjacent to the MOF and China Bay. No seagrass was found at any of the 312 stations sampled using a van Veen grab. This result indicates that the limited amounts of seagrass (both in terms of biomass and percentage cover) found by Thomas et al (2010) in 2009 may be no longer present. The decreasing annual trend in seagrass cover in 2010 also follows that seen in the area between 2008 and 2009 (URS, 2011c). Refer to Figure 3-7 for details on the seagrass communities.

Seagrass distribution and per cent cover has varied significantly within Port Curtis since 2011, following some severe flood events. While some recovery was observed in 2012, a flow event in the Calliope River caused a reversal of much of that recovery (Bryant *et al.* 2013). Seasonal influences on temperature, riverine discharges and light intensity are also factors affecting seagrass growth at Port Curtis over periods of months. A small area of *Halophila ovalis* has been identified near the LNG Facility jetty, with the inshore channels leading to the LNG Facility only having small areas of sparse seagrass (Bryant *et al*. 2013).

4 ENVIRONMENTAL MANAGEMENT AND MITIGATION PLANS

The facility was designed using Best Available Techniques (BAT), and as discussed in Section 2.10, a Design Safety Case was completed to support the construction and operation of the LNG facility in a manner that prevents personal injury, loss of life or physical damage to property and the environment. Environmental values and potential impacts from LNG facility operations are discussed below, along with the management and reporting practices to be employed to manage and mitigate potential impacts to these values during operation of the LNG facility and associated marine infrastructure. Further details regarding environmental values can be found in the GLNG EIS and SEIS.

4.1 Air Quality

Air quality in the project area, assessment of potential emissions and greenhouse gas (GHG) impacts, and proposed mitigation measures associated with the operation of the LNG facility are discussed below.

4.1.1 Description of Environmental Values

Air quality for the LNG facility study area is derived from a number of sources including air quality monitoring data from DEHP and other modelling sources. A number of long-term air quality monitors are located within the Gladstone region as part of DEHP and Queensland Health's (QH) Clean and Healthy Air for Gladstone program. Some of the air quality parameters measured as part of the program are shown in Table 4-1.

Table 4-1. Selected Queensland DEHP Monitoring sites in the Gladstone Region

Pollutant	Targinie	Clinton	Barney Point (mobile)	South Gladstone	Boat Creek	Auckland Point	Boyne Island (Beacon Avenue)
Nitrogen oxides (NO_X)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sulphur dioxide (SO_2)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Particulate Matter <10 microns (PM_{10})	Yes	Yes	Yes	Yes	Yes	No	Yes
PM <2.5 microns ($PM_{2.5}$)	Yes	No	Yes	Yes	Yes	No	Yes
Ozone (O_3)	No	No	No	No	No	Yes	No

A summary of the ambient air quality monitoring data from the Clean and Healthy Air for Gladstone program for June 2008 to July 2010 (DERM 2011) for NO_2, SO_2, O_3, PM_{10} and PM2.5 are provided in Table 4-2 (N.B. not all sites were monitored for the entire period).

Table 4-2. Air Quality Monitoring Data for Gladstone Region: June 2008 to July 2010

Pollutant	Averaging Time	Maximum Pollutant Concentration at Monitoring Location (µg/m³)							Guideline (µg/m³)
		Barney Point	South Gladstone	Clinton	Auckland Point	Boyne Island	Boat Creek	Targinie	
Nitrogen Dioxide (NO_2)	1 hour	33	33	35	40	44	59	38	250 EPP (Air) 2008 246 NEPM
Sulphur Dioxide (SO_2)	1 hour	67	140	155	62	72	89	66	570 EPP (Air) 2008 and NEPM
Ozone (O_3)	1 hour	n/a	n/a	n/a	47	n/a	n/a	n/a	210 EPP (Air) 2008 and NEPM
	4 hour	n/a	n/a	n/a	42	n/a	n/a	n/a	160 EPP (Air) 2008 179 NEPM
Particulate Matter (PM_{10})	24 hour, maximum (average)	260.9 (26.5)	252.3 (19.8)	275.8 (17.7)	n/a	264.4 (16.4)	275.6 (18.7)	314.6 (14.8)	50 EPP (Air) 2008 and NEPM
Particulate Matter ($PM_{2.5}$)	24 hour, maximum (average)	62.2 (9.2)	50.8 (8.3)	39.0 (7.1)	n/a	105.6 (5.7)	218.2 (7.0)	61.5 (4.4)	25 EPP (Air) 2008 and NEPM

The monitoring results show that the existing levels of NO_2, SO_2 and O_3 are well below the relevant Environmental Protection (Air) Policy 2008 (EPP (Air) 2008) guidelines and National Environmental Protection Measure for Ambient Air Quality (Air NEPM) guidelines at all monitoring sites.

During the monitoring period there were 68 exceedences of the NEPM 24-hour average PM_{10} standard of 50 µg/m³ and 43 exceedences of the NEPM 24-hour average advisory $PM_{2.5}$ standard of 25 µg/m³ across the Gladstone air monitoring network with most occurring between August and October 2009. All these exceedences were likely associated with the presence of additional sources of PM_{10} and $PM_{2.5}$ in the region from dust storms and/or smoke from bushfires (DERM 2011). The 24-hour average concentration for the monitoring period for all sites for both PM_{10} and $PM_{2.5}$ were lower the standards in the respective Guidelines.

4.1.2 Potential Adverse or Beneficial Impacts

Emission sources associated with the LNG facility operations include the following.

- Point source emissions during normal operating conditions including emissions from processing feed gas for LNG production and combustion of gas to support process operations;
- Point source emissions during start-up, maintenance, or upset conditions. Emission rates during these activities (outside normal continuous operations) may be variable, but are generally of short duration.

- Fugitive emissions and mobile/temporary sources including vehicles, vacuum trucks, pumps or mobile generators that may be needed for maintenance or other works of short duration. Fugitive emissions may also result from trace leaks of process equipment (e.g., process safety valves (PSVs) and vents on process/storage equipment, etc.)

The location of point source emissions at the LNG facility are illustrated on Figure 4-1 and listed in Environmental Authority EPPG00712213. Potential impacts of static and fugitive emissions are discussed below.

Modelling of predicted ground level constituent concentrations at the identified potentially sensitive receptors due to emissions from the LNG facility are low with predicted maximums as follows:

- The maximum predicted ground level 1-hour average NO_2 concentration is 47 µg/m³. The cumulative impact, including a background level of 30 µg/m³, is predicted to be 77 µg/m³. This is well below the air quality objective specified in the EPP (Air) for NO_2 of 250 µg/m³ (SLR 2014)

  The maximum predicted incremental annual average NO_2 concentration is 0.6 µg/m³. The cumulative impacts predicted based on a background annual average NO_2 concentration of 5 µg/m³ are well below the EPP (Air) objective of 33 µg/m³ (health and biodiversity of ecosystems)(SLR 2014).
- The maximum predicted ground level 24-hour average PM10 concentration is 3.2 µg/m³. The cumulative impact, including a background level of 30 µg/m³, is predicted to be 33.2 µg/m³. This is well below the EPP (Air) objective for 24-hour PM10 concentrations of 50 µg/m³ (SLR 2014).
- Total Suspended Particles (TSP) and $PM_{2.5}$ emissions were assumed to be equivalent to PM_{10}, resulting in the same low incremental impact of these pollutants as for PM_{10}.
- Maximum SO_2 concentrations of 0.3 µg/m³ for 1-hour averaging time, 0.1 µg/m³ for 24-hour averaging time, and less than 0.05 µg/m³ for the annual average concentration.
- Air dispersion modelling has predicted ground level NO_2 concentrations below the EPP (Air) 2008 guidelines for human health. Modelling results also show that the impacts from the LNG facility's SO_2, CO, and particulate emissions are negligible.

LNG does not contain strong odorous compounds. Minor odour associated with oxides of nitrogen (primarily due to NO) is not a concern due to the relatively low levels of these pollutants released and the distance from the LNG facility to residential locations. The odour related to non-methane VOC releases is not of concern either as their emissions from the LNG facility are very low, and emissions such as ethane and propane are odourless.

Air emission release points and associated NO_2 emission limits are specified in Environmental Authority EPPG00712213.

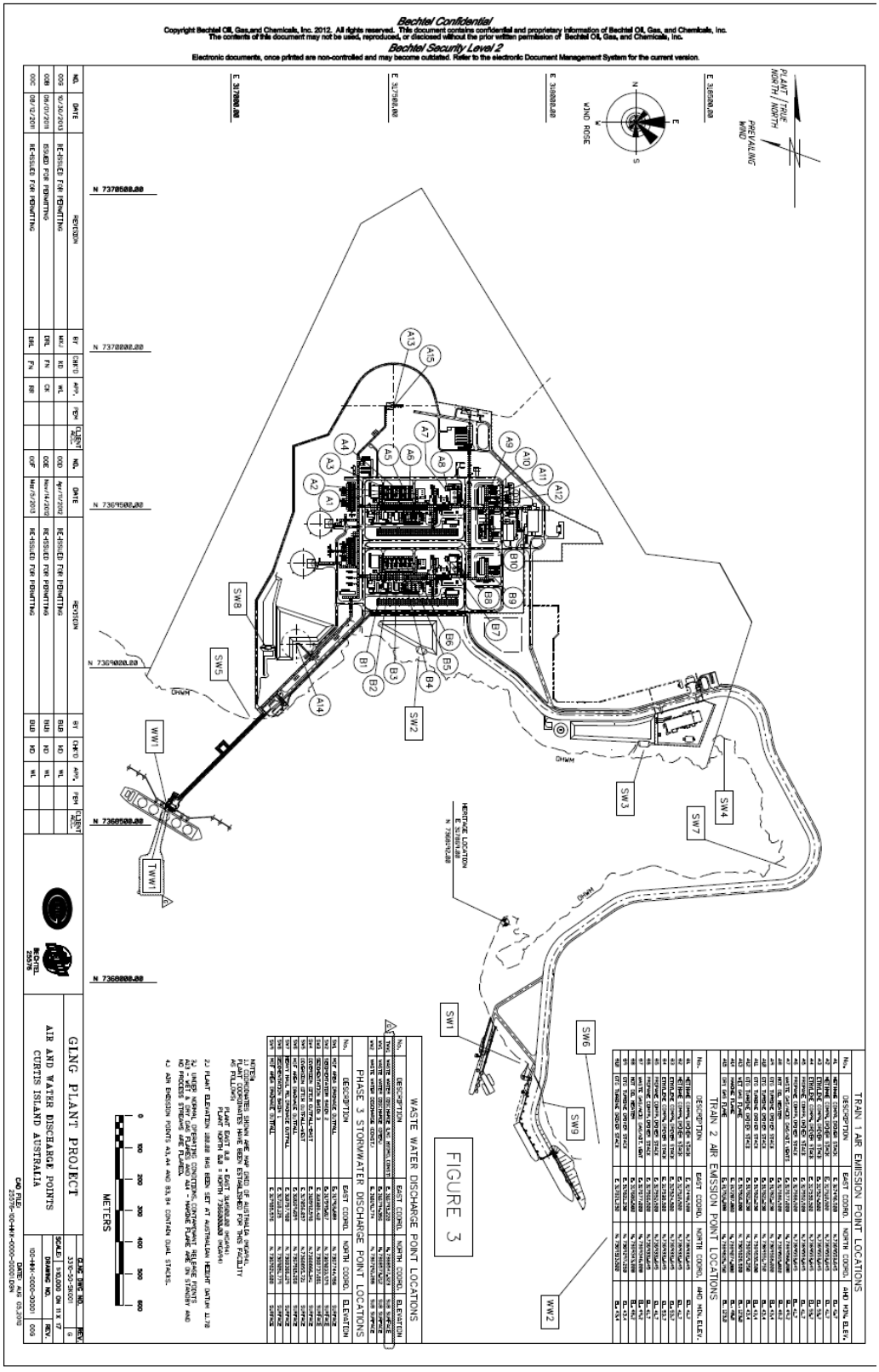

Figure 4-1. LNG Facility Air and Water Discharge Locations

4.1.2.1 *Potential cumulative impacts during normal operation of all proposed LNG facilities*

The cumulative impact assessment of air emissions from all of the proposed Gladstone LNG projects were reported in the EIS for the Australia Pacific LNG Project. Cumulative impacts from existing and proposed future industrial developments were assessed. The assessment included emissions from all of the existing Gladstone industrial plants included in Gladstone Airshed Modelling System (GAMS) Version 3 airshed model together with the following LNG projects:

- Queensland Curtis LNG (Curtis Island)
- Australia Pacific LNG (Curtis Island)
- GLNG Project (Curtis Island)
- LNG Limited (Fishermans Landing)
- Sun LNG (Fishermans Landing)

The cumulative assessment indicated that all predicted ground level concentrations will be below the air quality objectives of the EPP (Air) at the nearest sensitive receptors.

Modelling has shown that the ground level concentrations for NO_2 (1 hour) and SO_2 (1 hour and 24 hour) from the background sources (i.e. without any input from the GLNG Project) exceed guideline levels in the vicinity of the Clinton and Yarwun areas. Ground level concentrations from the LNG facility alone are well below the relevant guidelines. There are no changes in the maximum predicted background ground level concentrations caused by the GLNG Project emissions.

It should be noted that the guideline exceedances presented in GLNG SEIS Part 3: Attachment J, Section 5.7, Table 5.3 occur in a very small area in the vicinity of existing industrial uses in the Clinton and Yarwun areas. Outside of this limited area all air quality guidelines are met both with and without the GLNG Project emissions.

The significance of the overall cumulative impact on air quality is assessed as low.

4.1.2.2 *Potential impacts during upset conditions of the LNG facility*

The LNG facility was designed in accordance with applicable safety standards and guidelines to minimise the likelihood of plant upset conditions occurring. The design uses the operating principle that the flares on site act as the back-up measure for releases of gas or refrigerants from the site in the event of a process or equipment failure.

Scheduled maintenance of the LNG facility is planned to occur approximately every three years. Flaring required during scheduled maintenance is expected to occur for approximately 1 to 2 days to shut-down and start-up the facility. This was modelled as an upset scenario. Modelling results indicate that the EPP (Air) 2008 1-hour NO_2 guideline of 250 µg/m³ will not be exceeded at any sensitive receptors for any emission scenario either as a standalone industrial facility or with consideration of background emission sources in

Gladstone, at any sensitive receptors. The predicted impacts for this upset condition are similar to or slightly lower than impacts under normal operating conditions.

4.1.2.3 Greenhouse Gas Emissions

Greenhouse gas (GHG) emission Scope 1 sources (i.e. those sources directly linked to the operation of the LNG facility included in the assessment inventory were:

- Fuel consumption in process equipment
- On-site power generation via gas turbine power station
- Diesel fuel consumption in vehicles during all stages of the project
- Flaring and venting of gas

Scope 2 emissions are the release of GHGs as a result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but do not form part of the facility. Scope 2 emissions for the LNG facility and associated infrastructure were considered to be immaterial as there will be no significant purchases of electricity for any portion of the project.

Diesel consumption by vehicles at the facility during operation was considered immaterial as no large vehicles will be operating on-site on a regular basis and light vehicle traffic will be minimal. However, emissions produced by employee commuter traffic and materials and equipment deliveries to the LNG facility were calculated.

Flaring rates provided for the LNG facility design were based on flaring required for scheduled shutdowns for maintenance and inspection. Flaring for plant upset conditions were not included as this is assumed to be a rare or non-occurring situation and unlikely to represent a significant contributor to total GHG emissions.

Fugitive emissions include all those quantities of gas that are lost directly to the atmosphere through uncontrolled sources such as leaks from process equipment or PSVs. Leaks typically occur at pipe joints such as flanges, caps, plugs, valves, pump seals, and connections points. Estimates of fugitive emission rates from the facility design were included in the inventory.

4.1.2.4 Potential impacts during GLNG Project life

GHG emissions were also calculated as a total over a 25-year period in order to capture the project's full impact and eliminate the averaging used to produce the annual emission rates. Scope 2 emissions were not included for the project operation as they are immaterial in the context of the total emissions. Over the entire project life GHG emissions are estimated to be approximately 66,400,000 CO_2-e for the 3 Mtpa and approximately 110,300,000 – 165,900,000 CO_2-e for the 10 Mtpa base cases. This represents for the GLNG Project a 0.46% (3 Mtpa) and 0.86% - 1.25% (10 Mtpa) Scope 1 contribution to the total Australian emissions and 1.55% (3 Mtpa) and 2.90% - 4.21% (10 Mtpa) Scope 1 contribution to the total Queensland emissions when compared to 2006 data based on current growth in Australian emissions.

The LNG facility, as constructed, is a two train operation with a 7.8Mtpa design capacity. Actual emissions will lie somewhere in between the 3Mtpa and 10Mtpa base cases.

4.1.3 Environmental Protection Commitments, Objectives and Control Strategies

The environmental protection commitments, objectives and control strategies for potential impacts to air from LNG facility operations are summarised in Table 4-3. .

Table 4-3. Air Operational Environmental Management Sub Plan - Air

AIR – LNG facility and Associated Infrastructure – Operational EM Sub Plan
Operation Policy or Management Objective To operate the LNG facility in a manner that maintains ambient air quality of the local area in accordance with licence conditions.
Performance Criteria Maintain specified emission levels under normal operating conditions. Operate in accordance with the project's environmental permits.

Implementation Strategy
• The design of the LNG facility has incorporated the use of Best Available Technology Not Entailing Excessive Cost (BATNEEC). In line with this commitment, measures to reduce air quality emissions include the following:
  ○ Once operational, generation of on-site power will utilise methane gas for the LNG facility's electricity requirements to avoid the use of coal-fired power from the Queensland power grid.
  ○ Use of dry low-NO_x technology in refrigeration compressors and power generation turbines to reduce NO_x emissions.
  ○ Incorporation of waste heat recovery units on gas turbine exhausts to provide hot oil for use elsewhere in facility.
  ○ The Flare/Vent System is designed to allow safe disposal of hydrocarbon streams and venting of waste gases, particularly during shutdowns and process interruptions.
  ○ As part of the carbon dioxide removal process, careful selection of solvents to minimise the co-release of methane.
  ○ Boil off gas from LNG storage will be used as a fuel rather than flaring to reduce emissions from flares.
  ○ Where practicable, major emission sources have been separated to avoid plume convergence on the site.
• Point-source air emissions will be managed using best practice technology and emission controls.
• Stacks within the plant are provided with monitoring ports where necessary.
• The LNG facility will consider participation in the Clean and Healthy Air for Gladstone program if invited by DEHP to participate.

Monitoring and Auditing Air emission monitoring will be conducted as outlined in Section 6 of this OEMP. Monitoring will include visual observation and quantitative measurements of air emissions to document compliance with discharge limits in Project approvals. Auditing will be conducted in accordance with Section 1.10 of this OEMP.

Reporting and Corrective Action

Reporting of environmental non-compliances with be in accordance with environmental permit requirements.

Environmental Monitoring Records will be recorded and managed in an environmental monitoring database.

Reporting, investigation and management of corrective actions associated with environmental events will be managed through the IMS.

4.2 Noise

Assessment of noise sources in the project area and evaluation of the potential terrestrial noise impacts and proposed mitigation measures for the operational phases of the LNG facility are discussed below. Further details of the noise assessment are provided in the EIS. Potential impacts and mitigation measures for shipping activities are addressed in the Operational Shipping Activity Management Plans for the LNG facility operations.

4.2.1 Environmental Values

4.2.1.1 Terrestrial Noise

Background noise monitoring was conducted by Heggies (now SLR Consulting) in 2008 to determine the existing ambient noise environment in the vicinity of the LNG facility. Measurements were taken at seven ambient noise monitoring locations within the vicinity of the LNG facility to confirm background noise levels and observe typical noise sources (See Table 4-4). The nearest receptor identified during the EIS process was located on Tide Island 3.4 km south of the proposed LNG facility. It is noted that Tide Island is now leased to GLNG and is no longer considered to be a sensitive receptor.

Table 4-4. Noise Monitoring Locations

Monitoring point	Location	Distance from LNG facility (km)
Plant 1 (P1)	Tide Island (GLNG owned) Watt Island	3.4 4.4
Plant 2 (P2)	Curtis Island (South End)	10
Plant 3 (P3)	Auckland Hill	7.9
Plant 4 (P4)	Yarwun	12.4
Plant 5 (P5)	Bridge Crossing (Targinie)	10.5
Plant 6 (P6)	Gladstone Marina	7.2
Plant 7 (P7)	Fishermans Rd	7.0

Source: Heggies 2009

The background levels at each monitoring location, provided in Table 4-5. , were derived from the monitoring program and adjusted to take into consideration the extraneous noise, such as insects and wind. Typical noise sources associated with the ambient noise

environment in Gladstone include industrial noise, power boats, domestic noise, traffic, insect, bird/bat and wind noise, and ocean movement.

Table 4-5. Ambient Noise Levels

Monitoring point	Background Level (dBA)		
	Day (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 7am)
Plant 1 (P1)	41[1]	41[1]	41[1]
Plant 2 (P2)	33	32	31
Plant 3 (P3)	42	42	37
Plant 4 (P4)	41	40	37
Plant 5 (P5)	31[2]	31[2, 3]	33[3]
Plant 6 (P6)	45	42	38
Plant 7 (P7)	50[4]	45[4]	40[4]

Notes:
[1]Adjusted to correct for elevated wind levels and increased noise levels due to lapping of harbour waves
[2]Adjusted to correct for elevated wind levels and increased noise levels due to movement of trees
[3]Adjusted to correct for enhanced noise levels as a result of insect noise
[4]Assumed typical background noise levels for an 'Industrial Area' as defined in the Ecoaccess guideline, *Planning for noise control* 'Recommended Outdoor Planning Noise Levels'

Table 4-6. lists the environmental values that are set out in Section 7 of the EPP (Noise).

Table 4-6. Environmental Values for the Acoustic Environment

Environmental Values	Relevance to Gladstone Region
Protection of the health and biodiversity of ecosystems	✓
Protection of human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following— (i) sleep (ii) study or learn (iii) be involved in recreation, including relaxation and conversation	✓
Protection of the amenity of the community	✓

Table Note:
✓Suitable for the environmental value
× Not suitable for the environmental value

4.2.1.1.1 Protection of the health and biodiversity of ecosystems

According to the EPP (Noise), sensitive environmental receptors include:

- Marine park under the *Marine Parks Act 2004*

- Protected area, or an area identified under a conservation plan under the *Nature Conservation Act 1992* as a critical habitat or an area of major interest

To conserve the environmental values of these sensitive receptors, the level of noise is to be maintained to a level that preserves the amenity of the existing marine park, area or place.

Monitoring points, Plant 1 (P1) and Plant 2 (P2), are situated on Tide and Witt Islands and at South End respectively and as such, are suitable representations of the noise impact from the LNG facility on sensitive receptors (i.e. Great Barrier Reef World Heritage Area and the Environmental Management Precinct on Curtis Island).

The background levels at Tide and Witt Islands (P1) are 41 dB(A) at all times and range from 31 to 33 dB(A) at South End monitoring point (P2). Common noises at these locations include industry from Gladstone, bird and insect noises, ocean movements, power boats (P1 only) and domestic noises (P2 only).

The proposed operational noise limits will reduce the allowable noise from the LNG facility during the day (7am – 6pm) at both P1 and P2. During the night (10pm – 7am), the allowable noise from the LNG facility will increase at both sites but will remain below the measured background levels.

4.2.1.1.2 Protection of human health and wellbeing

Sensitive receptors in terms of human health and wellbeing include:

- Dwellings
- Libraries, childcare centres, kindergartens, schools, colleges, universities and other educational institutions

The EPP (Noise) sets an acoustic quality objective of 50 dB(A) ($L_{Aeq,adj,1hr}$) for outside dwellings during the day and evening. The EPP (Noise) objective for inside dwellings is 35 dB(A) ($L_{Aeq,adj,1hr}$) for day-time and evening and 30 dB(A) ($L_{Aeq,adj,1hr}$) for night-time. As no noise monitoring was conducted indoors, there are no results to compare with the EPP (Noise) objectives for inside dwellings.

All the monitoring points were located outside dwellings scattered across the Gladstone region. The background levels, with no background creep, do not exceed 50 dB(A) at any location.

4.2.1.1.3 Protection of the amenity of the community

Sensitive receptors relating to the amenity of the community include:

- Parks and gardens that are publically accessible for use other than for sport or organised entertainment

To conserve the environmental value of the community amenity, the level of noise is to be maintained at a level that preserves the amenity of an existing park or garden.

Monitoring points, Plant 3 (Auckland Hill) and Plant 6 (Gladstone Marina) are located within the vicinity of a number of recreational areas. Plant 3 has a background level of 42 dB(A) during the day and evening and 37 dB(A) during night-time while Plant 6 has a background noise level ranging from 38 to 45 dB(A). Common noises at these locations include audible industrial noise, particularly from coal loading, traffic (P5 only), bird and insect noise and tree movement.

The EA noise limits will maintain the noise level at all times to these background levels with no background creep in accordance with the EPP (Noise).

4.2.1.2 Marine Noise

Marine noise in relation to the LNG facility operations is associated with marine traffic (i.e., ferry, barge and LNGC). The likelihood of an adverse acoustic impact upon a marine species depends upon the likelihood that the species will be in an area that contains high sound levels. If a species is likely to be within an area influenced by high sound pressure levels it will depend upon available food sources or documented migration paths, for example, that are in or traverse the area.

Turtle, dugong, dolphin, whale shark and humpback whale were considered in the assessment insofar that they *could* be present within the area. The most likely coincidence of species in the LNG facility and associated infrastructure areas identified to have elevated underwater noise levels relate to turtle and migrating dugong and dolphin. The water rat and yakka skink would only inhabit the fringe coastal areas and are unlikely to be impacted by underwater sound levels from marine traffic and are not considered further.

Manatee and dugong have similar vocalization and it is presumed that dugong have similar audiograms to manatee. A study of the effects of environmental noise on Manatee (Miksis-Olds, 2006) demonstrated a preference for sea grass habitat that has particular acoustic conditions. A preference was shown from observations and sound recording correlations that the grass beds manatees selected were those that had lower ambient noise below 1 Kilohertz (kHz) and above 2 kHz.

A sound pressure estimate of 150 decibel ratio (dB) at 10 metres was measured from 100 horsepower (hp) and 115 hp outboard engines moving at 5 miles per hour (8 km/hr) (Miksis-Olds, 2006). Frequency weighting of the sound to account for the hearing characteristics of the Manatee shows that such operations (outboard motor) provide peak audibility in the 2 kHz frequency range, although maximum sound energy is below 1 kHz. Playback of these sounds to wild manatee (150 dB received level) showed no significant response; however sounds from typical personal watercraft approaches (typically 160 dB received level) that contain similar high frequency sounds at some 15 dB higher sound pressure level in the 5 kHz to 20 kHz region, showed significant response, with 20% of the animals exposed leaving the area. The tests were completed using recordings played to manatees 10 metres away and under these circumstances high frequencies would not be attenuated significantly.

As summarised in the EIS, the range of ships in the Port of Gladstone is not dissimilar in size to those in Port Phillip Bay, Victoria where underwater noise emissions from general shipping have been recorded. Underwater sound levels from passing ships at 100 metres were measured for the Port of Melbourne Channel Deepening Project. On average the typical maximum short-term sound emission level was 149 dB (4 dB standard deviation) at a distance of 100 metres, similar to the low frequency sound playback level reported to produce no significant response in wild manatee 10 metres away.

4.2.2 Potential Adverse or Beneficial Impacts

4.2.2.1 Terrestrial Noise

Operational noise sources primarily relate to the operation of the LNG facility and process trains (single train operation, and two-train operation following commissioning of Train 2). Other noise sources associated with the plant include the high pressure flare operation and LNGC movements. Flare noise is intermittent and a short term event. Flaring only occurs when there is an upset within the facility, which is rare, or during scheduled maintenance.

The initial GLNG EIS study, which the existing EA noise limits for operations are based on, used noise criteria in accordance with the Ecoaccess guideline, 'Planning for noise control'. Since the EIS was issued, the Queensland Government has amended the *Environmental Protection (Noise) Policy 2008* (EPP Noise) and introduced the Guideline *Prescribing Noise Conditions for Environmental Authorities for Petroleum and Gas Activities*.

At most locations, P1 to P7, the measured background noise levels are above the deemed background noise levels in the DEHP guideline, '*Prescribing Noise Conditions for Environmental Authorities for Petroleum and Gas Activities*'. As such, the measured background noise levels have been used in place of the deemed background noise levels in determining the appropriate noise criteria.

The Ecoaccess guideline calculates long term noise emission limits based on background noise levels plus background creep of 5 dB(A) (between 6am and 10pm) or 3 dB(A) (between 10pm and 6am). The EPP (Noise) calculates continuous noise as the background noise levels plus 0 dB(A) background creep.

The most stringent noise criteria under current legislation and guidelines are the background creep criteria for continuous noise, specified in the EPP (Noise). Noise limits at sensitive receptors for the LNG facility operational phases are set out in Environmental Authority EPPG00712213.

4.2.2.2 Marine Noise

Normal operating conditions for the LNG facility and associated marine facilities are not expected to produce noise levels significantly above ambient background levels such that there are communication problems or sound levels causing avoidance for marine mammals. The movements of tugs and vessels to the loading berth are short term events and are unlikely to produce long term evacuations from the area.

Due to the high volume of marine traffic already present on the waters of Gladstone Harbour, ferries/barges for operations personnel transport and materials receiving is expected to have negligible noise impacts on surrounding sensitive receptors (e.g. Tide Island).

4.2.3 Environmental Protection Commitments, Objectives and Control Strategies

The environmental protection commitments, objectives and control strategies for potential impacts of noise from LNG facility operations are summarised in Table 4-7.

Table 4-7. Operations Environmental Management Sub Plan - Noise

NOISE – LNG Facility and Associated Infrastructure – Operational EM Sub Plan
Operation Policy or Management Objective To prevent excessive noise emissions from LNG facility operations.
Performance Criteria • All activities will be conducted in accordance with the relevant Environmental Permits.

Implementation Strategy
• Managing noise in order to meet applicable noise criteria at agreed sensitive receptors during reasonably foreseeable meteorological conditions.
• The fitting of appropriate acoustic lagging on selected compressor piping.
• Acoustic controls to reduce noise emissions will be considered for the following areas:
  ○ Acoustic insulation on selected piping.
  ○ Silencers on select combustion turbines.
  ○ Low-noise air-cooled exchangers.
  ○ Silencers on gas turbine generators.
  ○ Acoustic blankets on select compressors.
• Where practicable, items that cannot comply with the 85 dBA specification will be contained in buildings or specially designed acoustic enclosures.
• Best available work practices will be employed on-site to minimise occupational noise levels.
• To mitigate disturbance to marine fauna barge/ferry mitigation strategies include:
  ○ Use of fewer larger craft vessels rather than multiple small craft;
  ○ Use existing deep water channels wherever possible; and
  ○ Strict adherence to speed limits

Monitoring and Auditing Should a justifiable noise complaint be received, an appropriately designed monitoring program will be implemented. Any noise monitoring will be conducted in accordance with the requirements of the Environmental Protection Policy (EPP (Noise)) and any relevant Environmental Authority conditions.
Reporting and Corrective Action Reporting of environmental non-compliances with be in accordance with environmental permit requirements. Environmental Monitoring Records will be recorded and managed in an environmental monitoring database. Reporting, investigation and management of corrective actions associated with environmental events will be managed through the IMS.

4.3 Visual Impact and Light

The project site was undeveloped prior to construction of the LNG facility and associated marine facilities. The impact on the visual amenity of the area and impact of lighting during operations were considered in the project approvals and design of the facility. The resultant impact and mitigation measures are summarised below.

4.3.1 Environmental Values

The visual amenity of the Project area and potential for impacts associated with lighting at the LNG facility were considered in the design and operation of the LNG facility. As discussed in Section 3, the LNG facility is located within the GBRWHA which is listed as a WHA for its outstanding universal value, and also within the GSDA where visual amenity is already attenuated by existing industrial developments. In addition to visual amenity there are fauna species expected to inhabit or migrate through the area (i.e., turtles) that are considered to have potential to be impacted by lighting from the LNG facility.

4.3.2 Potential Adverse or Beneficial Impacts

The natural landscape of the LNG facility site and associated marine facilities absorb some of the changes with construction of the facility, however structures higher than existing tree layers and man-made elements that contrast with surrounding landscape are visually observable. The majority of the LNG facility infrastructure is visible from Port Curtis, however the LNG trains and storage tanks are not visible from most views of the site due to the tree covered ridges that surround the valley in which the facilities were constructed. The flare stacks and flames will be visible from most vantage points around the site and ships/barges/ferries moored at the MOF or PLF will be visible from Port Curtis and Mount Larcom-Gladstone Road in Gladstone (URS, 2009e).

Lighting at LNG facility and associated marine facilities, including warning and security lights, is required for safe operations at the LNG facility. Lighting has been linked to disorientation in turtles, particularly during periods of nesting and hatching (Lutcavate et al, 1996; Pendoly 1997), and may impact on crew and passengers of recreational watercraft on Port Curtis waterway and ships berthing at Fisherman's Landing (URS, 2009e).

4.3.3 Environmental Protection Commitments, Objectives and Control Strategies

GLNG has collaborated with QCLNG and APLNG to develop a Long Term Turtle Management Plan. This plan has been approved by DoTE independently of the GLNG CEMP for MNES and this OEMP for MNES to monitor impacts to turtles.

The environmental protection commitments, objectives and control strategies for visual impact and light associated with the LNG facility operations are summarised in Table 4-7.

Table 4-8. Operations Environmental Management Sub Plan – Visual Impact and Light

VISUAL IMPACT AND LIGHT – LNG Facility and Associated Infrastructure – Operational EM Sub Plan
Operation Policy or Management Objective To minimise the visual impact and the impact of light emissions from LNG facility operations.
Performance Criteria • All activities will be conducted in accordance with the relevant environmental permit conditions.

Implementation Strategy
• Mitigation of visual impact (including lighting) was considered in the design, layout and construction of the facility which minimised clearing required and utilised the natural landscape to the extent possible to achieve screening of facilities.
• To minimise visual impact during operation of the LNG facility and associated marine infrastructure, GLNG is committed to applying a colour scheme to the facilities and buildings (excluding LNG storage tanks and any necessary corrosion-protected structures and pipe insulation) from the palette of predominate colours found around Curtis Island. In addition maintenance of treated earthworks (rehabilitated areas) will be maintained to promote vegetation establishment and visual amenity.
• Potential impacts from lighting at the LNG facility are mitigated through the design height, orientation and shading/shrouding of lighting and controlling to the extent practical the frequency, duration and timing of gas flaring. To minimise light spills and directed light outside the LNG facility and associated marine facility, boundary lights are screened/hooded to the extent possible to restrict light to the immediate work area where needed.
• As stated in Section 8 of the SEIS the Visual assessment (URS, 2009e) estimated that the flare stack may be partially visible from Curtis Island South End and Facing island townships.
• As identified in the EIS (Figure 8.12.1 in the EIS and Figure 2.1 in the Turtle and Dugong Management Plan in EIS Supplement Attachment F5 (URS 2009a), the turtle nesting beach on Curtis Island lies just outside of the range of direct line of sight of the flare stack and associated flaring activities.
• The potential for impacts to hatchling turtles from LNG facility flaring events are likely to be low based on the following:
  ○ There is a recognised spectral intensity that lies outside of the recognised range of the most disruptive light waves for turtle hatchlings;
  ○ The distance from the flare stack to the turtle nesting beach is greater than 8 km; and
  ○ There is currently no direct line of site between the stack and turtle nesting beach.

Monitoring and Auditing Should visual impact or lighting be identified as an issue during audits, then an appropriate mitigation program will be implemented (e.g. additional revegetation works on exposed batters).
Reporting and Corrective Action Reporting of environmental non-compliances with be in accordance with environmental permit requirements. Environmental Monitoring Records will be recorded and managed in an environmental monitoring database. Reporting, investigation and management of corrective actions associated with environmental events will be managed through the IMS.

4.4 Water

A summary of surface water and groundwater environmental values and assessment of potential impacts to surface water and groundwater and proposed mitigation measures for LNG facility and associated marine facilities operations follows.

4.4.1 Environmental Values

4.4.1.1 Surface Water

The LNG facility is located on Curtis Island (China Bay area), within the Boyne-Calliope sub-region of the Fitzroy Basin, within the Curtis Coast Region, which is bounded by Raglan Creek to the north, Colosseum Inlet to the south and the Capricorn Group of islands to the east. The western boundary is defined as the landward edge of the coastal catchments (the Boyne River, Calliope River and part of the Fitzroy River catchment) within the GRC local government area. The Curtis Island Basin has a total catchment area of 576 km².

The major drainage feature on Curtis Island is Graham Creek, located north of the LNG facility site. The creek channels a significant portion of surface water runoff from the southern half of Curtis Island into The Narrows. Graham Creek, however, is not within the LNG facility's catchment area.

The LNG facility site catchment area is approximately 3.8 square kilometres (km^2) and is located to the southwest coast of Curtis Island. The site stretches from the hills to the east at approximately 124 m AHD in elevation, down to the flat salt marsh of the China Bay coast. Within this area eight drainage features have been identified. The features are all ephemeral in nature, with small catchments (less than 5 km^2 in size) which only contain water during and immediately after rainfall events. Within the LNG facility area there are no named watercourses or minor tributaries. However, watercourses on Curtis Island (such as Graham Creek) and waters surrounding Curtis Island are protected under the EPP (Water). Port Curtis is the receiving water for discharges from the site. Saltpan and mangrove communities are present along the sheltered intertidal zones to the south and west of the Project site.

Surface water discharges from the LNG facility are to the Gladstone Harbour (Port Curtis) being the marine receiving environment. Gladstone Harbour falls within the Shoalwater Coast bioregion as defined in the Integrated Marine and Coastal Regionalisation for Australia (Commonwealth of Australia 2006). This bioregion includes the coastal and island waters from Mackay south to Baffle Creek.

Port Curtis is a natural deepwater embayment that is protected from the open ocean by Curtis Island and Facing island. The coastal geomorphology is characterised by a partially enclosed embayment and shallow estuaries, including small, continental rocky islands, intertidal flats and estuarine islands.

Port Curtis estuary is a composite estuarine system that includes the Calliope and Boyne Rivers, The Narrows, Auckland Creek and several smaller creeks and inlets that merge with deeper waters to form the naturally deep harbour protected by Curtis Island and Facing Island. Elevated natural turbidity occurs within the shallow marine and estuarine waters with significant input of freshwater and alluvial sediments from the Boyne and Calliope Rivers (URS, 2011d).

Recent monitoring of ecosystem health in Port Curtis has been through the Port Curtis Integrated Monitoring Program (PCIMP). The PCIMP has been conducting annual comprehensive water quality assessments of Gladstone Harbour on an annual basis since 2005. Raw data has been collected at these sites for physicochemical parameters, including turbidity, and is available for all sites from 2005 onwards.

Numerous studies of water quality have also been conducted in Port Curtis to assess and manage the impacts of multiple dredging campaigns, and baseline water quality monitoring events within Port Curtis were completed in 2012 (URS, 2013a) as part of the Receiving Environment Monitoring Program (REMP) for the LNG facility. The combination of these studies and the PCIMP data, provide sufficient data to assess background conditions within Port Curtis. General conclusions from the studies have illustrated that Port Curtis is a naturally turbid system that is influenced by re-suspension of sediments by tidal driven current speeds and wet season flows from the catchment that discharge into the Port.

The system does show some evidence of nitrification and in particular, regularly demonstrates exceedances for nitrogen (URS 2011). This is likely to enter the system during wet season catchment flows into Port Curtis. However, nutrient and biochemical oxygen demand within Port Curtis appears to be relatively low and consistent with high quality estuarine water (URS 2011).

Turbidity in Port Curtis increases with depth and tidal velocity. This is most likely attributed to bottom sediment re-suspension, while pH and temperature are relatively uniform with depth, with evidence of only slight stratification (URS, 2014b).

Anthropogenic sources of pollution in Port Curtis have been identified as a mixture of point source pollution (industrial discharges), stormwater runoff and ship ballast waters. A natural source of sedimentation and nutrient deposition can be attributed to the Calliope River with approximately 30,000 tonnes of sediment discharging into Port Curtis per year. The high turbidity of the area can be, in some sense, attributed to this natural process (Connell Hatch 2006).

Monitoring conducted by GLNG recorded the background levels of heavy metals within China Bay. These background levels suggest that Port Curtis is moderately disturbed with elevated levels of heavy metals exceeding National Water Quality Guideline trigger values (ANZECC/ARMCANZ 2000). While Port Curtis is a well-connected estuary, allowing dissolved material to be evenly mixed throughout, material does not readily leave Port Curtis to the ocean (Herzfeld et al. 2004).

Environmental values and water quality objectives for Gladstone Harbour have recently (November 2014) been developed by DEHP (*"*Curtis Island, Calliope River and Boyne River Basins Environmental Values and Water Quality Objectives*"*, listed under Schedule 1 of the EPP (Water)). Environmental values related to the LNG facility, which is within the Western Basin section of Gladstone Harbour, are summarised in Table 4-9.

Table 4-9. Environmental Values for the Watercourses and Receiving Environment of the LNG Facility

Environmental Value	Relevance to LNG Facility Receiving Environment (Western Basin Area)
Aquatic ecosystems	✓
Irrigation	×
Farm supply/use	×
Stock water	×
Aquaculture	×
Human consumer	✓
Primary recreation	×
Secondary recreation	✓
Visual recreation	✓
Drinking water	×
Industrial use	✓
Cultural and spiritual values	✓

✓ Environmental Value applicable to Western Basin area

X = Environmental Value not applicable to Western Basin area

4.4.1.2 Groundwater

The main geological unit underlying the LNG facility is the Wandilla Formation, which comprises sediments and metamorphic units. Groundwater level measurements indicate that the groundwater table within the alluvial and estuarine formations is generally less than 5 metres below ground level (URS, 2009f).

Review of available data allowed for a preliminary assessment of the shallow groundwater resources associated with the lithologies present within the LNG facility study area. The available information allowed for limited evaluation to the groundwater resource environment values in line with the EPP Water as discussed below.

The groundwater resource has had little or no current or past usage, has restricted future development potential, and has poor ambient groundwater quality. Based on the studies, groundwater resources of the LNG facility hold no specific cultural or spiritual values.

The environmental values for groundwater are summarised in Table 4-9.

Table 4-10. Environmental Values for Groundwater at the LNG Facility

Environmental Value	Relevance to Groundwater
Protection of high ecological value aquatic habitat	X
Protection of slightly to moderately disturbed aquatic habitat	X
Suitability for drinking water supplies	X
Suitability for crop irrigation	X
Suitability for stock watering	✓
Suitability for aquaculture (e.g. red claw, barramundi)	X
Suitability for human consumers of aquatic food	X
Suitability for industrial use (including manufacturing plants, power generation)	✓

✓ Suitable for the environmental value

X Not suitable for the environmental value

4.4.1.3 Biological Integrity of a Pristine or Modified Aquatic Ecosystem

The biological integrity of the aquifers identified within the LNG facility area have elevated dissolved solids and metal concentrations exceeding the ANZECC guidelines Trigger Levels for Freshwater and Marine Ecosystems. The naturally occurring discharge of shallow groundwater into the water resources occurs at concentrations above the ANZECC guidelines for surface water.

4.4.1.4 Suitability for Minimal Treatment before Supply as Drinking Water

All groundwater samples that have been collected in and adjacent to the LNG facility site were unsuitable for drinking purposes and thus would require treatment to achieve recognised drinking water quality guidelines. This groundwater would require complex and expensive treatment, such as reverse osmosis, to achieve drinking water quality to satisfy the Queensland Water Quality Guidelines 2006 or the Australian Drinking Water Guidelines 2004.

Issues of salinity and the ease of obtaining a rainwater tank supply are factors which preclude the usage and potential for usage of the groundwater as a drinking water source.

4.4.1.5 Suitability for Stock Watering

A number of bores were present on the LNG facility that were used in the past for stock watering.

4.4.1.6 Suitability for Use in Agriculture, Aquaculture, Aquatic Food for Human Consumption

Water quality data indicate that salinity is above the range recommended for irrigation of crops. Thus groundwater appears to have limited potential use in terms of irrigation, depending on crop type, soil type and irrigation regime.

The onsite aquifers contain limited groundwater (low sustainable bore yields), which reduces suitability for use in aquaculture or the production of aquatic food for human consumption as these activities would typically require reliable assured water supplies.

4.4.1.7 Suitability for Industrial Use

Groundwater quality may be suitable for a large number of industrial processes including cooling water, process water, utility water, and wash water. As industrial processes require particular water quality, specific hydro-chemical data would be required to evaluate suitability for specific industrial uses.

Limited opportunities for industrial use are currently available on Curtis Island. Industrial users tend to require large volumes of water which would be unsustainable for the groundwater resources identified within the LNG facility study area.

4.4.2 Potential Adverse or Beneficial Impacts

Potential impacts to surface water and groundwater from LNG facility operations are associated with potential contact of contaminants from spills/releases of petroleum-based products (e.g. fuels and lubricants, LNG) or other chemicals, stormwater contact with contaminants, elevated turbidity during rainfall events and discharge of waste waters.

4.4.2.1 Stormwater and Wastewater

A variety of mitigation strategies were implemented during the construction phase of the GLNG facility and these will be maintained during the operational phase of the project. These will include:

- Maintain the permanent stormwater drainage channels so that they convey the design flows without erosion;
- Stormwater which falls into the catchment of the LNG Facility will be captured and channelled to Sediment Basins;
- Undertake routine inspection and maintenance of the erosions and sediment control measures including clean out (as required) of the sediment that settles in the Sediment Basins and Diversion Drains;
- After significant rainfall events undertake an assessment of the Sediment Ponds for any degradation/damage;
- Maintain the engineered slope faces, which have been stabilised with rock, grass, geotextile or a combination of each;
- Maintain the sealed permanent site roads. Each road will be stabilised using roadbase, compacted aggregate cover or bitumen seal;
- Areas that may be contaminated, such as within the plant, or oil and chemical storage areas are bunded and have drains with isolated collection sumps that collect the contaminated water; and

- Monitor the performance of the sediment basins for turbidity and pH using a hand held meter as required to determine if flocculants are required for reducing turbidity/suspended sediment load prior to release from site.

Poor wastewater management could result in the impacts to stormwater exiting the site and potentially impacting on receiving waters in Port Curtis. The following measures are in place to minimise the potential for these impacts:

- The LNG process is essentially a dry process that produces only minor quantities of waste water.
- Clean stormwater from undisturbed catchments is intercepted in diversion drains and directed around the perimeter of the facility and discharged via stabilised outlet structures into Port Curtis.
- In undisturbed/ “Clean” (non-process) areas, stormwater is directed to one of the site sedimentation ponds (sediment basins), which overflow to Port Curtis;
- The main liquefaction process areas are located on concrete slabs and drain to a Process Area Spill Containment Sump (PASCS). The sump acts as a first-flush system during rain – once full, further stormwater will divert to the stormwater drainage system. A skimmer on the sump directs skimmed water with potential oil contamination to the Oily Water Treatment Plant (OWTP). Retained water is pumped to the stormwater system on a controlled basis or released through the authorised discharge point WW1.
- Other process and storage areas with potential for contamination are paved and bunded with an integral sump. Water collected in the bund sumps, including stormwater and utility water from cleaning operations or testing of firefighting equipment, can be pumped to the OWTP for removal of oil, grease and suspended solids if required, otherwise it will be released to the stormwater system.
- Maintenance, utility and support facilities are covered and/or contained within bunded/curbed concrete slabs with integral sumps. Sump water from these areas is directed to the OWTP if required or if deemed clean released to the stormwater system. Contaminated water from hot oil and pig receiver area drains is pumped to the OWTP. Brine (ROC) and treated effluent is discharged to Port Curtis via diffuser WW1.
- The WW1 effluent diffuser was designed based on several factors including the amount of effluent, type of effluent, and tidal/flow characteristics at the discharge point. The diffuser releases treated effluent at a rate and in such a manner that it quickly mixes with the receiving water (seawater) thus diluting any potential contaminants.
- Results of WW1 diffuser modelling indicate effluent discharges from the diffuser would be highly diluted in the near mixing zone and are unlikely to have an adverse effect on the environment.

4.4.2.2 *Groundwater*

Potential impacts to groundwater are associated with potential spillage of hydrocarbons or other chemicals that may impact underlying soils and/or surface water enabling migration of contaminants into groundwater/down-gradient aquifers. Poor waste management practices and substandard waste storage facilities could act as surface contaminant sources to the shallow groundwater resources. Rainfall infiltration and poor quality runoff can seep into the underlying groundwater and alter the hydrochemistry.

The LNG facility is constructed with hardstand in process and chemical/fuel storage areas reducing potential recharge areas and potential for infiltration of spills and releases of contaminated surface water into the alluvium and weathered and fractured rock aquifers. Stormwater control facilities and treatment systems (sediment basins and OWTP) are in place to collect stormwater runoff within process areas and fuel/chemical storage areas operations, and direct overland flow of surface water around/away from process and fuel/chemical storage areas.

4.4.3 Environmental Protection Commitments, Objectives and Control Strategies

The environmental protection commitments, objectives and control strategies for potential impacts to surface water and groundwater from LNG facility operations are summarised in Table 4-11. .

Table 4-11. Operations Environmental Management Sub Plan - Water

WATER – LNG Facility and Associated Infrastructure – Operational EM Sub Plan
Operation Policy or Management Objective ***Surface Water*** To prevent the release of contaminants that may adversely affect downstream surface water quality, including Port Curtis. ***Groundwater*** To protect the quality of the existing groundwater resources.
Performance Criteria • Compliance with the requirements of the LNG facility's environmental permits. • Chemical and fuel storage areas will be bunded in accordance with AS 1940:2004 and AS 3780:1994.
Implementation Strategy ***Surface Water*** A stormwater, Sediment and Erosion Management Plan has been developed. The site is divided into different stormwater management catchments according to activity/land-use. Surface water management strategies for each area are listed below. <u>Process Area Runoff</u> • Where required, process areas are contained by bunded concrete slabs to capture any potential contamination of stormwater runoff. • Potentially contaminated stormwater runoff from the process areas (including "first flush" during storm events) drain to the PASCS. A skimmer on the sump directs skimmed water/oil to the oily water treatment plant for removal of oil and suspended solids.

- Sumps will be emptied after rain to provide adequate capacity for subsequent storm events. Retained sump water can be tested and, if suitable, discharged to the stormwater drainage system; if not (off-spec) it can be pumped to the contaminated water tank for off-site disposal.

Fuels and Chemicals Storage Areas

- Bunded storage areas for fuels and dangerous goods will be provided with spill clean-up kits in accordance with Australian standards (AS 1940:2004 and AS 3780:1994).
- Refuelling will occur only within bunded areas.
- All transfers of fuels and chemicals will be controlled and managed to prevent spillage outside bunded areas.
- Any hydrocarbon spillage from storage areas, diesel and chemical spills, or industrial waste spills will be contained, reported, and treated/remediated in accordance with appropriate legislative and regulatory agency requirements.

General LNG Facility Areas

- The facility's stormwater system outside the LNG process area is designed to direct water away from process and chemical handling/storage areas, and minimise potential erosion or contamination.
- Accidental spills will be captured and cleaned in accordance with spill and emergency procedures.
- Stormwater runoff from general facility areas will be discharged via the stormwater system sediment basins.
- Routine monitoring and maintenance will be undertaken to sustain integrity of the non-process area stormwater management system and ensure that discharges meet water quality standards.
- All features of the stormwater system, including pipes, open drainage channels, and basins shall be designed in accordance with best-practice engineering principles (Best Practice Erosion and Sediment Control, IECA Australasia 2008).

Undisturbed/Upstream Areas

- Undisturbed/ 'clean' areas of the LNG facility site will generate stormwater runoff quantity and quality similar to natural runoff. This runoff will be diverted around the process area catchments in diversion drains and enter Port Curtis via stabilised outlet structures.

Wastewater Discharge to Port Curtis

- Wastewater discharged to Port Curtis will be monitored in accordance with Section 6.4 of this OEMP.

Groundwater

- Fuel, chemical and industrial waste storage areas, workshop areas, vehicle and equipment wash-down areas, and equipment and machinery repair areas will be designed to the appropriate Australian Standards (e.g. AS 1940:2004 and AS 3780:1994) and contain spill clean-up kits as appropriate.
- All transfers of fuels and oils will be controlled and managed to prevent spillage outside bunded areas.
- Spills will be reported and immediately contained, removed or remediated as required.
- Chemical and fuel storage areas will be bunded in accordance with AS 1940:2004 and AS 3780:1994 to prevent the seepage of any contaminants into the groundwater system.

Monitoring and Auditing

Monitoring and auditing will be conducted in accordance with Sections 5, 6 and 1.10 of this OEMP.

All monitoring will be undertaken in accordance with the requirements of the LNG facility's environmental permits.

Surface Water

A surface water quality monitoring program will be implemented and will include the sediment basins. Sediment Basin spillways have been designed to allow samples of the pond overflow waters to be collected.

Monitoring of discharged wastewater to Port Curtis will be conducted to confirm compliance with discharge limits.

Groundwater

The integrity of storage facilities for hazardous materials and wastes and bunded areas will be routinely

inspected.

A groundwater monitoring program will be implemented to monitor for potential groundwater impacts from operation of the LNG facility.

Reporting and Corrective Action

Reporting of environmental non-compliances with be in accordance with environmental permit requirements.

Environmental Monitoring Records will be recorded and managed in an environmental monitoring database.

Reporting, investigation and management of corrective actions associated with environmental events will be managed through the IMS.

4.5 Land

Land values and assessment of the potential topography, geomorphology, geology, soils, land contamination and use at the LNG facility, and nature conservation impacts are discussed below along with proposed mitigation measures for potential impacts from LNG facility operations.

4.5.1 Description of Environmental Values

The topography of the LNG facility study area comprises low rounded hilly, intermediate steep hilly and steep high hilly lands developed on Upper Carboniferous to Lower Devonian Wandilla Formation sedimentary rock types and meta-sediments comprising mudstone, lithic sandstone, quartz greywacke, siltstone, chert, slate and local schist. Near flat to gently undulating alluvial plains with slopes mostly < 2 % occur in the valley bottoms. In most cases these alluvial valley flats extend towards the coast and merge with estuarine supra-tidal flats which are mostly fringed by tidal mangrove flats along the coast line.

The geology of the LNG facility study area and surrounds has been mapped by the Geological Survey of Queensland (GSQ, 2005). The geological regimes that occur within the general vicinity of the LNG facility study area include:

- Qe- Quaternary (Holocene) estuarine delta and coastal marine deposits, comprising saline silty clays and clays, saline muds and sands;
- Qa- Quaternary alluvium, comprising clay, silt, sand and gravel deposits; and
- Cw- Carboniferous Wandilla Formation, comprising mudstone, lithic sandstone, quartz greywacke, siltstone, jasper, chert, slate and schist.

The survey identified that naturally occurring elevations in a number of heavy metals (including arsenic, copper, chromium manganese and vanadium), are located within the LNG facility study area which exceed the Queensland DEHP Environmental Investigation Levels (EILs).

The soil profile characteristics of the study area were identified primarily from 21 test pits excavated as part of the field investigation program. Five major soil groups have been identified within the LNG facility study area which are identified in Table 4-12. The soil groups were determined from various sources including the regional land systems and soils

mapping by Commonwealth Scientific and Industrial Research Organisation (CSIRO) (1967, 1968 and 1974) and the Atlas of Australian Soils (Isbell et al., 1967), which collectively cover the study area. The soil types identified for each of the main soil groups are summarised in Table 4-13.

Table 4-12. Soil Groups identified within the LNG facility study area

Soil Group No.	Summary Soil Description	Soil Classification			
		Aust. Soil Group	P.P.F.	U.S.C.	A.S.S.
4	Shallow to deep (>0.5 m) mainly uniform or weakly gradational, very stony and gravelly loams to clay loam soil profiles.	Shallow Loams Gravelly Loams Lateritic Red – Yellow Earths	Um2.12 K-Um2.12 Um4.11	CL/GC-CL/GC GC-CL/GC	Brown Kandosol; Gravelly Lithic; Leptic Rudosols
5	Medium to deep (0.5 - 1.2 m) dark brown gravelly loam to gravelly clay loam surface soils, locally with a pale or bleached gravelly loam or clay loam sub-surface (A2) horizon over red-brown, brown or yellow-brown acidic medium to heavy clays or gravelly clays subsoils.	Red, Yellow & Brown Podzolic Soils Grey & Brown Soloths	Dr2.31 K-Dr3.21 Db3.51 K-Db3.51 Db1.41 K-Dy3.21 Dy3.32	GC-CL/GC/CH CL-ML/GC/CH or CL-CH ML/GM/CL-CH	Ferric Red-Brown Chromosols; Sodic Yellow & Brown Kurosols
6	Thin dark grey-brown acidic clay loamy surface duplex soils with diffusely mottled grey-brown and yellowish brown slightly acidic medium to heavy clay sub-soils over alkaline clay deep subsoils.	Brown Solodic Soils	Db2.23	CL/CH/CL-CH	Subnatric Brown Sodosols
7	Three soil type variants identified include:				
	Type 7.1: Shallow to medium deep (< 0.5 - 0.8 m) uniform red-brown clay soils and gradational gravelly loam over yellow-brown to yellowish-red gravelly clay subsoils;	Uniform Gravelly Clays	Uf6.61 Gn4.81 Gn4.14	CL-CH/CH GM-GC/GC/ CL-CH or GC-CL/GC/ CL-CH	Acidic Sodic Red Dermosol, Melanic Red & Brown Dermosol
	Type 7.2: Medium deep (0.5 - 1.0 m) uniform silty clay over acidic structured heavy clay subsoils underlain by massive alkaline heavy clay deeper subsoils;	Alluvial Soils	Uf6.31	CL/CH/CH	Sodic Brown Dermosol

Soil	Summary Soil Description	Soil Classification			
	Type 7.3: Medium to deep (0.5 - 1.5 m) uniform silty clay surface soils over brown or red-brown weakly structured acidic medium to heavy clay subsoils, and gradational clay loam to gravelly loam surface soils over gravelly light clay subsurface horizons transitioning to medium to heavy or heavy acidic to strongly acidic clay or gravelly clay subsoils.	Grey, Brown or Red (Non-Cracking) Clay Soils	Uf6.61 Uf6.12 Gn4.12 Gn4.11 Gn2.11	CL/CL-CH CL/GC-CL/CH CL/GC-CL/CH GC-CL/CL-CH CL/CL/GC-CL	Acidic-Sodic Red Dermosol; Ferric Brown Dermosol; Ferric red Dermosol
9	Deep to very deep, very soft, uniform, gradational or weak duplex soil profiles, with organic silty clay to silty clay loam surface soils and seasonally or permanently saturated subsoils, typically greyed saline clays, clayey silt, silty sand or sandy mud.	Humic Gleys Solonchaks	Uf6.41 Dg2.11	CL-ML/OL-OH	Supratidall Hydrosols, Redoxic Hydrosols

Table 4-13. Soil Type Description

Soil Group No.	Soil Type 1	Soil Type 2	Soil Type 3
4	Undifferentiated: Shallow (< 0.5 m) and medium to deep (0.5 - >1.5 m) stony, gravelly and clay loam soil profiles with gravelly/stony/clay loam surface soil horizons.		
5	Undifferentiated: Medium to deep (0.5 - 1.5 m) gravelly to gravelly clay loam with a pale or bleached (A2) gravelly/clay loam sub-surface horizon. Clear/sharp change to subsoil (B) gravelly clays or acidic to neutral medium to heavy clays with blocky to prismatic structure directly underlain by variegated heavy clay substrate soils with very dense massive structure.		
6	Undifferentiated: mostly thin fine sandy loam, silt loam and clayey loam surface duplex soils, often with a pale or bleached subsurface (A2) horizon over brown, yellowish-brown or reddish brown medium to heavy or heavy clay subsoils that are neutral to alkaline, locally strongly alkaline usually with carbonate present.		
7	*Soil Type 7.1*: Shallow to medium deep (< 0.5 - 0.8 m) clay, gravelly clay loam or gravelly clay surface soils or gravelly clay sub-surface (A2) with fine gravel to coarse fragments over gravelly acidic clays or medium to heavy acidic subsoils	*Soil Type 7.2*: Medium to deep (0.5 - >1.5 m) uniform clay soil profiles with hardest acidic silty clay surface soils becoming moderately to strongly alkaline in heavy clay subsoils.	*Soil Type 7.3*: Deep (> 1.5 m) uniform or gradational silty clay or heavy clay surface soils with acidic, locally strongly acidic medium to heavy or heavy clay subsoils.
9	Undifferentiated: considerable variation in both in the vertical and horizontal directions including deep to very deep, very soft, uniform, gradational and weak duplex soil profiles with highly organic silty clay, silty clay loam surface soils and seasonally or permanently saturated subsoils, typically gleyed and saline clays, clayey silt sand or sandy mud		

As mapped in the GLNG EIS Section 8.3, the LNG facility soils site study area is 384.6 ha. Based on the cumulative areas of the terrain units that occur within the study area and the

corresponding agricultural land classes determined, a summary of the results of the (pre-development) land capability assessment is as follows:

- Class A land was not identified in the LNG study area;
- Class B land comprises 43.5 ha (11.3 %) of the LNG facility study area;
- Class C1 land comprises 34.6 ha (9.0 %) of the LNG facility study area;
- Class C2 land comprises 78.0 ha (20.3 %) of the LNG facility study area;
- Class C3 land comprises 151.4 ha (39.4 %) of the LNG facility study area; and
- Class D land encompasses 77.1 ha (20.0 %) of the LNG facility study area.

Approximately 165.9 ha (94.2 %) of the land in the LNG facility site disturbance footprint area has been rated as having moderate to high (M-H) erosion potential where the land was subject to clearing and earthworks for site development purposes. A further 2.3 ha (1.3 %) has been rated moderate (M) and 7.9 ha (4.5 %) has been rated as having low to moderate (L-M) erosion potential.

The distribution of actual acid sulfate soils (AASS) is widespread laterally throughout the low lying areas that fringe the coastline, and continued down-sequence to the general 2-m depth of testing at a number of locations. The AASS was generally at a low level but was widely present. As anticipated, there were no AASS sediments identified in the offshore sequences.

The soils on site, whilst not deep, are potentially highly erosive because of their dispersive properties and the steep slopes combined with the high annual rainfall and potential for intense rainfall events exacerbate the potential for soil erosion.

4.5.1.1 Land Use

The LNG facility site is located on land owned as freehold or leased from the Crown either by GLNG or the Coordinator General, comprised of the following lots:

- Lot 1 on SP235007;
- Lot 4 on SP235007;
- Lot 1 on SP228184;
- Lot 4 on SP235936; and
- Lot 7 on SP239683

The LNG facility site and surrounds were used for grazing cattle purposes prior to acquisition by GLNG and the Coordinator-General.

The small settlement known as South End is located at the southeast end of Curtis Island, approximately 8.5 km from the LNG facility site. Prior to commencement of construction in 2011, there were approximately 50 dwellings in South End, with approximately 20 permanent residents and 90 seasonal residents. South End has no road access but is

serviced by a barge from Gladstone. There is a local aircraft landing strip which is used in case of emergency. The local store (Capricorn Lodge) is a focal point for the community and is generally open four to five days per week. It provides limited grocery supplies and fuel as well as serving alcohol and counter meals. Other small islands in Port Curtis contain permanent or seasonal residents including She Oak Island and Compigne Island.

Gladstone is a regional industrial centre containing a number of major international industries. The administrative and commercial centre of Gladstone is on the southern side of Port Curtis, within 6 km of the LNG facility site.

A commercial fishing fleet is located in Gladstone Harbour. The harbour is also a base for recreational boating activities.

4.5.2 Potential Adverse or Beneficial Impacts

Potential impacts to land from LNG facility operations are primarily associated with potential for spills/releases of fuels and chemicals in process, storage or maintenance areas. Exposure of erosive soils or disturbance to Potential Acid Sulphate Soils (PASS) or AASS may occur via land disturbance.

4.5.3 Environmental Protection Commitments, Objectives and Control Strategies

The environmental protection commitments, objectives and control strategies for potential impacts to land from LNG facility operations are summarised in Table 4-14.

Table 4-14. Operations Environmental Management Sub Plan - Land

LAND – LNG Facility and Associated Infrastructure – Operational EM Sub Plan
Operation Policy or Management Objective To prevent the release of contaminants to land that may adversely affect soils or migrate to surface water or groundwater.
Performance Criteria • Compliance with the requirements of the LNG facility's environmental Permits. • Chemical and fuel storage areas will be bunded in accordance with AS 1940:2004 and AS 3780:1994.
Implementation Strategy • Implement Spill Prevention, Containment and Control measures. • Fuel and chemical storage and waste storage areas, workshop areas, vehicle and equipment wash-down areas, and equipment and machinery repair areas will be designed to the appropriate Australian Standards (e.g. AS 1940:2004) and contain spill clean-up kits as appropriate. • Refuelling will occur only within bunded areas. • All transfers of fuels, oils and chemicals will be controlled and managed to prevent spillage outside bunded areas. • The bunds will drain into the process area drainage system. A number of transfer sumps are equipped with oil-water separators. • Any hydrocarbon spillage from storage areas, diesel and chemical spills, or industrial waste spills will be contained, reported, and treated/remediated in accordance with appropriate legislative and regulatory

agency requirements.

- Chemicals and petroleum products will be stored in appropriate containers and storage areas will be routinely inspected.
- Personnel will receive training in the management of fuels and chemicals on site (containment, storage and spill response)
- Controls will be placed on any additional land disturbance to minimise the potential for exposure of erosive soils or disturbance to Potential Acid Sulphate Soils (PASS) or AASS.

Monitoring and Auditing

Auditing and reporting of environmental performance data will be conducted in accordance with Section 1.10 of this OEMP.

The Senior Environmental Advisor will report monitoring results to the appropriate Manager.

The Senior Environmental Advisor will report monitoring results to the DEHP in accordance with the LNG facility's environmental authority.

The integrity of storage facilities for hazardous materials and wastes and bunded areas will be routinely inspected.

Reporting and Corrective Actions

Reporting of environmental non-compliances with be in accordance with environmental permit requirements.

Environmental Monitoring Records will be recorded and managed in an environmental monitoring database.

Reporting, investigation and management of corrective actions associated with environmental events will be managed through the IMS.

4.6 Biodiversity

4.6.1 Description of Environmental Values

4.6.1.1 Nature Conservation

The LNG facility is situated within the Southeast Queensland bioregion, close to the boundary with the Brigalow Belt bioregion (Sattler and Williams, 1999). The Southeast Queensland bioregion contains ten sub-regions or provinces that delineate significant differences in geology and geomorphology (Young and Dillewaard, 1999). The LNG facility site is located within the Burnett-Curtis Hills and Ranges sub-region. It should be noted that the site is situated near the northern-most boundary of the Burnett-Curtis Hills and Ranges sub-region, bordering on the Marlborough Plains sub-region of the adjacent Brigalow Belt bioregion.

There are no major Environmentally Sensitive Areas (ESAs) within or immediately adjacent to the LNG facility site. Six Regional Ecosystems (REs) were described and mapped for the LNG facility site, based upon the field survey results and interpretation of aerial photo stereo images. Table 4-15 below lists these REs with the clearing limits permitted in the EA and corresponding areas cleared to date. No further disturbance is expected during the operation of the LNG facility.

Table 4-15. Regional Ecosystems recorded at the LNG facility site

RE	Vegetation Community Description	EA Clearing Limits (Condition BF1) (ha)	Area Cleared to Date (ha)
12.1.2	Saltpan vegetation comprising *Sporobolus virginicus* grassland and samphire herbland on Quaternary estuarine deposits.	0.6	0.449
12.1.3	Mangrove shrubland to low closed forest on Quaternary estuarine deposits.	1.9931	0.051
12.2.2	Microphyll/notophyll vine forest on beach ridges.	0	0
12.3.3	*Eucalyptus tereticornis* open forest to woodland on Cainozoic alluvial plains.	38.0363	38.0363
12.11.6	*Corymbia citriodora* and *Eucalyptus crebra* open forest to woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanic.	104.5	87.5045
12.11.14	*Eucalyptus crebra, E. tereticornis* grassy woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments.	42.921	42.921
n/a	Non-remnant areas.		

4.6.1.2 Terrestrial Flora

The flora survey identified the presence of 191 taxa representing 60 families and 150 genera of plants. This result represents a moderate floral diversity typical of the ecosystems found within the region. Families represented by three or more genera included Asteraceae (10 genera), Chenopodiaceae (3), Convolvulaceae (3), Euphorbiaceae (4), Fabaceae (13), Malvaceae (3), Myrtaceae (4), Poaceae (26), Rhizophoraceae (3), and Verbenaceae (5). Genera represented by three or more species included *Acacia* (6 species), *Chloris* (3), *Corymbia* (5), *Cyperus* (4), *Eucalyptus* (3), *Fimbristylis* (4) and *Sida* (3).

Three vegetation communities are identified as having either 'Of Concern' or 'Endangered' conservation status (as listed under the *Vegetation Management Act, 1999*) and 'Of Concern' or 'Endangered' biodiversity status (as per the EPA Biodiversity Status listing). Details are provided in Table 4-16.

Table 4-16. Regional Ecosystems of Conservation Significance

RE	Vegetation Community Description	Vegetation Management Act Status	Biodiversity Status	EPBC Act Status
12.3.3	*Eucalyptus tereticornis* open forest to woodland on Cainozoic alluvial plains.	Endangered	Endangered	Not Listed
12.2.2	Microphyll/notophyll vine forest on beach ridges.	Of Concern	Endangered	Critically Endangered

RE	Vegetation Community Description	Vegetation Management Act Status	Biodiversity Status	EPBC Act Status
12.11.14	*Eucalyptus crebra, E. tereticornis* grassy woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanic.	Of Concern	Of Concern	Not Listed

There was a moderate diversity of weed species within the site with 30 species found. Families with the most exotic weed taxa were Asclepediaceae (3), Asteraceae (5), Poaceae (5) and Verbenaceae (4). Four weed species were identified as being of management concern. These species are listed as pest species under the Queensland *Land Protection (Pest and Stock Route Management) Act, 2002*. Two of these species, rubber vine and lantana, are also listed as Weeds of National Significance (WONS). Developed by Australian New Zealand Environment and Conservation Council (ANZECC), WONS are exotic weed species identified as causing significant environmental damage on a national scale (Thorp and Lynch, 2000).

4.6.1.3 Terrestrial Fauna

A total of 81 native and 5 introduced terrestrial vertebrate species were recorded during a pre-construction field survey. Native species included 4 amphibian, 13 reptile, 67 bird and 12 mammal species. This list also includes species observed outside the LNG facility study area site boundary which are likely to occur at the LNG facility site and elsewhere on the island.

Twenty significant fauna species were identified as potentially present as an outcome of desktop database searches. Of these, two species, the beach stone curlew (*Esacus neglectus*) and sooty oystercatcher (*Haematopus fuliginosus*), were recorded at or near the LNG facility study area. It is considered that the remaining 16 species, consisting of birds, reptiles and mammals, are unlikely to be present.

The RE 12.3.3 (*Eucalyptus tereticornis* woodland to open forest on alluvial plains) within the study area has been mapped by the EPA as Essential Habitat for the koala (*Phascolarctos cinereus*) (EPA, 2008b). RE 12.3.3 is also mapped as koala habitat to the immediate north of the study area. No evidence of koalas was observed during the field survey. Anecdotal information from local informants on Curtis Island indicated that koalas had not been seen for many years in the vicinity of the LNG facility site.

The EPBC Act Protected Matters Report (Department of the Environment, Water, Heritage and the Arts (DEWHA), 2008) notes 19 terrestrial, wetland and marine migratory birds that may occur within the area. The list includes eight terrestrial migratory species. The LNG facility study area does not act as core habitat for any of these species as similar vegetation communities and topography is found elsewhere in the region. Similarly, those wetland migratory species that favour freshwater wetland habitats are unlikely to be reliant on the two small water bodies present in the study area. The three listed migratory marine species

reliant on marine wetlands are Latham's snipe (*Gallinago hardwickii*), little curlew (*Numenius minutus*) and little tern (*Sterna albifrons*).

Prior to the commencement of construction, domesticated cattle and horses were present throughout the LNG facility site and surrounds. One feral cat (*Felis catus*) was observed on the site, as were numerous signs and sightings of pigs, (*Sus scrofa*) and tracks from wild dogs or dingos (*Canis familiaris*). Cane toads were abundant throughout the study area. The presence of feral fauna may have impacted native ground dwelling fauna as indicated by the low trapping results observed in the fauna survey.

4.6.1.4 Marine Ecology

The nearest Ramsar wetlands are the Shoalwater and Corio Bay areas, located approximately 150 km to the north. The Directory of Important Wetlands (DEW, 2005) lists The Narrows, Port Curtis and Colosseum Inlet/Rodds Bay as important wetlands.

As discussed in Section 3.1.3, the Rodds Bay Dugong Protection Area (DPA) was designated in 2002 and encompasses the majority of the Gladstone port limit area. DPAs are prescribed under the Queensland *Fisheries Regulation 2008* and restrict the use of fishing nets in those areas.

The Rodds Harbour Fish Habitat Area (FHA) and the Colosseum Inlet FHA are approximately 20 km south of Gladstone. FHAs are declared under the Queensland *Fisheries Act 1994* for the conservation, protection and management of essential fish habitat.

The Port Curtis area includes over 1,000 km^2 of coastal hinterland, wetlands and estuarine waters with marine and coastal zone wetlands covering an area over 300 km^2 (McKinnon et al. 1995). Mangrove, seagrass, salt marsh, rocky and sandy shoreline, open water and subtidal benthic habitats support varied biological communities within Port Curtis and adjacent marine areas.

A total of 30 intertidal habitats within The Narrows and Port Curtis were mapped including seagrass, mudflats, saltmarsh, mangroves and rocky shores (Danaher et al. 2005). Exposed mud banks and sandbanks dominated the intertidal marine habitat within Port Curtis with a total cover of 24% or 5,143 ha. Closed *Rhizophora* mangrove forest (20%) and saltpans (18%) were also dominant intertidal habitat types within Port Curtis (Danaher et al. 2005).

Of the 14 mangrove species previously recorded from the Port Curtis area, 11 were recorded in the LNG facility vicinity.

Table 4-17 provides a list of rare, threatened and vulnerable species listed under the NC Act, assessed as possibly occurring with the Curtis Coast region.

Table 4-17. Queensland Nature Conservation Act - Rare, Vulnerable and Endangered Species

Common Name	Scientific Name	Rare	Vulnerable	Endangered
Birds				
Sooty Oystercatcher	*Haematopus fuliginosus*	✓		
Southern Giant-Petrel	*Macronectes giganteus*			✓
Northern Giant Petrel	*Macronectus halli*		✓	
Herald Petrel	*Pterodroma arminjoniana*			✓
Little Tern	*Sterna albifrons*			✓
Beach stone-curlew	*Esacus neglectus*			
Mammals				
Dugong	*Dugong dugon*		✓	
Humpback Whale	*Megaptera novaeangliae*		✓	
Irrawaddy Dolphin	*Orcaella brevirostris*	✓		
Indo-Pacific Humpback Dolphin	*Sousa chinensis*	✓		
Reptiles				
Loggerhead Turtle	*Caretta caretta*			✓
Green Turtle	*Chelonia mydas*		✓	
Salt-water Crocodile	*Crocodylus porosus*		✓	
Leatherback Turtle	*Dermochelys coriacea*			✓
Hawksbill Turtle	*Eretmochelys imbricata*		✓	
Pacific Ridley, Olive Ridley	*Lepidochelys olivacea*			✓
Flatback Turtle	*Natator depressus*		✓	
Sharks				
Grey Nurse Shark	*Carcharias taurus*			✓

The beaches on the ocean side of southern Curtis Island and Facing Island support an important, intermediate breeding population of Flatback turtles (Limpus, 2007), with occasional nesting by green and loggerhead turtles (Limpus, 1999). The flatback turtle population utilising these beaches for nesting has remained at approximately 50 females annually throughout the 35 years monitoring has been conducted (Limpus et al. 2006). Flatback turtle nesting commences in mid-October, reaches a peak in late November – early December and ceases by about late January. Hatchlings emerge from nests between early December and late March, with a peak in February (Limpus, 2007).

A total of 22 wader and shorebird species were identified within or near the study area during the December 2008 survey for the Project with eleven of these species considered as migratory species under the EPBC Act and three species considered to be conservation significant under state legislation. As discussed in Section 3.2, results of subsequent surveys completed for the Project yielded a very low diversity of shorebirds compared to the

diversity of international migrants known from Port Curtis and compared to other marine/wader habitats in Queensland (e.g. Great Sandy Straights and Moreton Bay). The southwest cost of Curtis Island contains marine habitat of limited value to wader and shoreline birds. The LNG facility site does not act as core habitat for any of these species as similar vegetation communities and topography is found elsewhere in the region.

There are currently 26 marine species listed as being introduced into Queensland waters (National Introduced Marine Pest Information System (NIMPIS) website – http://www.marine.csiro.au/crimp/nimpis/). A marine introduced pest survey of Port Curtis was conducted in 2000 (Lewis et al. 2001) no pest species were detected in Port Curtis, however, low abundances of ten introduced species were detected.

4.6.2 Conservation Reserves

There are a number of conservation and forestry areas in proximity to the LNG facility and associated infrastructure including:

- Garden Island Conservation Park approximately 2 km east of the site
- Curtis Island National Park approximately 5 km north of the site
- Curtis Island State Forest approximately 5 km north of the site
- Great Barrier Reef Marine Park on the ocean side of Curtis Island
- Great Barrier Reef Coast Marine Park in The Narrows

4.6.3 Potential Adverse or Beneficial Impacts

Impacts to terrestrial flora and fauna and marine plants are not anticipated from operations of the LNG facility. Impacts from construction are addressed with the Environmental offset plan.

4.6.4 Environmental Protection Commitments, Objectives and Control Strategies

The environmental protection commitments, objectives and control strategies for potential impacts to biodiversity from LNG facility operations are summarised in Table 4-18.

Table 4-18. Operations Environmental Management Sub Plan - Biodiversity

BIODIVERSITY – LNG Facility and Associated Infrastructure – Operational EM Sub Plan
Operation Policy or Management Objective To minimise adverse impacts on biodiversity from the LNG facility's operations.
Performance Criteria • Compliance with the requirements of the LNG facility's environmental authority. • No detrimental impacts on MNES values.
Implementation Strategy • Ensure any additional clearing, if required, is in accordance with limits specified in approval conditions to

minimise impacts on REs.

- Implement monitoring programs specified in approvals for MNES.
- Implement the approval biodiversity offsets strategy (i.e. the Monte Cristo offset package).

Monitoring and Auditing

Auditing and reporting of environmental performance data will be conducted in accordance with Sections 1.10 and 6 of this OEMP.

The Senior Environmental Advisor will report monitoring results to the appropriate Manager.

The Senior Environmental Advisor will report monitoring results to the DEHP in accordance with the LNG facility's environmental authority.

Reporting and Corrective Actions

Reporting of environmental non-compliances with be in accordance with environmental permit requirements.

Environmental Monitoring Records will be recorded and managed in an environmental monitoring database.

Reporting, investigation and management of corrective actions associated with environmental events will be managed through the IMS.

5 SPECIFIC MANAGEMENT PROGRAMS

5.1 Waste Management

5.1.1 Waste Types/Volumes

Wastes generated during operations of the LNG facility include general wastes and process wastes. The types, quantities and management and disposal of these waste streams are summarised in Table 5 1 and Table 5 2.

Table 5-1. General Waste Streams

General Waste Streams	Physical Form	Estimated Quantity	Source	Management/Disposal
Batteries	Solid	Minor	Equipment operations	Transported off-site for treatment/disposal at local licensed facility
General waste (including putrescible waste)	Solid	52,000 m^3/yr	LNG Plant and Admin Areas	Non-recyclable general waste will be disposed of at the local landfill. Putrescible waste will be stored in covered containers and disposed of at the local landfill.
Packing materials	Solid	Minor quantities	LNG operations	Where possible reused on site, or recycled at a local facility.
Recyclable waste (aluminium cans, cardboard, glass, paper, plastics and tin)	Solid	Minor quantities	LNG facility administration areas.	Where appropriate recyclable waste will be recycled at local facilities.
Sanitary waste including Female Sanitary bins	Solid and Liquid	See table below	LNG facility and admin areas	Collected by Sanitary Waste Water Pumping System; sewage is pumped to the GRC Waste Water Pipeline for off-site treatment.
Waste oils	Liquid	50,100 L/yr	Plant and equipment	Waste oils will be stored separately and disposed of at an off-site licensed facility.

Table 5-2. Process Waste Stream Quantity Estimates

Process Waste Streams	Quantity (kg/yr)
Cellulose	2,200
Biological sludge	5,600
Oily Sludge/Float	16,700
Ceramic balls	9,700
Molecular Sieve Wastes	94,500
Activated Carbon	83,000

Process Waste Streams	Quantity (kg/yr)
General Waste	102,000
Waste Lubricating Oils	16,600
Spent oils	2,400
Treated process/contaminated stormwater (oily-water treatment system)	3 m^3/hr average 58 m^3/hr maximum

Wastes generated by LNG facility operations are contained and treated/disposed of off-Site. No wastes from LNG Facility operations will be disposed to land at the site, and access to the Site is restricted to authorised personnel.

Solid wastes generated by the LNG facility operations are segregated, stored in containers in designated areas, and transported off-site by licensed contractors for recycling or disposal at appropriate facilities on the mainland. Waste storage is designed to inhibit contact with stormwater and minimize potential emission of odours (e.g., putrescible wastes are stored in closed containers). As described in Section 2.7, liquid wastes generated include treated effluent from the OWTP, waste water from the WTP (UF cleaning water and ROC), and sanitary sewage. Oil collected by the OWTP will be transported off-site for recycling. Treated effluent from the OWTP and the WTP effluent are discharged to Port Curtis via diffuser WW1. Sanitary sewage is pumped to the GRC aboveWaste Water Pipeline and treated off-site.

Solid and Liquid wastes generated onsite shall be managed in accordance with licence/approval.

5.1.2 Potential Adverse or Beneficial Impacts

Poor or inappropriate waste management could lead to land contamination (e.g. oil spillage to ground) and impacts on water quality.

Wastes generated on site are segregated and contained in appropriate containers prior to treatment/off-site disposal. No landfilling of wastes occurs on site. It is not anticipated that there would be any risks to human health resulting from LNG facility wastes generation, storage or final disposition.

5.1.3 Environmental Protection Commitments, Objectives and Control Strategies

The environmental protection commitments, objectives and control strategies for potential impacts from waste generated for LNG facility operations are summarised in Table 5.3.

Table 5-3. Operations Environmental Management Sub Plan - Waste

WASTE – LNG Facility and Associated Infrastructure – Operational EM Sub Plan
Operation Policy or Management Objective To manage wastes from the operation of the LNG facility and associated infrastructure in such a way that any potential impacts on the environment are minimised or avoided by incorporating the waste management hierarchy.
Performance Criteria Prevent adverse environmental impacts from wastes generated by LNG facility operation. Adhere to waste minimisation principles by: • Minimising waste generation. • Maximising water and materials reuse and recycling. • Safely treating and disposing of all non-reusable and non-recyclable materials. • No inappropriate disposal or management of wastes. • No contamination of soil, air or water as a result of waste storage, transport or handling.

Implementation Strategy
The waste management plan will be developed prior to commencement of operations and will include:
• Environmental values to be protected.
• Inputs and outputs of the process, and the impact on the environmental values.
• Opportunities and actions to be taken to implement the waste management hierarchy.
• Life cycle assessment recommendations.
• Specific action plans.
• Emergency response procedures.
• Training and management.
• A monitoring and reporting program.
The following tasks will be undertaken to achieve the performance requirements:
• The appropriate Manager will approve the waste management plan for all operational aspects of the LNG facility.
• Careful planning will be employed when ordering materials. Where practical, any excess materials and used chemical containers and packaging will be returned to the supplier or to a local consumer.
• Preference will be given to materials that will result in no or low levels of waste (from both the materials and packaging).
• Waste streams will be separated into various components where these are produced. Waste separation at source will be achieved by providing bins for re-useable or recyclable materials. For large quantities of waste, an area on-site is allocated for the collection of materials.
• Waste storage will occur in a secure area. Where there is a possibility that leaching from wastes onto the ground could affect either groundwater or surface water quality, engineering features will be put in place to prevent this.
• Any wastes that cannot be re-used or recycled will be disposed of at an approved landfill.
• No waste will be disposed of onsite.
• All wastes leaving the facility will be tracked in accordance with the requirements of the *Environmental Protection (Waste Management) Regulation 2000* Schedule 2.
• All regulated waste will be removed from site by an authorised contractor to a licensed facility.
• If a hazardous contaminant is released to waters or land the following steps will be taken:
  ○ Take immediate action to stop any further release;
  ○ Take immediate action to contain the hazardous contaminant to the affected area, taking particular care to protect environmentally sensitive areas;

- Restore or rehabilitate the environment to its condition before the release occurred; and
- Take necessary action to prevent a recurrence of the release.
- Notifications required will be made in accordance with the project environmental approvals.

All site personnel and contractors will implement the waste management hierarchy when undertaking activities on site in the following order of priority:

- The generation of waste will be prevented or reduced by substituting inputs for those that generate waste; increasing efficiency in the use of raw materials, energy, water or land; redesigning processes or products; and improving maintenance and operation of equipment.
- Re-use of waste will be achieved by recovering solvents, metals or oil and re-using these for a secondary purpose.
- Wastes will be segregated for recycling into new products. Wastes that can be recycled include glass, cardboard, paper, plastics, aluminium, batteries, oil, drums and rubber.
- Where appropriate, licensed contractors will dispose of waste, or treat and dispose of waste, in ways that minimise harm to the environment.

Monitoring and Auditing

Monitoring and auditing will be conducted in accordance with Sections 1.10 of this OEMP.

- Volumes of waste being sent off-site for reuse, recycling and disposal will be monitored regularly via the waste tracking procedures.
- Waste materials and reusable and recyclable materials storage areas will be monitored by the Senior Environmental Advisor to ensure appropriate disposal contractors are engaged and to ensure materials are removed as required to minimise potential for cross-contamination of materials.
- Waste generation will be audited to assess whether improved practices can be implemented to further reduce the volume of waste disposed to landfill.

Reporting and Corrective Actions

Reporting of environmental non-compliances with be in accordance with environmental permit requirements.

Environmental Monitoring Records will be recorded and managed in an environmental monitoring database.

Reporting, investigation and management of corrective actions associated with environmental events will be managed through the IMS.

5.2 Weed and Pest Management

At the LNG facility, GLNG are committed to:

- Prevent the introduction and spread of weeds and pests;
- Minimise the risk of spreading weeds to undisturbed areas; and
- Remove weeds and pests encountered at this site.

5.2.1 Sources

The major sources for introduction of noxious weeds will be associated with the transport of materials and equipment to the site from the mainland or elsewhere and the spread of weeds from existing infestations in areas adjacent to the LNG facility on to the site.

5.2.2 Weed and Pest Species

Weeds

Four weed species were identified as being of management concern during the EIS and during subsequent weed surveys and treatment programs (RPS, 2014). There species were Lantana (*Lantana camara*), Rubber Vine (*Cryptostegia grandiflora*), Giant Rat's Tail Grass (*Sporobolus pyramidalis*) and Prickly Pear (*Opuntia stricta*) and are listed as pest species under the *Land Protection (Pest and Stock Route Management) Act 2002*.

The LP Act LP Act declared weed infestations were identified on Curtis Island in estuarine (MOF Area, Haul Road, Jetty, and Area neighbouring QCLNG) and non-estuarine (MOF Laydown Area/WTP and Rear of site neighbouring GAWB) locations (RPS, 2014).

Introduced (Pest) Animal Species

Domesticated cattle and horses (brumbies) are present in the area. Feral cats have been observed on the site prior to construction as well as signs and sightings of pigs and tracks of wild dogs and/or dingo. Cane toads are also abundant in the area. An infestation of Fire Ants was identified on an adjacent LNG site during its construction phase and the LNG Precinct largely falls within a Declared Fire Ant Restricted Area.

There are currently 26 marine species listed as being introduced into Queensland waters (NIMPIS website - www.marine.csiro.au/crimp/nimpis) A marine introduced pest survey of Port Curtis was conducted in 2000 (Lewis et al. 2001) by the Central Queensland University in conjunction with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Centre for Research and Introduced Pests. No declared pest species were detected in Port Curtis; however, low abundances of ten introduced species were detected. These species are widespread in ports across Australia and around the world, and are not considered to be a threat to native species, aside from direct competition for space between some bryozoans.

5.2.3 Control Methods

Control measures to be implemented at the LNG facility include:

- Inclusion of weed and pest management (weed and pest species, methods of introduction or spread, environmental impacts, control methods) in site induction training.
- Boundary fencing to exclude large pest/feral species already present on Curtis Island (brumbies, pigs) from the site.
- Off-site washdown of all plant and equipment prior to it arriving on site to prevent the introduction of weeds.
- Vehicle washdown facility on site for cleaning site vehicles that may enter or lease areas where weeds may be present.
- Access to the Curtis Island Environmental Management Precinct is prohibited without prior authorisation.

- Regular monitoring inspections about site to identify weeds that may be present
- Regular weed eradication (e.g. chemical spraying) program to control any weeds found.
- The GLNG LNG facility is within a Declared Fire Ant Restricted Area and the site is operated in accordance with an approved Fire Ant Risk Management Plan (FARMP).

5.2.4 Environmental Protection Commitments, Objectives and Control Strategies

The environmental protection commitments, objectives and control strategies for potential impacts from weeds and pests for LNG facility operations are summarised in Table 5-4.

Table 5-4. Operations Environmental Management Sub Plan – Weeds and Pests

WEEDS AND PESTS – LNG Facility and Associated Infrastructure – Operational EM Sub Plan
Operation Policy or Management Objective To minimise adverse impacts due to weeds and pests on biodiversity from the LNG facility's operations, in particular, to: • Prevent the introduction and spread of weeds and pests; • Minimise the risk of spreading weeds to undisturbed areas; and • Remove weeds and pests encountered at this site
Performance Criteria • Compliance with the requirements of the LNG facility's environmental permits. • No detrimental impacts on MNES values adjacent to the LNG facility.
Implementation Strategy • Develop and implement a Pest and Weeds Management Plan. • Ensure machinery and equipment washdown procedures are implemented and followed. • Ensure personnel are familiar with weed and pest species, their identification and the requirement to report any occurrences or sightings. • Implement an Operations Fire Ant Risk Management Plan. • Implement a weed and pest management program.
Monitoring and Auditing Auditing and reporting of environmental performance data will be conducted in accordance with 1.10 of this OEMP. The Senior Environmental Advisor will report monitoring results to the appropriate Manager. The Senior Environmental Advisor will report monitoring results to the DEHP in accordance with the LNG facility's environmental authority.
Reporting and Corrective Actions Reporting of environmental performance data will be conducted in accordance with Section 1.10 of this OEMP. Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses and non-compliance events) will be managed through the IMS and reported to the appropriate authority as required.

6 MONITORING

The LNG facility operations environmental monitoring and sampling program provides information needed to assess potential impacts from the LNG facility operations, the basis for on-going monitoring required, and documents appropriate trigger values for mitigation and cessation of works. The environmental monitoring required under the project approvals includes monitoring of air emissions, stormwater and waste water discharges, and groundwater monitoring. The requirements and basis for monitoring each of these media are summarised below and have been incorporated into a Environmental Monitoring Plan.

6.1 Air Emissions Monitoring

Air emissions during operation of the LNG facility include stationary sources (release point) emissions and fugitive emissions. Monitoring of air emissions to ensure compliance with limits outlined in approvals will include the following.

- Release point emissions monitoring will be conducted as outlined in Environmental Authority EPPG00712213 at the nominated emission release points. Monitoring will be conducted in accordance with Australian Standard (AS) 4323.1 – 1995 Stationary source emissions, Method 1: Selection of sampling positions' (or more recent editions). Testing will include the following:
  - Measurement of gas velocity, volume flow rate, temperature, NO_x and water vapour concentration (moisture content) to allow assessment of compliance with emission limits.
  - Sampling will be conducted at expected maximum emission rates with production rates, raw materials and fuels used, and the number of plant or equipment in operation at the time of sampling recorded. Reference to actual test methods used and accuracy of the test methods will also be recorded.
- During operations, flares will be observed for visual signs of smoke or particulate emissions.
- Reasonable and practicable operating, maintenance and management practices will be employed to minimise potential fugitive VOC emissions associated with LNG facility operations.
- Only natural gas, methane gas or diesel fuel will be used in fuel burning equipment during LNG facility operations. Fuels used will contain a sulphur content that does not exceed 0.5 percent by weight.

6.2 Stormwater Monitoring

Monitoring of discharged stormwater quality shall be conducted at the nominated water monitoring locations SW1 to SW9 in accordance with Environmental Authority EPPG00712213. Grab samples shall be taken for laboratory analysis. All laboratory analysis will be conducted by a NATA-certified laboratory.

6.3 Waste Water Discharge Monitoring

Authorised discharges through the WW1 diffuser include uncontaminated stormwater from the PASCS, treated water from the OWTP, and UF unit cleaning water and RO concentration (ROC) from the WTP.

Monitoring of water released to Port Curtis via the WW1 diffuser is conducted to document discharge water quality and compliance with the water quality limits in Environmental Authority EPPG00712213. Monitoring of discharged water is conducted via in-line probes/meters to continuously monitor pH, hydrocarbons and flow rate/volume, and grab samples collected from an in-line valve for laboratory analysis. Grab samples for laboratory analysis are collected from an automated sampler at monitoring point S9, located upstream of WW1. Samples for operational monitoring may also be collected from a sample valve at sample point S1, located immediately downstream of the OWTP, prior to mixing with the waste water stream from the operations WTP.

6.4 Receiving Environment Monitoring

A Receiving Environment Monitoring Plan (REMP) (URS, 2014b) was developed to identify, monitor, and record the effects of the release of contaminants in discharges from the LNG facility during operations to ensure compliance with the conditions of Environmental Authority EPPG00712213 and assess any adverse impacts to local environmental values or changes in the receiving water. The REMP was developed with consideration of studies previously completed (URS, 2013a, 2013b and 2014b) including baseline surface water conditions assessments, ecological assessment (including benthic habitat mapping), validation of diffuser modelling completed for the construction phase diffuser (WW2), and discharge modelling for the operational diffuser WW1 (URS, 2014c). The results of these studies were used to support the REMP developed for monitoring during LNG facility operations (URS, 2014b).

The REMP to be implemented during LNG facility operations will include the following:

- Stormwater discharge monitoring at monitoring points SW1 through SW9 as described in Section 6-2.
- Monitoring of waste water discharges through WW1. Discharges to WW1 are monitored at sample point S9 as described in Section 6.3.
- Validation of the WW1 diffuser discharge modelling as described in Section 6.4.1.

Further details regarding the monitoring methods to be employed, the basis for monitoring, and water quality targets developed for the receiving environment monitoring program are provided in the REMP (URS, 2014b).

6.5 Monitoring for Potential Adverse Environmental Impacts to Receiving Waters

Impact monitoring will be conducted, in accordance with Environmental Authority EPPG00712213, to obtain qualitative data on the potential environmental impact of waste

water discharges on the estuarine environment in the vicinity of diffuser WW1. Monitoring will utilise the following three categories of water quality sites:

- Impact Sites - within the initial mixing zone
- Near Reference Sites – beyond the initial mixing zone but potential impacted
- Reference Sites – beyond the zone of influence of the waste water discharge

All laboratory analysis will be conducted by NATA-certified laboratory. Uni-variate and multi-variate statistical analysis techniques will be used to evaluate the water quality data to determine whether the water quality objectives and targets developed in the REMP are exceeded beyond the initial mixing zone.

6.6 Marine Turtle Monitoring

A Long-Term Turtle Management Plan (LTTMP) has been developed on behalf of LNG proponents QGC, GLNG and Australia Pacific LNG (LNG proponents, 2014). The LTTMP was developed to assess risks, develop mitigation strategies, and associated monitoring tasks focused on the Port Curtis, Curtis Island and Facing Island areas where environmental risks associated with the LNG developments are highest.

Given the known gaps in existing monitoring programs of relevance to the long-term conservation of marine turtles in the Gladstone region, additional monitoring measures will be implemented under the LTTMP. Integration with the existing monitoring programs, where possible, will eliminate the need for replication of studies and value-add to the work already being completed. Existing programs may be expended, where relevant, to address identified monitoring gaps. The additional monitoring will provide a comprehensive program capable of identifying, and responding to (if required), any negative effects that the construction and operation of the LNG facilities may have on marine turtles and their habitats within the Gladstone region. Monitoring activities will be conducted and reviewed by turtle experts to achieve a high level of scientific rigour and in many cases will supplement or expand existing research projects to also address the objectives of this monitoring plan.

The LNG proponents will seek to enter into research agreements with relevant turtle experts to deliver the monitoring commitments within the plan. DEHP will be consulted regarding the protocols it has established for the collection and storage of turtle research data. The LNG proponents will require turtle researchers implementing the LTTMP to apply the DEHP research protocols in order to maximise the benefits of the data collected to the Queensland Government's long-term turtle research programs.

The LTTMP monitoring component is based on environmental risk and will include detailed examination of anthropogenic-related causes of mortality, ongoing measurement of sky glow at strategic times during nesting and hatchling emergence, necropsy examination of stranded turtle carcasses, health surveillance of marine turtle populations, monitoring of the orientation of hatchling dispersal on beaches and a range of turtle nesting parameters on Curtis Island and at a control nesting site of Wild Duck Island, within the Broad Sound Islands National Park, north of Shoalwater Bay.

The monitoring plan will be regularly reviewed to maintain its relevance to emerging information and to address relevant knowledge gaps in the environmental health of the Gladstone region.

In addition, potential impacts on marine turtles from port-wide dredging and capital dredging and ongoing maintenance dredging in LNG facilities' berths is monitored by GPC for the Western Basin Dredging and Disposal Project. This involves extensive surveys pre, during and post dredging, for a period of 10 years. The GLNG marine facilities are included in the GPC survey area. GLNG is a financial contributor to this marine megafauna monitoring program as a funding party for the Western Basin Dredging and Disposal Project. The LTTMP considers potential synergies with the dredging project, with the two projects providing comprehensive assessment, monitoring and management of potential impacts.

6.7 Migratory Shorebirds

Migratory shorebird surveys will be undertaken to fulfil the requirements of EPBC Approval No. 2008/4058 for the development of the LNG marine facilities. Surveys are undertaken to determine baseline population densities and habitat utilisation for migratory birds on or contiguous to the LNG facility site. Surveys are undertaken annually/twice annually during northward and southward migrations.

6.8 Groundwater Monitoring

A number of groundwater monitoring bores were established for baseline assessment during the EIS stage of the project. Subsequent construction of the LNG facility has resulted in the removal of these bores. A monitoring program will be established and implemented to detect potential impacts to groundwater associated with the operation of the LNG facility.

6.9 Monitoring Reporting

The results of the monitoring programs, including reports on the REMP, will be included in the annual monitoring report in accordance with reporting requirements of approvals.

7 REHABILITATION AND DECOMMISSIONING

The LNG facility and associated infrastructure has a design life of 20 years but may continue operations for a longer period. Nevertheless, planning is required for its eventual closure. This section outlines the rehabilitation and decommissioning stages which will be required for the LNG facility and associated infrastructure. Rehabilitation and decommissioning plans will be developed in conjunction with regulatory agencies at least five years prior to closure. At that time there will be a greater understanding of the current decommissioning standards and alternative land uses available for the project site.

GLNG has statutory obligations under the *Petroleum and Gas (Production and Safety) Act* as well as contractual obligations to government bodies which will determine which infrastructure will remain on-site for future use. The LNG facility will otherwise be decommissioned and a site decommissioning and closure plan will be developed in conjunction with the regulatory authorities. All decommissioning works will be conducted in accordance with standard practices applicable at the time including the requirements of the *Petroleum and Gas (Production and Safety) Act 2004* (Qld) as amended or superseded from time to time and any requirements as stipulated under the site's Environmental Authority.

Progressive rehabilitation (where practicable) of the LNG facility and associated infrastructure will occur for areas that have been disturbed. Partial rehabilitation of construction disturbances is conducted under the CEMP.

7.1 Goals

Subject to existing contractual obligations, the specific goals for rehabilitating the LNG facility site are as follows:

- Achievement of acceptable land use suitability – Rehabilitation will aim to create a stable landform and rehabilitate the site to its natural state with a post-project land use capability and/or suitability similar to that prior to disturbance, unless other beneficial land uses are pre- determined and agreed by the applicable stakeholders and regulatory authorities;
- Creation of stable landform - The site will be rehabilitated to a safe condition that is self-sustaining or to a safe condition where maintenance requirements are consistent with an agreed post-project land use; and
- Preservation of downstream water quality – sediment levels and water quality in the immediate area of the LNG Facility will be returned to pre-construction background levels.

To achieve the rehabilitation objectives, rehabilitation of the site will be conducted so that:

- Suitable species of vegetation are planted and established;

- The potential for water and wind induced erosion is minimised, including likelihood of environmental impacts being caused by the release of dust;
- The quality of surface water released from the site is such that releases are not likely to cause environmental harm;
- The water quality of any residual water bodies does not have the potential to cause environmental harm; and
- The final landform is stable and not subject to slumping or erosion.

7.2 Success Criteria

During the development of the decommissioning plan, preliminary success criteria (or closure criteria) for the rehabilitation areas will be developed. The success criteria are performance objectives or standards against which rehabilitation success in achieving a sustainable system for the proposed land use is demonstrated.

The success criteria are likely to include indicators for vegetation, fauna, soil, stability, land use and safety on a domain basis.

7.3 Monitoring

Monitoring of the rehabilitated areas will be undertaken during the initial vegetation establishment period and beyond to determine whether the objectives of the rehabilitation strategy are being achieved and whether a sustainable, stable landform has been obtained. Monitoring will include inspections for the following key aspects:

- Soil erosion;
- Revegetation success;
- Weed infestation; and
- Integrity of water diversion drains, waterways and sediment control structures.

Monitoring will be conducted by suitably skilled and qualified persons at locations which will be representative of the range of conditions on the rehabilitating areas. Annual reviews will be conducted of monitoring data to assess trends and monitoring program effectiveness. The outcome of these reviews will be included in reporting to the relevant government authorities.

Maintenance works will be undertaken to address any deficiencies or areas of concern identified from the monitoring. This may include the re-application of topsoil, re-seeding, re-planting, weed control, additional fertiliser applications, de-silting or repair of drainage works and sedimentation dams and infill and re-grading of eroded areas.

7.4 Financial Assurance

GLNG has provided a bank guarantee (revised from time to time) to the State in respect of activities carried out pursuant to the EA. The amount of the financial assurance for the operations phase has been agreed with DEHP.

7.5 Decommissioning

7.5.1 Site Services

All services including power, water and telecommunications on the site will be isolated, disconnected and rendered safe. The inspection pits and junction boxes for underground services will be sealed. Generally, all underground services will be rendered safe and left buried in the ground. Overhead project-specific power lines will be removed and the equipment (i.e. poles and wires) recovered for potential re-sale or recycling as applicable.

7.5.2 Equipment and Buildings

All items of equipment to be decommissioned will be isolated, de-oiled, degassed, depressurised and decontaminated. This may involve flushing all process equipment and associated pipe work with water. This water will be disposed of as per the decommissioning plan developed in conjunction with the regulatory authorities. All hazardous materials will be removed from the site in accordance with the handling and transportation requirements applicable at the time.

Subject to contractual obligations, all buildings and infrastructure will be demolished or otherwise removed from the site.

The remaining items will be demolished, and removed/transported from the site as required. All recoverable scrap steel will be sold and recycled, with the remaining non-recyclable wastes being taken to a licensed landfill on the mainland.

Prior to disposal, all wastes will be assessed and classified in accordance with the *Environmental Protection (Waste Management) Policy 2000* and the *Environmental Protection (Waste Management) Regulation 2000* (or requirements applicable at that time) and appropriate management procedures will be developed.

All concrete footings and pads will be broken up to at least 1.5 metres below the surface. The waste concrete will be crushed to produce an aggregate that can either be used on the site or sold for some other beneficial reuse.

If sediment ponds and sumps are to be removed, they will be drained, decontaminated, filled with backfill, topsoiled and revegetated. Any stormwater management ponds present at the time of decommissioning will be used to assist with the provision of water for rehabilitation, where necessary.

7.5.3 Roadways, Car Parks and Hardstands

Other than the haul road which is subject to contractual obligations, all paved roadways, car parks and hardstand areas will be removed with the inert waste material being transported to a licensed landfill or sold as fill. Where possible, assets will be sold. These areas will then be recontoured and revegetated. Stormwater drainage facilities will be installed as necessary.

7.5.4 Contaminated Land

Potential exists for land to become contaminated by sewage, hydrocarbons or other chemicals or general and regulated waste.

Sites contaminated by operational activities will be identified in the site management plan (including register and survey plan) which will be maintained for the life of the project. Identified contaminated areas will be included on the DEHP's Environmental Management Register (EMR) and Contaminated Land Register (CLR) as appropriate.

Upon decommissioning, contaminated land assessments will be conducted in potentially contaminated areas to standards applicable under legislation at that time, which currently are those prescribed by the *Environmental Protection Act 1994*. Contaminated areas will be assessed for the type and amount of contaminants. Areas that have elevated levels of contaminants will be remediated using suitable methods as they become available during the life of the project. Any hazardous materials and wastes will be removed from site or remediated. Remediation measures will be discussed with the relevant regulatory authority prior to commencement of remediation works. Such measures could include bio-remediation on-site or disposal off-site at a licensed facility.

7.5.5 Bulk Earthworks and Site Rehabilitation

Contaminated or unsuitable material (e.g. gravel, etc.) will be removed from the hardstand surfaces and disposed of as appropriate.

The entire facility will be dozer trimmed to facilitate the appropriate drainage of surface runoff from the site. Appropriate surface water management structures (contour banks, drains and settlement ponds) will also be retained or constructed, as required to assist surface stabilisation and minimise erosion of the reconstructed landforms and offsite sediment movement. The site will be rock raked to remove all surface rocks to a size of less than 500 mm and ripped to a depth of at least 1 metre. Fertiliser and pasture/tree seed will be applied to stabilise the surface.

7.5.6 Post Closure Monitoring and Management

Following closure of the facility, the existing environmental monitoring program will be maintained until all decommissioning and rehabilitation works have been completed. Notwithstanding this, there may be the need to establish some additional monitoring sites depending on the nature of the decommissioning works.

The type and location of this monitoring will be determined during the decommissioning phase of the site.

A Decommissioning Environmental Management (EM) Sub Plan is provided in Table 7-1.

Table 7-1. Decommissioning Environmental Management Sub Plan

LNG Facility and Associated Infrastructure – Decommissioning EM Sub Plan
Operation Policy or Management Objective To ensure that the LNG facility and associated infrastructure is effectively decommissioned in an environmentally sustainable manner.
Performance Criteria The site contains no long term environmental hazards. Risks to the public are mitigated to acceptable levels. The site is returned to its former natural state, subject to contractual obligations.
Implementation Strategy At least five years prior to closure of the LNG facility and associated infrastructure, a detailed site decommissioning plan will be developed to the satisfaction of the relevant authority that will establish procedures and methods for decommissioning. • Site preparation; • Relevant planting / seeding methods; • Relevant species and densities; • Realisation targets; • Schedule of monitoring and maintenance; and • Prescriptions for the establishment of benchmark reference sites to guide rehabilitation monitoring. Decommissioning procedures at the site will involve: • All services including power, water and telecommunications on the site will be isolated, disconnected and rendered safe. • The removal of equipment and structures from the site for re-sale, re-cycling or disposal. • Prior to disposal, all wastes will be assessed and classified in accordance with the *Environmental Protection (Waste Management) Policy 2000* and the *Environmental Protection (Waste Management) Regulation 2000* (or requirements applicable at that time) and appropriate management procedures will be developed. • Phase 1 and 2 contaminated land assessments will be conducted on potentially contaminated parts of the site to standards prescribed by the EP Act. Where necessary, decontamination or site remediation work will be undertaken. • The land based areas will then be recontoured and rehabilitated to achieve a stable self-sustaining landform. • Undertake environmental monitoring to confirm the success of the decommissioning activities.
Monitoring and Auditing Monitoring and auditing will be conducted in accordance with Section 6 of this OEMP. A monitoring program that will assess the effectiveness of rehabilitation and decontamination efforts at the site will be developed as part of the preparation of the final decommissioning plan. On-going environmental monitoring will be undertaken for a period of time to ensure decontamination and rehabilitation procedures have been successful and that there is no likelihood of any further contamination resulting from the site's previous activities.
Reporting and Corrective Action Records will be kept of any areas where decontamination is required. The results of rehabilitation, decontamination and any monitoring programs will be kept and presented in a decommissioning report which will be submitted to the DEHP. Reporting of environmental non-compliances will be in accordance with environmental permit requirements. Environmental Monitoring Records will be recorded and managed in an environmental monitoring database. Reporting, investigation and management of corrective actions associated with environmental events will be managed through the IMS. The decommissioning plan will be reviewed and revised in consultation with the regulatory authorities, as required.

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9 SUBORDINATE INTERNAL DOCUMENTS MENTIONED

(in no particular order)

Environmental Awareness Training Presentation

Environmental Code of Conduct (3301-GLNG-5-1.3-0059)

Emergency Response Plan (3301-GLNG-5-1.6-0024)

Environmental Contingency and Emergency Response Plan (3301-GLNG-5-1.3-0060)

Stormwater, Sediment and Erosion Management Plan (3301-GLNG-5-1.3-0005)

Pest and Weed Management Plan (3301-GLNG-5-1.3-0004)

Waste Management Plan (3301-GLNG-5-1.3-0006)

Fire Ant Risk Management Plan (draft)

OEMP Environmental Monitoring Plan (3301-GLNG-5-1.3-0003)

10 ACRONYMS AND GLOSSARY

Abbreviation	Description
AASS	Actual Acid Sulfate Soil
AHD	Australian Height Datum
AIM	Audit And Inspection Manager
aMDEA	Activated Methyldiethanolamine
ANAN	Air Natural Air Natural
API RP	American Petroleum Institute Recommended Practice
APLNG	Australia Pacific LNG
AQIS	Australian Quarantine And Inspection Service
AS	Australian Standard
AS/NZS	Australian Standard/New Zealand Standard
ASC	Anti-Surge Control
BAAM	Biodiversity Assessment And Management
BAT	Best Available Techniques
BNR	Biological Nutrient Removal
BOD	Biological Oxygen Demand
BOG	Boil-Off Gas
BQCC	Biosecurity Queensland Control Centre
°C	Degrees Celcius
CAMBA	China-Australia Migratory Bird Agreement
CCR	Central Control Room
CCTV	Closed Circuit Television
CEMP	Construction Environmental Management Plan
CG	Coordinator-General
CLR	Contaminated Land Register
CO_2	Carbon Dioxide
CoP	ConocoPhillips
CPI	Corrugated Plate Interceptor
CSG	Coal Seam Gas
DAF	Dissolved Air Flotation
dBA	Decibel (A filter)
DCS	Distributed Control System
DEEDI	Department Of Employment, Economic Development And Innovation

Abbreviation	Description
DEHP	Department of Environmental And Heritage Protection
DERM	Department of Environment and Resource Management
DIP	Department of Infrastructure And Planning
DLE	Dry Low Emission
DMP	Dredging Management Plan
DPA	Dugong Protection Area
DPA	Dugong Protection Area
DPI&F	Department Of Primary Industries And Fisheries
DTA	Direct Toxicity Assessment
EA	Environmental Authority EPPG00712213 held by Santos, PETRONAS and Total
ED	Electro-Deionisation
EDP	Emergency Depressurisation
EHS	Environment, Health And Safety
EHSMS	Environment Health And Safety Management System
EIS	Environmental Impact Statement
EM	Environmental Management
EMP	Environmental Management Plan
EMR	Environmental Management Register
EP	Environmental Protection
EP Act	Environmental Protection Act 1999
EPA	Environmental Protection Agency
EPBC Act	Environment Protection And Biodiversity Conservation Act 1999
ERA	Environmentally Relevant Activity
ERS	Emergency Release System
ESD	Emergency Shutdown
ESDF	Emergency Shutdown Feed
ESDL	Emergency Shutdown Of Ship Loading
ESDL	Emergency Shutdown Ship Loading
ESDP	Emergency Shutdown Process
ESDP	Emergency Shutdown Process
ESDV	Emergency Shutdown Valve
ESSS	Emergency Safety Shutdown System
FAR	Field Auxiliary Room
FHA	Fish Habitat Area
FGS	Fire And Gas System

Abbreviation	Description
GAWB	Gladstone Area Water Board
GBRMPA	Great Barrier Reef Marine Park Authority
GBRWHA	Great Barrier Reef World Heritage Area
GHG	Greenhouse Gases
GLNG	Gladstone Liquefied Natural Gas
GLNG OPL	Gladstone Liquefied Natural Gas Operations Pty Ltd
GPC	Gladstone Ports Corporation Ltd
GRC	Gladstone Regional Council
GSDA	Gladstone State Development Area
GTG	Gas Turbine Generator
GTP	Gas Transmission Pipeline
H_2S	Hydrogen Sulphide
ha	Hectares
HART	Highway Addressable Remote Transducer
HAT	Highest Astronomical Tide
HPFG	High Pressure Fuel Gas
HVAC	Heating Ventilation, Air Conditioning
ICC	Incident Command Centre
ICSS	Integrated Control And Safety System
IFO	Independent Fauna Observer
IMS	Incident Management System
IR	Infrared
JAMBA	Japan-Australia Migratory Bird Agreement
kHz	Kiloherz
km	Kilometres
KOGAS	KGLNG Liquefaction Pty Ltd
kPag	Kilopascals Gauge
LCP	Local Control Panel
LOEC	Lowest Observable Effect Concentration
LNG	Liquefied Natural Gas
LNG Facility	GLNG's Liquefaction and export Facility
LNGC	Liquefied Natural Gas Carrier
LoLo	Lift-On/Lift-Off
LPFG	Low Pressure Fuel Gas
LPG	Liquefied Petroleum Gas

Abbreviation	Description
m^3	Cubic Metres
m^3/h	Cubic Metres Per Hour
MAC	Manual Alarm Call
MCU	Material Change Of Use
MNES	Matters Of National Environmental Significance
MOF	Materials Offloading Facility
MPag	Megapascals Gauge
MPFG	Medium Pressure Fuel Gas
Mtpa	Megatonnes per annum
N_2	Nitrogen (Gas)
NATA	National Association Of Testing Authorities
NC Act	Nature Conservation Act 1992
NFPA	National Fire Protection Association
Nox	Nitrogen Oxides
O_3	Ozone
OAMP	Offset Area Management Plan
OCD	Operator Control Desk
OEMP	Operational Environmental Management Plan
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
OWS	Operator Workstation
OWTP	Oily-Water Treatment Plant
PASCS	Process Area Spill Containment Sump
PERC	Powered Emergency Release Coupling
PETRONAS	PAPL (Downstream) Pty Ltd
PFL	Petroleum Facility Licence
PLF	Product Loading Facility
PM_{10}/PM_2	Particulate Matter (up to 10 or 2.5 micrometres in size)
PSD	Process Shutdown
PSV	Pressure Safety Valve
QLD	Queensland
QPWS	Queensland Parks And Wildlife Service
RE	Regional Ecosystem
REMP	Receiving Environment Management Plan
RO	Reverse Osmosis

Abbreviation	Description
ROC	Reverse Osmosis Concentrate
RoRo	Roll-On/Roll-Off
Santos	Santos GLNG Pty Ltd
SDPWO Act	State Development And Public Works Organisation Act 1971
SEIS	Supplementary Environmental Impact Statement
SEWPaC	Department Of Sustainability, Environment, Water, Population And Communities
SIS	Safety Instrument System
SO_2	Sulfur Dioxide
SPA	Sustainable Planning Act 2009
SSS	Safety Shutdown System
STP	Sewage Treatment Plant
t	Tonnes
TIAC	Turbine Inlet Air Chilling System
Total	Total GLNG Australia
TSS	Total Suspended Solids
UCP	Unit Control Panel
UPS	Uninterruptible Power Supply
WHA	World Heritage Area
WHS	Work Health And Safety
WHSQ	Workplace Health And Safety Queensland
WTP	Water Treatment Plant