Santos
GLNG Project

GLNG
Gas Transmission Pipeline

Environmental Management Plan for Marine Crossing GTP

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1. Introduction

1.1 Background

GLNG Operations, a joint venture between Santos GLNG Pty Ltd (Santos), PAPL (Downstream) Pty Ltd (PETRONAS), Total GLNG Australia (TOTAL) and KGLNG Liquefaction Pty Ltd (KOGAS) propose to construct a high pressure Gas Transmission Pipeline (GTP) to transport coal seam gas (CSG) from the CSG fields at Roma and Fairview to a proposed liquefied natural gas (LNG) facility on Curtis Island (refer Figure 1.1). The GTP forms one component of the Gladstone LNG (GLNG) Project (the Project), which includes the following:

- Exploration and production of CSG in the Surat and Bowen Basin gas fields
- Construction and operation of an approximate 420 km GTP from the CSG fields in Roma and Fairview to the LNG Facility on Curtis Island (Santos GLNG GTP)
- Construction and operation of a gas liquefaction and export facility on Curtis Island and associated infrastructure

On 22 October 2010, in accordance with the EPBC Act, the Minister approved the development, construction, operation and decommissioning of the GTP (and the other components of the Project). Condition 29 and 30 of the EPBC Act approval for the GTP require an Environmental Management Plan (EMP) to be prepared for the crossing of The Narrows and submitted for the approval of the Minister prior to commencing the activity. This EMP has been prepared to address the conditions of the EPBC Act approval relevant to The Narrows Crossing (refer Table 1.7).

The Marine Crossing GTP section of the Project is shown in Figure 1.1 and Figure 1.2 between reference points A and E (hereafter referred to as Points) and represents *The Narrows Crossing*, as approved under the EPBC Act approval.

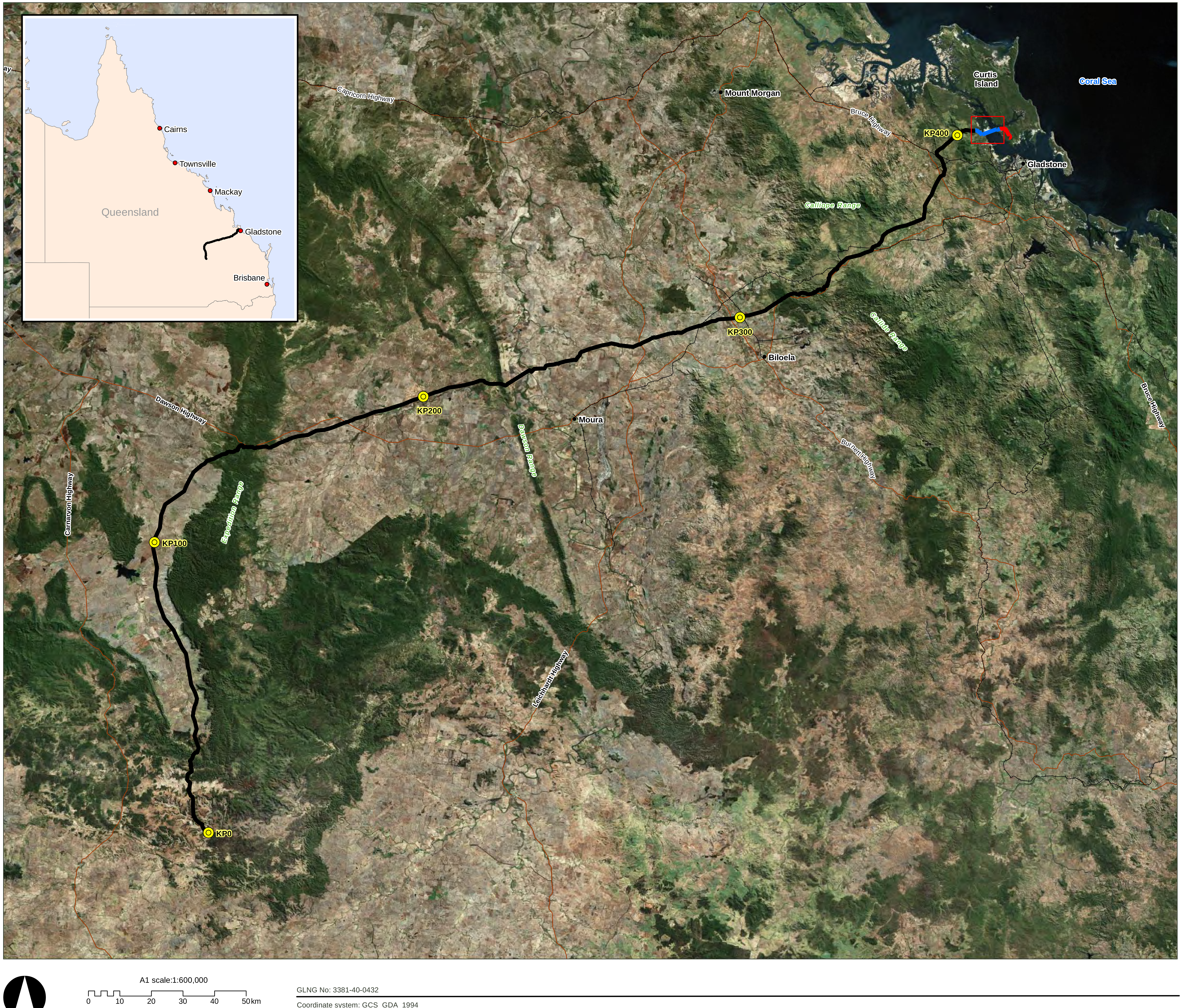
The EMP has also been prepared in support of a Level 1 Environmental Authority (EA) (Chapter 5A activities) application for the Marine Crossing GTP. This EMP was submitted to the former Department of Environment and Resource Management (DERM) in September 2011 (now the Department of Environment and Heritage Protection (DEHP)) in accordance with the *Environmental Protection Act 1994* (EP Act), Section 310D.

1.1.1 Marine Crossing GTP Project construction methodology

GLNG Operations reviewed the proposed construction methodology and have selected to proceed with a standalone (not in a bundled crossing) option for the crossing of The Narrows. Approval to proceed with the selection of a standalone option was confirmed through correspondence with the former Department of Infrastructure and Planning (DIP), dated 30 November 2010.

The construction methodology for the marine crossing includes bored tunnelling using a tunnel boring machine (TBM) under the intertidal area south of Kangaroo Island and the marine waters of The Narrows, together with conventional trenching techniques for the terrestrial sections of the Santos GLNG GTP on both the mainland and Curtis Island. The environmental benefits of the Marine Crossing tunnel compared to the bundled crossing method include:

- No direct disturbance to tidal flows or impact on sensitive saltpan and salt marsh areas south of Kangaroo Island
- Construction of access tracks, HDD drill pads and pipe stringing activities within the intertidal areas is no longer required



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Marine Crossing GTP EMP

Marine Crossing GTP EM Project Footprint (Figure 1.2) Extent

Gas Transmission Pipeline (GTP)

Mainland GTP

Marine Crossing GTP

Curtis Island GTP

Kilometre Post Distance Marker (km)

Major Road

Rail

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: BING, Feb 2011.

Locality Plan
Figure 1.1

GLNG No: 3381-40-0432

Coordinate system: GCS_GDA_1994

Date: 20/06/2012

Version: h

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_002.mxd 20/06/2012 15:16

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

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Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.

Indicative Project Footprint
Figure 1.2

A1 scale: 1:15,000

0 250 500 750 1,000 1,250m

GLNG No: 3381-40-0433

Coordinate system: GCS_GDA_1994

Date: 20/06/2012 Version: r

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_032.mxd 20/06/2012 15:18

- Reduced risk of pollution and contamination impacts from leaked drill fluids and/or disturbed acid sulfate soils (ASS) within intertidal areas
- Removal of the risk of accelerated erosion and sediment movement within the intertidal area south of Kangaroo Island, due to the Marine Crossing GTP Project disturbance footprint being restricted to terrestrial areas and watercourse crossings
- Minimisation of disturbance to tidal areas by moving the Humpy Creek right of way (ROW) crossing
- Placement of ancillary works away from the upper reach, mangrove and estuarine habitats of Mosquito Creek tidal area
- Tunnel operations will commence from the mainland and end on Curtis Island in purpose built construction site pads. Restricting the tunnel support operations to the construction site pads allows for a high degree of control and environmental management of associated construction activities, which include handling of tunnel spoil, chemical and fuel storage and management of tunnel seepage water

Additional information and a detailed description of the construction methodology for the Marine Crossing GTP Project is provided in Chapter 2.

1.1.2 Commonwealth legislation and approval

Separate referrals were submitted under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) for the various components of the Project, including the Santos GLNG GTP (2008/4096).

On 22 October 2010, in accordance with the EPBC Act, the Minister approved the development, construction, operation and decommissioning of the Santos GLNG GTP (refer Figure 1.1), and the other components of the Project. Conditions 2, 3 and 4 of the EPBC Act approval require an EMP to be submitted to the Minister for approval for the area excluding The Narrows. Conditions 29 and 30 require the submission of an EMP for the Santos GLNG GTP crossing of The Narrows.

This EMP addresses the Santos GLNG GTP crossing of The Narrows (Marine Crossing GTP). The Marine Crossing GTP is an 8.4 km section within the Project (refer Figure 1.2) that includes the final 3 km to the Mainland GTP (between Points A and C) and 900 m on Curtis Island to join with the Curtis Island GTP section of the Project (between Points D and E). For the purposes of this document, The Narrows crossing includes the intertidal area south of Kangaroo Island and the marine waters of The Narrows (between Points C and D).

The terrestrial mainland section of the Marine Crossing GTP (Point A to Point C) and the terrestrial Curtis Island section of the Marine Crossing GTP (Point D to Point E) are subject to Conditions 2 - 4 of the EPBC Act approval. The Narrows crossing of the Marine Crossing GTP (Point C to Point D) is subject to Conditions 29 and 30 of the EPBC Act approval. This EMP addresses the requirements of Conditions 2, 3, 4, 29 and 30 of the EPBC Act approval for the Marine Crossing GTP.

Separate EMPs have been submitted for the mainland and Curtis Island sections of the Santos GLNG GTP, these EMPs address Conditions 2, 3 and 4 of the EPBC Act approval as the pipeline sections are classified as being within areas excluding The Narrows.

1.1.3 State legislation and approval

On 16 July 2007, the Queensland Government declared the Project to be a significant project requiring an Environmental Impact Statement (EIS). Throughout 2008 and 2009 an EIS was prepared for the Project (URS, 2009a). The EIS was approved by the Coordinator-General (CG) for release for public and advisory agency comment from 20 June to 17

August 2009. Submissions covered a broad range of environmental, social, accommodation, materials and employee transport, infrastructure location and regulatory approval matters.

The CG requested additional information about the EIS and the Project in the form of a supplementary EIS (SEIS). The SEIS was subsequently prepared and provided to the former Department of Infrastructure and Planning (now the Department of Local Government and Planning (DLGP)) in December 2009 (URS, 2009b). The SEIS provided additional information to address the EIS submissions received, and identifed refinements to the Project design.

The Coordinator-General's evaluation report for the Project (CG Report) was published in May 2010 (Queensland Government, 2010a), which allowed the Project to proceed, subject to conditions.

1.2 GLNG Operations

GLNG Operations is a joint venture between Santos GLNG Pty Ltd (Santos), Australia's largest domestic gas producer; PAPL (Downstream) Pty Ltd (PETRONAS), Malaysia's national oil and gas company and the world's second largest LNG exporter; Total GLNG Australia (TOTAL), French energy major and the world's fifth largest publicly traded integrated international oil and gas company; and KGLNG Liquefaction Pty Ltd (KOGAS), the world's largest LNG importer.

The Project will initially produce 7.8 million tonnes per annum (Mtpa) of LNG, with a maximum potential production of 10 Mtpa.

With more than 100 years of experience in the oil and gas industry, the GLNG partners have expertise in the whole LNG supply chain (www.glng.com.au). Further details of the joint venture partners are provided below.

1.2.1 Santos

Santos is a major Australian oil and gas exploration and production company with CSG interests in Queensland. Santos has interests and operations in every major Australian petroleum province as well as interests in Indonesia, Papua New Guinea, Vietnam, India, Kyrgyzstan and Egypt. Santos is Australia's largest onshore domestic gas producer, supplying sales gas to all mainland Australian states and territories, ethane to Sydney, and oil and other liquids to domestic and international customers.

The Cooper Basin oil and gas field in southwest Queensland and north-eastern South Australia, which Santos and its joint venture partners have discovered and developed, is one of Australia's largest onshore resources projects. Over $8 billion has been invested to date in this basin.

In Australia, Santos has one of the largest exploration portfolios by area of any company and it also has assembled a large, well-situated acreage position in Indonesia. The company is also pursuing new joint venture opportunities in North Africa and Central and South East Asia.

Santos is positioning itself to perform alongside the top quartile of the world's oil and gas companies - expanding its exploration interests and delivering production growth through an exciting suite of development projects.

Significant development projects contributing to the growth of Santos include the following:

- CSG exploration and developments in Queensland

- Bayu-Undan Liquids and Darwin LNG projects in the Timor/Bonaparte Basin area offshore Darwin
- Mutineer-Exeter oil fields and John Brookes gas field developments in the Carnarvon Basin offshore Western Australia
- Casino gas development in offshore Victoria
- Oyong oil and gas field and Maleo gas field in offshore East Java

1.2.2 PETRONAS

PETRONAS is the acronym for Petroliam Nasional Berhad, a leading Malaysian based oil and gas multinational incorporated on 17 August 1974. Over the years, PETRONAS has grown to become a fully-integrated oil and gas corporation and is ranked among FORTUNE Global 500's largest corporations in the world. PETRONAS has four subsidiaries listed on the Bursa Malaysia (Kuala Lumpur Stock Exchange) and has projects and operations globally in more than 30 countries worldwide. Since its inception, PETRONAS has grown to encompass the full spectrum of oil and gas operations in the areas of upstream oil and gas exploration and production to downstream oil refining; marketing and distribution of petroleum products; trading; gas processing and liquefaction; gas transmission pipeline network operations; marketing of LNG; petrochemical manufacturing and marketing; shipping; and property investment.

On an equity basis, PETRONAS is the largest LNG producer in Asia and is the third largest in the world. The company operates the PETRONAS LNG Complex in Bintulu, Sarawak, which is the world's largest integrated LNG facility with a total capacity of approximately 23 Mtpa from 8 LNG trains. PETRONAS is also a partner in the ELNG Project in Egypt and in the Dragon LNG Project in Wales. It is the world's largest single owner-operator of LNG ships and has long standing relationships with an extensive base of high volume LNG customers in Asia.

Apart from the GLNG Project PETRONAS's interests in Australia include a 16.7% share in pipeline operator APA Group, and a 25% shareholding in the Evans Shoal gas field, 300 km northwest of Darwin, in which Santos is the operator with a 40% interest.

1.2.3 Total

Total is a leading multinational energy company with operations in more than 130 countries. Together with its subsidiaries and affiliates, Total is the fifth largest publicly-traded integrated international oil and gas company in the world[1].

Total engages in all aspects of the petroleum industry, including upstream operations (oil and gas exploration, development and production, LNG) and downstream operations (refining, marketing and the trading and shipping of crude oil and petroleum products). Total is also a major player in chemicals (base and specialty chemicals) and also has interests in the coal mining and power generation sector and is developing complementary next generation energy activities (solar, biomass, nuclear).

Total is a leading producer in the LNG sector, with strong and diversified positions along the LNG chain. Total is active in most of the major LNG producing regions as well as main LNG markets and continues to develop LNG as a key component of its development strategy. Total produces LNG in Indonesia, Qatar, the United Arab Emirates, Oman, Nigeria, Norway and Yemen. The startup of Yemen LNG and Qatargas 2 Train 5 has increased Total's LNG

[1] Based on market capitalisation (in dollars) as of December 31, 2009.

production by around 40% in 2010. Angola LNG, which is currently under construction, will complement this portfolio in 2012.

Total also secured long-term access to LNG re-gasification capacity located in key LNG markets: North America (Sabine Pass in the United States and Altamira in Mexico), Europe (Fos Cavaou in France and South Hook Terminal in the United Kingdom) and Asia (Hazira in India) (www.total.com/en).

In Australia, Total is a 24% owner of the Ichthys LNG Project, and operates four exploration permits in Australia. Total E&P Australia is also present in six other exploration permits. Total E&P Australia inaugurated its Perth office in 2008, consolidating its presence in Australia, and preparing for future increases in its exploration and development activities (www.glng.com.au).

1.2.4 KOGAS

KOGAS, an abbreviation for Korea Gas Corporation, was incorporated by the Korean Government in 1983. Since its founding, it has grown to become the world's largest LNG importer. KOGAS currently operates three LNG terminals and a nationwide pipeline network spanning over 2,739 km.

KOGAS imports LNG from around the world and supplies it to power generation plants, gas-utility companies and city gas companies throughout the country. It produces and supplies natural gas, purifies and sells gas-related by-products, builds and operates production facilities and a distribution network, and explores, imports and exports natural gas for domestic and overseas markets.

In 2009 KOGAS purchased approximately 26 Mtpa of LNG and had revenue of KRW 19,391 billion and employs over 2,800 people worldwide.

KOGAS' other interests in Australia include a 10% stake in Blue Energy Limited and farm-in agreements into two of Blue Energy's permits (www.kogas.or.kr).

1.3 Purpose of the EMP

This EMP is submitted in accordance with Conditions 2, 3, 4, 29 and 30 of the EPBC Act approval. It is also a planning document that demonstrates that GLNG Operations has considered all potential impacts of the proposed construction and operation (including decommissioning) of the Marine Crossing GTP.

1.4 Scope of the EMP

As required in the CG Report, the GTP EMPs have been submitted (Mainland Section, Marine Crossing Section and Curtis Island Section) to support new EAs for the relevant PPLs. Each EMP has been prepared as a 'stand alone' document to be used as the basis for managing activities as the Project progresses.

This EMP describes the Marine Crossing GTP Project (refer Figure 1.2), the surrounding and associated environmental values, the potential environmental impacts and the proposed mitigation measures to minimise potential impacts. Specifically, this EMP:

- Provides a description of the Marine Crossing GTP Project, including the Project rationale, details of the Proponent and applicable legislation
- Describes the Marine Crossing GTP terrestrial trenching construction methodology
- Describes the revised Marine Crossing GTP construction methodology for the crossing of The Narrows in response to DEHP's statutory notice for additional information

- Identifies the environmental values that may be affected
- Recognises that this EMP is a planning document that informs the detailed design, construction and operational phases of the Project
- Identifies and assesses cumulative impacts
- Identifies environmental protection commitments and environmental management procedures
- Includes details of financial assurance for the Project

This Marine Crossing GTP EMP has been prepared based on the findings outlined in the EIS (URS, 2009a); studies undertaken during the preparation of the SEIS; work undertaken in response to conditions specified in the CG Report (Queensland Government, 2010a); additional work undertaken in response to the statutory notice for additional information issued by DEHP on 1 December 2011 pursuant to Section 556 of the EP Act so that DEHP may further assess and decide the application (PEN103428811).

This EMP has been prepared in accordance with Queensland Government guidelines: *Preparing an Environmental Management (EM Plan) for Coal Seam Gas (CSG) Activities* (DERM, 2010b), and covers construction and operational activities associated with the Marine Crossing GTP right of way (ROW). It is also consistent with the Australian Pipeline Industry Association's (APIA's) Code of Environmental Practice (2005).

1.5 EMP format

The EMP elements are addressed in the Chapters as outlined in Table 1.1 and each Chapter addresses the preconstruction, detailed design, construction and operational phases of the Marine Crossing GTP. Environmental sub plans for each element (where relevant) have been developed and include specific mitigation measures and controls to address the potential impacts resulting from the construction and operation of the Marine Crossing GTP.

Table 1.1 EMP elements

EMP chapter	Element	Related Management Plan	Status
1	Introduction	No plan identified for this Chapter	-
2	Project description	Construction Management Plan (CMP) Operational Management Plan (OMP)	CMP to be prepared prior to construction OMP to be prepared prior to operation
3	Environmental management system	Project Health Safety and Security Management Plan (HSSMP) Compliance Management System (CMS)	HSSMP (3380-SAIP-4-1.2-1836) CMS to be prepared prior to construction
4	Financial assurance	No plan identified for this Chapter	-
5	Air quality	No plan identified for this Chapter	-
6	Dams	No plan identified for this Chapter	-
7	Land management	Acid Sulfate Soils Management Plan (ASSMP) Stormwater Management and Erosion and Sediment Control Plan (SMESCP)	ASSMP (refer Appendix A) SMESCP (refer Appendix C)
8	Land tenure and use	No plan identified for this Chapter	-

EMP chapter	Element	Related Management Plan	Status
9	World and national heritage values	ASSMP Pest and Weed Management Plan (PWMP) SMESCP Species Management Plan (SMP) Significant Species Management Plan (SSMP)	ASSMP (refer Appendix A) PWMP (refer Appendix B) SMESCP (refer Appendix C) SMP (3380-GLNG-3-1.3-0036) currently being updated SSMP (3380-GLNG-3-1.3-0031) currently being updated
10	Flora and fauna	PWMP SMP SSMP Water Mouse Management Plan (WMMP) Aquatic Values Management Plan (AVMP)	PWMP (refer Appendix B) SMP (3380-GLNG-3-1.3-0036) currently being updated SSMP (3380-GLNG-3-1.3-0031) currently being updated Currently being prepared Currently being prepared
11	Noise and vibration	No plan identified for this Chapter	-
12	Social	Social Impact Management Plan (SIMP) Mosquitoes and Midges Management Plan (MMMP)	SIMP (3301-GLNG-3-8.6-0014) approved by State Government in May 2012 MMMP (refer Appendix G)
13	Heritage	Cultural Heritage Management Plan (CHMP)	CHMP to be prepared prior to construction
14	Waste	Waste Management Plan (WMP)	WMP (refer Appendix F)
15	Water	ASSMP SMESCP DHWLRMP HTMP	ASSMP (refer Appendix A) SMESCP (refer Appendix C) DHWLRMP (refer Appendix D) HTMP to be prepared prior to hydrostatic testing
16	Rehabilitation	Landscape Rehabilitation Management Plan (LRMP)	LRMP (refer Appendix E)

The above elements are addressed in terms of environmental protection objectives, standards and measurable indicators, control strategies and corrective actions, as detailed in Table 1.2.

Table 1.2 Structure of environmental protection commitments

Environmental protection commitments	Outcomes to be achieved
Specific objectives	The specific objectives outline limits or targets that are to be used when auditing the performance of the management/environmental protection objective
Control strategies	Appropriate measures to be taken to ensure that the objectives are being met or achieved
Performance indicators	Indicators to be used to gauge the level of compliance and performance of the control stragetgy
Monitoring, recording and corrective actions	Monitoring, recording and corrective actions have been addressed in Chapter 3 (Environmental Management System)

1.6 Description of petroleum tenures/petroleum authorities

1.6.1 Location

The GLNG GTP Project involves the design, construction, operation and decommissioning of a 420 km pipeline network to link CSG fields north of Roma and near Fairview, in Central Queensland, to the proposed LNG facility located on Curtis Island near Gladstone.

This EMP has been prepared for the 8.4 km Marine Crossing GTP section (refer Figure 1.2) which connects with the Mainland GTP (at Point A) and joins the Curtis Island GTP (at Point E). Bored tunnelling technology will be used to cross beneath the intertidal area south of Kangaroo Island and The Narrows (between Points C and D).

1.6.2 Relevant resource authorities

An application for a petroleum pipeline licence (PPL) was lodged with the former DEEDI and an acknowledgement notice was received in February 2011, which identified the licence as PPL 167.

1.6.3 Relevant blocks and sub-blocks

A summary of the petroleum authority blocks traversed by the Marine Crossing GTP and will form part of PPL 167 are provided in Table 1.3. The location of each block is illustrated in Figure 1.3.

Table 1.3 Relevant petroleum authority blocks and sub-blocks traversed by the Marine Crossing GTP

PPL blocks	PPL sub-blocks	Map name
ROCK3254	ROCK3254B	ROCKHAMPTON
	ROCK3254C	ROCKHAMPTON
	ROCK3254D	ROCKHAMPTON
	ROCK3254E	ROCKHAMPTON
	ROCK3254H	ROCKHAMPTON
	ROCK3254J	ROCKHAMPTON
ROCK3255	ROCK3255A	ROCKHAMPTON
ROCK3183	ROCK3183V	ROCKHAMPTON
	ROCK3183W	ROCKHAMPTON

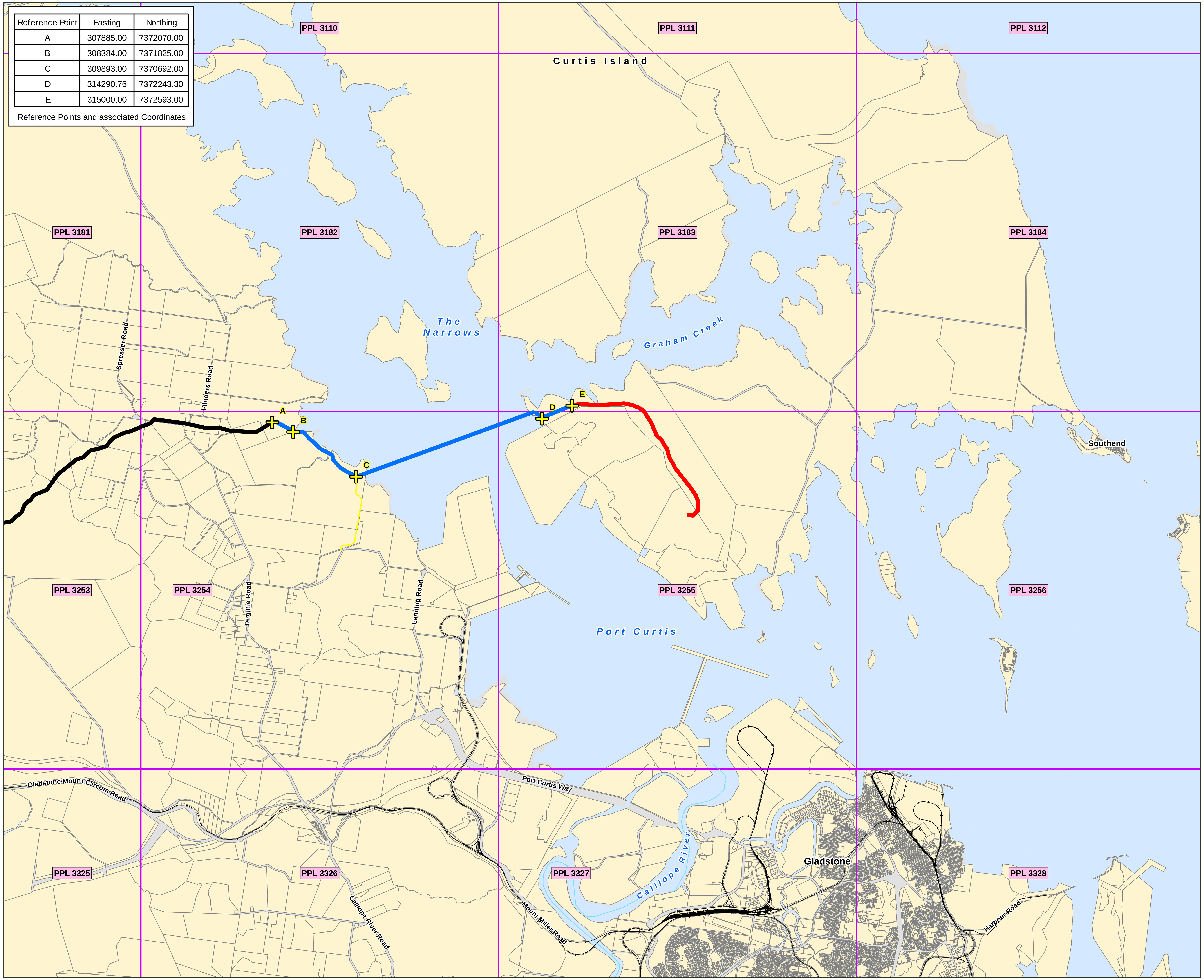
1.6.4 Real property descriptions

The land within the Marine Crossing GTP is freehold above highest astronomical tide (HAT). Below the HAT, the land is unallocated state land (USL). This USL is described in the CG Report as the Kangaroo Island Wetlands and is recognised as a Nationally Important Wetland. Chapter 8 provides further details on tenure.

1.7 Potentially affected properties

As the ROW for the Marine Crossing GTP is a relatively small study area consisting of primarily conservation based land use, the population of the area is low.

The closest major population centre is the City of Gladstone, which is located approximately 8 km to the south and has a population of approximately 30,000 persons (ABS, 2010).



Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

A1 scale: 1:50,000

0 1,000 2,000 3,000 4,000 5,000 m

GLNG No: 3381-40-0434

Coordinate system: GCS_GDA_1994

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Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)

- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Access Road
- Petroleum Pipeline Licence (PPL) Block
- Rail
- Cadastre

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Cadastre: Department of Environment and Resource Management, Jun 2011.
PPL Blocks: Santos, Feb 2011.

PPL Blocks
Figure 1.3

Date: 20/06/2012

Version: k

The land surrounding Port Curtis is utilised for a range of industrial and manufacturing purposes, materials handling facilities and transportation infrastructure.

1.8 Relevant legislation

Table 1.4 outlines the legislation and policies that have been taken into account in developing this EMP.

Table 1.4 Applicable legislation and governing authorities

Legislation	Assessment authority	Relevant chapter(s) addressing legislation
Commonwealth legislation		
Environment Protection and Biodiversity Conservation Act 1999	Department of Sustainability, Environment, Water, Population and Communities (SEWPaC)	Chapter 9 – World and national heritage values Chapter 10 – Flora and fauna Chapter 16 – Rehabilitation
Native Title Act 1993	SEWPaC	Chapter 12 – Social Chapter 13 – Cultural heritage
Great Barrier Reef Marine Park Act 1975	Great Barrier Reef Marine Park Authority (GBRMPA)	Chapter 9 – World and national heritage values Chapter 10 – Flora and fauna Chapter 15 – Water
National Environment Protection (Movement of Controlled Waste between States and Territories) Measure	Environment Protection and Heritage Council	Chapter 14 – Waste
State legislation		
Petroleum and Gas (Production and Safety) Act 2004	Department of Natural Resources and Mines (DNRM)	This EMP
Environmental Protection Act 1994 (EP Act)	DEHP	This EMP
Environmental Protection Regulation 2008	DEHP	This EMP
Environmental Protection (Waste Management) Regulation 2000	DEHP	Chapter 14 – Waste
Sustainable Planning Act 2009	Department of State Development, Infrastructure and Planning (DSDIP)	This EMP
Waste Reduction and Recycling Act 2011	DEHP	Chapter 14 – Waste
Environmental Protection (Air) Policy 2008	DEHP	Chapter 5 – Air Quality
Environmental Protection (Noise) Policy 2008	DEHP	Chapter 11 – Noise and vibration Chapter 12 – Social
Environmental Protection (Water) Policy 2009	DEHP	Chapter 15 – Water
Nature Conservation Act 1992	Department of National Parks, Recreation, Sports and Racing (DNPRSR)	Chapter 10 – Flora and fauna Chapter 16 – Rehabilitation
Aboriginal Cultural Heritage Act 2003	DNRM	Chapter 13 – Cultural heritage
Torres Strait Islander Cultural Heritage Act 2003	DNRM	Chapter 13 – Cultural heritage

Legislation	Assessment authority	Relevant chapter(s) addressing legislation
Transport Infrastructure Act 1994	Department of Transport and Main Roads (DTMR)	This EMP
Transport Operations (Road Use Management) Act 1995	DTMR	This EMP
Forestry Act 1959	Jointly Managed by the DNRM and the Department of Agriculture, Fisheries and Forestry (DAFF)	Chapter 10 – Flora and fauna
Land Act 1994	DNRM	This EMP
Land Protection (Pest and Stock Route Management) Act 2002	DNRM	Chapter 10 – Flora and fauna Chapter 14 – Waste
Water Act 2000	DNRM	Chapter 15 – Water
Marine Parks Act 2004	(DNPRSR)	Chapter 9 – World and national heritage values Chapter 10 – Flora and fauna Chapter 15 – Water
Fisheries Act 1994	DAFF	Chapter 10 – Flora and fauna Chapter 16 – Rehabilitation
Coastal Protection and Management Act 1995	DEHP	Chapter 10 – Flora and fauna Chapter 15 – Water
Dangerous Goods Safety Management Act 2001	Department of Justice and Attorney-General	Chapter 14 – Waste
Waste Reduction and Recycling Strategy 2010 – 2020	State Government	Chapter 14 – Waste
SPP 1/92 – *Development and the Conservation of Agricultural Land*	State Government	Chapter 7 – Land management
SPP 2/02 – *Planning and Managing Development Involving Acid Sulfate Soils*	State Government	Chapter 7 – Land management

1.9 Environmentally Sensitive Areas

In accordance with the CG Report (Queensland Government, 2010a), Environmentally Sensitive Areas (ESAs) within and adjacent to the ROW must be considered. For the purposes of this EMP, Category A and B ESAs have been defined pursuant to Sections 25 and 26 of the *Environmental Protection Regulation 2008* (EP Reg), whilst Category C ESAs have been defined pursuant to the DEHP guideline “*Preparing an Environmental Management Plan (EM Plan) for Coal Seam Gas (CSG) Activities*” (DERM, 2010b).

The application of the ESAs to the Marine Crossing GTP ROW specifically dictates the width of the ROW. For the Marine Crossing GTP the ROW has been reduced to 30 m, other than for ancillary work areas. Table 1.5 identifies the Category A, B and C ESA classification that has been used in this EMP.

Table 1.5 Environmentally Sensitive Area Classification*

Category	ESA definition	Relevant chapter(s) addressing ESA
A	Any of the following under the *Nature Conservation Act 1992*: • a national park (scientific) • a national park • a national park (Aboriginal land) • a national park (Torres Strait Islander land) • a national park (Cape York Peninsula Aboriginal land) • a national park (recovery) • a conservation park • a forest reserve	No Category A ESAs are located within the Marine Crossing GTP Project disturbance footprint
	The wet tropics area under the *Wet Tropics World Heritage Protection and Management Act 1993*	
	The Great Barrier Reef Region under the *Great Barrier Reef Marine Park Act 1975* (Commonwealth)	
	A marine park under the *Marine Parks Act 2004*, other than a part of the park that is a general use zone under that Act	
B	Any of the following areas under the *Nature Conservation Act 1992*: • a coordinated conservation area • a wilderness area • a World Heritage management area • an international agreement area • an area of critical habitat or major interest identified under a conservation plan[1] • an area subject to an interim conservation order	-
	An area subject to the following conventions to which: • the 'Convention on the Conservation of Migratory Species of Wild Animals' (Bonn, 23 June 1979) • the 'Convention on Wetlands of International Importance, especially as Waterfowl Habitat' (Ramsar, Iran, 2 February 1971) • the 'Convention Concerning the Protection of the World Cultural and Natural Heritage' (Paris, 23 November 1972)	-
	A feature protection area, State forest park or scientific area under the *Forestry Act 1959*	-
	A declared fish habitat area under the *Fisheries Act 1994*	-
	A place in which a marine plant under the *Fisheries Act 1994* is situated	Chapter 10 – Flora and fauna
	An endangered regional ecosystem identified in the database known as the 'Regional ecosystem description database' kept by the department	Chapter 10 – Flora and fauna
	A zone of a marine park under the *Marine Parks Act 2004*	Chapter 8 – Land tenure and use
	An area to the seaward side of the highest astronomical tide (HAT)	Chapter 10 – Flora and fauna

[1] Note: There are currently no declared 'critical habitats' or 'areas of major interest' listed under the *Nature Conservation Act 1992* (DERM, 2010b)

Category	ESA definition	Relevant chapter(s) addressing ESA
	The following under the *Queensland Heritage Act 1992*: • a place of cultural heritage significance • a registered place • an area recorded in the Aboriginal Cultural Heritage Register established under the *Aboriginal Cultural Heritage Act 2003*, section 46, other than the area known as the 'Stanbroke Pastoral Development Holding', leased under the *Land Act 1994* by lease number PH 13/5398	-
C	Nature Refuges under the *Nature Conservation Act 1992*	-
	Koala Habitat Areas as defined under the *Nature Conservation Act 1992*	
	State Forests or Timber Reserves as defined under the *Forestry Act 1959*	-
	Resources reserves under the *Nature Conservation Act 1992*	-
	An area identified as 'essential habitat', defined under the *Nature Conservation Act 1992*	-
	"Of Concern" regional ecosystems identified in the database maintained by DNRM (former DERM) called 'Regional ecosystem description database' containing regional ecosystem numbers and descriptions	Chapter 10 – Flora and fauna
	Declared catchment areas under the *Water Act 2000*	-
	Any wetland shown on the Map of Referable Wetlands available from DNRM (former DERM) website	Chapter 15 – Water

Table note: For the purposes of this assessment, Category A and B ESAs have been defined pursuant to Sections 25 and 26 of the EP Reg, whilst Category C ESAs have been defined pursuant to the DEHP guideline *"Preparing an Environmental Management Plan (EM Plan) for Coal Seam Gas (CSG) activities"* (DERM, 2010b).

1.10 Coordinator General Report

The CG Report confirmed that the Project could proceed, subject to a number of conditions. Table 1.6 outlines the conditions of the CG Report that are relevant to the Marine Crossing GTP, as well as the chapters and sections in which the conditions are addressed in this EMP.

1.11 EPBC Referral No 2008/4096 conditions

Table 1.7 outlines the conditions of the EPBC Act approval that are relevant to the Marine Crossing GTP, as well as the chapters and sections in which the conditions are addressed in this EMP.

Table 1.6 CG Report conditions relevant to the Marine Crossing GTP

Conditions relevant to the EMP	Chapter addressed
Appendix 1 – Part 2	
Condition 13. During the detailed design phase of the project and prior to any road or access track upgrade or construction for the project the proponent will consult with DERM to identify, assess and mitigate impacts to terrestrial and aquatic ecosystems and develop an EMP for design and construction of environmental offset and mitigation measures associated with road and access track works, including assessment of any proposed offsets	Access Road: Chapter 2, Section 2.4 Terrestrial and Aquatic ecosystems: Chapter 10
Appendix 3 – Part 1	
Condition 4. The proponent is also required to obtain an environmental authority approval from DERM prior to the commencement of construction	This EMP
Appendix 3 – Part 2	
Condition 3. The proponent must include provisions in the Environmental Management Plan for the gas pipeline, ensuring that, on land identified as being good quality agricultural land (GQAL), the pipeline contractor must:	Chapter 7
a) On completion of construction, remove temporary access tracks	Chapter 7, Section 7.5
b) On completion of construction, lightly rip disturbed areas, replace topsoil and return the surface to a land use condition that serves the preconstruction use	Chapter 7, Section 7.5
c) On completion of construction, implement land management and erosion control measures	Chapter 7, Section 7.5
d) On land with GQAL class A, B or C1, bury the pipeline to at least 0.9m below finished land surface, or greater if deep ripping is a normal practice	Chapter 7, Section 7.5
Condition 13. A mosquito and biting midge management plan will be developed as part of the EMP and will include:	Appendix G
a) Assessment of work areas to be undertaken prior to works and on an informal basis to identify potential breeding sites	Appendix G
b) Any required specific area control plans based on assessment of potential breeding sites will conform to DERM'S *Mosquito Management Code of Practice for Queensland*; and Queensland Health and the relevant local councils will be contacted for assistance in choosing a suitable method	Appendix G
Condition 23. Prior to lodging an application for an environmental authority (pipeline licence) for the gas transmission pipeline section across the Kangaroo Island wetlands and The Narrows, the following information shall be submitted to the Coordinator-General for review and approval:	-
d) A draft environmental management plan (EMP) as detailed in Condition 24	This EMP

Conditions relevant to the EMP	Chapter addressed
Condition 24. The draft EMP must contain, but not necessarily be limited to:	-
a) An assessment of the environmental values and potential impacts to the environmental values of the Kangaroo Island wetlands and The Narrows, Port Curtis, Great Barrier Reef Coast Marine Park and the Great Barrier Reef World Heritage Area based on the site specific construction methodology detailing proposed mitigation measures. The EMP must be prepared in accordance with section 310D of the *Environmental Protection Act 1994*, and the DERM published guideline: *Preparing an environmental management plan (EM Plan) for Coal Seam Gas (CSG) activities*	Chapter 9, 10 and 15, Sections 10.5, 10.6 and 15.2, 15.5 and 15.6
b) The final pipeline route, design and construction methodology of the pipeline with specific detail on the crossing of Humpy and Targinie Creeks	The works associated with the crossing of Humpy and Targinie Creeks (and two other minor unnamed tidal creeks) will be subject to a subsequent detailed application for Operational Works. The current ROW alignment crosses these creeks at a location where the flow and tidal influence is minor
c) Geotechnical information to demonstrate that the engineered solution is technically feasible	Chapter 7, Section 7.2.3
d) Acid sulfate soils data and analysis addressing the area within the proposed extension of the Gladstone State Development Area	Appendix A
e) An acid sulfate soils management plan based on the final design and construction	Appendix A
f) Surface water and groundwater hydrological assessment of the Kangaroo Island wetlands	Chapter 15, Sections 15.2.3, 15.2.5
g) Water quality assessment of the Kangaroo Island wetlands and The Narrows	Chapter 15, Section 15.2.1
h) Assessment of fish habitat, fish passage and marine plant values and impacts (temporary and permanent) within, and adjacent to, the corridor and strategies to avoid or minimise these	Chapter 10, Sections 10.5.5, 10.6
i) Assessment of impacts on navigation and strategies to avoid or minimise these	Chapter 12 deals with some impacts. Detailed shipping and navigation impact study will be completed prior to commencing construction if required
k) Details of proposed environmental offsets consistent with the *Queensland Government Environmental Offset Policy 2008* and specific issue policies	Chapter 10, Table 10.24, Chapter 16, Section 16.6
Condition 25. Environmental authorities under section 310M of the EP Act and pipeline licences under section 410 of the *Petroleum and Gas (Production and Safety) Act 2004* may be issued separately for the following sections of the gas transmission pipeline:	-
a) Gas-fields to the Kangaroo Island wetlands	See Mainland EMP

Conditions relevant to the EMP	Chapter addressed
b) Kangaroo Island wetlands and the Narrows	This EMP
c) Curtis Island	See Curtis Island EMP
Appendix 3 – Part 3	
Condition 1. The EMP developed in accordance with section 310D of the *Environmental Protection Act 1994* to support the applications for pipeline leases must provide:	-
a) A construction schedule and methodology including plans and maps showing how the pipeline will be constructed through specific vegetation and soil types, topography and across riparian areas to avoid or minimise environmental harm	Chapter 2, Sections 2.2.3, 2.4. Chapter 10, Section 10.5. Chapter 7, Section 7.5
b) Details on how the proponent's pipeline will be constructed in common use infrastructure corridors in conjunction with other pipelines and services to minimise cumulative impacts, both on the mainland and Curtis Island	Chapter 2, Sections 2.2.3, 2.3.1, Chapter 5, Section 5.7; Chapter 7, Section 7.5; Chapter 8, Section 8.2; Chapter 10, Section 10.6; Chapter 11, Sections 11.5.3, 11.7.2; Chapter 12, Section 12.4
c) Details on waste management, treatment and disposal, including hydrostatic test water	Chapter 14, Table 14.7, for hydrotest water refer SMESCP and DHWLRMP
d) A maintenance and rehabilitation plan following construction to protect soil values and prevent weed invasion	Appendix B
Condition 2. The EMP developed in accordance with section 310D of the *Environmental Protection Act 1994* to support the applications for pipeline leases must:	-
a) Be prepared in accordance with the DERM published guideline: Preparing an environmental management plan (EMP) for Coal Seam Gas (CSG) activities, where relevant	This EMP
b) Specifically address:	-
i. The pipeline construction schedule and proposed methodology	Chapter 2, Sections 2.1.3, 2.4
ii. Construction in common use infrastructure corridors	Chapter 2, Sections 2.2.2, 2.3
Condition 3. Prior to the commencement of petroleum activities the proponent must provide to DERM for review the following aquatic values impacted by the Gas Transmission Pipeline, including:	Chapter 15
a) A detailed assessment of aquatic values (including animal breeding places) along the pipeline route must be provided. Site specific data must be included that accurately and comprehensively describes the environmental values and ecological condition at each aquatic site. The information must be used to determine the location of each watercourse or wetland crossing and site specific mitigation measures to protect the values identified	Chapter 10 and 15

Conditions relevant to the EMP	Chapter addressed
b) The information must also demonstrate that mitigation measures for permanent creek crossings are consistent with AS2885 . *Pipelines. Gas, Liquid and Petroleum* and the *Australian Pipeline Industry Association Code of Environmental Practice*. Those documents provide the approach to be taken when determining the optimal route selection as well as engineering standards that must be applied to the construction of the pipeline, including:	-
i. Minimisation of adverse impacts on fauna and significant habitat areas	Chapter 10, Table 10.24, Chapter 15, Table 15.3
ii. Minimisation of impacts on riparian, aquatic and water dependent flora and fauna	Chapter 10, Table 10.24, Chapter 15, Table 15.3
iii. Minimise erosion and sediment impacts	Chapter 15, Table 15.15
iv. Maintain water quality and water flow requirements	Chapter 15, Table 15.15
v. Maximise rehabilitation success of achieving long term site stability	Chapter 15, Table 15.15
c) Soils ground truthing, including identification of all sensitive soil and landform areas along the pipeline corridor including Good Quality Agricultural Land, cross referenced to known information on land units and land systems. Any variation between identified land values and DERM data sets must be identified and explained. An assessment of the potential impacts must be provided along with appropriate mitigation measures and construction methods applicable to the identified soil types or landforms	Chapter 7, Sections 7.2.6, 7.3.4
d) Protection and restoration of good quality agricultural land that could qualify as strategic cropping land under the Government's draft discussion paper Protection of Strategic Cropping Land	Chapter 7, Sections 7.2.6, 7.3.4
e) Hydrostatic test water, including a detailed assessment of impacts from hydrostatic test water along the pipeline route, which must be provided. Source water quality data and characteristics of additives, particularly biocides) must be provided along with the proposed storage, treatment and disposal methods. The information must be used to determine the site specific mitigation measures including monitoring and reporting	Chapter 2, Chapter 15
Appendix 3 – Part 4	
Condition A12. An Environmental Management Plan (EMP) 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 EMP must be kept	Chapter 3
Condition A13. The EMP required by condition (A12) must address, at least, the following:	-
1. Describe each of the following:	-
(a) Each relevant resource authority for the environmental authority	Chapter 1, Section 1.8
(b) All relevant petroleum activities	Chapter 2, Section 2.9, 2.10
(c) The land on which the activities are to be carried out	Chapter 7

Conditions relevant to the EMP	Chapter addressed
(d) The environmental values likely to be affected by the activities	Chapters 5, 6, 7, 8, 9, 10, 11, 13, 14 and 15.
(e) The potential adverse and beneficial impacts of the activities on the environmental values	Chapter 5, Section 5.4; Chapter 7, Section 7.3; Chapter 8, Section 8.3; Chapter 9, Section 9.4; Chapter 10, Section 10.6; Chapter 11, Sections 11.6 and 11.7; Chapter 12, Section 12.3; Chapter 13, Section 13.3; Chapter 14, Section 14.8 and Chapter 15, Section 15.6
2. State the environmental protection commitments the applicant proposes for the activities to protect or enhance the environmental values under best practice environmental management	Chapter 5, Section 5.8; Chapter 7, Section 7.5; Chapter 8, Section 8.5; Chapter 9, Section 9.4; Chapter 10, Section 10.8; Chapter 11, Section 11.11; Chapter 12, Section 12.5; Chapter 13, Section 13.5; Chapter 14, Section 14.11 and Chapter 15, Section 15.8
3. Include a rehabilitation program for land proposed to be disturbed under each relevant resource authority for the application	Chapter 16, Appendix E
4. State a proposed amount of financial assurance for the environmental authority as part of the rehabilitation program	Chapter 4
5. Training staff in the awareness of environmental issues related to carrying out the petroleum activities, which must include at least:	Chapter 3
(b) Any relevant environmental objectives and targets, so that all staff are aware of the relevant performance objectives and can work towards these	Chapter 5, Section 5.8; Chapter 7, Section 7.5; Chapter 8, Section 8.5; Chapter 9, Section 9.4; Chapter 10, Section 10.8; Chapter 11, Section 11.8; Chapter 12, Section 12.5; Chapter 13, Section 13.5; Chapter 14, Section 14.11 and Chapter 15, Section 15.8
(c) Control procedures to be implemented for routine operations for day to day activities to minimise the likelihood of environmental harm, however occasioned or caused	Chapter 5, Section 5.8; Chapter 7, Section 7.5; Chapter 8, Section 8.5; Chapter 9, Section 9.4; Chapter 10, Section 10.8; Chapter 11, Section 11.11; Chapter 12, Section 12.5; Chapter 13, Section 13.5; Chapter 14, Section 14.11 and Chapter 15, Section 15.8
(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)	Chapter 3, Section 3.5

Conditions relevant to the EMP	Chapter addressed
(e) Organisational structure and responsibility to ensure that roles, responsibilities and authorities are appropriately defined to ensure effective management of environmental issues	Chapter 3, Section 3.3
(f) Effective communication procedures to ensure two-way communication on environmental matters between operational staff and higher management	Chapter 3, Section 3.5
(g) Obligations with respect to monitoring, notification and record keeping obligations under the EMP and relevant approvals	Chapter 3, Section 3.3
(h) Monitoring of the release of contaminants into the environment including procedures, methods and record keeping	Chapter 3, Section 3.5
6. The conduct of periodic reviews of environmental performance and procedures adopted, not less frequently than annually	Chapter 3, Section 3.1
7. A program for continuous improvement	Chapter 3, Section 3.1

Table 1.7 EPBC conditions relevant to the Marine Crossing GTP that are addressed in this EMP

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
Environmental Management Plan (excluding the Narrows)		
2. The proponent must prepare an Environmental Management Plan to manage the impacts of construction, operation and decommissioning of the pipeline (other than in relation to the Narrows) on listed threatened species and ecological communities, listed migratory species and values of the World and National Heritage-listed Great Barrier Reef	Points A and C,D and E (refer Figure 1.2)	This EMP
3. The Environmental Management Plan must include:	-	-
a) Provisions for detailed pre-clearance surveys by a suitably qualified ecologist along the entire length of the ROW, in accordance with conditions 5 to 10	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24, Sub-heading - Vegetation clearing
b) Measures to minimise native and riparian vegetation clearance and to minimise the impact on listed species, their habitat and ecological communities in accordance with management plans required for MNES under this approval	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24, Sub-heading - Vegetation clearing
c) Measures to manage the impact of clearing on each listed species and ecological community in accordance with management plans required for MNES under this approval	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24, Sub-heading - Vegetation clearing
d) Measures to regenerate vegetation on the ROW where natural regeneration is not successful to a condition at least equivalent to the ROW condition prior to commencement	Points A and C, D and E (refer Figure 1.2)	Chapter 16 LRMP (refer Appendix E)
e) Measures to minimise impacts on fauna during pipeline construction, including:	-	-
i. Measures to protect Matters of National Environmental Significance (MNES) in the areas of the ROW where trenching is being undertaken, including measures to exclude listed terrestrial fauna from gaining access to those areas of the ROW where trenching is currently being undertaken	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24, Sub-headings – Conservation significant fauna species, Fauna injury and mortality. SSMP (document number 3380-GLNG-3-1.3-0031) SMP (document number 3380-GLNG-3-1.3-0036)
ii. Mechanisms to allow fauna to escape from the pipeline trench	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24, Sub-headings – Conservation significant fauna species, Fauna injury and mortality. SSMP (document number 3380-GLNG-3-1.3-0031) SMP (document number 3380-GLNG-3-1.3-0036)

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
iii. Daily morning surveys for trapped fauna	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24 Sub-heading – Conservation significant fauna species, Fauna injury and mortality
iv. Mechanisms for a suitably qualified person to relocate fauna	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24, Sub-headings - Conservation significant fauna species, Fauna injury and mortality. SSMP (document number 3380-GLNG-3-1.3-0031) SMP (document number 3380-GLNG-3-1.3-0036)
v. Record keeping for all survey, removal and relocation activities	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24, Sub-headings - Conservation significant fauna species, Fauna injury and mortality. SSMP (document number 3380-GLNG-3-1.3-0031) SMP (document number 3380-GLNG-3-1.3-0036)
f) Machinery wash down procedures and ongoing monitoring to minimise the spread and establishment of weeds in the ROW. Monitoring of weed infestations within disturbed areas must occur at least monthly during construction and then quarterly for a period of two years after completion of construction. Appropriate weed control measures must be implemented. After the two-year period, the frequency of monitoring must be reconsidered by the proponent, based on the success of control measures, the level of infestations and pipeline maintenance activities	Points A and C, D and E (refer Figure 1.2)	PWMP (refer Appendix B)
g) Measures to manage and control feral animals that may spread due to the establishment of the ROW	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24, Sub-headings – Feral animals PWMP (refer Appendix B)
h) Measures for the prevention of ignition sources to protect habitat values	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24, Sub-heading – Fire
i) Measures for the management of acid sulfate soils	Points A and C, D and E (refer Figure 1.2)	Chapter 7, Table 7.7, Sub-heading – Acid sulfate soils ASSMP (refer Appendix A)

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
4. The Environmental Management Plan must be submitted for the approval of the Minister. Commencement must not occur without approval (except for activities critical to commencement and associated with mobilisation of plant, equipment, materials, machinery and personnel prior to start of pipeline construction which will have no adverse impact on MNES). The approved plan must be implemented	Points A and C, D and E (refer Figure 1.2)	This EMP
Pre-clearance surveys		
5. Before the clearance of native vegetation in the pipeline ROW, the proponent must:	-	-
a) Undertake pre-clearance surveys for the presence of listed threatened species and migratory species, their habitat and listed ecological communities	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031) SMP (document number 3380-GLNG-3-1.3-0036)
b) Alternatively, where recent surveys have already been undertaken and those surveys meet the Department's requirements for surveys for the relevant MNES, the proponent may elect to develop management plans based on those surveys in accordance with the requirements of Condition 8	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031) SMP (document number 3380-GLNG-3-1.3-0036)
6. Pre-clearance surveys must:	-	-
a) For each listed species, be undertaken in accordance with the Department's survey guidelines in effect at the time of the survey. This information can be obtained from http://www.environment.gov.au/epbc/guidelines-policies.html#threatened	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031) – Section 2.1.1 SMP (document number 3380-GLNG-3-1.3-0036) – Section 2.1.1
b) Be undertaken by a suitably qualified ecologist approved by the Department in writing	Points A and C, D and E (refer Figure 1.2)	All ecological surveys will be undertaken by suitably qualified ecologists who are approved by the Commonwealth prior to the survey period
c) Document the survey methodology, results and significant findings in relation to MNES	Points A and C, D and E (refer Figure 1.2)	This will be undertaken as part of the pre-clearance survey work
d) Apply best practice site assessment and ecological survey methods appropriate for each listed threatened species, migratory species, their habitat and listed ecological communities	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031) – Sections 4 to 6 Methodology to adopt Commonwealth guidelines, if not available State guidelines will be adopted

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
7. Pre-clearance survey reports (which document the methods used and the results obtained) must be published by the proponent and provided to the Department on request	Points A and C, D and E (refer Figure 1.2)	Upon completion of the targeted surveys, a report detailing the survey methodologies and the field results will be provided to the relevant State and Commonwealth agencies and additionally published on the GLNG Operations website as per approval conditions
8. If a listed threatened species or migratory species or their habitat, or a listed ecological community is encountered during the surveys undertaken as required by condition 5 and is not specified in the Table 1 or 2 at condition 11 and 12, the proponent must submit a separate management plan for each species or ecological community to manage the unexpected impacts of clearing. In relation to each listed species or ecological community, each plan must address:	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031)
a. The relevant characteristics describing each ecological community	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031)
b. A map of the location of species, species' habitat, or ecological community in proximity to the ROW	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031)
c. Measures that will be employed to avoid impact on the species, species' habitat, or ecological community	Points A and C, D and E (refer Figure 1.2)	Chapter 10, Table 10.24, SSMP (document number 3380-GLNG-3-1.3-0031)
d. A quantification of the unavoidable impact (in hectares and/or individual specimens)	Points A and C, D and E (refer Figure 1.2)	Chapter 10, SSMP (document number 3380-GLNG-3-1.3-0031)
e. Where impacts are unavoidable and a disturbance limit is not specified for the listed species or ecological community under condition 11, propose offsets to compensate for the impact on the population of the species' habitat, or the ecological community	Points A and C, D and E (refer Figure 1.2)	Chapter 16
f. Current legal status (under the EPBC Act)	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031)
g. Known distribution	Points A and C, D and E (refer Figure 1.2)	Chapter 10, SSMP (document number 3380-GLNG-3-1.3-0031)

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
For listed species, each plan must also include:	-	-
a. Known species' populations and their relationships within the region	Points A and C, D and E (refer Figure 1.2)	Chapter 10, SSMP (document number 3380-GLNG-3-1.3-0031)
b. Biology and reproduction	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031)
c. Preferred habitat and microhabitat including associations with geology, soils, landscape features and associations with other native fauna and/or flora or ecological communities	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031)
d. Anticipated threats to MNES from pipeline construction, operation and decommissioning	Points A and C, D and E (refer Figure 1.2)	Chapter 10, SSMP (document number 3380-GLNG-3-1.3-0031)
e. Management practices and methods to minimise impacts, such as:	-	-
i. Site rehabilitation timeframes, standards and methods	Points A and C, D and E (refer Figure 1.2)	Chapter 16
ii. Use of sequential clearing to direct fauna away from impact zones	Points A and C, D and E (refer Figure 1.2)	Chapter 16, SMP (document number 3380-GLNG-3-1.3-0036)
iii. Re-establishment of native vegetation in linear infrastructure corridors	Points A and C, D and E (refer Figure 1.2)	Chapter 16
iv. Handling practices for flora specimens	Points A and C, D and E (refer Figure 1.2)	SMP (document number 3380-GLNG-3-1.3-0036)
v. Translocation and/or propagation practices and monitoring for translocation/propagation success	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031)
vi. Monitoring methods including for rehabilitation success and recovery	Points A and C, D and E (refer Figure 1.2)	Chapter 16 and Appendix E
f. Reference to relevant conservation advice, recovery plans, or other policies, practices, standards or guidelines relevant to MNES published or approved from time to time by the Department	Points A and C, D and E (refer Figure 1.2)	Chapter 9, Chapter 10, SMP (document number 3380-GLNG-3-1.3-0036), SSMP (document number 3380-GLNG-3-1.3-0031)
9. Each plan required under condition 8 must be submitted for the approval of the Minister. Commencement in the location covered by the management plan must not occur without approval. Each approved plan must be implemented	Points A and C, D and E (refer Figure 1.2)	Chapter 1

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
10. If, during construction a listed threatened species or migratory species or their habitat, or a listed ecological community is encountered and is not specified in the table at condition 11 or 12, the proponent must submit a separate management plan for each species or ecological community in accordance with condition 8 within 20 business days of encountering that MNES. Work must not continue at the construction site where the MNES is encountered until the relevant management plan has been approved	Points A and C, D and E (refer Figure 1.2)	SMP (document number 3380-GLNG-3-1.3-0036), SSMP (document number 3380-GLNG-3-1.3-0031)
11. The following maximum disturbance limits apply to any disturbances authorised for unavoidable impacts on listed threatened communities and potential habitat for listed threatened species or migratory species as a result of the construction, operation and decommissioning of the pipeline (and all associated activities)	Points A and C, D and E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031) WMMP

Table 1 EPBC Listed threatened ecological communities

Ecological community	EPBC status	Disturbance limit (ha)
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	4.4
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	2.4
Species	**EPBC status**	**Disturbance limit (ha)**
Cycas megacarpa (Large-fruited Zamia)	Endangered	28.0

Note: These conditions provide offsets for species identified in Table 1 except for Brigalow, for which offsets are provided in EPBC 2008/4059 (Santos/PETRONAS coal seam gas fields expansion)

<table>
<tr><th>EPBC conditions relevant to the Marine Crossing GTP</th><th>Section of the Marine Crossing GTP Project</th><th>Section addressed</th></tr>
<tr><td>12. The proponent must prepare a management plan for each species in Table 2 below. Each plan must be prepared in accordance with the requirements of condition 8
<table>
<tr><th colspan="2">Table 2: Species management plans required before commencement</th></tr>
<tr><th>Listed species</th><th>EPBC Act Status</th></tr>
<tr><td>Philotheca sporadica</td><td>Vulnerable</td></tr>
<tr><td>Cadellia pentasylis (Ooline)</td><td>Vulnerable</td></tr>
<tr><td>Paradelma orientalis (Brigalow Scaly-foot)</td><td>Vulnerable</td></tr>
<tr><td>Furina dunmalli (Dunmall's Snake)</td><td>Vulnerable</td></tr>
<tr><td>Egernia rugosa (Yakka Skink)</td><td>Vulnerable</td></tr>
<tr><td>Geophaps scripta scripta (Squatter pigeon – southern)</td><td>Vulnerable</td></tr>
<tr><td>Nyctophilus corbeni (Eastern Long-eared Bat)</td><td>Vulnerable</td></tr>
<tr><td>Chalinolobus dwyeri (Large-eared Pied Bat)</td><td>Vulnerable</td></tr>
<tr><td>Xeromys myoides (Water Mouse)</td><td>Vulnerable</td></tr>
</table>
Note: The intent of Table 2 is to require preparation of management plans for those species that are likely to be encountered along the ROW, but where a disturbance limit has not been quantified. To the extent that the requirements of condition 8 are satisfied for each species, a single Species Management Plan may be prepared for this purpose</td><td>Points A and C, D and E (refer Figure 1.2)</td><td>SSMP (document number 3380-GLNG-3-1.3-0031)</td></tr>
<tr><td>13. Each management plan must be submitted for the approval of the Minister. Commencement must not occur without approval. Commencement in the location covered by the management plan must not occur without approval. Each approved plan must be implemented</td><td>Points A and C, D and E (refer Figure 1.2)</td><td>Chapter 1</td></tr>
<tr><td>14. Disturbance of vegetation related to the construction and maintenance of the pipeline must be confined to the ROW. Any proposed siting of construction camps, vehicle access tracks and pipe lay-down areas outside the ROW during construction must be undertaken so as to minimise potential adverse impacts on MNES and must comply with conditions 5 to 13</td><td>Points A and C, D and E (refer Figure 1.2)</td><td>Chapter 10, Table 10.24, Sub-heading - Vegetation clearing</td></tr>
<tr><td>28. To offset the unavoidable impacts on listed migratory birds within the ROW at the Kangaroo Island wetlands west of the Narrows, the proponent must contribute at least $250,000 to the Gladstone Ports Corporation's migratory bird research study required by conditions for the Gladstone Western Basin Dredging and Disposal Project (EPBC 2009/4904)</td><td>Points C to D (refer Figure 1.2)</td><td>GLNG Operations has committed to contributing $250,000 to Gladstone Ports Corporation migratory bird research study</td></tr>
</table>

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
The Narrows Crossing		
29. The proponent must prepare an Environmental Management Plan for the crossing of the Narrows. This must include, if the proponent does not proceed in a bundled crossing:	Points C to D (refer Figure 1.2)	-
a) If the crossing is undertaken concurrently with the construction of one or more additional gas transmission pipelines (a 'bundled crossing'):	Not applicable	GLNG Operations will not be participating in the 'bundled crossing'
b) A construction method which, in the opinion of the Minister, will result in minimal surface disturbance to the Kangaroo Island Wetlands and minimal disturbance to the area of the estuary of the Narrows (preferably achieved by horizontal directional drilling or tunnelling)	Points C to D (refer Figure 1.2)	Chapter 2
i. Details of the final pipeline route, design and construction methodology, including details of inclusion of pipes for water supply and sewerage	Points C to D (refer Figure 1.2)	Chapter 2
ii. Potential impacts from the construction of the pipeline on listed threatened species, ecological communities, migratory species and World and National Heritage-listed values of the Great Barrier Reef	Points C to D (refer Figure 1.2)	Chapter 9, Section 9.4, Chapter 10, Section 10.6
iii. Mitigation measures to reduce impacts to listed threatened species, ecological communities, migratory species and World and National Heritage-listed values of the Great Barrier Reef	Points C to D (refer Figure 1.2)	Chapter 9, Section 9.4, Chapter 10, Table 10.8
iv. Proposed offsets to compensate for the unavoidable impacts of the action on listed threatened species and ecological communities, listed migratory species and values of the World and National Heritage-listed Great Barrier Reef	Points C to D (refer Figure 1.2)	Chapter 10, Table 10.24, Subheadings – Vegetation clearing, Conservation and commercially significant flora, Conservation significant fauna species GLNG Operations has submitted an offset package to SEWPaC. Offsets (including World and National Heritage listed Great Barrier Reef) have been addressed in this package
v. Measures for the management of acid sulfate soils	Points C to D (refer Figure 1.2)	Chapter 7 ASSMP (Appendix A)
vi. Measures for ongoing maintenance and decommissioning of the pipeline	Points C to D (refer Figure 1.2)	Chapter 2, Sections 2.6 and 2.7, Chapter 16, Section 16.3 An OMP will be developed during detailed design and prior to completion of construction

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
30. The Environmental Management Plan must be submitted for the approval of the Minister. The activity which is the subject of the Environmental Management Plan must not start without approval. The approved plan must be implemented	Points C to D (refer Figure 1.2)	This EMP
Water Crossings		
35. Where reasonably possible horizontal directional drilling must be used for major waterway crossings, including:	-	-
b) Humpie and Targinie Creeks before marshlands near Kangaroo Island and The Narrows	Points A to C (refer Figure 1.2)	To be confirmed during design stage
36. Trenchless techniques are not required in minor creek beds within the known distribution of the Fitzroy River Turtle (Rheodytes leukops) and Murray Cod (Maccullochella peelii peelii) where there is no water at the crossing site and the distance to the nearest water is sufficient to buffer any potential impacts resulting from the crossing technique	Points A to E (refer Figure 1.2)	Noted
37. The proponent must prepare an Aquatic Values Management Plan. This plan must include:	-	-
a) A detailed assessment of aquatic values, including animal breeding locations for listed threatened and migratory species within the ROW	Points A to E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031) This will be detailed in the AVMP, which will be provided prior to construction
b) Measures to minimise impacts on listed riparian, aquatic and water dependent flora and fauna	Points A to E (refer Figure 1.2)	This will be detailed in the AVMP, which will be provided prior to construction
c) Measures to minimise erosion and sediment impacts to waterways	Points A to E (refer Figure 1.2)	SMESCP (Appendix C) This will be detailed in the AVMP, which will be provided prior to construction
d) Measures to maintain water quality and water flow requirements, including treatment and disposal methods for hydrostatic test water	Points A to E (refer Figure 1.2)	Chapter 15 This will be detailed in the AVMP, which will be provided prior to construction

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
e) Site-specific mitigation measures for any potential impacts from construction and operation of the pipeline on listed threatened species, including but not limited to the Fitzroy River Turtle	Points A to E (refer Figure 1.2)	SSMP (document number 3380-GLNG-3-1.3-0031)
38. The Aquatic Values Management Plan must be approved in writing by the Minister. Activities the subject of the plan must not start without approval. The Plan must be implemented	Points A to E (refer Figure 1.2)	Noted
52. On the request of and within a period specified by the Department, the proponent must ensure that:	-	-
a) An independent audit of compliance with these conditions is conducted	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
b) An audit report, which addresses the audit criteria to the satisfaction of the Department, is published on the Internet and submitted to the Department	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
53. Before the audit begins, the following must be approved by the Department:	-	-
a) The independent auditor	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
b) The audit criteria	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
54. The audit report must include:	-	-
a) The components of the project being audited	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
b) The conditions that were activated during the period covered by the audit	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
c) A compliance/non-compliance table	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
d) A description of the evidence to support audit findings of compliance or non-compliance	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
e) Recommendations on any non-compliance or other matter to improve compliance	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
f) A response by the proponent to the recommendations in the report (or, if the proponent does not respond within 20 business days of a request to do so by the auditor, a statement by the auditor to that effect)	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
g) certification by the independent auditor of the findings of the audit report	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
55. The financial cost of the audit will be borne by the proponent	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
56. The proponent must:	-	-
a) Implement any recommendations in the audit report, as directed in writing by the Department after consultation with the proponent	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
b) Investigate any non-compliance identified in the audit report	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
c) If non-compliance is identified in the audit report - take action as soon as practicable to ensure compliance with these conditions	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
57. If the audit report identifies any non-compliance with the conditions, within 20 business days after the audit report is submitted to the Department the proponent must provide written advice to the Minister setting out the:	-	Chapter 3, Section 3.7
a) Actions taken by the proponent to ensure compliance with these conditions	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
b) Actions taken to prevent a recurrence of any non-compliance, or implement any other recommendation to improve compliance, identified in the audit report Note: To avoid doubt, independent third party auditing may include audit of the proponent's performance against the requirements of any plan required under these conditions	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
Reporting non-compliance	-	-
58. The proponent must, when first becoming aware of a non-compliance with these conditions, or a plan required to be approved by the Minister under these conditions:	-	-
a) Report the non-compliance and remedial action to the Department within five business days	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
b) Bring the matter into compliance within a reasonable time frame specified in writing by the Department	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
Record keeping		
59. The proponent must:	-	-
a) Maintain accurate records substantiating all activities associated with or relevant to these conditions of approval, including measures taken to implement a plan approved under these conditions	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
b) Make those records available on request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with these conditions Note: Audits or summaries of audits carried out under these conditions, or under section 458 of the EPBC Act, may be posted on the Department's website. The results of such audits may also be publicised through the general media	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
Financial assurance		
60. The proponent must:	-	-
a) Provide the Minster with a financial assurance in the amount and form required from time to time by the Minster for activities to which these conditions apply	Points A to E (refer Figure 1.2)	Chapter 4
b) Review and maintain the amount of financial assurance based on proponent reporting on compliance with these conditions, and any auditing of the activities	Points A to E (refer Figure 1.2)	Chapter 4
61. The financial assurance is to remain in force until the Minister is satisfied that no claim is likely to be made on the assurance Note: The financial assurance may be used for rehabilitation of habitat and other purposes not addressed adequately by the proponent during the life of the project	Points A to E (refer Figure 1.2)	Chapter 4
Annual environmental return		
62. The proponent must produce an Annual Environmental Return which:	-	-
a) Addresses compliance with these conditions	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.6
b) Records any unavoidable adverse impacts on MNES, mitigation measures applied to avoid adverse impacts on MNES; and any rehabilitation work undertaken in connection with any unavoidable adverse impact on MNES	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
c) Identifies all non-compliances with these conditions	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7

EPBC conditions relevant to the Marine Crossing GTP	Section of the Marine Crossing GTP Project	Section addressed
d) Identifies any amendments needed to plans to achieve compliance with these conditions	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
63. The proponent must publish the Annual Environmental Return on its website within 20 calendar days of each anniversary date of this approval. In complying with this publication requirement, the proponent must ensure that it has obtained relevant rights in relation to confidentiality and intellectual property rights of third parties	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.7
64. If requested by the Department, the proponent must provide all species and ecological survey data and related survey information from ecological surveys undertaken for MNES. The data must be collected and recorded to conform to data standards notified from time to time by the Department	Points A to E (refer Figure 1.2)	Chapter 3, Section 3.6

2. Project description

This EMP addresses the Marine Crossing section of the Santos GLNG GTP (refer Figure 2.1) which includes:

- Establishment and construction of the Access Road between Forest Road and the construction site pad (mainland), including the weed washdown facilities and the designated ASS treatment area
- Establishment and construction of the construction site pad (mainland) and TBM launch shaft at Point C
- Establishment and construction of the construction site pad (Curtis Island) and TBM receptor shaft at Point D
- Bored tunnel beneath the intertidal area south of Kangaroo Island and The Narrows (between reference points C and D)
- Conventional open cut trenching from the Mainland GTP for approximately 3 km to the construction site pad (mainland) (between reference points A and C) and 900 m of trenching on Curtis Island to join with the Curtis Island GTP section of the Project (between reference points D and E)
- Ancillary work within the Marine Crossing GTP ROW including the establishment of access tracks for trenching work, pipe stringing areas and designated laydown areas

Collectively these construction components comprise the Marine Crossing GTP Project.

The survey reference locations for the Marine Crossing GTP Project are identified in Table 2.1.

Table 2.1 Survey reference locations for the Marine Crossing GTP Project

Reference Point	Easting	Northing
Point A	307885.00	7372070.00
Point B	308384.00	7371825.00
Point C	309893.00	7370692.00
Point D	314290.76	7372243.30
Point E	315000.00	7372593.00

2.1 Project justification

2.1.1 International demand

World demand grows for all energy sources and is predicted to continue, with the world's primary demand for energy to increase by one-third between 2010 and 2035. Global gas demand is projected to increase by 1.7% per year to 2035, resulting in a projected increase in demand for LNG of 176 million tonnes (Mt) between 2009 and 2035 [IEA, 2011] to around 354 Mt [IEA, 2012] (BREE, 2012a). The increase in global demand predicted for LNG is an outcome of the increasing pressure to find less carbon-intensive energy solutions in an increasingly carbon-constrained world. The Project is a less carbon-intensive energy solution than other fossil fuel alternatives. As such, the Project can be a global contributor to energy needs with reduced greenhouse gas outputs.

In the calendar year 2011, Australia exported 18.9 Mt of LNG, valued at around $11.1 billion [RET, 2012] (BREE, 2012a). Exports of LNG have increased strongly over the past 20 years, and have risen particularly rapidly over the past five years. Exports of approximately 63 Mt are predicted for 2016/17.

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Weed Washdown Facility (Indicative)
- Access Road
- Watercourse Crossing Ancillary Areas
- Highest Astronomical Tide

Note: High Astronomical Tide (HAT) is approximate and indicative only.

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.
Extra Works Areas: GLNG, Jul 2012.

Indicative Project Footprint
Figure 2.1

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_061.mxd 11/07/2012 09:06

A1 scale: 1:15,000
0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0550
Coordinate system: GCS_GDA_1994

Date: 11/07/2012 Version: f

BREE (2012b) predicts that the growth in exports will continue, with natural gas exports expected to grow by 21% per year until 2017. Most of this growth is expected to come from increased production from the North West Shelf project and the Conoco-Phillips LNG plant in Darwin, supplying LNG to Japan. More West Australian operations are in the development phase, including Gorgon and Pluto projects in the Carnarvon Basin, and several in the Browse Basin. In 2012, Australia's liquefaction capacity is expected to increase to 24 million tonnes per annum (Mtpa), with the completion of the first train at the 4.3 Mt Pluto project. Between 2014 and 2015, three coal seam gas LNG projects, with a combined capacity of 25 Mt, are scheduled to start up:

- Australia Pacific LNG project (APLNG)
- Queensland Curtis LNG project (QCLNG)
- GLNG project

While funding has only been committed for the first train of the APLNG project, a positive foreign investment decision is assumed on the second train in 2012, given the establishment of binding sales and purchase agreements. The remaining LNG projects scheduled for completion include:

- Gorgon (15 Mt, in 2014/15)
- Wheatstone (8.9 Mt, in 2016)
- Prelude (3.6 Mt, in 2016/17)
- Ichthys (8.4 Mt, in 2016/17)

The majority of the world's large importers of LNG are in the Asia Pacific region, giving Australia a natural advantage in terms of the relatively short distances to these key markets. In 2010, Australia exported over 19.11 Mt of LNG predominantly to Japan, [RET, 2012]. Australia's LNG exports are delivered mainly to Japan, the Republic of Korea, Chinese Taipei and China (BREE, 2012b).

Demand for LNG is expected to increase to over 150 Mt by 2015. There is a clear opportunity for the Project to fill some of this need.

Economic data presented by BREE (BREE, 2012b) indicates that Asia-Pacific imports of LNG are forecast to reach 162 Mt in 2012, supported by stronger gas-fired electricity generation and higher industrial and residential consumption in existing and emerging LNG importing economies. In 2013, growth of LNG imports into the Asia-Pacific region are forecast to slow to 4% and to total 170 Mt. Increased LNG imports into the Republic of Korea, China, India and Chinese Taipei are forecast to offset a forecast decline in Japan's imports.

Imports of LNG into Asia-Pacific region are projected to increase by an average of 7% per year to reach 217 Mt in 2017. China is projected to account for one-third of the total increase in the region's LNG imports.

Projected increases in the global demand for LNG and the establishment of binding long-term contracts to secure future supplies have underpinned investment in additional liquefaction capacity.

Given long construction times, projections of global liquefaction capacity growth are based on projects that are either committed or under construction. In 2012/13, global liquefaction capacity is forecast to increase by 3% each year to reach 296 Mtpa in 2013, underpinned by projects in Australia, Angola and Algeria. Over the outlook period (2014 to 2017), global liquefaction capacity is projected to increase at an average annual rate of 5%, to reach 366 Mtpa by the end of 2017.

Australia's LNG export earnings are projected to increase by an average of 20% per year to total $30 billion (in 2011/12 dollars) in 2016/17. The growth will be underpinned by higher export volumes supported by the start up of 66 Mtpa of additional LNG production capacity over the outlook period (BREE, 2012b).

2.1.2 Domestic demand

Within Australia, increasing demand for natural gas is likely to change the market structure in coming years. At present there are a small number of producers and a small number of large consumers, with relatively low household consumption. In 2007, there were approximately 3.75 million households in Australia using natural gas, most supplied by low pressure gas pipelines (ABARE, 2008). Recent economic data suggest that the mining sector will continue to perform strongly in terms of both volumes of exports and growth in capital investments. Overall, Australian domestic demand continues to grow at a robust pace, although the high level of the exchange rate, and changes in household spending and borrowing behaviour continue to have a negative effect on some industries. As in many other countries, volatility in global financial markets has resulted in noticeable declines in measures of consumer and business confidence in the latter half of 2011 (BREE, 2012b).

Domestic consumption of natural gas is predicted to nearly double by 2030 (ABARE, 2008). This increase is due to increased demand for natural gas in electricity generation, manufacturing and mining, partly as a result of government policy incentives such as the Queensland 13% Gas Scheme. Under this scheme electricity retailers are required to source 13% of the electricity they sell in Queensland from gas-fired generation. The target will increase to 18% by 2020. The Scheme is designed to diversify Queensland's energy mix towards the greater use of gas, assist in encouraging the development of new gas sources and infrastructure in Queensland and reduce the production of greenhouse gas emissions from the Queensland electricity sector.

In 2009/10, gas accounted for 1,371 petajoules (PJ) of Australia's primary energy consumption, or around 23% of total energy consumption. This is projected to increase to 35% in 2034/35 (BREE, 2012a).

The Australian domestic gas market consists of three distinct regional markets:

- Eastern market comprised of Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia and Tasmania
- Western market comprised of Western Australia
- Northern market comprised of Northern Territory

These markets are geographically isolated making transmission and distribution of gas between markets currently not economically viable and all gas production is either consumed within each market or exported as LNG (BREE, 2012a).

The Eastern market accounted for one-third of Australia's gas production in 2009/10 (ABARES, 2011) and is the only region where CSG (accounting for one-quarter of total gas production) supplements conventional gas supplies. This market is Australia's largest consumer of natural gas and accounted for around 56% of Australian gas consumption in 2009/10 (BREE, 2012a).

The energy consumption predictions presented by BREE incorporate the introduction of a carbon pricing mechanism, which is expected to contribute to the predicted strengthening in gas demand (BREE, 2012a).

2.1.3 Project timing and life

The Project runs from the CSG fields located at Roma and Fairview to the LNG facility on Curtis Island over a distance of approximately 420 km, of which the Marine Crossing GTP Project forms an 8.4 km section within the corridor.

For the first stage of the Project the CSG fields are expected to produce approximately 5,300 PJ (140 billion m^3) to supply to the LNG facility. This will involve the development of approximately 2,650 exploration and production wells. It is anticipated that approximately 1,200 wells will be established prior to 2015, with the potential for a further 1,450 or more additional wells to be established thereafter. Additional supporting infrastructure, including field gathering lines, nodal compressor stations, centralised compression and water treatment facilities, accommodation facilities, power generation and water management facilities will also be installed.

The LNG facility is to be developed in three stages and each stage is termed a 'train'. Construction of the first train (Train 1), including the marine facilities and capital dredging commenced in 2011 with construction taking approximately four years with a projected completion date of December 2014.

The LNG facility operations are planned to commence in early 2015. Construction of Train 2 will commence as early as 2012, which will bring the LNG facility up to its ultimate capacity of 10 Mtpa. However the timing of these trains is dependent on market conditions, gas availability, labour availability and the economic climate. It is possible that construction of Trains 1 and 2 may overlap.

During this time, development of the CSG fields will be ongoing, up to the 5,300 PJ production rate required for Train 1. As each production well will have an approximate life of 5 to 15 years it will be necessary to replace depleted wells with new ones. New wells will be developed at a rate that is sufficient to provide enough CSG for the annual LNG production.

The total impact area for the Marine Crossing GTP ROW Project will be restricted to the maximum disturbance areas specified in the QLD Government Environmental Authority (EA) approval conditions issued on 7 September 2012, these maximum disturbance areas include:

- Mainland ROW (Section A to C) and watercourse crossing ancillary construction areas - 13.1 ha
- Construction site pads (mainland and Curtis Island), Access Road including ASS treatment area and washdown facility -15.2 ha
- Curtis Island ROW (Section D to E) - 2.4 ha
- Total 30.7 ha

The design life and expected operational life of the Project, including the Marine Crossing GTP is approximately 42 years.

The proposed construction schedule is provided in Figure 2.2.

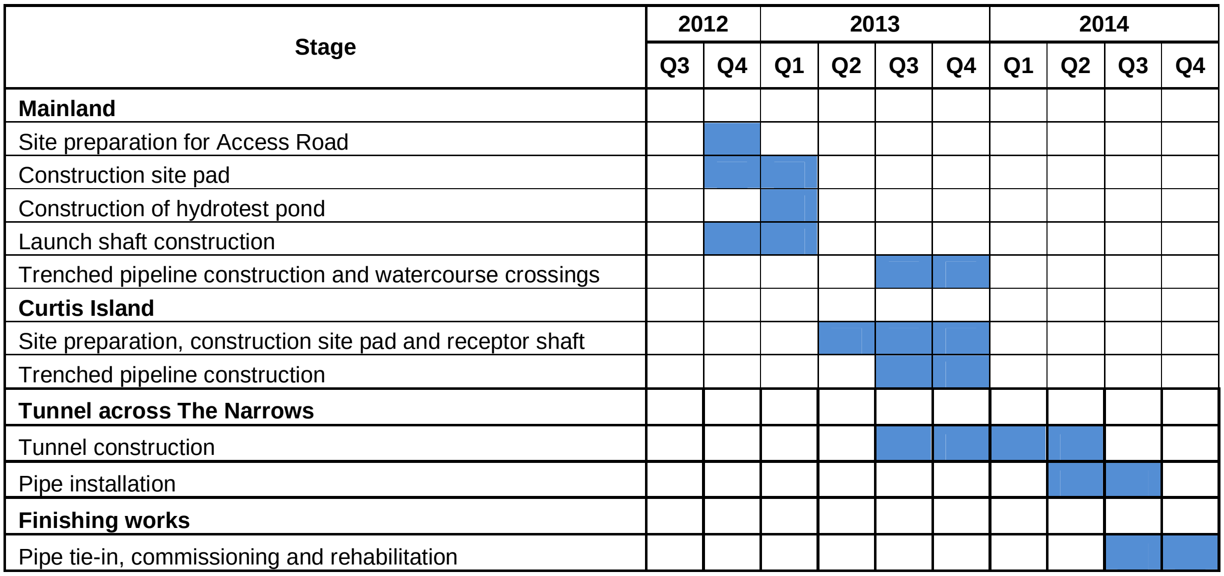


Figure 2.2 Project construction schedule

2.2 Marine Crossing GTP ROW

2.2.1 Alignment selection process

The criteria used to determine the most appropriate alignment for the Marine Crossing GTP Project was based on the APIA Code of Environmental Practice (APIA, 2005) and Australian Standard (AS) 2885. The criteria listed in Table 2.2 were used in the selection of the Marine Crossing GTP alignment.

Table 2.2 Criteria for alignment selection

Issue	Criteria
Land use	Minimise access through populated areas and near rural homes and buildings
	Parallel property boundaries adjacent to fence line where possible, rather than dissecting lots
	Minimise crossing specialist agricultural blocks (eg irrigated areas, contoured land)
	Minimise number of landowners affected and avoid small rural lots
Environmental	Avoid sites of known cultural heritage significance
	Protection of landscape values
	Avoiding ecosystems of conservation significance and essential habitats
	Minimise impacts of vegetation clearing where avoidable
	Cross watercourses at 90° to flow where practical
	Avoid crossing watercourses at bends, to prevent erosion of disturbed land
	Minimise impacts on riparian vegetation, by crossing at disturbed areas
	Avoid wetlands wherever possible
	Ensure environmental sustainability

Issue	Criteria
Co-use of easements	Road easements can be utilised, but not all easements will be able to cater for a 40 m ROW. Generally, road easements contain services which can threaten pipeline integrity
	Pipeline easements can be used
	Powerline easements can be used; however, additional design costs apply
	Railway easements are not ideal, unless significant space available
	Cross roads, highways, railways and other services at 90° where practical and safe
Safety	Relevant safety standards
	Assessment of safety risks
Commercial	Present market requirements
	Construction and operating costs
Engineering	Relevant construction and operation standards
	Construction access requirements
	Terrain and geotechnical constraints
Physical constraints	Avoid side slope (eg paralleling contours on a hill)
	Run with slope (eg cross contours at 90°)
	Avoid escarpments – unless prepared to use Horizontal Directional Drilling (HDD)
	Avoid unstable soils and erosion prone areas

2.2.2 Methods of construction considered

Four different construction alternatives for the work below HAT and the crossing of The Narrows were examined and internally assessed for feasibility and environmental impact. All options involved conventional trenched pipeline construction within the mainland and Curtis Island sections of the GTP.

Co-location

This involved constructing a conventional trenched pipeline within a bundled pipeline arrangement with other LNG proponents. This option involved synchronisation with other proponents to minimise environmental harm. This option was deemed to be a medium risk to sensitive environmental values (predominantly roosting shorebirds) due to the uncontrollable timing aspects of the co-location approach.

Standalone trenching

This alternative involved constructing a conventional trenched pipeline north of the bundled pipeline arrangement. This required the creation of an open cut trench adjacent to the Great Barrier Reef Coast Marine Park (GBR Coast MP). This option was deemed to be of medium risk to sensitive environmental receptors due to its proximity to a conservation marine park, below lowest astronomical tide (LAT) and potential impacts on the marine environment.

Standalone HDD and trenching

This HDD option was deemed to be of lower risk to sensitive environmental receptors than conventional trenching techniques, due to the associated minimal surface footprint.This option utilised conventional trenching within the terrestrial portions on the mainland and Curtis Island, and HDD techniques to drill under the intertidal area of Kangaroo Island and The Narrows.

The use of HDD would reduce the potential and quantity of ASS to be disturbed and handled during construction compared to conventional trenching, the construction of an access track and HDD drill pads on the intertidal area could result in the potential disturbance of ASS causing a medium risk to sensitive environmental receptors utilising the area and the adjoining Port Curtis.

Tunnelling and trenching (proposed construction method)

The preferred alternative for the marine crossing involves retention of the open trench method between points A and C (mainland) and points D and E (Curtis Island), and using bored tunnelling construction using a TBM for tunnelling under the intertidal area south of Kangaroo Island and The Narrows. This option has a considerably lower risk to sensitive environmental receptors through the reduced intertidal disturbance footprint. Additional environmental benefits include:

- No direct disturbance to tidal flows or impact on sensitive intertidal areas south of Kangaroo Island
- Construction of access tracks, HDD drill pads and pipe stringing activities within the intertidal areas is no longer required
- Minimal risk of pollution and contamination impacts from leaked drill fluids and/or disturbed ASS within intertidal areas
- Minimal risk of accelerated erosion and sediment movement within the intertidal areas of Kangaroo Island, due to the Marine Crossing GTP Project disturbance footprint being restricted to terrestrial areas on the mainland and Curtis Island
- Minimisation of disturbance to tidal areas by relocating the Humpy Creek and Targinie Creek crossings and the location of the construction site pad (mainland) away from the mangrove and estuarine habitats of the Mosquito Creek tidal area (due to change in alignment, refer to Section 2.2.3)

2.2.3 Alignment selection and method of construction

GLNG Operations has adopted the preferred TBM method for the Marine Crossing GTP Project due mainly to environmental reasons.

An alignment was identified that minimises potential environmental impacts. The bored tunnel alignment avoids the mangrove and estuarine habitats surrounding Mosquito Creek, avoids direct disturbance of migratory and shorebird roost habitats along the shoreline and water mouse habitat associated with the Kangaroo Island intertidal areas.

The proposed alignment of the Marine Crossing GTP Project bored tunnel was selected to:

- Locate the construction site pads and tunnel outside the GBR Coast MP
- Cause no direct disturbance to the sensitive intertidal area surrounding Kangaroo Island (on the eastern shore of Port Curtis) on the mainland
- Minimise the tunnel length

Figure 2.1 details the preferred alignment of the Marine Crossing GTP Project as defined in Section 2.1.

It should also be noted that the other LNG proponents' pipelines will cross the Project ROW at a point approximately 200 m to the east of Point B and at a point approximately 500 m west of the Curtis Island shoreline, beneath The Narrows (refer Figure 8.3c). An assessment of the cumulative impacts of all pipeline work is presented for each affected environmental aspect at the end of each chapter in this EMP.

2.3 Design and engineering

The Marine Crossing GTP ROW is 8.4 km in length and follows the alignment as shown in Figure 2.1. Approximately 3 km will be constructed using conventional open cut trenching methods, with the balance utilising bored tunnelling construction methods under The Narrows. The Marine Crossing GTP Project, for ease of description, may be considered in three sections:

- Terrestrial mainland trenched section (Point A to Point C), including watercourse crossings, which uses conventional open cut trenching and pipelaying methods
- The Narrows tunnel section (Point C to Point D), which utilises bored tunnelling technology to minimise potential construction environmental impacts to intertidal areas and Port Curtis by tunnelling under these areas. This section also includes the Access Road and construction site pads (mainland and Curtis Island)
- Terrestrial Curtis Island trenched section (Point D to Point E), which uses conventional open cut trenching and pipelaying methods

The three Marine Crossing GTP Project sections are described below.

2.3.1 Terrestrial mainland trenched section (Point A to Point C)

From the exit of the Queensland Energy Resources (QER) land-bridge, the Marine Crossing GTP ROW runs southeast within the boundaries of the Northern Infrastructure Corridor (NIC) Sub-Precinct within the Materials Transportation and Services Corridor Precinct (MTSC) of the Gladstone State Development Area (GSDA) on the eastern side of the QER oil shale mining lease area (refer Figure 8.3b) and above the HAT (refer Figure 2.1) towards the eastern shoreline of Port Curtis. This section of the Marine Crossing GTP ROW will run parallel to the other LNG proponents pipelines as it does for the previous portion of the Northern Infrastructure Corridor.

Through this mainland trenched section, the Marine Crossing GTP ROW will cross minor watercourses, which include two unnamed tributaries of Mosquito Creek, as well as Humpy Creek and Targinie Creek (refer Figure 2.1). The method of construction for watercourse crossings is provided in Section 2.4.5.

Conventional open cut trenching construction techniques will be used throughout the mainland trenched section of the Marine Crossing GTP ROW.

2.3.2 The Narrows tunnel (Point C to Point D)

The Narrows tunnel starts at Point C where the construction site pad (mainland) and TBM launch shaft will be located. The bored tunnel then traverses beneath the intertidal area and The Narrows, and ties in with the TBM receptor shaft located within the construction site pad (Curtis Island) at Point D, as shown in Figure 2.1.

Construction activities associated with The Narrows tunnel include:

- The Access Road between Forest Road and Point C (refer Table 2.3 for the design specifications of the Access Road)
- Construction site pad and TBM launch shaft on the mainland, at Point C (refer Table 2.4 for the design specifications)
- Tunnelling beneath the intertidal area and The Narrows (refer Table 2.5 for the design specifications)

- Construction site pad and TBM receptor shaft on Curtis Island, at Point D (refer Table 2.6 for the design specifications)
- Pipeline installation through the ROW (refer Section 2.3.4)

Construction details are provided in Tables 2.3 to 2.6 based on concept design and may be revised during detailed design of the Project.

Table 2.3 Access Road design specifications (Forest Road to Point C)

Design element	Details
Approximate length	2,247 m
Corridor	25 m
Disturbance area	41,250 m^2
Carriageway	7 – 10 m
Batter slope and drainage width	6.5 m
Washdown area	2,500 m^2
ASS treatment area	5,025 m^2
Planned Project life – design and operation	Construction phase only

Table 2.4 Construction site pad (mainland)

Design element	Details
Approximate area	74,850 m^2
Tunnel launch shaft length	65 m
Tunnel launch shaft width	8 m
Tunnel launch shaft depth	9.35 m
Depth to tunnel crown	5.3 m
Construction pond volume	15,000 m^3
Construction pond length	150 m
Construction pond width	30 m
Construction pond depth	6.4 m
Construction pond freeboard	1 m or 1:10 year average return interval (ARI), whichever is greater
Water treatment plant (WTP) output	15 L/s
Sedimentation pond	1,463 m^3
Gantry crane	40 tonnes
Gantry crane	25 tonnes
Planned Project life – design and operation	Construction phase only

Table 2.5 Tunnel design specifications for The Narrows tunnel (Point C to Point D)

Design element	Details
Approximate length	4,439 m
Cutting diameter	4.05 m

Design element	Details
Internal diameter	3.40 m
Grout	6,700 m^3
Water	10,000 megalitres (ML)
Concrete segment (thickness)	200 mm
Tunnel spoil	83,000 m^3
Planned Project life – design and operation	Approximately 44 years

Table 2.6 Construction site pad (Curtis Island)

Design element	Details
Approximate area	22,290 m^2
Tunnel receptor shaft length	15 m
Tunnel receptor shaft width	8 m
Tunnel receptor shaft depth	9.33 m
Depth to tunnel crown	5.25 m
Stockpile area	1,000 m^2
ASS treatment area	200 m^2
Planned Project life – design and operation	Construction phase only

2.3.3 Terrestrial Curtis Island trenched section (Point D to Point E)

The Marine Crossing GTP ROW through the Curtis Island trenched section is from Point D to Point E, where it connects to the Curtis Island GTP ROW and is within the boundaries of the Curtis Island Corridor Sub-Precinct, within the MTSC of the GSDA (refer Figure 8.3b).

This section of the Marine Crossing GTP will be installed using conventional open cut trenching techniques.

2.3.4 Marine Crossing GTP Specifications

Key engineering and design features of the Marine Crossing GTP Project are provided in Table 2.7, Table 2.8 and Table 2.9.

Table 2.7 GTP specifications for the terrestrial mainland trenched section (Point A to Point C)

Design element	Details
Approximate length	Approximately 3 km
Maximum diameter	1,067 mm
Wall thickness	15.00 mm
Line pipe specification	API 5L X70 PSL2
Factory-applied external coating	Double layer Fusion-bonded Epoxy (FBE) coating
Factory-applied internal lining	Two-part liquid epoxy
Pipeline medium	Sales quality gas
Operational pressure	10.2 megapascals (MPa)
Maximum allowable operating pressure (MAOP)	10.2 MPa
Specified minimum yield stress	485 MPa

Design element	Details
Standard construction ROW width	30 m
Operational easement width	30 m
Minimum depth of cover	1,200 mm
Planned Project life – design and operation	Approximately 42 years
Corrosion protection	External coating and impressed current cathodic protection
Non-destructive testing	100% radiography or ultrasonic testing of welded joints. Hydrostatic pressure testing of completed pipeline to 125% of MAOP
Pipeline monitoring system	Supervisory control and data acquisition (SCADA) system for remote monitoring and control of all facilities at each end of the pipeline and at key intermediate points along the pipeline; periodic patrolling along the pipeline

Table 2.8 GTP specifications for The Narrows tunnel (Point C to Point D)

Design element	Details
Approximate length	4.4 km
Maximum diameter	1,067 mm
Wall thickness	23.5 mm
Line pipe specification	API 5L X70 PSL2
Factory-applied external coating	Double layer FBE coating
Factory-applied internal lining	Two-part liquid epoxy
Pipeline medium	Sales quality gas
Operational pressure	10.2 MPa
Maximum allowable operating pressure (MAOP)	10.2 MPa
Specified minimum yield stress	485 MPa
Standard construction ROW width	30 m
Operational easement width	30 m
Minimum depth of cover (terrestrial)	5 m
Minimum depth of cover (marine)	8 m
Planned Project life – design and operation	Approximately 42 years
Corrosion protection	External coating and sacrificial anodes
Non-destructive testing	100% radiography or ultrasonic testing of welded joints. Hydrostatic pressure testing of completed pipeline to 125% of MAOP
Pipeline monitoring system	SCADA system for remote monitoring and control of all facilities at each end of the pipeline and at key intermediate points along the pipeline; periodic patrolling along the pipeline

Table 2.9 GTP specifications for the terrestrial Curtis Island trenched section (Point D to Point E)

Design element	Details
Approximate length	1 km
Maximum diameter	1,067 mm
Wall thickness	15.0 mm, 17.9 mm
Line pipe specification	API 5L X70 PSL2
Factory-applied external coating	Double layer FBE coating
Factory-applied internal lining	Two-part liquid epoxy
Pipeline medium	Sales quality gas
Operational pressure	10.2 MPa
Maximum allowable operating pressure (MAOP)	10.2 MPa
Specified minimum yield stress	485 MPa
Standard construction ROW width	30 m
Operational easement width	30 m
Minimum depth of cover	900 mm
Planned Project life – design and operation	Approximately 42 years
Corrosion protection	External coating and impressed current cathodic protection
Non-destructive testing	100% radiography or ultrasonic testing of welded joints. Hydrostatic pressure testing of completed pipeline to 125% of MAOP
Pipeline monitoring system	SCADA system for remote monitoring and control of all facilities at each end of the pipeline and at key intermediate points along the pipeline; periodic patrolling along the pipeline

2.4 Construction methodology for the Marine Crossing GTP

2.4.1 Clearing and grading

Clearing within the Marine Crossing GTP Project disturbance footprint will be in accordance with this EMP, the SSMP (document number 3380-GLNG-3-1.3-0031) and SMP (document number 3380-GLNG-3-1.3-0036). Protected or retained vegetation will be marked as 'no-go' zones as outlined in Chapter 10 of this EMP and in accordance with the SMP.

The typical plant and equipment to be used for clearing and to level the Marine Crossing GTP ROW and associated construction areas are listed in Section 2.4.9. Clearing will include the removal of trees, brush, stumps and other obstacles. Timber will be either chipped for use during rehabilitation activities or stockpiled, along with other vegetation, in windrows along the edges and within the Marine Crossing GTP ROW and associated construction areas in accordance with Chapter 10 of this EMP.

Selected timber and vegetation cleared and stockpiled during construction will be spread during rehabilitation works to optimise regrowth and reinstatement of the Marine Crossing GTP Project disturbance footprint.

Existing water flows across the Marine Crossing GTP Project disturbance footprint will be maintained during clearing and grading, all grading works will be undertaken in accordance with the requirements stipulated in the SMESCP (refer Appendix C). Where necessary, temporary drainage structures will be used to maintain flows and all temporary drainage structures will be removed when they are no longer required in accordance with the SMESCP.

Topsoil will be managed as follows:

- Topsoil will be stripped and stockpiled in windrows along the edge of the Marine Crossing GTP ROW and associated construction areas, where topsoil has not been previously stripped
- Topsoil stockpiles will not be placed within drainage lines
- Openings in trench spoil banks will be provided to allow normal drainage of the area and to prevent surface water from ponding
- Topsoil will not be placed against trees or within the driplines of identified protected vegetation
- Stripped topsoil will be stockpiled for use in reinstatement works within the Marine Crossing GTP ROW and associated construction areas

Subsoil from the levelling of the Marine Crossing GTP Project disturbance footprint will be stockpiled separately from vegetation and topsoil. It will be used to assist with restoring original contours.

Topsoil and subsoil stockpiles will be covered/stabilised in accordance with the SMESCP. Any surplus excavated rock material and surface boulders within the Marine Crossing GTP Project disturbance footprint will be stockpiled separately.

2.4.2 Access Road

Construction of the Access Road is between Forest Road and the construction site pad (mainland) at Point C. Clearing and grading will occur progressively as detailed in Section 2.4.1. Clearing will be restricted to a 25 m wide corridor following the alignment shown in Figure 2.1. The Access Road corridor passes through native vegetation (RE 12.3.3) just north of Forest Road, a detailed description of the vegetation within the Access Road clearing footprint is provided in Chapter 10 of this EMP. All clearing will be in accordance with this EMP and the SSMP (document number 3380-GLNG-3-1.3-0031) and SMP (document number 3380-GLNG-3-1.3-0036).

The Access Road will be designed and constructed for heavy vehicles and will require grading (including cut and fill) to minimise dips and rises within the vertical alignment. Swale drains and culverts will be installed as appropriate in any drainage lines that the road crosses. Road base material will be used to achieve all-weather trafficability.

The Access Road corridor (refer Figure 2.3) will include batters, erosion and sediment controls as detailed in the SMESCP, an ASS treatment area and weed washdown facility. Indicative locations of the ASS treatment area and weed washdown facility are shown on Figure 2.1.

Water carts will be used during construction of the Access Road to manage dust and meet the moisture content requirements of the compacted material. Once the road base has been completed, it will be gravelled to minimise dust generation throughout the construction phase.

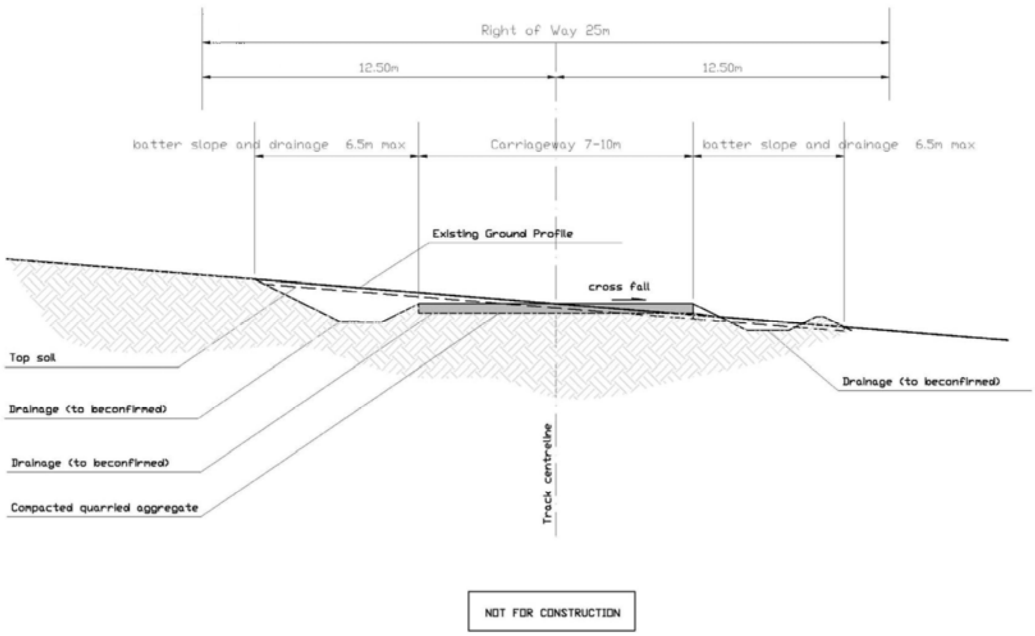


Figure 2.3 **Access Road typical cross section**

2.4.3 Construction site pads

The Narrows tunnelled section of the Marine Crossing GTP Project requires construction areas to launch the TBM from the mainland and to receive the TBM on Curtis Island. Two construction site pads are proposed as shown in Figure 2.1. The construction site pad (mainland) is located at Point C and the construction site pad (Curtis Island) is located at Point D.

Following clearing and grading activities, as outlined in Section 2.4.1, the construction site pads will be levelled through a cut and fill process. This will be undertaken with conventional earth moving equipment (bulldozers, excavators, trucks, graders and rollers) listed in Section 2.4.9. The construction site pads will be designed with sufficient crossfall so that surface water will runoff into the erosion and sediment control devices as detailed in the SMESCP (refer Appendix C).

Hardstand areas will be provided within the construction site pads for storage areas, such as the pipe laydown area in the construction site pad (mainland). This hardstand will be constructed of compacted aggregate. Concrete hardstand areas will be constructed for liquid and chemical storage areas, washdown pads and workshops. Concrete footings and floors will also be poured for any sheds and demountable site buildings required.

Construction site pad (mainland)

The construction site pad (mainland) is located on freehold land with limited access, hence the need for the Access Road described in Section 2.4.2. The construction site pad (mainland) will be constructed following the Access Road. Any spoil from the construction site pad (mainland) that contains ASS will be treated within the designated area inside the construction site pad (mainland) or transported to the additional ASS treatment area to the south and adjacent to the Access Road and managed in accordance with the ASSMP (refer Appendix A).

The indicative layout of the construction site pad (mainland) is shown in Figure 2.4 and includes the following:

- Project office, crib rooms and workshops
- Parking area
- Tunnel segment storage area
- Pipe stockpile area
- Pipe strings fabrication and laydown area
- TBM launch shaft
- Grout plant
- Bentonite plant
- Bunded fuel tanks
- Hazardous materials storage area
- Potable and construction water tanks
- Generator and enclosure
- Sediment pond and WTP
- Construction water pond
- Spoil stockpile areas (bunded)
- ASS treatment area
- Gantry cranes
- Waste sorting area
- Air compressors and hyperbaric chamber

Construction site pad (Curtis Island)

The construction site pad (Curtis Island) will be located on Curtis Island on freehold land. Access to the construction site pad (Curtis Island) will be via barge from the mainland to the existing barge landing at Laird Point and then via the existing access road. Any spoil that contains ASS will be transported to the ASS treatment area located at the construction site pad (Curtis Island) and managed in accordance with the ASSMP (refer Appendix A).

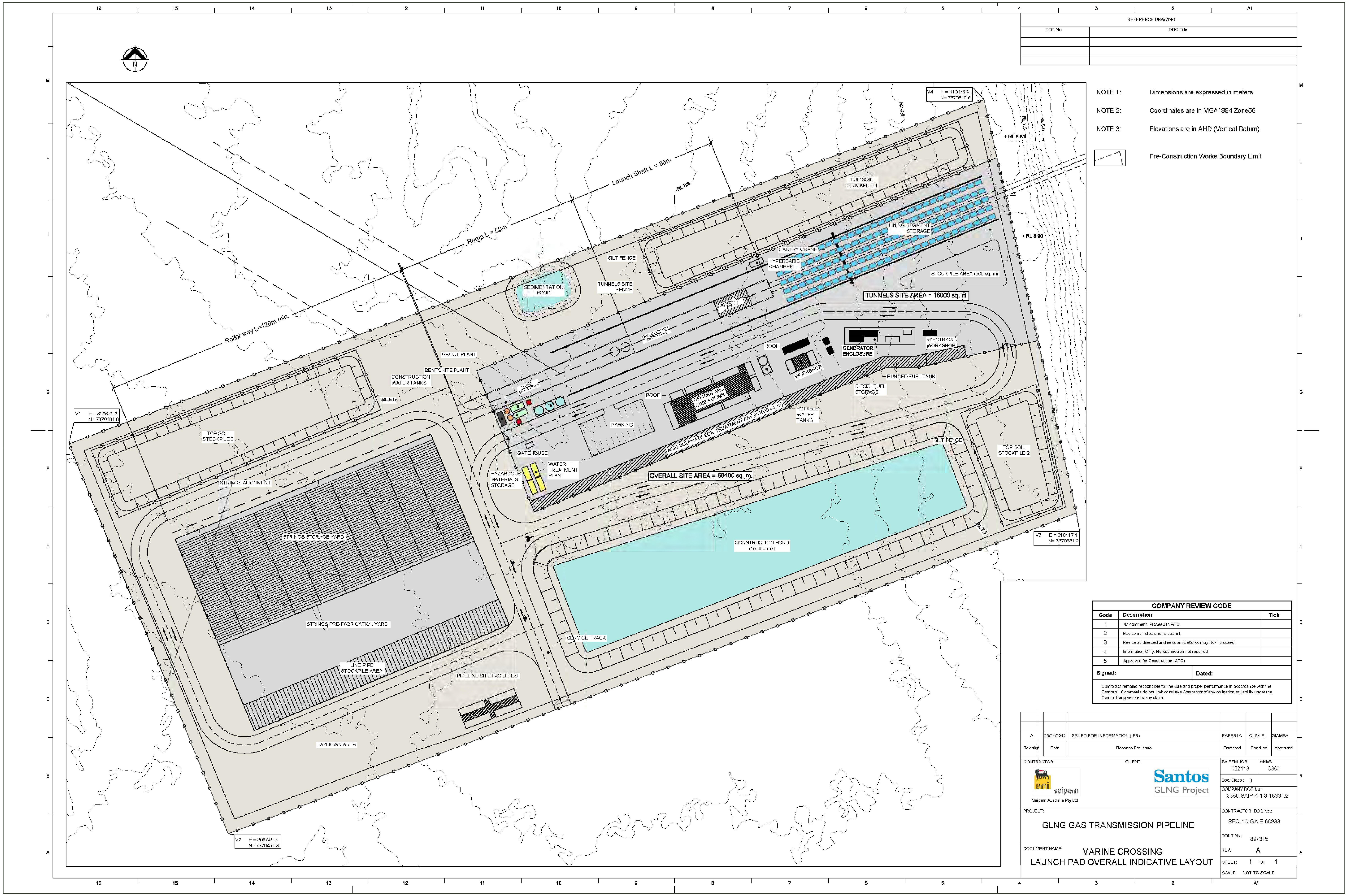
The indicative layout of the construction site pad (Curtis Island) is shown in Figure 2.5 and includes the following:

- Project office and crib room
- Parking area
- Tunnel receptor shaft
- Stockpile area
- ASS treatment area
- Crawler crane

Tunnel shafts (launch and receptor)

The TBM launch shaft is located within the construction site pad (mainland) and has been sized to allow adequate space to assemble and launch the TBM at the correct depth, it will also serve as the main access point to the TBM for operation and maintenance. The TBM launch shaft will be a rectangular box. Tunnel services, including compressed air, groundwater dewatering, cooling water, grout, sodium silicate (grout accelerator) and ventilation will be installed progressively down the TBM launch shaft wall.

The TBM receptor shaft is located within the construction site pad (Curtis Island) and will be a rectangular box. Both TBM shafts will follow the construction methodology described below.



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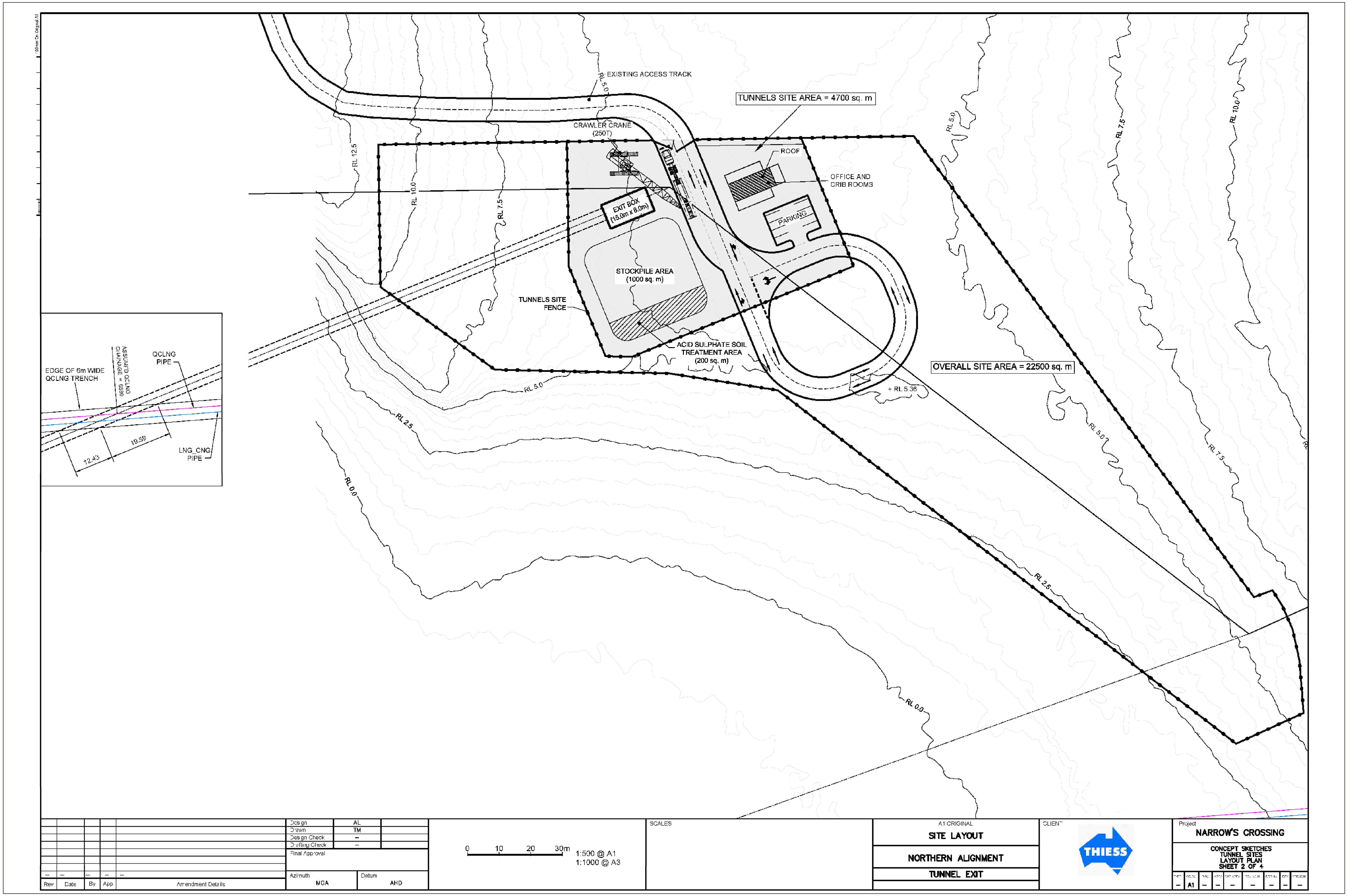
Construction Site Pad (Mainland) Indicative Layout: Figure 2.4



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Santos GLNG Project

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Source: Thiess, 2012. GLNG No: 3381-40-0552

Marine Crossing GTP EMP

Construction Site Pad (Curtis Island) Indicative Layout: Figure 2.5

Interlocking steel sheetpiles will be driven into the ground by a crawler crane around the perimeter of the shaft by either vibrating hydraulic hammer or hydraulic impact hammer until competent rock is hit. Once the sheetpiles have been installed around the perimeter enclosing the structure and providing a water tight seal, excavators will remove the soil. If the shaft depth is deeper than the level the sheetpiles can be driven, then ground support in the form of rock bolts and mesh will be installed as the excavation progresses. Soil will be stockpiled within the construction site pads prior to disposal or reuse during rehabilitation works.

Once the TBM shaft has been excavated and reached the finished depth, a reinforced concrete floor will be constructed at the bottom of each shaft to provide a clean, level working surface. The TBM launch shaft will be used to assemble the TBM and then after launching of the TBM it will support the temporary railway. A concrete sump will be incorporated into the TBM shafts concrete floor to allow any groundwater seepage to be collected and pumped to the WTP for treatment and then storage in tanks for reuse during construction. The concrete floor within each TBM shaft will be left in place and backfilled during rehabilitation works.

Two gantry cranes will be utilised, a 25 tonne and 40 tonne, to service the TBM launch shaft and unload deliveries. These cranes will be installed onto a common rail, which sits on a concrete foundation above the shaft on a hardstand area. A crawler crane (250 tonne) will be used at the construction site pad (Curtis Island) to lift the TBM up and out of the TBM receptor shaft on completion of the tunnel construction works. The TBM will be dismantled on Curtis Island and transported to the mainland.

2.4.4 Tunnelling

The tunnelling construction activities for the Marine Crossing GTP Project extend between Point C on the mainland and Point D on Curtis Island (refer Figure 2.1). Tunnel works commence at the tunnel launch shaft located within the construction site pad (mainland) and finish at the tunnel receptor shaft located within the construction site pad (Curtis Island). The LNG pipe will be pulled through once the tunnel has been completed.

Selected TBM

An earth pressure balance (EPB) TBM, with a cutter head diameter of 4.05 m is proposed to be used for the bored tunnel under the intertidal area and The Narrows for the Marine Crossing GTP Project. Construction of the Marine Crossing tunnel will result in a tunnel structure that is approximately 4.4 km long and has an internal diameter of 3.4 m. The EPB TBM has been selected for its suitability in the geological conditions along the Marine Crossing tunnel alignment. Given the geological conditions, it is anticipated that the TBM will be operated in closed mode for the entire length of the Marine Crossing tunnel, which is suitable for soft ground or mixed geological conditions. A description of the excavation process for the EPB TBM operating in closed mode is provided in the following section of this EMP.

A contingency is in place should the geological conditions become unsuitable for the TBM operating in closed mode to be switched to open mode or slurry mode. Geotechnical investigations are not always conclusive in determining geology that may be encountered during construction and therefore the option to change the TBM operation mode would ensure the safe completion of the Marine Crossing tunnel should hard rock or very stiff clay geology be encountered.

Open mode requires a drilling fluid (bentonite) to be pumped or injected into the cutter head to stabilise and maintain the required pressure around the cutting head; closed mode does not require a drilling fluid. If the TBM is required to be operated in open mode, then the environmental impacts will be assessed and management measures developed prior to recommencing TBM operation. A bentonite management plan will be prepared to address the handling, storage and use of bentonite as the drilling fluid for TBM operation in open mode.

SEWPaC approval of the Bentonite Management Plan (as an attachment to this Marine EMP) is required prior to the use of Bentonite and implementation of the Bentonite Management Plan.

The use of Bentonite will not occur without SEWPaC approval of a revised Marine EMP.

The TBM selected is a Herrenknecht machine that was previously used in Victoria. It will be shipped to Brisbane where it will be refurbished, reassembled and commissioned by Herrenknecht before being disassembled and shipped to Gladstone. The TBM will be brought to the Marine Crossing construction site pad (mainland) by truck. Oversize loads will be required to transport the TBM cutter head and shield.

Tunnel Construction methodology

TBM tunnelling is a cyclical process consisting of two distinct activities, excavation and segment erection.

Once the TBM has been assembled onto the launch cradle within the TBM launch shaft, the TBM will advance to the face of the launch eye and begin excavation. The TBM shield is a steel cylinder that consists of the cutter head, which rotates to excavate the ground. The screw conveyor extracts spoil from the excavation chamber behind the cutter head, while the segment erector builds the tunnel lining from precast concrete segments to make a ring (refer Figure 2.6). A seal is placed around each concrete segment ring so that grout may be filled between the excavated ground and concrete segment ring. The shield supports the surrounding ground and is equipped with water seals to keep the tunnel dry. Any water entering the tunnel portal and groundwater leakage through the precast concrete segments will be collected and pumped to the construction site pad (mainland) for treatment at the WTP before being stored in tanks for reuse during construction.

Hydraulic rams push forward on the precast concrete segments that have been previously installed. As the shield moves forward it tows a gantry backup system, consisting of a series of trailers, which carry various electrical, mechanical and hydraulic components that power the TBM.

During the excavation cycle it is necessary to inject foam into the excavation chamber to reduce wear on the cutter head, and make the spoil easier to transport. The foam is mixed in a section on the backup system and will be biodegradable.

Minimal groundwater seepage into the Marine Crossing tunnel during construction is expected, with a maximum design ingress rate of 1 L/100 m/h being adopted. Where high groundwater flows are encountered, the closed-face shielded configuration of the TBM combined with constant face pressure on the formation will minimise groundwater inflow. Any groundwater inflow that does occur at the excavation face will be contained within the excavation chamber. Trenches and tunnel construction may impact on existing groundwater levels. It is expected that the volumes of water encountered within the trenching section will not be significant with any impact being confined to a discrete, localised area and temporary draw-down is unlikely to generate long-term impacts. Groundwater levels are likely to recharge after construction.

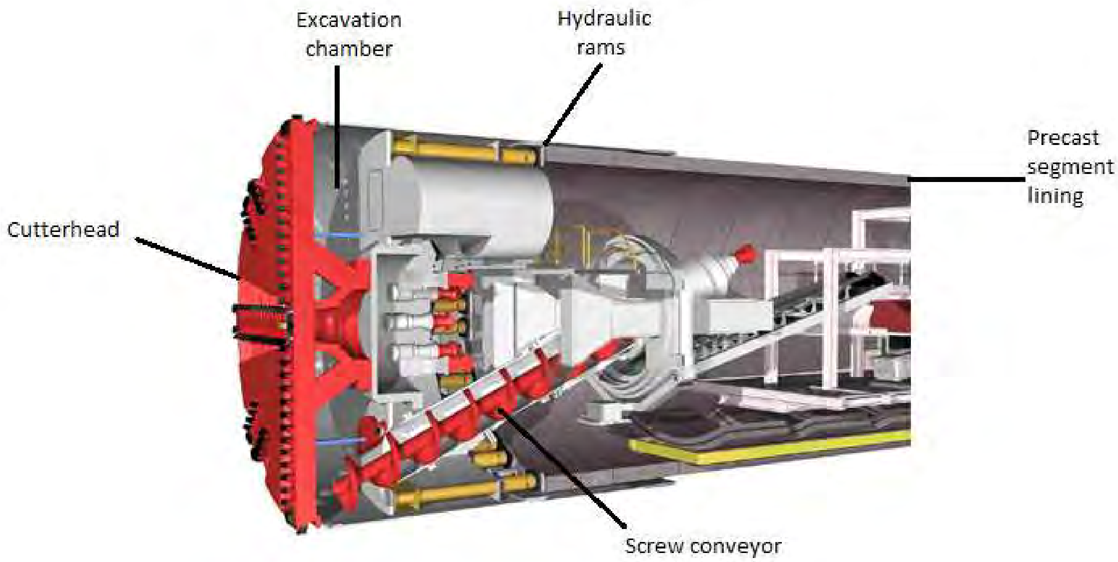


Figure 2.6 **Cross section of TBM shield and segment lined tunnel** (Source: Thiess, 2012)

Depending on the ground conditions encountered it may be necessary to pressurise the excavation chamber with compressed air to prevent water inundating the chamber during maintenance work for the TBM. This is called a compressed air intervention and requires personnel to work and breath in a compressed air environment similar to diving. The bulkhead of the excavation chamber has an airlock to allow workers and materials to enter the pressurised environment. A hyperbaric chamber will be located on the construction site pad (mainland) to respond to any decompression sickness in TBM maintenance personnel.

Construction railway

Labour and materials for the TBM will be transported within the tunnel on a construction railway system. Track is laid on curved sleepers that are bolted to the concrete rings as the TBM advances. Diesel locomotives or trains are specially designed for working underground and will be used to pull a rake consisting of:

- Segment cars
- Flat cars for miscellaneous materials
- A manrider car for transporting personnel
- Muck cars for removing tunnel spoil

The backup gantry is designed so that the train can drive up inside it to deliver segments to the segment feeder.

The muck cars will have a bin on them so that the cars can be lifted to the surface and tipped on a tipping frame to place the tunnel spoil into a stockpile located within the construction site pad (mainland). If a conveyor belt is installed to bring the spoil to the surface the muck cars will not be required.

Trains will bring segments for one ring and other materials to the TBM from the TBM launch shaft and return with tunnel spoil. It is anticipated that three trains will be required due to the length of the tunnel and therefore two California switches will be installed in the tunnel to allow the trains to pass each other.

Surface activities

Within the construction site pad (mainland), ancillary surface activities for the TBM will occur including:

- Precast concrete segments being delivered daily by truck
- Tunnel spoil from the stockpile area being removed daily by trucks. The tunnel spoil stockpile will have a 24 hour capacity
- A grout plant to batch grout and pump it to the TBM as required. The cement, bentonite, water, retarder and superplacticiser will be stored in silos adjacent to the grout plant
- Delivery of other materials, including temporary pipe work, services brackets, railway tracks and sleepers, vent bags, and TBM lubricants
- Mechanical and electrical workshop facilities to service and maintain the TBM and associated plant

TBM recovery

The TBM will advance until it has broken through the soft eye prepared in the wall of the TBM receptor shaft. A steel cradle similar to the launch cradle will be built in the bottom of the shaft for the TBM shield to advance onto.

Once the shield is on the cradle the backup will be disconnected from the shield, and the shield will be cleaned, disassembled and lifted to up to the construction site pad (Curtis Island) by crane, where it will be loaded onto trailers and taken back by barge to the mainland.

2.4.5 Trenching

Conventional open cut trenching will be undertaken for the Marine Crossing GTP Project through the terrestrial mainland section (Point A to Point C) and the terrestrial Curtis Island section (Point D to Point E).

Construction work for the open cut trench sections will be carried out as an extension of the Project in accordance with AS 2885 Pipelines – Gas and Liquid Petroleum, the APIA Code of the Environmental Practice (APIA, 2005) and to meet the GTP specifications summarised in Section 2.3.4.

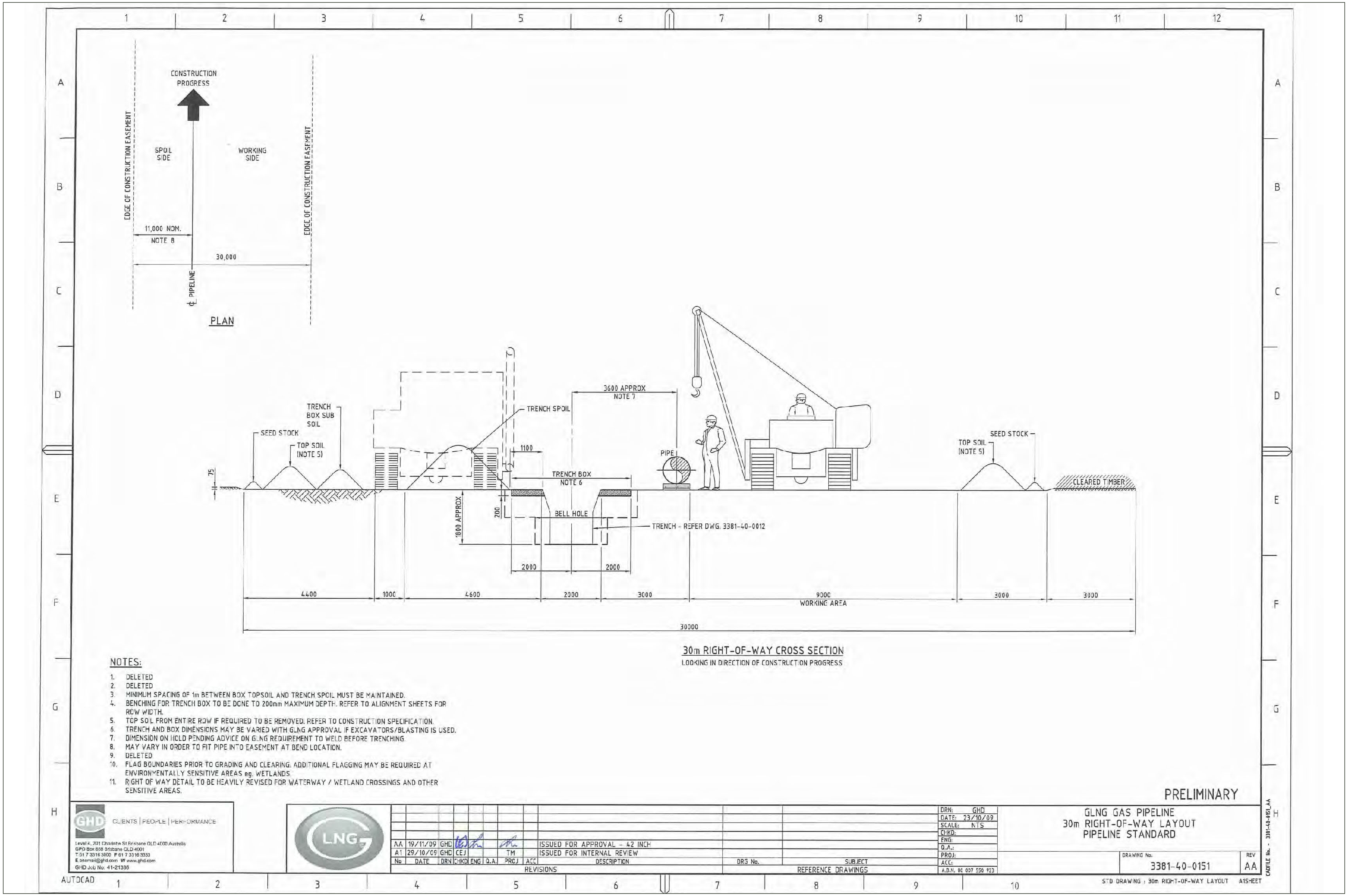
The Marine Crossing GTP ROW will be 30 m wide and as it lies within a defined ESA (refer Figure 10.1). A typical 30 m ROW layout is presented in Figure 2.7. Clearing within the ROW will be undertaken as outlined in Section 2.4.1.

The trench will be excavated by backhoes and the spoil will be windrowed beside the trench allowing gaps at regular intervals for access tracks and for surface drainage. The amount of open trench will be restricted to that which is necessary for efficient completion of the work. Fauna escape features, such as ramps and hessian ladders will be installed within open trench areas in line with approval conditions to allow fauna to escape from the trench.

Prior to lowering the pipe into the trench, water in the bottom of the trench will be removed as required and treated for reuse during construction or disposed by either the ASSMP (refer Appendix A) or the DHWLRMP (refer Appendix D). In ASS areas, the management of spoil and associated water will comply with the ASSMP (refer Appendix A).

Watercourse crossings

The Marine Crossing GTP Project will traverse ephemeral drainage lines and watercourses (refer Figure 2.1 and Table 2.10). A detailed description of the ecological attributes at each



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watercourse crossing location is given in Section 10.5.7; water quality, watercourse profiles, and hydraulic assessments for each watercourse catchment are given in Section 15.2.3.

Table 2.10 Watercourse crossing locations within the terrestrial mainland section of the Marine Crossing GTP Project

Watercourse name	Easting	Northing
Humpy Creek (minor northern tributary) at Point B	308373.88	7371859.67
Humpy Creek (southern creek line)	309233.77	7371273.63
Unnamed drainage feature (connecting Humpy Creek and Targinie Creek)	309378.77	7371054.77
Targinie Creek	309641.02	7370828.05

The watercourse crossing construction methodology has been developed to:

- Minimise the area of disturbance
- Minimise the overall length of time for disturbance, and in particular, the length of time that trenches will remain open in the bed and banks of each watercourse
- Provide for preservation of the sediment/soil profile
- Provide for prompt stabilisation of the bed and banks of each watercourse following pipe placement
- Provide for special reinstatement techniques to restore aquatic ecosystems and prevent scouring and/or GTP exposure and damage by subsequent flows

Prior to laying any pipe within a watercourse, welded joint testing will be undertaken by the method described in Section 2.5.1. Undertaking non-destructive testing to confirm pipe integrity prior to laying the pipe within a watercourse will reduce or prevent the need for the watercourse to be disturbed at a later date due to leakage.

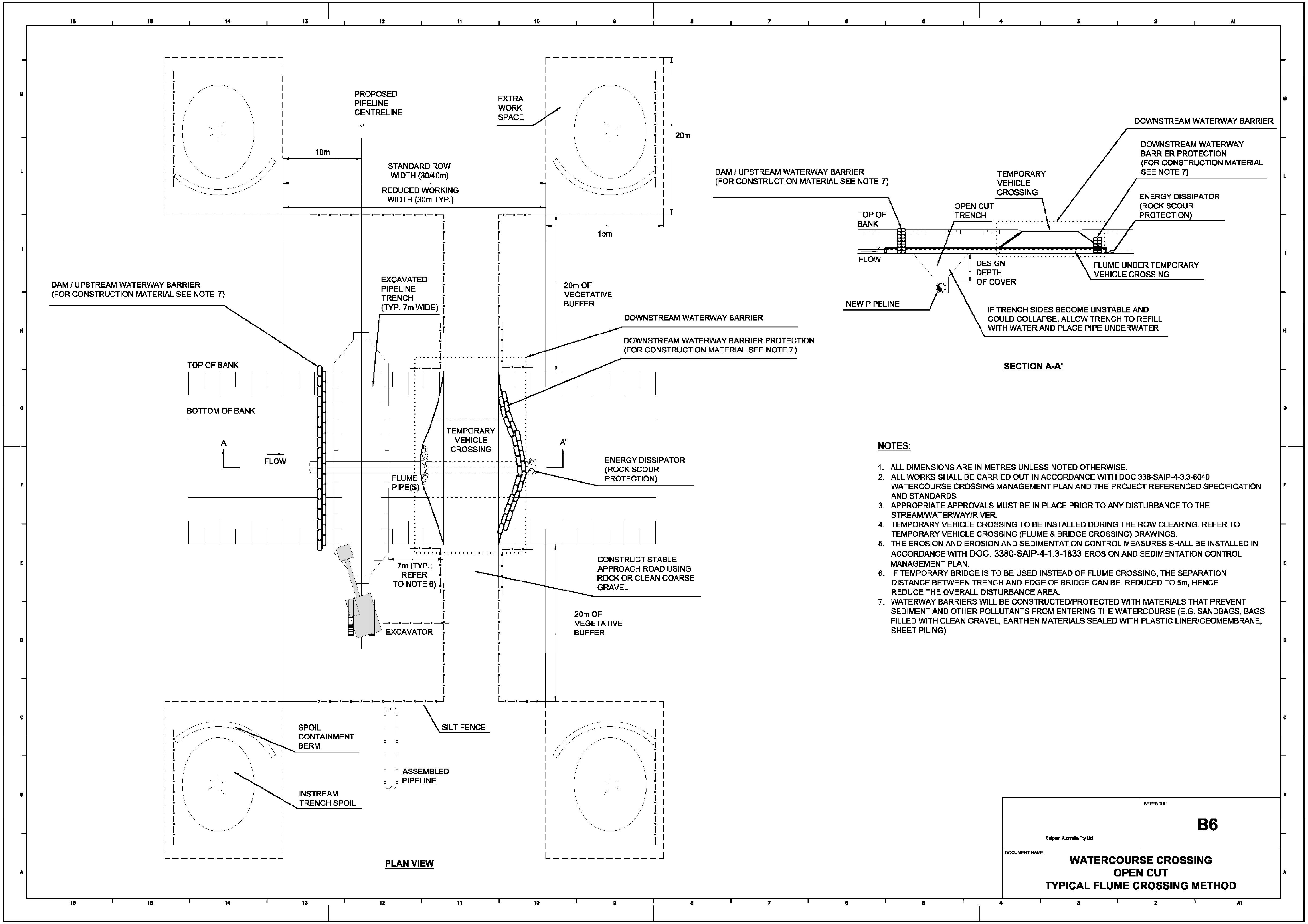
Hydrotesting will be carried out on completion of the Marine Crossing GTP section (including the watercourse crossings) to test the integrity of the GTP as a whole, this will be undertaken by the method described in Section 2.5.2.

The CG Report instructed that hydrotesting of pipe sections where pipe joints fall within a watercourse be undertaken prior to installation of the pipe sections, however the proposed method of testing welded joints in Section 2.5.1 is considered adequate to verify pipe integrity. Hydrotesting of the pipe sections prior to laying in the watercourse carries the risk of having to maintain an open trench for additional time, increased disturbance associated with additional personnel and equipment to set up hydrotesting on isolated sections of pipe, and the sourcing and discharging of additional hydrotest water.

Watercourse crossing construction method

The four tidal watercourses, which will be crossed utilising the flume watercourse crossing method, which involves the construction of a waterway barrier upstream of the GTP crossing location and diverting flow through a flume laid on the stream bed. The advantages of this proposed watercourse crossing method is limited sedimentation, the ability to maintain stream flow and fish passage. A typical flume watercourse crossing method is detailed in Figure 2.8 and includes:

- Designing the flume pipe so that it is sufficiently sized to be able to take the overload triggered by event based storms
- Installing the flume pipe before any trenching is undertaken



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Santos GLNG Project

Date: 11/07/2012 Version: a

Source: Saipem, 2012. GLNG No: XXXX-XX-XXXX

Marine Crossing GTP EMP

Watercourse Crossing Open Cut Typical Flume Crossing Method: Figure 2.8

- Constructing dams with materials that prevent sediment and other pollutants from entering the watercourse (eg sandbags or clean gravel with plastic liner, sheetpiling)
- Properly aligning flume pipes to prevent bank erosion and stream bed scour
- Maintaining flume throughout trenching, pipe laying, backfilling activities and initial streambed restoration
- Removal of all flume pipes and dams as soon as final clean-up of the streambed and bank is complete

During construction works, the existing bed material will be stockpiled at the locations shown on Figure 2.1, so that it may be placed back into the watercourse at completion of the construction work, in accordance with the SMESCP, the LRMP (refer Appendix C and E, respectively) and the AVMP. If the existing bed material is unable to be salvaged, a comparable sediment sized material will be used in the reinstatement and rehabilitation works.

Watercourse bank protection and reinstatement will be an important component of the proposed watercourse crossing works as they will maintain the hydrological regime of the watercourses and ensure the integrity of the GTP during operation. Bonded fibre matrix will be used to reinstate the banks of all watercourses, except Targinie Creek. Bonded fibre matrix is a highly effective, hydraulically-applied mix which dries to form a seeded erosion control blanket. The banks of Targinie Creek will be reinstated via grass-seeding utilising mulching.

Streambed and bank stabilisation will be completed before returning diverted flow to the watercourse channel. Native cobbles, clean coarse gravel or rock will be placed over the instream area of disturbance to guard against scour. Watercourse bank profile levels will be reinstated so that there will be no impediment to the passage of aquatic fauna.

2.4.6 Pipelaying (trenched areas)

Stringing and bending

Pipe stringing involves laying the pipe out in lengths in preparation for welding. Pipe will be transported for storage at the construction site pad (mainland) via the Access Road (from Forest Road to Point C) (refer Section 2.4.7).

The pipes will be placed on wooden skids in order to elevate the pipe above the ground surface, standing water and mud. Where required, pipe lengths are bent to match changes either in elevation or trenching direction using a hydraulic bending machine.

Welding and coating

Once the pipe is strung it will then be positioned using side boom tractors and clamped for welding. All separated, welded sections of the GTP will be welded into a continuous length after the strings are lowered into the trench. Tie-in connections will be completed by special crews, equipped with all necessary cutting, bevelling and welding equipment.

Following welding and NDT the weld joints will be cleaned by grit blasting and coated with speciality polymer coating.

Lowering and backfilling

Typically, the pipe will be placed directly on the trench bottom without bedding beneath it. When trenching through areas where bedding is required (eg continuous rock or rock-bearing soil) then bedding, shading and padding will be used. The pipe string will generally be located in the centre of the trench, away from trench walls.

The trench will be visually inspected before bedding, padding and backfilling operations commence. Trapped fauna will be removed from the trench by a suitably qualified fauna handler (refer Chapter 10), prior to the lowering-in of the pipe.

The pipe will then be lowered into the trench using side-booms with roli-cradles. The pipe may be supported using foam pillows, or if necessary, soil filled bags. Backfill soils will be compacted to a level consistent with surrounding soils, with the aim of preventing trench subsidence, tunnel erosion and water ponding.

Any subsidence that occurs, including any subsidence occurring during the contract maintenance period, will be rectified. Surplus excavated material will be spread across the ROW in accordance with the requirements of the SMESCP (refer Appendix C).

2.4.7 Pipelaying (tunnel)

Once the tunnel is complete and the TBM removed, the tunnel will be flooded with seawater from a location approved by the administering authority. Pipe strings will be installed in 150 m sections. Pipe stringing, welding and coating will be undertaken as outlined in Section 2.4.6. The pipe strings will be pushed/pulled through the flooded tunnel and welded together at a specified location immediately prior to the tunnel entrance.

Anodes and reference electrodes will be installed within the tunnel as part of the pipeline corrosion protection system.

2.4.8 Construction hours

Tunnelling work will be undertaken seven days per week, 24 hours per day. Tunnel shaft excavations and sheetpiling will also be undertaken seven days per week, 24 hours per day for a period of not more than 60 days between mid December 2012 and mid February 2013 (not withstanding unforeseen weather and/or mechanical delays). The 60 day construction window of the 24 hour activities includes an initial phase of sheetpiling (approximately 15 days in total) followed by mechanical excavation of earth material for the launch shaft (approximately 45 days), continuing through to the commencement of the programmed tunnelling activities. Other works will be undertaken seven days per week, 12 hours per day, from 6.30 am to 6.30 pm with a one hour break.

2.4.9 Proposed plant and equipment

The plant and equipment proposed to be used for construction work are listed in Table 2.11.

Table 2.11 Plant and equipment proposed for construction of the Marine Crossing GTP Project

Activity	Equipment
Establishment of Access Road	Bulldozer D8
	Grader
	Roller
	Water Truck
	Trailer Trucks (material deliveries)
Establishment of Construction site pads	Excavator (30 tonne)
	Loader (CAT 966)
	Grader (same plant as Access Road)
	Roller (same plant as Access Road)
	Tipper (12 tonne)

Activity	Equipment
	Water Truck
	Trailer Trucks (material deliveries)
	Sheet Piling Rig (400 hp)
	Sheet Piling Power Pack (500 hp)
	Welding Rig (65 hp)
	Mobile Crane (100 tonne)
	Concrete Boom Pump
Access to Curtis Island	Barge (AMS 1210)
	Tug Boat
	Crew Transfer Vessel
Tunnel construction	Tunnel Boring Machine
	Locomotives
	Flat Cars
	Segment Cars
	Muck Cars
	Manrider
	Grout Cars
	Tipping Frame
	Ventilation Fan
Equipment located within construction site pad (mainland)	Gantry Crane (25 and 40 tonne)
	Mobile Crane (200 tonne Crawler) – TBM Mobilisation
	Mobile Crane (25 tonne Franna)
	Water Pumps
	Water Treatment Plant
	Grout Plant
	Bentonite Mixing Plant
	Generator (1250 kVA)
	Diesel Welder (405 A)
	Compressor (600 Cfm)
	Mobile Lighting
Equipment located within construction site pad (Curtis Island)	Mobile Crane (100 tonne Crawler)
	Mobile Crane (200 tonne Crawler)
	Mobile Crane (25 tonne Franna)
	Genset (100 kVA)
	Mobile Lighting
Trenching and pipelaying	Excavator modified for stringing
	Side-boom or crane with suitable rigging
	Spreader bar with guide lines at each end
	Bending machine

Activity	Equipment
	Trucks equipped with working tools
	Diesel welding machines
	Backhoe excavators
	Excavators with rock hammers
	Traxcavator (combined excavator and track machine)
	Dewatering equipment
	Dumper trucks
	Trailer trucks
	Roli-cradles
	Padding machine
	Pay welder sets
	Winch
	Thruster
General transport	4WD trucks, utilities and buses

2.4.10 Traffic and transportation

Transportation of pipe from overseas to the Project and Marine Crossing GTP section

The pipe for the Project will be shipped from overseas in 12 m lengths. It will be received by the Contractor at the Port of Gladstone in four ship consignments from December 2011 to September 2012. Unloading of each ship is expected to take four days working 24 hours per day.

Transport of plant, equipment and other construction related materials

Heavy vehicle movements associated with the Marine Crossing GTP Project include the transport of plant and equipment. Plant, equipment and other construction related materials will also be moved on a daily basis from Auckland Point to the construction site pad (mainland).

Transport of tunnel spoil for disposal

GLNG Operations is having ongoing discussion with other Gladstone project proponents regarding receival of the Marine Crossing tunnel spoil. Three potential locations have been identified and negotiations have commenced. There will be sufficient capacity to store up to 24 hours' worth of tunnel spoil within the Marine Crossing GTP Project construction site pad areas. At this stage the tunnel spoil will be transported directly to one of the following three locations:

- The Wiggins Island Coal Export Terminal reclamation area
- Existing Fisherman's Landing reclamation area
- Ash Pond 7 under Gladstone Regional Council management (letter of intent has been received by GLNG Operations)

The final tunnel spoil disposal location will be selected prior to commencing the tunnel construction.

Prior to disposal, tunnel spoil will be tested to meet the disposal locations requirements. Any ASS will be managed in accordance with the ASSMP (refer Appendix A). It is expected that tunnel spoil will only contain ASS in the upper section of the TBM launch shaft and PASS through the bored tunnel under the intertidal area and The Narrows.

Tunnel spoil that contains ASS will be transported to the ASS treatment area located within the construction site pad (mainland). Once this material has been treated and tested it will then be transported to the disposal location.

Existing barge landing facility on Curtis Island

All pipe, plant and equipment for the Curtis Island section of the Marine Crossing GTP Project will be transported from Fisherman's Landing via barge to an existing barge landing located at Laird Point. An existing access track will be utilised from the barge landing to the construction site pad (Curtis Island).

Transport along the ROW and access tracks

All access to and from the access tracks and ROW on the mainland and Curtis Island will be via washdown facilities in accordance with the PWMP (refer Appendix B).

Transport of construction personnel

The total Project peak workforce is expected to be approximately 900 (850 contractors and 50 GLNG staff). Of this total, it is expected that approximately 90 personnel will be working on the Marine Crossing GTP Project at its peak.

Construction of the Marine Crossing GTP Project will occur 12 hours per day, seven days per week, with the exception of tunnel shaft excavation, including sheetpiling and tunnelling works, which will be undertaken on a 24 hour basis.

Construction personnel that operate on a fly-in/fly-out basis will use commercial flights to gain access to Gladstone and Rockhampton airports. Construction personnel will then be transported to and from the airports in project vehicles, including buses. A ferry service will be used to move personnel between Curtis Island and the mainland.

Daily movement of construction personnel from housing provided in Gladstone to the Marine Crossing GTP Project will be via dedicated buses. When construction personnel are required at the construction site pad (Curtis Island) a ferry service located at the Port of Gladstone Marina will be used to transfer them across to the existing barge landing located on Curtis Island. The ferry service will run in the morning and at the end of each day to coincide with completion of daily works. The existing barge landing facility at Graham Creek on Curtis Island will not require upgrading.

Landing craft transport barges (48 m) will be used for material and equipment haulage, as well as for the transfer of construction personnel. Vessel types and movements will be in accordance with the requirements of GLNG Harbour Management Plan and the Maritime Safety Management Plan.

The dedicated buses will have a capacity ranging from 17 to 50 seats. Once onsite construction personnel movement within the Marine Crossing GTP Project will be predominately by 4WDs and buses.

2.4.11 Construction waste

The construction process is not expected to generate large quantities of non-reusable or non-recyclable materials. The anticipated waste streams from the construction process include:

- General waste
- Recyclable waste such as paper, cardboard, plastics, glass, aluminium and timber
- Putrescible waste
- Medical and first-aid waste
- Scrap metals
- Sanitary waste
- Hydrotest water
- Waste oils and chemicals
- Regulated waste
- Tunnel spoil

The management of these waste streams is discussed in Chapter 14 and the WMP (Appendix G).

2.5 Testing and commissioning

2.5.1 Welded joint testing

Once the pipe is strung and welded, the integrity of pipe strings will be verified by non-destructive testing of all weld joints by 100% radiography or ultrasonic testing. If any defects in the welded joint are identified, these will be corrected at this point.

2.5.2 Hydrostatic testing

Pipe integrity will be verified by hydrostatic testing (hydrotesting). Hydrotesting will be undertaken in accordance with the Hydrotest Management Plan (HTMP) which has been developed by the Construction Contractor and will be finalised prior to construction.

During the hydrotesting process the pipeline will be sectionalised based on elevation limits and the ends of each pipe section being capped with test headers. Each pipe section will be filled with clean water and pressurised. A strength test will be undertaken where the pressure is maintained for a minimum of 2 hours to verify the ‘as built’ strength of the pipe. The pressure will then be lowered slightly for the 24 hour leak test to confirm that there are no leaks. The section is then depressurised. Following dewatering, a number of test sections will be joined together and final cleaning and drying will take place to remove any residual water or fine debris. Hydrotesting will be undertaken in accordance with the HTMP.

Hydrotest water is planned to be sourced from bores to the west in the Arcadia Valley or near Bauhinia Downs and will be recycled from one section of the Project to another. Once the Mainland GTP has been tested, the water will be transferred to the construction pond located within the construction site pad (mainland). This pond will have a capacity of approximately 15,000 m^3 and will be built fit for purpose. On completion of the hydrotesting, the water will be recycled for testing the Curtis Island GTP.

On completion of hydrotesting the Santos GLNG GTP, the hydrotest water will be monitored and released from the construction pond as detailed in Chapter 15 (refer Section 15.4). The hydrotest water is expected to be essentially freshwater. No biocide or corrosion inhibitors will be used during the hydrotesting process and water will be tested and treated as required.

Cleaning and commissioning

After completion of hydrotesting the Santos GLNG GTP will be dewatered, cleaned and dried such that:

- All water is removed and drained to land in accordance with the HTMP
- The entire internal surface area is dry and protected from the prevailing atmospheric conditions
- The section is substantially free of residual dust

Commissioning of the Marine Crossing GTP will be undertaken at the completion of hydrotesting, cleaning and drying of the entire Santos GLNG GTP.

2.6 Post construction rehabilitation and decommissioning

On completion of construction, the Marine Crossing GTP ROW will be rehabilitated in accordance with the LRMP (refer Appendix F).

The rehabilitation process will commence at the construction site pads, the ASS treatment area, weed washdown facility, and the Access Road once all GTP construction activities have been completed and the pipeline has been installed and commissioned.

The Marine Crossing tunnel will be flooded with sea water prior to the pipeline being pushed/pulled through. Following tie-in of the pipeline, the TBM launch shaft and TBM receptor shaft will be plugged and backfilled.

All machinery will be demobilised from the construction site pads along with all offices and workshops. The grout plant, generators, water treatment plant and gantry crane will be disassembled and demobilised.

Any concrete slabs and foundations on the surface will be broken up with an excavator using a rock breaker attachment and the rubble trucked off site and recycled. Any imported fill and aggregate will be removed and trucked off site and the area reshaped to match its original profile. The stockpiled topsoil will be respread over the ground and the site rehabilitated in accordance with the LRMP.

2.6.1 Decommissioning

The Marine Crossing GTP has a design life and an expected operation life of 42 years. At Project closure, it will be decommissioned or reused in consultation with regulatory authorities and other potential users.

In the event that the Santos GLNG GTP is no longer required, it will be decommissioned in accordance with the legislative requirements of the day, AS2885 and the APIA Code of Environmental Practice (APIA, 2005) or equivalent at that time.

2.7 Operation

The operation of the Marine Crossing GTP will be in accordance with the EA conditions, the Project's Health, Safety and Security Management Plan (HSSMP) (document number 3380-SAIP-4-1.2-1836), AS 2885, the APIA Code of Environmental Practice 2005 and the OMP. The OMP will be developed prior to operation and implemented in the operation and decommissioning phases of the Project.

The OMP will include a maintenance programme that will include leak detection and external coating surveys, ground and/or aerial patrols, repair or replacement of faulty/damaged components, internal cleaning of the GTP, corrosion monitoring and remediation, and easement and lease area maintenance.

Aerial and/or ground inspections will include checking for encroachment activities close to the Marine Crossing GTP corridor, discolouration of vegetation which can be an indicator of a gas leak, detection of erosion, monitoring of rehabilitation success and detection of weed species.

Monitoring of the cathodic protection system (required for steel pipes in corrosive marine environments) will be undertaken in accordance with the requirements stipulated in the OMP. The frequency of monitoring to be included in the OMP will be determined during the development of the detailed operating procedures and detailed design (prior to commencement of operation).

The operational workforce for the Project (including the Marine Crossing GTP section) is anticipated to be between 15 and 20 persons. This crew will be responsible for undertaking the operational and maintenance activities as described above. Further details of the key operational and maintenance activities are provided below.

Operational monitoring

The Marine Crossing GTP section is to be monitored remotely from a gas control centre via a SCADA system located at the LNG facility.

Ground patrols

Ground control inspections will be carried out along the pipeline ROW by vehicle and foot patrols to check on the condition of the ROW and identify any activities that may have the potential to impact on the integrity of the pipeline. The frequency of these inspections will be stipulated in the OMP. The inspections will also be undertaken as per the monitoring and auditing measures stipulated in the OMP.

Additional patrols will be undertaken after heavy storms or significant events to check for damage to the pipeline. In particular, low level remediation for erosion, subsidence and weeds is likely to be necessary primarily during the first 12 months following construction.

Aerial surveillance

Aerial patrols will be undertaken along the Marine Crossing GTP ROW in accordance with the programme stipulated in the OMP.

Internal pipeline inspection

Internal pipeline inspections are required to monitor the integrity of the pipe which will be carried out by intelligent pigs on an as-required basis.

Cathodic protection surveys

A cathodic protection system is required to protect the pipe and it will be installed along the length of the Marine Crossing GTP, and will be checked in accordance with the requirements to be stipulated in the OMP. The tunnel pipe sections will be protected with a sacrificial cathodic protection system.

Issue specific monitoring

The OMP will identify areas that require a high level of monitoring. These areas will be incorporated into the operational monitoring programme.

Special ground, marine and/or aerial patrols may be undertaken after heavy storms or earthquakes to check for damage to the ROW.

2.8 Relevant stakeholders

There are a number of stakeholders that will be both directly and indirectly affected by construction and operation of the Marine Crossing GTP. The land located above the high-water mark directly affected by the ROW on the mainland and Curtis Island is freehold land. The land tenure of the Marine Crossing GTP Project below the high-water mark between Point C and Point D, where it passes beneath The Narrows, is unallocated state land administered by DNRM. DNRM also administer the watercourses within the ROW.

Relevant stakeholders include:

- Government (local and State in their capacity as both regulator and land owner in some cases)
- Relevant Aboriginal groups and Traditional Owners
- Other proponents
- Parties requiring crossing agreements
- Infrastructure providers

As the Marine Crossing GTP is to be constructed beneath the bed of Port Curtis, it will not have any impact on coastal shipping or recreational boating activities in Port Curtis.

2.9 Proposed Level 1 Chapter 5A and Chapter 4 activities

This EMP supports an application for a Level 1 EA for Chapter 5A activities. The Marine Crossing GTP section falls into item 8, a petroleum activity that includes Chapter 4 activities or environmentally relevant activities (ERA). Details of the Level 1 Chapter 5A and Chapter 4 activities that may be triggered as a result of the Marine Crossing GTP Project activities are provided in Table 2.12.

Table 2.12 Level 1 Chapter 5A and Chapter 4 activities

ERA	Comment
3. A petroleum activity that is likely to have a significant impact on a category A or B environmentally sensitive area	The Marine Crossing GTP will impact on Category B and C Environmentally Sensitive Areas as detailed in Chapter 1 (Table 1.5)
8. A petroleum activity, other than a petroleum activity mentioned in items 1 to 7, that includes a chapter 4 activity for which an aggregate environmental score is stated	The GTP is a petroleum activity that will involve a number of Chapter 4 activities listed in Schedule 2 (refer activities described below)
Schedule 2, Activity 8 – Chemical Storage	Fuel will be stored on the launch and receiving pads Other chemicals to be stored and used during construction but below the ERA 8 threshold include, fertilisers, herbicides, oils and greases, waste oils, paint, fusion bond epoxy powder, polyurethane tar coating compound, oxygen scavenger, biocide, radioactive isotope/material/element within weld inspection device (pipe crawler), wastewater treatment plant chemicals All chemicals stored in accordance with Australian Standards (AS 1940 – The storage and handling of flammable and combustible liquids; AS 3833 – The storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers; AS 3780 – The storage and handling of corrosive substances)

ERA	Comment
Schedule 2, Activity 16 – Extractive and screening activities	Extractive and screening activities that consist of more than 5,000 t of material in a year from an area other than a wild river area, that is not extracted through dredging activities
Schedule 2, Activity 17 – Abrasive blasting	Pipe joints, welds and pipe ends and possibly cold pipe bends may require abrasive blasting to remove rust and scale prior to welding
Schedule 2, Activity 18 – Boilermaking or engineering	Engineering consisting of assembling metal product
Schedule 2, Activity 38 – Surface coating	Pipes will be coated with a corrosion protection substance
Schedule 2, Activity 43 – Concrete batching	Grout will be batched onsite for tunnelling activities
Schedule 2, Activity 47 – Timber milling and wood	Some timber removed from the ROW may be milled or chipped as part of project activities
Schedule 2, Activity 50 - Bulk material handling	Loading and unloading of pipes and other construction material will occur as part of project works

Source: EP Reg; http://www.legislation.qld.gov.au/LEGISLTN/SLS/2008/08SL370.pdf

2.10 Notifiable activities

The following Notifiable Activities may occur as a result of construction of the Marine Crossing GTP:

1 Abrasive blasting—carrying out abrasive blast cleaning (other than cleaning carried out in fully enclosed booths) or disposing of abrasive blasting material

7 Chemical storage (other than petroleum products or oil under item 29)—storing more than 10 t of chemicals (other than compressed or liquefied gases) that are dangerous goods under the dangerous goods code

23 Metal treatment or coating—treating or coating metal including, for example, anodising, galvanising, pickling, electroplating, heat treatment using cyanide compounds and spray painting using more than 5 L of paint per week (other than spray painting within a fully enclosed booth)

29 Petroleum product or oil storage—storing petroleum products or oil:

(a) in underground tanks with more than 200 L capacity

(b) in above ground tanks with;

(i) for petroleum products or oil in class 3 in packaging groups 1 and 2 of the dangerous goods code—more than 2500 L capacity

(ii) for petroleum products or oil in class 3 in packaging groups 3 of the dangerous goods code—more than 5000 L capacity

(iii) for petroleum products that are combustible liquids in class C1 or C2 in AS 1940, 'The storage and handling of flammable and combustible liquids' published by Standards Australia—more than 25000 L capacity

2.11 Cumulative impacts

The approach taken in assessing the cumulative impacts is aligned with the conditions outlined in the CG Report (Queensland Government, 2010a). It aims to identify potential cumulative impacts related to the Marine Crossing GTP as part of the identification of management measures which have a multi-project component. In doing so it considers the following:

- Sensitive receptors (Environmental Values): stated receptors of defined sensitivity upon which impacts may be caused
- Project scope/assessment scenario: the combination of projects being assessed
- Temporal scope: time period over which impacts are assessed and extent to which overlapping or contiguous timeframes for different projects contribute to cumulative impacts
- Geographical scope: geographical extent of the assessment of direct and indirect impacts
- Cumulative impacts: as defined in the CG Report
- Cumulative impact mitigation: Specific measures for mitigating cumulative impacts (as opposed to those for standalone projects)

2.11.1 Sensitive receptors

The Environmental Values are taken as the starting point for identifying the cumulative impacts. The receptors affected by cumulative impacts are described and assessed in full in the relevant sections of this EMP.

2.11.2 Temporal scope

This assessment considers a construction only scenario which considers both the cases of maximum likely intensity (ie greatest project overlap) and maximum likely duration. Programme information available in the public domain is high level and with conservative timescales for activities for each scheme.

2.11.3 Geographical scope

As noted in Chapter 1, the Marine Crossing GTP Project is part of a larger linear development. This EMP covers one section with defined start and finish points. Therefore this assessment covers the terrestrial and tunnel elements of the Project footprint between Point A on the mainland and Point E on Curtis Island and indirect impacts resulting elsewhere from Project activities.

The geographical scope is based on the spatial extent of the potential impacts and the area within which the Project interacts, including:

- The footprint of the development
- Downstream/tidally connected water bodies influenced by construction activities
- Habitat of fauna outside these areas influenced by activities in areas above through severance of migratory pathways

As the Marine Crossing GTP represents only a very small fraction of the economic and social activity associated with the overall Project construction works, it is not possible to isolate the economic and social effects of the Marine Crossing GTP component and are therefore included in the effects of the broader Project. Consequently potential social, economic and community impacts on populations outside the construction footprint and immediately adjacent areas are not considered in this EMP.

2.11.4 Cumulative impacts identification approach

Impact identification

Identification of cumulative impacts has involved the following steps:

- Establish a distinct scenario for the assessment
- Identify the activities within each scenario in aggregate as distinct from each project, and establish the temporal scale for when these activities occur
- Identify the impacts that result from each activity and where the similar impacts result from different activities
- Identify receptors (or categories of receptors) that are affected by each impact
- Evaluate the impacts on receptors

Impact scoring

This EMP contains a qualitative assessment using a matrix based comparison of Project activities, timescales and impacts with environmental values using professional judgement and reference to previous studies. The specific cumulative impact assessment for each of the environmental parameters is contained within the relevant chapters.

An indicative evaluation of the impact is undertaken based on the magnitude of impact (ie the size of the potential change to the environment resulting from the Project) and the sensitivity of the affected receptor. The approach to scoring of impacts is displayed in Table 2.13 and has been used throughout the cumulative impact sections of this EMP.

Table 2.13 GLNG Cumulative impact scoring

Significance	Description	Matrix indicator
Major negative	Widespread, prolonged and/or large magnitude impacts affecting the quality or viability of a receptor at a state or national level. Should be avoided or eliminated wherever possible, and otherwise offset or fully compensated. Plans of specific mitigation and targeted monitoring program are included in the EMP	***
Moderate negative	Locally widespread and/or moderate magnitude impacts affecting quality or viability of a receptor at a Regional or local level. Plans of specific mitigation and targeted monitoring program are included in the EMP	**
Minor negative	Localised, short term and/or low level impacts managed by standard environmental management practices and routine monitoring	*
Negligible	No measurable impacts following implementation of standard measures	N
Positive	Impacts where a beneficial impact on the receptors are anticipated	+
Permanent	Impacts that are effectively permanent	(P)

3. Environmental compliance management system

3.1 Environmental management

The Marine Crossing GTP EMP is to provide sufficient information for the administering authority to evaluate the Project in relation to the regulatory requirements of the EA for the PPL. Hence this EMP is aligned with the Queensland Government guidelines: *Preparing an Environmental Management Plan for Coal Seam Gas (CSG) Activities* (DERM, 2010b).

This EMP has also been developed in order to provide guidance to achieve compliance of the Marine Crossing GTP Project for the EA.

Not all the impacts from the Marine Crossing GTP Project are known at this time, especially location specific design detail. This EMP recognises that there is a continuous improvement process that leads from concept design to the detailed design. This EMP provides the values and commitments which are to inform the detailed design, construction and operation of the Marine Crossing GTP. The detailed design will inform the construction methodology and also the method of operation and maintenance. Figure 3.1 illustrates the environmental documentation process adopted for the Project.

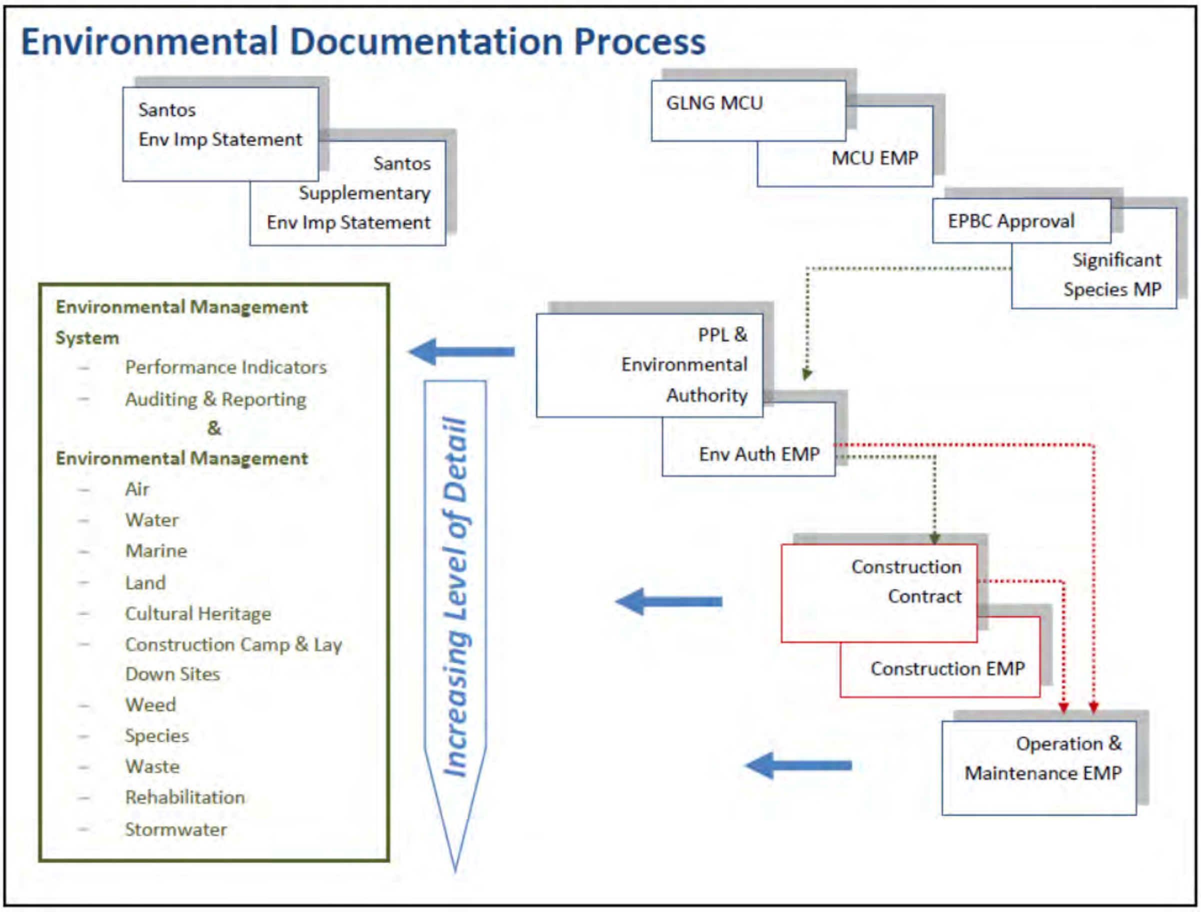


Figure 3.1 Environmental documentation processes

This EMP identifies the following for the Marine Crossing GTP Project:

- Primary environmental values
- Potential environmental impacts
- Associated mitigation and management measures

This EMP also identifies:

- Who is responsible (refer Section 3.3)
- What the performance criteria for measuring the achievement of objectives are
- When monitoring and reporting against objectives occurs (refer Section 3.6)
- Where/why monitoring occurs
- What the triggers for corrective action are

3.2 Health, safety and security

A HSSMP has been developed and describes GLNG Operations' personnel and Construction Contractor's responsibilities for managing health, safety and security issues during the construction and operation of the Marine Crossing GTP. This is the primary document for the overall management of health, safety and security matters. The purpose of the HSSMP is:

- To clearly detail the health and safety objectives and expectations and provide guidance for GLNG Operations' and Construction Contractor's personnel in satisfying them
- To list personnel responsibilities (or reference associated documents in which these are detailed)
- To document the methods by which health, safety and security issues shall be identified, communicated and managed
- To list the systems, processes, tools, risk controls and mitigation measures to be used in achieving the health, safety and security objectives

This HSSMP will be progressively updated by GLNG Operations' Health, Safety and Security Manager as the risk profile of the Project changes and as new relevant information becomes available to ensure that potential hazards and impacts are understood and addressed.

The HSSMP is a working document that will be revised and reissued as necessary.

3.3 Roles and responsibilities

GLNG Operations' personnel and Construction Contractor's personnel will be responsible for implementing this EMP in a manner which complies with all relevant environmental standards, adheres to all legislative requirements and ensures that all environmental objectives associated with the work are achieved.

Contract documents for the detailed design, construction, maintenance and operation will include the environmental commitments in this EMP, as well as requiring compliance with the EA, design and construction specifications, technical drawings and the general environmental duty.

All personnel are responsible for the environmental performance of their activities and for complying with the EP Act, and also have "stop task" and "stop work" authority where there is potential environmental harm caused or threatened. Specific environmental responsibilities assigned to organisational roles, as they are relevant to the Marine Crossing GTP Project, are detailed in Table 3.1.

Table 3.1 Specific environmental responsibilities

Position	Overview
GLNG Operations Pipeline Project Manager	The GLNG Operations Pipeline Project Manager is ultimately responsible for the standard of management, including environmental management. To assist in fulfilling this responsibility, the GLNG Operations Pipeline Project Manager is supported by a series of specialised personnel
Construction Manager	The Construction Manager is responsible for all construction activities including planning, procedure approvals and execution of work. The Construction Manager is also responsible for ensuring that adequate provision is made for compliance activities
Engineering Manager	The Engineering Manager is responsible for generating the design drawings and specifications consistent with the EMP and AS2885
Pipeline Construction Superintendent	The Pipeline Construction Superintendent will direct work in a manner that complies with all relevant environmental procedures; adheres to all legislative requirements and ensures that all environmental objectives associated with the Project are achieved. The Pipeline Construction Superintendent has “stop task” and “stop work” authority
Environmental Manager	The Environmental Manager will direct work in a manner that complies with all relevant environmental procedures; adheres to all legislative requirements and ensures that all environmental objectives associated with the Project are achieved. The Environmental Manager has “stop task” and “stop work” authority
Construction Contractor	The Construction Contractor is responsible for ensuring compliance with this EMP and the development and implementation of a specific CEMP. This will include training of personnel (refer Section 3.5), provision and maintenance of equipment, facilities and associated services and consumables and the monitoring of compliance to this EMP

3.4 Project specific documentation

3.4.1 EMP

This EMP provides specific guidance for each of the environmental aspects potentially affected by the Marine Crossing GTP Project in each of the EMP Chapters (Chapters 5 to 16 of this document). Performance criteria, control measures, monitoring, reporting, corrective action and review relevant to each environmental aspect has been identified.

A number of key management plans have been developed as part of this EMP.

This EMP and the relevant key management plans form the foundation for the development of:

- The EPC Contract
- The CEMP
- The OMP (refer Figure 3.1)

3.4.2 Key management plans

There are a number of key management plans that have been developed for the Project with the purpose of guiding the management of specific environmental aspects and issues, and the implementation of specific mitigation measures and controls. The key management plans that are applicable to the Marine Crossing GTP Project are summarised in Section 3.4.2.1 to 3.4.2.12, below.

3.4.2.1 ASSMP

An ASSMP has been prepared which details typical control measures that will be implemented to mitigate any ASS encountered during the construction of the Marine Crossing GTP Project (refer Appendix A).

3.4.2.2 PWMP

A PWMP has been prepared which details the requirements for the management of pests and weeds associated with the construction of the Project (refer Appendix B). It outlines pest and weed management protocols for the various stages of the Project to ensure all construction activities (surveys, landholder access, site visits, infrastructure upgrades and preparation) do not transfer Class 1 or Class 2 weeds from areas currently infested to new "clean" areas.

3.4.2.3 SMESCP

A SMESCP has been prepared which details typical control measures for the management of stormwater, erosion and sediment impacts associated with the Marine Crossing GTP Project (refer Appendix C).

3.4.2.4 DHWLRMP

A concept DHWLRMP has been prepared which specifies procedures and criteria for the management of dewatering activities associated with trenching, tunnel shaft construction and bored tunnelling by TBM. In addition it also specifies management procedures and criteria for hydrotest water and land release limits and locations (refer Appendix D).

3.4.2.5 LRMP

A LRMP has been prepared which specifies criteria and standards for rehabilitation and monitoring of all areas impacted by the Project (refer Appendix E).

3.4.2.6 WMP

A WMP has been prepared which specifies criteria and standards for the management of waste for the Project, including the Marine Crossing GTP Project (refer to Appendix F).

3.4.2.7 MMMP

A MMMP has been prepared which outlines measures for the control of mosquitos and biting midges whose populations could increase as a result of the Marine Crossing GTP Project (refer to Appendix G).

3.4.2.8 SMP

A SMP has been prepared which addresses the impacts to affected flora and fauna species (regardless of status) and habitat, and aims to provide for the survival of the species in the wild and achieve a net conservation benefit for the species. The SMP (document number 3380-GLNG-3-1.3-0036) has been submitted to DEHP for approval.

3.4.2.9 SSMP

A SSMP has been prepared. The SSMP includes details of the specific mitigation measures for the mitigation or offsetting of all impacts to significant flora and fauna species in accordance with the CG Report. The SSMP (document number 3380-GLNG-3-1.3-0031) will be provided to DEHP for approval prior to construction commencing.

3.4.2.10 SIMP

A SIMP has been developed which outlines measures to reduce any potential adverse impacts that the local community may be subjected to as a result of the proposed work. The SIMP has been submitted for review by DLGP, Communities Branch.

3.4.2.11 CEMP

A CEMP has been developed to address the Construction Contractor's responsibilities and obligations for the management and protection of environmental values and potential adverse impacts of the Project during construction activities.

3.4.2.12 Operational management plan

An OMP will be developed during detailed design and prior to completion of construction. The OMP will include a summary of Project, legal and community requirements and the responsibilities of all levels of personnel involved with the Project, along with guidance on the management of environmental impacts during operational activities.

3.5 Induction and training

GLNG Operations' personnel, Construction Contractors and visitors are required to undertake relevant environmental training and induction programs. Personnel will not be allowed to access the Project sites unless properly trained. Competency requirements and training results from the assessment of all personnel will be identified and recorded, respectively.

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 this EMP. They will also be responsible for identifying additional training and competency requirements.

All staff will complete a comprehensive Project induction. The induction will include a comprehensive review of environmental requirements and standards, safety, and access protocols, including fire safety awareness training. All supervisors and managers will have additional detailed training on the use and implementation of this EMP.

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. Any environmental issues will be captured and reviewed through a hazard identification system.

3.6 Environmental monitoring

Monitoring programs will be undertaken in accordance with this EMP. Routine environmental monitoring of the Marine Crossing GTP Project will be conducted to ensure compliance with performance standards. Monitoring, undertaken by personnel and specialist service providers, will be periodically conducted in accordance with site-specific management plans.

Specialist studies to investigate particular aspects of the environment (eg flora and fauna, weeds, hydrological risk) will be periodically commissioned when a need is determined during environmental review and risk assessment.

Suitably qualified, experienced and competent person(s) will conduct all monitoring required for each of the monitoring programmes implemented under the specific management plans. All monitoring results will be recorded, compiled and kept for a minimum of five years and made available for inspection upon request from the relevant administering authority.

Long term monitoring programmes (extending into operation and decommissioning phases of the Project) will be implemented in accordance with the specific management plan through the OMP.

Monitoring results relating to rehabilitation will be kept until the relevant petroleum tenure is surrendered.

The weed control programme will consist of the following strategies:

- Vehicle and equipment washdowns
- Record keeping
- Close monitoring
- Spraying
- Vehicle stickers
- Training
- Management of vehicle movements

An Annual Environmental Return will be prepared for the monitoring, compliance and environmental performance of the Project in relation to the EPBC Act Controlled Action Approval conditions and will be submitted to SEWPaC within 20 calendar days of the anniversary date of the EPBC Act Controlled Action Approval.

An Annual Return will be prepared for the monitoring, compliance and environmental performance of the Marine Crossing GTP Project in relation to the EA and submitted to the administering authority (DEHP) in accordance with the EA conditions.

3.7 Reporting, recording and auditing

During construction and operation, compliance audits will be conducted in accordance with the requirements of this EMP as well as construction procedures, relevant legislation, license and permit conditions and industry standards. To ensure stakeholders are adequately informed of relevant Environmental, Health and Safety (EHS) performance, reports, where necessary will be prepared for internal and external stakeholder review through the GLNG Operations reporting process.

All inspection and audit reports of environmental performance will be stored in GLNG Operations' electronic database which will be implemented to record incidents, complaints and audit findings and enable corrective actions identified during the inspection/auditing process to be recorded, tracked and closed out. Third party audits will be conducted to determine compliance and the reports from these audits will be provided to the CG and SEWPaC. These documents will be published on the internet. In order to comply with SEWPaC requirements, prior to beginning the audit process, the independent auditor and the audit criteria will be submitted for approval by SEWPaC.

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

- During construction, the Construction Contractor will be required to report on environmental compliance and incidents, on a monthly basis, and corrective actions processes established/implemented
- During construction, internal audits will be undertaken at regular intervals to verify that all work is proceeding in accordance with this EMP
- A post construction audit of the Marine Crossing GTP Project will be conducted annually for two years following completion of construction to evaluate revegetation, erosion controls and soil stability, weed control, watercourse equilibrium and success of bed and bank re-profiling

- GLNG Operations will act upon any matters contained within the audit report and record the findings in the database to facilitate and investigate close out and remedial actions as appropriate
- Following the submission of the audit report, GLNG Operations will provide written advice to the administering authorities for review and will address the following:
  - Actions taken to ensure compliance with the conditions in the CG Report
  - Actions taken to routinely prevent a recurrence of any non-compliance issues
- When first becoming aware of a non-compliance, the Construction Contractor will:
  - Undertake action to bring the matter into compliance within an effective time frame
  - Report the non-compliance and remedial action(s) to GLNG Operations, who will report to the relevant administering authorities within the specified timeframe
- Environmental incidents (including complaints) will be recorded on a database and addressed. Each incident will be investigated to determine the underlying causes and actions to prevent recurrences.
- Environmental complaints that are not resolved within the specified timeframes will be escalated in accordance with GLNG Operations reporting processes and stakeholder engagement throughout this process will be conducted in accordance with the SIMP

The financial cost of the audit will be borne by GLNG Operations.

SEWPaC and DEHP will be notified of non-compliance with statutory approvals within the specified timeframe(s).

3.8 Emergency response

GLNG Operations recognises that emergencies arising from activities could have serious and long term health and safety effects. GLNG Operations will develop and implement an ERP to address emergency situations at the operating sites, premises and relevant functional locations. The ERP will outline the emergency procedures and describe the organisation, defining members, tasks, responsibilities and roles of the emergency response team. The ERP will include the following:

- Information outlining the connection to relevant legislation, specific EMP Chapters and the key management plans applicable to the Marine Crossing GTP Project
- Inclusion of the District Officers from the local police districts to represent the Queensland Police Service (QPS) as a stakeholder when developing the ERP
- Communication and coordination with the District Disaster Management Group regarding the Project
- Development of a response, investigation, command, control and recovery for both natural disasters and other disasters/emergencies and incidents
- Engagement with QPS and other agencies in emergency response exercises
- Response procedures in the event of a fire, chemical release, spill, leak, explosion, equipment failure, bomb threat, natural disaster (including cyclone, severe storm and flood events) or any other likely emergency
- Communication arrangements and contact details for key roles and responsibilities
- Roles and responsibilities of responsible personnel
- Emergency controls and alarms
- Evacuation procedures
- Emergency response equipment
- Leak detection and control points
- Training requirements
- Site access and security

4. Financial assurance

The FA for the Marine Crossing GTP Project has been prepared in accordance with the former DERM guideline *Financial assurance for chapter 5A activities* (DERM FA Guideline) (DERM, 2011a) using quantities determined from this EMP.

4.1 Background

Under Section 312O of the EP Act, the administering authority may require the giving of FA in a stated form or amount.

The purpose of the FA is to provide security for compliance with the environmental authority and certain costs and expenses.

The proposed amount of FA for the Project is:

- Calculated on a whole Project basis (ie may cover several petroleum activities on one or more petroleum authorities)
- Based on estimates for the work to be completed by third party contractors. This will ensure that the total cost of rehabilitation is specific to the site and is a realistic estimate of the cost expected to be incurred by government should it be required to rehabilitate disturbed areas (the estimates cover the full extent of work necessary to meet the conditions of the EA).
- Estimated using the former DERM FA Guideline (DERM, 2011a)

The main components of the schedule of disturbance that contribute to the annual rehabilitation costs are:

- The Total Rehabilitation Cost – which is the sum of the rehabilitation costs [R] for each type of disturbance and partly rehabilitated areas. The costs are calculated using the formula below:
  - Rehabilitation Cost [R] = Unit Rehabilitation Cost [C] x Disturbed Area [A]
  - C = the unit rehabilitation cost (ie the cost per unit area to complete rehabilitation for each type of disturbed or partially rehabilitated area)
  - A = maximum significantly disturbed area for each type of disturbance (eg evaporation pond) proposed during the period of the work program or development plan, including any carryover of existing significant disturbance at commencement of program or plan

Consumer Price Index (CPI) – has been incorporated into the estimate of FA to cover inflation for the term of the work program or development plan.

Goods and Services Tax (GST) – rate of ten (10) percent on all taxable supplies listed above that do not include GST in them.

The amount of FA that is required is defined as the maximum total rehabilitation cost for complete rehabilitation of all disturbed areas, and may vary on an annual basis due to progressive rehabilitation. The amount required for the FA must be the highest total rehabilitation cost calculated within the period covered by the work program or development plan.

4.2 Project specific financial assurance

Santos retained EHS Support, Inc. (EHS Support), a US-based environmental consulting firm with FA cost estimation experience, to develop a FA estimate for the Marine Crossing GTP Project. The FA estimate for the Project is based on a combination of contractor bids for specific tasks developed as part of the Mainland GTP Project FA process and engineering estimates developed by EHS Support using third-party unit rates.

The Marine Crossing GTP Project FA estimate has been developed based on the discrete phases of the construction and operation of the Marine Crossing GTP Project. Detailed cost estimates have been developed for the following phases of the Marine Crossing GTP Project:

- Phase 1 - Mobilisation, setup and construction. This phase includes establishment of site facilities, trenching, pipe installation, trench backfilling, removal of spoil, ROW rehabilitation, rehabilitation of laydown and pipe stringing areas and removal of Construction Contractors' equipment
- Phase 2 – Abandonment of the Marine Crossing GTP and monitoring (prior to commissioning). For this phase, costs have been included to allow for the future use of the Marine Crossing GTP (including nitrogen purge and maintenance of cathodic protection) and then cut capping and slurry filling of the pipeline
- Phase 3 – Formal abandonment of the Marine Crossing GTP following commissioning, involving purging, cutting and capping of the Marine Crossing GTP at the entry and exit to the tunnel under the intertidal area and The Narrows and slurry filling of the tunnel entrances

The mobilisation and setup and construction costs are captured in the FA estimates for the other sections of the Mainland GTP and Curtis Island GTP, and are therefore excluded from the FA estimate for the Marine Crossing GTP Project.

Under the standalone HDD and trenching option presented in the GLNG Gas Transmission Pipeline Environmental Authority Application and Environmental Management Plan for the Marine Crossing Gas Transmission Pipeline dated September, 2011 the estimates of the Marine Crossing GTP FA requirements for the phases discussed above were provided as follows:

- Phase 1 – Establishment and active construction (2012) - $4,230,000
- Phase 2 – Abandonment/retention of GTP asset (2013 - 2015) - $294,000 (includes monitoring of restoration)
- Phase 3 – Formal abandonment of GTP Asset (2016) - $88,000

However, In response to the former DERM's (now DEHP) "additional information required" notice pursuant to Section 556 of the EP Act, GLNG Operations reviewed the proposed HDD marine crossing construction methodology and selected an alternative tunnelling option in order to reduce the potential of environmental impacts to the intertidal and marine ecosystems of Port Curtis.

The preferred alternative for the marine crossing involves retention of the open trench method between points A and C (mainland) and points D and E (Curtis Island), and using bored tunnelling construction using a TBM for tunnelling under the intertidal area south of Kangaroo Island and The Narrows. This option has lower risk to sensitive environmental receptors through the reduced intertidal disturbance footprint.

In line with the current proposed construction method, the Marine Crossing GTP Project is comprised of the following sections (refer Figure 2.1) and construction methods:

- Point A to Point C – conventional open cut trenching methods
- Point C to Point D – Bored tunnelling by TBM under the intertidal area and The Narrows from the construction site pad and launch shaft at Point C to the construction site pad and receptor shaft at Point D
- Point D to Point E – conventional open cut trenching methods

In the conventional open cut trenching GTP installation (Marine Crossing Points A to C and D to E), restoration and rehabilitation activities will be comprised of:

- Backfilling of the open trench with treated soils
- Grading and seeding of the Marine Crossing GTP ROW
- Pipe stringing
- Laydown and ASS treatment areas

A detailed description of the Marine Crossing GTP Project and proposed construction methods is provided in Chapter 2.

In the final phase of the Project (Phase 3), one new rehabilitation requirement would be introduced, which would comprise purging of the pipeline and cutting and capping the Marine Crossing tunnel under the intertidal area and The Narrows. This would occur prior to slurry filling of the tunnel launch and receptor shafts and backfilling to grade.

The construction of the Marine Crossing GTP will be conducted sequentially with trench rehabilitation activities. A number of restoration activities may need to be completed over the Project lifecycle. These include:

- Management and disposal of tunnel spoil
- Removal and rehabilitation of the construction site pads
- Removal and rehabilitation of associated construction infrastructure and equipment
- Rehabilitation of the Access Road, ASS treatment area and weed washdown facility

Considering the lifecycle of the Project, estimates of the Marine Crossing GTP Project FA requirements for the phases discussed above are provided as follows:

- Phase 1 – Establishment and active construction - $2,068,873
- Phase 2 – Abandonment/retention of Marine Crossing GTP asset - $993,922
- Phase 3 – Formal abandonment of Marine Crossing GTP Asset - $946,242

The FA estimate will be reviewed and maintained based on the reporting and auditing undertaken to ensure compliance with the conditions of the Project. The FA will remain in force until the DEHP and SEWPaC is satisfied that no claim is likely to be made on the assurance.

Copies of third party rates and cost estimates referred in this section, and signed FA certification form and signed statutory declaration form will be provided to DEHP prior to issuing the EA for Marine Crossing GTP Project.

4.2.1 Key assumption for estimating financial assurance for GLNG Project phases

Key assumptions and inputs for Phase 1

Below are key assumptions and inputs used in the development of the FA estimates for Phase 1:

- All construction will be completed during the course of an 18 month schedule based on the construction plans provided by GLNG Operations
- The construction methodology will comprise initially construction of the construction site pads on mainland and Curtis Island, and launch and receptor shafts, completion of tunnelling and then welding and pulling of the pipeline through the completed tunnel
- The only ASS that will be disturbed will be the spoil generated during the excavation for creation of the launch and receptor shafts and entry and exit points for the TBM. All these soils will be treated on the mainland and Curtis Island for ASS treatment. On completion of treatment and tunnel construction, these soils will be used for grading and backfill in the area
- All tunnel spoil will be trucked from the area as it is generated for either beneficial reuse or landfill disposal. For the purposes of developing a conservative cost estimate it has been assumed that one week of spoil will be stockpiled onsite (actual onsite stockpile is 24 hours) and will require offsite disposal along with the soils excavated from the launch and receptor shafts. Based on the geotechnical properties of the rock under The Narrows it is considered most likely that these materials can be used as structural fill in adjacent construction areas. A unit rate (m3) for ASS treatment was developed using the estimated cost to standard volume of soil (1,600 m3 per day) and the following assumptions:
  - Soil density of 1.7 tons per m^3
  - Lime dosage rate = 40 kgs per tonne at $100/tonne (delivered)
  - Processing rates for treatment of 1,600 m^3/day
- Key project dimensions used to quantify disturbances were developed based on engineering drawings provided by GLNG Operations. These comprised:
  - 42 inch pipeline that will be installed in a 3.4 m internal diameter tunnel which will be constructed
- Pipe stringing will be conducted on the mainland and will be pulled through the tunnel to the Curtis Island. A number of facilities will be constructed on the mainland to support the pipeline installation activities. These include a pipe laydown and stringing areas on the construction site pad
- At Curtis Island, the disturbances will be limited to the construction site pad and receptor shaft established for the tunnel and pipeline construction. Limited soils will be managed on Curtis Island
- Accommodation facilities will be provided using a combination of local accommodation and/or camps that have been established on the mainland
- An environmental investigation will be conducted at the Construction Contractor's fuel storage area at the construction site pads. It is anticipated that a minimum of 25,000 litres of fuel will be stored at each site. Although the construction site pad on Curtis Island will have a fuel storage area, the investigation of this area is covered under the FA estimate for the Curtis Island GTP Project
- Rehabilitation activities at the construction site pads will be completed in this Phase at the completion of the construction activities. This will comprise:
  - Removal of all mobile offices and structures
  - Management and removal of all surplus stockpiled soils and/or spoil
  - Grading and seeding of the site with stockpile soils (including topsoil)

- The value of scrap steel will offset the costs associated with removal of pipe and associated fittings. The cost for these activities has subsequently been set to $0
- Environmental rehabilitation monitoring will commence in 2015, following completion of the construction activities. Five years of monitoring costs have been provided in the Phase 1 cost estimate in the event the Project would be terminated during construction. Management costs are assumed to be at a minimum 10% of the total Project costs. Consistent with the monitoring costs, EHS Support did not cap these costs at $20,000 as this is not considered representative

Key assumptions and inputs for Phase 2 and Phase 3

Below are key assumptions and inputs used in the development of the FA estimates for Phase 2 and Phase 3:

- All rehabilitation activities will have been at the end of Phase 1. Activities during this phase are limited to cutting and capping of the Marine Crossing GTP
- It has been assumed that the Marine Crossing GTP will be cut and capped at two locations on the mainland. One cut and cap location at Curtis Island (at the receptor shaft) has already been provided in the Curtis Island GTP Project estimate. Consistent with industry practices, the remainder of the Marine Crossing GTP will be closed and remain in place, which prevents further disturbances from its removal
- The cost for cutting and capping was based on an engineering estimate assuming cut and removal of a section of the Marine Crossing GTP and capping both ends of the pipe
- No slurry filling of the Marine Crossing GTP is proposed as it is not located under roads or other sensitive infrastructure
- Following cutting and capping of the pipeline the tunnel entrance will be slurry filled to prevent the entry of vermin and soil into the tunnel. It has been assumed that a 30 m long plug of cement will be poured into the tunnel. Following slurry filling native soils will be used to backfill and grade the area to ground surface
- Cathodic protection will be maintained once construction is complete to protect the asset and, if the Project is terminated, until such time as an alternative use can be identified. If no end use of the Santos GLNG GTP can be identified then formal abandonment (Phase 3) will be implemented
- The Santos GLNG GTP will only be charged with gas in Phase 3 and as a result cutting and capping of the Marine Crossing GTP will only require purging of the pipeline in Phase 3
- Environmental rehabilitation monitoring will commence in 2015, following completion of the construction activities
- Management costs are assumed to be at a minimum of 10% of the total project costs. Consistent with the monitoring costs, EHS Support did not cap these costs at $20,000 as this is not considered representative

5. Air quality

5.1 Chapter summary

This chapter outlines existing air quality values within the area surrounding the Marine Crossing GTP Project. A qualitative air impact assessment has been undertaken by SLR Consulting Pty Ltd (SLR) to identify potential sources of air emissions from the construction of the Marine Crossing GTP, and to determine mitigation measures so that adverse air quality impacts do not occur as a result of these activities. The assessment considered the following:

- Existing values of the air environment within and in the vicinity of the Marine Crossing GTP Project
- The nature and scale of activities that may result in release of pollutants to the air
- The location of sensitive and commercial places in relation to the emission sources
- Mitigation measures to reduce the identified potential impacts

5.1.1 Summary of existing air quality values

The climatic conditions and existing values of the air environment within and in the vicinity of the Marine Crossing GTP ROW and associated construction areas include:

- Maximum ground level concentrations have been set for nitrogen oxides (NOx) (as nitrogen dioxide) and carbon monoxide (refer Table 5.5)
- Ambient air quality objectives have been adopted from Schedule 1, Environmental Protection (Air) Policy 2008 (EPP Air (2008)) for total suspended particulates (TSP) and Particles as PM10 (refer Table 5.6)
- The dust deposition guideline adopted by DEHP has been adopted for the Project (refer Table 5.7)
- Rainfall peaks during the summer months, with a maximum average of 195 mm recorded during February, which is associated with an average of 11.6 rain days per month. During the remainder of the year, the rainfall is much lower, ranging from 22 – 61 mm/month.
- Mean maximum temperatures range from 23°C in winter to 31°C in summer, while mean minimum temperatures range from 12°C in winter to 23°C in summer
- Strong winds (>30 km/hr) generally only occur from the east and are more frequent during the afternoon
- The existing air quality environment of the Marine Crossing GTP Project area is influenced by regional air pollutant sources and local industry, including two other LNG plants, with minor contributions from local traffic, construction, rural/cropping activities and oceanic emissions (eg salt spray)
- The closest sensitive receptor (place of residence on an agricultural property) to the Marine Crossing GTP Project is located approximately 2 km from the construction site pad (mainland) located at Point C (refer Figure 5.1)

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road
- Acid Sulfate Soils Treatment Area

Sensitive Receptor
- Community Use
- Industrial
- Residence
- Ambient Noise Monitoring Locations

Source:
Gas Transmission Pipeline (GTP): Santos, Mar 2012.
Aerial: Santos, Feb 2011.
Sensitive Receptors: Downes, Apr 2012.

Sensitive Receptors
Figure 5.1

A1 scale: 1:25,000

0 500 1,000 1,500 2,000 2,500 m

GLNG No: 3381-40-0553

Coordinate system: GCS_GDA_1994

Date: 20/06/2012

Version: d

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_066.mxd 20/06/2012 15:37

5.1.2 Summary of potential impacts on air quality

Construction

Dust emissions can occur at any point where soil, fill, rock and vegetation are handled, traversed, crushed, conveyed or open to erosion by the wind. The rate of emission of dust from construction activities will vary with activity, soil type, soil compaction, production rate, any recent rain and prevailing wind conditions and humidity levels. Wind data for the Gladstone area (refer Figure 5.4 and Figure 5.5) indicates that moderate to strong easterly and northeasterly afternoon winds may be expected and may blow any air emissions generated by construction activities towards the nearest sensitive receptor (refer Figure 5.1).

A large portion of the construction work associated with the Marine Crossing GTP Project will occur below ground. The construction of the Marine Crossing tunnel will involve the progressive excavation, handling and stockpiling of tunnel spoil at the construction site pad (mainland). This spoil will be moist in nature due to the operating mode of the TBM.

Odours may be generated during the excavation, handling and treatment of ASS due to the generation of reduced sulphur compounds including hydrogen sulphide (H_2S). ASS may be encountered during trenching work through the watercourse crossings on the mainland and excavation of the tunnel launch shaft on the mainland and the tunnel receptor shaft on Curtis Island.

Dust impacts on sensitive receptors during trenching work and construction of the Marine Crossing GTP Project will be temporary in nature and have been assessed as “unlikely to be of concern” due to separation distances (approximately 2 km to the nearest sensitive receptor on the mainland).

Operation

Monthly inspections will be carried out along the Marine Crossing GTP ROW by vehicle and foot patrols to check on the condition of the Marine Crossing GTP rehabilitated areas post-construction. Typically, maintenance on the Marine Crossing GTP ROW will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required.

Air quality impacts from these operational activities are expected to be low and manageable due to the low number of vehicle movements, infrequent maintenance activities and long separation distances from the Marine Crossing GTP ROW to the sensitive receptors.

Furthermore, all activities and work associated with these operational activities will be in accordance with the OMP, which will be developed prior to operation.

5.1.3 Summary of proposed mitigation measures for air quality

Table 5.1 summarises the proposed mitigation measures for managing air quality for the Marine Crossing GTP Project.

Table 5.1 Summary of proposed mitigation measures for air quality

Measure	Outcome
Environmental protection objective	• Construction of the Marine Crossing GTP Project in a manner that maintains ambient air quality within the local airshed • Operation of the Marine Crossing GTP in a manner that maintains ambient air quality within the local airshed
Specific objectives	• No warranted complaints from landholders, and all complaints responded to within 24 hours • No excessive dust emissions during construction of the pipeline • The release of odour, dust or any other airborne contaminant(s) from the Marine Crossing GTP Project does not cause an environmental nuisance at any sensitive place or commercial place • Comply with maximum ground level concentration limits • The register of fuel burning and combustion equipment is accurate and correct
Control strategies	• Construction site pads, Access Road and Marine Crossing GTP ROW access tracks will be watered on an as required basis to minimise the potential for environmental nuisance due to dust generation • Vehicles and machinery will be fitted with appropriate exhaust systems and emission control devices; these devices will be maintained in good working order • Fuel burning and combustion equipment pollution control devices comply with EA conditions • GLNG Operations will develop and implement a GHG reduction strategy for the Project • Rehabilitation of the Marine Crossing GTP Project disturbance footprint will be undertaken progressively and following construction, in order to stabilise the disturbed surface and limit the potential for dust generation during operation Refer to Table 5.12 for a full description of the air quality control strategies to be implemented during construction and operation of the Marine Crossing GTP
Performance indicators	• Complaints responded to within 24 hours • No excessive dust emissions during construction of the Marine Crossing GTP Project

5.2 Existing environment

5.2.1 Climate and meteorology

The nearest available meteorological monitoring station to the Marine Crossing GTP Project is the Bureau of Meteorology's (BoM) Gladstone Airport monitoring station, which is located approximately 12 km to the south. Long term climate statistics for Gladstone Airport are discussed below.

Rainfall

The time period examined for measured rainfall at Gladstone Airport was 1994 to 2010. Long term rainfall statistics for Gladstone Airport have been summarised in Figure 5.2. Typically, rainfall peaks during the summer months, with a maximum long term average of 195 mm rainfall recorded during February which equates to an average of 11.6 rain days per month. During the remainder of the year, the rainfall is significantly lower, ranging from 22 to 61 mm/month. The highest monthly rainfall recorded at Gladstone Airport over the time period examined was 657 mm recorded in February 2003.

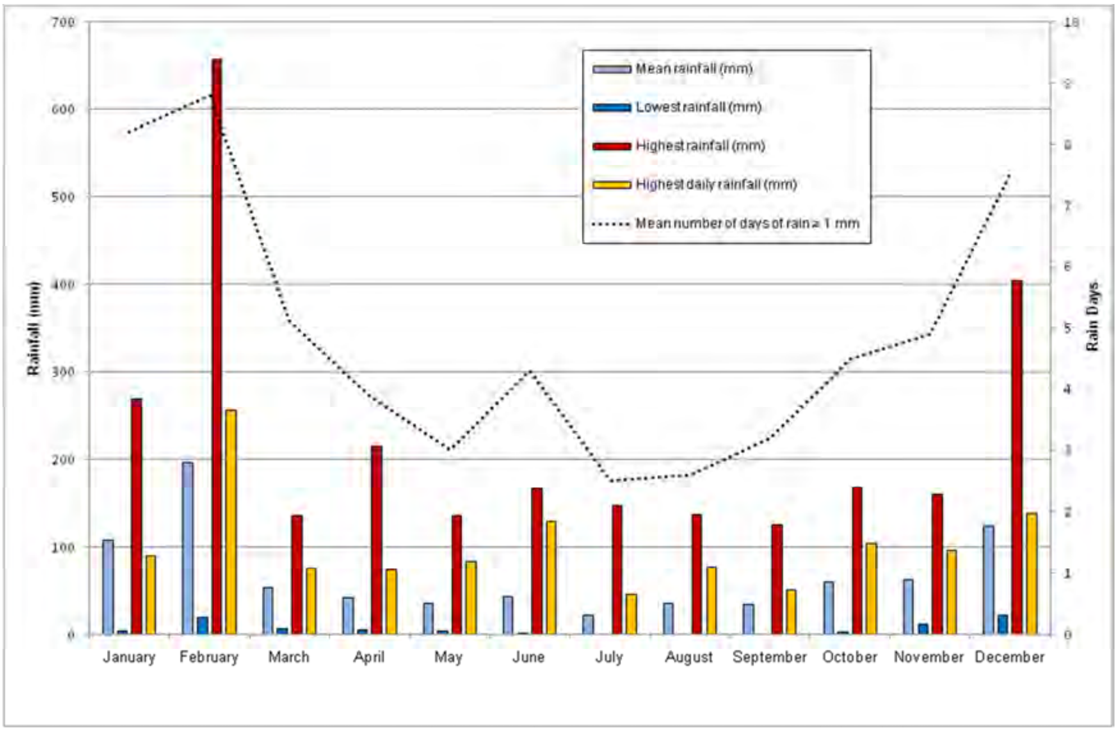


Figure 5.2 **Long term rainfall data for Gladstone airport (1994 - 2010) (BoM, 2011)**

Temperature

The time period examined for recorded temperatures at Gladstone Airport was 1993 to 2010. Mean maximum temperatures range from 23°C in winter to 31°C in summer, while mean minimum temperatures range from 12°C in winter to 23°C in summer. Long term temperature statistics for Gladstone Airport are summarised in Figure 5.3.

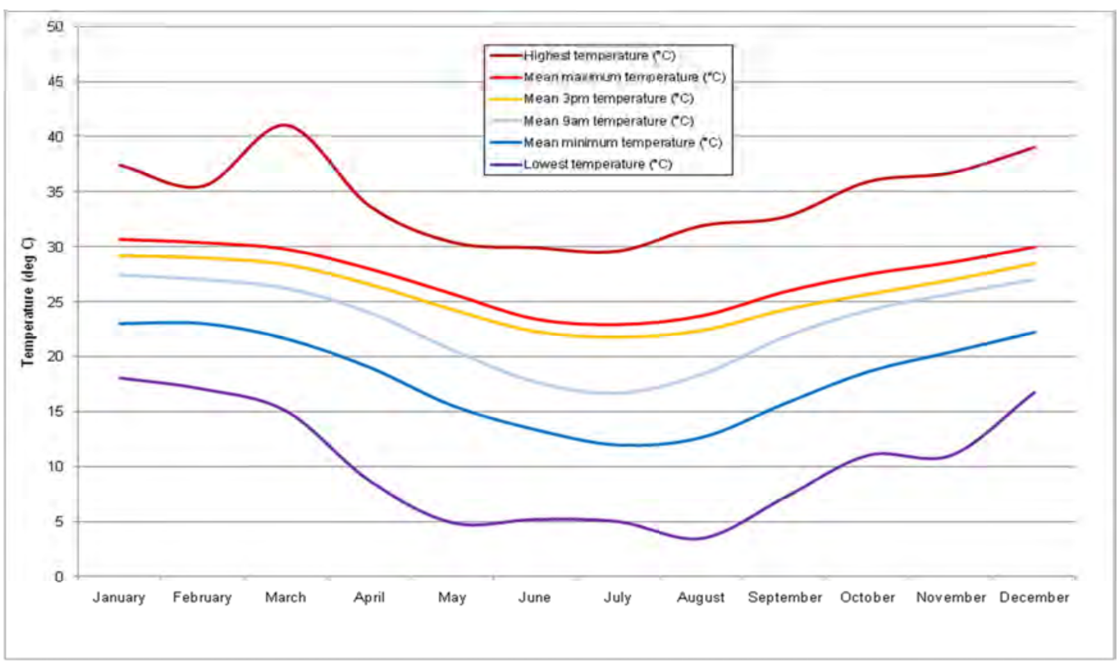


Figure 5.3 **Long term temperature data for Gladstone Airport (1993 - 2010) (BoM, 2011)**

Wind speed and direction

Long term wind speed and direction data was obtained at the Gladstone Airport BoM station and is presented as monthly windroses (9am and 3pm) in Figure 5.4 and Figure 5.5, respectively.

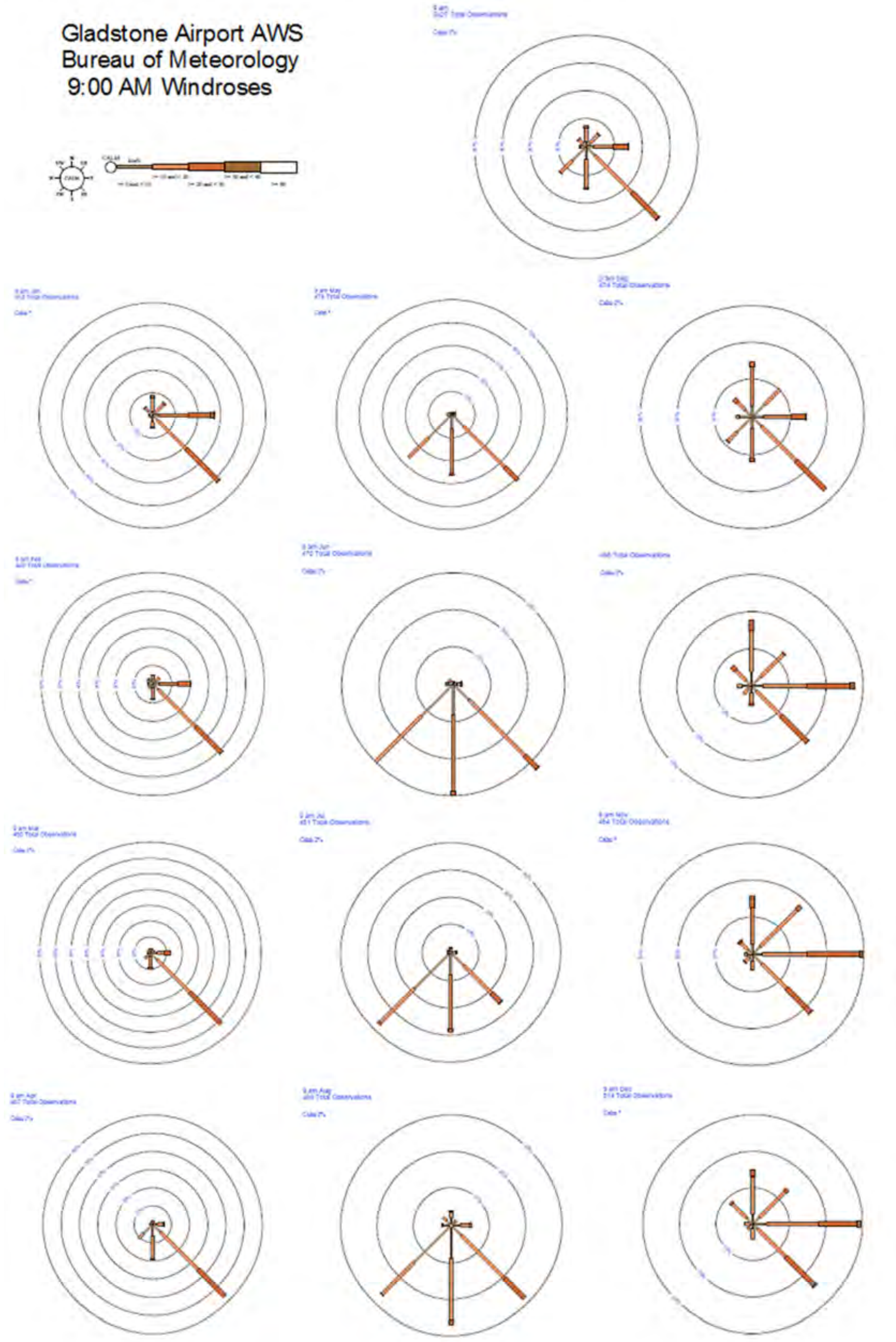


Figure 5.4 Gladstone Airport 9am windroses (BoM, 2011)

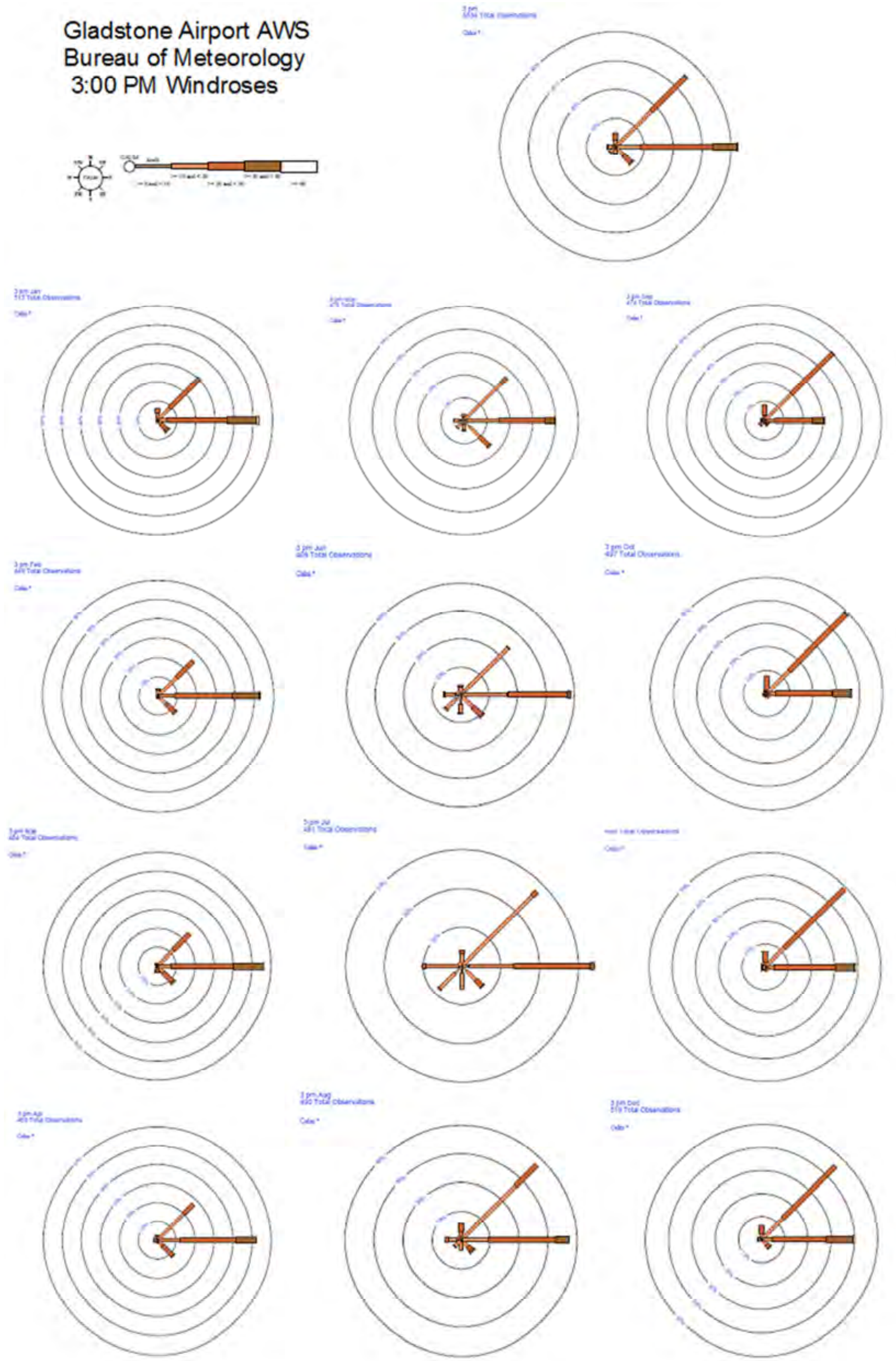


Figure 5.5 **Gladstone Airport 3pm windroses (BoM, 2011)**

Analysis of this windrose data shows the following (BoM, 2011):

- From January to April, morning winds are predominantly southeasterly, shifting to easterly during the afternoon
- During autumn and winter (May to August) morning winds blow predominantly from the southwest to southeast quadrant. In the afternoon, easterly winds predominate, with northeasterly winds occurring with increasing frequency over this period.
- During spring and early summer (September to December) the morning winds tend to be more widespread, with easterly and southeasterly winds dominating. In the afternoon, easterly and northeasterly winds predominate.
- Strong winds (>30 km/hr) generally only occur from the east and are more frequent during the afternoon

5.2.2 Existing air environment

There are no ambient air quality measurements available in the immediate vicinity of the Marine Crossing GTP Project.

The existing air quality within the vicinity of the Marine Crossing GTP Project is likely to be affected by emissions from existing industrial facilities located within Gladstone and the surrounding area. The proximity of a number of industrial facilities to the Marine Crossing GTP Project is shown in Figure 8.3b and is described in Table 5.2 below. Existing industrial facilities have the potential to contribute to elevated levels of PM_{10} within Gladstone and surrounding areas.

Table 5.2 Industrial facilities

Primary land Use	Approximate distance from Marine Crossing GTP Project (Point C) (km)
Orica	8.5
Rio Tinto Alumina's Yarwun Refinery	7.1
Fisherman's Landing Wharf Facilities	6.6
Transpacific	5.4
Queensland Energy Resource Limited (QERL)	4.4
Cement Australia	3.5

Current land use activities within the Marine Crossing GTP Project are not likely to result in the release of air quality pollutants that would exceed the criteria values of the EPP Air (2008).

The closest air quality monitoring station is located at Targinie, which is less than 10 km from the Marine Crossing GTP Project, and is operated and maintained by DEHP. A summary of the monthly maximum 24 hour PM_{10} concentrations measured at the Targinie monitoring station between January 2009 and October 2010 is presented in Figure 5.6 and summarised in Table 5.3.

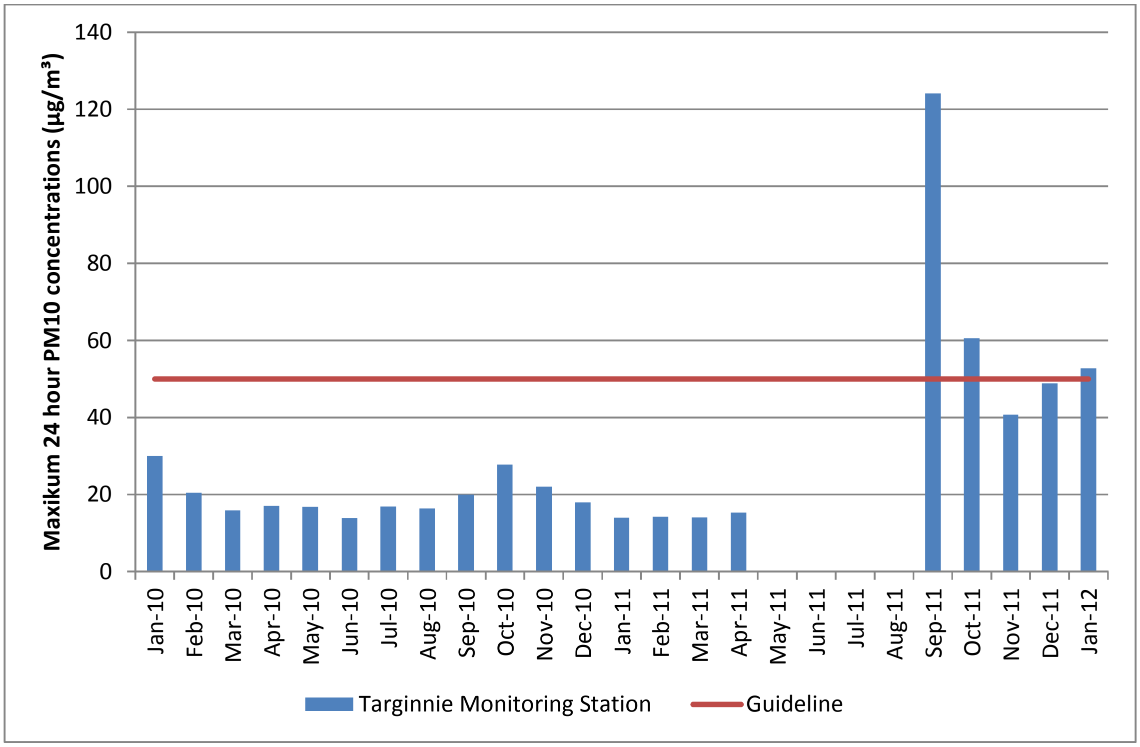


Figure 5.6 Maximum measured 24 hour PM_{10} concentrations at Targinnie (*sic*)

Source: Air Quality Bulletin – Central Queensland (DERM, 2012a)

Table 5.3 Existing Environmental values and conditions

Environmental Value	Site ID	Current Condition
24 hour average PM_{10} Concentrations	Targinnie (*sic*)	No exceedances of the EPP Air guideline of 50 µg/m³ (5 allowable exceedances per year
Annual average TSP	Targinnie (*sic*)	Not reported
Annual average dust deposition	Targinnie (*sic*)	Not reported

5.2.3 Sensitive receptors

The closest sensitive receptor (residence) to the Marine Crossing GTP Project is located approximately 2 km from the construction site pad (mainland) at Point C. Table 5.4 summarises the sensitive receptor locations within 4 km of the Marine Crossing GTP Project and the location of sensitive receptors is shown on Figure 5.1.

Table 5.4 Sensitive receptors within 4 km of the Marine Crossing GTP Project (Point C)

ID	Lot	Plan	Address	Receptor type	Distance to GTP alignment (m) (Shortest Distance)	Approx. distance to TBM site (m) (Reference Point C)	Approx. distance to pipe stringing site (m) (Reference Point C)
1	72	DS628	63 Flinders Rd	Residential	499 m	4,300 m	3,900 m
2	101	RP866910	101 Flinders Rd	Residential	566 m	4,200 m	3,800 m
3	1305	MPH34872	1023 Targinie Rd	Residential	317 m	4,000 m	3,400 m
4	1	MPH2955	1057 Targinie Rd	Commercial	318 m	4,100 m	3,400 m
5	1	MPH30856	908 Targinie Rd	Residential	1,302 m	3,200 m	2,400 m
6	1	RP615663	17 Swan Rd	Residential	2,316 m	3,000 m	2,300 m
7	41	DS290	820 Targinie Rd	Residential	1,804 m	2,800 m	2,200 m
8	58	DS290	Unnamed Rd	Residential	1,508 m	2,800 m	2,300 m
9	3	RP617399	749 Targinie Rd	Residential	2,950 m	3,250 m	3,000 m
10	3	DS710	17 Swan Rd	Residential	3,050 m	3,380 m	3,150 m
11	1	MPH3003	587 Targinie Rd	Residential	4,050 m	4,050 m	3,850 m
12	1	MPH2921	28 Wilson Rd	Residential	4,300 m	4,300 m	4,100 m
13	3	MPH23069	19 Wilson Rd	Residential	4,370 m	4,370 m	4,150 m

5.3 Air quality emissions and assessment

5.3.1 Emission sources

The Marine Crossing GTP Project will be developed in the following phases, which may result in emissions to air:

- Clearing and grading work along the Access Road, ROW laydown and work areas, construction site pads and Marine Crossing GTP ROW terrestrial areas (mainland and Curtis Island)
- Construction of the Access Road, ROW laydown and work areas, construction site pads (including the tunnel launch and receptor shafts), traditional open cut trenching between Point A and Point C (on the mainland), and Point D and Point E (on Curtis Island), handling and stockpiling of tunnel spoil and the installation of the pipeline
- Rehabilitation of the disturbance footprint associated with Access Road, ROW laydown and work areas, construction site pads and other construction areas not required for the ongoing operational phase of the Marine Crossing GTP
- Testing and commissioning
- Operation of the Marine Crossing GTP
- Closure and rehabilitation of the Marine Crossing GTP Project disturbance footprint

Point source emission

The generation and release of air pollutants during the construction of the Marine Crossing GTP Project will include a number of point source emissions, primarily from generators, gantry crane and other construction or earthmoving equipment whilst in operation. These emissions are anticipated to be minor and temporary.

Combustion related air emissions (eg oxides of nitrogen, sulphur dioxide, carbon monoxide, particulate matter and volatile organic compounds) are derived from mobile sources (eg motor vehicles or earthmoving equipment). A list of potential point source emitters for the Marine Crossing GTP Project is provided in Table 5.5.

Table 5.5 Preliminary equipment schedule for the Marine Crossing GTP Project

Item/activity	Plant/equipment description	Quantity	Duration (days)	Total days
Clearing and grubbing – Mainland and Curtis Island terrestrial areas	Dozer Cat D9 with ripper	1	8	8
	Dozer Cat D8N	4	8	32
	Dozer Cat D7H	1	8	8
	Backhoe excavator Cat 325	2	8	16
	Motorgrader Cat 14H	1	8	8
	Wheel loader Cat 966	1	8	8
	Dumper truck 4x4 (14 m^3)	1	8	8
	Motorsaw	3	8	24
	Wood shipping machine	1	8	8
	Minibus 10 seats 4x4	2	8	16
	Pick up 4x4	1	8	8
Excavation	Backhoe Cat 330L	7	8	56
	Hammer for backhoe Cat 330L	2	8	16
	Minibus 10 seats 4x4	1	8	8
	Pick up 4x4	1	8	8
	Dewatering pump	3	8	24
Stringing - bending	Excavator with vacuum lift	1	8	8
	Sideboom Cat 578/583	2	8	16
	Road tractor 6x4	6	8	48
	Semitrailer flat bed 30 tons	6	8	48
	Bending machine 42”	1	8	8
	Truck 5 tons 4x4	1	8	8
	Minibus 10 seats 4x4	1	8	8
	Pick up 4x4	2	8	16
Welding	Sideboom Cat 583	2	8	16
	Pipe facing machine 42”	1	8	8
	Backhoe excavator Cat 325	1	8	8
	Pay welder 2 hold	6	8	48
	Welding machine 400 Amp	2	8	16
	Pneumatic internal clamps	1	8	8
	AUT equipment	1	8	8
	Bus 22 seat 6x4	2	8	16
	Pick up 4x4	1	8	8
	Grinding machine 48V	12	8	96
	Truck 5 tons 4x4	1	8	8

Item/activity	Plant/equipment description	Quantity	Duration (days)	Total days
Field joint coating - lowering	Sandblasting set (including compressor and tractor)	1	8	8
	Induction heating set	1	8	8
	FJ coating spraying equipment	1	8	8
	Sideboom Cat 589/594	6	8	48
	Backhoe excavator Cat 325	1	8	8
	Holiday detector	2	8	16
	Minibus 10 seats 4x4	1	8	8
	Pick up 4x4	1	8	8
	Truck 5 tons	1	8	8
Bedding – padding – backfilling	Screening equipment	1	8	8
	Backhoe excavator Cat 325	5	8	40
	Dozer Cat D7	2	8	16
	Dumper 4x4 (14 m^3)	6	8	48
	Pay loader Cat 966	2	8	16
	Bus 22 seat 4x4	1	8	8
	Pick up 4x4	1	8	8
	Truck 5 tons	1	8	8
The Narrows tunnel GTP tie-in	Sideboom Cat 589/594	2	8	16
	Welding machine 400 A	6	8	48
	Truck 5 tons	2	8	16
	Ossirotor for cut pipe	2	8	16
	Minibus 10 seats 4x4	1	8	8
	Pick up 4x4	1	8	8
Restoration	Dozer Cat D7H	1	8	8
	Dozer Cat D8N	1	8	8
	Backhoe excavator Cat 325	2	8	16
	Motorgrader Cat 14H	1	8	8
	Dumper truck 4x4 (14 m^3)	2	8	16
	Minibus 10 seats 4x4	1	8	8
	Pick up 4x4	1	8	8

The effects of these mobile sources are transitory and are present within the Marine Crossing GTP disturbance footprint for short duration events and would not result in ground level concentrations of combustion gases that will exceed the EPP Air (2008) guideline values (refer Section 5.3.2).

Dust emissions

Dust emissions from the Marine Crossing GTP Project are expected from:

- Wind erosion from stockpiles and areas previously cleared and disturbed

- Materials handling associated with the onsite management and removal of excavated material, including tunnel spoil
- Vehicular movements along the Access Road and other unsealed roads used for the transport of construction materials and equipment to the construction site pads, and the transport of tunnel spoil to disposal location

Air quality emissions associated with operation

During operation of the Marine Crossing GTP, periodic inspections will occur which include driving along the Marine Crossing GTP ROW; however, no surface disturbance is expected to occur for routine operational activities.

5.3.2 Air quality criteria

Environmental values relating to air are managed through the EPP Air (2008), which has the objective of enhancing and protecting these values by:

- Protecting the health and biodiversity of ecosystems
- Protecting human health and wellbeing
- Protecting the aesthetics of the environment, including the appearance of buildings structures and other property
- Protecting agricultural use of the environment

Maximum ground level concentration limits for nitrogen dioxide and carbon monoxide have been set for the Project under the Mainland and Curtis Island EA (refer Table 5.6).

Table 5.6 Maximum ground level concentration limits

Contaminant	Concentration at 0 deg C	Units	Averaging time
NO_x (as nitrogen dioxide)	250	micro g/m^3	1 hour
NO_x (as nitrogen dioxide)	33	micro g/m^3	1 year
Carbon monoxide (CO)	11	mg/m^3	8 hour

Source: Schedule F, Table 1 CG Report (Queensland Government, 2010a)

Ambient air quality objectives and dust deposition guidelines relevant to the Project are provided in Table 5.7. It should be noted that the dust deposition guideline values adopted by DEHP are not defined within the schedule of the EPP Air (2008), however are used by DEHP to define environmental nuisance.

Table 5.7 Ambient air quality objectives and dust deposition guideline levels relevant to the Project

Indicator	Environmental value	Averaging period	Air quality objective	No. of days of exceedance allowed per year
TSP[A]	Health and wellbeing	1 year	90 micro g/m^3	N/A[B]
PM_{10}[A]	Health and wellbeing	24 hour	50 micro g/m^3	5
Dust deposition[C]	Nuisance complaints	1 month	120 micro g/m^2	N/A[B]
Dust deposition[D]	Nuisance complaints	1 year	4 g/m2	N/A[B]

Table notes:
[A] Source: EPP Air (2008)
[B] N/A – not applicable
[C] Dust deposition guideline adopted by DEHP (former DERM)
[D] Dust deposition guideline adopted by New South Wales Office of Environment and Heritage (former DECCW)

5.3.3 Air quality assessment methodology

A qualitative assessment of potential air quality impacts associated with the Marine Crossing GTP Project has been completed based on the proposed construction methodology contained in Chapter 2.

The predominant air quality impacts anticipated for the Marine Crossing GTP Project potential are dust emissions and point source emissions from the use of vehicles and equipment. Dust generation is expected to be confined to terrestrial areas of the mainland and Curtis Island, where trenching work and spoil handling activities are to be carried out. In most cases, excavated soils are likely to be wet or moist inhibiting dust emissions. There are not expected to be any air emissions associated with bored tunnelling activities beneath The Narrows. Hence, the air quality assessment has focused on developing dust, vehicle and equipment air emission management strategies.

The plant and equipment proposed to be used for construction of the Marine Crossing GTP Project have been assessed to determine the potential for air emissions. A preliminary equipment schedule list is provided in Table 5.5, based on this equipment schedule the operational usage conditions have been determined for the construction phase and are outlined in Table 5.8.

Table 5.8 Proposed equipment schedule for operational usage conditions during construction

Phase	Activity	Plant	Hours of operation
Site establishment	Construct proposed Access Road	Dozer Loaders Graders Trucks Rollers Water cart	Daytime only
	Establish ROW laydown and work areas, and construction site pads	Dozer Loaders Graders Trucks Rollers Water cart Concrete trucks	Daytime only
Tunnelling	Sheetpiling	Crane Sheetpiling Dozer Loaders Trucks	24 hours (approximately 15 days within a 60 day construction window between mid December 2012 and mid February 2013)
	Tunnel shaft excavation	Dozer Loaders Trucks	24 hours (approximately 45 days within a 60 day construction window between mid December 2012 and mid February 2013)
	Tunnelling works	Crane TBM Pumps	24 hours
	Spoil management within construction site pad (mainland)	Front end loaders Trucks Grader	24 hours

Phase	Activity	Plant	Hours of operation
	Spoil management from construction site pad (mainland) to spoil disposal site	Trucks Water cart for Access Road	Daytime only
Pipe stringing line	Place pipes	Crane	Daytime only for trench operations on the Mainland and Curtis Island 24 hour for tunnelling beneath The Narrows
	Brushing, bending, welding, field joint coating, bedding, padding, backfilling, crossing and tie-in	Hand grinders, welders, sandblasting and spraying, heating, screening Trucks Backhoe and hammer Loader Tractor Dozer	Daytime only for trench operations on the Mainland and Curtis Island 24 hour for tunnelling beneath The Narrows
Site demobilisation		Trucks Cranes	Possibly 24 hour Marine access will be 24 hour to take advantage of tidal windows

5.4 Potential impacts on air quality

5.4.1 Construction impacts

The key activities within the Marine Crossing GTP Project disturbance footprint that have the potential to emit dust include:

- Clearing and grading, including mulching and stockpiling of vegetation
- Establishment and construction of the Access Road, ROW laydown and work areas, and construction site pads, including excavation and grading
- Trenching work
- Vehicle movements on the Access Road and other unsealed roads
- Wind erosion of stockpiles and disturbed areas

The rate of dust emissions from each of these activities will vary with activity, soil type, soil compaction, production rate, recent rain and prevailing wind conditions, humidity levels and soil moisture content.

The nearest residential sensitive receptor to the Marine Crossing GTP Project is a residence located approximately 2 km from the construction site pad (mainland) located at Point C. This residence is positioned on a hill and overlooks the construction activities. Windrose data from BoM indicates that moderate to strong easterly and northeasterly afternoon winds are a feature of the area and these winds may blow any air emissions generated by the construction activities towards the sensitive receptors (refer Figure 5.4 and 5.5). It will therefore be important to visually monitor the potential for offsite emissions under these wind conditions, particularly during extended dry periods and implement the control strategies shown in Table 5.12 as required. Control strategies for other sensitive receptors located along the haul routes for the Marine Crossing GTP Project will be implemented through the RUMP.

Dust emissions would be expected to peak during the site establishment phase, when the construction of the Access Road, ROW laydown and work areas, and construction site pads (mainland and Curtis Island) is undertaken. This site establishment phase will require the use of dozers, loaders, graders and trucks to clear vegetation, excavate and transport soils, and to grade and level the road surface, laydown and work areas, and construction site pads. Subsequent phases will require less mobile equipment and the most significant source of emissions is expected to be from wind erosion on disturbed areas. During excavation and construction of the tunnel launch shaft, tunnel receptor shaft and bored tunnel under The Narrows, the excavated materials will become wet, and potential dust emissions from the handling and transport of this spoil will be reduced.

Construction of the Marine Crossing GTP Project will also result in the generation of fugitive, wheel generated and general construction dust and exhaust emissions. Potential exhaust emissions from the diesel powered mobile plant and equipment will include oxides of nitrogen, sulphur dioxide, carbon monoxide, particulate matter and volatile organic compounds. The potential levels of exhaust emissions predicted are expected to have minimal impact on the surrounding environment and sensitive receptors.

The excavation, handling and treatment of ASS and potential ASS (PASS) may produce odours due to the generation of hydrogen sulphide, which has a distinctive “rotten egg” smell. Emission character and levels of odour from these soils can vary, however the treatment process would be expected to significantly reduce any generation of odours from ASS or PASS. In addition, the proposed ASS treatment area is sufficiently separated from sensitive receptors and as such, there are not expected to be any potential impacts to sensitive receptors from odour.

Potential impacts on air quality in the immediate area surrounding the Marine Crossing GTP Project will be temporary in nature and limited to the duration of the construction works. The potential impacts have been summarised in Table 5.9.

Table 5.9 Aspects and potential impacts on air quality

Activity	Aspect	Potential impact
Clearing, site establishment and construction, trenching	Health and wellbeing	None anticipated
	Foliage and fodder	None anticipated
Operation of TBM	Health and wellbeing	None anticipated
	Foliage and fodder	None anticipated
Rehabilitation of site	Health and wellbeing	None anticipated
	Foliage and fodder	None anticipated

5.4.2 Operational impacts

Monthly inspections will be carried out along the Marine Crossing GTP ROW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Typically, maintenance of the Marine Crossing GTP ROW will be carried out by light vehicles and small maintenance crews on an annual basis, or as required.

Potential air quality impacts from normal operational activities are expected to be low and manageable due to the low number of vehicle movements, infrequent monitoring activities and sufficient separation distances from the Marine Crossing GTP ROW to the nearest sensitive receptors.

Furthermore, all activities and work associated with these operational activities will be in accordance with the OMP which will be developed and implemented prior to the completion of the construction phase.

5.5 Greenhouse gas emissions and assessment

The greenhouse gas (GHG) emissions from the construction and operation of the Marine Crossing GTP Project have been assessed as part of the Project rather than for the individual sections (mainland, marine crossing and Curtis Island), as the GHG emissions from the Marine Crossing GTP Project represent a very small (and immaterial) component of the GHG emissions from the construction and operation of the Project, overall.

5.5.1 GHG assessment methodology

The GHG emissions inventory has been prepared for the Project in accordance with the methodology set out in *The Greenhouse Gas Protocol Corporate Accounting and Reporting Standard* (the Protocol) (World Resources Institute, 2004), the relevant emissions factors in the National Greenhouse Accounts (NGA) Factors - July 2011 (DCCEE, 2011), the *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2006 – Energy (Fugitive Fuel Emissions)* (NGGIC, 2007) and the Intergovernmental Panel on Climate Change Good Practice Guidance (IPCC, 2010).

The Protocol defines direct and indirect emissions through the concept of emission “scopes”:

- **Scope 1** – *Direct GHG Emissions* are produced as a direct result of activities that constitute a facility controlled by a company (eg emissions from combustion in boilers or vehicles, fugitive emissions and emissions from onsite power generators) or directly associated with an operational activity
- ***Scope 2*** – *Electricity Indirect GHG Emissions* arise from purchased electricity, heat or steam
- ***Scope 3*** – *Other Indirect GHG Emissions* are emissions that occur outside the boundary of a facility as a result of activities at the facility. This is an optional reporting class that accounts for all other indirect GHG emissions resulting from a company’s activities but occurring from sources not owned or controlled by the company (eg transportation of products and end use of sold products and services)

5.5.2 GHG Emission sources

The following GHG emission “scopes” have been identified for the construction phase of the Marine Crossing GTP:

- **Scope 1** GHG emissions for the Marine Crossing GTP Project arising from land clearing of the Access Road and access tracks, ROW laydown and work areas, construction site pads and the onsite consumption of diesel fuel in earth moving and construction equipment during construction of the Marine Crossing GTP Project
- **Scope 2** GHG emissions arise from electricity purchased for workforce accommodation and office facilities during construction of the Marine Crossing GTP Project (not specifically quantified for the construction phase)
- **Scope 3** GHG emissions during construction of the Marine Crossing GTP Project are due to the indirect emissions attributable to the extraction, production and transport of diesel fuels used in the construction

GHG emissions during operation of the Marine Crossing GTP Project are assumed to be negligible since:

- The Santos GLNG GTP will be fully welded
- There will be no regular process emissions

- Compression of the gas will be carried out at the CSG field facilities (eg there are no compressor stations on the pipeline itself)

The main GHGs emitted during construction and operation of the Marine Crossing GTP will be carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). To report these emissions, they have been converted to carbon dioxide equivalents ($CO_{2\text{-}e}$) using their global warming potential, as detailed in the NGA Factors. Construction activities associated with the Marine Crossing GTP Project will result in the emission of CO_2 and trace amounts of N_2O from diesel combustion in stationary and mobile engines. Trace amounts of methane may be emitted as a result of vegetation clearing. Operational emissions of GHG (mostly CO_2) will be from vehicles involved in inspection and maintenance. Methane is not likely to be released during the operational phase.

Carbon sequestration due to the rehabilitation of cleared areas has not been included in the inventory, this provides a worst case assessment of emissions (eg the estimate of GHG presented in this assessment is conservative).

5.5.3 GHG Emission factors

Emission factors have been used to estimate GHG emissions, in accordance with the NGA Factors (July 2011).

Emission factors for the carbon loss associated with land clearing for the Access Road and construction site pads were obtained using a reference factor of 200t $CO_{2\text{-}e}$/ha, from the report titled “The Australian Pacific LNG Project, Volume 5: Attachments, Attachment 31: Greenhouse Assessment – LNG Facility(p 20) (Worley Parsons, 2010b).

The adopted emission factors are detailed in Table 5.10.

Table 5.10 Emission factors used in the GHG inventory for the Santos GLNG GTP

Emission Source	Emission Factor			
	Energy content GJ/kL	CO_2 t $CO_{2\text{-}e}$	CH_4 t $CO_{2\text{-}e}$	N_2O t $CO_{2\text{-}e}$
Scope 1 – Diesel combustion [A]	38.6	69.2	0.2	0.5
Scope 3 – Diesel combustion [A]	38.6	5.3	-	-
Scope 1 – Land clearing [B]	$CO_{2\text{-}e}$/ha	200	-	-

Table notes: [A] Source: NGA Factors (July 2011) (DCCEE, 2011)
[B] Source: The Australian Pacific LNG Project, Volume 5: Attachments, Attachment 31: Greenhouse Assessment – LNG Facility, page 20, dated March 2010 (Worley Parsons, 2010b)

5.5.4 Estimated GHG emissions

A summary of Scope 1 and Scope 3 emissions for the Marine Crossing GTP Project is provided in Table 5.11. The calculation of emissions from diesel combustion during the construction phase of the Marine Crossing GTP has been assumed for a construction period of 21 months, with a six month ramp-up/ramp-down period with activity rates 50% of that occurring during the main construction period (15 months). Activity rates for the main construction period assumed a workforce of 1,000 workers and construction equipment of 100 heavy vehicles operating 10 hours per day and consuming 500 kL of diesel, based on the estimates of preliminary quantities for key environmental materials, as presented in Chapter 2.

Worst case assumptions have been incorporated in calculating carbon loss associated with land clearing. These assumptions are:

- Complete clearance of an easement for the Access Road of 2,247 m in length by 25 m wide
- Complete clearance of vegetation associated with the trenching work on the mainland and Curtis Island
- Vegetation of the entire route characterised by vegetation types that are present close to the main watercourses

This has resulted in a conservative estimate of the GHG emissions, which are presented in Table 5.11.

Table 5.11 Total Scope 1 and Scope 3 GHG Emissions for the GLNG Marine Crossing GTP

Emissions source	Scope 1 emissions t $CO_{2\text{-}e}$	Scope 3 emissions t $CO_{2\text{-}e}$
Construction and earth moving equipment	1,349	102
Land clearing	4,700	0
Total	**6,049**	**102**

Source: NGA Factors (DCCEE, 2011)

Scope 3 emissions have been investigated and estimated for the Marine Crossing GTP Project. These emissions were calculated using the Climate Change NGA Factors Workbook, 2011 as 3,231 tonnes ($CO_{2\text{-}e}$).

5.6 Potential impacts from GHG emissions

GHG emissions from the construction of the Marine Crossing GTP Project form a small part of the total GHG emissions profile for the Project and are relatively small in comparison to State and National emissions. The estimated annual Scope 1 emissions for the Santos GLNG GTP over the 21 month construction period represent approximately 0.05% of Queensland's annual emissions (2008 data) and less than 0.02% of Australian annual emissions (2006 data). The impact of the Project's GHG emissions in the context of the regulatory framework and State and National emissions and targets are further discussed in the EIS (URS, 2009a).

5.6.1 GHG management strategy

Climate change is a global issue requiring significant resources to meet complex environmental, energy, economic and political challenges. As global stakeholders in the energy business, GLNG Operations recognise that one of its most important environmental responsibilities is to pursue strategies that address the issue of GHG emissions.

Condition 4, Appendix 1, Part 1 of the CG Report requires a GHG reduction strategy to be implemented for the Project and submitted to the CG for approval.

The key components addressed by the GHG reduction strategy will be:

- Design and construction of assets (development)
- Energy efficiency and continuous improvement (operations)
- Measurement and reporting of GHG emissions

The philosophy of design applied to the Project explicitly requires that environmental considerations, including maximising energy efficiency and minimising GHG emissions, are given priority in the design of the Project. The requirements include quantitative guidelines and general qualitative goals. All equipment to be installed must be compared against best-practice performance to ensure that the most up to date technologies are used.

Opportunities to reduce GHG emissions from the Santos GLNG GTP are more limited and relate principally to minimising land clearing, the use of fuel efficient equipment and operational procedures that minimise gas releases.

Climate change performance will be reported and disclosed according to legislative requirements and numerous voluntary commitments, including:

- Publication of emissions profile on the Project website and Annual and Sustainability Reports
- The *Energy Efficiency Opportunities Act 2006*
- The *National Greenhouse and Energy Reporting Act 2007*
- International Carbon Disclosure Project (Carbon Disclosure Project, 2012)

The Project emissions inventory is subject to voluntary assurance by independent auditors in accordance with Australian Auditing and Assurance Standard ASAE 3000 *Assurance Engagements Other than Audits or Reviews of Historical Financial Information*.

Appropriate emission and inventory databases are maintained to meet these reporting requirements.

5.7 Cumulative impacts

Air emissions from the construction of the Marine Crossing GTP Project will consist primarily of dust and combustion pollutants.

Potential sources of dust emissions include the clearing of vegetation, earth works, trenching and vehicle and machinery movements. Construction of the bored tunnel under the intertidal area and The Narrows will not generate dust. Given the relatively short construction timeframe, the small number of sensitive receptors close to the Marine Crossing GTP Project, and the high moisture content of excavated spoil, potential impacts will be minor and short term in nature.

The generation and release of odour, dust and any other airborne contaminant(s) that may reduce local and regional air quality is considered to be an additive impact. However, it is unlikely that the emissions will combine to exceed air quality objectives except in an extremely localised and short term manner.

It is expected there will be negligible cumulative impacts on air quality from construction and operation of the Marine Crossing GTP Project. Specific mitigation measures are outlined in Table 5.12.

5.8 Environmental protection commitments, objectives and control strategies – air quality (construction and operation)

Environmental protection commitments, objectives and control strategies proposed to protect environmental values during construction and operation are presented in Table 5.12.

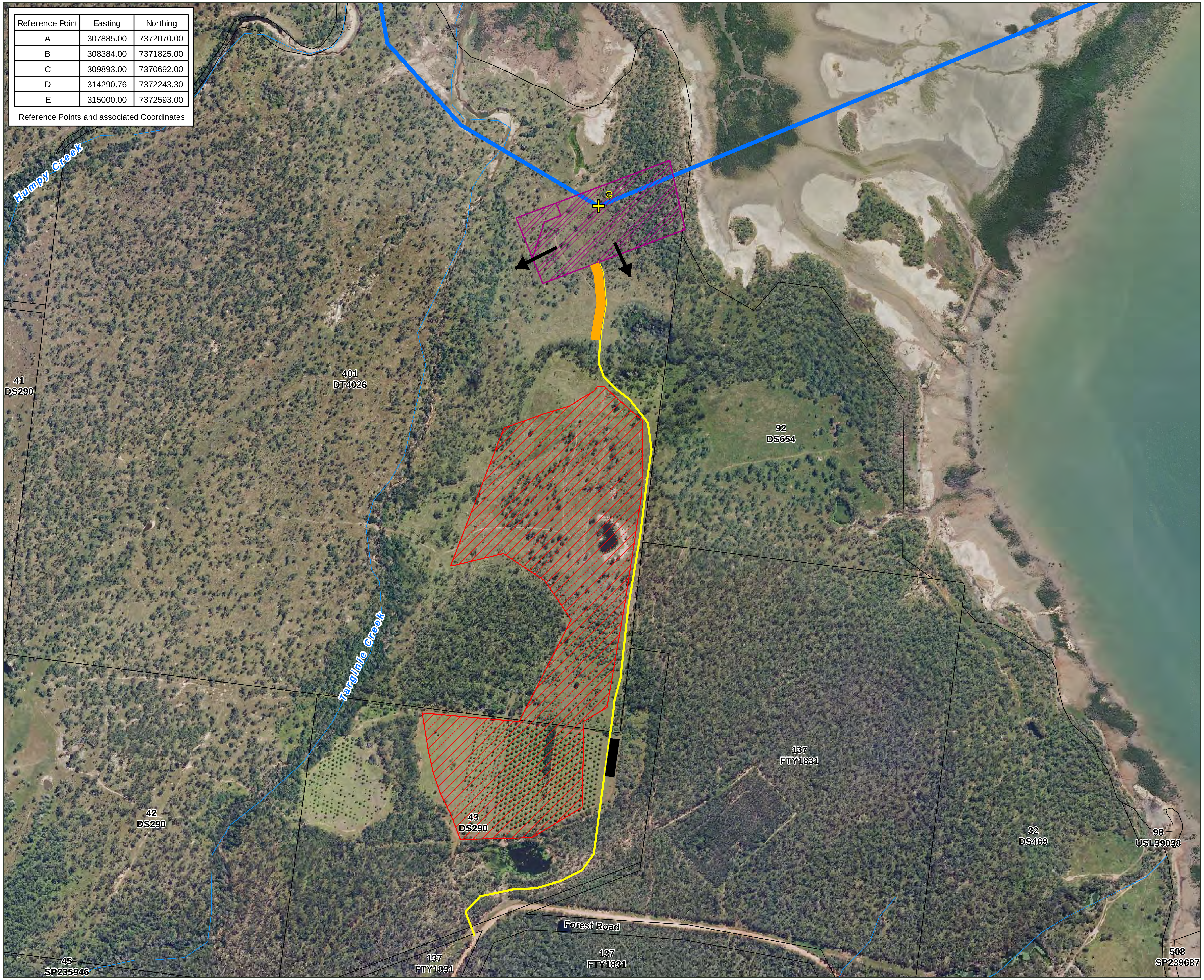
Table 5.12 Environmental protection commitments, objectives and control strategies - air quality

Item	Outcome
Environmental protection objective	• Construction and operation the Marine Crossing GTP in a manner that does not significantly affect the values of the air environment
Specific objectives	• No warranted complaints from landholders, and complaints responded to within 24 hours • No excessive dust emissions, during construction of the Marine Crossing GTP Project, resulting in air quality related complaints or impacts to significant plants due to dust deposition on foliage • The release of odour, dust or any other airborne contaminant(s), from the Marine Crossing GTP Project does not cause an environmental nuisance at any sensitive receptor location
Control strategies	**Pre-construction phase** • GLNG Operations will develop and implement a GHG reduction strategy for the Project. The strategy will include GLNG's policy on GHG emissions, an energy efficiency program, a continuous improvement program, better control systems and a CO_2 recovery plan. The strategy will be submitted to the CG for approval within three months of the granting of the petroleum facilities licence for the LNG Facility **Construction phase** • Landholders with the potential to be impacted by temporary dust emissions from construction will be advised and consulted, prior to the commencement of scheduled activities • Vehicles and machinery will be fitted with appropriate exhaust systems and emission control devices. The devices will be maintained in good working order • Construction site pads, stockpiled materials, the Access Road and the Marine Crossing GTP ROW access tracks will be watered, on an as required basis, to minimise the potential for environmental nuisance due to dust. Watering frequency will be increased during periods of high risk (eg high winds and extended dry conditions) • The extent and period of exposure of bare surfaces will be minimised • The area of work will be rehabilitated following construction, in order to stabilise the disturbed surface and limit the potential for dust generation in accordance with the SMESCP and LRMP • Construction vehicles speeds will be controlled within the Marine Crossing GTP Project area • A no burning policy for cleared vegetation will be implemented • Ensure excessive dust deposition does not occur on the foliage of significant plants and ecological communities adjacent the disturbance footprint and affect the plants ability to photosynthesise • The release of odour, dust or any other airborne contaminant(s), from the petroleum activity must not cause an environmental nuisance at any sensitive place or commercial place. Sensitive or commercial place is any Residential Dwelling, School, University, Child Care Facility, Hospital or commercial place within 500 m of the ROW • The Construction Contractor will provide to GLNG Operations for approval, a Sustainability Management Plan that includes specific criteria and deliverables that will demonstrate how a high performance for all sustainability indicators for the design and construction of the proposed GTP will be achieved. This plan will include appropriate chapters or sub plans regarding energy efficiency and greenhouse gas emissions
Performance indicators	• No air quality related complaints from neighbouring residential areas and industrial sites • No visible dust emissions leaving the site during construction of the Marine Crossing GTP Project

Item	Outcome
Monitoring and auditing	• All active and rehabilitated work areas will be scheduled for regular inspection to assess the effectiveness of dust mitigation measures implemented • Regular visual monitoring will be conducted by the construction contractor (including haul truck operators) for dust emission and watering frequency will be adjusted, as required • When requested by the administering authority, dust and particulate monitoring will be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any warranted complaints (eg which are neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive place or commercial place
Reporting and corrective action	• Reporting of environmental performance data will be conducted in accordance with the EMS, CEMP and the OMP • Reporting, investigation and management of corrective actions associated with environmental events (including incidents, hazards, near misses, non-compliance events and third party complaints) will be managed through the IMS and reported to the appropriate authority, as required • Reporting will occur on an incident, weekly and monthly basis to the Environmental Manager • Landholder complaints will be recorded in a complaints register and appropriate corrective actions will be implemented and closed out by the Environmental Manager

6. Dams

No dams referenced in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (DERM, 2012) and the former DERM guideline *Structures which are dams or levees constructed as part of environmentally relevant activities* EM634 (2011) are proposed for the Marine Crossing GTP Project. Potential impacts and proposed control strategies associated with water related construction activities, temporary storage ponds and uses have been addressed in Chapter 15.



Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_069.mxd 22/06/2012 09:19

A1 scale: 1:5,000

0 100 200 300 400 500m

GLNG No: 3381-40-0554

Coordinate system: GCS_GDA_1994

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Proposed Discharge Point
- Access Road
- Proposed Land Release Area
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Weed Washdown Facility (Indicative)
- Cadastre
- Watercourses

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.
Watercourses: Department of Environment and Resource Management, Sep 2011.
Cadastre: Department of Environment and Resource Management, Oct 2011.

Proposed Land Release Areas
Figure 6.1

Date: 22/06/2012 Version: d

7. Land management

7.1 Chapter summary

This chapter describes the existing environment, and the potential impacts and mitigation measures related to topography, geology, soils (including ASS), agricultural land and potentially contaminated land within the area impacted by the Marine Crossing GTP Project.

The descriptions of topography, geology, soils, agricultural land values and potential land contamination conditions for the Marine Crossing GTP Project are described for the following three sub-sections as shown in Figure 1.2:

- The mainland:
  - Point A to Point C - terrestrial Marine Crossing GTP ROW (mainland trenching section)
  - Access Road (Forest Road to Point C) – road construction footprint
  - Construction site pad (mainland) at Point C – TBM launch shaft and associated work site
- The Narrows:
  - Point C to Point D - marine tunnel (excluding the construction site pads, and TBM launch and receptor shafts)
- Curtis Island:
  - Point D – construction site pad (Curtis Island), including the TBM receptor shaft
  - Laird Point (Point D to Point E) - terrestrial GTP ROW (Curtis Island trenching section)

Figure 1.2 illustrates the Marine Crossing GTP Project.

Specific management plans that provide more technical detail in relation to mitigation measures associated with the Land Management aspects of the Marine Crossing GTP Project, as well as appropriate performance indicators, monitoring methods and compliance reporting are referenced in the chapter and contained in the following Plans:

- ASSMP (refer Appendix A)
- SMESCP (refer Appendix C)
- LRMP (refer Appendix E)
- WMP (refer Appendix F)

7.1.1 Summary of existing environmental values and conditions for land management

A summary of existing environmental values and conditions is provided in Table 7.1.

Table 7.1 Existing environmental values and conditions

Environmental Value	Section	Current condition
Geological conditions (refer Figure 7.1)	Marine Crossing GTP Project (mainland)	• Underlain by Cainozoic sediments and Quaternary alluvium comprised of sand, silt, gravel and residual soils within floodplains and alluvial flats
	The Narrows (Tunnel)	• Quaternary (Holocene) age sediments comprised of estuarine and coastal sediments of sandy mud and muddy sand underlying the intertidal area • Beneath The Narrows geological conditions are mapped as Tertiary age sediments comprising claystone, shale, sandstone, mudstone, limestone and/or conglomerate • A major fault zone is identified within The Narrows Graben rock type underlying The Narrows

Environmental Value	Section	Current condition
	Marine Crossing GTP Project (Curtis Island)	• Characterised by Carboniferous age Curtis Island Group of the Wandilla Formation comprising metamorphosed and deformed mudstone, siltstone, sandstone, quartz, greywacke, cherts and phyllite
Terrain and landforms (refer Figure 7.2)	Marine Crossing GTP Project (mainland)	• Traverses undulating to near flat Quaternary alluvial plains, local, gently inclined footslopes and outwash fan deposits with overall slopes generally ranging between 3% and 7% • Four tidal creeks are located adjacent to, or are crossed in this section, including two unnamed tributaries of Mosquito Creek, Humpy Creek and Targinie Creek • Between Forest Road and Point C the Access Road traverses the slopes of a low hill located to the south of Point C in a generally northerly direction • The construction site pad (mainland), including launch shaft are located in the vicinity of Point C, on the footslope of the low hill and adjacent to the upper reach of Mosquito Creek and intertidal area
	The Narrows (Tunnel)	• The Narrows consists of the marine waters in the northern area of Port Curtis, between the mainland and Curtis Island and is bounded by tidal mudflats with tidal creek networks, and mangrove and estuarine habitat • The proposed concrete-lined tunnel, with an external diameter of 4.05 m, will cross under the intertidal area and The Narrows, extending from the construction site pad (mainland) at Point C to the construction site pad (Curtis Island) at Point D
	Marine Crossing GTP Project (Curtis Island)	• Traverses gently to moderately inclined mid to lower slopes and footslopes, which are mostly comprised of slopes up to approximately 12% on the western side of the hill, and crosses the crest of low rounded hilly and steep to very steep higher hilly lands where slopes are up to 25% on the eastern side of the hill
Soil conditions (refer Figure 7.3 and Figures 7.5 – 7.8)	Marine Crossing GTP Project (mainland)	• Underlying mapped soils are generally comprised of sandy or loamy duplex profiles with clay subsoils, and shallow to deep uniform fine textured (non-cracking) clay soils in the western section, between Point A and Point B • Soils mapped between Point B and Point C are generally characterised as loamy or clayey duplex profiles with medium to heavy clay subsoils, transitioning into shallow and deep uniform fine textured (non-cracking) clay soils and tidal area soils in the vicinity of the construction site pad (mainland) • Mapped soils are generally considered to be consistent with the findings of the preliminary soil sampling investigations conducted by O2 Environmental + Engineering (O2) for erosion potential assessment • Preliminary ASS sampling investigations conducted by Golder Associates, between Point A and Point C, have indicated that soils encountered were generally comprised of sandy soils overlying clayey subsoils and contain variable amounts of silt and gravel within the profile • Groundwater sampling and analysis conducted by Golder Associates during the ASS investigations indicated that the groundwater pH was slightly acidic at the time of sampling

Environmental Value	Section	Current condition
		• Highly sodic soils have been mapped within the Marine Crossing GTP Project, between Point B and Point C, the construction site pad (mainland) and the Access Road • Preliminary soil samples collected by O2 at Point C were moderately to strongly acidic (acidity increasing with depth) and were not saline and not sodic • Preliminary soil samples collected by O2 at the southern end of the Access Road indicated that subsoils at this location were slightly acidic, not saline and not sodic • ASS and soil salinity have been mapped in the vicinity of the creek crossings and adjacent intertidal areas associated with Mosquito Creek • Waste Solutions Australia Pty Ltd (Waste Solutions) have conducted a targeted Stage 2 Environmental Site Assessment and concluded that there is no evidence of potentially contaminating activities or contamination within the areas of their investigations and that it is unlikely that the Marine Crossing GTP Project will encounter contaminated soil within Lot 401 DT4026 • A stockyard potentially containing a cattle dip with pesticide use was identified during the EIS (URS, 2009a), associated with Lot 401 on DT4026. As part of the Stage 2 Environmental Site Assessment referred to above, testing was conducted on this property and no evidence of contamination was identified
	The Narrows (Tunnel)	• Overlying the tunnel within the intertidal area the soils are mapped as generally comprising shallow and deep uniform fine textured (non-cracking) clay soils and tidal area soils • PASS within marine clay sediments associated with The Narrows, and actual ASS (AASS) within the intertidal area have been identified in the ASS mapping. However, no surface disturbance of ASS is proposed within the intertidal and tidal areas or The Narrows due to the proposed tunnel passing beneath these areas • PASS disturbance may occur during tunnel construction as a result of intercepting marine clay sediments at depth and localised changes to groundwater levels at the construction site pads • The tunnel is proposed to have minimum cover of 5 m of overlying geology and sediment in terrestrial tunnel sections at the launch and receptor shafts extending to not less than 8 m of overlying geology and sediment in the marine section of the tunnel beneath The Narrows
	Marine Crossing GTP Project (Curtis Island)	• Underlying soils at the construction site pad (Curtis Island) are mapped as generally comprising sandy or loamy duplex profiles with clay subsoils in the vicinity of Point D • Soils mapped between Point D and Point E, associated with the hillcrest are generally characterised as medium textured gravelly uniform or gradational loam to clay loam soils and shallow and deep uniform fine textured (non-cracking) clay soils • Soils in the vicinity of Point E are mapped as generally sandy or loamy duplex profiles with clay subsoils and shallow and deep uniform fine textured (non-cracking) clay soils

Environmental Value	Section	Current condition
		• Preliminary ASS sampling investigations conducted by Golder Associates, between Point D and Point E, have indicated that soils encountered were generally comprised of sandy clay and gravelly silt clay soils containing variable amounts of silt and gravel within the profile • Groundwater sampling and analysis conducted by Golder Associates during the ASS investigations indicated that the groundwater pH was slightly acidic at the time of sampling • Localised pockets of moderately reactive soils, with shrinking and swelling characteristics have been mapped associated with the Marine Crossing GTP Project (Curtis Island) crossing of the hillcrest • Moderately sodic soils on the mid to lower slopes of the hill and affecting the receptor shaft and construction site pad (Curtis Island) • Small areas of soil salinity in the intertidal area have been mapped associated with The Narrows in the vicinity of Point D • Preliminary soil samples collected by O2 at the construction site pad (Curtis Island) indicated that topsoil at this location is moderately acidic, not saline and not sodic
Soil stability (refer Figure 7.5 and Figure 7.6)	Marine Crossing GTP Project (mainland)	• Erosion potential mapping has characterised the erosion potential between Point A and Point B and the southern half of the Access Road as moderate and high erosion potential has been mapped associated with the terrestrial area of the Marine Crossing GTP Project (mainland), between Point B and Point C and the northern half of the Access Road • O2 conducted an erosion risk assessment using the Revised Universal Soil Loss Equation (RUSLE), which indicated that soils within the terrestrial areas of the Marine Crossing GTP Project (mainland), including the Access Road, have a very low erosion risk rating • Areas of high risk dispersive soils are mapped in this section of the Marine Crossing GTP Project
	The Narrows (Tunnel)	• The mudflats within the intertidal area have been assessed as having moderate and moderate to low erosion potential (URS, 2009a). However, these areas will be undisturbed by the proposed tunnel construction beneath The Narrows
	Marine Crossing GTP Project(Curtis Island)	• Erosion potential mapping indicated that there is a moderate to high erosion risk, however the erosion risk assessment completed by O2 identified that the erosion risk rating for the construction site pad is low to moderate and for the area between Point D and Point E is high to extreme • Moderately dispersive soils (URS, 2009a) are mapped extending between the construction site pad (Curtis Island) in the vicinity of Point D to Point E

Environmental Value	Section	Current condition
Agricultural land and Strategic Cropping Land (refer Figure 7.4)	Marine Crossing GTP Project (mainland and Curtis Island)	• GQAL Class C, described as, *Pasture Land, that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production*, is mapped for land between Point A and Point C (mainland), the Access Road and the construction site pads, and the area of the Marine Crossing GTP Project (Curtis Island) between Point D and Point E • GQAL Class D, described as, *Non-agricultural land not suitable for agricultural uses due to extreme limitations*, is mapped for the eastern part of the construction site pad on the Mainland and overlies the tunnel alignment extending under the intertidal area through to The Narrows • Strategic Cropping Land is mapped across parts of the southern section of the Access Road alignment

7.1.2 Summary of potential impacts on land

A summary of the aspects and potential impacts related to land management is presented in Table 7.2.

Table 7.2 Aspects and potential impacts on land

Activity	Aspect	Potential impact
Clearing of vegetation on slopes, in drainage paths and adjacent to waterways	Soil stability	• Removal of vegetation results in ground disturbance which can trigger erosion, followed by sedimentation in waterways, particularly in areas of moderate to extreme erosion risk rating, steep slopes and/or comprising problematic soil conditions
Stripping of topsoil	Soil stability	• Ground disturbance can trigger erosion, followed by sedimentation in waterways
Bulk earthworks	Soil stability	• Ground disturbance can trigger erosion, followed by sedimentation in waterways • Disturbance to sodic or dispersive soils may exacerbate erosion • Soil profile inversion in areas where sodic or saline subsoils occur, resulting accelerated erosion, soil degradation and sediment movement offsite • Soil compaction reducing pore space and continuity and suitability to support vegetation
	Soil condition (mainland)	• Oxidation of ASS following disturbance of sediments and leading to generation of acid leachate and mobilisation of metals contamination in sediments, subsoils and groundwater, particularly in association with disturbance at creek crossings adjacent to intertidal areas
Formation of access tracks, laydown areas, construction site pads and launch and receptor shafts	Soil conditions (mainland and Curtis Island)	• Ground loading causes soil compaction which makes soil less suitable for supporting vegetation • Oxidation of ASS following disturbance of sediments and leading to generation of acid leachate and mobilisation of metals contamination in sediment, subsoils and groundwater in the vicinity of the construction site pads, and launch and receptor shafts
	Agricultural land and Strategic Cropping Land	• Temporary removal of land from agricultural production (including Strategic Cropping Land) during construction and use of Access Road between Forest Road and Point C

Activity	Aspect	Potential impact
	Soil stability	• Disturbance of sodic or dispersive soils may exacerbate erosion
Trenching (including watercourse crossings)	Soil stability	• Conventional open trenching can trigger accelerated erosion of exposed soils in trench voids and on batter slopes open for extended durations • Installation of waterway barriers at watercourse crossings and trenching through the bed and banks of the watercourses within the Marine Crossing GTP Project (mainland) can trigger erosion and sediment mobilisation within the watercourses • Redirecting and concentrating overland flow in trenches and watercourse crossings can trigger accelerated erosion, particularly in areas of moderate to extreme erosion risk rating, steep slopes/changes in elevation and/or compromising problematic soil conditions
	Soil condition	• Soil inversion, with greatest impact on areas where sodic subsoils occur, which if exposed to the surface, could trigger accelerated erosion • Oxidation of ASS following disturbance of sediments in the vicinity of the creek crossings leading to generation of acid leachate and mobilisation of metals contamination in sediments, subsoils and groundwater
	Agricultural land	• Temporary removal of land from agricultural production during construction work
Backfilling	Soil stability	• Potential for differential settlement of backfilled areas and inability to reinstate original compaction levels, this can cause depressions or mounds to form and may lead to drainage concentration and gullying or waterlogging • Soil profile inversion in areas where sodic or saline subsoils occur, resulting in accelerated erosion, soil degradation and sediment movement offsite
Tunnelling	Geological stability	• Abrupt change in geology encountered, such as from alluvium to rock (fault) can cause ground movement
	Soil conditions	• Oxidation of ASS following disturbance of marine clay sediments intercepted by TBM and pumped to surface treatment areas for neutralisation
Pipeline installation	Soil stability	• Burying the pipeline in subsoil may create a preferential pathway for subsurface flow; water that accumulates and flows alongside the buried pipeline pathway may result in tunnelling erosion • Temporary removal of land from agricultural production during construction

7.1.3 Summary of proposed mitigation measures for land management

Mitigation measures are proposed to manage potential impacts and to protect environmental values. The mitigation measures are summarised in Table 7.3.

Table 7.3 Summary of proposed mitigation measures for land management

Item	Outcome
Environmental protection objectives	Minimise and manage potential impacts to soils by: • Limiting the occurrence and extent of trench subsidence and soil erosion • Preventing soil inversion • Developing a stable, vegetated land surface within the Marine Crossing GTP Project post-construction
Specific objectives	• Erosion controlled and limited to that consistent with "natural processes" such that pipeline cover is maintained and land capability/suitability is not reduced • All erosion control strategies implemented, functional and maintained • All topsoil stockpiled separately and no spoil piles remain on surface after restoration • All access contained to designated areas
Control strategies	• Surface disturbance footprint has been minimised through design and selection of the proposed TBM tunnelling construction method • Impact on Strategic Cropping Land has been minimised through design of the Access Road alignment between Forest Road and Point C • Implement specific erosion and sediment controls (ESC) measures through the implementation of the SMESCP • Implement specific spoil management measures, particularly where ASS occur, through the implementation of the ASSMP • Minimise soil compaction through the implementation of designated traffic areas, haul routes and plant and equipment laydown areas identified in accordance with the CEMP • Ensure that topsoil and subsoils are properly reinstated through the implementation of the SMESCP and the LRMP • Implement specific sampling and analysis monitoring for treated ASS, site surface runoff and groundwater quality in accordance with the ASSMP Refer Table 7.7 for more details on land management control strategies to be implemented during construction, operation and decommissioning of the Marine Crossing GTP ROW
Performance indicators	• Erosion is controlled to a degree that is consistent with "natural processes" • Land capability/suitability is not being reduced • Erosion control strategies are implemented, functional and maintained • Topsoil is stored separately and no spoil piles remain on surface after restoration

More details on specific mitigation measures are presented in the accompanying management plans for ASS, ESC, Landscape Rehabilitation and Waste Management (refer Appendices A,C, E and F, respectively.)

7.2 Existing environmental values and conditions

7.2.1 Background

This chapter describes the existing environment and potential impacts related to topography, geology, soils, agricultural land and potentially contaminated land within the Marine Crossing GTP Project disturbance footprint. This assessment is based on a review of available information. This section addresses:

- The topography of the Marine Crossing GTP Project showing the significant features of the landscape
- The physical and chemical properties of the soils, identifying any influences on land contamination, ASS, erosion potential, stormwater runoff quality, rehabilitation and agricultural productivity of the land (including Strategic Cropping Land)
- The geology of the Marine Crossing GTP Project, with particular reference to the physical and chemical properties of surface and subsurface materials and geological structures within the proposed areas of disturbance
- The depth and quality of soil that is appropriate for use in accordance with the standards outlined in the *Planning Guidelines: The Identification of GQAL* (former DPI and the Department of Housing Local Government and Planning (DHLGP) 1993), which supports the State Planning Policy (SPP) 1/92: *Development and the Conservation of Agricultural Land*
- Potential land contamination from existing and historical use, based on land use history and the nature and quantity of any contaminants

Other land related issues that could potentially be affected by the Marine Crossing GTP Project include land tenure and use, landscape and visual amenity which have been addressed in Chapter 8, and flora, fauna and bioregions for the terrestrial and marine environments, which have been addressed in Chapter 10.

7.2.2 Methodology

The following methodology has been used to assess environmental values and conditions in relation to geology, terrain, soils, agricultural land and potentially contaminated soils for the areas to be disturbed by the Marine Crossing GTP Project.

Geological assessment

The area in the vicinity of the Marine Crossing GTP Project has been subject to several geotechnical investigations as part of the Project engineering studies. These include:

- Geotechnical Investigation and Analysis Report Curtis Island Road/Bridge Concept Design/The Department of the Coordinator General, Connell Wagner, December 2008 (Connell Wagner, 2008)
- Factual Report on Offshore Geotechnical Investigation, Friend Point, Port Curtis, Coffey Geotechnics, December 2009 (Coffey Geotechnical, 2009a)
- Factual Report on Offshore Geotechnical Investigation, The Narrows, Port Curtis, Coffey Geotechnics, December 2009 (Coffey Geotechnics, 2009b)
- Geotechnical Baseline Report, Curtis Island Tunnel Project, Coffey Geotechnics, April 2012

The findings of these studies, together with the review of geological mapping have been used to inform this assessment.

A total of 16 geotechnical borehole and three cone penetrometer tests were conducted as part of the geotechnical investigations. A limited number of laboratory tests have been completed on samples within the proposed pipeline alignment. Standard Penetration Tests and pocket penetrometer testing have been conducted at frequent depth intervals within the boreholes. These results were assessed alongside published correlations and engineering judgement to supplement the laboratory results to assess design parameters for the tunnel and shaft structures.

Terrain assessment

The terrain within the Marine Crossing GTP Project has been assessed in terms of geological regimes, landform types and associated soils. Terrain mapping was carried out with reference to existing geological, topographic and soils information. This information was compiled using the background data sources listed below which have provided the basis for identifying *Terrain Units*[1] that occur within the ROW (URS, 2009a):

- Colour aerial photography – The Queensland Department of Natural Resources Management and Energy (NRM&E) Series QAP 5719 flown 02/05/99 at a nominal scale of 1:40,000 for the Curtis Island segment of the Marine Crossing GTP ROW and associated construction areas, colour 06.ECW (SPOT) imagery provided by Santos for the mainland sectors of the pipeline corridor
- Route corridor topographic data with 5 m Lidar Contours provided by Santos covering the majority of the main route corridor; with Geoscience Australia (100k) 20 m Contours, supplemented by reference to Google Earth 3D imagery, in the southern sector of the corridor and in various route alternative corridor sectors considered
- Geological mapping derived from the Gladstone 1:100,000 Series Geological Mapping, included in the Geoscience Data Set compiled by the Geological Survey of Queensland (July 2004) (Geological Survey of Queensland, 2004)
- Land resources digital data sets, including CSIRO Land Research Series No. 19 (1967) Lands of the Isaac-Comet Area Queensland (CSIRO, 1967); Land Research Series No. 21 (1968) – Lands of the Dawson Fitzroy Area – Queensland (CSIRO, 1968); Land Research Series No. 34 (1974) – Lands of the Balonne-Maranoa Area Queensland (CSIRO, 1974)
- Land Resources and Evaluation of the Capricornia Coastal Lands (CCL) – Sheet 3 Calliope area, NRW Data (DNRW, 1995)
- Queensland Department of Natural Resources and Water (NRW – 2004)) regional compilation of mapping (1:250,000) Central West Region - Good Quality Agricultural Lands (GQAL) (DNRW, 2004)
- Denison Trough Gas Project – Gladstone Option. Results of Terrain Analysis and Field Investigations, prepared by Terrain Analysis QLD Pty Ltd on behalf of CSR Oil and Gas Division (CSR, 1984)

In addition to the above sources, the former Department of Natural Resources, Mines and Water's (NRMW) 1:100,000 scale geological map sheet "Gladstone Special" (Sheet 9150) was reviewed and further information was obtained from field geotechnical investigations and additional soil investigations, which have been used to 'ground truth' the Terrain Units and the enhance understanding of the existing environment. This information has been incorporated below to assess the soil, land and geological environment of the GLNG Marine Crossing GTP Project.

Assessment of soils and soil characteristics

Soil types in the Marine Crossing GTP Project have been assessed using terrain units to identify their occurrence and distribution. These are presented in Table 7.4.

Soil groups have been classified using texture grade and key features, in accordance with the Australian Soil Classification (Isbell, 2002). Soils characterised by erosion risk, dispersibility, potential contamination, salinity and presence of ASS are described as 'Problem Soils'. Soil groups along the length of the pipeline from Fairview to the Curtis Island

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1 A terrain unit comprises a single or recurring area of land that is considered to have a predictable combination of physical attributes in terms of bedrock, surface slope and form, and soil/substrate conditions (URS, 2009a)

LNG Facility have been determined during the EIS from interpretation of available data, combined with field logs and visual interpretation from photographs of soil exposures (URS, 2009a).

In addition to these sources the following investigations have also been conducted as part of the preparation of this EMP:

- Phase 1 Acid Sulfate Soil Investigation Santos GLNG Pipeline Route – The Narrows, Gladstone, Golder Associates, June 2012 (Golder, 2012)
- Stormwater Management and Erosion and Sediment Control Plan Marine Crossing – Gas Transmission Pipeline, O2 Environment + Engineering, May 2012 (O2, 2012b)

Salinity in the Marine Crossing GTP Project was rated during the EIS (URS, 2009a) based on the following soil attributes (refer Figure 7.6):

- *Low (L)* – electrical conductivity (EC) (mS/cm) <0.25 (sand), <0.4 (loam), <0.55 (clay) – Nil to low salinity
- *Moderate (M)* – EC (mS/cm) 0.25-0.47 (sand), 0.4-0.8 (loam), 0.55-1.15 (clay) – Medium salinity
- *High (H)* – EC (mS/cm) >0.47 (sand), >-0.8 (loam), >1.15 (clay) – High to very high salinity

Sodicity in the Marine Crossing GTP Project was rated based on exchangeable sodium percentage (ESP) (taken from Northcote and Skene, 1972) is illustrated in Figure 7.6 and is described as follows:

- *Negligible* – very low or non Sodic, ESP <6%
- *Rating 1* – Sodic, ESP 6-14%
- *Rating 2* – Strongly sodic, ESP >14%
- *Rating 3* – Very strongly sodic, ESP >25%

Soil reactivity within the Marine Crossing GTP Project was rated during the EIS (URS, 2009a) based on the following soil attributes and is shown in Figure 7.6:

- *Low* – Nil or low reactivity, predominately sandy coarse-textured soils with Kaolin clay minerals where present
- *R1* – Moderately reactive soil, (eg soils which have medium to heavy clay subsoils, but are not subject to substantial soil swelling or shrinkage) mainly illite clay minerals present
- *R2* – Shallow or medium deep, highly reactive (cracking) clay soils, underlain by low or non-reactive substrate soils or weathered rock
- *R3* – Deep, highly reactive (cracking) clay soils subject to substantial swelling and shrinkage on wetting and drying; mainly smectite clay minerals present

Potential Acid Sulfate Soils (PASS) were assessed from previous reports. Preliminary investigations in the vicinity of the Marine Crossing GTP Project have been completed by Ross (DNRM, 2004), Coffey Geotechnics (2009a and 2009b), URS (2009a), GHD (2009), Worley Parsons (2010a) and Golder Associates Pty Ltd (2012). Queensland Government ASS mapping was also referred to.

Assessment of agricultural land capability

An assessment of the agricultural land capability of the area was conducted for the EIS to provide a benchmark of existing/potential agricultural land use (URS, 2009a). Land within the Marine Crossing GTP Project was identified in accordance with SPP 1/92: *Development* *and the Conservation of Agricultural Land*. The assessment was based on the four class system for defining GQAL as detailed in the Planning Guidelines (DPI/DHLGP, 1993).

Potentially contaminated land assessment

A baseline assessment was conducted in accordance with the *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland* (DoE, 1998) and included a Tier 1 and Tier 2 review as follows:

- *Tier 1 comprised a review of aerial photography within the Marine Crossing GTP Project to identify high risk sites or Areas of Potential Concern (AOPC). AOPC were identified based on the presence of visible infrastructure associated with potentially contaminating activities such as chemical storage tanks, cattle dip sites, industrial facilities and other notifiable activities, as contained in the EP Act*
- *A Tier 2 assessment was then conducted on the identified AOPC and included:*
  - A review of historical aerial photographs
  - A search of historical titles
  - A search of DEHP (formerly DERM) land registers, including the Environmental Management Register (EMR) and Contaminated Land Register (CLR)
  - A search of local government records (eg development applications, Flammable and Combustible chemical storage or Dangerous Goods licenses)

In addition to these sources, Waste Solutions Australia Pty Ltd was also commissioned to complete a Stage 2 Environmental Site Assessment (Waste Solutions, 2012).

7.2.3 Geology

Review of geological mapping

The published geological map, NRMW's 1:100,000 scale geological map sheet "Gladstone Special" (Sheet 9150) indicates that the Marine Crossing GTP ROW and associated construction areas are underlain by the following geological units:

- Quaternary age estuarine and coastal sediments comprising sandy mud and muddy sand
- Tertiary age Narrows Group comprising claystone, shale, sandstone, mudstone, limestone and/or conglomerate
- Carboniferous age Curtis Island Group, (the Doonside, Wandilla and Shoalwater Formations) comprising metamorphosed and deformed mudstone, siltstone, sandstone, quartz greywacke, cherts and phyllite

Existing data suggests that the Palaeozoic age Curtis Island Group subcrop close to the surface on the Curtis Island side of The Narrows, and underlie the estuarine/coastal sediments in the eastern portion of the marine channel.

Tertiary age lacustrine sedimentary rocks from The Narrows Group comprise the Curlew, Rundle and Worthington Formations underlying the estuarine sediments in the western portion of the marine channel. On the mainland, these rocks occur close to the surface, overlain by a few metres of residual soils developed from weathered sedimentary rocks.

The published geological map also indicates that locally The Narrows Group rocks are overlain by unconsolidated Tertiary or Quaternary to Tertiary age sediments comprising clay, silt, sand and gravel. Colluvial sediments comprising clay, silt, sand and gravel also occur in this area, generally related to infilled old valleys. The youngest sediments (ie the Quaternary age estuarine and coastal sediments) generally comprise interbedded sandy and clayey/silty estuarine sediment on the mudflats and coastal sands and gravelly sands in the marine channel.

Geological structural features and faults

From the published geological maps it is apparent that extensive faulting exists within the Marine Crossing GTP Project, especially beneath The Narrows. The 'Rockhampton' sheet shows faults running northwest/southeast immediately offshore to the west of Curtis Island, and approximately east/west along Graham's Creek. In contrast, the "Gladstone Special" 1:100,000 map has removed the fault running northwest/southeast through The Narrows and instead extended a parallel fault in the region of the Kangaroo Island tidal mudflats (Connell Wagner, 2008).

The "Gladstone Special" 1:100,000 map shows The Narrows Graben running parallel to The Narrows, with the eastern extent of the fault crossing Kangaroo Island, and the western extent running parallel approximately 3 km inland. A cross section of the regional geology in the Marine Crossing GTP Project, including a section of The Narrows Graben and faults are presented on The "Gladstone Special" (Sheet 9150).

Although the exact location and continuity of the fault is not known, large faults are indicated on the local geology maps. These faults are not thought to be active at the present time, however their existence can produce large variations in the existing underlying geology, specifically changes in rock type and, potentially significant changes to rockhead level.

The regional geological regime of the Marine Crossing GTP Project is presented in Figure 7.1.

Review of geotechnical investigations

Site investigations have been conducted for the mainland, The Narrows and Curtis Island areas. The proposed tunnel traverses under the mudflats associated with the intertidal area and through The Narrows Graben under The Narrows.

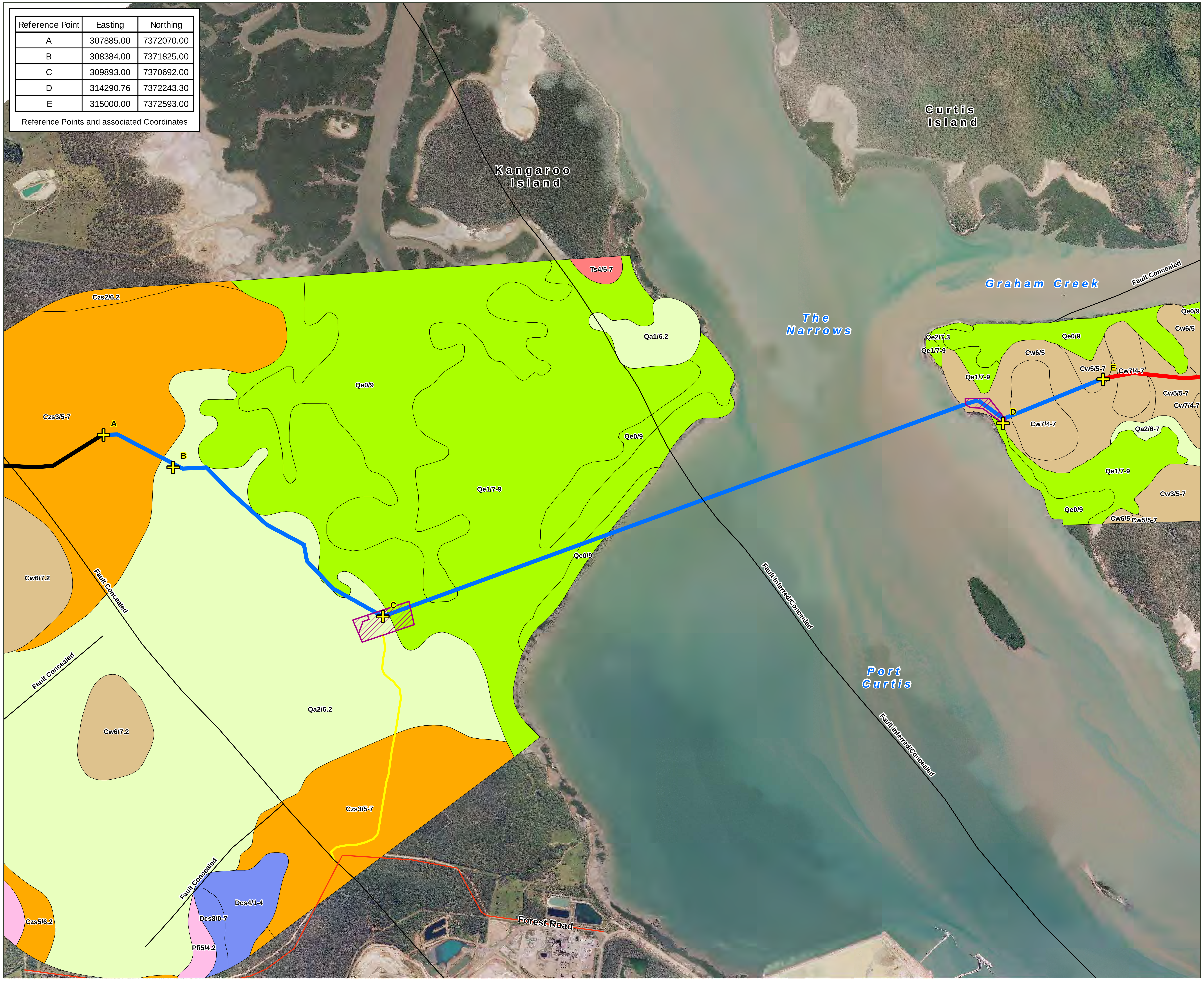
The location of the eastern bounding fault is not well defined with no surface expansion. Recent studies of The Narrows may locate the eastern fault further east of the location shown on the published geological map. Primarily based on geophysical investigations, this fault could be 1,400 m further east at a location within the centre of The Narrows channel. Two other local faults have been interpreted to be present in The Narrows but locations are speculative at this stage of investigation.

Whilst historically modern earthquakes are expected to have occurred in the area, a desktop study has not revealed any recent activity (eg within the last 12,000 years).

Boreholes drilled in the area as part of previous geotechnical investigations encountered soils and rocks consistent with the geological units indicated on the geological mapping.

The interpreted stratigraphy of the site identified seven longitudinal sections along the tunnel alignment, displaying similar geological and faulting characteristics within each section. Index properties for soils were determined, together with soil grading in order to assist in the characterisation of materials, particularly sand and gravels. Limited soil strength testing results were available from samples collected but considered sufficient to determine soil strength parameters, based on empirical correlations for cohesive soils and engineering judgement.

The tunnel alignment passes through regions of varying geological characteristics in both the vertical and horizontal profiles. The marine alluvium, found near the surface is anticipated to



Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_019.mxd 20/06/2012 15:44

A1 scale: 1:15,000

0 250 500 750 1,000 1,250m

GLNG No: 3381-40-0438

Coordinate system: GCS_GDA_1994

Santos GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)

- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Geology

- Cw Carboniferous Wandilla Formation
- Czs Cainozoic Sediments
- Dcs Late Devonian Intermediate Extrusive Rocks
- Pfi Late Permian-Early Triassic Felsic Intrusives
- Qa Quaternary Alluvium
- Qe Quaternary (Holocene) Estuarine Sediments
- Ts Tertiary Sediments
- Fault
- Road

Note: All figures should be reviewed in conjunction with Table 7.1 *"Generic Key to the identification of Terrain Units", URS 2009.*

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
GTP Marine Crossing Reference Points: GLNG, Apr 2012.
Aerial Imagery: Santos, Feb 2011.
GLNG Terrain Units: Supplementary EIS, URS, 2009.

Geological Regime
Figure 7.1

Date: 20/06/2012 Version: I

pass through the crown of the tunnel. The remaining units are of high importance to tunnelling conditions. The geological conditions encountered at tunnel level can simply be divided into regions based on longitudinal stratigraphy.

There has been limited geological investigation work undertaken in the vicinity of the proposed tunnel alignment, however the TBM tunnelling method has been selected having regard for the geological conditions that are expected to be encountered beneath The Narrows. Detailed geotechnical investigation of the proposed Marine Crossing GTP route will be completed prior to commencing tunnelling

The TBM has been specifically selected for its ability to be operated in two modes depending on the geological conditions encountered and allows for its conversion between the two operating modes in order to manage differing geological conditions.

The geology, within the Marine Crossing GTP Project is further discussed for each of the following three sections (refer Figure 7.1):

- Mainland: Point A to Point C
- The Narrows: Point C to Point D
- Curtis Island: Point D to Point E

Marine Crossing GTP Project (mainland)

In the terrestrial areas between Point A and Point C, the geological mapping illustrates the geological regime as Quaternary Sediments. These are comprised mainly of sandy sediment with some gravel and clay (residual soils). At Point B, the surface geology is Quaternary alluvium, comprising of sand, silt and gravel (floodplain alluvium).

The Narrows (Tunnel)

The geological maps indicate that the geological regime between Point C and Point D is generally comprised of Tertiary and Lower Paleozoic aged formations. There are three principal rock formations making up the Paleozoic aged Curtis Island Group, the Doonside, Wandilla and Shoalwater formations. The principal rock types of these formations comprise mudstones, siltstone, sandstone, quartz greywacke, cherts and phyllite (Connell Wagner, 2008).

The geological cross section shown on “Gladstone Special” (Sheet 9150) suggests that these materials should exist from close to the surface on the Curtis Island side of The Narrows, and underlie tertiary aged rocks from The Narrows Group on the mainland side of The Narrows. The Narrows Group is comprised of three formations, the Curlew, Rundle and Worthington Formations, all generally comprised of sedimentary rocks; namely claystone, shale, sandstone, mudstone, limestone and/or conglomerate (Connell Wagner, 2008).

Quaternary sediments are likely to be present on the surface of active stream channels and low terraces (clay, silt, sand and gravel).

Marine Crossing GTP Project (Curtis Island)

On Curtis Island, between Point D and Point E, the geological maps indicate that the onshore areas of the Marine Crossing GTP ROW and associated construction areas are generally comprised of Lower Paleozoic aged formations. The maps indicate that the principal rock formations likely to be encountered in these regions are the Doonside and Wandilla formations (members of the Curtis Island Group). The principal rock types of these formations comprise mudstones, siltstone, sandstone, quartz greywacke, cherts and phyllite. Due to the close proximity of the site to the Port of Gladstone and the presence of creek beds across the site, it was also expected that Quaternary Alluvium material would be encountered during this investigation, especially in boreholes located near to the existing intertidal area or in localised depressions. This would likely include unconsolidated or slightly consolidated clay, sand, silt and gravel materials (Connell Wagner, 2008).

7.2.4 Topography

Marine Crossing GTP Project (mainland)

On the mainland, between Point A and Point C, the Marine Crossing GTP Project traverses undulating to near flat Quaternary alluvial plains, local gently inclined footslopes and outwash fan deposits with overall slopes ranging between 3% and 7%, mapped as containing mostly sandy and loamy surface duplex sodic soils (Sodosols).

The Narrows (Tunnel)

Overlying The Narrows tunnel, between Point C and Point D the terrain consists of mudflats associated with the intertidal area, with some mangrove habitat on the fringes of Friend Point (mainland) and Laird Point (Curtis Island).

Marine Crossing GTP Project (Curtis Island)

On Curtis Island, between Point D and Point E the Marine Crossing GTP Project traverses gently to moderately inclined mid to lower slopes and footslopes (mostly < 12%) of low rounded hilly and steep to very steep higher hilly lands developed on lithic sandstone and other sedimentary rock sequences, including greywacke and in places meta-sediments associated with the Carboniferous Wandilla Formation.

These hilly lands have intervening narrow valley floors and undulating valley plains, locally with alluvial drainage-ways included. The soils in these areas are mapped as comprising deep soft saline clays, silt and muddy sand soils on the estuarine flats (Intertidal and Extratidal Hydrosols), with deep uniform clay soils and silt loamy surface duplex soils (Dermosols and Sodosols) on the alluvial flats and drainage-ways. Medium to deep gravelly loamy surface duplex soils (Chromosols and Sodosols) and uniform or gradational gravelly clay soils (Dermosols) occur on the lower hill slopes and the valley plains (URS, 2009a).

The topography of the Marine Crossing GTP Project is presented in Figure 7.2.

7.2.5 Soils

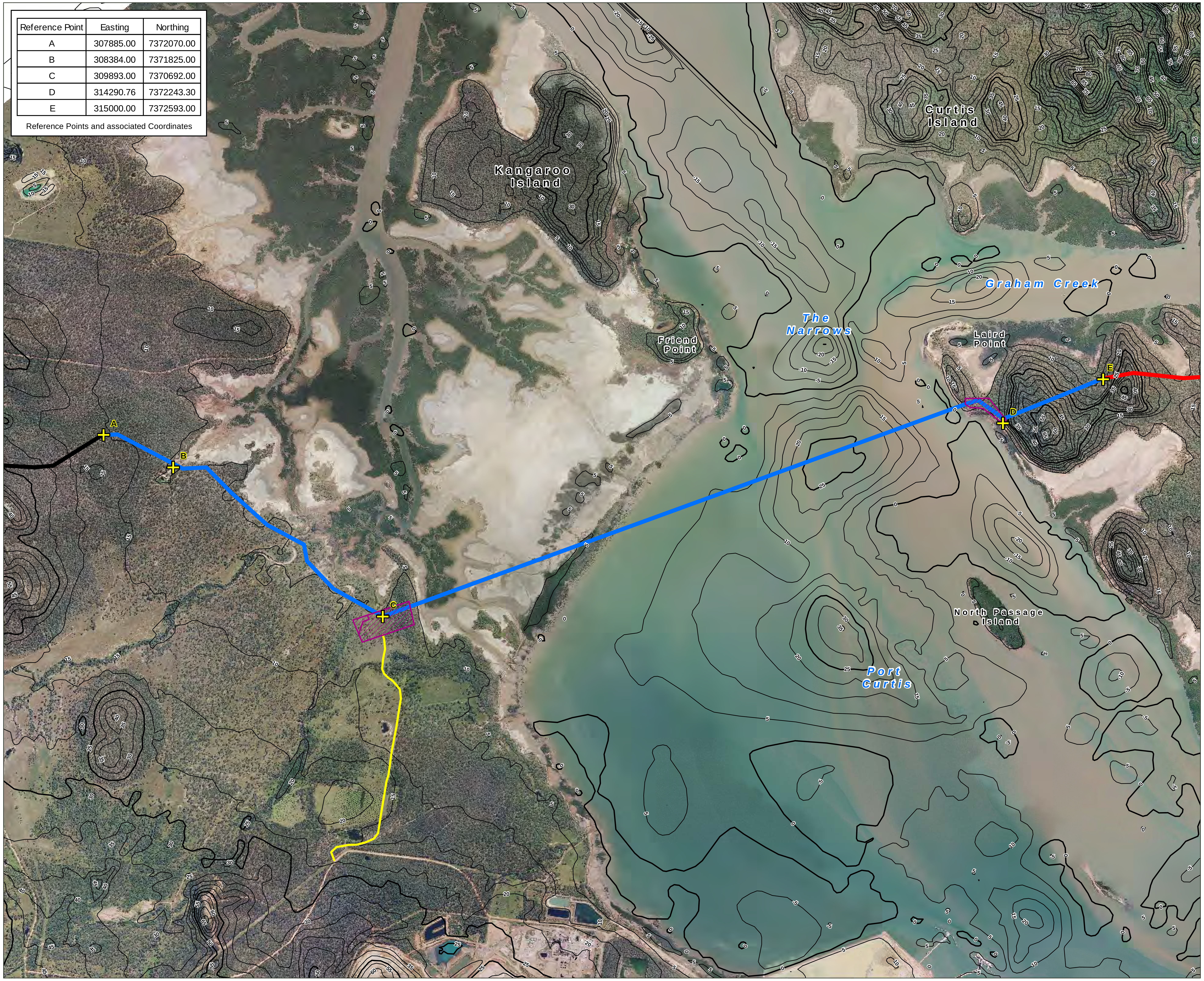
Soil characteristics are strongly related to parent material, formation process and relief according to the Australian Soil and Land Survey Field Handbook (McDonald *et al.*, 1990). The dominant parent material within the Marine Crossing GTP Project is sedimentary rocks (as discussed in Section 7.2.3) as well as alluvium and colluvium.

Santos
GLNG Project

Marine Crossing GTP EMP

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates



Gas Transmission Pipeline (GTP)

- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road
- Contour (5m)
- Contour (25m)

Note: All figures should be reviewed in conjunction with Table 7.1 *"Generic Key to the identification of Terrain Units", URS 2009.*

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
GTP Marine Crossing Reference Points: GLNG, Apr 2012.
Aerial Imagery: Santos, Feb 2011.
Topography: Santos, Apr 2012.

Topography
Figure 7.2

A1 scale: 1:15,000
0 250 500 750 1,000 1,250m

GLNG No: 3381-40-0439
Coordinate system: GCS_GDA_1994

Date: 20/06/2012 Version: I

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_024.mxd 20/06/2012 15:46

Terrain Unit Distribution within the Marine Crossing GTP Project

Soil types within the Marine Crossing GTP Project have been assessed using terrain units to identify their occurrence and distribution.

The distribution of geology, landform and soil groups as terrain units within the Marine Crossing GTP Project is presented in Figure 7.1 and descriptions are provided in Table 7.4. Note that information on terrain units should be read in conjunction with *"Generic Key to the identification of Terrain Units",* (URS, 2009a). This key represents all possible combinations of geological regime, landform-terrain type and soils that occur along the ROW from Fairview to Curtis Island. Only some of these combinations are present within the Marine Crossing GTP Project.

Table 7.4 Generic Key to the Identification of Terrain Units

Generic Key to the Identification of Terrain Units

GEOLOGICAL REGIME

Symbol	Description
Qe	Quaternary (Holocene) Estuarine Sediments
Qa	Quaternary Alluvium
Czs	Cainozoic Sediments
Ts	Tertiary Sediments
Tb	Tertiary Volcanic Rocks mostly basalt
Jp	Jurassic Precipice Sandstone
Je	Early-Middle Jurassic Evergreen Formation
Jh	Early Jurassic Hutton Sandstone
Rc	Early-Middle Triassic Clematis Group
Rm	Triassic Moolayember Formation
Ra	Triassic Arcadia Formation, Rewan Group
Ps	Permian Sediments
Pv	Permian Volcanics
Pfi	Late Permian-Early Triassic Felsic Intrusives
Pii	Late Permian Intermediate Intrusive Rocks
Ct	Carboniferous Torsdale Volcanics
Cr	Carboniferous Rockhampton Group
Cw	Carboniferous Wandilla Formation
Dce	Late Devonian Intermediate Extrusive Rocks
Sf	Silurian-Devonian Volcaniclastic Rocks
W	Water Body
D	Disturbed Area – not mapped
Note:	Refer to EIS Report Section 1.3 for more detailed descriptions of Geological Regimes

LANDFORM – TERRAIN TYPE

Type	Surface Form and Slope
0	Channel floors, banks and active levees of major streams and waterways with irregular steep, and locally benched bank slopes and low flood terraces. Locally tidal mangrove and marine flats and tidal inlets with mangroves fringing.
1	Floodplains, alluvial flats, lower stream terraces and flat to broadly depressional backplains, slopes typically <1%; periodically floodprone and locally poorly drained areas. Locally comprising estuarine/marine plains, extratidal and supratidal flats subject to periodic tidal inundation; slopes mostly <0.5%.
2	Flat to gently undulating or gently inclined intermediate to higher stream terraces, older alluvial plains or, floodplains and higher stream terraces, with slopes generally <2%; occasionally floodprone in lower-lying areas and along tributary drainage channels.
3	Undulating plain and gently rolling to broadly rounded rises with gently inclined planar to concave intervening lower-lying broadly depressional areas; slopes mostly in the range 1-3%.
4	Undulating to strongly undulating plains and rolling rises, locally flat to undulating upland plateau crestal areas and undulating uplands; with slopes mostly in the range 3-5%.
5	Gently to moderately inclined planar to concave intermediate to lower hill and ridge slopes or convex planar dissection slope interfluves; slopes variable mostly within the range 5-12%.
6	Isolated low rounded hills and rises and low hilly lands mostly with broadly rounded crestal areas and hill slopes in the range 12-25%.
7	Steep hilly lands with mostly narrow rounded hill and ridge crests and steep irregular planar hill and ridge slopes mostly in the range 20-40%
8	Steep to very steep ridges and high hilly lands; mostly with narrow rounded ridge and spur crests, with slopes typically in the range 30-50%, with local sub-vertical rocky scarps and bluffs
9	Very steep high hilly to mountainous lands or very steep to locally sub-vertical or vertical escarpment slopes 35 ->100%.

Example Terrain Unit Qa2/6-7

Qa	2	6-7
(Geological Regime)	(Landform)	(Soils)

SOILS

Group	Soil Types [1]
0	Extensive areas of rock outcrop, locally with skeletal to shallow usually stony or gravelly soils
1	Skeletal, rocky or gravelly soils (>60% coarse fragments) with sandy, silty, loamy or clayey soil matrix (K- Uc1, Um1, Gn1, Uf1).
2	Sand soils; shallow to deep uniform or weakly gradational profiles, includes stratified alluvial soils, residual sand soils, earthy sands (Uc1-Uc6) [2], Rudosols or Tenosol Soil Orders. [3]
3	Coarse to medium-textured soils; uniform or gradational profiles; predominantly sandy earths, silty or clayey sand profiles (Uc4-5, Um1-3); Tenosols or Podosol Soil Orders.
4	Medium-textured sandy, sandy loam or silt to clay loamy surface uniform or gradational profiles, often (siliceous or ferruginous) gravelly or stony soils; (Um4-7, Gn1-2); Tenosols, Kandosols or Ferrosol Soil Orders.
5	Sandy to loamy surface duplex soils with neutral to acidic, in places strongly acidic sandy clay to medium to heavy clay subsoils (Dr1-5, Dy1-5); Chromosol or Kurosol Soil Orders.
6	Fine sandy, silty or clay loamy surface duplex soils with neutral to alkaline often calcareous, sodic and locally saline medium to heavy clay or heavy clay subsoils; (Db-Dd-Dy1-5); Chromosols, Sodosols or Calcarosols Soil Orders.
7	Uniform fine-textured (non-cracking) clay soils or gradational clay loam or light clay surface soils with acidic or alkaline often sodic and/or saline medium to heavy clay subsoils – locally incipient cracking clays; (Uf5-6); Dermosol or Hydrosol Soil Orders.
8	Uniform fine-textured (cracking) clay soils, locally with thin self-mulching surficial soils with dark grey, brown or black mostly alkaline or alkaline over acidic heavy clay subsoils; (Ug5-Ug6); Vertosols Soil Order.
9	Uniform, weakly gradational or weak duplex soils with highly organic silty to clay loamy surficial soils and seasonally or permanently saturated often gleyed and saline silty clay or medium to heavy clay subsoils; Um, Dd-Dy, Uf-Ug 5-6 profiles; Organosols, Hydrosols some Vertosol Soil Orders.

Notes:- (1) – Soil profile form and texture class
(2) – Principal Profile Form (Northcote, 1974)
(3) – Australian Soil Classification (Isbell, 1996)
Dual symbols eg (2-7) indicate both soil types may be present.

Soil groups

Nine soil groups were identified as occurring across the length of the pipeline from Fairview to the Curtis Island LNG Facility, however a review of the EIS mapping indicates that only five of these soil groups (Groups 4 to 7 and 9) occur within the Marine Crossing GTP Project disturbance footprint. These groups along with their typical characteristics, constraints and properties are summarised below.

The five broad soil groups that occur within the Marine Crossing GTP Project disturbance footprint (Groups 4 to 7 and 9) are listed from least to most clay content. The occurrence of these Soil Texture Groups is shown in Figure 7.3.

Soil Group 4 – Sandy Uniform and Gradational Soils

Soil Group 4 – Sandy Uniform and Gradational Soils have the following characteristics:

- Uniform or gradational loam to clay loam soil profiles with clay loam, light clay or medium clay subsoils
- Soil depth varies from 0.2 m to 1.0 m
- Soils have massive to weakly structured subsoils
- Soils are frequently stony or gravelly
- Soils are generally red or brown in colour

Within the Marine Crossing GTP Project, these soils occur on Curtis Island at Point E, within terrain unit Cw7/4-7 (refer Table 7.4), located on the higher parts of the crestal areas and upper marginal slopes of hilly lands where they comprise mainly shallow (<0.5 m) stony and/or ferruginous, gravelly, uniform or weakly gradational brownish black, brown, red-brown or red massive loams and clay loam soil profiles, underlain by weathered rock. These soils are classified as Leptic Rudosols and Red-Brown Kandosols.

Soil Group 5 - Sandy Texture Contrast Soils

Soils have a distinct texture contrast between the surface horizon and the subsoil, generally with a change from sandy to loamy with sandy clay to medium to heavy clay subsoils. The boundaries between the horizons are clear, abrupt or sharp, and subsoils have mostly acidic to neutral or slightly alkaline pH levels.

Within the Marine Crossing GTP Project these soils occur immediately inland of the Curtis Island foreshore, in terrain unit Cw6/5 (refer Table 7.4). Soils have variable depth (0.1 to 0.3 m) of surface soils, consisting of sandy, sandy loam or loamy surface soils that tend to be hard-setting, usually with a pale or bleached (A2) subsurface horizon underlain by brown or yellowish brown sandy clay or medium clay neutral to moderately acidic hard, medium to coarse blocky structured subsoils. These soils are classified as Red-Brown Chromosols, Red-Brown Sodosols and Sodic Kurosols.

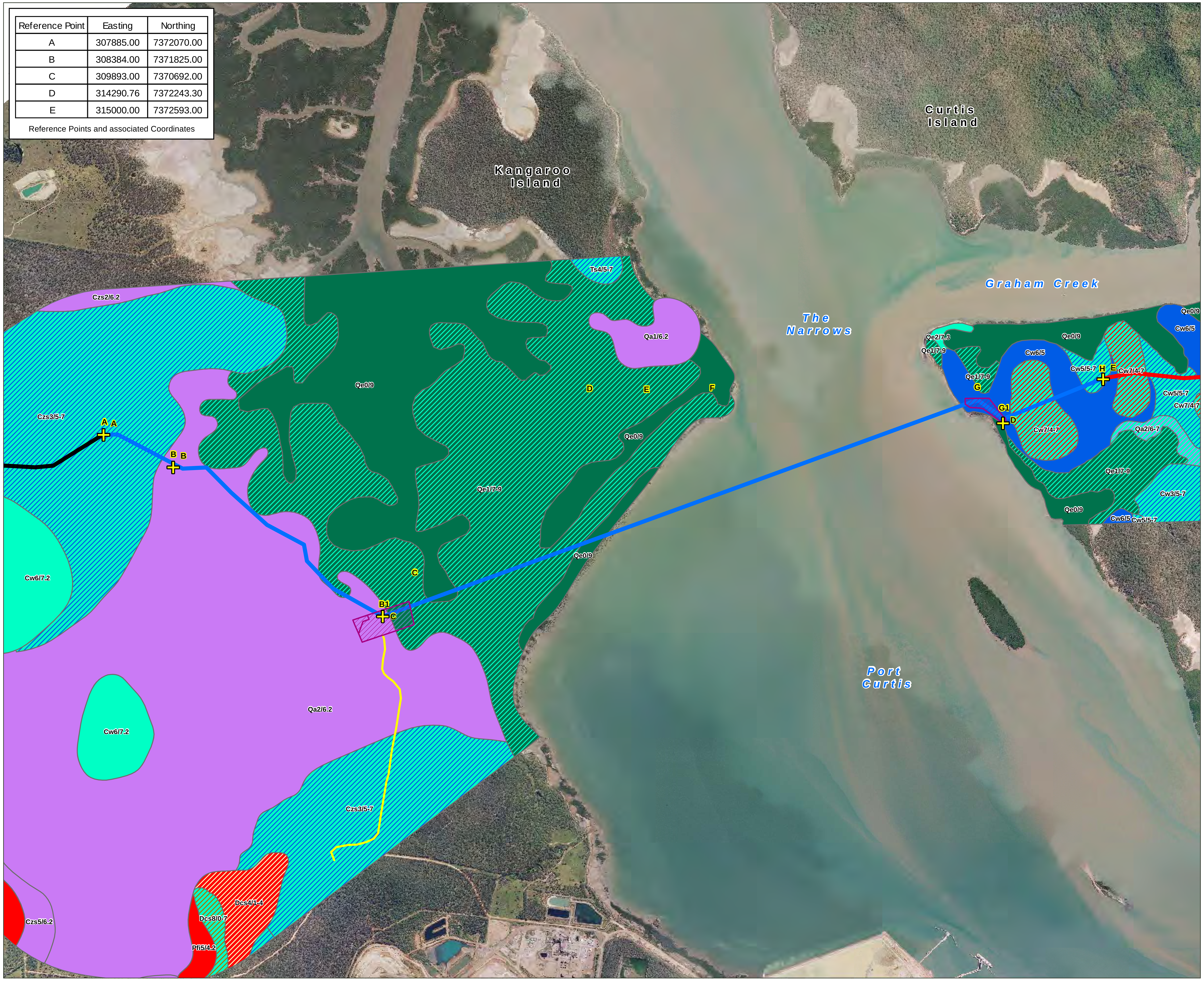
Soil Group 6 – Loamy Texture Contrast Soils

Soil Group 6 – Loamy Texture Contrast Soils have the following characteristics:

- Soils have a distinct texture contrast between the surface horizon and the subsoil
- Surface soils are mostly thin fine sandy loam, silt loam or clay loam with medium to heavy clay or heavy clay subsoils
- Subsoils are neutral to alkaline, often strongly alkaline, usually with carbonate present

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates



Santos
GLNG Project

Marine Crossing
GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Soil Group
- 4 - Medium-textured gravelly uniform or gradational loam to clay loam soils
- 5 - Sandy or loamy duplex profiles with clay subsoils
- 6 - Loamy or clayey duplex profiles with medium to heavy clay subsoils
- 7 - Shallow and deep uniform fine-textured (non-cracking) clay soils
- 9 - Tidal area soils

Combined Soil Group
- 0-7
- 1-4
- 4-7
- 5-7
- 6-7
- 7-9

Note: All figures should be reviewed in conjunction with Table 7.1 *"Generic Key to the identification of Terrain Units", URS 2009.*

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
GTP Marine Crossing Reference Points: GLNG, Apr 2012.
Aerial Imagery: Santos, Feb 2011.
GLNG Terrain Units: Supplementary EIS, URS, 2009.

Soil Groups
Figure 7.3

A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0440

Coordinate system: GCS_GDA_1994

Date: 20/06/2012

Version: I

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_020.mxd 20/06/2012 15:49

These soils occur on the undulating to near flat Quaternary alluvial plains, local gently inclined footslopes and outwash fan deposits within terrain unit Qa2/6.2 (refer Table 7.4). The soils comprise medium to deep (0.5 to >1.0 m) mainly thin (<0.3 m) hardsetting slightly acidic, fine sandy to silt loamy or clay loamy surface duplex soils in places with a pale or bleached subsurface (A2) horizon. There is a sharp transition to the subsoil (B) horizon which comprises brown, yellow-brown or red-brown alkaline to strongly alkaline medium to heavy clay subsoils, which have moderate amounts of soft carbonate inclusions and weak to moderate blocky to columnar soil structure with hard dry consistence. The deeper subsoils tend to become more massive, apedal and strongly cohesive heavy clays with low to moderate levels of sodicity and salinity usually present. These soils may be classified as Red-Yellow-Brown Calcic Mesonatric Sodosols.

Soil Group 7 – Uniform or Gradational Non-Cracking Soils

Soil Group 7 – Uniform or Gradational Non-cracking soils have the following characteristics:

- Shallow and deep uniform fine textured (non-cracking) clay soils and gradational soils
- Clay loam or light clayey surface soils with either acidic or alkaline, often sodic and in places saline medium to heavy clay or heavy clay subsoils
- Locally the soils tend to exhibit characteristics of (incipient) cracking clay soils

Within the mainland section of the Marine Crossing GTP Project, these soils occur in association with the Soil Group 9 (marine clays). On Curtis Island, these soil profiles occur locally in association with soils of Group 5 on the lower footslopes in terrain unit Cw5/5-7 (refer Table 7.4) at Point E. In both locations soils comprise deep uniform clays or gradational brown to yellowish red silty clay or heavy clay surface soils with diffusely mottled reddish-brown, brown or yellow-brown neutral to acidic, in places strongly acidic, sodic subsoils and locally, approaching the coast, moderately to highly saline in medium to heavy or heavy clay subsoils. These soils may be classified as Acidic Sodic Mottled Grey, Brown and Red-brown Dermosols or Acidic Sodic Dermosolic Hydrosols.

Soil Group 9 - Organic silty clays with seasonally or permanently saturated subsoil

As mapped, these soils occur on the intertidal mangrove flats and tidal inlets in terrain unit Qe0/9 (refer Table 7.4) and in the estuarine supratidal and extratidal flats in terrain unit Qe1/7-9 (refer Table 7.4), which occur along the coastal fringe on Curtis Island, along the southern boundary of Graham Creek.

These soils varied considerably and included a wide range of 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, silty sand or sandy mud.

7.2.6 GQAL

Four classes of agricultural land have been defined in Queensland, as described in Table 7.5.

Table 7.5 GQAL Classes

Class	Description
Class A	Cropland – Land that is suitable for current and potential crops with limitations to production which range from none to moderate levels. Considered to be GQAL in all areas
Class B	Limited cropland – Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping. Considered to be GQAL in most areas
Class C	Pasture land – Land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment. Not considered to be GQAL
Class D	Non-agricultural land – Land is not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage. Not considered to be GQAL

Source: DPI/DHLGP, 1993

Class A land in all areas is considered to be GQAL. In some areas, Class B land (where agricultural land is scarce) and better quality Class C land (where pastoral industries predominate), are also considered to be GQAL (DPI/DHLGP, 1993).

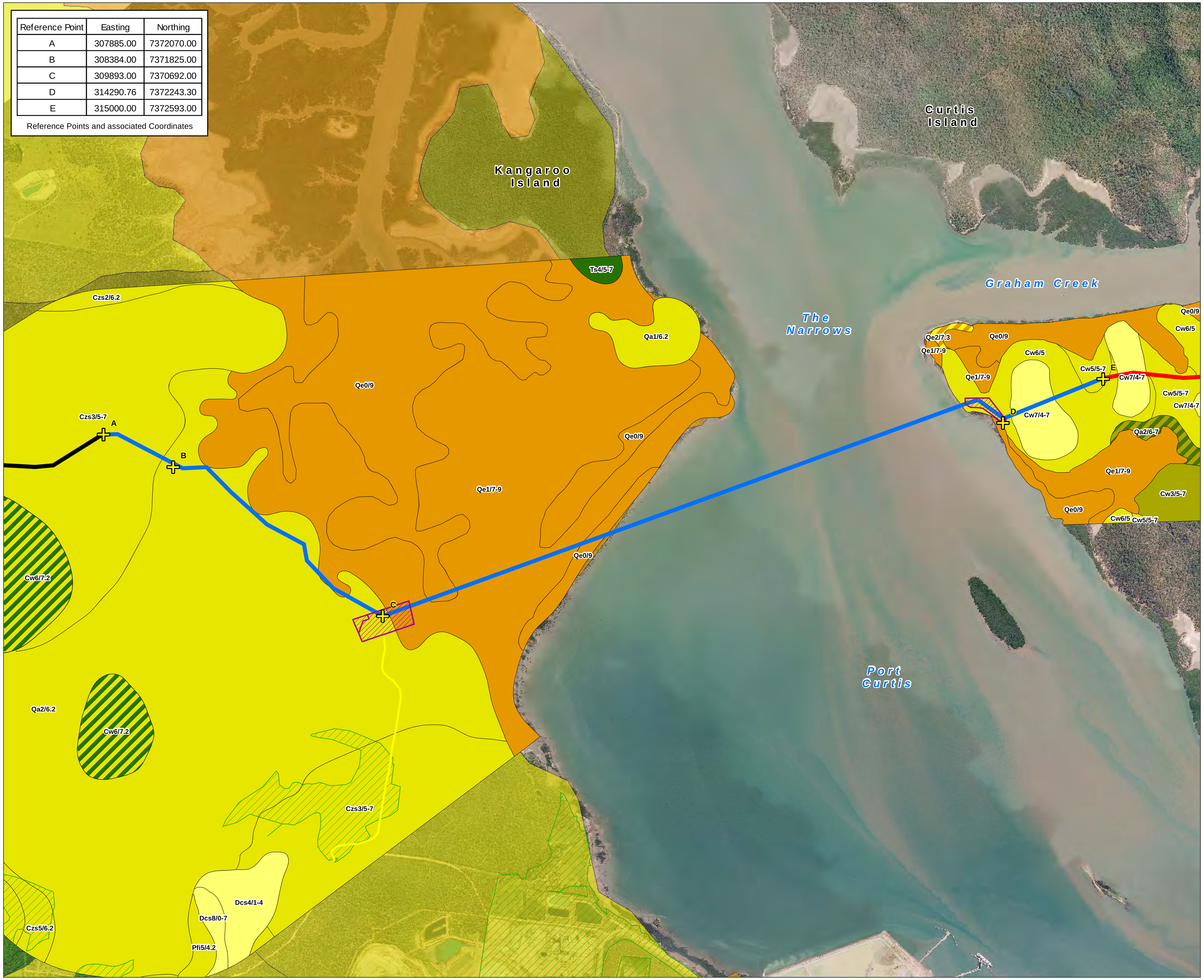
The assessment of GQAL within the Marine Crossing GTP Project was undertaken by reviewing terrain classes, as Queensland GQAL mapping does not currently cover the entire extent of the Marine Crossing GTP Project disturbance footprint. The occurrence and distribution of agricultural land classes within this area is shown in Figure 7.4.

The mapping identifies the mainland section between Point A and Point C (in terrain unit Czs3/5-7 and Qa2/6.2) as Class C2 Agricultural Land. This is a subclass of Class C GQAL and is considered to be land primarily suited to grazing of native pastures, with or without the addition of improved pasture species but without ground disturbance.

In the vicinity of the construction site pad (mainland) the mapping indicates that Class D Agricultural Land is associated with terrain unit Qe1/7-9. This land is considered to be non-agricultural land that is not considered to be GQAL and is not suitable for agricultural uses due to extreme limitations.

On Curtis Island, the mapping identified Class C2 Agricultural Land in association with terrain units Cw6/5 and Cw5/5-7. The hilly areas of terrain unit Cw7/4-7 have been classified Class C3 Agricultural Land, which is considered to be land that is suited to restricted light grazing of native pastures in accessible areas, otherwise steep to very steep hilly lands more suited for forestry, conservation or catchment protection.

It is noted that the Marine Crossing GTP Project (excluding The Narrows) falls within the GSDA. The GSDA has been established in recognition of the overriding need for orderly industrial development in the Gladstone/Curtis Island area as delineated by the former DIP (CG, 2010). The purpose of the GSDA is to secure and protect land for industrial development. This land has therefore been reserved for industrial use and is therefore not intended to be used for agricultural purposes as a primary use.



Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road
- Strategic Cropping Land

Agricultural Land Class
- A
- A , C1
- A-C2
- C1
- C2
- C3
- C-D
- D

Good Quality Agricultural Land (DERM)
- A
- C1
- C2
- D

Note: All figures should be reviewed in conjunction with Table 7.1 *"Generic Key to the identification of Terrain Units", URS 2009.*

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
GTP Marine Crossing Reference Points: GLNG, Apr 2012.
Aerial Imagery: Santos, Feb 2011.
Strategic Cropping Land: Department of Management and Resource Management, Sep 2011.
Good Quality Agricultural Land: Department of Environment, Resource and Management, Feb 2011.
GLNG Terrain Units: Supplementary EIS, URS, 2009.

Good Quality Agricultural Land and Strategic Cropping Land Figure 7.4

A1 scale: 1:15,000

0 250 500 750 1,000 1,250m

GLNG No: 3381-40-0441

Coordinate system: GCS_GDA_1994

Date: 20/06/2012

Version: I

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_047.mxd 20/06/2012 15:51

Strategic cropping land

Figure 7.4 shows the preliminary Strategic Cropping Land mapping produced by the Queensland Government, and indicates that the majority of the Marine Crossing GTP Project areas do not lie within an area classified as Strategic Cropping Land or potential Strategic Cropping Land as defined under the *Strategic Cropping Land Act 2011*. However, the proposed alignment for the construction of the Access Road does intercept an area of mapped potential Strategic Cropping Land at the southern extent of the alignment and where it joins Forest Road. A review of aerial photography indicates that parts of this area are currently used for fruit growing activities.

7.2.7 Soil salinity

Salinity refers to the concentration of soluble salts in the soil water and is measured as EC. Salinity can adversely affect plant growth and/or land use. At high concentrations, soil salinity can increase the potential for corrosion of buried steel and/or concrete.

The distribution of potentially saline soils within the Marine Crossing GTP Project is shown in Figure 7.6.

Preliminary soil sampling and analysis conducted by O2 in the vicinity of the proposed Access Road, where it joins Forest Road, at Point C and at Point D indicated that there was no evidence of soil salinity identified within the Marine Crossing GTP Project. However, on Curtis Island, saline soils are likely to exist at Laird Point and along the boundaries of Graham Creek, in terrain units Qe0/9 and Qe1/7-9. The marine clays within Soil Group 9, associated with the intertidal area, are likely to have high levels of salinity throughout the profile.

7.2.8 Sodicity

Sodicity is the level of exchangeable sodium in the soil and is determined using the ESP, which is the amount of exchangeable sodium, expressed as a percentage of the Cation Exchange Capacity (CEC). Sodic soils are susceptible to structural degradation on exposure and tend to exhibit the following general problems:

- Severe surface crusting
- Likely dispersion on wetting
- Very low infiltration and hydraulic conductivity
- Very hard dense subsoils
- High susceptibility to severe gully erosion if exposed and unprotected
- High susceptibility to tunnel erosion

Figure 7.6 indicates sodic soils are associated with terrain unit Qa2/6.2 in the terrestrial areas of the mainland section, between Point B and Point C. On Curtis Island, moderately sodic soils are mapped as occurring in terrain unit Cw6/5 (URS, 2009a)

Based on the data assessed during the EIS, disturbance to sodic soils, with potentially increased risk of erosion, were considered likely in association with the trenching works in the terrestrial mainland section and to a lesser extent, for the trenching works on Curtis Island. However, preliminary soil sampling and analysis conducted by O2 in the vicinity of the Access Road, where it joins Forest Road, at Point C and at Point D indicated that soils sampled were not sodic (O2, 2012b).

7.2.9 Reactive soils

Reactive soils exhibit substantial shrinkage and swelling characteristics due to wetting and drying cycles which may result in damage to structures, foundations and buried services (including pipelines) due to differential ground movements. The degree of shrinkage and swelling of soils and associated soil movement is dependent on the thickness of the soil profile, the clay content and the clay mineral type present.

The distribution of reactive soils associated terrain units within the Marine Crossing GTP Project disturbance footprint is shown in Figure 7.6.

Moderately reactive soils are expected to be present in the Cw6/5 terrain unit, towards the eastern end of the Marine Crossing GTP (Curtis Island) trenching section.

7.2.10 ASS

ASS are soils that contain sulfidic materials, most commonly pyrite and/or monosulfidic material. When exposed to oxygen the pyrite oxidises to form sulfuric acid. This generally occurs when soil environments change from anaerobic to aerobic conditions.

These soils generally occur in marine or estuarine sediments, which are predominantly confined to coastal lowlands below 5 m AHD. Within these sediments, the majority of soils that present an environmental risk for ASS are generally confined to the Holocene (<10,000 years) material (GHD, 2009).

AASS are more common where tidal inundation is less frequent such as in extratidal and supratidal land. AASS is also generally close to the surface and often grades into PASS at depth, at the permanently saturated zone.

Within the Marine Crossing GTP Project, PASS is generally present from approximately 0.5 m depth, either at the zone of permanent saturation or underlying younger sediments (URS, 2009a), in the vicinity of the creek crossings and the construction site pad (mainland). Preliminary ASS investigations conducted by Golder Associates indicated that ASS is likely to be encountered during trenching activities associated with creek crossings and excavations associated with the construction site pad (mainland) and tunnel launch shaft (Golder, 2012). It is also anticipated that PASS material may be encountered in marine clay sediments disturbed during the construction of the tunnel under The Narrows.

Site investigations undertaken by URS (2009a) in the vicinity of Laird Point and Graham Inlet on Curtis Island indicated Actual Acidity in the samples obtained from this area were either nil or relatively low, with %S ranging from <0.04 – 0.07%S. Potential acidity in samples from this area within the Holocene aged sediments from mangroves were very high (ranging from 2.71 – 4.7%S), but values in the surface soils were negligible. This suggests oxidation of surface soils has occurred. Potential acidity was also recorded in clayey silt sandwiched by terrestrial clay materials, however no acidity was recorded in the terrestrial materials.

Investigations of sediments in The Narrows were carried out to a depth of approximately 2.5 m below the seafloor and identified PASS.

The ASSMP is included in Appendix A.

7.2.11 Contaminated Land

A baseline land contamination assessment of the Marine Crossing GTP Project was conducted during the EIS (URS, 2009a) and the SEIS (URS, 2009b). The assessment involved a targeted desktop study aimed at identifying high risk sites or AOPC on lots which are traversed by the Marine Crossing GTP Project.

In addition to the desktop study a Stage 2 Environmental Site Assessment of Lot 401 on DT4026 was conducted by Waste Solutions

The Tier 1 assessment in the preliminary site investigation identified two AOPC (refer Figure 7.8). Details for each AOPC and findings of the DEHP register searches are provided in Table 7.6.

Table 7.6 Areas of potential concern

ID	AOPC	Lot and Plan	EMR	CLR	Land use and potential contaminant
1	Stockyard and Farmyard Infrastructure	Lot 41 on DS290	No	No	Stockyard: potential cattle dip with pesticide use
2	Stockyard	Lot 401 on DT4026	No	No	Stockyard: potential cattle dip with pesticide use

Table notes: EMR – Environmental Management Register
CLR – Contaminated Land Register

Of these sites, the Marine Crossing GTP Project traverses Lot 401 on DT4026 (Stockyard) for the construction of the pipeline between Humpy Creek and the construction site pad (mainland), and for the formation of the Access Road extending south from Point C. Neither of the sites listed in Table 7.6 are registered on the EMR. The property boundaries for the two AOPC are shown in Figure 7.8.

Investigations conducted as part of the Stage 2 Environmental Site Assessment (Waste Solutions, 2012), which involved the collection of soil samples from 13 locations within the Marine Crossing GTP Project on the mainland. Investigation findings indicated that there was no evidence of potentially contaminating activities within the areas inspected within Lot 401 on DT4026. As such, it was concluded by Waste Solutions that the Marine Crossing GTP Project disturbance footprint was not likely to encounter contaminated soil and that no remedial actions have been recommended at the time of the report (Waste Solutions, 2012).

7.3 Potential aspects and impacts

This section identifies how the Marine Crossing GTP Project activities will impact upon the existing land management values and conditions.

Aspects of the Marine Crossing GTP Project that could contribute to potential impacts on land management values include the following:

- Clearing of vegetation
- Stripping of topsoil
- Construction and usage of the Access Road
- Bulk earthworks (including construction of laydown and work areas)
- Trenching and backfilling (including watercourse crossings)
- Tunnelling activities and tunnel spoil material
- Disturbance of problem soils (including saline, sodic and/or dispersive soils), ASS or contaminated soils
- Construction in high rainfall periods
- Slow or ineffective design and/or installation of ESC measures

- Slow rehabilitation/revegetation works
- Fuel and chemical storage and handling
- Nutrients from fertilisers, herbicides and pesticides used in rehabilitation
- Temporary removal of land from agricultural productivity, including loss of Strategic Cropping Land affected by the Access Road

Potential impacts from these activities are discussed below.

7.3.1 Potential erosion and sedimentation impacts

Erosion is the detachment and movement of soil or rock by water, wind or other factors such as gravity. Whilst erosion is a natural process, anthropogenic disturbances can result in accelerated erosion and cause rapid detrimental effects to the environment.

Erosion processes within the Marine Crossing GTP Project can be divided into:

- Surface (river, runoff/sheetwash, rain splash, rilling and gullying)
- Subsurface (piping/tunnelling)
- Wind

Any activity which involves ground disturbance and/or vegetation removal has the potential to trigger or exacerbate accelerated erosion. Eroded material can be redeposited downslope, downstream or downwind and both erosion and sedimentation can have a negative impact on the Marine Crossing GTP through reduced ground stability resulting from subsidence and tunnel erosion.

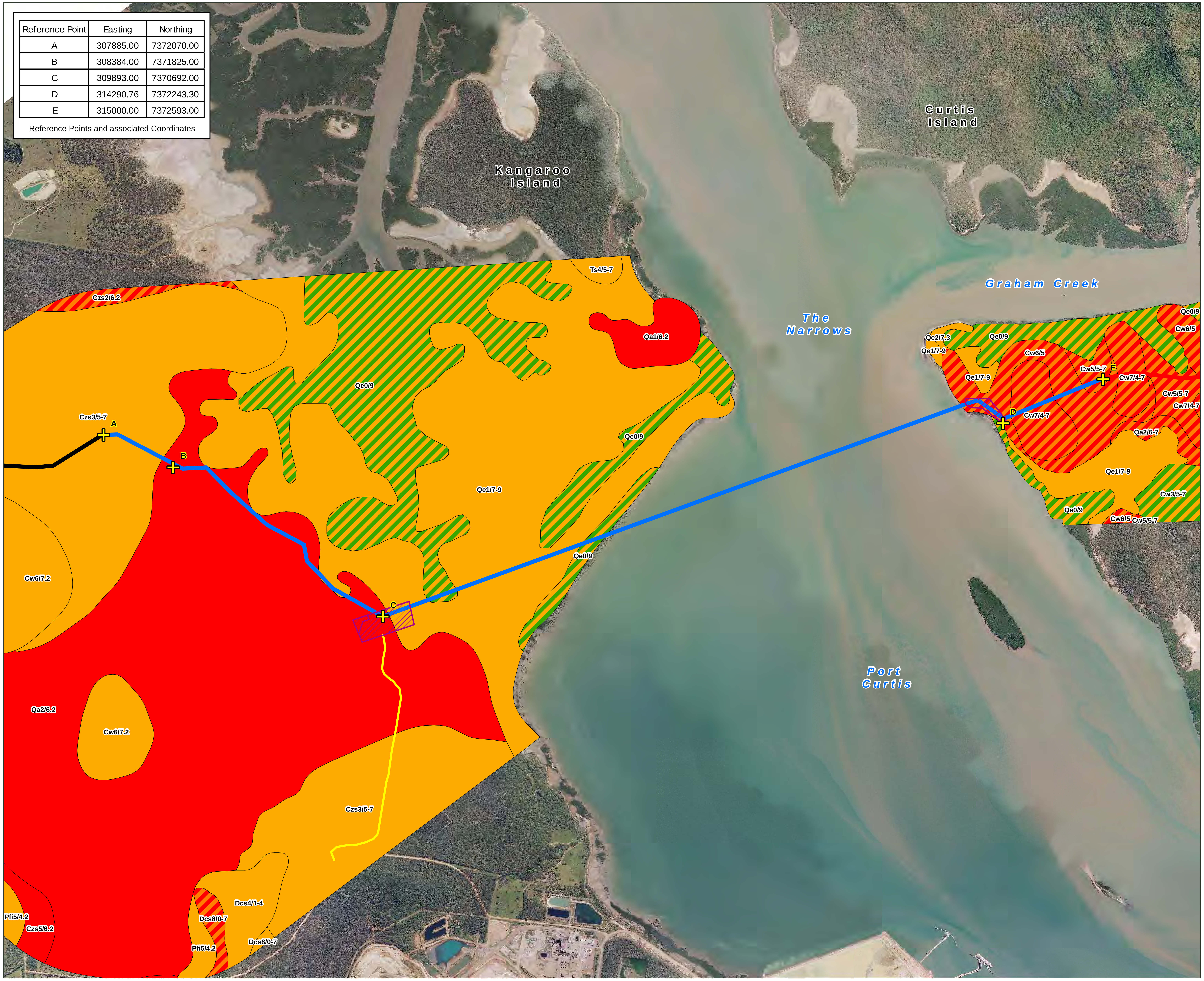
If water flows are concentrated (eg through culverts, flumes, across exposed batter slopes or along access tracks) velocities and water volumes will increase, thereby increasing the likelihood of accelerated erosion. Once initiated, rills and gullies promote flow concentration and are difficult to remediate successfully.

The erosion potential due to construction activities within the Marine Crossing GTP Project disturbance footprint as a result of clearing and/or surface disturbance was assessed in the EIS with the following classes identified and mapped (URS, 2009a):

- Low (L) – The combination of surface slope, run-on/runoff and soil erodibility is such that no appreciable erosion damage is anticipated
- Moderate (M) – Significant short term erosion is likely to occur due to the combination of slope, soil erodibility factors and extent of run-on/runoff. Erosion control can be achieved using structural works, topsoiling and revegetation techniques and other site specific intensive soil conservation work. Some slightly dispersive soil layers may be present in the profile
- High (H) – High to very high erosion/sediment losses are likely, due to the steepness of slopes, surface condition, soil texture and erodibility factors and surface runoff conditions. Intensive soil conservation work will be required to minimise the effects of accelerated erosion. Moderately high to highly dispersive soil layers are usually present within the soil profile

The distribution of erosion potential classes and associated terrain units within the Marine Crossing GTP Project are shown in Figure 7.5.

An assessment of soil related risks (erosion and salinity) for the Marine Crossing GTP Project was conducted using reports available from the Queensland Digital Exploration Reports System, a site visit and a visual soil profile inspection during the EIS (URS, 2009a).



Reference Point	Easting	Northing
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B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Map by: RB

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A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0442

Coordinate system: GCS_GDA_1994

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)

- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Erosion Potential

- High (H) - High to very high erosion/sediment losses are likely, due to the steepness of slopes,surface condition, soil texture and erodibility factors and surface runoff conditions.
- Moderate - High (M-H)
- Moderate (M) - Significant short term erosion is likely to occur due to the combination of slope, soil erodibility factors and extent of run-on/run-off.
- Low - Moderate (L-M)
- Low (L) - The combination of surface slope, run-on/run-off and soil erodibility is such that no appreciable erosion damage is anticipated.

Note: All figures should be reviewed in conjunction with Table 7.1 *"Generic Key to the identification of Terrain Units", URS 2009.*

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
GTP Marine Crossing Reference Points: GLNG, Apr 2012.
Aerial Imagery: Santos, Feb 2011.
GLNG Terrain Units: Supplementary EIS, URS, 2009.

Soil Constraints: Erosion Potential Figure 7.5

Date: 20/06/2012

Version: I

The findings from these investigations indicated that soils in the mainland section (Point A to Point C) have a high erosion potential, particularly in terrain unit Qa2/6.2. This included the area south of Point C where the Access Road is proposed to be located (refer Figure 7.5). Soils in this terrain unit were identified as Sodosols, and therefore are expected to have sodic subsoils with ESP >6% (URS, 2009a).

Additional investigations, including preliminary soil sampling and analysis, and erosion risk assessment were conducted by O2 (O2, 2012). The findings of these investigations indicated that soils sampled within the Marine Crossing GTP Project (mainland) in the vicinity of Point C and where the Access Road joins Forest Road (at the southern extent), were found to be:

- Not saline
- Not sodic
- Prone to dispersion
- Assessed as having a very low erosion risk rating

Soils in the mudflats associated with the intertidal area were assessed during the EIS to have a moderate to moderate–low erosion potential. However, these areas will be not be disturbed by the proposed tunnelling activities that will be under the intertidal area and The Narrows. On Curtis Island the soils likely to be disturbed by the Marine Crossing GTP Project were assessed during the EIS to have a moderate to high erosion potential, as they were also expected to have sodic subsoils.

Findings from the preliminary soil sampling and analysis conducted by O2 indicated that soils sampled within the Marine Crossing GTP Project (Curtis Island), in the vicinity of Point D, were found to be:

- Not saline
- Not sodic
- Prone to dispersion
- Assessed as moderate to low erosion risk rating at the construction site pad
- Assessed as high to extreme erosion risk rating within the Marine Crossing GTP ROW between Point D and Point E

The remaining areas have been assessed to have a moderate and low-moderate erosion potential (refer Figure 7.5).

Erosion within the Marine Crossing GTP Project disturbance footprint will be controlled through the implementation of the SMESCP (refer Appendix C). The SMESCP will also address the ESC to be adopted for the management of tunnel spoil excavated during the tunnelling activities beneath The Narrows and stockpile management measures for topsoil, subsoil and imported materials.

7.3.2 Potential soil inversion impacts

Trenching activities (Point A to Point C) have the potential to result in soil inversion. Soil inversion can result in the effective “loss” of topsoil and may arise due to the mixing of topsoil with trench spoil during stockpiling, covering topsoil with sediment washed in from adjacent areas or returning topsoil and trench spoil to the trench in the wrong order.

Soil inversion can adversely affect easement restoration and revegetation as it limits nutrient availability, biomass and productivity. Soil inversion can also affect soil permeability and water holding capacity.

Soil inversion can occur in any soil type within the Marine Crossing GTP Project. Its impacts will be the greatest in soils identified as having sodic or saline subsoils as this hostile material could be exposed to the surface, therefore triggering accelerated erosion. However, given that topsoil and subsoil material will be stockpiled separately and replaced in their original soil horizons in accordance with the LRMP (refer Appendix E), impacts associated with soil inversion are anticipated to be minimal (refer Table 7.7).

7.3.3 Potential soil compaction impacts

Soil compaction may result from activities which subject the ground to loading, such as the formation and construction of the Access Road, ROW laydown and work areas, construction site pads, including ASS treatment areas, lay-down and stockpile areas, washdown facilities and the TBM tunnel launch and receptor shafts, as well as along the Marine Crossing GTP ROW.

Compacted soil has smaller soil pores, less pore continuity and greater strength. This makes the soil less suitable for supporting vegetation as roots cannot access reserves of soil moisture or nutrients deeper down in the soil profile.

Compaction also reduces the rate of water infiltration and can result in increased runoff with an associated increase in soil erosion. Soils in traffic areas are prone to compaction when they are moist. Once compacted, it can be difficult to return material to its original state of compaction. This is particularly important in GQAL and Strategic Cropping Land areas, where compacted soil can cause long term damage to agricultural land with the loss of productivity.

Compaction is more likely to occur in soil Groups 6 to 9 of which all soil types within the Marine Crossing GTP Project are within this range (refer Figure 7.3). The degree of compaction will be affected by the moisture condition of the soils during the compaction event.

Mitigation measures for soil compaction associated with these activities are detailed in Table 7.7 and include stripping topsoil prior to works commencing to prevent its compaction. It is anticipated that the implementation of these mitigation measures and other specific measures in accordance with the LRMP (refer Appendix E) will result in impacts associated with compaction being minimal.

7.3.4 Potential impacts to GQAL and Strategic Cropping Land

The Marine Crossing GTP Project intersects areas identified as Class C2 GQAL. The location of GQAL and Strategic Cropping Land is presented in Figure 7.4.

A review of aerial photography indicates that the Marine Crossing GTP ROW is unlikely to be used for cropping, but the area is used for grazing. These land areas are designated as part of the GSDA corridor and therefore are unlikely to be used for agriculture as a primary long term land use (refer Figure 8.3b). However, the Access Road alignment, extending south of the construction site pad (Point C) to Forest Road is not located within the GSDA and does intercept an area mapped as potential Strategic Cropping Land on Lot 401 on DT4026. Aerial photography in this area indicates that fruit cropping occurs in this area.

There are likely to be temporary impacts on agricultural uses of land within the Marine Crossing GTP Project disturbance footprint during establishment and use of the Access Road, construction site pads (mainland and Curtis Island) and construction activities associated with trenching, waterway crossings and pipeline installation. These temporary impacts will include:

- Temporary loss of land within the Marine Crossing GTP ROW from agricultural land use (including grazing activities)
- Permanent loss of agricultural land use involving cultivation and deep ripping of soils within the GTP easement of the GSDA corridor during the operational life of the GTP (refer Figure 8.3b)
- Temporary loss of cropping land use for up to 2.5 ha within potential Strategic Cropping land on Lot 401 on DT4026 for the construction and operation of the Access Road between the construction site pad (mainland) at Point C and the intersection with Forest Road (refer Figure 7.4)
- Temporary exclusion fencing at the boundary of the marine Crossing GTP ROW and the Access Road alignment, which will exclude access of landholders, members of the public and livestock
- Rehabilitation and reinstatement work required for the Marine Crossing GTP Project disturbance footprint post construction to restore land to pre-disturbance condition for agricultural land use and cropping in accordance with landholder agreements

The Marine Crossing GTP ROW and the majority of the associated construction areas do not lie within an area classified as Strategic Cropping Land. However, up to 2.5 ha of parts of the southern portion of the Access Road, in the vicinity of Forest Road, does intercept an area of mapped potential Strategic Cropping Land (refer Figure 7.4). A review of aerial photography indicates that parts of this area are currently utilised for fruit growing activities.

The proposed development approved during the EIS (URS, 2009a) is excluded from the application of the *Strategic Cropping Land Act 2011* under Section 283, as the EIS stage was completed prior to 31 May 2011. However, the design and placement of the Access Road has occurred since the approval of the EIS (Queensland Government, 2010a) and as such will be subject to development assessment under the *Strategic Cropping Land Act 2011*.

The development of the Access Road will be a temporary impact on mapped potential Strategic Cropping Land, and as such will be subject to Development Approval for development on potential Strategic Cropping Land. The design of the development has given consideration to the current land use activities within the mapped area of potential Strategic Cropping Land and has avoided disturbance of fruit growing activities and, where possible, minimised encroachment of the mapped potential Strategic Cropping Land, in line with the hierarchy of Strategic Cropping Land principles under the *Strategic Cropping Land Act 2011*.

The impact on GQAL resulting from the construction of the Marine Crossing GTP Project within the ROW and the construction site pads will be largely temporary, with permanent impacts to GQAL (Class C2) associated with the operational life of GTP easement (42 years), post-construction, which will be restricted to the GSDA corridor. Post-construction the Marine Crossing GTP Project disturbance footprint will be restored to pre-disturbance conditions, post construction, in accordance with the LRMP and landholder agreements.

The impact to potential Strategic Cropping Land resulting from the disturbance footprint for the Access Road will be restored to pre-disturbance conditions, post construction. Reinstatement and rehabilitation of the Access Road alignment will be conducted in accordance with the LRMP and landholder agreements, which is in line with the Strategic Cropping Land principles and the standard conditions code.

7.3.5 Potential salinity impacts

Salinity can have the following effects, if uncontrolled:

- Salt-affected soil retards plant growth, reducing vegetation cover and, in extreme, cases can cause land to be completely unproductive. This may affect rehabilitation attempts of saline soils
- Saline land can be susceptible to wind and water erosion if vegetation cover is reduced
- Soils with high salinity as a result of sodium chloride have a tendency to disperse in water due to weak sodium bonds between clay particles (eg soil sodicity). This increases the risk of subsurface erosion, such as tunnel erosion
- Saline soils can cause corrosion of footings and other susceptible surface infrastructure
- Mobilisation of saline soils offsite to non-saline areas

Estuarine and intertidal areas of the Marine Crossing GTP Project have been identified as areas of potential saline soils (refer Figure 7.6). There is potentially some increased erosion risk from soil disturbance in this area.

If salinity occurs as a result of unmanaged construction activities, the following secondary impacts may occur (on and around the Marine Crossing GTP Project):

- Loss of soil productivity
- Loss of existing vegetation communities due to increased soil salinity in root zones
- Disruption of plant lifecycle due to increases in soil salinity leading to loss of native vegetation communities invasion from pest species
- Loss of fauna through reduction of habitat or effect of saline environment (eg frogs)
- Reduction in health of groundwater/watertable dependant ecosystems
- Reduction in groundwater quality
- Increased area of erosion prone soils
- Increased area of shrink-swell soils

Mitigation and management measures to minimise the impacts associated with saline soils are detailed in Table 7.7. It is anticipated that the implementation of these mitigation measures will facilitate successful rehabilitation and therefore result in impacts associated with increased soil salinity being minimal.

7.3.6 Differential settlement of backfill and padding

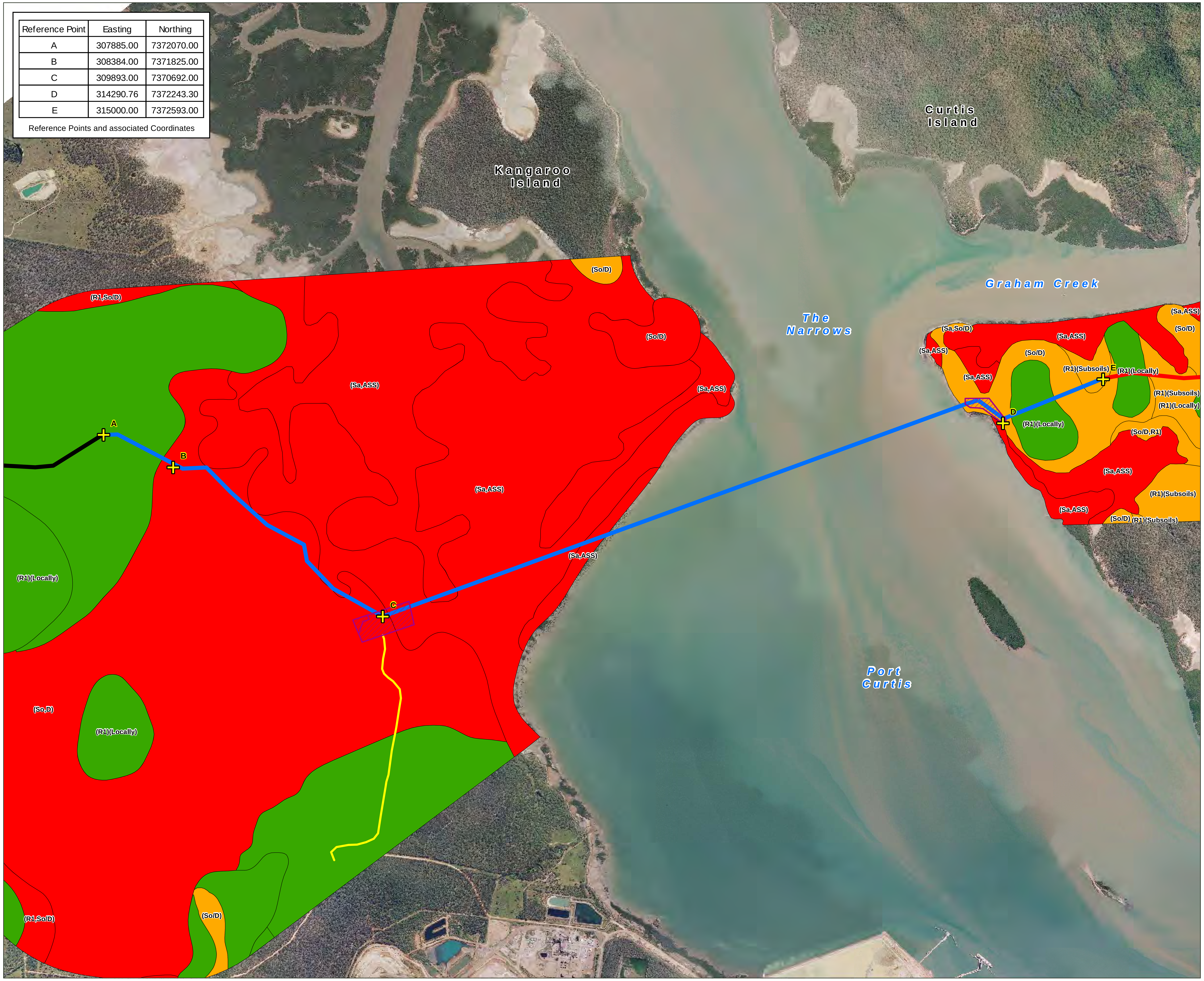
It is possible that backfilled and filled areas will not be returned to original compaction levels. Differential settlement of fill could cause depressions or mounds to form which could potentially lead to drainage concentration and gullying or waterlogging.

Mitigation and management measures to minimise the impacts associated with differential settlement of backfill and padding are detailed in Table 7.7. It is anticipated that the implementation of these mitigation measures will result in impacts associated with differential settlement being minimal.

7.3.7 Potential impacts on subsoil

Burying a pipeline in subsoil may create a preferential pathway for subsurface flow. Water which accumulates and flows alongside the buried pipeline pathway may result in piping (tunnelling) erosion. Collapse of the subsurface void may lead to pipeline exposure.

This process may present a hazard for construction work through Soil Groups 4 (Sandy Alluvial Soils) and 5 (Sandy Texture Contrast Soils) on both the mainland and Curtis Island



Reference Point	Easting	Northing
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D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Problem Soil
- High
- Moderate
- Low

Description:

R
Soil Reactivity
L - Nil or low soil
R1 - Moderately reactive soils
R2 - Shallow or medium deep, highly reactive (cracking) clay soils
R3 - Deep, highly reactive (cracking) clay soils

Sa
Soil Salinity
L - Nil to Low Salinity
M - Medium Salinity
H - High to Very High Salinity

So
Sodicity (ESP)
N - Very low or non Sodic, ESP <6%
Rating 1 - Sodic, ESP 6-14%
Rating 2 - Strongly Sodic, ESP >14-25%
Rating 3 - Very strongly Sodic, ESP >25%

D
Dispersion Class
N - Non-dispersive
Sl - Slightly Dispersive
M - Moderately Dispersive
H - Strongly Dispersive

ASS
Acid Sulfate Soils

Note: All figures should be reviewed in conjunction with Table 7.1 *"Generic Key to the identification of Terrain Units", URS 2009.*

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
GTP Marine Crossing Reference Points: GLNG, Apr 2012.
Aerial Imagery: Santos, Feb 2011.
GLNG Terrain Units: Supplementary EIS, URS, 2009.

Soil Constraints: Problem Soils
Figure 7.6

A1 scale: 1:15,000

0 250 500 750 1,000 1,250m

GLNG No: 3381-40-0443

Coordinate system: GCS_GDA_1994

Date: 20/06/2012 Version: I

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_022.mxd 20/06/2012 15:55

sections of the Marine Crossing GTP Project, particularly where sodic soil conditions are encountered.

7.3.8 PASS impacts

ASS are known to occur within the Marine Crossing GTP Project areas. The potential for this acidity to provide an enhanced impact on receiving environments is recognised in legislation (SPP 2/02). The generation of acid due to the oxidation of pyrite and/or monosulfidic material can have an impact on receiving environments through direct acidification and liberation of toxic metals. Impacts and risks can be avoided or reduced through the implementation of ASS management measures.

The proposed tunnel under the intertidal area and The Narrows will reduce the magnitude of surface disturbance of ASS and will reduce the amount of PASS material disturbed during construction to that associated with the subsurface marine clay sediment material directly removed during tunnelling. The proposed tunnel alignment will be in the geological units at depth (>5 m below ground level) beneath The Narrows. It is anticipated that ASS may also be encountered during the trenching work associated with the Marine Crossing GTP crossing of Humpy Creek and Targinie Creek, the construction of the tunnel launch and receptor shafts and construction site pads. ASS material and marine clay sediments disturbed during construction will be transported to the designated ASS treatment areas as indicated on Figure 7.7 for treatment in accordance with the ASSMP. Groundwater seepage and rainfall runoff dewatering from construction activities will be pumped to designated water storage/treatment ponds for treatment in accordance with the ASSMP.

Detailed information of the management of ASS is presented in the ASSMP (refer Appendix A).

7.3.9 Potential soil contamination impacts

Two AOPC were identified within the Marine Crossing GTP Project as detailed in Section 7.2.11 (refer Figure 7.8). Further investigations of Lot 401 on DT4026 were conducted by Waste Solutions, from which Waste Solutions concluded that there was no evidence of contaminating activities or contamination above the Environmental Investigation Levels (DoE, 1998) within the locations inspected and subsequent sample analysis results. As such, Waste Solutions Australia has concluded that the Marine Crossing GTP Project is unlikely to encounter contaminated soil and no remediation actions were recommended at the time of the report (Waste Solutions, 2012).

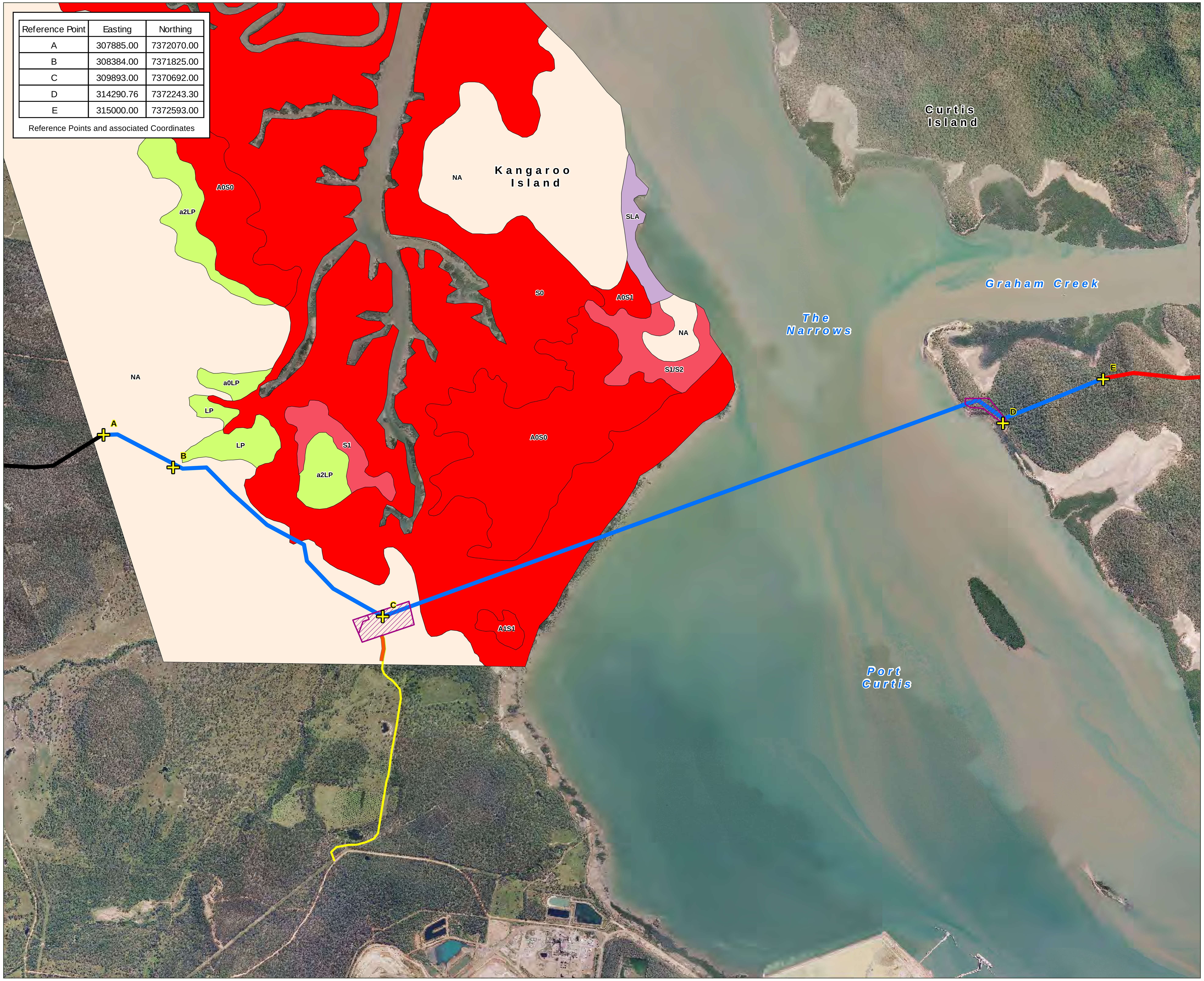
The potential impact associated with land contamination during the development of the Marine Crossing GTP Project is associated with construction activities that may result in land contamination through:

- Fuel and chemical spills associated with the storage and refuelling of construction equipment at the construction site pads
- Refuelling of vehicles and equipment within the Marine Crossing GTP ROW
- Storage and treatment of ASS
- Equipment washdown

To minimise the impacts of land contamination all liquid and chemical storage areas, washdown pads and workshops within the construction site pads will be located on concrete hardstand, and within bunded areas as required. Refuelling of vehicles and equipment within the Marine Crossing GTP ROW will be undertaken by licenced contractors operating mobile refuelling tankers within designated in field servicing and maintenance areas within the ROW and not within 50 m of a watercourse or the marine environment.

Santos
GLNG Project

Marine Crossing GTP EMP



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Reference Points and associated Coordinates

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road
- Acid Sulfate Soils Treatment Area (Indicative location only)

Acid Sulfate Soils
- High
- Moderate
- Low
- Very low
- Not assessed
- Not classified

Note: All figures should be reviewed in conjunction with Table 7.1 *"Generic Key to the identification of Terrain Units", URS 2009.*

Source:
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GTP Marine Crossing Reference Points: GLNG, Apr 2012.
Aerial Imagery: Santos, Feb 2011.
Acid Sulfate Soils: Department of Environment, Resource and Management.
Other Proponents Pipeline RoW: GLNG, March 2011.

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_023.mxd 20/06/2012 15:57

A1 scale: 1:15,000
0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0444
Coordinate system: GCS_GDA_1994

Acid Sulfate Soils
Figure 7.7

Date: 20/06/2012 Version: I

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road
- Area of Potential Concern
- Contaminated Property

Note: All figures should be reviewed in conjunction with Table 7.1 *"Generic Key to the identification of Terrain Units", URS 2009.*

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
GTP Marine Crossing Reference Points: GLNG, Apr 2012.
Aerial Imagery: Santos, Feb 2011.
Contaminated Land Sites: GLNG, Apr 2012.

Contaminated Land Sites
Figure 7.8

A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0445

Coordinate system: GCS_GDA_1994

Date: 20/06/2012

Version: I

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_046.mxd 20/06/2012 16:00

In the event that contaminated soil is encountered during excavation activities as a result of the prior use of the site, the affected excavated spoil will be managed in accordance with the EP Act (refer Chapter 7, Part 8) and mitigation measures outlined in Table 7.7. All wastes will be managed as per the WMP (refer Appendix F).

7.4 Cumulative impacts

Cumulative impacts on land and land management practices are described below. The significance of cumulative impacts on land and land management practices are expected to be negligible.

Cumulative impact issues will arise from combined effects of erosion from one or more construction fronts being open at one time. These will include loss of topsoil, and subsequent reduced rehabilitation success, as well as degraded stormwater runoff quality and subsequent effects on sensitive coastal receiving environments.

Extended periods of topsoil storage prior to reinstatement may increase the degradation of topsoil and result in accelerated erosion. A cumulative impact may result if the combined programmes of more than one proponent result in one or more projects undertaking work in the same location, or leaving bare soil exposed during the wet season may also exacerbate soil erosion.

Rehabilitation success for each of the individual pipelines may also be compromised by adjacent works, particularly where runoff and vehicle movements from one project footprint disturbs another. Although it will be possible to achieve rehabilitation working separately, as long as runoff and erosion from adjacent projects are controlled, a cooperative approach to rehabilitation is likely to be effective.

7.5 Proposed environmental protection commitments, objectives and control strategies – land management (construction, operation and decommissioning)

This section addresses the preventative strategies and mitigation measures relevant to topography, geology, soils, agricultural land and potentially contaminated land issues.

Table 7.7 provides the environmental protection commitments, objectives and control strategies proposed for land management within the Marine Crossing GTP Project.

Table 7.7 Environmental protection commitments, objectives and control strategies for land management

Item	Outcome
Environmental protection objectives	Minimise and manage adverse impacts to soils by: • Limiting the occurrence and extent of trench subsidence and soil erosion • Preventing soil inversion • Developing a stable, vegetated ROW and disturbance footprint of the Marine Crossing GTP Project post-construction
Specific objectives	• Erosion controlled and limited to that consistent with “natural processes” such that pipeline cover is maintained and land capability/suitability is not reduced • All erosion control strategies implemented, functional and maintained • All topsoil stockpiled separately and no spoil piles remain on surface after restoration • All access restricted to designated areas

Item	Outcome
Control strategies	• Surface disturbance footprint has been minimised through design and selection of the proposed TBM tunnelling construction method • Impact on Strategic Cropping Land has been minimised through design of the Access Road alignment between Forest Road and Point C • Implement specific ESC measures through the implementation of the SMESCP • Implement specific spoil management measures, particularly where ASS occur, through the implementation of the ASSMP • Implement specific sediment management measures through the implementation of waterway barrier and watercrossing construction and rehabilitation/reinstatement specifications • Minimise soil compaction through the implementation of designated traffic areas, haul routes and plant and equipment laydown areas identified in accordance with the CEMP • Ensure that topsoil and subsoils are properly reinstated through the implementation of the SMESCP and the LRMP • Implement specific sampling and analysis monitoring for treated ASS, site surface runoff and groundwater quality in accordance with the ASSMP **Preconstruction phase** • Soil ground truthing, including identification of all sensitive soil and landform areas within the Marine Crossing GTP Project (such as ASS areas) will be cross referenced to known information on land units and land systems prior to construction. Any variation between identified land values and DEHP data sets will be identified and explained. An assessment of the potential impacts will be provided along with mitigation measures and construction methods applicable to the identified soil groups or landforms • A SMESCP has been developed (refer Appendix C) and will be implemented for the purpose of minimising accelerated erosion and the release of sediment, and contamination of stormwater from disturbed areas associated with construction • Detailed stormwater management and erosion and sediment control plans will be developed for each stage of construction, in accordance with Best Practice Erosion and Sediment Control (IECA, 2008) and the SMESCP (refer Appendix C), and certified by a Certified Professional in ESC, or a professional with relevant experience and/or qualifications accepted by the administering authority, and implemented for all stages of pipeline activity prior to construction

Item	Outcome
	Construction phase *Minimise disturbance* • Limit the Marine Crossing GTP ROW width to a maximum width of 30 m as it is within ESAs (refer Chapter 8 and Chapter 10) • Limit the Access Road disturbance footprint width to a maximum of 25 m within the area mapped as potential Strategic Cropping Land on Lot 401 on DT4026 (refer Chapter 2, and Figure 2.3 and Figure 7.4) • Minimise the time that pipeline trenches are left open to the extent practicable • Minimise the length of pipeline trench open at any one time *Formation of access* • Where present, topsoil will be stripped across the Access Road, and the GTP ROW and trench for reuse • Topsoil and subsoil will be stockpiled separately within the easement and all necessary measures will be taken to prevent cross-contamination between topsoil and subsoil materials • Stockpiles will be covered/stabilised in accordance with the SMESCP • Topsoil will be placed on the high side of the ROW on hills and slopes where practicable and safe to do so and ESC measures will be implemented downslope of stockpiles and equipment laydown areas in accordance with the SMESCP • Sediment excavated from the bed of watercourses for the construction of waterway barriers and watercourse crossing work will be stockpiled in the watercourse crossing laydown and work area for reuse during reinstatement work post construction • Where access is required in the long term, access tracks within the ROW will be constructed with a compacted base and placement of gravel surface, which will be maintained to permit all-weather access. The Access Road will also be constructed to permit all-weather access for heavy vehicles and machinery and the transport of construction equipment and supplies to the ROW and construction site pad (mainland) at Point C. Where access is required for temporary (construction) use only, disturbed areas will be rehabilitated and reinstated to be suitable for the primary land use • Construction of the Access Road and temporary and permanent access tracks shall comply with the “Design of Site Access Roads” (GLNG, 2012b) in order to achieve the design specifications for the Project • Diversion velocity control measures for overland flow will be constructed for formation of the Access Road, and permanent and temporary access tracks within the ROW to ensure that run-on is diverted away from disturbed areas and directed towards stabilised locations within the surrounding landscape, and runoff is directed towards stabilised roadside drainage controls in accordance with the SMESCP

	• Batter slopes will be stabilised in accordance with the SMESCP
	• Sediment ponds will be located within low points in the landscape adjoining disturbed areas to capture and contain runoff during rainfall events in accordance with the SMESCP
	Clearing and grading
	• Clearing and grading will be conducted in a manner that:
	  - Does not place fill in areas where clearing of vegetation significantly isolates, fragments or dissects tracts of vegetation resulting in a reduction in the current level of ecosystem functioning, ecological connectivity and/or results in an increase in threatening processes
	  - Limits the ROW width to a maximum width of 30 m within ESAs, except as otherwise authorised by the administering authority, in writing
	  - Minimises disturbance to land in order to prevent land degradation
	  - Ensures that for land that is to be significantly disturbed by petroleum activities (except in areas of highly erosive soils), the top layer of the soil profile is removed; and (a) stockpiled in a manner that will preserve its biological and chemical properties, and (b) used for rehabilitation purposes in accordance with condition

Item	Outcome
	• Cleared vegetation or soil will not be pushed up against trunks of trees • Cleared vegetation and soil will not be stored against fencelines • Soil stockpiles will not be placed within the bed or banks of watercourses • The stockpiles will be breached in appropriate locations (coinciding with designated access roads or tracks, fencelines) to allow vehicular, stock and wildlife access. Vehicular movement over stockpiled soil will not be allowed • Soil and surface stability will be maintained at all times (eg temporary erosion control berms, drains and sediment barriers will be installed as necessary and maintained until final construction clean-up is completed) • Install, maintain and monitor erosion and sediment control devices (eg berms, jute matting) so that ground is stable and vegetation cover is maintained and promoted • Ensure that runoff control devices are maintained and work at all times to prevent erosion • Carry out excavation work in accordance with the provisions of the CEMP • Install, operate and maintain sediment ponds to protect receiving waterways and ensure that the release quality of site stormwater meets water quality limits for the site • Install permanent erosion controls around active erosion adjacent to the ROW and watercourses as needed to keep areas stable • Maintain sediment control devices to ensure they remain effective including emptying regularly • Consider erosion potential, sedimentation and land contamination issues when formulating incident specific emergency responses • Sediment control measures will be used to preserve stockpiled soils to prevent siltation of any land surface and water or blockage of any existing drainage channels • Where erosion management structures are impacted they will be reinstated as quickly as practicable or alternative structures erected to retain an adequate level of erosion control • Temporary and permanent erosion control banks will be installed across slopes and in the vicinity of drainage lines along the easement as necessary to avoid and control stormwater (eg temporary drainage diversion control measures will be installed along the easement and in lay-down and storage areas as necessary to divert clean stormwater away from disturbed areas of the site and control stormwater runoff)
	• Location of trench breakers will be marked prior to backfilling • Erosion control measures put in place prior to construction will be recontoured to the original conditions as soon as practicable following construction, in consultation with the landholder • An inspection and maintenance programme for the erosion and sediment control features is included in the SMESCP and will be reviewed and updated in accordance with the SMESCP reviews • Inspection and maintenance of erosion control devices will ensure adequate access to control devices and identification of measures required to remediate any failures

Item	Outcome
	Trenching • If contamination is identified during trenching work, known contaminated areas will be identified on field maps, located onsite, fenced and avoided, where avoidance is not possible, potentially contaminated material excavated will be stockpiled in a designated contaminated spoil location for investigation and management, as required in accordance with the EP Act • Trenching supervisor will be instructed in process for handling previously unidentified contaminated areas or ASS in the event that any such areas are uncovered during trenching. These will include: – Cessation of trenching at the location – Relocation and recommencement of trenching 50 m ahead – Advising Construction Manager and completing an assessment of the ASS or potential contamination. This may require the collection and analysis of the soil to delineate AOPC and ASS – Initiating suitable remedial action based on the assessment findings and expert recommendations • Formation and maintenance of topsoil stockpiles will be in accordance with the SMESCP and will comply with requirements specified in relation to stockpiling in the LRMP and SMP (document number 3380-GLNG-3-1.3-0036) • Trench spoil (subsoils) will be stockpiled separately to topsoil and vegetation • Where practicable, additional topsoil and subsoil will be won from places where cutting is required • Fill material will be stockpiled in a designated temporary workspace, wherever possible • Soil stockpiles near drainage lines will be located and protected by ESCs in accordance with the SMESCP, unless otherwise outlined in other management plans (eg in line with the SSMP (document number 3380-GLNG-3-1.3-0031)) and soil stockpiles will be located at least 10 m from the high banks of water courses • Areas of potential ASS will be clearly marked on construction drawings. Where potential or actual ASS is disturbed during trenching, trench spoil must be stockpiled within a designated and contained ASS area in accordance with the ASSMP • Trench spoil will be stockpiled outside watercourses, and/or behind containment structures so as to prevent siltation of any land or surface water or blockage of any existing drainage channels • Regular gaps and spaces in the topsoil, subsoil and vegetation stockpiles will be provided for fauna movement in accordance with the SMP and SSMP • Trench plugs will be utilised in accordance with the SMESCP, SMP and SSMP to allow access across the ROW during trenching work • The pipeline trenches will be left open for the minimum time practicable • The trench will not be left open for extended periods on slopes upgradient of drainage lines or watercourses • Trenching work for watercourse crossings will comply with the watercourse crossing specifications and permit/approval conditions for each watercourse crossing within the Marine Crossing GTP Project • Temporary ESC devices will be removed when stabilisation requirements have been achieved in accordance with the SMESCP • Temporary waterway barriers will be removed in accordance with permit/approval conditions and watercourse crossing specification methods
	Pipe laying and backfilling • Compaction will be carried out in layers and will use techniques and equipment that will not damage the pipeline or pipeline coating • Pipe laying crews will prepare for identified third party crossings and will have materials and equipment available • Gentle crown to be left over the trench line to allow for future settlement of soils, with breaks to allow for natural surface water flows across the ROW

Item	Outcome

	• Pipeline markers will be installed with consideration to land use
	• Topsoil will not be used as bedding material
	• Topsoil will only be reinstated after the excavated spoil has been backfilled and compacted
	• Compaction of backfilled trenches is to be completed prior to spreading topsoil
	• Erosion berms will be constructed across the ROW on slopes to divert rainfall runoff away from the ROW and to discharge onto stabilised areas in accordance with the SMESCP
	• Measures will be implemented to manage subterranean water movement along the backfilled trench in accordance with the SMESCP and ASSMP
	• Where possible original trench material will be reused to backfill, otherwise measures will be installed to provide a barrier against preferential flow paths associated with backfilled trenches
	• Mounding of the trench backfill to allow for sufficient settling and no development of a linear depression for ponding of water or waterlogging of localised areas along the ROW
	Rehabilitation
	• Rehabilitated areas will be maintained to ensure:
	  – Stability
	  – Erosion control measures remain effective and stormwater runoff does not negatively affect receiving waters
	  – Plants and revegetation show healthy growth and recruitment is occurring
	• Subsoil will be respread and compacted over the trench, with crown development, and used for the construction of contour banks on steep slopes and above banks at water crossings
	• The ROW will be re-profiled to original or stable contours, re-establishing surface drainage lines and other land features
	• Topsoil application will only take place after subsoil respreading and compaction and will be evenly spread and left with a slightly rough surface
	• Driving vehicles on freshly topsoiled ROW will be prohibited
	• Subsoil displaced by the pipe, and not utilised in backfill, may be stockpiled in designated stockpile locations for use during operations
	• Imported topsoil, of a suitable quality and weed-free, may be required for ROW repairs,
	• Flagging used to identify clearing boundaries and sensitive features will be removed
	• Erosion and sediment control measures will be installed. Existing soil erosion measures will be reinstated to a condition at least equal to the pre-existing state
	• Fertilisers and soil supplements will be used in accordance with the LRMP

<table>
<tr><th>Item</th><th>Outcome</th></tr>
<tr><td></td><td>Specific soils
Good quality agricultural land and Strategic Cropping Land
• On land with GQAL Class A, B or C1, the Marine Crossing GTP will be buried to at least 0.9 m below the finished surface, or greater if deep ripping occurs as a normal farming practice
• Upon completion of construction of the Marine Crossing GTP, on any land identified as being GQAL:
- temporary access tracks will be removed
- disturbed areas will be lightly ripped (unless deep ripping is preferred by the land owner)
- land management and erosion control methods will be implemented and maintained until stabilisation objectives have been achieved in accordance with the SMESCP
• Construction of the Access Road, where it intercepts potential Strategic Cropping Land, in the vicinity of Forest Road, will be conducted in accordance with Santos' policy for Strategic Cropping Land and approved standards procedures
• The scheduled duration for the construction and use of the Access Road is 18 months, followed by removal of surface infrastructure reinstatement of the soil profile and compaction levels and rehabilitation of the site to pre-disturbance land use in accordance with landholder agreement conditions
Sodic soils
• Topsoil removal in areas containing (or likely to contain) sodic subsoils will be limited to the area along the trench and where subsoil is to be placed
• Clearing methods, in sodic soils, will be utilised that minimise ground disturbance and maintains root stock as far as possible
• In areas of sodic soil, vegetation will be mulched to provide additional organic matter to the soil for the reinstatement process
• In areas of sodic soil additional drainage, soil and erosion control measures will be implemented where evidence of erosion or scouring is found
• Areas of sodic soil will be clearly marked on alignment sheets
• Where strongly or very strongly sodic and/or dispersive materials are encountered they will not be used for rehabilitation purposes. Suspected sodic or dispersive materials exposed as a result of site earthworks will be treated in accordance with the soil management procedure and SMESCP</td></tr>
<tr><td></td><td>ASS
• Management of ASS will be undertaken in accordance with the ASSMP (refer Appendix A).
• The location of AASS or PASS will be clearly indicated on design drawings, alignment sheets and in the field. Cross-references will be made to relevant management protocols, the soil management procedure and the ASSMP
• Where PASS or AASS is disturbed during trenching, the spoil must be stockpiled within a designated and contained ASS treatment area in accordance with the ASSMP
• If ASS material is excavated, immediate steps will be undertaken to segregate and contain the material within approved areas and dealt with according to the established ASSMP</td></tr>
</table>

Item	Outcome

	Land contamination
	• The Contractor Environmental Officer will be responsible for visual inspections of excavation work and identifying evidence of contamination in the event that suspected contamination is encountered or material spills occur, and initiating reporting and corrective actions in accordance with the CEMP
	• Site-specific and contaminant-specific management measures will be developed and implemented for any areas that are identified as contaminated in accordance with the CEMP
	• If suspected contamination is found during earthworks, work in that area will stop until a the Contractor Environmental Officer has inspected the site, the hazard has been assessed and action has been taken and documented
	• DEHP approval will be obtained if contaminated material must be removed from the work area or across property boundaries
	• All personnel will be made aware of potential contamination issues during induction training
	• Within 3 months post construction, where land has been subject to contamination caused by petroleum activities, the contaminated land status must be investigated in accordance with EP Act requirements and the *National Environment Protection (Assessment of Site Contamination) Measure 1999*
	• Known contaminated areas will be identified on field maps, located on site, fenced and avoided
	• Trenching supervisor will be instructed in process for handling previously unidentified contaminated areas (eg dip, waste pit) or ASS in the event that any such areas are uncovered during trenching. These will include:
	  - Cessation of trenching at the location
	  - Deviating around the affected site
	  - Relocation and recommencement of trenching 50 m ahead
	  - Advising Construction Manager and completing an assessment of the ASS or potential contamination. This may require the collection and analysis of the soil to delineate AOPC and ASS
	Operational phase
	• There is expected to be minimal ongoing access requirements for operational maintenance along the Marine Crossing GTP ROW, however typical mitigation and controls for the operational phase of the GTP will be detailed in the OMP, which will be developed prior to completing construction
	• Vehicle access will be restricted to stable ground where practicable and additional care will be taken near watercourses and drainage lines
	• The reinstated GTP trench will be routinely checked for subsidence and exposure of the pipe, particularly at watercourse crossings and drainage depressions in accordance with GLNG Operations monitoring maintenance requirements
	• Stability of the GTP easement and, in particular, the condition of watercourse bed, banks and riparian vegetation will be inspected in accordance with an agreed inspection programme
	• Disturbance of ASS during operations will be avoided or minimised in accordance with the OMP
	• The GLNG GTP WMP will be implemented during operation
	• Hazardous wastes will not be stored or handled within the vicinity of any surface water
	• Detailed Pipeline Spill Prevention and Response Plans will be developed for all operational pipelines where spills may be detrimental to public safety or the environment. Plans will address local issues, such as areas of particular environmental, social or cultural sensitivity

Item	Outcome
	Decommissioning phase • On completion of construction the Marine crossing GTP ROW will be rehabilitated in accordance with the decommissioning phase actions in the LRMP (refer Appendix E) • Land within the temporary / construction disturbance footprint will be restored to a level compatible with or better than pre-disturbance conditions and will be suitable for the reinstatement of primary land uses in areas where temporary impacts or disruption to land use occurred • Rehabilitation to pre-clearance conditions will be undertaken within all previously restricted vegetation growth areas in accordance with the EPBC Act Approval Condition 3d • Upon decommissioning, appropriate measures will be installed to discourage use of decommissioned access ways for safety reasons and for the purpose of assisting site recovery. These may be temporary or permanent structures • The easement will not be used as a general thoroughfare • Access to the ROW for decommissioning activities will, as far as is practicable, be via existing tracks • The width of access tracks will be kept to a minimum practicable to enable safe vehicular movement • Vehicle access will be restricted to stable ground where practicable and additional care will be taken near watercourses and drainage lines • Should erosion and sedimentation occur, appropriate corrective action will be undertaken in accordance with the SMESCP (refer Appendix C) • All waste material generated from the decommissioning of the site will be recycled, re-used or disposed at a suitably licenced waste facility • Refuelling or maintenance of equipment and vehicles will be conducted as far away as is reasonably practical from any surface water body to reduce the risk of contamination in the event of accidental fuel or oil release and in accordance with relevant standards and guidelines for these activities • Should the Santos GLNG GTP no longer be required at some time during its design life (42 years), it will be decommissioned in accordance with the legislative requirements of the day, AS2885 and the APIA Code of Environmental Practice (APIA, 2005) or equivalent at that time
Performance indicators	• Erosion is controlled to a degree that is consistent with "natural processes" • Land capability/suitability is not being reduced • Erosion control strategies are implemented, functional and maintained • Topsoil is stored separately and no spoil piles remain on surface after restoration

7.6 Measureable performance indicators

A number of technical documents have been prepared, in order to provide more specific and detailed mitigation measures, as well as performance indicators. The technical documents include:

- ASSMP (refer Appendix A)
- SMESCP (refer Appendix C)
- LRMP (refer Appendix E)
- WMP (contamination) (refer Appendix F)

The supporting technical documents present an assessment of performance criteria and measurable performance indicators for the protection of environmental values. There is also reference to how the performance indicators satisfy compliance with monitoring of relevant approval conditions and permits pertaining to the regulatory framework.

7.7 Monitoring and compliance reporting

In addition to the development of measurable performance indicators, the supporting technical documents also present methodologies for monitoring of performance indicators, including monitoring frequency, and describe the types of reporting required, with reference to the regulatory framework.

8. Land tenure and use

8.1 Chapter summary

This chapter outlines existing land tenure and use within and adjacent to the Marine Crossing GTP Project disturbance footprint. Potential impacts to land tenure and use as a result of proposed construction and operation activities are also identified.

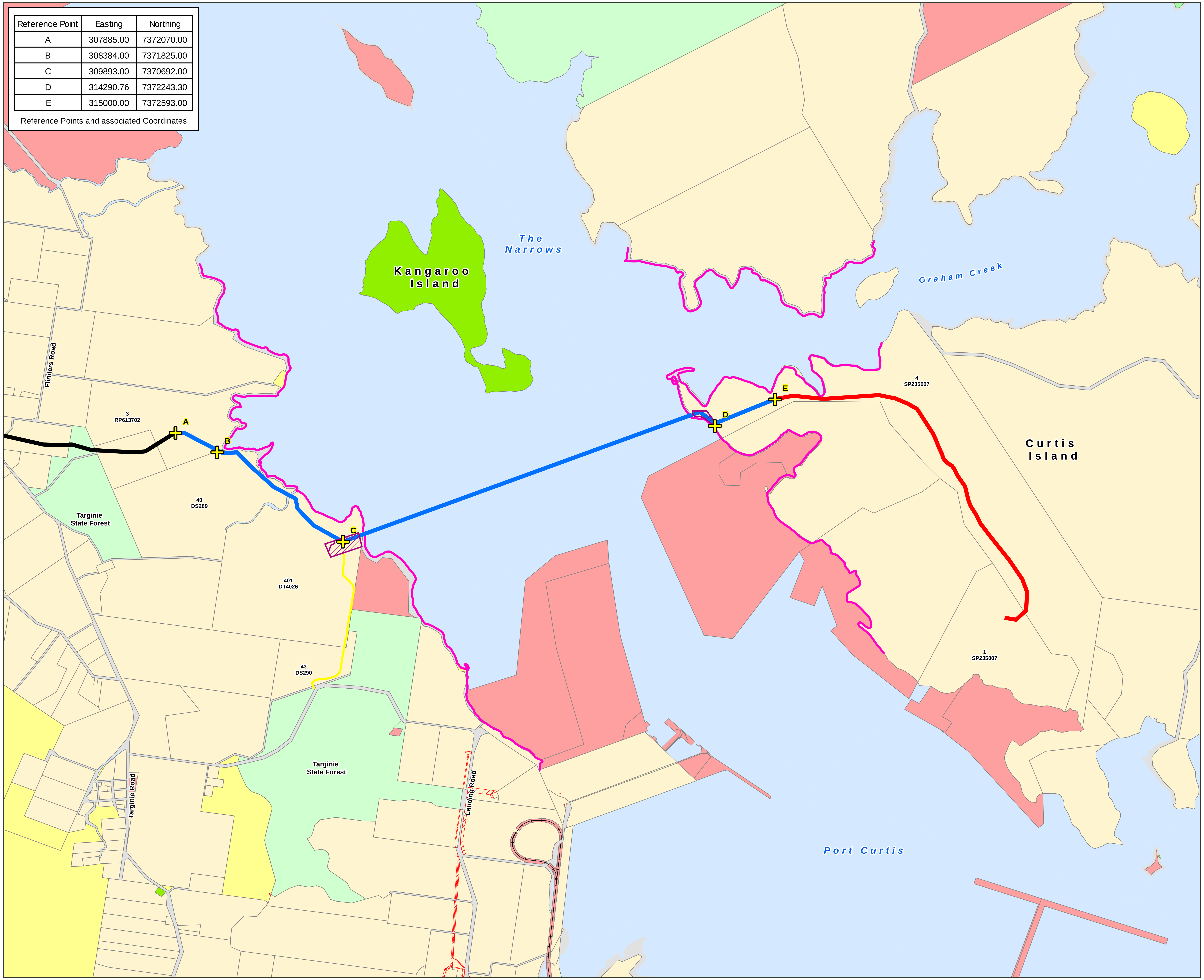
8.1.1 Summary of existing land tenure and use

Land tenure

- Land tenure of affected properties and surrounding areas is illustrated on Figure 8.1
- The CG has purchased a number of properties neighbouring the GSDA
- The Marine Crossing GTP Project disturbance footprint extends from Point A to Point C (mainland), Point C to Point D (tunnel under The Narrows) and Point D to Point E (Curtis Island), and includes the ROW laydown and work areas, the construction site pads (mainland and Curtis Island) at Point C and Point D, respectively, and the Access Road extending between Forest Road and Point C
- The Access Road, between Forest Road and Point C passes through horticulture land subject to exploration tenure and mapped as potential Strategic Cropping Land
- GPS coordinates for the reference points for the Marine Crossing GTP Project disturbance footprint are provided in Figure 8.1
- Sections of the Marine Crossing GTP from Point A to Point C (mainland) and Point D to Point E (Curtis Island) are located within the MTSC of the GSDA and pass through two sub-precincts, Northern Infrastructure Corridor and Curtis Island Corridor, respectively
- There are no existing registered easements within the ROW
- The land tenure of the Marine Crossing GTP Project disturbance footprint, Point A to Point C (mainland), ROW laydown and work areas, Forest Road and Point C (Access Road) and Point D to Point E (Curtis Island) that is above high-water mark is freehold land
- The land tenure of the Marine Crossing GTP Project disturbance footprint below the high-water mark between Point C and Point D, where it passes beneath The Narrows, is USL administered by DNRM
- The resource tenures relevant to the Marine Crossing GTP Project are exploration permit (minerals), mineral development licence and mining lease tenures (refer to Figures 8.2a, 8.2b and 8.2c)

Land use

- Land use of affected properties and surrounding areas is illustrated on Figures 8.3a and 8.3b
- The Marine Crossing GTP Project disturbance footprint passes through land used for grazing of livestock, which is located within the MTSC of the GSDA and is zoned for gas transportation infrastructure (refer Figure 8.3b)
- The Access Road alignment passes through land that is mapped as potential Strategic Cropping Land in the vicinity of the intersection with Forest Road, south of Point C (refer Chapter 7 and Figure 7.4)
- The Marine Crossing GTP Project disturbance footprint passes through land that is subject to mining, mineral development and exploration resource tenures, which indicates that the area may be developed for industrial uses in the future



Reference Point	Easting	Northing
A	307885.00	7372070.00
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Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road
- Mean High Water Springs (MHWS) Levels

Land Tenure
- Freehold
- Housing Land
- Industrial Estates
- Lands Lease
- National Park
- Port and Harbour Boards
- Reserve
- Railway
- State Forest
- State Land
- Easement
- Road Parcel
- Water Parcel
- Rail

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Cadastre, Tenure and Easements: Department of Environment and Resource Management, Oct 2011.

Note:
Lot and Plan details given only for cadastre intersecting Marine Crossing GTP

Land Tenure
Figure 8.1

A1 scale: 1:25,000

0 500 1,000 1,500 2,000 2,500 m

GLNG No: 3381-40-0446

Coordinate system: GCS_GDA_1994

Date: 20/06/2012

Version: I

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Map by: TW

- The Marine Crossing GTP Project disturbance footprint is located within Port limits but does not extend into or through the GBR Coast MP or Habitat Protection Zone (refer Figure 8.4a)
- The area locally known as The Narrows is of recreational value to local tourism and contains the Commonwealth mapped Great Barrier Reef World Heritage Area (GBRWHA) and Dugong Protection Area, which are intercepted by the proposed tunnel alignment beneath the Narrows, extending to include Point D and Point E on Curtis Island (refer Figure 8.4b)
- The Gladstone City is the closest major population centre, and a smaller centre exists at Targinie
- The Marine Crossing GTP Project disturbance footprint does not cross roads or other infrastructure, but the Access Road connects to Forest Road, south of Point C
- No stock routes have been identified within the Marine Crossing GTP Project

8.1.2 Summary of potential impacts on land tenure and use

Construction

Land use activities will be temporarily restricted over the Marine Crossing GTP ROW and the Access Road alignment during construction. Generally the primary land use can recommence following construction and rehabilitation, except for the land within the Marine Crossing GTP Project disturbance footprint that will be subject to some permanent restrictions through Land Management Agreements to protect the GTP infrastructure integrity and ensure future access to the Marine Crossing GTP for operation and maintenance activities. The Narrows tunnel will be constructed beneath the seabed via bored tunnel and will not impact on coastal shipping or recreational boating.

Construction activities for the Marine Crossing GTP Project may pose a risk to public safety where construction traffic enters/exits public roads in the area. These risks will be mitigated in accordance with the management measures identified in the Road Use Management Plan (RUMP) and agreed in consultation with GRC, DTMR, DSDIP, Queensland Rail National, GPC, and the Gladstone Economic and Industry Development Board to minimise disruption to road and other transport route users.

Earthworks will require the removal of vegetation and construction of temporary structures resulting in some visual impacts. However, these impacts on visual amenity from the clearing and construction of the Marine Crossing GTP Project will be temporary during construction. Rehabilitation post construction will reinstate land for primary land uses and revegetate disturbed areas. The impacts to flora and fauna and proposed mitigation measures are discussed in Chapter 10.

Operation

Land within the Marine Crossing GTP Project will be subject to some restrictions post construction, through Land Management Agreements, to protect GTP infrastructure integrity and to maintain future access to the Marine Crossing GTP for operation and maintenance activities.

The Marine Crossing GTP is below ground surface through the terrestrial mainland and Curtis Island sections, and runs beneath the seabed via bored tunnel through The Narrows, as such there will be no impact to coastal shipping operations or recreational boating.

Following construction, the Marine Crossing GTP Project will be restored, as close as practicable, to the natural contours and compaction levels of the ground surface. There will be no above ground infrastructure associated with the operation of the GTP, other than the

GTP protection signage installed for public safety, therefore there will be no impacts on the visual amenity of the area during operation.

8.1.3 Summary of proposed mitigation measures for land tenure and use

Table 8.1 Summary of environmental protection commitments, objectives and control strategies – land tenure and use

Item	Outcomes
Environmental Protection Objectives	• Social disruption to the local communities from the construction of the Marine Crossing GTP Project is minimised • Minimal impacts on third party infrastructure during the construction of the Marine Crossing GTP Project
Specific Objectives	• No warranted complaints from landholders and the community, with complaints responded to within 24 hours • Minimal interruption to third party infrastructure • No unauthorised impacts on third party infrastructure
Control Strategies	• Locate infrastructure associated with construction and operation of the Marine Crossing GTP Project so that it does not adversely impact on existing landholder management practices • Install temporary fencing to protect humans and livestock and to minimise unauthorised access • Rehabilitate disturbed areas from construction work progressively and reinstate fencing and infrastructure in consultation with landholders and as set out in Landholder Agreements and the Landscape and Rehabilitation Management Plan (LRMP) (refer Appendix F) • Consider potential impact on visual amenity when siting activities and structures within the Marine Crossing GTP Project disturbance footprint Refer to Table 8.6 for additional land tenure and land use control strategies to be implemented during construction and operation of the Marine Crossing GTP Project
Performance Indicators	• Report on the performance in management of complaints to the Gladstone Regional Coordination Committee • The number of complaints received from stakeholders and the time taken to investigate, take suitable action and close-out

8.2 Existing land tenure and use

The land tenure for each of the properties intercepted by the Marine Crossing GTP Project disturbance footprint are provided in Table 8.2 and illustrated in Figure 8.1.

Table 8.2 Land tenure for land intercepted by the Marine Crossing GTP Project alignment

Lot	Plan	Tenure type	Area (ha)	Landowner/consent
Mainland				
3	RP613702	Freehold	141	The Coordinator General
41	SP239338	Freehold	7	The Coordinator General
40	SP239338	Freehold	179	Queensland Energy Resources Limited A.C.N. 107 882 057
401	CP DT4026	Freehold	259	Butler, CW & BW
Humpy Creek (tenured watercourse)				DNRM
43	CP DS290	Freehold	51	Stuart Energy (Nominees) Pty Ltd A.C.N. 078 274 629

Lot	Plan	Tenure type	Area (ha)	Landowner/consent
The Narrows tunnel crossing				
Unallocated State Land (USL) (being the intertidal area and The Narrows)				DNRM
Curtis Island				
4	SP235007	Freehold	519	The Coordinator General

The Marine Crossing GTP Project disturbance footprint will cross from land north of Gladstone, beneath the intertidal area and The Narrows, to Curtis Island. The Marine Crossing GTP Project disturbance footprint on either side of The Narrows is freehold land within the MTSC of the GSDA. The proposed bored tunnel beneath The Narrows will be located directly south of the GBR Coast MP boundary. The Marine Crossing GTP tunnel alignment will be located within the seabed beneath waters of The Narrows, part of which occurs within the mapped Commonwealth GBRWHA and Dugong Protection Area. The Marine Crossing GTP ROW will intercept the GBRWHA on Curtis Island (refer Figure 8.4b). The Marine Crossing GTP Project does not enter the GBRMP because this is located to the east of Curtis Island (refer Figure 8.4a).

The Marine Crossing GTP Project disturbance footprint extends from Point A to Point E (refer Figure 8.1) and passes through the Northern Infrastructure Corridor (NIC) Sub-Precinct on the mainland and the Curtis Island Corridor Sub-Precinct on Curtis Island, which are located in the MTSC of the GSDA (CG, 2010).

Construction of gas transportation infrastructure in the Curtis Island Corridor Sub-Precinct is considered by Schedule 3 of the Development Scheme for the GSDA to be “highly likely” to meet the scheme’s objectives and a development application for a material change of use has been submitted.

Figure 8.3a illustrates existing primary land uses within and surrounding the Marine Crossing GTP Project and Figure 8.3b shows the proximity of the Marine Crossing GTP Project to neighbouring large-scale industrial sites (existing and proposed) associated with the GSDA.

8.2.1 Easements

There are no registered easements over land within the Marine Crossing GTP Project.

An easement will be registered for the Marine Crossing GTP ROW through freehold land on the mainland and Curtis Island, across The Narrows, Humpy Creek, Targinie Creek and the intertidal area at the location where the proposed bored tunnel alignment is indicated on Figure 8.1.

Current proposed ROW alignments for LNG project proponents are indicated on Figure 8.3c.

8.2.2 Land tenure

Table 8.2 provides a summary of the land tenure crossed by the Marine Crossing GTP, as well as the Access Road, and neighbouring land and is illustrated in Figure 8.1. The land tenure of the Marine Crossing GTP that is above high-water mark is freehold land. The land tenure for the areas located below the high-water mark is USL, administered by DNRM.

8.2.3 Resource tenure

The resource tenures relevant to the Marine Crossing GTP Project are discussed below and shown in Figures 8.2a to 8.2c:

- Exploration permit (minerals)
- Mineral development licence
- Mining lease

Exploration Permit (Minerals)

Exploration permit (minerals) (EPM-3215) (Figure 8.2a) applies to the westernmost section of the Marine Crossing GTP Project (mainland). The eastern section of the Marine Crossing GTP Project (Curtis Island) is located adjacent to an area that is the subject of an application for an exploration permit (minerals) (EPM-18190) (Figure 8.2a).

Mineral Development Licence

The majority of the Marine Crossing GTP Project (mainland) is located on terrestrial land, which is subject to a mineral development licence (MDL-177) and the westernmost section of the proposed bored tunnel alignment beneath The Narrows is within land subject to mineral development licence MDL-225 (refer Figure 8.2b).

Mining Lease

There is an application for a mining lease (ML-80081) over land within the Marine Crossing GTP Project disturbance footprint from Point A to Point C and including the northern portion of the Access Road immediately south of Point C. The southern section of the Access Road (including the washdown facilities), extending to the connection with Forest Road is across land that is subject to an existing mining lease (ML-80003) (refer Figure 8.2c).

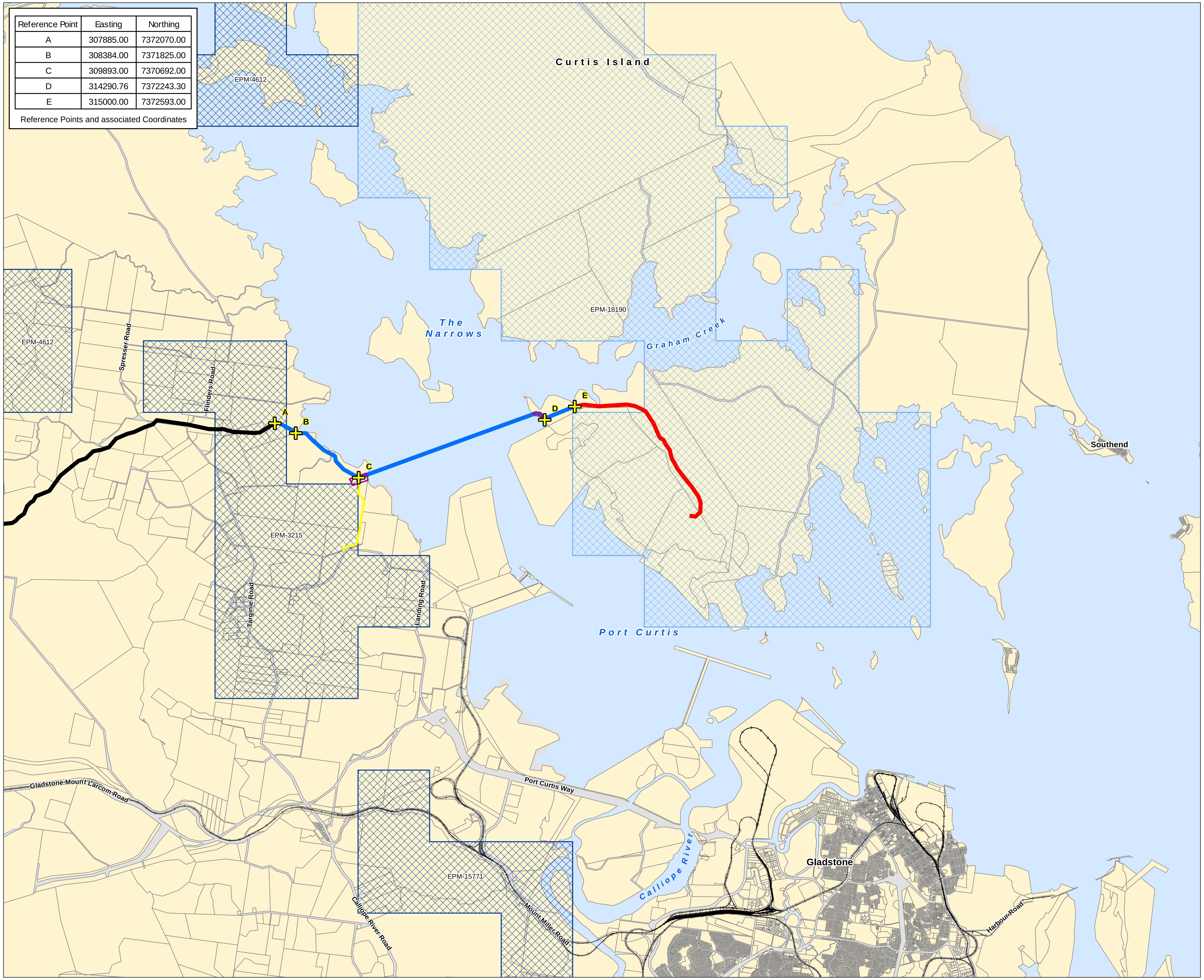
8.2.4 Land use

The primary land use within the Marine Crossing GTP Project disturbance footprint is grazing and agriculture. Other land uses in the vicinity of or adjacent to the land affected by the Marine Crossing GTP Project include irrigated perennial horticulture, private water storage dams/reservoirs and production forestry (eg Targinie State Forest) (refer Figure 8.3a).

Other neighbouring land uses and potential future land uses include industrial and conservation activities. The Marine Crossing GTP Project passes through the NIC Sub-Precinct on the mainland and the Curtis Island Corridor Sub-Precinct on Curtis Island of the MTSC within the GSDA. The adjoining land west of Point A and Point B (mainland) is located within the Targinie Precinct of the GSDA and the Marine Crossing GTP Project between Point D and Point E (Curtis Island) is within the Curtis Island Industry Precinct. The land adjacent to the southern boundary of the Marine Crossing GTP Project (mainland) between Point B and Point C and the Access Road is predominantly freehold land that has been purchased by the CG (refer Figure 8.1 and Figure 8.3b). Recreation and tourism activities are predominantly associated with The Narrows.

Agriculture

The Marine Crossing GTP Project passes through land used for grazing of livestock. This land is within the GSDA in an area zoned for gas transportation infrastructure.



Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_006.mxd 28/05/2012 16:32

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GLNG No: 3381-40-0447

Coordinate system: GCS_GDA_1994

Santos GLNG Project

Marine Crossing GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Proposed Access Road

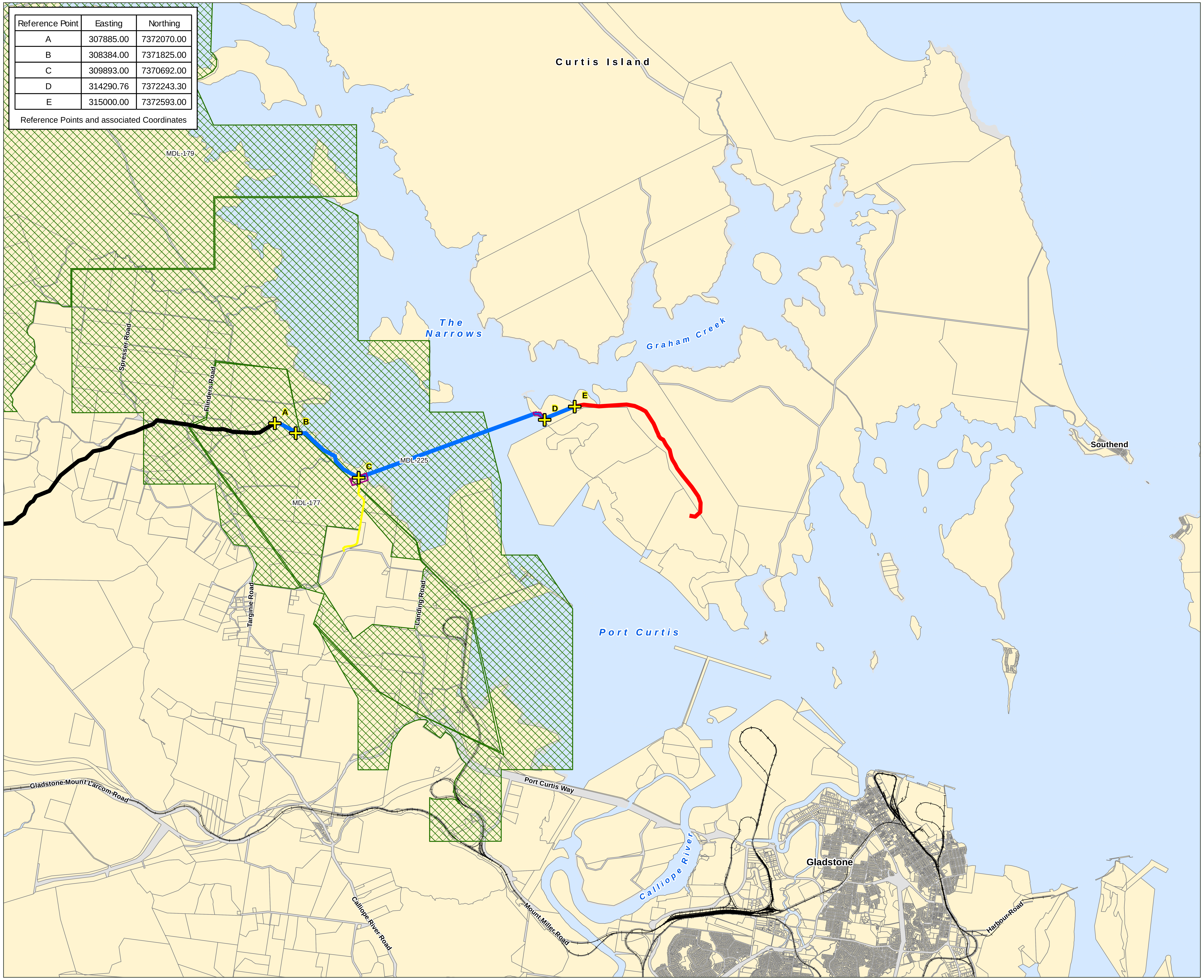
Exploration Permit for Minerals

- Granted
- Application
- Cadastre
- Rail

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Cadastre: Department of Environment and Resource Management, Oct 2011.
Resource Tenure: Department of Mines and Energy, Feb 2011.

Resource Tenure: Exploration Permit for Minerals Figure 8.2a

Date: 28/05/2012 Version: i



Reference Point	Easting	Northing
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B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Mining Development Lease
- Granted
- Cadastre
- Rail

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Cadastre: Department of Environment and Resource Management, Oct 2012.
Resource Tenure: Department of Mines and Energy, Feb 2011.

Resource Tenure:Mineral Development Lease Figure 8.2b

A1 scale: 1:50,000
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GLNG No: 3381-40-0448
Coordinate system: GCS_GDA_1994

Date: 20/06/2012 Version: j

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Reference Point	Easting	Northing
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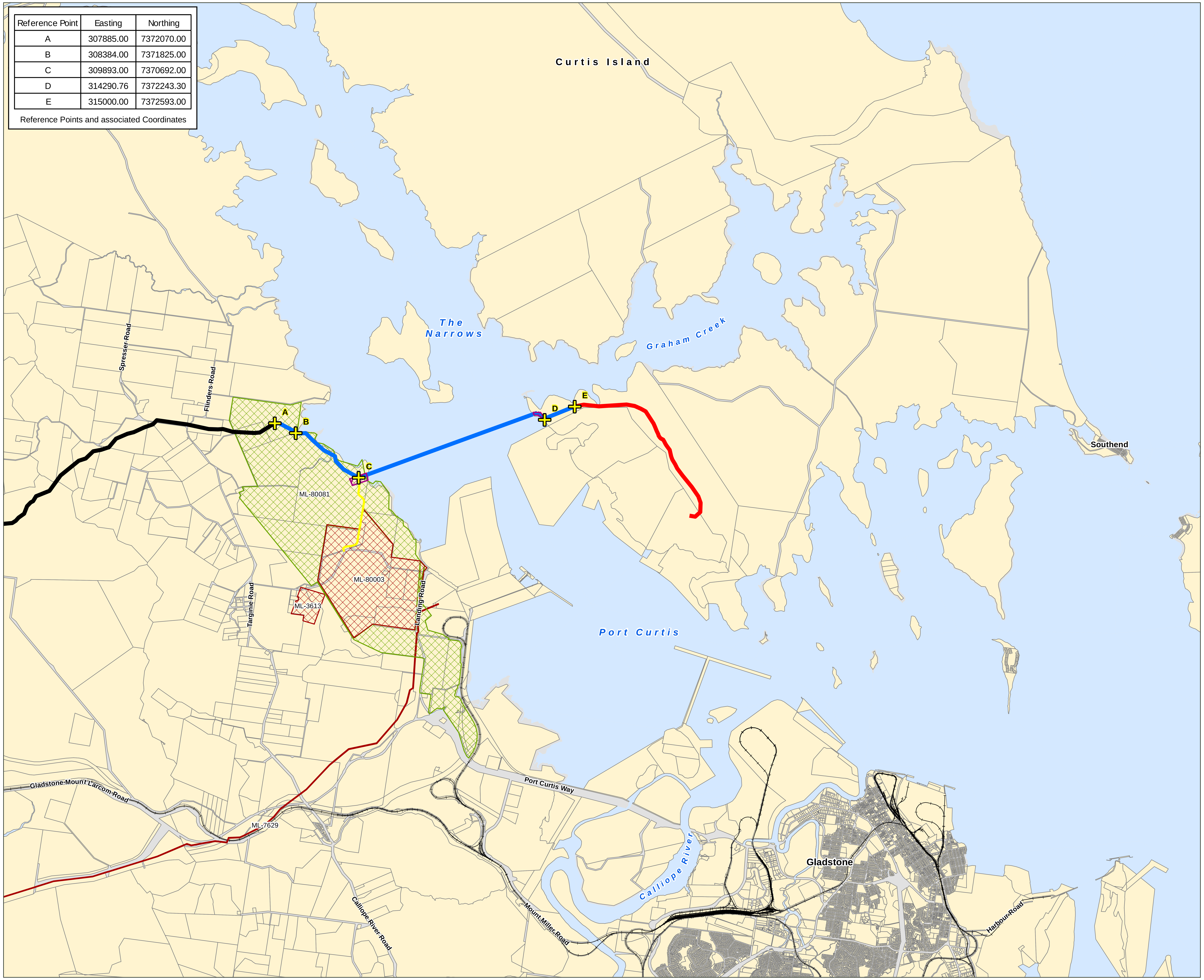
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates



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GLNG No: 3381-40-0449

Coordinate system: GCS_GDA_1994

Santos
GLNG Project

Marine Crossing GTP EM Plan

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Mining Lease
- Granted
- Application
- Cadastre
- Rail

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Cadastre: Department of Environment and Resource Management, Oct 2012.
Resource Tenure: Department of Mines and Energy, Feb 2011.

Resource Tenure: Mining Lease Figure 8.2c

Date: 20/06/2012 Version: j

Reference Point	Easting	Northing
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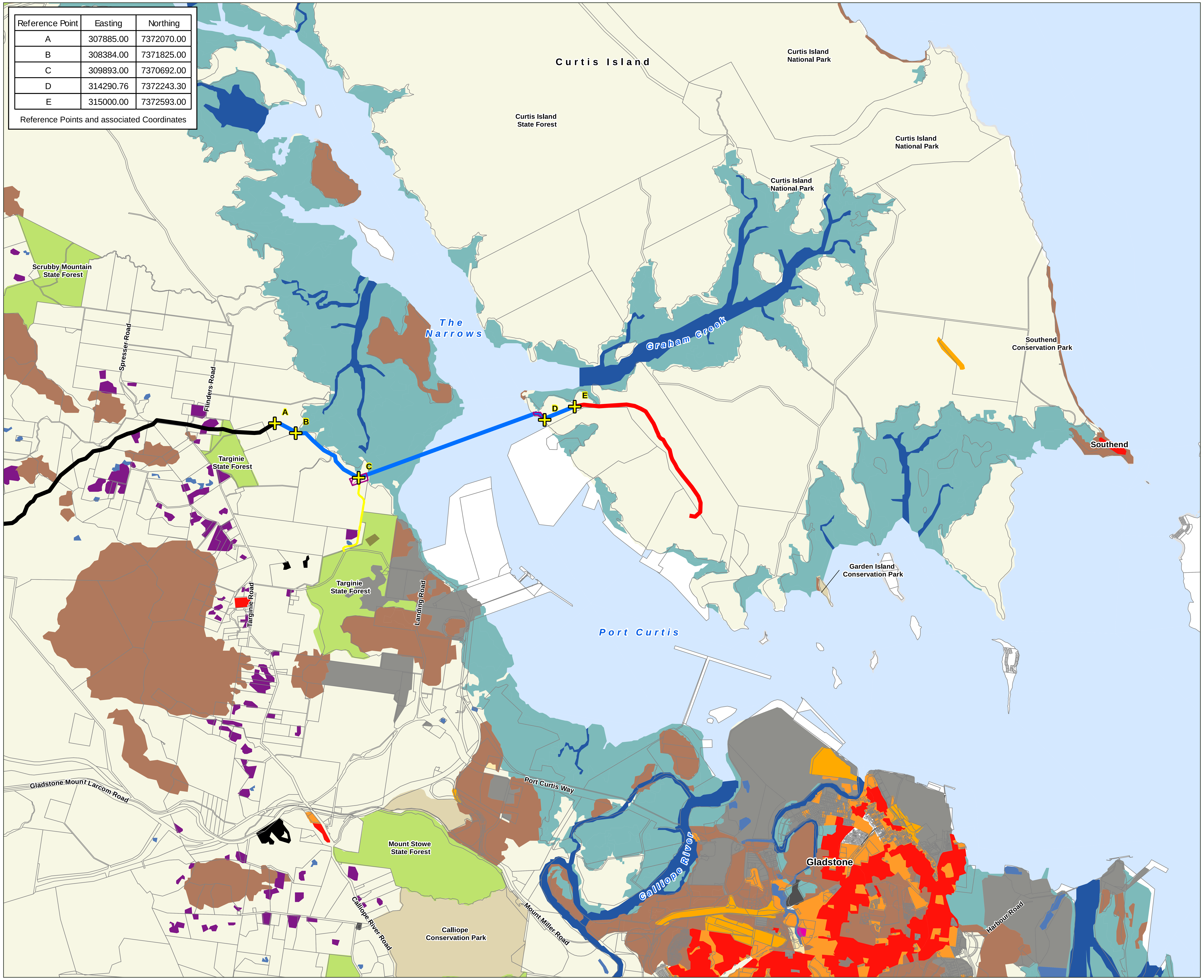
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates



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GLNG No: 3381-40-0450

Coordinate system: GCS_GDA_1994

Santos GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

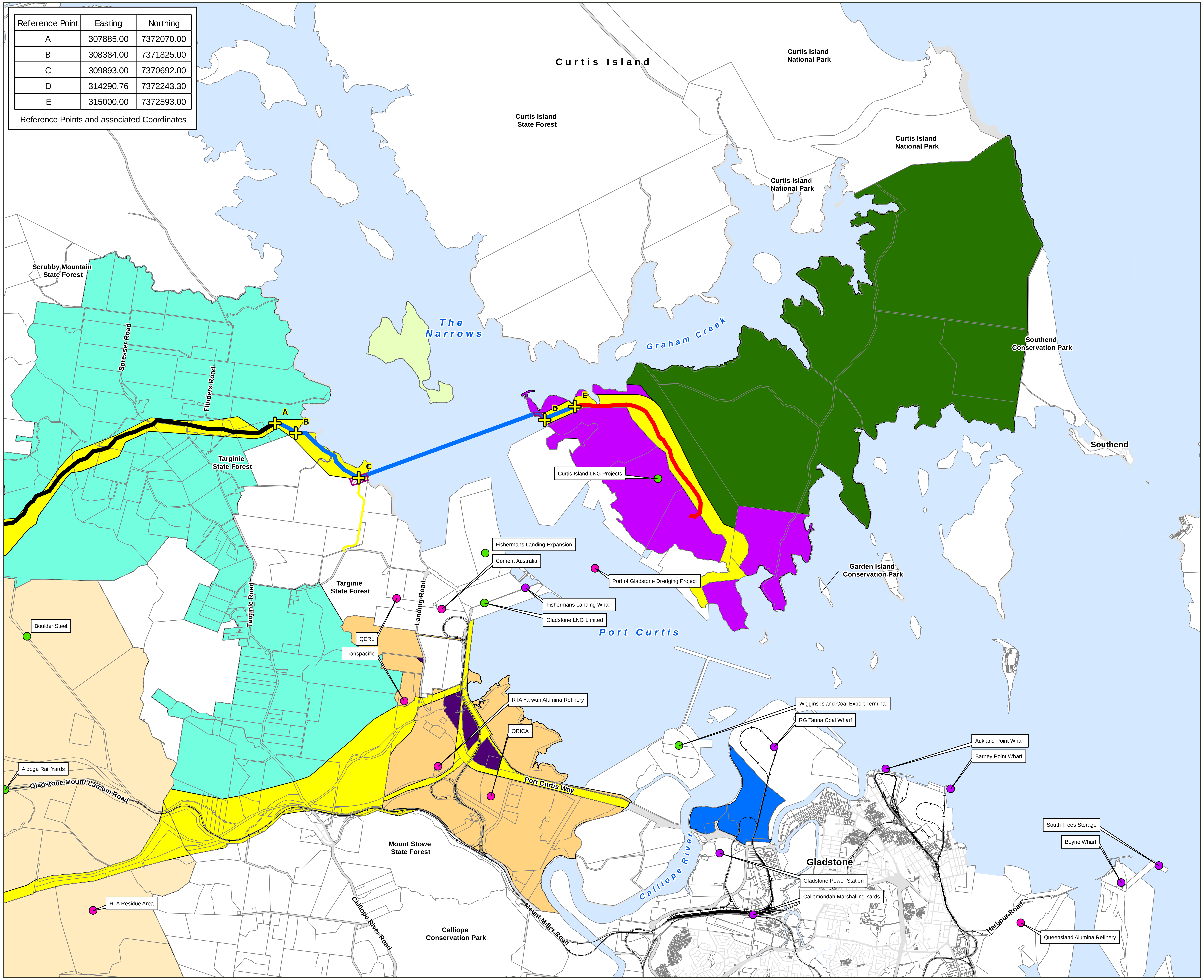
Queensland Land Use Mapping Program (2004)
- Nature conservation
- Other minimal use
- Grazing natural vegetation
- Production forestry
- Plantation forestry
- Irrigated perennial horticulture
- Intensive horticulture
- Manufacturing and industrial
- Residential
- Services
- Utilities
- Transport and communication
- Mining
- Waste treatment and disposal
- Reservoir/dam
- River
- Marsh/wetland
- Rail
- Cadastre

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Cadastre: Department of Environment and Resource Management, Oct 2012.
Queensland Land Use Mapping Program: Queensland Land UseMapping Program1999 with updates from 2004. Queensland Government, 1999, 2004.

Note: Cadastral boundaries shown only for non residential areas

Land Use
Figure 8.3a

Date: 20/06/2012 Version: j



Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

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Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)

- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

GSDA Regions

- Aldoga Precinct
- Clinton Precinct
- Corridor Buffer Area Precinct
- Curtis Island Industry Precinct
- Environmental Management Precinct (Curtis Island)
- Environmental Management Precinct (Kangaroo Island)
- Materials Transportation and Services Corridor
- Stuart Oil Shale Reserve Preservation Area
- Targinnie Precinct
- Yarwun Precinct
- Rail
- Cadastre

Gladstone Projects

- Existing Projects
- Existing Infrastructure
- Proposed Projects

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Cadastre: Department of Environment and Resource Management, Oct 2012.
Queensland Land Use Mapping Program: Queensland Land UseMapping Program1999 with updates from 2004.
Queensland Government, 1999, 2004.

Note: Cadastral boundaries shown only for non residential areas

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GLNG No: 3381-40-0555

Coordinate system: GCS_GDA_1994

GSDA and Existing/Proposed Infrastructure Figure 8.3b

Date: 20/06/2012

Version: j

Industrial

The Marine Crossing GTP Project passes through land that is subject to mining, mineral development and exploration resource tenures (refer Section 8.2.3).

The land between Point A and Point C and Point D to Point E is within the MTSC, NIC Sub-Precinct and Curtis Island Corridor Sub-Precinct of the GSDA (refer Figure 8.3b).

Land within the Marine Crossing GTP Project will be subject to the proposed PPL. The PPL will be comprised of a number of blocks and sub-blocks, which are listed in Table 1.3 and shown in Figure 1.3.

Conservation

Construction of the Marine Crossing GTP Project will involve tunnelling underneath the intertidal area and The Narrows. The Marine Crossing GTP Project disturbance footprint is located within Port limits and does not extend into or through the GBR Coast MP or Habitat Protection Zone (refer Figure 8.4a). However, the Marine Crossing GTP tunnel alignment will be located within the seabed beneath waters of The Narrows, part of which occurs within the mapped Commonwealth GBRWHA and Dugong Protection Area, and the Marine Crossing GTP ROW will intercept the GBRWHA on Curtis Island (refer Figure 8.4b).

Great Barrier Reef Coast Marine Park

Within the vicinity of Gladstone, the GBR Coast MP includes the water locally known as The Narrows (north of Friend and Laird Points), out to three nautical miles from the HAT of Curtis Island and Facing Island and the mainland south of Canoe Point (Figure 8.4a).

The *Marine Parks (Declaration) Regulation 2006* designates the boundary of the GBR Coast MP as:

- Generally northerly, westerly and southerly along Curtis Island at HAT to where it intersects latitude 23º44.905' south
- Then west along latitude 23º44.905' south to where it intersects Kangaroo Island at high water

Work related to the construction of the Marine Crossing GTP Project will be carried out in the buffer zone.

Great Barrier Reef World Heritage Area

The GBRWHA covers an area of Curtis Island and The Narrows (refer Figure 8.4b). The GTP tunnel alignment will be located within the seabed beneath waters of The Narrows, part of which occurs within the mapped Commonwealth GBRWHA and Dugong Protection Area from Point C to Point D. The GBRWHA applies to the level of the seabed and not beneath the seabed where the Marine Crossing GTP tunnel will be located. The Marine Crossing GTP Project disturbance footprint (Curtis Island) is also within the GBRWHA from Point D to Point E.

Great Barrier Reef Marine Park

The Marine Crossing GTP Project does not cross the GBRMP boundary located on the seaward side of Curtis Island (refer Figure 8.4a).

Recreation and tourism

Recreation and tourism focuses on The Narrows. This area is located close to Gladstone and is readily accessible by boat, making it popular for local boating and recreational boating.

8.2.5 Population centres

The closest major population centre is Gladstone, and a smaller centre exists at Targinie (refer Table 8.3).

Table 8.3 Population of nearby towns

Town	Approximate distance from Marine Crossing GTP	Population (current)
Targinie	6-7 km	210
Gladstone City (urban area)	15-20 km	29,229

8.2.6 Easements and infrastructure

The Marine Crossing GTP Project does not cross roads or other infrastructure, except for the rights of way for the pipelines of other LNG project proponents, which will occur approximately 200 m east of Point B and at a point approximately 500 m west of the construction site pad (Curtis Island) at Point D (refer Figure 8.3c).

The Marine Crossing GTP Project is located to the north of Fisherman's Landing and as such the construction and operation of the Marine Crossing GTP is not expected to interfere with the operations of the Port of Gladstone or any proposed future expansion of Fisherman's Landing.

8.2.7 Roads

There are three local roads in the vicinity of the Marine Crossing GTP Project. These roads will not be crossed, but will be required for access during construction and operation. As such, the Marine Crossing GTP Project may pose a risk to public safety where construction traffic enters/exits public roads in the area. These risks will be mitigated in accordance with the management measures identified in the RUMP and agreed in consultation with GRC, DTMR, DSDIP, Queensland Rail National, GPC, and the Gladstone Economic and Industry Development Board to minimise disruption to road and other transport route users.

The Access Road from Forest Road to the construction site pad (mainland) at Point C (as shown on Figure 1.2) will be constructed to facilitate all-weather access for construction of the Marine Crossing GTP Project construction activities, including the movement of personnel, equipment and materials, and removal of tunnel spoil.

8.2.8 Stock routes

No stock routes are located within the Marine Crossing GTP Project disturbance footprint.

8.2.9 Visual amenity

The surrounding area is generally flat with coastal vegetation against a backdrop of the higher elevations culminating at Mount Larcom, the highest peak in the area.

The mainland section of the Marine Crossing GTP Project is located on the low-lying coastal alluvial fan to the east of Mount Larcom and runs generally southeast along the slightly undulating coastal fringe through open forest woodland crossing two minor unnamed tributaries of Mosquito Creek, Humpy Creek and Targinie Creek to a slightly elevated boundary with the intertidal area south of Mosquito Creek. The tunnel alignment then runs generally northeast beneath the intertidal area and The Narrows, exiting at the interface with the marine environment on Curtis Island, rising from the foreshore quickly to a narrow plateau marked by a change in vegetation.

Table 8.4 contains photos of indicative viewsheds in the vicinity of the Marine Crossing GTP Project.

Table 8.4 Indicative viewsheds in the vicinity of the Marine Crossing GTP Project disturbance footprint

Location	Viewshed
Marine Crossing GTP Project (mainland) – view towards The Narrows from elevated ridges behind the lower lying coastal fringe	
Marine Crossing GTP Project (The Narrows) – view of the marine and intertidal area interface near Point C	

Location	Viewshed
Marine Crossing GTP Project (Curtis Island) – view landward from the foreshore near Point D	

8.3 Potential adverse or beneficial impacts on existing land tenure and land use (construction and operation)

8.3.1 Landholders and land use

The Marine Crossing GTP Project has been sited to avoid interference with existing land use, where practical. The alignment of all pipelines through the GSDA is required to follow the MTSC to confine impacts to this area as specified in the Development Scheme for the GSDA dated December 2010 (CG, 2010).

The land above the high-water mark directly affected by the Marine Crossing GTP Project disturbance footprint is freehold. There are four private landholders on the mainland section of the Marine Crossing GTP Project within the direct area of disturbance. Construction work will include clearing and grading, establishment of the Access Road, establishment of the ROW laydown and work areas, and construction site pad (mainland) including launch shaft for the tunnelling work, and traditional open cut trenching and pipelaying. On Curtis Island, two private landholders will be affected by the proposed construction work, which will include establishment of the construction site pad (Curtis Island) including receptor shaft for the tunnelling work, and traditional open cut trenching and pipelaying (refer to Table 8.2 and Figure 8.1).

Tidal land and tidal waters below the high-water mark is USL administered by DNRM.

Existing land use activities will be temporarily restricted within the Marine Crossing GTP Project. A 50 m wide corridor has been set aside for GLNG for the length of the MTSC within the GSDA. Within this corridor, a standard ROW construction width of 40 m has been specified. The Marine Crossing GTP Project disturbance footprint will be located within an area adjacent to mapped ESAs, and as such the ROW between Point A and Point E will be reduced to a 30 m wide ROW in order to reduce impacts in accordance with the CG Report. Trenching activities on the mainland and Curtis Island will advance at an average rate of approximately 1.5 km per day. Therefore, the period that any one section will be affected at the peak of construction activities is limited.

The Marine Crossing GTP tunnel will be located under the intertidal area and The Narrows in a bored tunnel, there will be no impacts from tunnel construction on coastal shipping or recreational boating activities.

Primary land uses within the Marine Crossing GTP Project disturbance footprint (including the Access Road) can recommence following site reinstatement and landscape rehabilitation work post-construction for the majority of the disturbed areas. However, land within the Marine Crossing GTP ROW will be subject to some land use restrictions, these will be administered through Land Management Agreements with landholders to protect the GTP integrity and restrict future access to the Marine Crossing GTP during operation.

8.3.2 Community safety

Measures will be adopted to protect the safety of the community during construction. These measures will apply to both the terrestrial mainland and Curtis Island sections of the Marine Crossing GTP Project disturbance footprint. It should be noted that the Marine Crossing GTP trenched sections, construction site pads and Access Road, are located on freehold land and as such these works can be expected to only impact on the respective landholder for the particular property where the work is being carried out.

Construction activities for the Marine Crossing GTP Project may pose a risk to public safety where construction traffic enters/exits public roads in the area. These risks will be mitigated in accordance with the management measures identified in the RUMP and agreed in consultation with GRC, DTMR, DSDIP, Queensland Rail National, GPC, and the Gladstone Economic and Industry Development Board to minimise disruption to road and other transport route users.

There will be no requirement for the management of water traffic during construction works under The Narrows because tunnelling activities will occur within the seabed beneath The Narrows and construction personnel will utilise existing barges to access Curtis Island work areas. Construction activities occurring within Port limits and below the high-water mark will be conducted in accordance with the conditions of the CG Report and all relevant permits and approvals.

A number of permanent warning signs will be erected surrounding the Marine Crossing GTP Project. During construction, these areas will be under constant supervision and will have restricted access points.

During operation there will not be the same need to manage community safety as during the construction phase; however GTP protection signage and markers will be erected to indicate the location of the Marine Crossing GTP ROW post construction.

8.3.3 Visual amenity

During construction of the Marine Crossing GTP, clearing and grading work will involve the removal of vegetation resulting in visual impacts (eg temporary impacts on views from Mount Larcom). Views from Gladstone will not be impacted, due to the limited extent of the construction activities, the distance of the disturbance locations from Gladstone, and existing industrial activities within the surrounding viewshed of Gladstone.

Construction activities associated with trenching works for the Marine Crossing GTP will include the placement of temporary stockpiles of material adjacent to the trenches within the ROW. This may result in visual impacts from vegetation clearing, exposed soils and visual disruption from the modification of the landscape. It is proposed that maximum material stockpile heights will be maintained at 3 m or less, in accordance with material handling specifications and the SMESCP, and material is used insitu during backfilling, unless unsuitable material is excavated that requires strategic reburial or disposal in designated areas or offsite.

The construction site pad (mainland) will comprise a 7.48 ha launch shaft and work area dedicated to tunnelling operations and ancillary support infrastructure, such as water treatment plant and sedimentation pond. It is anticipated that the tunnelling support infrastructure and work areas will be operational for up to 18 months. Access to the construction site pad (mainland) will be via the Access Road from Forest Road.

The construction site pad (Curtis Island) has a 2.25 ha footprint and includes the TBM receptor shaft and associated work area. Construction equipment and staff will access the construction site pad (Curtis Island) via barge to the existing jetty facilities at Laird Point and then along the existing access track.

Post construction, the construction site pads and Access Road will be rehabilitated and revegetated for the purpose of reinstating the primary land use, where practical. As such, visual impacts associated with construction of the Marine Crossing GTP Project disturbance footprint and associated construction activities will be temporary in nature.

During operation, the Marine Crossing GTP and all associated infrastructure will be below ground surface and as such it is not anticipated that there will be any impact on the visual amenity of the area.

8.4 Cumulative impacts

Measures set out in this EMP for the Marine Crossing GTP Project will result in only negligible cumulative impacts on land tenure and use.

8.4.1 Visual amenity (lighting)

Cumulative impacts from illumination of construction sites at night on neighbouring sensitive receptors are likely to be negligible as the nearest sensitive receptors are considered to be too far away to be affected by the lighting at the construction site pads (Point C and Point D).

It should be noted that construction activities associated with open cut trenching works and pipelaying on the mainland and Curtis Island sections will not be carried out during night hours. As such, plant lighting is not expected to be used as part of the construction phase in these sections. However, construction activities associated with the bored tunnel will be 24 hours per day and as such will require lighting plant at the construction site pads (Point C and Point D). It is considered that these locations will not be visible from sensitive receptor locations and are therefore unlikely to generate impacts on visual amenity.

Light impacts on fauna are discussed in Chapter 10. Measures have been set out in this EMP to minimise cumulative impacts on visual amenity (lighting) from the construction of the Marine Crossing GTP Project.

8.4.2 Visual amenity (impacts on visual receptors)

Works are all at a low level and unlikely to be visible to nearby sensitive receptors.

The Marine Crossing GTP Project disturbance footprint may have temporary impacts on more distant sensitive receptors in elevated positions and publicly accessible elevated areas with views over the Marine Crossing GTP Project, such as bushwalkers on Mt Larcom and potentially the community of Mt Larcom and nearby small lot rural landholdings.

Recreational users of The Narrows may also experience visual impacts when in positions with direct views of the foreshore of Curtis Island. The construction site pad (mainland) will not be visible from The Narrows due to the low ridgeline along the edge of the coastal zone and also due to the visual buffering effect of the mangroves fringing the intertidal area, and nearby terrestrial vegetation.

Cumulative impacts on visual amenity may result from:

- Potential dust plumes
- General construction activities
- Creation of corridors of cleared vegetation

Visual impacts from within The Narrows will be temporary and visual impacts from dust during the construction phase on neighbouring sensitive receptors are likely to be minimal given the remote location of the Marine Crossing GTP Project.

The accumulation of multiple pipelines under construction will intensify temporary visual impacts and extend over a 21 month period albeit to a relatively small number of sensitive receptors.

Measures set out in this EMP will minimise negative cumulative impacts on visual amenity (impacts on visual sensitive receptors) from construction of the Marine Crossing GTP.

Post construction visual impacts of the Marine Crossing GTP are considered to be minor and unnoticeable for sensitive receptor locations within close proximity. Existing vegetation within the ROW will be cleared prior to construction, and while disturbed areas will be stabilised, the rehabilitation will not involve replanting of trees or shrubs within the Marine Crossing GTP ROW to maintain GTP infrastructure integrity. In sections where the Marine Crossing GTP traverses open forested areas, the ROW will become an element of the overall landscape given the scale and extent will be restricted to 30 m width through the terrestrial section of the Marine Crossing GTP Project (mainland and Curtis Island).

8.5 Environmental protection commitments, objectives and control strategies – land tenure and use

Table 8.5 Environmental protection commitments, objectives and control strategies

Item	Outcomes
Environmental protection objective	• Social disruption to the local communities from the construction of the Marine Crossing GTP is minimised • Minimal impacts on third party infrastructure during the construction of the Marine Crossing GTP
Specific objectives	• No warranted complaints from landholders and the community, with any complaints responded to within 24 hours • Minimal interruption to third party infrastructure • No unauthorised impacts on third party infrastructure
Control Strategies	**Construction Phase** *Landholders and Use* • GLNG Operations will locate infrastructure so that adverse impacts on existing landholder management practices such as placement of farm infrastructure, fences and erosion management structures are minimised • Permanent GTP warning signs will be erected along the ROW • Where required along the route, temporary fences will be installed to protect humans and livestock

Item	Outcomes

	• Fences or other barriers will be installed where appropriate and where approved by the landholder to minimise unauthorised access
	• Property fences and gates will be installed, maintained and reinstated to a condition at least equal to the pre-existing condition
	• Landholder complaints will be recorded in a complaints register (that forms part of the Project HSSMP) and appropriate corrective actions will be implemented and closed out by the Environmental Manager
	• Rehabilitation of disturbed areas will be undertaken progressively throughout construction in accordance with the LRMP (refer Appendix E)
	• Rehabilitation can be considered successful when it achieves the acceptance criteria developed based on the pre-disturbed land use and suitability class with no greater maintenance requirements (or as otherwise agreed in a written document with the landowner/holder and administering authority) is established in accordance with the LRMP
	Community
	• GLNG Operations will contribute to local liveability programs and initiate a community consultation and awareness campaign to promote Project benefits to the community
	Visual amenity
	• Existing roads and tracks will be used where practicable
	• Route alignment, storage locations and additional work areas and Access Road will be based on, to the extent practicable, the following criteria:
	  - Avoiding unduly steep or rugged terrain
	  - Avoidance of conflicting land uses
	  - Maximising the use of existing roads and tracks
	  - Minimising the width of tracks
	  - Meeting landholder requirements
	  - Providing adequate road access
	  - Avoiding existing infrastructure
	Infrastructure
	• New tracks will be located as close to fences or property boundaries as possible, subject to the requirements of the landholder and in accordance with conditions of Landholder Agreements
	• The location of the existing third party infrastructure in the ROW will be accurately identified on the alignment sheets and marked physically on the ground, prior to trenching activities
	Transport
	• Equipment and material transport routes and storage areas will be planned in consultation with GRC, DTMR, DSDIP, Queensland Rail National, GPC, and the Gladstone Economic and Industry Development Board to minimise disruption to road and other transport route users
	Operational phase
	• Typical mitigation and control measures for the operational phase of the Marine Crossing GTP will be detailed in the OMP, which will be developed prior to construction

Performance Indicators	• Report on the performance in management of complaints to the Gladstone Regional Coordination Committee • The number of complaints received from stakeholders and the time taken to investigate, take suitable action and close out

9. World and National Heritage values

9.1 Introduction

This chapter identifies the World and National Heritage values of the GBRWHA associated with the Marine Crossing GTP Project and identifies the potential impacts on these values during the construction and operation (including decommissioning) phases of the Project.

Mitigation measures for the protection of the World and National Heritage values are outlined, including references to specific management plans.

9.1.1 Summary of existing World Heritage and National Heritage Values

The Great Barrier Reef is one of Queensland's five World Heritage Areas (WHAs), and meets all the criteria for natural world heritage listing. The Great Barrier Reef:

- Represents major stages of the earth's evolutionary history
- Is an outstanding example of ongoing ecological and biological processes
- Contains superlative natural phenomena
- Contains important natural habitats for conservation of biological diversity

9.1.2 Summary of potential impacts to World Heritage and National Heritage Values

The construction methodology for the Marine Crossing GTP includes bored tunnelling by TBM under the intertidal area south of Kangaroo Island and the marine waters of The Narrows. This tunnelling technique, in conjunction with conventional open cut trenching techniques is being used in the terrestrial sections on both the mainland and Curtis Island sections of the Marine Crossing GTP.

The Marine Crossing GTP Project is not located within the Great Barrier Reef Marine Park (Cth) (GBRMP) and is sufficiently removed by distance so that any potential indirect impacts are likely to be negligible. In addition, the proposed Marine Crossing GTP ROW will be constructed outside the southern boundary of the GBR Coast MP (Qld).

Adopting a bored tunnelling construction technique minimises significant disturbance within ESAs as it will not directly impact upon the ecological communities on the seabed, intertidal regions or within the water column. In addition, the tunnelling work will reduce the potential for indirect impacts on MNES under the EPBC Act.

Runoff from the construction site has the potential to introduce contaminants into downstream environments within the GBRWHA and the GBR Coast MP. In addition, there will be localised clearing and substrate disturbance within tidal creeks that are upstream of The Narrows, which forms part of the GBRWHA and the GBR Coast MP.

Potential indirect impacts include a decrease in marine water quality from the release of contaminants on the receiving environment, including marine waters. Potential sources of water from the Project that may be released to marine waters could include:

- Pipeline trench water
- Stormwater from the construction site pad (mainland)
- Stormwater from the construction site pad (Curtis Island)
- Treated ASS leachate from the treatment pad areas

The Receiving Environment Monitoring Programme (REMP) will be developed and implemented prior to construction to monitor and record the effects of any release of contaminants on the receiving environment, including marine waters.

There is a very low risk that bentonite could be released into downstream environments within the GBRWHA and the GBR Coast MP. Currently, the construction methodology does not include the usage of bentonite, however if deemed necessary, bentonite may be used in the instances where spoil from the cutting face of the TBM is not of ideal moisture content to ensure proper sealing of the pressurised system. This method of tunnelling has been successfully used previously in Australia on a number of projects, including Airport Link in Queensland. Any bentonite which does not remain in the annulus between the pre-cast concrete panels and the earthen wall will be contained in the spoil. Tunnel spoil will be tested to meet the disposal location acceptance conditions and have the pH corrected as necessary. In the unlikely event that the quality of the spoil does not meet the requirements of the selected disposal location, spoil will be disposed of at an appropriately licensed waste disposal facility.

All bentonite will be stored in bulk storage containers within the construction site pad on the mainland. All storage containers will be weather tight to prevent water ingress which would result in the material being unusable. From the storage container the bentonite would be transported to the TBM cutting face via the construction railway as described in Chapter 2. Any spillage of bentonite will be recovered immediately and reused where possible. In the event that the bentonite is considered unusable, it will be incorporated into spoil from the TBM and disposed of off-site or managed in accordance with the Waste Management Plan and EA conditions.

No direct potential impacts on MNES are expected from the use of bentonite during tunnelling as in the normal course of TBM operation it is expected that these additives will be contained in the spoil material.

The use of foam to reduce wear on the cutter head may be required during tunnelling. There is a low risk that foam could be released into downstream environments within the GBRWHA and the GBR Coast MP. The use of soil conditioning additives, such as foam, is highly dependent on soil and geological conditions and formation encountered during the tunnelling operation. These additives make the extraction of the material easier by reducing friction and preventing clogging of the TBM cutting head.

Where practicable, all soil conditioning additives or foams will be biodegradable, non-toxic and have short lived effects. It is expected that the foam will be contained within the tunnel spoil and as such, no direct potential impacts on MNES are expected from the use of foam during tunnelling. Tunnel spoil will be tested to meet the disposal location acceptance conditions and in the unlikely event the quality of the spoil does not meet the requirements of the selected disposal location, spoil will be disposed of at an appropriately licensed waste disposal facility. Pipe integrity of the Marine Crossing GTP will be verified through hydrotesting as described in Chapter 2 (refer Section 2.5.2).

The Commonwealth, Scientific and Industrial Research Organisation (CSIRO) (Tjandraatmadja *et.al*, 2005) conducted a study that found the quality of used hydrotest water did not represent a hazard to the environment, provided that the source water was of adequate quality. This study identified the primary driver of the quality of used hydrotest water as the quality of the source water (refer Section 15.3.5).

Under the Queensland Government Environmental Authority (EA) approval conditions issued on 7 September 2012, release of hydrotest water to waters is not authorised and as such, no impacts are anticipated.

Other potential ecological impacts associated with the World and National Heritage values are discussed in Chapter 10.

The overall risk of indirect impacts on World and National Heritage values within the region as a result of the Marine Crossing GTP construction and operational phases are not considered to be significant. Implementing the appropriate mitigation measures during construction and operation contained in this EMP and management plans will further minimise any potential environmental impacts.

9.2 Existing environmental values

9.2.1 The Great Barrier Reef World Heritage Area

The Great Barrier Reef is one of Queensland's five WHAs, and meets all the criteria for natural world heritage listing. The Great Barrier Reef:

- Represents major stages of the earth's evolutionary history
- Is an outstanding example of ongoing ecological and biological processes
- Contains superlative natural phenomena
- Contains important natural habitats for conservation of biological diversity

The GBRWHA (refer Figure 9.1) extends over 2,000 km from the top of Cape York to just north of Fraser Island and covers an area of approximately 348,000 km^2 (SEWPaC, 2011c).

The GBRWHA extends from the low water mark of the mainland, and includes all islands (eg Curtis Island), internal waters of Queensland, and *Seas and Submerged Lands Act 1973* exclusions. The Narrows, Port Curtis and parts of the Port of Gladstone fall within the WHA boundaries; however these areas are controlled by the Queensland Government as they are defined as internal Queensland Waters.

Curtis Island forms part of the NC Act listed World Heritage Management Area (WHMA), which is considered an ESA Category B, as defined in Chapter 1.

The construction site pad (Curtis Island) and ROW located on Curtis Island occurs within 1 km of the Great Barrier Reef Region (ESA Category A), listed under the provisions of the *Great Barrier Reef Marine Park Act 1975* (GBRMP Act).

Furthermore, the Curtis Island section of the Marine Crossing GTP ROW is located adjacent (ie within 500 m) to The Narrows Habitat Protection Zone of the GBR Coast MP. Under the EP Act this area is defined as a Category A ESA.

Under the conditions of approval outlined in the CG Report, GTP works must not be located in or within 200 m of an ESA Category A. Potential impacts to ESA Category A and the associated 200 m buffer zone (based on the CG Report) are discussed in Chapter 10, Section 10.1.

9.2.2 Great Barrier Reef Coast Marine Park

The GBR Coast MP is managed by the Commonwealth and Queensland Government under the *Marine Parks Act 2004, Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004, Marine Parks Regulation 2006* and the *Marine Parks (Declaration) Regulation 2006.*

The GBR Coast MP encompasses tidal waters and tidal lands three nautical miles seaward of HAT. The Marine Park zoning and regulations generally complement the GBRMP (Cth), however there are Queensland-specific provisions that may apply.

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GLNG Project

Marine Crossing GTP EMP

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Weed Washdown Facility (Indicative)
- Access Road
- Great Barrier Reef World Heritage Area

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: BING, 2011.
Queensland Great Barrier Reef Coast Marine Park, DERM, Feb 2011.
Commonwealth Great Barrier Reef Marine Park, Great Barrier Reef Marine Park Authority, 2009.

Great Barrier Reef World Heritage Area Figure 9.1

A1 scale: 1:50,000
0 1,000 2,000 3,000 4,000 5,000 m

GLNG No: 3381-40-0557
Coordinate system: GCS_GDA_1994

Date: 20/06/2012 Version: b

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Map by: RB

Within the vicinity of Gladstone, the GBR Coast MP includes all tidal waters and tidal lands specifically, The Narrows (north of Friend and Laird Points), out to three nautical miles from the HAT of Curtis Island and Facing Island and the mainland south of Canoe Point (refer Figure 9.2).

The *Marine Parks (Declaration) Regulation 2006* which superseded the *Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004* re-designated the Great Barrier Reef Coastal Global Change Marine Park boundary as:

- Generally northerly, westerly and southerly along Curtis Island at HAT to where it intersects latitude 23044.905' south, then
- West along latitude 23044.905' south to where it intersects Kangaroo Island at high water

Work associated with the Marine Crossing GTP does not occur in the GBR Coast MP habitat protection zone.

9.2.3 Summary of proposed mitigation measures for World and National Heritage Values

A summary of the key mitigation measures is provided below to minimise the risk of the Marine Crossing GTP impacting upon the World Heritage and National values of the GBRWHA is provided below.

Table 9.1 Summary of proposed mitigation measures for the management of World and National Heritage values

Item	Outcome
Environmental protection objective	• World and National Heritage values of GBRWHA are protected
Specific objectives	• Minimal indirect impacts to World and National Heritage values during construction and operation of the Marine Crossing GTP Project • Compliance with the requirements of the EPBC Act and relevant Commonwealth and State legislation
Control strategies	• All fuel storage will occur within bunded areas within the construction site pads or ROW to ensure any spills are contained. Additionally, to minimise potential adverse impacts, all chemicals will be stored in accordance with: - AS 1940 – The storage and handling of flammable and combustible liquids - AS 3833 – The storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers - AS 3780 – The storage and handling of corrosive substances • Any contaminated material will be handled as per industry best practice and where necessary, remediated or removed from site • The SMESCP (refer Appendix C) will be implemented for the purpose of minimising erosion and the release of sediment and contaminated stormwater from the Marine Crossing GTP Project disturbance footprint • The construction site pads will be located on the landward side of a natural rise, offering some acoustic insulation to sensitive receptors within the GBRWHA • Any PASS material encountered will be treated in accordance with the ASSMP (refer Appendix A)
Performance indicators	• Compliance with the requirements of the EPBC Act controlled action conditions

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Weed Washdown Facility (Indicative)
- Access Road
- Great Barrier Reef Marine Park (Cth)
- Great Barrier Reef Coast Marine Park (Qld)

Marine Park Zone (Qld/Cth)
- Conservation Park Zone
- General Use Zone
- Habitat Protection Zone
- Marine National Park Zone

Cth - Commonwealth Great Barrier Reef Marine Park
Qld - Queensland Great Barrier Reef Coast Marine Park

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: BING, 2011.
Queensland Great Barrier Reef Coast Marine Park, DERM, Feb 2011.
Commonwealth Great Barrier Reef Marine Park, Great Barrier Reef Marine Park Authority, 2009.

Marine Parks
Figure 9.2

A1 scale: 1:50,000

0 1,000 2,000 3,000 4,000 5,000 m

GLNG No: 3381-40-0558

Coordinate system: GCS_GDA_1994

Date: 20/06/2012

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9.3 World and National Heritage Values

World Heritage properties are those properties listed under United Nations Educational, Scientific and Cultural Organisation's (UNESCO's) "Convention Concerning the Protection of the World Cultural and Natural Heritage". They include areas of splendid natural and anthropogenic beauty, and are defined as being of outstanding value to humanity. Australia currently possesses 17 World Heritage properties. These include the GBRWHA, which extends to the mean low water mark along the Queensland coast.

The GBRWHA is protected under the International Treaty-Convention concerning the Protection of the World Cultural and National Heritage, adopted by the UNESCO (UNESCO, 1972).

The GBRWHA is defined by the following four UNESCO criteria:

- (VII) Contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance
- (VIII) Outstanding example representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features
- (IX) Outstanding example representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals
- (X) Contains the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation

9.4 Potential impacts to Great Barrier Reef World and National Heritage Areas

Great Barrier Reef World and National Heritage values and associated potential impacts and mitigation measures for pipeline construction and operation (including decommissioning) are summarised in Table 9.2.

Table 9.2 Great Barrier Reef World and National Heritage values, associated potential impacts and mitigation measures

GBR World and National Heritage values	Potential construction impacts and mitigation measures	Potential operation and decommissioning impacts and mitigation measures
Exceptional natural beauty and aesthetic importance	• Direct impacts to the exceptional natural beauty and aesthetic importance of the WHA will be low due to the direct impact being restricted to work on Curtis Island. Some direct impacts on the aesthetic importance of The Narrows will be incurred from work on the mainland and Curtis Island. Port Curtis is already heavily industrialised which impacts directly on the existing aesthetic value of the area • The subtidal soft bottom communities of The Narrows will not be disturbed during the construction of the Marine Crossing GTP. The proposed tunnelling under the intertidal area south of Kangaroo Island and the marine waters of The Narrows will not impact on the WHA value of exceptional natural beauty and aesthetic importance • Potential indirect impacts include a possible decrease in marine water quality associated with any construction soil erosion, release of hydrocarbons and other liquid spills and/or waste materials • Potential construction impacts to WHA values of exceptional natural beauty and aesthetic importance will be minimised by the implementation of the mitigation measures contained in this EMP, and the implementation of the PWMP, (refer Appendix B), SMESCP (refer Appendix C) and WMP (refer Appendix F)	• Potential operational and decommissioning impacts will be minimal and generally limited to minor soil erosion, spread of weeds and waste materials associated with maintenance and decommissioning activities along the Marine Crossing GTP ROW • Potential impacts to WHA values during the operational and decommissioning phases of the Marine Crossing GTP will be minimised by implementing the PWMP, LRMP (refer Appendix E) and WMP
Significant geomorphic and physiographic features	• Tunnelling under The Narrows and trenching of the pipeline will result in physical disturbance to sediments, but will not impact on significant geomorphic or physiographic features that contribute to the WHA values of the Great Barrier Reef • Coral reefs will not be impacted by Marine Crossing GTP construction activities as there are no coral reefs or cays in the vicinity of The Narrows and Port Curtis • Direct impacts to the significant geomorphic and physiographic features of the WHA will be low as the Marine Crossing GTP Project will involve tunnelling below the ecological communities on the seabed, intertidal regions or within the water column • Potential indirect impacts include a decrease in marine water quality from soil erosion, release of hydrocarbons and other liquid spills and/or waste materials • Potential construction impacts to the significant geomorphic and physiographic features of the GBRWHA will be minimised by implementing the mitigation measures contained in this EMP, and the implementation of the SMESCP and WMP	• Potential operational and decommissioning impacts will be minimal and generally limited to soil erosion, spread of weeds and waste materials associated with maintenance and decommissioning activities along the Marine Crossing GTP ROW • Potential impacts to WHA values during the operational and decommissioning phases of the Marine Crossing GTP will be minimised by implementing the PWMP, SMESCP and WMP

GBR World and National Heritage values	Potential construction impacts and mitigation measures	Potential operation and decommissioning impacts and mitigation measures
Significant ongoing ecological and biological processes	• Runoff from the Marine Crossing GTP Project disturbance footprint has the potential to introduce contaminants into downstream environments within the GBRWHA and also the GBR Coast MP. In addition, there will be localised clearing and substrate disturbance within tidal creeks located on the mainland that discharge into The Narrows, which is part of the GBRWHA and also the GBR Coast MP • Trenching activities between Point A and Point C (refer Figure 2.1) will intercept marine plants associated with the tidal reaches of watercourses within the area (refer Chapter 10, Section 10.6.6). Trenching work on the mainland, and Curtis Island, between Points D and E, have the potential to indirectly impact on downstream intertidal wetlands. This is due to the close proximity of the Marine Crossing GTP Project disturbance footprint to these intertidal wetlands (in some instances less than 50 m) and the type of work occurring (ie marine plant and soil disturbance) • Construction of the Marine Crossing GTP Project will not interfere with any reefs directly and it is anticipated that indirect impacts will be negligible • While migratory birds and other native fauna (eg Water mouse) utilise the intertidal areas south of Kangaroo Island and tidal creeks, the potential direct impact of the Marine Crossing GTP Project is considered to be low due to the separation distance between construction activities and the large feeding/habitat extent; the temporary nature of construction activities; and mitigation measures to be implemented to minimise potential impacts • Indirect impacts on species of migratory marine mammals such as dolphins and dugong will be minimal given the existing industrialised nature of Port Curtis and the temporary nature of construction activities. Tunnelling under The Narrows significantly reduces the impacts compared to the previous HDD construction method and intertidal disturbance. Mitigation measures to be implemented will minimise potential impacts • Potential indirect impacts include a decrease in marine water quality from soil erosion, release of hydrocarbons and other liquid spills and/or waste materials • Potential impacts to WHA values of significant ongoing ecological and biological processes, habitat and biological diversity will be minimised by implementing the mitigation measures contained in this EMP, SMP, SSMP, WMMP, PWMP and LRMP • The SMESCP will be implemented for the purpose of minimising erosion and the release of sediment, and contaminated stormwater from disturbed areas and associated construction activities.	• Potential impacts to WHA values during the operational and decommissioning phases of the Curtis Island GTP will be minimised by implementing the SMP, SSMP, WMMP, SMESCP and WMP • Potential operational and decommissioning impacts will be minimal and generally limited to minor soil erosion, spread of weeds and waste materials associated with maintenance and decommissioning activities of the Marine Crossing GTP on Curtis Island. The PWMP, SMESCP and WMP will be implemented as required

GBR World and National Heritage values	Potential construction impacts and mitigation measures	Potential operation and decommissioning impacts and mitigation measures
Significant natural habitat for in situ conservation of biological diversity	• The tunnelling construction method under the intertidal areas south of Kangaroo Island and The Narrows will remove the direct disturbance within ESAs and will not directly impact upon the ecological communities on the seabed, intertidal regions or within the water column. In addition, the bored tunnelling under The Narrows reduces the potential impacts of the Project on MNES under the EPBC Act • A Contingency Plan for Emergency Environmental Incidents will be developed in accordance with the SSMP and the GLNG GTP Fauna Handling Procedure to mitigate the risk of impacts to MNES • Runoff from the construction site has the potential to introduce contaminants into downstream environments within the GBRWHA and also the GBR Coast MP. In addition, there will be localised clearing and substrate disturbance within tidal creeks that discharge into The Narrows, which is part of the GBRWHA and also the GBR Coast MP • Potential indirect impacts include a decrease in marine water quality from the release of contaminants on the receiving environment, including marine waters. • There is a very low risk that bentonite could be introduced in to downstream environments within the GBRWHA and the GBR Coast MP. Any bentonite which does not remain in the annulus between the pre-cast concrete panels and the earthen wall will be contained in the spoil. Tunnel spoil will be tested to meet the disposal location acceptance conditions and have the pH corrected as necessary. All bentonite will be stored in blk storage containers within the construction site pad. All storage containers will be weather tight to prevent water ingress. Any spillage of bentonite will be recovered immediately and used where possible, or incorporated into spoil from the TBM and disposed of in accordance with the Waste Management Plan • There is a very low risk that hydrotest waters could introduce contaminants into downstream environments within the GBRWHA and the GBR Coast MP. The EA does not authorise the release of hydrotest water to waters and therefore no impacts are anticipated. Measures to minimise the contaminant levels of the hydrotest water include: - Use a high quality water source - Avoid or minimise the use of additives to the water - If applicable, use clean tanks for storage	• Potential operational and decommissioning impacts will be minimal and generally limited to minor soil erosion, spread of weeds and waste materials associated with maintenance and decommissioning activities along the Marine Crossing GTP ROW • Potential impacts to WHA values during the operational and decommissioning phases of the Marine Crossing GTP will be minimised by implementing the SMP, SSMP, SMESCP, PWMP and WMP • Mitigation measures for the operational phase of the GTP will include measures such as: - Appropriate construction of bund walls - Measures such as grass swales to filter surface water runoff prior to entering the estuarine environment

GBR World and National Heritage values	Potential construction impacts and mitigation measures	Potential operation and decommissioning impacts and mitigation measures
	• The REMP will be developed and implemented prior to construction to monitor and record the effects of the release of contaminants on the receiving environment, including marine waters • There is a low risk that the use of foam during tunnelling could result in foam being introduced in to downstream environments within the GBRWHA and the GBR Coast MP. Where practicable, all soil conditioning additives or foams will be biodegradable, non-toxic and have short lived effects. Foam contained in the tunnel spoil will be tested to meet the disposal location acceptance conditions. • There will be a minor direct impact to mangrove communities from the trenching of the pipeline across the watercourses between reference points A and C. Loss of mangroves will be kept to a minimum and in accordance with the objectives of the *Fisheries Act 1994* • There are no inter-reef or lagoon areas adjacent to The Narrows that may be directly or indirectly impacted. The nearest significant coral communities are between Curtis and Facing Islands, more than 10 km south of the Marine Crossing GTP Project • While parts of Port Curtis may exhibit geological processes linking the various elements of the coastal environment (eg estuaries, intertidal flats, mangroves and embayments) the Marine Crossing GTP Project will not result in disturbance to these elements • Mitigation measures to avoid indirect impacts from runoff such as the construction of bunds, stormwater controls, upstream treatment and the provision of buffers (refer SMESCP) will minimise sediment loads to adjacent rocky reef and muddy soft bottom communities, such as algal and sponge gardens, soft corals and sea pens that are present at this location • Potential construction ecological impacts will be minimised by implementing the SMP, SSMP, WMMP, PWMP and LRMP	
The place has outstanding heritage value to the nation because of: • **The place's importance in the course, or pattern, of Australia's natural or cultural history**	• The Narrows represents an uncommon passage landscape and is one of only five narrow tidal passages separating a large continental island from the mainland in Australia. The Narrows is also an important indicator of past geomorphologic processes, as many of Queensland's headlands and coastal ranges have been joined to the mainland by sedimentation processes identical with those operating within The Narrows. Algal and sponge gardens, sandy and muddy bottom communities, and rocky reef subtidal communities are present • Direct impacts to the outstanding heritage values will be low as the Marine Crossing GTP Project involves the removal of only a small area of terrestrial vegetation and marine plants being approximately 8.5 ha of terrestrial vegetation on Curtis Island and	• Potential operational and decommissioning impacts will be minimal and generally limited to minor soil erosion, spread of weeds and waste materials associated with maintenance and decommissioning activities along the Marine Crossing GTP ROW • Potential impacts to WHA values during the operational and decommissioning phases of the Marine Crossing GTP will be

GBR World and National Heritage values	Potential construction impacts and mitigation measures	Potential operation and decommissioning impacts and mitigation measures
	the mainland, and less than 0.25 ha of marine plants associated with trenching across watercourses. None of the vegetation communities and flora species to be cleared for the Marine Crossing GTP Project are listed as threatened under the EPBC Act • No Indigenous or non Indigenous cultural heritage sites exist within the Marine Crossing GTP Project disturbance footprint. Construction activities will therefore not impact on cultural history of the national heritage values • Mitigation measures for any trenching activities in the marine intertidal component of the Marine Crossing GTP will include the use of silt curtains and timing of trenching to minimise impacts. Sub-tidal communities found at this location are represented regionally, therefore impacts to outstanding national heritage values are considered to be minimal	minimised by implementing the SMP, SSMP, SMESCP, PWMP and WMP • Mitigation measures for the operational phase of the GTP will include measures such as: - Appropriate construction of bund walls - Measures such as grass swales to filter surface water runoff prior to entering the estuarine environment
• **The place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history**	• The sandy channel between Friend Point and Laird Point contains soft coral, sponges and sea pen species • Direct impacts to intertidal areas are restricted to trenching work within the watercourse crossings on the mainland. These localised impacts will not impact on the outstanding National Heritage value of the GBRWHA • No breeding or spawning grounds for unique coral reef associated species are known within the vicinity of the proposed Marine Crossing GTP Project, however threatened and vulnerable species such as turtles and dugong frequent the Port Curtis area • Potential construction ecological impacts will be minimised by implementing the SMP, SSMP, PWMP and LRMP	• Potential operational and decommissioning impacts will be minimal and generally limited to minor soil erosion, spread of weeds and waste materials associated with maintenance and decommissioning activities along the Marine Crossing GTP ROW • Potential impacts to WHA values during the operational and decommissioning phases of the Marine Crossing GTP will be minimised by implementing the SMP, SSMP, SMESCP, PWMP and WMP • Mitigation measures for the operational phase of the GTP will include measures such as: - Appropriate construction of bund walls - Measures such as grass swales to filter surface water runoff prior to entering the estuarine environment

GBR World and National Heritage values	Potential construction impacts and mitigation measures	Potential operation and decommissioning impacts and mitigation measures
• **The place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history**	• The Marine Crossing GTP Project disturbance footprint on the mainland will not impact on the ability to gain information that will contribute to understanding Australia's natural or cultural history. No cultural heritage items have been found within or adjoining the Marine Crossing GTP Project due to the existing disturbed nature of the majority of the land • Curtis Island shows diversity of reef morphologies and ongoing geomorphic processes such as parabolic sand dunes, cliffed coastlines, parallel beach ridges, saltpans, rock platforms, mud flats and marine plains. The island offers potential for study that could contribute to further understanding Australia's natural and cultural history due to the partly undisturbed nature and the accessibility of the island • Impacts to these Curtis Island values from the construction of Marine Crossing GTP Project are considered negligible due to the relatively small scale nature of the disturbance from the Project • Potential construction impacts to the reduction in potential to yield information that will contribute to an understanding of Australia's natural or cultural history will be minimised by implementing the management plans that supplement this EMP	• Potential operational and decommissioning impacts will be minimal and generally limited to soil erosion, spread of weeds and waste materials associated with maintenance and decommissioning activities along the Marine Crossing GTP ROW • Mitigation measures for the operational phase of the GTP RoW will include measures such as: - Sediment/evaporation basins - Appropriate construction of bund walls - Measures such as grass swales to filter surface water runoff prior to entering the estuarine environment - Weed washdown facilities
• **The place's importance in demonstrating the principal characteristics of a class of Australia's natural or cultural** - **places; or** - **environments**	• Curtis Island and The Narrows are part of the GBRWHA that is internationally recognised as having the largest and most significant expanse and diversity of coral reef formations in the world. The Great Barrier Reef is important for its cultural heritage for indigenous populations within Australia in providing habitat for species used as a food source and for culturally significant events • Potential construction impacts to the GBRWHA natural and cultural characteristics will be minimised by implementing the mitigation measures contained in this EMP and associated management plans	• Operational activities will typically include monthly inspections along the Marine Crossing GTP ROW by vehicle and foot patrols to check on the condition of the GTP. Maintenance of the Marine Crossing GTP will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required • Potential cultural heritage (Indigenous and non Indigenous) related impacts from these operational activities are expected to be negligible and will be managed in accordance with the CHMP and OMP

GBR World and National Heritage values	Potential construction impacts and mitigation measures	Potential operation and decommissioning impacts and mitigation measures
• **The place's importance in exhibiting particular aesthetic characteristics values by a community or cultural group**	• The Narrows represent an uncommon passage landscape and is one of only five narrow tidal passages separating large continental islands from the mainland in Australia. The marine environment between Friend Point and Laird Point consists of highly turbid estuarine waters with minimal flushing during neap tides. Impacts to the aesthetic characteristics will be negligible • Construction mitigation measures will include minimising increased sedimentation and increased turbidity by implementing the SMESCP	• Operational activities will typically include monthly inspections along the Marine Crossing GTP ROW by vehicle and foot patrols to check on the condition of the GTP. Maintenance of the Marine Crossing GTP will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required • Potential cultural heritage (Indigenous and non Indigenous) related impacts from these operational activities are expected to be negligible and will be managed in accordance with the CHMP and OMP

10. Flora and fauna

This chapter identifies the ecological attributes of the terrestrial, intertidal and marine environment within and adjoining the Marine Crossing GTP Project (refer Figure 10.1) with respect to State and Commonwealth legislation, and the significance of these attributes from a local, regional and national perspective.

This chapter also identifies the potential impacts that the construction and operation (including decommissioning) of the Marine Crossing GTP may have on local and regional ecological values, and also considers the potential cumulative impacts from a local and regional perspective. Mitigation measures for the protection of ecological values are outlined, and include management strategies and specific ecological management plans.

10.1 Summary of existing flora and fauna values

10.1.1 Protected areas and environmentally sensitive areas

Construction works within the terrestrial environment of the Marine Crossing GTP will occur outside any protected areas as defined under the NC Act, *Forestry Act 1959* (FA Act) and/or the EPBC Act.

The works will not occur within the GBRMP (Cth) and are sufficiently removed by distance that any indirect impacts are likely to be negligible. The Marine Crossing GTP will pass underneath The Narrows and involves trenching on Curtis Island which forms part of the GBRWHA.

In addition, the proposed Marine Crossing GTP Project will be constructed outside the southern boundary of the GBR Coast MP (Qld).

The majority of the Marine Crossing GTP Project disturbance footprint is located outside the boundaries of Category A, B and C ESA as defined under the EP Act. Works on Curtis Island are within Category B ESA due to the NC Act listed protected area status. Small sections of the mainland ROW and Access Road are included in Category B and C ESA. Terrestrial flora and fauna

Flora

Vegetation structures observed within the Marine Crossing GTP Project disturbance footprint are:

- Grassland/Open Woodland which contains a sparse tree and/or shrub layer (<10%) with a Ground stratum density between 10% to 100%
- Woodlands which contain a canopy cover of 10% to 30% and trees to a height of 30 m
- Closed Forests which contain a canopy cover of 70% to 100% and trees to a height of 30 m. These communities are associated with the adjoining intertidal wetlands

The vegetation communities within the disturbance footprint of the Marine Crossing GTP Project are not defined as a Threatened Ecological Community (TEC) as listed under the EPBC Act.

Based on flora surveys undertaken to date, no threatened flora species, as defined under the provisions of the NC Act and/or EPBC Act have been identified from within the Marine Crossing GTP Project disturbance footprint.

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Washdown Facility (Indicative)
- Access Road
- Watercourse Crossing Ancillary Areas
- Great Barrier Reef Coast Marine Park (Qld)

Environmentally Sensitive Area
- Category A
- Category B
- Category C

Source:
Gas Transmission Pipeline (GTP): Santos, Aprl 2012.
Indicative Project Footprint: Aurecon, GLNG May, 2012.
Environmentally Sensitive Areas: Santos, Jun 2012.
Queensland Great Barrier Reef Coast Marine Park, DERM, Feb, 2011.
Aerial: Santos, Feb 2011.
Extra Works Areas: GLNG, Jul 2012.

Environmentally Sensitive Areas Figure 10.1

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_060.mxd 11/07/2012 09:15

A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0559

Coordinate system: GCS_GDA_1994

Date: 11/07/2012 Version: f

Fauna

The Marine Crossing GTP Project disturbance footprint intersects known habitat for 11 fauna species listed as threatened under the provisions of the NC Act and EPBC Act (denoted by *). These include the Powerful owl (*Ninox strenua*), Squatter pigeon (*Geophaps scripta scripta*)*, Little pied bat (*Chalinolobus picatus*), Eastern curlew (*Numenis madagascariensis*), Beach stone-curlew (*Escacus neglectus*), Little tern (*Stern albifronis*)*, Coastal sheathtail bat (*Taphozous australis*), Black-necked stork (*Ephippiorhynchus asiaticus*), Water mouse (*Xeromys myoides*)*, Koala (*Phascolarctos cinereus*)* and Square-tailed kite (*Lophoictinia isura*).

Based on known species habitat associations, additional species that are potentially supported by habitat (likely to occur) within the GTP ROW are the Death adder (*Acanthophis antarcticus*), Red goshawk (*Erythrotriorchris radiatus*)*, Grey goshawk (*Accipiter novaehollandiae*), Glossy-black cockatoo (*Calyptorhynchus lathami*), Large eared pied-bat (*Chalinolobus dwyeri*)*, Northern quoll (*Dasyurus hallucatus*)* and the Grey headed flying fox (*Pteropus poliocephalus*)* (based on habitat association and local records).

10.1.2 Marine and intertidal flora and fauna

Four nationally listed wetlands occur within the Curtis Coast area; The Narrows, Port Curtis, GBRMP and the Colosseum Inlet-Rodds Bay area. The Marine Crossing GTP Project intercepts areas associated with The Narrows and Port Curtis wetlands.

The proposed works traverse the three mainland watercourses (ie Humpy Creek [minor northern tributary], Humpy Creek [southern creek line] and Targinie Creek) approximately near their tidal limits.

The intertidal wetlands of The Narrows and Port Curtis are characterised by strong zonation and extensive saltflats. Danaher *et al.* (2005) mapped a total of 30 intertidal habitats within The Narrows and Port Curtis.

Flora

Mangrove communities within the broader Port Curtis area encompass an area of approximately 6,300 ha (Danaher *et al.,* 2005). Fourteen mangrove species are known from Port Curtis (Saenger, 1996) with the dominant species being the Red mangrove (*Rhizophora stylosa*), Grey mangrove (*Avicennia marina*), Yellow mangrove (*Ceriops australis*) and River mangrove (*Aegiceras corniculatum*). Of the fourteen known mangrove species, four mangrove species were recorded (Downes, 2012b) within the Marine Crossing GTP ROW watercourse crossings and include:

- Yellow mangrove
- River mangrove
- White flowered black mangrove (*Lumnitzera racemosa*)
- Myrtle mangrove (*Osbornia octodonta*)

In Port Curtis, saltmarsh occurs at the seaward edge of extensive saltpans, usually just landward of mangroves. It can also occur at the terrestrial side of saltflats where freshwater input reduces salinity. Saltmarsh vegetation is locally diverse with 40 species recorded within Port Curtis.

Marine plant species potentially impacted by the Marine Crossing GTP Project are limited to watercourse crossings of Humpy Creek (minor northern tributary), Humpy Creek (southern creek line) and Targinie Creek (Downes, 2012b), and include:

- Sea purslane (*Sesuvium portulacastrum*)
- Ruby salt bush (*Enchaylaena tormentosa*)
- Rusty sedge (*Fimbristylis polytrichoides*)
- Marine couch (*Sporobolus virginicus*)
- Sea blight (*Suaeda autralis*)
- Jellybean plant (*Suaeda arbusculoides*)
- Bead weed (*Sarcocornia quinqueflora*)
- Sea statice (*Limonium* sp.)

Seagrass within Port Curtis and the GBR Coast MP function as important feeding locations, nurseries and habitats for a diverse range of fauna such as dugongs, turtles and juvenile tiger prawns (Rasheed *et al.*, 2003). The Port Curtis and Rodds Bay seagrass communities are of regional significance as the nearest meadows are located at Hervey Bay to the south and Shoalwater Bay to the north (Rasheed *et al*, 2003 and Thomas *et al*., 2010).

Six species of seagrass have been identified within the Port Curtis locality (Rasheed *et al.*, 2003):

- *Halodule uninervis* (wide and narrow leaf morphology)
- *Halophila decipiens*
- *Halophila minor*
- *Halophila ovalis*
- *Halophila spinulosa*
- *Zostera capricorni*

Fauna

No Fish Habitat Areas have been declared within and adjacent to the Marine Crossing GTP Project. The EPBC protected matters search tool indicated fish species of conservation significance may occur in The Narrows or Port Curtis and includes three species of shark and 34 species of fish.

Four species of turtle; green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), flatback turtle (*Natator depressus*) and the loggerhead turtle (*Caretta caretta*) are known to occur along the Curtis Coast, and these species are listed as either “Endangered” or “Vulnerable” under the provisions of both the EPBC Act and the Queensland *Nature Conservation (Wildlife) Regulation 2006*. Flatback turtles are known to breed on the seaward beaches of Curtis Island.

The dugong (*Dugong dugon*), which is listed as vulnerable under the *Nature Conservation (Wildlife) Regulation 2006*, is recorded as occurring within the Port Curtis area. Dugongs prefer shallow and sheltered areas where their primary food source, seagrass, occurs. The Marine Crossing GTP Project occurs north of the Rodds Bay Dugong Sanctuary, which is a Zone B (restricted use) Dugong Protection Area (DPA) declared under the *Fisheries Act 1994*. The Gladstone coastline and the Rodds Bay DPA are recognised as important habitats for dugong populations despite being within and closely associated with commercial port activities. Dugongs are also protected as a marine species under the EPBC Act.

The EPBC protected matters search tool identified 11 cetacean species that may occur in the Port Curtis region, including offshore areas. Of these, the Indo-Pacific humpback dolphin (*Sousa chinensis*), the Australian snubfin dolphin (*Orcaella heinsohni*) and two species of Bottlenose dolphin (*Tursiops aduncus* and *Tursiops truncatus*) are believed to occur in waters adjacent to the proposed Marine Crossing GTP.

Other species of cetaceans previously observed in Port Curtis include the Southern right whale (*Eubalaena australis*), Humpback whale (*Megaptera novaeangliae*) and False killer whale (*Pseudorca crassidens*). However, records are infrequent and it is unlikely that these species occur within adjoining marine waters of Port Curtis.

A rich diversity of birds is known to inhabit and feed within the intertidal areas and near shore environments of Port Curtis, including the exposed banks and wetlands associated with Kangaroo Island and is identified as a nationally significant area for shorebirds.

Three species listed under the NC Act were recorded during the baseline bird surveys. These species were as follows:

- Little tern (*Sternula albifrons*) – listed as 'endangered'
- Beach stone-curlew (*Esacus magnirostris*) – Listed as 'vulnerable'
- Far eastern curlew (*Curlew numenius madagascariensis*) – listed as 'near threatened'

10.2 Summary of potential impacts to flora and fauna

The construction works within the terrestrial environment and watercourses will not have a direct disturbance impact on the GBRWHA, GBR Coast MP or threatened species listed under State and Commonwealth environmental legislation. Direct and indirect impacts during construction may result in the following to varying degrees and extent; in some cases the impacts described below will be minimal because of enhanced project design and mitigation measures to be employed:

- Vegetation clearing for the Marine Crossing GTP Project will result in the temporary removal of approximately 14.20 ha of remnant vegetation and 3.72 ha of high value regrowth which has the potential to reduce the flora genetic diversity and increase the prevalence of weed species
- Vegetation clearing will remove species habitat which could result in fragmentation and increase predation pressure, increased intra-specific competition and the loss of potential reproductive habitat for particular species
- Dust deposition on foliage reduces photosynthetic processes which in turn stunts floral growth rates and reduces the overall health of the remaining remnant communities within and adjacent to the Marine Crossing GTP Project. Dust may also carry nutrients which can lead to algal blooms in nearby watercourses and wetlands
- Weed proliferation is exacerbated by clearing activities that disturb and expose the soil. As such, activities of personnel and vehicles carried out within the Marine Crossing GTP ROW may increase the potential for the movement and introduction of weed species into other locations where they do not currently occur. Weeds may out-compete less disturbance-tolerant native species and/or smother native vegetation. This in turn may alter the species composition of the vegetation community they encroach upon, in addition to the faunal assemblages
- Edge effects are likely to occur across all woody vegetation communities adjacent the Marine Crossing GTP Project. Edge effects have the potential to create changes to the species composition of woody vegetation communities and increase the presence of introduced and disturbance dependant native species in the area
- Project activities which may potentially increase the risk and frequency of bushfires occurring from the Marine Crossing GTP Project, include stockpiling vegetation and mulching, the careless discarding of matches and cigarette butts, littering and the operation of equipment (eg sparks associated from heavy machinery)
- There is potential for erosion of areas disturbed by works associated with the construction of the Marine Crossing GTP. Where these activities occur on erosive soils and/or on slopes, mobilisation of sediment into the marine environment can occur. Potential impacts

to aquatic ecosystems can include the build-up of sediment in estuarine and marine habitats (including the intertidal areas of Kangaroo Island wetlands) with a subsequent reduction in available habitat, smothering of aquatic plants and substrate. Contamination through runoff can also lead to a loss of ecological values, reduced use of land and potential changes to ecological, economical and recreational values in the area

- The loss of habitat within an area via construction activities associated with the Project has the potential to reduce the density and distribution of localised species. Clearing for construction and other land use activities within the region is likely to increase the reliance of resident fauna on remaining habitat corridors. Many of the species displaced by construction activities are likely to persist in areas adjacent to the Marine Crossing GTP Project leading to an increase the competition for resources. Removal of habitat reduces food availability, increases predation risks and increases competition
- Construction activities are likely to create movement barriers for certain species. Fauna such as small mammals and birds are often deterred from crossing cleared/open areas, or areas subject to noise, vibration and lighting. In addition, the crossing of such areas can increase the potential for predation by native and introduced predators and increase predator access to fragmented habitat
- Potential impacts relating to fauna mortality during construction of the Marine Crossing GTP are likely to occur during associated clearing and trenching/tunnelling activities within the ROW and construction site pads. Such activities may result in fauna mortality relating to displacement, resource competition and vehicle/boat/machinery strikes
- During construction activities there is a risk of introducing and/or translocating pest/exotic species. Pest species can impact on the biodiversity of an area through increased competition for resources, habitat destruction, weed distribution, increase risk of diseases and predation
- Potential noise and vibration impacts to migratory bird species include increases in energy expenditure (through disturbance responses), reduction in food intake rates, reduced frequency of occurrence and abandonment of sites resulting in a reduction in habitat carrying capacity of a region
- Lighting associated with the Marine Crossing GTP Project may alter the movement, roosting and feeding behaviour of migratory marine species and shorebirds identified within the vicinity of the Marine Crossing GTP Project. Lighting pollution may potentially impact upon bat roosting sites within the immediate area. Lighting impacts on fauna over two seasons may have further effects on populations similar to noise and vibration impacts. This is due to a reduction on food reserve storages, increased energy consumption, reduced resting periods and increased competition for nesting and mating
- Potential waste management impacts may include water contamination, land contamination from spills, increased occurrences of introduced/pest species and potential adverse effects to flora and fauna. Due to the proximity of the works to the marine environment there is the potential for contaminants and pollutants to be introduced as a result of spills, leaks, runoff, inundation and also through wash-down activities. These contaminants and pollutants can impact on the local values of the marine environment
- The disturbance of ASS as a result of the construction works (trenching and tunnelling) may also impact on the local marine environment. This includes changes in the chemistry of the local substrates and water columns which could have adverse impacts on the local infauna and epifauna
- There are a number of watercourse crossings that are intersected by the Marine Crossing GTP ROW. Altered flow regimes may impact on hydrology causing disturbance to marine and intertidal vegetation/habitat and impact on the health and movement of marine fauna

10.3 Summary of proposed mitigation measures for flora and fauna

Table 10.1 Proposed mitigation measures for the management of flora and fauna

Objective	Outcomes
Environmental Protection Objective	• To avoid, minimise or manage direct and indirect ecological impacts to the ecological values from the Marine Crossing GTP Project • To rehabilitate disturbed areas to as close as practical to the pre-construction condition • To limit impacts (direct and indirect) to the marine flora and fauna as a result of the Marine Crossing GTP Project activities to those areas directly impacted
Specific Objectives	• Minimal disturbance of terrestrial, intertidal and marine flora and fauna during construction of the pipeline, associated tracks, services and accommodation facilities • No unplanned or unapproved damage to flora and fauna • No overall net loss of threatened species or communities • Restored ROW compatible with the surrounding conditions and pre-construction land use and compatible with the operation of the GTP • No spread of LP Act Declared weeds and compliance with the PWMP • Weed control programmes prioritised to high risk areas adjacent to land of conservation significance • Topsoil and vegetation material will be respread in the immediate vicinity of the area of origin to limit the potential spread of weeds and pathogens
Control Strategies	• Refer Tables 10.26, 10.27 and 10.28 for flora and fauna control strategies to be implemented during construction, operation and decommissioning of the Marine Crossing GTP Project
Performance Indicators	• Minimal disturbance of terrestrial flora and fauna during construction of the pipeline, associated tracks, services and accommodation facilities • No unplanned or unapproved damage to flora and fauna • No spread of weeds • Compliance with the PWMP, SSMP, SMP and WMMP • No new weed infestation in the ROW as a result of construction activities • Soils and vegetation stored appropriately to allow for restoration of disturbed areas to equivalent to surrounding area after construction

10.4 Background

The Project was approved as part of the EIS process which included flora and fauna surveys of the GTP ROW. Subsequent to the EIS a number of other environmental and ecological surveys have been undertaken within the local area. Table 10.2 outlines the environmental and ecological surveys undertaken on behalf of GLNG Operations, within the vicinity (ie <5 km) of the Marine Crossing GTP Project. A compilation of the findings of these reports has been incorporated into this chapter, where relevant.

Table 10.2 Previous ecological assessments of the Marine Crossing (mainland and Curtis Island) region

Date	Author	Report title	Assessment details
March 2009a	URS	GLNG Project - Environmental Impact Statement	Comprehensive ecological survey of the GLNG ROW
November 2009b	URS	GLNG Project - Environmental Impact Statement Supplement	Targeted searches for Koala (*Phascolarctos cinereus*) within mapped Essential Habitat areas of the Marine Crossing ROW

Date	Author	Report title	Assessment details
December 2009	BAAM	Curtis Island Water Mouse, Powerful Owl and Wading Bird Investigation	Targeted assessment of the potential occurrence of, and habitat values for, Powerful Owl (*Ninox strenua*), Water Mouse (*Xeroyms myoides*), and migratory wading birds on properties located on the south-west portion of Curtis Island
July 2010	GHD	Weed mapping along the GTP ROW	A targeted survey of the GTP ROW to identify and map the extent of weeds within the GLNG GTP ROW
August 2010	Sandpiper Ecological Surveys	Narrows Pipeline Crossing Review of Regional Shorebird Data And Discussion Of Impacts	A desktop assessment of the potential impacts of The Narrows crossing section of the QCLNG Coal Seam Gas Export Pipeline on migratory shorebirds, specifically Far Eastern Curlew, Whimbrel, Bar-tailed Godwit, Common Greenshank and Red-necked Stint, and the importance of habitat in the vicinity of the pipeline corridor to the local and regional shorebird population
October 2010	Footprints Environmental Consultants	Review of Shorebird Impacts within the Kangaroo Island Wetlands and The Narrows Crossing area	A desktop assessment of the shorebirds of the Kangaroo Island wetlands and The Narrows, and an evaluation of the impacts of the construction and operation of the GTP on the birds and their habitats
November 2010a	Worley Parsons	Environmental Assessment of the Kangaroo Island Wetlands and The Narrows	An environmental assessment of the GLNG crossing of The Narrows, which addresses Matters of National Environmental Significance (MNES), and includes detail regarding terrestrial flora and fauna associated with the Kangaroo Island wetlands and Curtis Island
April 2012	RPS	GLNG GTP Marine Crossing Flora Pre-clearance for the Crossing Pads and Access Tracks	Vegetation survey for the mainland Access Road and construction site pad (mainland) disturbance footprints
May 2012	Ecologica Consulting	Significant Species Management Plan/Species Management Plan	Targeted survey within ‘endangered’, ‘of concern’ and ‘least concern’ Regional Ecosystems (REs) within the GLNG ROW, focussing on the identification of threatened flora and fauna, assessment of habitat values for common and conservation significant species
May 2012a	Footprints Environmental Consultants	GLNG GTP ROW Preclearing Threatened Species Surveys – Water Mouse Assessment Report	A targeted survey for the Water mouse within the GLNG GTP ROW
May 2012b	Downes	Marine Plants Survey Report	A ecological survey of watercourse crossings that are intersected by the Marine Crossing GTP ROW
June 2012c	Footprints Environmental Consultants	GLNG GTP ROW Kangaroo Island Wetland Complex Migratory Bird Survey Baseline Assessment Report	A targeted survey of abundance, diversity spatial and temporal variation of marine migratory birds adjacent to the Marine Crossing GTP ROW, including Kangaroo Island wetlands and Curtis Island
June 2012b	Footprints Environmental Consultants	GLNG GTP ROW Threatened Terrestrial Fauna Species Preclearing Surveys Assessment Report	A quantitative targeted survey of abundance, spatial and temporal variation of threatened terrestrial vertebrate fauna species, within and adjacent to the Marine Crossing GTP ROW

The abovementioned studies were reviewed and information considered relevant and scientifically robust was extracted and forms the basis for describing the existing environment within and adjoining the Marine Crossing GTP Project. These studies also assist in qualifying and quantifying the potential impacts during construction, operation and decommissioning. In addition to a review of the existing studies and reports, the following environmental and ecological databases were searched:

- EPBC protected matters search tool provided by SEWPaC
- Wildlife Online (provided by DNRM)
- Queensland Museum
- DNRM's ESAs – Chapter 5a Activities (EP Act)
- DNRM's RE Mapping Version 6.0
- DNRM's Essential Habitat Mapping Version 3.0
- DNRM's Regrowth Mapping Version 2.0
- DNRM's Wetland information data base
- Queensland Herbarium RE Description Database (Version 6.0b)
- Queensland Herbarium (HERBRECS)
- Bird's Australia Birdata

The general limitations of the data are discussed within Section 10.4.2. In addition to the desktop assessment a review of recent legislation applicable to the Marine Crossing GTP Project was also undertaken.

10.4.1 Previous survey methodologies

The following section provides an overview of the methodologies adopted during the EIS and subsequent studies (refer Table 10.2) to describe the existing environment.

Flora

EIS survey

The flora survey undertaken to support the EIS focussed on the anticipated areas of disturbance for the Marine Crossing GTP. The EIS flora survey (including mainland, Marine Crossing and Curtis Island components) was conducted over three periods during May to October 2008 (dry season). A total of 32 days of field survey was undertaken by two qualified ecologists.

SSMP

A number of qualitative ecological surveys were conducted during 2010 along the entire extent of the Santos GLNG GTP ROW. Findings from these surveys, along with desktop assessments, summarised within the SSMP (Ecologica, 2012). The SSMP presents detailed species profiles, identifies and discusses significant flora and fauna species known to, or considered likely to be supported within habitats located within and/or adjacent to the Santos GLNG GTP ROW.

Preclearing survey (Access Road and construction site pads)

As part of a proposed suite of preclearing surveys, RPS undertook a flora and vegetation survey of the Access Road and construction site pads (mainland and Curtis Island) in April 2012. The field survey ground-truthed vegetation communities and flora species within and adjoining the proposed construction footprint of the Access Road and construction site pad (mainland).

The flora survey employed an assessment of floral taxa and REs in keeping with the methodology employed by the Queensland Herbarium for the survey of REs and vegetation communities (Neldner *et al*., 2005), including the use of secondary transects, quaternary sample plots and random meander searches (Cropper, 1993).

As part of the flora survey, community structural formation classes were assessed according to Neldner *et al.*, (2005), and RE classification of communities was determined as per Sattler and Williams (1999), and in accordance with the RE Description Database (REDD) Version 6.0b (DERM, 2011b).

Final vegetation mapping was undertaken utilising field survey data and aerial photograph interpretation of stereo pair images at a scale of approximately 1:22,000 (Aerometrex, 2008).

Summary of flora survey objectives

Combined, all these assessments aimed to:

- Identify and describe the status of the vegetation within and adjacent to the Marine Crossing GTP Project on a local, regional and national scale (eg EPBC Act listed Threatened Ecological Communities)
- Verify and delineate DNRM's RE mapping (DERM, 2011c)
- Describe the extent, floristic structure and composition of vegetation communities
- Identify the ecological values associated with the vegetation on the site
- Identify and delineate the extent of significant flora species, listed under the provisions of the EPBC Act and NC Act, and populations within and adjacent to the Marine Crossing GTP Project
- Assess the diversity of terrestrial vascular flora within the disturbance footprint and clarification and confirmation of the extent of ESAs
- Describe and map the extent of weed species and their distribution within the disturbance footprint
- Identify the potential impacts relating to the construction, operation and decommissioning of the Marine Crossing GTP on the surrounding vegetation in order to develop appropriate management strategies

Fauna

EIS survey

The fauna survey undertaken to support the EIS focussed on the anticipated areas of disturbance for the Marine Crossing GTP. The EIS fauna survey (including mainland, Marine Crossing and Curtis Island components) was conducted during 2008 (dry season). The fauna survey focused on habitat availability in the general vicinity as the exact Marine Crossing ROW was not known during the EIS phase.

For the purposes of this EMP information has been extrapolated based on previous surveys conducted within and adjacent to the Marine Crossing GTP Project (including habitats contiguous with the disturbance footprint), in addition to the findings of desktop assessments and local knowledge.

Targeted habitat assessment

As part of the targeted threatened flora survey, a habitat assessment was conducted by Ecologica in August/September 2010. The habitat assessment included mapping and recording key habitats within and adjacent to the Marine Crossing GTP ROW; identifying natural and anthropogenic pressures and recording fauna based on opportunistic observations.

Preclearing surveys

Santos GLNG GTP preclearing fauna surveys undertaken to date have included the following:

- Water mouse assessment report (FEC, 2012a)
  - This survey was undertaken December 2011 and confirmed this species occurs within the intertidal areas to the east of the mainland component of the Marine Crossing GTP Project, north of the construction site pad (mainland) and tidal watercourse crossing along the Marine Crossing mainland ROW
- Targeted threatened terrestrial fauna survey (FEC, 2012b)
  - This survey was undertaken during December 2011 and March 2012 and involved Elliot, cage, pitfall, hair tube and harp net trapping and timed reptile, amphibian and birds searches within key habitats identified in previous surveys
- Migratory bird survey (FEC, 2012c)
  - This survey was undertaken during December 2011, January, February and March 2012 and involved recording abundance and diversity of migratory birds at discrete roost and foraging areas

10.4.2 Limitations to previous survey methodologies

Flora and fauna surveys

All fauna surveys are subject to inherent limitations in the detection success of target species. Some fauna species may be more cryptic (ie harder to find) or are transient species that are typically absent during certain periods due to a variety of reasons (eg weather conditions, absence of food sources, migratory nature).

These limitations often result in a degree of false-absence records (ie a species is present, but not detected). It is important, therefore, that the limitations to fauna surveys are identified and the fauna survey results are viewed with these constraints in mind.

A summary of the limitations to the fauna surveys conducted include:

- The survey period not coinciding with the period that some migratory or nomadic species occur in the locality
- Species with large home ranges (eg owls and raptors) were not present in this part of their home range during the survey period
- The difficulty in detecting certain species during the survey period (eg cryptic species, species present in the study area at very low densities, and trap-shy species)
- Biological factors such as sex, age-class, and breeding biology, which may influence species' habitat use and detectability during different times of the year
- The lack of suitable climatic conditions necessary for the presence and/or detectability of certain species (eg amphibians following heavy rainfall)

For migratory or nomadic species not recorded during field investigations, habitat assessments have been completed to determine the likelihood of their occurrence within, and/or adjacent to the Marine Crossing GTP Project.

Database results

Caveats are attached to the information gained from database searches, including Wildlife Online and the EPBC protected matters search tool. The Wildlife Online database search is primarily based on specimens that have been actually identified and recorded within the vicinity of the given location(s) (DERM, 2011d). Thus, the absence of specimen records for a particular species does not indicate that the species does not occur in the area.

Results of the EPBC protected matters search tool are based on a combination of actual records (primarily from State Government databases), combined with modelled distributions of species according to their ecological characteristics. Not all species listed under the EPBC Act have been mapped and therefore the EPBC protected matters search tool is to be used as a general guide only.

Species record data received through the Queensland Museum and HERBRECS may vary in precision by up to approximately 100 km in some cases. Furthermore, some of the species records may be dated (ie pre 1950), and thus may not provide an accurate representation of species that currently exist within the region.

These factors have been considered when describing the existing environment, including the likelihood of a species inhabiting an area.

10.5 Existing environment

10.5.1 Regional and site context

The Marine Crossing GTP Project is situated within the South-East Queensland bioregion, close to the adjoining Brigalow Belt bioregion (Sattler and Williams, 1999) and located within the Burnett-Curtis Hills and Ranges sub-region. It should be noted that the ROW is situated within close proximity to the northern-most periphery of this sub-region, bordering on the Marlborough Plains sub-region of the adjacent Brigalow Belt bioregion.

Typical landforms on the mainland and Curtis Island within the Marine Crossing GTP ROW include; wooded alluvial plains, ephemeral watercourses, estuarine systems and fresh and saltwater wetlands.

The Marine Crossing GTP Project is located on the mainland, adjacent to the Kangaroo Island intertidal areas, and to the south of the intertidal areas of Graham Creek on Curtis Island (refer Figure 10.3). Saltpan and mangrove communities are present within these sheltered intertidal zones, outside of the direct disturbance from the Marine Crossing GTP Project.

A number of flora and fauna related ESAs (Category A, B and C) have been classified and defined by the EP Reg (for Category A and B), and the DEHP Guideline for 'preparing an environmental management plan for coal seam gas activities' (DERM, 2010b) as occurring within, and/or adjacent to the Marine Crossing GTP Project (refer Figure 10.1), namely:

- Marine Park under the *Marine Park Act 2004* (habitat protection zone) – Category A
- World Heritage Management Area (WHMA) – Category B
- 'Endangered' RE – Category B
- Areas the seaward side of HAT – Category B
- A place in which a marine plant under the *Fisheries Act 1994* is situated – Category B
- 'Of concern' RE – Category C
- Referable wetlands – Category C
- Essential habitat – Category C

10.5.2 Protected areas

The Great Barrier Reef and Great Barrier Reef Coastal Marine Park

The Great Barrier Reef is one of Queensland's five World Heritage Areas (WHAs) and meets the following criteria for natural world heritage (Great Barrier Reef Marine Park Authority, 1994) by:

- Representing major stages of the earth's evolutionary history
- Being an outstanding example of on-going ecological and biological processes
- Containing superlative natural phenomena
- Containing important natural habitats for conservation of biological diversity

The GBRWHA consists of an area approximately 348,000 km^2. It extends from the low water mark of the mainland, and includes all islands (eg Curtis Island), internal waters of Queensland, and *Seas and Submerged Lands Act 1973* exclusions (refer Chapter 9 for further details).

Curtis Island forms part of the NC Act listed protected area, which is defined as ESA Category B under the EP Act (refer Chapter 1).

The Marine Crossing GTP Project occurs within 1 km of the Great Barrier Reef Region[1] (ESA Category A), listed under the provisions of the *Great Barrier Reef Marine Park Act 1975* (GBRMP Act).

The GBR Coast MP is managed by the Queensland Government under the *Marine Parks Act 2004*, *Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004*, *Marine Parks Regulation 2006* and the *Marine Parks (Declaration) Regulation 2006*.

The GBR Coast MP extends from Baffle Creek (north of Bundaberg) to Cape York and encompasses tidal waters and tidal lands three nautical miles seaward from the HAT. The Marine Park zoning and regulations generally complement the GBRMP (Cth), however there are Queensland-specific provisions that may apply.

Within the vicinity of Gladstone, the GBR Coast MP includes all tidal waters and tidal lands specifically, The Narrows (north of Friend and Laird Points), out to three nautical miles from the HAT of Curtis Island and Facing Island and the mainland south of Canoe Point (Figure 8.4a and Figure 10.2).

The *Marine Parks (Declaration) Regulation 2006* which superseded and overrode *the Marine Parks (GBR Coast) Zoning Plan 2004* redesignated the GBR Coast MP boundary as:

- Generally northerly, westerly and southerly along Curtis Island at HAT to where it intersects latitude 23º44.905' south, then
- West along latitude 23º44.905' south to where it intersects Kangaroo Island at high water

Works associated with the Marine Crossing GTP Project do not occur in the GBR Coast MP habitat protection zone.

[1] The Great Barrier Reef Region (GBRR) (Register of National Estate Place ID 8230) exists as approximately 34,870,000 ha of sea bed, reefs, islands and seas, along the Queensland coast between the tip of Cape York and Fraser Island. The GBRR excludes Queensland owned islands (including Curtis Island).

Santos
GLNG Project

Marine Crossing GTP EMP

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP

Kilometre Post Distance Marker
- 5km
- 1km
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Washdown Facility (Indicative)
- Access Road
- Watercourse Crossing Ancillary Areas
- Great Barrier Reef Coast Marine Park (Qld)

Directory of Important Wetlands
- Port Curtis
- The Narrows

Referable Wetlands
- Wetland Management Area
- Wetland Management Area Trigger
- Watercourse

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Referable Wetlands: Department of Environment and Resource Management, 2010.
Watercourses: Department of Environment and Resource Management, 2011.
Aerial: Santos, Feb 2011.
Extra Works Areas: GLNG, Jul 2012.

Directory of Important Wetlands and Referable Wetlands Figure 10.2

A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0560

Coordinate system: GCS_GDA_1994

Date: 11/07/2012

Version: e

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Map by: RB

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

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Map by: RB

A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0561

Coordinate system: GCS_GDA_1994

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Washdown Facility (Indicative)
- Access Road
- Watercourse Crossing Ancillary Areas

Regional Ecosystem - Biodiversity Status
- Endangered - dominant
- Endangered - sub-dominant
- Of Concern - dominant
- Of Concern - sub-dominant
- Not of Concern

High Value Regrowth Vegetation
- Endangered Regional Ecosystem
- Of Concern Regional Ecosystem
- Least Concern Regional Ecosystem
- EPBC Threatened Speecies/ Ecological Community
- Regional Ecosystem where VM and BD status differ
- Essential Habitat (Essential Habitat centred near ROW Point B is for the Coast sheath-tail bat and Essential Habitat near Access Road is for the Koala and Coastal sheath-tail bat)
- Essential Regrowth Habitat
- Bioregion
- Watercourse

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Regional Ecosystems: Version 6.1, The State of Queensland (Department of Environment and Resource Management), Sep 2011.
High Value Regrowth Vegetation: Version 2.1, The State of Queensland (Department of Environment and Resource Management), Sep 2011.
EPBC Threatened Species and Ecological Community: Department of the Environment, Water, Heritage and the Arts, 2010.
Bioregions: Department of Environment and Resource Management, 2011.
Extra Works Areas: GLNG, Jul 2012.

Vegetation Communities
Figure 10.3

Date: 11/07/2012

Version: f

International and National important wetlands

The national DIWA lists four nationally important wetlands within the adjacent regions (<15 km) of the Marine Crossing GTP Project (Environment Australia, 2001). Table 10.3 shows the list of nationally important wetlands within close proximity or intersecting the Marine Crossing GTP Project.

These wetlands are considered nationally important as they meet at least one of the following criteria:

i. A good example of a wetland type occurring within a biogeographic region in Australia
ii. A wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex
iii. A wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail
iv. The wetland supports 1% or more of the national populations of any native plant or animal taxa
v. The wetland supports native plant or animal taxa or communities which are considered endangered or 'vulnerable' at the national level
vi. The wetland is of outstanding historical or cultural significance

Table 10.3 Nationally important wetlands within the broader region

Nationally important wetland	Approximate location	Criterion for inclusion
Great Barrier Reef Marine Park	0.07 km N of KP 413.25	i-vi
Northeast Curtis Island	17 km N of KP 415.50	i to iii and vi
Port Curtis (refer Figure 10.2)	Intersects >20m below the seafloor between KP 409.559 and KP 413.293. Adjacent to construction site pads (mainland and Curtis Island)	i-vi
The Narrows	Intersects >20 m below the seafloor at KP 409.12 and KP 409.56. Adjacent to GTP on the mainland between Points B and C	i to iii and vi

Source: Environment Australia (2001)

A map of referable wetlands for the Marine Crossing GTP Project illustrates the presence of wetland management areas (WMAs) and wetland management area triggers that intercept the Marine Crossing GTP Project (Category C ESA) (refer Figure 10.2).

Under these criteria, four nationally listed wetlands occur within the Curtis Coast area, including The Narrows, Port Curtis, Great Barrier Reef Marine Park and the Colosseum Inlet-Rodds Bay area. The Marine Crossing GTP Project tunnels under areas associated with The Narrows and Port Curtis wetlands.

The Port Curtis wetland includes all tidal areas in the vicinity of Gladstone from a line between Laird Point and Friend Point (southern end of The Narrows), to a line between Gatcombe Head and Canoe Point, including the seaward side of Facing Island and Sable Chief Rocks, and southern Curtis Island, west of a line between North Point and Connor Bluff (Environment Australia, 2001).

The inclusion of Port Curtis and The Narrows as an important wetland is in recognition of the area's geomorphology, cultural and socio-economic value and ecological diversity. The area supports a diverse range of wildlife, including significant flora and fauna, as well as being the preferred feeding grounds of several migratory birds listed under the China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA) and the Convention on Migratory Species (Bonn Agreement).

Fish Habitat Areas

Declared Fish Habitat Areas (FHAs) give protection to inshore and estuarine fish habitats that are important for sustaining local and regional fisheries. Once an area is declared as a FHA, it equally protects all habitat types (ie vegetation, sandbars and rocky headlands) from direct physical disturbance and coastal development. Declared FHAs are protected by the *Fisheries Act 1994* that restricts development activities.

No FHAs have been declared under the provisions of the *Fisheries Act 1994* within or adjoining the Marine Crossing GTP Project. The closest FHA (which is approximately 20 km north of the Marine Crossing GTP Project) is the Fitzroy River FHA, which was declared in March 2008. The Fitzroy River FHA is defined as a management level 'A' where strict management arrangements are in effect.

Despite the absence of FHA legislation to protect the area, the ecological value of the systems is significant. The mangrove, saltmarsh and seagrass communities, which are abundant within the vicinity of the Marine Crossing GTP Project, are recognised for their value to fisheries production.

Protected areas under the NC Act

The Marine Crossing GTP Project will not intersect any areas protected under the *Nature Conservation (Protected Areas) Regulation 1994* (NCPA Reg) (eg listed national parks, conservation parks, forest reserves, resource reserves or nature refuges).

Furthermore, the Marine Crossing GTP Project will not intersect areas protected under the provisions of the NC Act (eg State forest parks, State reserves/forests and timber reserves) (refer Chapter 8).

A number of protected areas occur within the broader Curtis Island region (ie within 10 km of the Marine Crossing GTP Project) (DERM, 2010c):

- Curtis Island National Park
- Curtis Island State Forest
- Curtis Island Nature Refuge
- Garden Island Conservation Park
- Southend Conservation Park
- Port of Gladstone – Rodds Bay Dugong Protection Area (Zone B)

The abovementioned areas are sufficiently separated from the Project and no direct impact will occur as a result of the proposed works.

10.5.3 Terrestrial flora

Regional Ecosystems (VM Act, EP Act)

The terrestrial environments found on the mainland (Point A to Point C and Access Road) are contained within the Brigalow Belt Bioregion. The terrestrial environments found on Curtis Island (Point D to Point E) are contained within the SE Queensland Bioregion.

Regional Ecosystems (REs) are significant remnant vegetation communities gazetted under the provisions of the VM Act. An RE code is an abbreviation used by the DNRM to describe a vegetation community according to its bio-region classification, its land zone classification and its species composition.

Table 10.4 summarises the RE types mapped within and adjacent to the Marine Crossing GTP Project, whilst Figure 10.3 shows their approximate locations.

Table 10.4 Regional Ecosystems mapped within/adjacent to the Marine Crossing GTP Project

Regional Ecosystem code	VM Act Status	Biodiversity Status	Short description of community (Regional Ecosystem Description Database, version 6.0b)
12.1.3	LC	NC	Mangrove shrubland to low closed forest
12.3.3[1]	E	E	*Eucalyptus tereticornis* woodland to open forest on alluvial plains
12.11.6	LC	NC	*Corymbia citriodora, Eucalyptus crebra* open forest on metamorphics +/- interbedded volcanics
12.11.6/12.11.14	LC/OC	NC/OC	*Corymbia citriodora* and *Eucalyptus crebra* open forest on metamorphics/*Eucalyptus crebra, E. tereticornis* woodland on metamorphics +/- interbedded volcanics
11.3.29/12.11.6[1]	LC/LC	NC/NC	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains/ *Corymbia citriodora* and *Eucalyptus crebra* open forest on metamorphics
11.3.26/11.3.4/11.11.15[2]	LC/OC/LC	NC/OC/NC	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains/*Eucalyptus tereticorni*s and/or *Eucalyptus* spp*.* tall woodland on alluvial plains/*Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics. Undulating plains

Table notes: VM Act = *Vegetation Management Act 1999*
E = Endangered
NC = No Concern at Present – EP Act
LC = Least Concern – VM Act
OC = Of Concern
1 Essential habitat for the Koala and Coastal sheath-tail bat
2 Essential habitat for the Coastal sheath-tail bat

Ground truthing of the RE types within the construction site pads (mainland and Curtis Island) and the Access Road was undertaken by RPS in April 2012. As a result of the flora survey, the extent and classification of REs differ from the mapped extent. A description of vegetation communities within the RPS study area is provided in Section 10.5.3.

Table 10.5 shows the REs reclassified as part of the preclearing flora survey.

Table 10.5 REs reclassified within the construction site pads and Access Roads

Regional Ecosystem code	VM Act status	Biodiversity status	Description
Mainland			
11.3.4	OC	OC	*Eucalyptus tereticornis* and/or *Eucalyptus spp.* Tall woodland on alluvial plains
12.11.14	OC	OC	*Eucalyptus crebra, E. tereticornis* woodland on metamorphics +/- interbedded volcanics
11.11.15	LC	NC	*Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics. Undulating plains
Curtis Island			
12.1.3	LC	NC	Mangrove shrubland to low closed forest. Occurs on Quaternary estuarine deposits
12.11.14	OC	OC	*Eucalyptus crebra*, E. *tereticornis* woodland on metamorphic +/- interbedded volcanics

Table notes: E = Endangered
OC = Of Concern
LC = Least Concern (VMA Act)
NC = No concern at present (BD)
BD = Biodiversity Status
Source: RPS 2012

Ground truthing of the Marine Crossing GTP Project ROW (Points A to C and Points D to E) will be undertaken as part of additional preclearing flora surveys prior to construction to confirm RE extent and classification, and the presence of threatened flora species.

The vegetation community type (eg woodland) is a term used to identify the particular vegetation structure based on canopy density/cover and height and is based on the canopy stratum. Vegetation structures observed within the Marine Crossing GTP Project disturbance footprint are:

- Grassland/Open Woodland which contains a sparse tree and/or shrub layer (<10%) with a Ground stratum density between 10% to 100%
- Woodlands which contain a canopy cover of 10% to 30% and trees to a height of 30 m
- Closed Forests which contain a canopy cover of 70% to 100% and trees to a height of 30 m. These communities are associated with the adjoining intertidal wetlands

Figure 10.3 shows the distribution of vegetation communities (shown as REs) and a description is provided below.

Mainland and Curtis Island ROW

The Marine Crossing ROW intercepts the ecotone between the littoral sclerophyll woodlands on the non-tidal mainland. The ROW traverses under the intertidal area south of Kangaroo Island and The Narrows via a tunnel, as described in Chapter 2, before surfacing on Curtis Island. The Marine Crossing ROW intercepts approximately 1.2 km of sclerophyll woodlands on undulating hills on Curtis Island.

Generally there is a clear demarcation between the intertidal vegetation and the terrestrial environments, however in some areas marine plant species are interspersed with terrestrial species (eg riparian zone of Targinie Creek).

The main terrestrial environment within the mainland section of the Marine Crossing GTP ROW is dry sclerophyll woodland dominated by Narrow leaved ironbark (*Eucalyptus crebra*) and/or Blue gum (*Eucalyptus tereticornis*) on alluvial plains. Some historic clearing and thinning has impacted on the structure and integrity of these communities, including the proliferation of introduced weed species and the loss of habitat complexity.

Patches of Allocasuarina and Casuarina woodlands and forests also occur along the ecotone, particularly in association with the watercourses.

The vegetation along the riparian zones of Humpy Creek and Targinie Creek is generally complex consisting of intertidal vegetation and in some instances dry rainforest species (eg Sandpaper fig) with the trailing vegetation associated with littoral sclerophyll woodlands (refer Section 10.5.7).

The ROW initially intercepts intertidal banks and rocky shores on Curtis Island, prior to extending south east through open *Eucalyptus crebra* on metamorphic hills on the landward side. The ROW then extends easterly through Eucalyptus woodland on metamorphics ± interbedded volcanics.

Ground-truthing exercises within the Curtis Island GTP ROW have confirmed that RE mapping (as illustrated in Figure 10.3) has a high degree of accuracy (URS, 2009a).

The heterogeneous RE12.3.3/12.3.7 is mapped as 'endangered' dominant and is also recognised as a 'Category B' ESA under the EP Reg (ie due to the presence of RE12.3.3, which has an 'endangered' biodiversity status). This heterogeneous RE is dominated by Queensland Blue gum (*Eucalyptus tereticornis*) and Swamp box (*Lophostemon suaveolens*). The shrub layer is represented by Spike sida (*Sida hackettiana)* and Cockatoo apple (*Planchonia careya*). Species present within the ground layer include Black spear grass (*Heteropogon contortus*), Slender cane grass (*Leptochloa decipiens* subsp. *decipiens*), Hairy indigo (*Indigofera hirsuta*), Hairy panicum (*Panicum effusum*), *Crotalaria montana* var. *angustifolia*, Graceful sedge (*Cyperus gracilis*) and Wombat berry (*Eustrephus latifolius*).

RE12.11.6 has a classified biodiversity status as 'no concern at present' and exists as an open woodland, with a canopy and mid-story that is dominated by Spotted gum (*Eucalyptus citriodora*) and Narrow leaved ironbark (*Eucalyptus crebra*). The shrub layer is dominated by Black wattle (*Acacia leiocalyx*), Native hop bush (*Dodonea lanceolata* var. *subsessilifolia*), and Medicine bush (*Pogonolobus reticulatus*). Grass trees (*Xanthorrhoea johnsonii* (Type A species)) are also present within the shrub layer. The ground stratum within this community includes Dodder laurel (*Cassytha filiformis*), Brown's lovegrass (*Eragrostis brownii*), Barb wire grass (*Cymbopogon refractus*), Glycine pea (*Glycine tabacina*), and Matrush (*Lomandra confertifolia* subsp. p*allida*).

The heterogeneous RE12.3.7/12.3.11 is mapped as 'of concern' subdominant. This heterogeneous RE polygon is dominated by Blue gum (*Eucalyptus tereticornis*), with fringing Weeping bottlebrush (*Melaleuca viminalis*) and River sheoak (*Casuarina cunninghamiana*). As these communities border the intertidal wetlands of Graham Creek there is some localised marine plant intrusion (eg Marine couch [*Sporobolus virginicus]*) within the ground stratum.

The heterogeneous RE12.11.6/12.11.14 is mapped as an 'of concern' subdominant Biodiversity status. This heterogeneous RE polygon is dominated in areas by Narrow leaved ironbark (*Eucalyptus crebra*) and Queensland Blue gum (*Eucalyptus tereticornis*), with Swamp box (*Lophostemon suaveolens*) also present in the sub-canopy. Dominant species within the shrub layer include Cockatoo apple (*Planchonia careya*) and Black wattle (*Acacia leiocalyx*). The ground stratum contains species, including Barb wire grass (*Cymbopogon refractus*), *Eragrostis brownii*, *Leptochloa decipiens* subsp. *decipiens*, Spiked sida (*Sida hackettiana*), Vernonia (*Cyanthillium cinereum*), Hairy panic (*Panicum effusum*) and Kangaroo grass (*Themeda triandra*).

Construction site pad (mainland) and Access Road

The construction site pad (mainland) and Access Road disturbance footprint traverses the following three distinct vegetation communities:

- Grazed, disturbed grasslands
- Queensland Blue gum (*Eucalyptus tereticornis*) woodland
- Long fruited bloodwood (*Corymbia clarksoniana*) woodland

Descriptions of these vegetation communities are provided below.

Grazed disturbed grasslands

This vegetation community occurs at the northern end of the site. It is comprised of ground covers that have been regularly grazed, including Black spear grass (*Heteropogon contortus*), Satin top (*Bothriochloa erianthoides*), Sida (*Sida filiformis*), Queensland bluegrass (*Dichanthium sericeum*), Slender chloris (*Chloris divaricarta*) and Gomphrena weed (*Gomphrena celosioides*) (RPS, 2012) (refer Plates 1 and 2).

Plate 1 Approximate location of Access Road – (near central dam)

Plate 2 Approximate location of Access Road – (adjacent orchard)

Eucalyptus tereticornis woodland

This vegetation community occurs at the north eastern end of the site, in association with alluvial soils. The canopy is dominated by Queensland Blue gum (*Eucalyptus tereticornis*), with White gum (*Eucalyptus platyphylla*) and Narrow-leaved ironbark (*Eucalyptus crebra*) also occurring. The secondary canopy is comprised of Silver-leaved paperbark (*Melaleuca dealbata*) and Hickory wattle (*Acacia implexa*). Occasional Broad-leaved paperbark (*Melaleuca quinquenervia*) also occurs (RPS, 2012).

A sparse shrub layer occurs within this community, comprising Myrtle Tree (*Canthium oleifolium*), Silverleaved ironbark (*Eucalyptus melanophloia*), Coffee bush (*Breynia oblongifolia*) and Cockatoo apple (*Planchonia careya*). The shrub layer ranges in height from approximately 1.5 to 4 m. Lantana (*Lantana camara*) also occurs throughout the shrub layer (RPS, 2012).

This vegetation community is analogous with RE 11.3.4, which is listed as 'of concern' under the VM Act. The community is not considered to be a Threatened Ecological Community (TEC), as listed under the EPBC Act.

Corymbia clarksoniana woodland

There are large areas of this vegetation community at the southern end of the site, particularly adjacent to the southern portion of the Access Road. The canopy is dominated by Long-fruited Bloodwood (*Corymbia clarksoniana*), with Queensland Blue gum (*Eucalyptus tereticornis*) also occurring. The secondary canopy is comprised of similar species, with the addition of Quinine tree (*Petalostigma pubescens)*, Creek sandpaper fig (*Ficus opposita*) and Poison peach (*Trema omentosa*) (RPS, 2012).

A sparse shrub layer is present, comprising Red Kamala (*Mallotus phillippensis*), Wild orange (*Capparis mitchellii*), Cockatoo apple (*Planchonia careya*) and Tuckeroo (*Cupaniopsis anacardioides*). Planted species including Chilli (*Capsicum* sp.), Guava (*Psidium guajava*) and Paw-paw (*Carica papaya*) also occur in this community (RPS, 2012).

This vegetation community is analogous with RE 12.11.14, which is listed as 'of concern' under the VM Act and has a biodiversity status – of concern. The community is not considered to be a TEC as listed under the EPBC Act.

Floristic diversity

Floristic diversity within the Marine Crossing GTP Project disturbance footprint is associated with open eucalypt woodlands with introduced and native grassland understorey, regrowth, pastoral grasslands, riparian zones and intertidal wetlands.

The main canopy species identified within the Marine Crossing GTP Project disturbance footprint includes Narrow leaved ironbark (*Eucalyptus crebra*), Queensland Blue gum (*Eucalyptus tereticornis*), Pink bloodwood (*Corymbia intermedia*), Gum-topped box (*Eucalyptus moluccana*) and marine species such as Red mangrove (*Rhizophora stylosa*) and Yellow mangrove (*Ceriops tagal*). These species are important refuge and feeding habitat for a range of fauna species and also have commercial values (eg Queensland Blue gum [*Eucalyptus tereticornis*] is used for saw logs, power poles, posts, fencing material and firewood).

The mid-storey contains a mix of species with local dominance variable across the site, including Cockatoo apple (*Planchonia careya*), Quinine bush (*Petalostigma pubescens*), Current bush (*Carissa ovata*), *Melaleuca* spp., *Acacia* spp. and Lantana (*Lantana camara*). The ground stratum contains a mix of introduced and native species, including Snake weed (*Stachytarpheta jamaicensis*), *Crotalaria* spp., Sida (*Sida cordifolia)*, *Aristida* spp. Black spear grass (*Heteropogon contortus*) and *Themeda* spp. (Ecologica, 2012).

Sedges and rushes were also interspersed throughout the Marine Crossing GTP Project disturbance footprint, while some aquatic macrophyte species (eg *Ludwigia* spp., *Persicaria* spp. and lilies) were identified in local areas. Dry rainforest species such as *Ficus* spp. and *Carissa ovata*. were interspersed with marine plants along the watercourses (refer Section 10.5.7). In addition, *Cymbidium* spp., which are listed as Type A plants under the NC Act, were identified in association with Narrow leaved iron bark (*Eucalyptus crebra*) from the Marine Crossing GTP ROW (Ecologica, 2012).

Comprehensive surveys undertake as part of the Stuart Oil Shale Project, identified 147 flora species from the local area (Houston *et al.*, 1999).

Threatened flora

The EPBC protected matters search tool, identified eight threatened (ie 'critically endangered', 'near threatened', 'endangered', 'vulnerable' under the EPBC Act) species as potentially inhabiting the Marine Crossing GTP Project disturbance footprint (SEWPaC, 2012). HERBRECS (up to 1,600 m accuracy only), and DNRM's Wildlife Online and essential habitat mapping database indicated that no threatened flora species occur within 1,600 m of the Marine Crossing GTP Project.

A recent pre clearing vegetation survey was undertaken by RPS in April 2012 for the mainland Access Road and construction site pads. This survey did not identify threatened flora within these areas.

It is therefore unlikely that any threatened flora occur within the disturbance footprint of the Marine Crossing GTP Project.

Declared pest flora

Eleven flora species observed within the Marine Crossing GTP Project disturbance footprint are declared pest plants under the provisions of the LP Act.

Of these species, five were identified from habitats within the Marine Crossing GTP Project. Detailed weed mapping to confirm these findings will be undertaken as part of the preclearing works. Table 10.6 lists declared pest flora species found within the Marine Crossing GTP Project disturbance footprint.

Table 10.6 Declared pest flora within the Marine Crossing GTP Project disturbance footprint

Scientific name	LP Act status
Rubber vine (*Cryptostegia grandiflora*)	Class 2
Lantana (*Lantana camara*)	Class 3
Creeping lantana (*Lantana montevidensis*)	Class 3
Cat's claw creeper (*Macfadyena unguis-cati*)	Class 3
Common prickly pear (*Opuntia stricta*)	Class 2

Table note: LP Act = *Land Protection (Pest and Stock Route Management) Act 2002*

Reasonable steps to keep the land free of Class 2 and Class 3 declared species is required under the LP Act. A person must not, without reasonable excuse, introduce a declared pest to any of the following areas unless a declared pest permit has been obtained.

In addition to the LP Act status, *Cryptostegia grandiflora* and *Lantana camara* are considered to be weeds of national significance (WONS) due to their invasive nature and their potential impacts to the environment and the economy (Thorp and Lynch, 2000).

10.5.4 Terrestrial fauna

During the EIS, a total of 51 native and five introduced terrestrial vertebrate species were recorded during the field survey within the Curtis Island GTP study area, in the vicinity of the Marine Crossing GTP Project. Native species included five reptile, 39 bird and seven mammal species.

The diversity of fauna found on the site was very low. Many species that typically might be expected to be present utilising the habitat available were not detected. The conspicuous absence of an assemblage of ground dwelling mammals is considered to be due to a number of factors, including the degree of disturbance to ground cover from current and historical grazing, presence of exotic flora in the groundcover, the extended drought conditions preceding the survey year, impacts from other historical land use disturbances such as fire, timber felling and thinning, and the high number of feral species known to be active in the locality.

The Marine Crossing GTP Project is located within the transitional zone between the Brigalow Belt bioregion and Southeast Queensland bioregion (as determined by Sattler and Williams, 1999) which provides habitat for a distinctive array of threatened fauna species as well as significant vegetation communities, a large percentage of which have and are still being cleared for agricultural purposes.

A summary of the terrestrial fauna species likely to inhabit the Marine Crossing GTP Project disturbance footprint is provided below.

Preclearing terrestrial fauna survey findings

Based on preclearing terrestrial fauna surveys undertaken between December 2011 and March 2012, the diversity and abundance of recorded fauna assemblage of the Marine Crossing GTP Project disturbance footprint and adjoining areas is considered to be quite low (FEC, 2012b). This section is based on the GLNG GTP ROW Threatened Terrestrial Fauna Species Preclearing Surveys Assessment Report by FEC (FEC, 2012c).

The lack of diversity and abundance can be partially explained by comparing the habitats supported within the Marine Crossing GTP ROW and the total diversity and habitats supported within the database search area. In addition, some habitats supported within the database search area are not supported within the Marine Crossing GTP terrestrial ROW, for example marine environs, which account for 30 bird species (eg shorebirds) and six mammals (eg dugongs).

Nonetheless, the assemblage recorded is considered to be quite depauperate, with a low diversity of species recorded and low total counts of individuals from each species. This is thought to be linked to a lack of habitat diversity within the Project ROW and surrounds.

The reason for this lack of habitat diversity can be linked to the highly disturbed condition of habitats supported within the study site, which are most likely attributable to a history of poor land management practises such as broad scale clearing, repetitive regrowth removal, over stocking, overgrazing and inappropriate fire management.

The fauna survey results are thought to be caused by two primary factors:

1. Much of the Project ROW has been systematically cleared of native vegetation for pasture improvement and those areas that have not been totally cleared, have been thinned and exposed to overgrazing pressures
2. Inappropriate fire regimes, with most areas being subjected to too frequent and too hot fire regimes as part of annual pastoral land management practises

These land management practises have not only affected the diversity and abundance of common wildlife, but have had an impact on threatened species which typically have very specific habitat niche requirements. Continual clearing and burning can result in gross simplification of habitats, in terms of distribution, diversity and structure. These broad scale activities, leading to habitat simplification have been identified as key threatening processes to threatened species persistence and survival (FEC, 2012b).

Specific remnant vegetation within the vicinity of the Marine Crossing GTP Project supports high habitat values for Powerful owl as these areas support complex and diverse vegetation communities. The Curtis Island sites have experienced regular fires, but not to the same effect (frequency and temperature) as the mainland sites, as some ground structure habitat still exists. Some of the listed reptile species may still persist within these areas as they still support complex vegetation communities with good structural diversity and ground habitat diversity. The remainder of the ROW has been systematically altered for pastoral improvement, so that only those species that are sufficiently mobile and disturbance tolerant, (eg squatter pigeon) can persist in these areas (FEC, 2012b).

Preclearing water mouse survey findings

A targeted Water mouse (*Xeromys myoides*) survey was undertaken by FEC between December 2011 and April 2012 at five survey sites (refer Figure 10.4). These sites were selected on the basis of the habitat requirements of this species and the alignment and disturbance footprint of the Marine Crossing GTP Project. This section presents a summary of survey findings.

Four survey sites were selected within the intertidal areas south of Kangaroo Island and an additional site on Curtis Island. It should be noted that whilst point locations are shown in Figure 10.4, survey sites consist of a survey area as described below.

Table 10.7 details the survey site nomenclature and the dates that each site was surveyed. The dates for each survey event were selected to ensure a high tide mid-afternoon so that Elliot traps could be deployed in the late afternoon and then collected during the night before the next high tide.

Table 10.7 Survey site nomenclature and survey dates

Survey site nomenclature	Dates surveyed (night)
Kangaroo Island Sites 1 and 1-1 (adjacent to mainland)	31 December 2011 – 4 January 2012
Kangaroo Island Sites 2 and 3 (Friend Point Area)	12 – 16 April 2012
Curtis Island Site 4	14 – 18 February 2012

Survey site descriptions

Descriptions and assessments of the five survey sites are presented in the sections below. Figure 10.4 illustrates the location of the survey sites.

Survey Site 1 habitat description

This site was located in the head waters of Mosquito Creek and consists of a mosaic of estuarine intertidal habitats and terrestrial supralittoral zone. The intertidal area consists of a thin veneer of bare mud flats and exposed bed rock and rock boulders between the supralittoral bank to the west and the creek. A vehicle access track was evident along the edge of the supralittoral zone. Some evidence of pigs was also observed. A very dense mangrove forest to approximately 4 m high lined Mosquito Creek and open, bare, very fine grained clay mud flats were located to the east. Mosquito Creek channel in this area was deeply incised and consisted of a deep creek channel with very steep, soft mud banks. The mangrove forests were inundated even on neap tidal cycles.

No evidence of Water mouse (mounds, prey middens, tracks etc) were observed during diurnal searches. Crab burrows were abundant in the area.

The habitat suitability assessment undertaken by FEC (2012a) classified this survey site area as very high as one Water mouse was captured within this area during survey period refer Figure 10.4).

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road
- Watercourse Crossing Ancillary Areas

Threatened Fauna Species
- Beach Stone-curlew
- Little Tern
- Powerful Owl
- Raptor Nest possibly White-bellied Sea-eagle
- Square-tailed Kite
- Squatter Pigeon
- Water Mouse
- Water Mouse Survey Sites

Pre-clearing Terrestrial Fauna Survey Sites
- Curtis Island Survey Site 1
- Survey Site 01
- Survey Site 02

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.
Footprints Environmental Consultants, 2012a, GLNG GTP ROW Pre-Clearing Threatened Species Surveys, Water Mouse Assessment Report.
Footprints Environmental Consultants, 2012b, GLNG GTP ROW Pre-Clearing Threatened Terrestrial Fauna Pre-clearing Surveys Assessment Report.
Extra Works Areas: GLNG, Jul 2012.

Location of Threatened Fauna Species Figure 10.4

Map by: RB   P:\GIS\Projects\214208_Santos_EMP\MC_074.mxd   11/07/2012 09:26

A1 scale: 1:15,000
0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0562
Coordinate system: GCS_GDA_1994

Date: 11/07/2012   Version: g

Survey Site 1-1 habitat description

This site was located on and around Targinie Creek, from the supralittoral zone into the estuarine habitats. This site consists of a mosaic of estuarine intertidal habitats and a highly disturbed terrestrial supralitttoral zone. Grazing related impacts within the supralittoral zone, adjacent terrestrial and estuarine habitats were evident. Extensive soil erosion from stock access and feral pig activity was observed. The intertidal area was characterised by a mosaic of salt couch grass (Sporobolus virginicus) flats, mangrove forests and bare, very fine grained mud flats. The mangrove forest was to approximately 3 m high. The creek channel in this area was wide and relatively shallow with very steep, near vertical marine clay soft mud banks. The mangrove forests appeared to be only inundated on spring tidal cycles.

No evidence of Water mouse (eg mounds, prey middens, tracks, etc) was observed during diurnal searches. Crab burrows were abundant in the area.

The habitat suitability assessment undertaken by FEC (2012a) classified this survey site area as very high as this area is located very near to where Water mouse presence has been confirmed.

Survey Site 2 habitat description

This site was located near Friend Point on Kangaroo Island. This site consists of a mosaic of estuarine intertidal habitats of mangrove forests, salt couch grasslands, samphire and fine grained mud flats. This area did not support a terrestrial-estuarine supralittoral zone. The mangrove forest was to approximately 4 m high encompassed by intertidal mud flats. The flats to the seaward (southeast) side of the mangroves were regularly tidally inundated. The mud flats to the northwest of the mangroves were only inundated on spring tidal events. Whilst there were drainage lines through the mangrove forests, the forests themselves appeared to be only inundated on very high spring tidal cycles.

Extensive evidence of dog/fox and cat presence was observed through this area.

No evidence of Water mouse (eg mounds, prey middens, tracks etc) was observed during diurnal searches. Crab burrows were abundant in the area.

The habitat suitability assessment undertaken by FEC (2012a) classified this survey site area as moderate to low.

Survey Site 3 habitat description

This site was located between the southern end of Kangaroo Island and Friend Point and was characterised by a mosaic of terrestrial supralittoral zone and estuarine intertidal habitats. The supralittoral zone of Kangaroo island was bordered by a mosaic of salt couch grasslands and samphire communities. The intertidal area consisted of a broad and wide shell grit ridge line which was possibly only submerged on king tides. This ridgeline was bordered by very dense mangrove forests to approximately 5 m high. Open, bar, fine, grained mud flats were located to the west of the mangrove forests. The mangrove forests and mud flats were dry (ie not inundated) only on neap tidal cycles.

Extensive evidence of dog/fox and cat presence was observed through this area.

No evidence of Water mouse (eg mounds, prey middens, tracks, etc) was observed during diurnal searches. Crab burrows were abundant in that area.

The habitat suitability assessment undertaken by FEC (2012a) classified this survey site area as very high due to potential foraging/nesting habitat.

Survey 4 habitat description

This site was located on Curtis Island where the GTP ROW is proposed to pass very close to marine intertidal habitats. The site consists of a mosaic of estuarine intertidal habitats and terrestrial supralittoral zone. The supralittoral zone was bordered by salt couch grasslands, which, in turn, were bordered by a thin line of stunted mangroves. Bare, coarse grained, almost stoney mud flats, with isolated patches of samphire, extended beyond this area to a very dense mangrove forest to approximately 4 m high situated along the intertidal drainage line. The drainage channel was very narrow and shallow, with very soft mud banks. The mangrove forests and most of the mud flats appeared to be inundated even on very low neap tidal cycles. There was some evidence of brumby and pig activity in this area.

No evidence of Water mouse (eg mounds, prey middens, tracks, etc) was observed during diurnal searches. Crab burrows were abundant in the area.

The habitat suitability assessment undertaken by FEC (2012a) classified this survey site area as low.

Survey findings

Kangaroo Island Wetland Complex

The capture of a Water mouse within habitats associated with Mosquito Creek confirms the presence of this vulnerable species, not only in areas within and adjacent to the Marine Crossing GTP Project, but within the estuarine and adjacent terrestrial habitats supported within Mosquito Creek and neighbouring terrestrial environs.

The Kangaroo Island wetland mosaic is a very complex system of intertidal creeks, drainage channels, mangrove forests, salt couch grasslands, samphire and extensive, fine grained mud flat communities.

The Water mouse is a highly mobile species that has been observed to travel up to 3 km a night. Home ranges for this species can vary from 0.53 ha to 3.42 ha (Gynther and Jenetzki 2008, Van Dyck 1996). As this species is so mobile, it is considered that this species occurs throughout the Mosquito Creek estuarine environs and also may venture into the adjacent supralittoral and terrestrial habitats.

Given the extent of the very high quality Water mouse habitat supported within the Mosquito Creek complex and the high mobility of the species, it is considered that the Water mouse occurs throughout the Mosquito Creek catchment area, and may also be present further to the east within habitats supported between Kangaroo Island and Friend Point.

Curtis Island

The survey programme on Curtis Island did not capture any water mice. Whilst the estuarine habitats supported on Curtis Island support similar vegetation communities to the Kangaroo island complex sites, it appears that the function of these habitats is very different.

The marine mud flats on Curtis Island were comprised of very coarse-grained mud, with stones up to 10 mm diameter. The mud banks that supported the mangrove forests were of a much more fine-grained nature.

The drainage channel within the mangrove forest was narrow and shallow with fine-grained mud banks.

The mangrove forests were often inundated, with the entire mangrove forest floor inundated with tidal heights above approximately 3.1 m AHD. This means that the mangrove forest floor, where the Water mouse forages, is completely inundated from/to approximately half tide height every tidal cycle. It is considered that this devalues the habitat value to the Water mouse as this species would only be able to forage, in a very small area, for a very limited amount of time during very nocturnal tidal cycle.

As a result it is considered that this area does not support high value water mouse habitat.

Figure 10.5 shows the predicted location of high quality Water mouse habitat which is based on the findings of the preclearing survey (FEC, 2012a) and further information collected on the species as part of the WMMP.

Potential wider distribution of recorded threatened species

Although the presence of several threatened species has been identified in specific areas, it is considered that many of these species have a high potential of occurrence elsewhere within or adjacent to the Marine Crossing GTP Project. The potential for these species to occur in other areas has been identified through habitat assessments and knowledge of individual species requirements. A brief summary is provided in Table 10.8.

Squatter pigeon (EPBC Act, NC Act)

This species is considered to be relatively common in central Queensland and is considered likely to occur anywhere within the Marine Crossing GTP Project disturbance footprint where suitable habitat exists.

Powerful owl (NC Act)

This species was recorded on Curtis Island and is considered to occur in all suitable habitats within and adjacent to the Marine Crossing GTP ROW on Curtis Island, in the vicinity of Point E. Whilst not recorded on the mainland during the survey period, it is considered highly likely that Powerful owl also occurs within suitable habitats between Point A and Point C as habitats within this area support attributes required for this species, due to complex woodland habitat structure, presence of trees supporting large hollows (>20 cm) and abundant prey species (eg possums, gliders). As such, management for this species should be included in these mainland sections.

Koala (EPBC Act, NC Act)

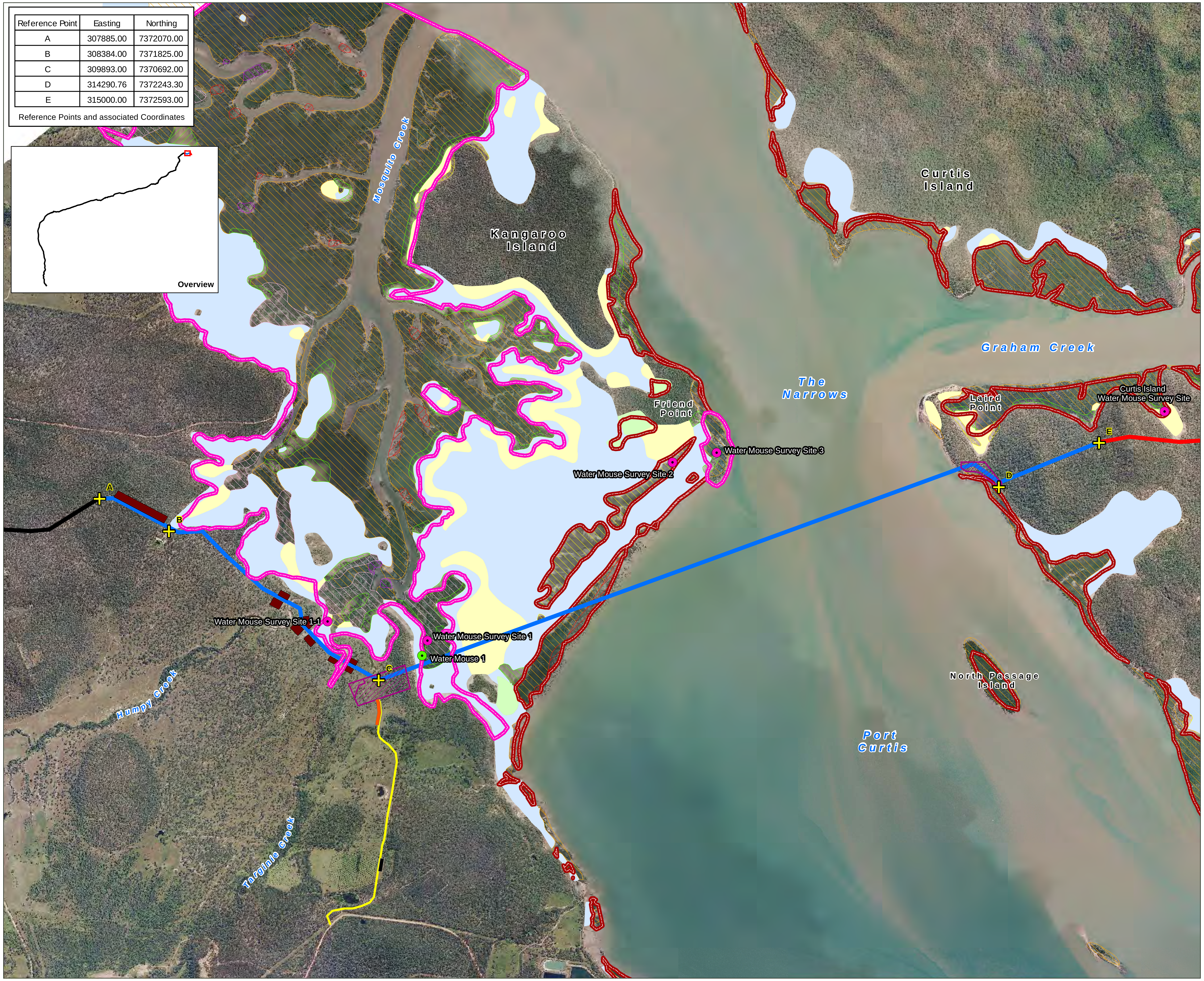
Whilst not physically recorded during the surveys, characteristic scratch marks of Koala were observed. As such, the precautionary principle should be applied and management for this species should be included within the Marine Crossing GTP Project.

Beach Stone-curlew (NC Act)

This species primarily occurs within estuarine intertidal areas. It is not considered likely to occur outside of the areas where it has been recorded.

Black-necked stork (NC Act)

Black-neck stork was observed near Point C foraging in a small farm dam. This species is highly mobile and has the capacity to occur within similar habitats throughout the area.



Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Washdown Facility (Indicative)
- Access Road
- Watercourse Crossing Ancillary Areas

Intertidal Wetlands

Mangroves
- Open Avicennia
- Closed Avicennia
- Closed Avicennia / Ceriops
- Open Avicennia / Ceriops
- Closed Aegiceras
- Closed Avicennia / Rhizophora
- Closed Ceriops
- Closed Mixed
- Closed Rhizophora

Saltmarsh
- Samphire Dominated Saltpan
- Saline Grassland
- Saltpan
- Potential Habitat for Water Mouse (based on EPBC Act Policy Statement 3.20 (Water mouse))
- High Quality Water Mouse Habitat (Based on GLNG pre-clearing results)
- Significant Species: Water Mouse
- Water Mouse Survey Site

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Intertidal Wetlands: Danaher, K.F., Rasheed, M.A. and Thomas, R., Intertidal Wetlands of Port Curtis. DPI&F Information Series Q105031, 2005.
Aerial: Santos, Feb 2011.
Regional Ecosystems: Version 6.1, The State of Queensland (Department of Environment and Resource Management), Sept 2011.
Water Mouse Survey Sites: GLNG GTP ROW - Pre-clearing Threatened Species Surveys Water Mouse Assesment Report, Footprints Environmental Consultants May 2012.
Extra Works Areas: GLNG, Jul 2012.

Water Mouse Habitat
Figure 10.5

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_075.mxd 11/07/2012 09:30

A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0570

Coordinate system: GCS_GDA_1994

Date: 11/07/2012

Version: f

Square-tailed kite (NC Act)

This species was recorded west of Point A. It is a highly mobile species and has the capacity to occur within woodlands, forests and timbered watercourses in the local area.

Potential wider distribution of un-recorded threatened species

Table 10.8 provides a brief summary assessment of the threatened species that were not recorded as part of the survey programme. An ‘un-recorded species’ does not necessarily indicate that a species is not present, rather that it was not recorded at the time of the survey. Consequently, Table 10.8 also provides an assessment of areas where these species may potentially occur based on their known distribution, habitat requirements and presence of suitable habitat within the vicinity of the Marine Crossing GTP Project.

Table 10.8 Summary of potential occurrence of threatened species within the GTP ROW

Zoological name	Common name	Presence confirmed	Other areas considered likely within/adjacent to ROW as they support suitable habitat	Potential occurrence of unrecorded species and reasons for discounting presence
Frogs				
Cyclorana verrucosa	Rough frog #			Highly unlikely, outside of known distribution, marginal habitat, very high frequency/intensity of fires major impact
Reptiles				
Delma tourquata	Collared delma* #		Most likely in vicinity of mainland site 5 and Curtis Island site 1	Possible. Known from local area
Paradelma orientalis	Brigalow scaly-foot* #		Most likely in vicinity of mainland site 5 and Curtis Island site 1	Possible. Known from local area, likely throughout GTP ROW
Strophorus taenicauda	Golden-tailed gecko #		Most likely in vicinity of mainland site 5 and Curtis Island site 1	Possible. Very high frequency and intensity of fires a major impact to species survival in the local area
Egernia rugosa	Yakka skink* #			Unlikely. Vegetation clearing and very high frequency and intensity of fires major a impact to species survival in the local area, destruction of suitable communal burrows etc
Furina dunmalli	Dunmallis snake* #		Most likely in vicinity of mainland site and Curtis Island Site 1	Unknown. Very little ecological information for this species. Possible around mainland sites 4 and 5. Fire is a major threat to occurrence
Birds				
Calyptorhynchus lathami	Glossy black cockatoo #		Areas within/adjacent to ROW supporting Casuarina food trees	Possible, nomadic occurrence. Very small patches of suitable food trees. Very high frequency and intensity of fires a major impact
Ephippiorhynchus asiaticus	Black-necked stork #	✓		
Erythrotriorchis radiatus	Red goshawk* #		No suitable habitat supported in the ROW	Highly Unlikely. Unsuitable habitat for species within or adjacent to ROW
Geophaps scripta scripta	Squatter pigeon* #	✓		

Zoological name	Common name	Presence confirmed	Other areas considered likely within/adjacent to ROW as they support suitable habitat	Potential occurrence of unrecorded species and reasons for discounting presence
Ninox strenua	Powerful owl #	✓	Considered highly likely in and around mainland sites 1 – 4 (sites 1 and 2 are within the Marine Crossing GTP Project disturbance footprint)	
Turnix melanogaster	Black-breasted button quail* #		Most suitable habitat in areas around mainland site 5 approximately 7 km to the west of the Marine Crossing GTP Project. Other areas supporting dense lantana that are not burnt frequently	Possible. Very cryptic species. Very high frequency and intensity of fires a major impact
Esacus magnirostris	Beach stone-curlew #	✓		
Bats				
Chalinolobus dwyeri	Large-eared pied bat* #			Highly Unlikely. Unsuitable habitat for species within or adjacent to ROW
Chalinolobus picatus	Little pied bat #			Highly Unlikely. Species readily recorded from Anabat surveys - no records from surveys
Nytophilus corbeni	Greater long-eared bat* #			Highly Unlikely. Unsuitable habitat for species within or adjacent to ROW
Taphozous australis	Coastal sheathtail bat #		Suitable roosting habitat on Mt Larcom, suitable foraging habitat over tree canopy in coastal area	Possible, foraging over areas along coastline
Mammals				
Dasyurus hallucatus	Northern quoll* #		Possible around mainland site 5, suitable habitat (ie SEVT and rocky scree slopes) associated with Mt Larcom nearby. Highly unlikely rest of ROW, including within and adjoining the Marine Crossing GTP Project	Possible to highly unlikely
Ornithorhynchus anatinus	Platypus #	N/A	Refer to surveys undertaken by Ecologica Consulting	Refer to surveys undertaken by Ecologica Consulting

Zoological name	Common name	Presence confirmed	Other areas considered likely within/adjacent to ROW as they support suitable habitat	Potential occurrence of unrecorded species and reasons for discounting presence
Phascolarctos cinereus	Koala*#	✓		Characteristic scratches recorded in ROW. Suitable habitat present
Tachyglossus aculeatus	Echidna#	✓		

Source: FEC (2012b)

Table Notes: **EPBC listed threatened species denoted by ***
State listed threatened species denoted by #

Tree hollows are common along the Marine Crossing GTP Project disturbance footprint. Most hollows were found in Queensland blue gums (*Eucalyptus tereticornis*), with significantly more hollows present on Curtis island when compared to the mainland. Tree hollows provide important habitat for many species of conservation significance, including the Powerful owl (*Ninox strenua*) and the Glossy-black cockatoo (*Calyptorhynchus lathami*).

10.5.5 Marine and intertidal flora and fauna

Mangroves

There will be direct impacts on some mangroves and other marine plants associated with watercourse crossings (refer Figure 10.6) on the mainland and a small area within the Curtis Island construction site pad (refer Section 10.5.3). Mangrove communities in the vicinity of the Marine Crossing GTP Project are discussed below.

Mangrove communities are considered ecologically important for a number of reasons, including:

- Provide essential nursery, feeding and breeding areas for many species of fish, invertebrates and migratory birds
- Facilitate biologically productive natural systems by contributing organic matter to estuaries
- Act as a filter of sediments and other substances that may accumulate from land runoff
- Provide key areas for educating the community and the general public on the nature and significance of coastal wetlands (http://www.epa.qld.gov.au)
- The root systems of mangrove communities assists in oxygenating substrates

These communities are also important in buffering natural and/or anthropogenic processes, including overland runoff, flooding, stabilising substrate, noise and visual aesthetics. The buffering capacity of the mangrove protects the near shore environment from such influences as flooding, sedimentation, eutrophication and pollutants (Danaher *et al.*, 2005).

Within Queensland 37 species of mangrove occur, with species richness inversely related to latitude south (ie 36 species are described from Cape York, while nine species are described from South East Queensland [Duke, 1992]).

Saenger (1996) conducted one of the longest continuous mangrove studies in Australia, observing mangrove demographics in Port Curtis from 1974 to 1983. Fourteen mangrove species are known from Port Curtis (Saenger, 1996) with the following 11 mangrove species recorded from mangrove communities (URS, 2009a, Ecologica, 2012, Downes 2012b) within and adjacent to the Marine Crossing GTP Project:

- *Aegialitis annulata* – Club mangrove
- *Aegiceras corniculatum* – River mangrove
- *Avicennia marina* – Grey mangrove
- *Bruguiera gymnorrhiza* – Large-leafed orange mangrove
- *Ceriops tagal* – Yellow mangrove
- *Excoecaria agallocha* – Milky mangrove
- *Lumnitzera racemosa* – White flowered black mangrove
- *Osbornia octodonta* – Myrtle mangrove
- *Rhizophora stylosa* – Red mangrove
- *Xylocarpus granatum* – Cannonball mangrove
- *Xylocarpus moluccensis* – Cedar mangrove

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP

Kilometre Post Distance Marker
- 5km
- 1km
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road
- Watercourse Crossing Ancillary Areas

Watercourse Crossings
- Drainage Feature
- Drainage Feature –Curtis Island
- Humpy Creek (northern minor tributary of creek)
- Humpy Creek (southern creek line)
- Mudflat / Saltpan Area
- Oxbow adjacent Targinnie Creek
- Targinnie Creek
- Watercourse

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Referable Wetlands: Department of Environment and Resource Management, 2010.
Watercourses: Department of Environment and Resource Management, 2011.
Aerial: Santos, Feb 2011.
Watercourse Crossings: Downes, 2012.
Extra Works Areas: GLNG, Jul 2012.

Watercourse Crossings
Figure 10.6

A1 scale: 1:15,000
0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0563
Coordinate system: GCS_GDA_1994

Date: 11/07/2012
Version: f

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_067.mxd 11/07/2012 09:31

Mangrove communities within Port Curtis encompass an area of approximately 6,300 ha (Danaher *et al.*, 2005). The dominant species are the Red mangrove, Grey mangrove, Yellow mangrove and River mangrove. The dominant mangrove community is closed *Rhizophora* forest, which encompasses an area of approximately 4,396 ha (Danaher *et al.*, 2005). On a local scale, species distribution and zonation is influenced by wave energy, salinity, nutrients and/or soil oxygen levels.

A long-term monitoring programme undertaken by Central Queensland University found the communities lining Port Curtis to be relatively healthy (Hendry *et al.*, 2005). However, there are localised impacts, including dieback as a result of natural and anthropogenic activities within the area.

Seagrass communities

Seagrass within Port Curtis and the GBR Coast MP function as important feeding locations, nurseries and habitats for a diverse range of fauna such as dugongs, turtles and juvenile tiger prawns (Rasheed *et al.*, 2003). Seagrass meadows support an array of epiphytic seaweeds and filter-feeding animals such as bryozoans, sponges, and hydroids. This assemblage of species is an important resource for a number of species, including fish, mammals and shorebirds (Danaher *et al*., 2005, Rasheed *et al.*, 2003, Guest and Connolly, 2004).

The Port Curtis and Rodds Bay seagrass communities are of regional significance as the nearest meadows are located at Hervey Bay to the south and Shoalwater Bay to the north (Rasheed *et al.*, 2003 and Thomas *et al*., 2010).

In collaboration with GPC, the former DPI&F (now DAFF) initiated an annual long term seagrass monitoring program in Port Curtis and Rodds Bay. An initial baseline study undertaken in 2002 (Rasheed *et al.*, 2003) identified 135 discrete coastal and deepwater seagrass meadows. Thirteen of these meadows are monitored during October and November annually by DAFF, however due to the dredging and reclamation associated with the Western Basin Project this monitoring has been increased to twice yearly for seagrass meadows within the region. In addition, DAFF is also scheduled to undertake quarterly assessments of permanent transect sites at selected key seagrass locations within the Port. Six species of seagrass have been identified within the Port Curtis locality (Rasheed *et al*., 2003):

- *Halodule uninervis* (wide and narrow leaf morphology)
- *Halophila decipiens*
- *Halophila minor*
- *Halophila ovalis*
- *Halophila spinulosa*
- *Zostera capricorni*

Results from surveys undertaken between 2002 and 2009 indicate a reduction in coverage by approximately 9% (1,500 ha). This reduction was recorded primarily in association with deepwater meadows (Thomas *et al.*, 2010).

Recent seagrass monitoring shows a significant difference in coverage and density between the monitoring undertaken in November 2009 and June 2010. Seagrass meadows reduce to approximately half their coverage and density during June when compared to areas of coverage recorded during November (Thomas *et al.*, 2010).

In addition, seagrass biomass was significantly higher in the wet season (December to March) than in the dry season (June to September) for the majority of meadows. *Zostera capricorni* meadows dominated the intertidal areas in both seasonal surveys (56% and 72% of meadows, respectively), while communities dominated by *Halophila decipiens* and *Halophila ovalis* dominated the subtidal areas (Thomas *et al.*, 2010).

Marine turtles

Four species of turtle; green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), flatback turtle (*Natator depressus*) and the loggerhead turtle (*Caretta caretta*) are known to occur along the Curtis Coast, and their range is expected to include Port Curtis (Queensland Government, 1994 and WBM, 1990). These species are listed as either 'Endangered' or 'Vulnerable' under the provisions of both the EPBC Act and the *Nature Conservation (Wildlife) Regulation 2006*. Flatback turtles are known to breed on the seaward beaches of Curtis Island.

Dugongs

The dugong, which is listed as 'vulnerable' under the *Nature Conservation (Wildlife) Regulation 2006*, is recorded as occurring within the Port Curtis area. Dugongs prefer shallow and sheltered areas where their primary food source, seagrass, occurs. The Marine Crossing GTP Project occurs north of the Rodds Bay Dugong Sanctuary, which is a Zone B (restricted use) Dugong Protection Area (DPA) declared under the *Fisheries Act 1994*. The Gladstone coastline and the Rodds Bay DPA are recognised as important habitats for dugong populations despite being within and closely associated with commercial port activities. Dugongs are also protected under marine status under the EPBC Act.

Cetaceans

The EPBC protected matters search tool identified 11 cetacean species that may occur in the Port Curtis region, including offshore areas. Of these, the Indo-Pacific humpback dolphin (*Sousa chinensis*), the Australian snubfin dolphin (*Orcaella heinsohni*) and two species of Bottlenose dolphin (*Tursiops aduncus* and *Tursiops truncatus*) are believed to occur in waters adjacent to the proposed Marine Crossing GTP.

Coastal dolphins are recognised among the most threatened species of cetaceans due to their close proximity to a range of direct and indirect human impacts (Thompson *et al.*, 2000). The Indo-pacific humpback dolphin and Australian snubfin dolphin are listed on the IUCN 2006 Red List of Threatened Species and listed as Migratory under the EPBC Act. The Australian snubfin dolphin is also listed as near threatened under the provisions of the NC Act.

Both the Australian snubfin dolphin and the Indo-Pacific humpback dolphin usually inhabit shallow coastal waters of less than 20 m in depth and are often associated with rivers estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al.*, 1997; Hale *et al.*, 1998; Parra, 2006). Research of habitat preferences of the two species by Parra (2006) indicated that the Australian snubfin dolphins preferred slightly shallower (1 to 2 m) waters than Indo-Pacific humpback dolphins (2 to 5 m). Shallow areas with seagrass ranked high in the habitat preferences of Australian snubfin dolphins, whereas Indo-Pacific humpback dolphins favoured slightly deeper waters.

During the EIS a pod of Indo-Pacific humpback dolphins were observed from Hamilton Point (URS, 2009a). Conditions of Approval for the Western Basin Project include a requirement to collect baseline information on the marine megafauna species between Port Curtis, Port Alma and Rodd's Peninsula; the Curtis Coast Region. During the summer and winter survey period in February/March and April 2011, marine megafauna boat-based sightings for the project duration (n= 201) comprised of 124 dolphins (Indo-Pacific humpback, Australian snubfin and inshore bottlenose dolphins), three dugong, 68 turtles (green, hawksbill, and loggerhead turtles) and six seasnakes. Aerial observations from combined surveys (both tides and seasons; n= 180) comprised of 57 dolphins, 11 dugong, 79 turtles, two seasnakes, four sharks and 27 rays (GHD, 2011).

Other species of cetaceans previously observed in Port Curtis include the Southern right whale (*Eubalaena australis*), Humpback whale (*Megaptera novaeangliae*) and False killer whale (*Pseudorca crassidens*). However, records are infrequent and it is unlikely that these species occur within adjoining marine waters of Port Curtis. Other oceanic whale species identified from database searches, such as Minke whale (*Balaenoptera acutorostrata*) and Bryde's whale (*Balaenoptera edeni*), are also unlikely to frequent adjoining marine waters of Port Curtis.

10.5.6 Shorebirds and marine migratory birds

As part of the preclearing baseline surveys FEC (2012c) carried out a desktop assessment and surveys for shorebirds and migratory birds within and adjacent to the Marine Crossing GTP Project.

Within Section 10.5.6, the term project area refers generally to the lands and associated habitats supporting shorebird habitats surrounding the study area, locally around Kangaroo Island, the mainland and southern Curtis Island.

The study area refers to the marine intertidal areas of Kangaroo Island and Laird Point on Curtis Island.

The conservation status of a species may be described as 'endangered', 'vulnerable', 'near threatened', 'special least concern' and 'least concern'. These terms are used in accordance with the provisions of the NC Act and its regulations and amendments, and/or the EPBC Act.

Threatened is a common term used to describe both 'endangered' and 'vulnerable' species.

With regard to migratory birds, the terms BONN, CAMBA, JAMBA and RoKAMBA refer to the following:

- BONN: Convention on the Conservation of Migratory Species of Wild Animals (1985)
- CAMBA: the Agreement between the Government of Australia and the Government of China for the protection of migratory birds in danger of extinction and their environment 1986
- JAMBA: the Agreement between the Government of Australia and the Government of Japan for the protection of migratory birds in danger of extinction and their environment 1974
- RoKAMBA: Agreement between the government of Australia and the government of the Republic of Korea on the protection of migratory birds and exchange of notes 2006

The nomenclature used in this section follows Christidis and Boles (1994, 2008).

The generic terms used in this section to describe the two broad categories of migratory birds are:

- Shorebirds or waders – relate specifically to those birds that are generally dependant on intertidal mud flats and high tide roost areas, for example birds from the following families:
  - Scolopacidae - snipes, sandpipers, godwits, curlews and their allies
  - Burhinidae - stone-curlews
  - Recurvirostridae - stilts and avocet
  - Charadriidae - plovers, dotterels and lapwings
  - Glareolidae – pratincoles
  - Haematopodidae - oystercatchers
  - Rostratulidae – painted snipe
  - Vanellinae – dotterel's and lapwings
- Marine migratory birds – include other marine migratory species that are not specifically identified as shorebirds/waders, for example birds from the following families:
  - Accipitridae – eagles and hawks
  - Ardeidae – egrets and herons
  - Laridae – terns and gulls

The survey area sites are shown on Figure 10.7, while the survey timing, coverage, data collection, and methodology are included in FEC (2012c).

Desktop review

Shorebirds

Desktop review of the literature available for the shorebird assessment has identified the likely and/or known occurrence of 40 shorebird species within the habitats supported in the project area. These species, their conservation status and the source of the data are presented in Table 10.9.

Table 10.9 contains brief ecological profiles for each species identified and an assessment of the likelihood of occurrence of each species within the study area. Of the 40 species identified, 17 are known to occur within habitats supported in the study area. A further 14 species are considered likely to occur in the study area, of which seven are considered highly likely and seven species likely. The remaining nine species are considered unlikely to occur due to the lack of suitable habitat preferred by these species.

The scoring of probability of a species occurrence within the study area is based on the:

- Information of species records within the project area
- Preferred habitat requirements known for each species
- The availability, extent and predicted value of those preferred habitats within the study area

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Washdown Facility (Indicative)
- Access Road
- Watercourse Crossing Ancillary Areas

Roost Sites
- Claypan Roost
- Friend Point Roost
- Kangaroo Island North Roost
- Laird Point Roost
- Low Tide Count Location
- Narrows Roost
- Major Shorebird Roost Site
- Shorebird Area (Shorebirds 2020)

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Indicative Project Footprint: Aurecon, GLNG Apr 2012.
High Tide Roosts: Santos GLNG Review of Shorebird Impacts within the Kangaroo Island Wetlands and the Narrows Crossing Area, Footprints Environmental Consultants, Oct 2010.
Aerial: Santos, Feb 2011.
Shorebird Sites, Shorebirds 2020, http://www.shorebirds.org.au/March 2011.
Major Shorebird Roost Site:
Shorebirds and Turtles, Shorebirds and Turtles, Curtis Coast Regional Coastal Management Plan, Department of Environment and Resource Management, 2003
Extra Works Areas: GLNG, Jul 2012.

Location of High Tide Roosts and Low Tide Foraging Areas Figure 10.7

A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0454

Coordinate system: GCS_GDA_1994

Date: 11/07/2012

Version: q

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_037.mxd 11/07/2012 09:32

Table 10.9 Database records for shorebird species and conservation status for the project area

Family	Zoological name	Common name	Conservation status				Database searches		Sandpiper 2010			QWSG (Sandpiper 2010)				
			NC Act	EPBC Act	BONN	C/J/R	EPBC Act	Wildlife Online	Driscoll (1997)[1]	Shorebirds 2020[1]	Friend to Laird Pt (Feb 09)[3]	Friend Point area	Graham's Creek roost	Narrows #3 Kangaroo Island	Passage Island area	Wiggins Island area
Rostratulidae	*Rostratula australis*	Australian painted snipe	V	V, m		C	✓		1							
Burhinidae	*Burhinus grallarius*	Bush stone-curlew						✓	4							
	Esacus magnirostris	Beach stone-curlew	V					✓	22		7					
Haematopodidae	*Haematopus fuliginosus*	Sooty oystercatcher	NT					✓	23	76						
	Haematopus longirostris	Australian pied oystercatcher						✓	245	165	6	3	2	2	4	
Recurvirostridae	*Cladorhynchus leucocephalus*	Banded stilt	Vagrant						2							
	Himantopus himantopus	Black-winged stilt		m			✓	✓	108	147						
	Recurvirostra novaehollandiae	Red-necked avocet		m			✓	✓	2	4						
Charadriidae	*Charadrius bicinctus*	Double-banded plover		m	a2h		✓		1							
	Charadrius hiaticula	Ringed plover		m		CJR			1							
	Charadrius leschenaultia	Greater sand plover		m	a2h	CJR	✓		304	130						
	Charadrius mongolus	Lesser sand plover		m	a2h	CJR	✓		434	450	25	50	25			
	Charadrius ruficapillus	Red-capped plover		m			✓	✓	210	107	42	33		19		
	Elseyornis melanops	Black-fronted dotterel						✓	40							
	Pluvialis fulva	Pacific golden plover		m	a2h	CJR	✓	✓	10	31	20				1	
	Pluvialis squatarola	Grey plover		m	a2h	CJR	✓	✓	36	5						
Vanellinae	*Erythrogonys cinctus*	Red-kneed dotterel							6							
Scolopacidae	*Actitis hypoleucos*	Common sandpiper		m	a2h	J	✓	✓		7						
	Arenaria interpres	Ruddy turnstone		m	a2h	CJR	✓		8	37						
	Calidris acuminate	Sharp-tailed sandpiper		m	a2h	CJR	✓	✓	111	90	5					
	Calidris alba	Sanderling		m	a2h	CJ		✓								
	Calidris canutus	Red knot		m	a2h	CJR	✓	✓		65						
	Calidris ferruginea	Curlew sandpiper		m	a2h	CJR	✓	✓	446	293						
	Calidris ruficollis	Red-necked stint		m	a2h	CJR	✓	✓	1195	1581	304	222				
	Calidris tenuirostris	Great knot		m	a2h	CJR	✓		260	265	18	51				
	Gallinago hardwickii	Latham's snipe		m	a2h	CJR	✓									
	Gallinago megala	Swinhoe's snipe		m	a2h	CJR	✓									
	Gallinago stenura	Pin-tailed godwit		m	a2h	CJR	✓									
	Limicola falcinellus	Broad-billed sandpiper		m	a2h	CJR										
	Limosa lapponica	Bar-tailed godwit		m	a2h	CJR	✓	✓	2726	1509	74	155			65	45
	Limosa limosa	Black-tailed godwit		m	a2h	CJR			41	4						
	Numenius madagascariensis	Far eastern curlew	NT	m	a2h	CJR	✓	✓	1532	515	62	37		9	1	50
	Numenius minutus	Little curlew		m	a2h	CJR	✓									
	Numenius phaeopus	Whimbrel		m	a2h	CJR	✓	✓	610	450	299	22		15		
	Tringa brevipes	Grey-tailed tattler		m	a2h	CJR	✓	✓	880	496	19	4			4	
	Tringa glareola	Wood sandpiper		m	a2h	CJR			4							

Family	Zoological name	Common name	Conservation status				Database searches		Sandpiper 2010			QWSG (Sandpiper 2010)				
			NC Act	EPBC Act	BONN	C/J/R	EPBC Act	Wildlife Online	Driscoll (1997)[1]	Shorebirds 2020[1]	Friend to Laird Pt (Feb 09)[3]	Friend Point area	Graham's Creek roost	Narrows #3 Kangaroo Island	Passage Island area	Wiggins Island area
	Tringa nebularia	Common greenshank		m	a2h	CJR		✓	370	198	1	1				
	Tringa stagnatilis	Marsh sandpiper		m	a2h	CJR	✓	✓	59	63		2				
	Xenus cinereus	Terek sandpiper		m	a2h	CJR	✓	✓	383	184	105	10				
Total number of individuals									**10074**	**6872**	**987**	**590**	**57**	**45**	**105**	**95**
Total number of species							**26**	**23**	**31**	**24**	**14**	**12**	**3**	**4**	**6**	**2**

Table notes: 1 = Maximum counts for the Curtis Coast Region (Rockhampton to Seventeen Seventy)
2 = Qld Wader Study Group (QWSG) maximum counts for Port Curtis (2009)
3 = Maximum counts at Friend Point, Friend Point claypan, Laird Point, Passage Islands and Grahams Creek
NC Act = Nature Conservation Act 1999
EPBC Act = Environment Protection and Biodiversity Conservation Act 1999
C/J/R = Bilateral agreements between Australia and China/Japan/Republic of Korea, where C = Camba; J = Jamba; R = RoKAMBA
V = Vulnerable
NT = Near Threatened
blank = common wildlife listed as least concern
m = listed under marine and/or migratory provisions of EPBC Act
a2h = Species listed under Appendix 2 of BONN convention, Migratory Species

Source: Sandpiper *et al.* 2010

Table 10.10 Shorebird species for the project area, ecological profiles and probability of occurrence within the study area

Zoological name	Common name	Species profile	Probability of occurrence
*Rostratula australis**	Australian painted snipe*	Occurs either singularly or in groups with movements unpredictable in response to local rain events (Geering *et al,.* 2007, Marchant and Higgins, 1993). Occurs primarily in freshwater marshes (Marchant and Higgins, 1993, Geering *et al.* 2007). Roosts in dense swamp vegetation during day, forages at dawn, dusk and night (Marchant and Higgins, 1993). Breeds in Australia in swamps with temporary water regimes with combination of shallow water, exposed wet mud and dense low fringing vegetation (Marchant and Higgins, 1993, Geering *et al.* 2007)	Highly unlikely
Burhinus grallarius	Bush stone-curlew	Occurs in a wide range of open woodland habitats, rarely within intertidal/marine habitats (Marchant and Higgins, 1993). A nocturnal species that shelters during the day in grass or under shady tree (Geering *et al.* 2007)	Highly likely
Esacus magnirostris	Beach stone-curlew	Exclusively a coastal species found in marine littoral habitats on all types of beaches - sandy, rocky, muddy, small large etc. (Marchant and Higgins, 1993). Primarily resident, though young are dispersive (Marchant and Higgins, 1993). Birds breed at the back of sandy beaches, banks, coral ridges or on open coast (Marchant and Higgins, 1993). Foraging occurs on intertidal mudflats, sandflats, sand banks and sand spits, open beaches and river mouths (Marchant and Higgins, 1993). Roosts within mangroves or beneath trees behind beach foredunes (Geering *et al.,* 2007)	Known
Haematopus fuliginosus	Sooty oystercatcher	This species is strictly coastal marine, usually within 50 m of the shoreline, with a preference for rocky intertidal shorelines (Marchant and Higgins, 1993). Breeding occurs mainly on offshore islands and rock stacks, occasionally on remote headlands, promontories and rocky outcrops (Marchant and Higgins, 1993). Roosting occurs on offshore islands, isolated rock platforms, beaches, banks and spits (Marchant and Higgins, 1993)	Unlikely
Haematopus longirostris	Australian pied oystercatcher	A sedentary coastal species which prefers intertidal mudflats and sand banks in large marine embayments and along open ocean sandy beaches (Marchant and Higgins, 1993). Forages on exposed intertidal flats, rocks and rubble (Marchant and Higgins, 1993). Roosts primarily on sandy beaches, spits, dunes and small islets within bays, lagoons and inlets (Marchant and Higgins, 1993)	Known
Cladorhynchus leucocephalus	Banded stilt	Inhabits predominantly saline and hypersaline waters both coastal and inland (Marchant and Higgins, 1993). Foraging occurs in shallow or deep waters and they roost/loaf on banks, bars, shores, islands, spits etc. (Marchant and Higgins, 1993). The species is a rare visitor to Qld, breeding primarily in WA and SA (Marchant and Higgins, 1993)	Unlikely
*Himantopus himantopus**	Black-winged stilt*	A wide ranging species in Australia that prefers shallow, open freshwater wetlands, but also common in saline environments including saltmarsh and tidal lagoons (Marchant and Higgins, 1993). Foraging occurs in shallow water margins of wetlands or in saturated mud, occasionally along margins of tidal estuaries (Marchant and Higgins, 1993). Roosts on shallow water, banks, spits and sand flats in estuaries (Marchant and Higgins, 1993)	Likely

Zoological name	Common name	Species profile	Probability of occurrence
*Recurvirostra novaehollandiae**	Red-necked avocet*	Australian endemic species with a sparse distribution in Qld (Marchant and Higgins, 1993). Preferred habitat shallow ephemeral saline wetlands, but ranges from fresh to hypersaline wetlands (Marchant and Higgins, 1993). Usually breed at inland salt lakes on low islands/banks and forage in shallow water margins on soft mud (Marchant and Higgins, 1993)	Likely
*Charadrius bicinctus**	Double-banded plover*	Distribution in Qld primarily restricted to the south east. South of Rockhampton, birds are found within estuarine and fresh or saline terrestrial wetlands within the littoral zone including saltmarsh areas (Marchant and Higgins, 1993). Birds roost in bare open earth areas, either adjacent to or hundreds of metres away from foraging areas which include open shallow waters, muddy flats, rocky/gravelly areas etc. (Marchant and Higgins, 1993)	Highly likely
Charadrius hiaticula	Ringed plover	Breeding occurs in Canada, Greenland, Iceland and northern Europe. An accidental visitor to Australia (Marchant and Higgins, 1993). In Australasia, has been recorded from moist tidal mud/sandflats, sheltered bays, and estuaries in littoral zone (Marchant and Higgins, 1993)	Unlikely
*Charadrius leschenaultia**	Greater sand plover, large sand plover*	Non-breeding summer migrant. Mainly sandy or muddy beaches with large intertidal sandbanks or mudflats (Marchant and Higgins, 1993). Typically roost on sand spits and banks, often on rocky points (Marchant and Higgins, 1993)	Highly likely
*Charadrius mongolus**	Lesser sand plover, Mongolian plover*	Non-breeding summer migrant. Mainly sandy or muddy beaches with large intertidal sandbanks or mudflats (Marchant and Higgins, 1993). Typically roost near feeding grounds on sand spits and banks, occasionally on rocky points and reefs (Marchant and Higgins, 1993)	Known
*Charadrius ruficapillus**	Red-capped plover*	Widespread, predominantly inland species in Australia which inhabits littoral, estuarine and terrestrial wetlands, with a preference for saline and brackish waters (Marchant and Higgins, 1993). Foraging occurs on sand/mudflats, along marine/estuarine shorelines and amongst gravel and shell grit (Marchant and Higgins, 1993)	Known
Elseyornis melanops	Black-fronted dotterel	Widespread throughout Australasia and the most widespread wader in Australia occurring in terrestrial freshwater wetlands, sometimes brackish and less often in saline wetlands (Marchant and Higgins, 1993). Forage primarily along water margin in soft fine mud and roost alongside foraging areas (Marchant and Higgins, 1993)	Likely
*Pluvialis fulva**	Pacific golden plover*	Non-breeding summer migrant. Mainly sandy or muddy beaches with large intertidal sandbanks or mudflats, though also salt marsh, mangroves and estuarine mudflats (Lane 1987; Marchant and Higgins, 1993)	Known
*Pluvialis squatarola**	Grey plover*	Non-breeding summer migrant. Mainly marine shores, sandy or muddy beaches with large intertidal sandbanks or mudflats, though also salt marsh, mangroves and estuarine mudflats (Lane 1987; Marchant and Higgins, 1993)	Likely

Zoological name	Common name	Species profile	Probability of occurrence
Erythrogonys cinctus	Red-kneed dotterel	Widespread throughout Australia occurring in terrestrial freshwater wetlands, rarely brackish and less often in saline wetlands (Marchant and Higgins, 1993). Forage primarily along waters margin in soft fine mud and roost alongside foraging areas (Marchant and Higgins, 1993)	Unlikely
*Vanellus miles**	Masked lapwing*	Non-breeding summer migrant. Forages for aquatic invertebrates in shallow waters of fresh and brackish wetlands (Lane, 1987). Often highly dispersive, with movements associated with seasonal changes in rainfall and availability of wetlands (Higgins and Davies, 1996)	Known
*Actitis hypoleucos**	Common sandpiper*	Non-breeding summer migrant. Wide range of coastal and inland habitats of varying salinities (Higgins and Davies, 1996). Preferred coastal habitats include muddy intertidal zones of mangrove-lined estuaries, tidal rivers and creeks (Lane, 1987). Also muddy margins or rocky shores of wetlands, though large coastal mudflats apparently not favoured (Higgins and Davies, 1996). High tide roosts include rocks or roots/branches of mangroves (Lane, 1987)	Highly likely
*Arenaria interpres**	Ruddy turnstone*	Non-breeding summer migrant predominately found in coastal areas on exposed rock/coral reefs, platforms, shelves, often with shallow tidal pools, also on sand and coral beaches and estuaries, harbours, bays and coastal lagoons (Higgins and Davies, 1996). Roosts and loafs on beaches, among rocks, shells, rocky islets, mudflats and sandflats above tide line (Higgins and Davies, 1996)	Highly likely
*Calidris acuminate**	Sharp-tailed sandpiper*	Non-breeding summer migrant. Coastal and inland habitats, feeding for invertebrates in mud or shallow water along edges of shallow wetlands, lagoons, dams and sewage farms (Higgins and Davies, 1996)	Known
*Calidris alba**	Sanderling*	Non-breeding summer migrant to Australia, restricted to coastal areas, predominantly open sandy beaches exposed to open sea swell, exposed sandbars and spits etc. (Higgins and Davies, 1996). Birds roost on bare sand, behind beachcast kelp etc. and behind coastal dunes, in south east Qld, they have been recorded on tidal flats during storms (Higgins and Davies, 1996). Foraging occurs along sandy beaches, exposed sand bars at the water edge in wave washed zone (Higgins and Davies, 1996)	Likely
*Calidris canutus**	Red knot*	Non-breeding migrant to Australia, restricted mainly to coastal regions, within sheltered coastal habitats supporting large intertidal mud/sand flats including bays, inlets, estuaries, harbours lagoons and also ocean beaches (Higgins and Davies, 1996). Foraging occurs within the intertidal flats in shallow water, soft mud/sand, at the water edge, often as tide recedes, with roosting occurring in sheltered areas near foraging areas (Higgins and Davies, 1996)	Likely
*Calidris ferruginea**	Curlew sandpiper*	Non-breeding summer migrant. Occurs on both coastal and inland wetland habitats, though not as widespread as red-necked stint and sharp-tailed sandpiper (Higgins and Davies, 1996). Prefers bare, wet, muddy surfaces and adjoining shallow water margins of fresh, saline, or brackish open water bodies and wetlands (Lane, 1987; Higgins and Davies, 1996)	Likely

Zoological name	Common name	Species profile	Probability of occurrence
*Calidris ruficollis**	Red-necked stint*	Non-breeding summer migrant. Occurs in a wide variety of coastal and inland wetland habitats from salt lakes, freshwater swamps, intertidal mudflats and sandy ocean beaches (Lane, 1987; Higgins and Davies, 1996). More abundant coastally where it mainly feeds wet or drying mud near waterline on intertidal mudflats and roosts on sandy beaches (e.g. spits) (Lane, 1987)	Known
*Calidris tenuirostris**	Great knot*	Non-breeding migrant to Australia, restricted mainly to coastal regions, within sheltered coastal habitats supporting large intertidal mud/sand flats including bays, inlets, estuaries, harbours, lagoons and also ocean beaches (Higgins and Davies, 1996). Foraging occurs within the intertidal flats in shallow water, soft mud/sand, at the water edge, often as tide recedes, with roosting occurring in sheltered areas near foraging areas (Higgins and Davies, 1996)	Known
*Gallinago hardwickii**	Latham's snipe, Japanese snipe*	Non-breeding summer migrant in a variety of freshwater and brackish wetlands. Feeds on soft wet ground or in shallow water for invertebrates, seeds and vegetation (Higgins and Davies, 1996; Todd, 2000). Usually found close to dense ground cover (Garnett and Crowley, 2000)	Highly unlikely
Gallinago megala	Swinhoe's snipe	Non-breeding rare vagrant migrant to Australia, within primarily freshwater wetlands (Higgins and Davies, 1996)	Highly unlikely
Gallinago stenura	Pin-tailed snipe	Non-breeding rare vagrant migrant to Australia, within primarily freshwater wetlands (Higgins and Davies, 1996)	Highly unlikely
*Limicola falcinellus**	Broad-billed sandpiper*	Non-breeding summer migrant in sheltered parts of the coast, favouring estuarine mudflats, occasionally on saltmarshes, shallow freshwater lagoons, large soft intertidal mudflats, +/- shell or sandbanks nearby. They favour mud among, or fringed by, mangroves, particularly on the seaward side and sometimes occur in estuaries edged by saltmarsh. Foraging occurs on exposed flats of soft mud or wet sand at edges of coastal and near-coastal wetlands. They forage in soft mud near mangroves and in shallow water on muddy edges of ponds. Roosting occurs on banks of sheltered sandy, shelly or shingly beaches (Higgins and Davies, 1996)	Known
*Limosa lapponica**	Bar-tailed godwit*	Non-breeding summer migrant. Exclusively coastal, inhabiting broad intertidal mud or sand flats (often with seagrass meadows) and feeding on soft wet mud and/or shallow waters (Higgins and Davies, 1996). High tide roosts on sandy beaches, spits, muddy bars and islets in sheltered environments (Lane, 1987; Higgins and Davies, 1996)	Known
*Limosa limosa**	Black-tailed godwit*	Non-breeding summer migrant. Mainly coastal, occurring on sheltered bays and estuaries and feeds in soft mud or shallow water on wide intertidal mudflats or sand flats (Higgins and Davies 1996). Also uses near coastal tidal and non-tidal wetlands (eg salt marsh and salt flats) that are shallow and sparely vegetated (Higgins and Davies, 1996)	Highly likely
*Numenius madagascariensis**	Far eastern curlew*	Non-breeding summer migrant. Intertidal mud or sand flats of sheltered coasts, estuaries and harbours (Higgins and Davies, 1996). High tide roosts on sandy spits and beaches, though also amongst coastal vegetation such as salt marsh and mangroves (Lane, 1987)	Known

Zoological name	Common name	Species profile	Probability of occurrence
*Numenius minutus**	Little curlew, little whimbrel*	Non-breeding summer migrant, occurring in fresh and saline wetland habitats, feeding mostly in dry grasslands and sedgelands but have been recorded from flooded claypans and flood plains inundated from spring/king tides (Higgins and Davies, 1996)	Highly likely
*Numenius phaeopus**	Whimbrel*	Non-breeding summer migrant. Prefers mudflats within mangrove habitats, though also forage at low tide on open tidal mudflats, on sandy beaches, and along banks of tidal rivers and creeks (Lane, 1987; Higgins and Davies, 1996). Roost in mangrove trees, though also on muddy, sandy or rocky beaches (Higgins and Davies, 1996)	Known
*Tringa brevipes**	Grey-tailed tattler*	Non-breeding summer migrant. Exclusively coastal, occurring mainly in areas which support extensive mangal communities and intertidal mudflats (Higgins and Davies, 1996). May prefer intertidal mudflats which support seagrass meadows (Thompson, 1992). Roosts on rocks and beaches, though prefers mangroves when present (Lane, 1987)	Known
*Tringa glareola**	Wood sandpiper*	Non-breeding summer migrant to Australia with largest numbers recorded in the north west, sparsely scattered records through Qld. primarily within well vegetated shallow freshwater wetlands, more rarely in brackish wetlands, dry saltmarsh, but not on coastal flats (Lane, 1987, Higgins and Davies, 1996). Forages amongst dry/wet mud, vegetation within habitats and roosts on grassy hillocks and also in low trees (Higgins and Davies, 1996)	Highly unlikely
*Tringa nebularia**	Common greenshank*	Non-breeding summer migrant. Forages for aquatic invertebrates in shallow waters of fresh and brackish wetlands (Lane, 1987)	Known
*Tringa stagnatilis**	Marsh sandpiper*	Non-breeding summer migrant occurring in coastal and inland permanent and ephemeral wetlands of varying salinity including swamps, estuaries, saltpans, saltmarshes, inundated floodplains and intertidal mudflats (Higgins and Davies, 1996). Foraging occurs within shallow water at edge of wetland and roosts on tidal mudflats, mew low saltmarsh and inland swamps (Higgins and Davies, 1996)	Known
*Xenus cinereus**	Terek sandpiper*	Non-breeding summer migrant. Exclusively coastal, feeding on soft muddy substrates, especially near mangroves within sheltered estuaries, harbours and coastal lagoons (Higgins and Davies, 1996). High tide roosts on beaches, though often prefers mangroves when present (Lane, 1987)	Known

Source: FEC (2012c)
Table Note: * Denotes EPBC listing

Marine migratory birds

The database review has highlighted the potential presence of an additional ten marine migratory bird species. These are listed in Table 10.11 below, with their conservation status and an assessment of the likelihood of occurrence within the study area.

Table 10.11 Database records for additional marine migratory bird and conservation status for the project area

Zoological name	Common name	Status			Likelihood of occurrence
		1	2	3	
Ardea alba	Great egret		m	CJ	Possible, suitable habitat supported in area
Ardea ibis	Cattle egret		m	CJ	Highly unlikely, unsuitable habitat
Charadrius bicinctus	Double-banded plover		m		Possible
Charadrius ruficapillus	Red-capped plover		m		Highly likely
Egretta sacra	Eastern reef egret		m	C	Highly likely
Haliaeetus leucogaster	White-bellied sea-eagle		m	C	Highly likely
Himantopus himantopus	Black-winged stilt		m		Possible, marginal habitat
Pandion cristatus	Eastern osprey		m		Highly likely
Rostratula australis	Australian painted snipe	V	V	C	Unlikely, unsuitable habitat
Sternula albifrons	Little tern	E	E	CJR	Highly likely

Source: FEC (2012c)

Table Note:
1 – NC Act
2 – EPBC Act
3 – CAMBA/JAMBA/ROCKAMBA listing
m – Marine and or Migratory pursuant to EPBC Act
V – Vulnerable
E – Endangered
C – CAMBA
J – JAMBA
R – ROKAMBA

Curtis Coast Regional Coastal Management Plan

The Curtis Coast Regional Coastal Management Plan (EPA, 2003) (CCRCMP) identifies natural resource areas of State and regional significance in the Gladstone/Port Curtis region. The study area is located within these important natural resource areas and has been identified as a significant coastal wetland at both State and regional scales (CCRCMP Section 2.8, Maps 11 and 14, EPA, 2003).

Furthermore, two major shorebird roost sites were identified on Kangaroo Island, one at the northern section of the island, the other at Friend Point. A major shorebird foraging area was also identified along the south-east facing shoreline of Kangaroo Island (see Figure 10.7).

Survey counts

A total of 30 survey events (15 high tide and 15 low tide) were completed for the baseline bird surveys. The surveys provided records for a combined total of 4,440 birds from 23 species. Of these records, shorebirds accounted for 3,278 birds from 15 species, with marine migratory birds accounting for 712 records from eight species. Full details of the recorded assemblage are presented in FEC (2012c).

A total of 3,728 shorebirds from 15 species were recorded as part of the survey events. Winter surveys provided records for 198 birds from six species, whilst the summer surveys identified 3,530 birds from 15 species. Full details of the total number of species and birds recorded are presented in FEC (2012c).

The surveys highlighted the importance of the habitats to support large numbers of birds during the summer months, averaging 197 birds per monthly event. Of particular importance is the significant rise to 406 birds, more than double the previous monthly average, during the March surveys. This increase in numbers is most likely due to the arrival of shorebird species from southern Australia that had begun their annual migration to Asia. This result is significant in that it highlights the importance of the Kangaroo Island wetland complex not only for those birds that are summer residents in the area, as identified through the December – February counts, but that the complex provides an important staging platform for birds in the east Australian flyway as they migrate north and south through the Port Curtis area.

Eight species of marine migratory birds were recorded as part of the survey programme, providing records for a total of 712 birds.

Conservation significant species

Three species listed under the NC Act were recorded during the surveys. These species were as follows:

- Little tern (*Sternula albifrons*) – listed as 'endangered' (also listed as Marine Migratory pursuant to the EPBC Act)
- Beach stone-curlew (*Esacus magnirostris*) – Listed as 'vulnerable'
- Far eastern curlew (*Curlew numenius madagascariensis*) – listed as 'near threatened' (Also listed as Marine Migratory pursuant to the EPBC Act)

Two species identified through literature review, Australian painted snipe (*Rostratula australis*) ('vulnerable' NC Act and EPBC Act) and Sooty oystercatcher (*Haematopus fuliginosus*) ('near threatened' NC Act), are considered to have little to no potential to occur within the Kangaroo Island wetland complex as this area does not support suitable habitat for these two species.

Summary of survey findings for Kangaroo Island Wetland Complex

Friend Point, Narrows and Claypan Roost

The Kangaroo Island wetland complex supports high quality roosting habitat for shorebirds and marine migratory birds with records for 23 species recorded utilising habitats supported therein.

The data recorded from low tide foraging surveys of the intertidal mudflats indicates that these habitats possibly support only marginal foraging habitat, due to the low numbers of birds observed, as indicated in the records from roost surveys (average of 40 birds at low tide vs 208 birds at high tide).

Kangaroo Island North Roost

As discussed, although the area at the northern end of Kangaroo Island (Kangaroo Island North Roost) has been identified as a "Major Shorebird Roost Site" by the CCRCMP, based on the observations of this survey, the area does not appear to be a significant roost. Despite this area being surveyed on several occasions, a total of only three Far eastern curlews were observed. It is unclear as to why this area was not being utilised for roosting.

Summary of survey findings for Laird Point Roost

The pre clearing surveys failed to record any marine migratory birds nor shorebirds at Laird Point.

The construction of a barge landing facility and access tracks at Laird Point and the associated very high and frequent movements of vessels, vehicles and humans both day and night has resulted in a significant level of disturbance in the Laird Point area.

The high level and volume of anthropogenic disturbance is likely to have had a major effect of the birds that used to utilise these roost sites, causing localised absence of shorebird and other migratory birds from these once nationally significant roost areas.

Assessment of Study Area Significance

Clemens *et al.* (2008) have developed the most detailed and comprehensive "significance" criteria for the East Asian-Australasian Flyway Action Plan for the Shorebirds 2020 project. Whilst the data collected for this pre clearing survey is insufficient to accurately define a "shorebird area", defined as "…*the geographic area that had been used by the same group of shorebirds over the main non-breeding period*", it is a useful tool to assess the importance of the areas assessed.

A detailed review of information and available data for the Curtis Coast region and the data collected from the pre clearing survey has been used to determine the significance of the Kangaroo Island wetland complex area for shorebirds.

Table 10.12 details the established criteria, to assess the significance of shorebird populations at international, national, State and regional levels.

Table 10.12 Assessment criteria for Shorebird Site Significance

Geographic scale	Source	Accepted criteria
International	Ramsar (2005)	Criterion 5 -The wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds Criterion 6 -The wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird
	East Asian-Australasian Shorebird Action Plan	Adopted criterion 6
	Bamford *et al.* (2008)	Adopted criterion 6 and identified a new criterion for identifying staging areas of international importance: 0.25% of a population as the staging criterion. This criterion could apply only during the migration period and the site must be along the migration route of the species
National	Clemens *et al*. (2008)	Regularly supports greater than 2,000 shorebirds; and regularly supports greater than 0.1% of the flyway population estimate for at least one migratory shorebird species or sub-species
	DEWHA (2009a, b), DEH (2005)	Adopted the same criteria as above and added one additional criterion: Supports 15 shorebird species
State	Clemens *et al*. (2008)	A shorebird area is of state significance if it: Is significant at the National level; Exhibits significant decline in: a) the total number of shorebirds; or b) populations of any species, not known to be experiencing declines more broadly; or Supports threatened or endangered shorebird species; or Supports greater than 1% of the population of any resident Australian shorebird species

Geographic scale	Source	Accepted criteria
Regional	Clemens *et al*. (2008)	A shorebird area is of regional significance if it: Has associated records of 15 or more species of migratory shorebird; Has associated records of 20 or more migratory and resident shorebirds; or Forms one of three most abundant shorebird areas, within each Natural Resource Management boundary, for any of the following and Australian Pratincole; species: Latham's Snipe, Little Curlew, Oriental Plover, Oriental Pratincole; Areas that support threatened species or endangered shorebirds; or Areas that support greater than 1% of the Australian population of any resident shorebird species

Source: Sandpiper *et al.* 2010

Review of the literature has concluded that whilst there were no internationally significant roost areas in the Curtis Coast area, additional regional surveys conducted in accordance with the determination criteria may confirm the presence of internationally significant populations of Far eastern curlew and Grey-tailed tattler.

With respect to national significance, the Port Curtis area satisfied both of the determination criteria (as proposed by Clemens *et al.,* 2008) and the three criteria proposed by the DEWHA (2009a, b). Consequently, Port Curtis can be identified as a nationally significant area for shorebirds.

Of particular importance for this assessment is that Sandpiper *et al*. (2010), through analysis of QWSG data and their own records, have determined that the Friend Point area satisfies the national, State and regional criteria, and as such can be identified as a roost area of national significance. Of note, is that data analysis for the Laird Point area, where the proposed pipeline will "enter" Curtis Island, also meets the determination criteria for a national, State and regionally significant roost area. However, the data analysis is not supported by the survey findings of Laird Point. The assessment also concluded that the Friend Point roost site supported nationally significant populations of far eastern curlew and whimbrel and the Claypan roost site supported a nationally significant population of far eastern curlew (Sandpiper *et al.,* 2010).

Comparative analysis of data collected from 47 shorebird areas in the Curtis Coast region determined the following relative ranked values of the Friend Point roost within the Curtis Coast shorebird areas (Sandpiper *et al*., 2010):

- 7th for National Criteria
- 1st for State Criteria
- 7th against Regional Criteria
- 6th for total population counts

The data collected from the current assessment continues to provide evidence that the roosts supported within the Kangaroo Island wetland complex support nationally significant populations of Far eastern curlew.

From this analysis, it can be concluded that the Friend Point area continues to support high values at national, State and regional scales.

Of particular note is that nationally significant roost counts were recorded at all Friend Point and Claypan roost sites on Kangaroo Island.

10.5.7 Marine watercourse crossings

The Marine Crossing GTP ROW (mainland) crosses a number of watercourses. Figure 10.6 shows the location of these watercourse crossings and this section details the ecological attributes of each watercourse crossing associated with the Marine Crossing GTP Project.

Humpy Creek (minor northern tributary)

Humpy Creek (minor northern tributary) is located along the Marine Crossing GTP ROW at Point B (refer Plates 3 and 4).

The creek is a tidally influenced minor tributary, with a steep cut bank on the northern side and sandy substrates deposited as small sandbars over topping a clayey mud and gravel creek base. The top of bank to the top of the bank is approximately 12 m at the widest point inside the ROW.

Historical disturbance on this site is evidenced by the minor soil excavations and existing vehicular access track that crosses the watercourse. Immediately upstream of the proposed Marine Crossing GTP ROW crossing is the newly constructed haul road and works areas for the QCLNG GTP.

The surrounding vegetation is characterised by *Eucalyptus crebra/Corymbia citriodora* open woodland associations. South of the watercourse is notably open (possibly due to historical vegetation clearing). Evidence of marine influence on the watercourse is clear with patches of marine couch (*Sporobolus virginicus*) binding the sandy soils which occur in small sand bars overtopping the muddy clay base of the creek. Occasional saltbush and a few mangroves (refer Table 10.13), and Sea purslane (*Sesuvium portulacastrum*) were also noted during the site assessment.

Plate 3 Humpy Creek (minor northern tributary) – Looking south from the northern boundary of the ROW

Note: Pink flagging tape represents northern extent of ROW disturbance

Plate 4 **Humpy Creek (minor northern tributary) – Looking north from the pipeline crossing**

Marine plants within the proposed Marine Crossing GTP ROW crossing of Humpy Creek are summarised in Table 10.13.

Table 10.13 **Vegetation species within Humpy Creek (minor northern tributary)**

Species	Common name	Stem counts/m^2	Notes/observations
Sesuvium portulacastrum	Sea Purslane	6 patches	
Enchylaena tormentosa	Ruby Saltbush	8 plants	Poor quality specimens
Fimbristylis polytrichoides	Rusty Sedge	Growing together with marine couch areas	Patchy poor quality population
Sporobolus virginicus	Marine Couch	125 m^2	
Ceriops australis	Yellow Mangrove	4 larger shrubby (1-2 m) and approximately 10 seedlings	
Lumnitzera racemosa	White Flowered Black Mangrove	4 larger shrubby (1-2 m) and approximately 10 seedlings	

Source: Downes, 2012b

Mudflat and saltpan area

The mudflat and saltpan area is located along the Marine Crossing GTP ROW at KP 407.5 and is the edge of the open mudflat/saltpan areas of Mosquito Creek.

This location represents the interface between the open forest (mostly *E. crebra* forest) grazing land, and the open mudflats and saltpan areas of The Narrows/Mosquito Creek area. The landward grazing areas are open and display evidence of historical vegetation clearing, with only patchy canopy and open grassy understorey.

The Marine Crossing GTP ROW intersects with the edge of this area and as a result, will disturb a small number of marine plants as identified in Table 10.7. The open saltpan areas that fall within the Marine Crossing GTP ROW footprint are in two distinct areas and measure approximately 20 m x 10 m and 3 m x 3 m. Plate 3 shows the minor extent of disturbance with the white tape pictured marking the northern extent of the ROW. The open crowsfoot grass (*Elusine indica*), Juncus and green couch (*Cynodon dactlyon*) pasture merges with the marine couch (*Sporobolus virginicus*), and Rusty Sedge (*Fimbristylis polytrichoides*) associations – occasionally punctuated with 4-5 m high Swamp She-oak (*Casuarina glauca*).

The demarcation of the saltpan areas are abrupt with a minor eroding bench (approximately 200 mm -300 mm high) notable between the hypersaline saltpan and the adjacent marine couch dominated land (refer Plate 5).

Plate 5 Marine couch and saltpan area

Note: White measuring tape represents northern extent of Marine Crossing GTP ROW disturbance

Table 10.14 indicates that one mangrove seedling is present (ie Myrtle Mangrove *Osbornia octodonta*) occur at this location or in immediate vicinity of the Marine Crossing GTP ROW. However samphires and other marine plants were noted (refer Plate 6 and Table 10.14). The site is consistent with the upper extent of Regional Ecosystem description RE11.1.2 (ie Sparse samphire forbland on marine clay plains).

Plate 6 **From Left : *Suaeda australis, Suaeda arbusculoides*** **and *Sarcocornia quinqueflora***

Marine plants within the proposed Marine Crossing GTP ROW crossing of the mudflat and salt pan area are presented in Table 10.14.

Table 10.14 Vegetation species within mudflat and saltpan area

Species	Common name	Stem counts/m^2	Notes/observations
Sesuvium portulacastrum	Sea Purslane	3 plants	Small plants
Osbornia octodonta	Myrtle Mangrove	1 plant	Seedling plant
Suaeda australis	Sea Blight	8 plants	Small plants
Suaeda arbusculoides	Jellybean Plant	8 plants	Small plants
Sarcocornia quinqueflora	Bead Weed	6 plants	Small plants
Fimbristylis polytrichoides	Rusty Sedge	Growing together with marine couch areas	Patchy poor quality population, Juncus sp. also present and dominate on upper fringes (less salt)
Sporobolus virginicus	Marine Couch	565 m^2	Crows Foot Grass and Green Couch (*Cynodon dactlyon*) also interspersed with Marine Couch at this location. *Phylla nodiflora* also occasionally observed
Dead or fallen marine plant material		Negligible	

Source: Downes, 2012b

Humpy Creek (southern creek line)

The Humpy Creek (southern creek line) crossing is located along the Marine Crossing GTP ROW at KP 407 (refer Plates 7 and 8). The crossing location is a more significant watercourse than the northern anabranch and measures approximately 20 m wide from top of both banks. This watercourse is defined by large amounts of alluvium being stabilised by marine couch along the south-east bank with a tall cut batter 2.5 m tall along the north-west bank.

Surrounding vegetation is very patchy with *Eucalyptus crebra* and *E. tereticornis* present on both banks and within the adjacent open grazing areas.

Evidence of marine influence is clearly notable from mangrove seedling recruitment and the dominance of the dense marine couch and rusty sedge populations. Also of note were marine Mud whelks (*Telescopium telescopium*).

Plate 7 Humpy Creek (southern creek line) Crossing – Looking east

Note: White measuring tape represents southern extent of the Marine Crossing GTP ROW disturbance

Plate 8 **Humpy Creek (southern creek line) Crossing – Looking south**

Marine plants contained within the proposed Marine Crossing GTP ROW crossing Humpy Creek are summarised in Table 10.15.

Table 10.15 Vegetation and species within Humpy Creek (southern creek line)

Species	Common name	Stem counts/m^2	Notes/observations
Sesuvium portulacastrum	Sea purslane	6 patches	Mostly on northern bank
Sarcocornia quinqueflora	Bead weed	6 plants	Mostly on northern bank
Limonium sp.	Sea statice	5 plants	
Fimbristylis polytrichoides	Rusty sedge	Growing together with marine couch areas	*Juncus* sp. also present and dominant on upper fringes (less salt)
Sporobolus virginicus	Marine couch	435 m^2	Thick and good quality marine couch with rusty sedge
Ceriops australis	Yellow mangrove	5 larger shrubby (1-2 m) and approximately 10 seedlings	
Lumnitzera racemosa	White flowered black mangrove	6 larger shrubby (1-2 m) and approximately 10 seedlings	
Aegiceras corniculatum	River mangrove	2 larger shrubby (1-2 m)	
Dead or fallen marine plant material		Small amount present	Mostly attributable to organic materials collecting around base of mangroves and larger terrestrial plant debris

Source: Downes, 2012b

Unnamed drainage feature (connecting Humpy and Targinie Creeks)

The unnamed drainage feature (connecting Humpy and Targinie Creeks) crossing is located along the Marine Crossing GTP ROW at KP 408.17 (refer Plates 9 and 10).

Vegetation is analogous with areas of Targinie Creek catchment and includes open *Eucalyptus crebra/E. tereticornis* forest which has historically been cleared or thinned and is presently used for grazing purposes.

This drainage gully consists of a shallow, open ephemeral drainage line which displays a mosaic of gravelly sediments bound by patchy marine couch (*Sporobolus virginicus*) and scoured mud and clay pan base. Cut banks are evident on both banks in different sections, consistent with the gentle meandering alignment. The site is consistent with the RE 11.1.2 (is: Sparse samphire forbland on marine clay plains).

Access tracks and other minor disturbances are noted across the drainage line, inside and adjacent to the proposed Marine Crossing GTP ROW alignment. Marine tidal influence is evidenced by the presence of mangroves and mangrove seedlings, as well as other marine dependent species as listed in Table 10.16.

Plate 9 Unnamed Drainage Feature – Looking east

Plate 10 Unnamed Drainage Feature – Looking north across vehicle crossing point

Note: Pink flagging tape represents north-eastern boundary of the Marine Crossing GTP ROW

Marine plants within the proposed Marine Crossing GTP ROW crossing of the unnamed drainage feature connecting Humpy and Targinie Creeks are summarised in Table 10.16.

Table 10.16 Vegetation species within unnamed drainage feature (connecting Humpy and Targinie Creeks)

Species	Common name	Stem counts/m^2	Notes/observations
Sesuvium portulacastrum	Sea Purslane	4 patches	Larger clumps/patches
Sarcocornia quinqueflora	Bead Weed	9 plants	
Limonium sp.	Sea Statice	4 plants	
Suaeda australis	Sea Blight	6 plants	Small clumps
Osbornia octodonta	Myrtle Mangrove	2 plants	Seedling plants
Fimbristylis polytrichoides	Rusty Sedge	Growing together with marine couch areas	*Juncus* sp. also present and dominate on upper fringes
Sporobolus virginicus	Marine Couch	675 m^2	Patchy and poor condition with larger areas of open mudflat and disturbed vehicle crossing
Ceriops australis	Yellow Mangrove	3 larger shrubby (1-2 m) and approximately 10 seedlings	1 – 1.5 m high shrubby specimens with organic material deposited around base
Lumnitzera racemosa	White Flowered Black Mangrove	4 larger shrubby (1-2 m) and approximately 10 seedlings	

Species	Common name	Stem counts/m^2	Notes/observations
Dead or fallen marine plant material		Small amount present	Mostly attributable to organic materials collecting around base of mangroves and larger terrestrial plant debris

Source: Downes, 2012b

Oxbow adjacent to Targinie Creek

The oxbow adjacent to Targinie Creek crossing is located along the Marine Crossing GTP ROW at KP 408.4 (refer Plate 11).

This feature appears to be an oxbow type oval shaped water body which is connected to Targinie Creek by an open gentle grade swale. It is unclear as to whether the oxbow is natural or constructed, however there was no significant bunding or shaping to suggest that it is a man-made dam or basin. The batters of this basin are almost exclusively vegetated with marine couch (*Sporobolus virginicus*) which rapidly merges with green couch (*Cynodon dactlyon*) before merging with surrounding pasture grass species at the top of the batters.

An access track crosses immediately to the south of this drainage feature and the surrounding area is very open grassland with occasional wattle (*Acacia* sp.) and gums (*Eucalyptus tereticornis, Eucalyptus crebra*). Site assessment confirms that the proposed Marine Crossing GTP ROW just bisects the southern edge of the basin and may disturb the landscape feature by approximately 14 m.

Plate 11 **Oxbow adjacent Targinie Creek – Looking north-east**

Marine plants within the proposed GTP ROW within the oxbow adjacent to Targinie Creek are summarised in Table 10.17.

Table 10.17 Vegetation species within oxbow adjacent to Targinie Creek site

Species	Common name	Stem counts/ m^2	Notes/observations
Limonium sp.	Sea Statice	4 plants	
Sporobolus virginicus	Marine Couch	100 m^2	Fairly poor condition patch with no other notable marine sedges or grasses present. Some Green couch on fringes
Dead or fallen marine plant material		Negligible	

Source: Downes, 2012b

Targinie Creek

The Targinie Creek crossing is located along the GTP at KP 408.4 (refer Plates 12 and 13).

The crossing site for Targinie Creek displays evidence of being at the very upper edge of the saltmarsh and freshwater wetland ecotone, with freshwater wetland sedges noted inside the proposed Marine Crossing GTP ROW. Marine couch (*Sporobolus virginicus*) and Green couch (*Cynodon dactlyon*) both dominate the sandy sediments which occur on large sandy deposits within the watercourse and on both banks. The creek is a wide waterbody and has large deposits of river rock and sand in-stream.

Freshwater macrophytes such as Joint sedge (*Baumea articulate)*, Sedge (*Juncus usitatus)*, and the introduced Cumbungi (*Typha orienatalis*) also occur at this watercourse crossing.

Disturbance is limited with a vehicular crossing (infrequently used) located to the north of the Marine Crossing GTP ROW. Areas within the ROW are in good condition with no open scour or eroding banks notable. High banks occur on both sides of the watercourse but are mostly well vegetated, with fringing freshwater sedges and pasture grasses.

Plate 12 **Targinie Creek Crossing – Looking south**

Plate 13 **Targinie Creek Crossing – Cumbungi, Green Couch and Marine Couch on alluvium**

Marine plants within the Marine Crossing GTP ROW crossing of Targinie Creek are summarised in Table 10.18.

Table 10.18 Vegetation species within Targinie Creek

Species	Common name	Stem counts/ m^2	Notes/observations
Sporobolus virginicus	Marine Couch	525 m^2	Area calculation includes both Marine Couch and Green Couch (*Cynodon dactlon)*, which are both dominant on site
Baumea articulata,	Joint Sedge		
Juncus usitatus			
Lumnitzera racemosa	White Flowered Black Mangrove	1 small shrubby (1 m) and approximately 5 seedlings	
Dead or fallen marine plant material		Small amount present	Mostly attributable to organic materials and larger terrestrial plant debris

Source: Downes, 2012b

10.5.8 Summary of all species potentially impacted by pipeline project activities

All the species that have potential to be impacted by pipeline project activies are summarised in Table 10.19 and Table 10.20.

Table 10.19 Fauna Species potentially disturbed by pipeline project activities and conservation status

Description		Status	
Zoological name	**Common name**	**EPBC Act**	**NC Act**
Fauna			
Ninox strenua	Powerful owl		V
Geophaps scripta scripta	Squatter pigeon	V	V
Chalinolobus picatus	Little pied bat		NT
Numenis madagascariensis	Eastern curlew	m	NT
Escacus neglectus	Beach stone-curlew		V
Sterna albifronis	Little tern	m	E
Taphozous australis	Coastal sheathtail bat		V
Ephippiorhynchus asiaticus	Black-necked stork		NT
Xeromys myoides	Water mouse	V	V
Phascolarctos cinereus	Koala	V	V
Lophoictinia isura	Square-tailed kite		NT
Acanthophis antarcticus	Death adder		NT
Erythrotriorchis radiatus	Red goshawk	V	E
Accipiter novaehollandiae	Grey goshawk		NT
Calyptorhynchus lathami	Glossy-black cockatoo		V
Chalinolobus dwyeri	Large eared pied-bat	V	V
Pteropus poliocephalus	Grey headed flying fox		V
Dasyurus hallucatus	Northern quoll	E	E
Cyclorana verrucosa	Rough frog		NT
Delma torquata	Collared delma	V	V

Description		Status	
Paradelma orientalis	Brigalow scaly-foot	V	V
Strophurus taenicauda	Golden-tailed gecko		NT
Egernia rugosa	Yakka skink	V	V
Furina dunmalli	Dunmallis snake	V	V
Turnix melanogaster	Black-breasted button quail	V	V
Nyctophilus corbeni	South eastern long-eared bat	V	V
Ornithorhynchus anatinus	Platypus		SLC
Tachyglossus aculeatus	Echidna		SLC
Chelonia mydas	Green turtle	V	V
Eretmochelys imbricata	Hawksbill turtle	V	V
Natator depressus	Flatback turtle	V	V
Caretta caretta	Loggerhead turtle	E	E
Dugong dugon	Dugong	m	V
Sousa chinensis	Indo-Pacific humpback dolphin	m	NT
Orcaella heinsohni	Australian snubfin dolphin	m	NT, data deficient
Tursiops aduncus	Bottlenose dolphin	m	
Tursiops truncatus	Bottlenose dolphin	m	
Eubalaena australis	Southern right whale	E	
Megaptera novaeangliae	Humpback whale	V	V
Pseudorca crassidens	False killer whale	m	
Balaenoptera acutorostrata	Minke whale	m	
Balaenoptera edeni	Bryde's whale	m	
Curlew numenius madagascariensis	Far eastern curlew	m	NT
Rostratula australis	Australian painted snipe	V, m	V
Burhinus grallarius	Bush stone-curlew		
Esacus magnirostris	Beach stone-curlew	V	V
Haematopus fuliginosus	Sooty oystercatcher		NT
Haematopus longirostris	Australian pied oystercatcher		
Cladorhynchus leucocephalus	Banded stilt	Vagrant	
Himantopus himantopus	Black-winged stilt		
Recurvirostra novaehollandiae	Red-necked avocet	m	
Charadrius bicinctus	Double-banded plover	m	
Charadrius hiaticula	Ringed plover	m	
Charadrius leschenaultia	Greater sand plover	m	
Charadrius mongolus	Lesser sand plover	m	
Charadrius ruficapillus	Red-capped plover	m	
Elseyornis melanops	Black-fronted dotterel		
Pluvialis fulva	Pacific golden plover	m	

Description		Status	
Pluvialis squatarola	Grey plover	m	
Erythrogonys cinctus	Red-kneed dotterel		
Actitis hypoleucos	Common sandpiper	m	
Arenaria interpres	Ruddy turnstone	m	
Calidris acuminate	Sharp-tailed sandpiper	m	
Calidris alba	Sanderling	m	
Calidris canutus	Red knot	m	
Calidris ferruginea	Curlew sandpiper	m	
Calidris ruficollis	Red-necked stint	m	
Calidris tenuirostris	Great knot	m	
Gallinago hardwickii	Latham's snipe	m	
Gallinago megala	Swinhoe's snipe	m	
Gallinago stenura	Pin-tailed godwit	m	
Limicola falcinellus	Broad-billed sandpiper	m	
Limosa lapponica	Bar-tailed godwit	m	
Limosa limosa	Black-tailed godwit	m	
Numenius madagascariensis	Far eastern curlew	m	NT
Numenius minutus	Little curlew	m	
Numenius phaeopus	Whimbrel	m	
Tringa brevipes	Grey-tailed tattler	m	
Tringa glareola	Wood sandpiper	m	
Ardea alba	Great egret	m	
Ardea ibis	Cattle egret	m	
Egretta sacra	Eastern reef egret	m	
Haliaeetus leucogaster	White-bellied sea-eagle	m	
Pandion cristatus	Eastern osprey	m	

Table notes:
E = Endangered
V = Vulnerable
NT = Near Threatened
LC = Least Concern
SLC = Special Least Concern
m = Marine or migratory provisions of EPBC Act

Table 10.20 Flora Species potentially disturbed by pipeline project activities and conservation status

Description		Status	
Zoological name	**Common name**	**EPBC Act**	**NC Act**
Flora			
Rhizophora stylosa	Red mangrove		LC
Avicennia marina	Grey mangrove		LC
Ceriops australis	Yellow mangrove		LC
Aegiceras corniculatum	River mangrove		LC

Description		Status	
Lumnitzera racemosa	White flowered black mangrove		LC
Osbornia octodonta	Myrtle mangrove		LC
Aegialitis annulata	Club mangrove		LC
Bruguiera gymnorrhiza	Large-leafed orange mangrove		
Excoecaria agallocha	Milky mangrove		LC
Xylocarpus granatum	Cannonball mangrove		
Xylocarpus moluccensis	Cedar mangrove		
Enchaylaena tormentosa	Ruby salt bush		
Suaeda autralis	Sea blight		
Suaeda arbusculoides	Jellybean plant		
Sarcocornia quinqueflora	Bead weed		
Limonium sp.	Sea statice		LC
Halodule uninervis	-		
Halophila decipiens	-		
Halophila minor	-		
Halophila ovali	-		
Halophila spinulosa	-		
Zostera capricorni	-		
Sesuvium portulacastrum	Sea Purslane		LC
Enchylaena tormentosa	Ruby Saltbush		
Fimbristylis polytrichoides	Rusty Sedge		LC
Sporobolus virginicus	Marine Couch		LC
Eleusine indica	Crowsfoot grass		
Cynodon dactlyon	Juncus and green couch		
Casuarina glauca	Swamp She-oak		
Suaeda australis	Sea Blight		LC
Baumea articulata	Joint Sedge		LC
Juncus usitatus	Soft Rush		

Table notes: E = Endangered
V = Vulnerable
NT = Near Threatened
LC = Least Concern
SLC = Special Least Concern
m = Marine or migratory provisions of EPBC Act

10.5.9 Pest species

Pest species can impact on the biodiversity of an area through predation impacts increased competition for resources, modifying habitat, distributing weeds, and increasing the risk of disease outbreaks.

The most common and abundant pest species identified were cane toads (*Bufo marinus)*, rabbits *(Oryctolagus cuniculus)* and hares (*Lepus europeaus*). However, there is strong evidence (tracks and scats) that feral dogs (*Canis lupus familiaris*)/dingos (*Canis lupus dingo*) are also common throughout the area. Some evidence is likely to be due to domesticated dogs frequenting the area as the local landowners have dogs as pets and/or for work and recreational purposes (eg mustering and pigging) (URS, 2009 and Ecologica, 2012).

Feral cats, European foxes, rabbits, feral pigs, feral dogs and dingoes are declared as 'Class 2 declared pest species' under the provisions of the LP Act. It is a legal requirement that landowners must take reasonable steps to keep land free of Class 2 pests.[2]

Local landholders were observed to have control measures in place for pigs, feral dogs and dingoes, with hunting and baiting the two main control measures in practice.

The impacts from the introduction of feral cats, foxes, feral pigs, rabbits and the cane toad are listed under the EPBC Act as Key Threatening Processes. A key threatening process is defined as one that threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community. As a result, a number of corresponding threat abatement plans have been compiled to mitigate and reduce potential impacts.[3]

10.6 Potential construction impacts

The Marine Crossing GTP Project involves tunnelling underneath the intertidal areas south of Kangaroo Island and the marine waters of The Narrows which are within the GBRWHA and works will not be undertaken within the GBR Coast MP.

Adopting a tunnelling construction technique will significantly minimise the disturbance within ESA Category B associated with this area, as tunnelling will not directly disturb ecological communities on the seabed, intertidal regions or within the water column. In addition, the works will reduce the potential impact of the Project on MNES under the EPBC Act.

Construction works within the GTP ROW, although outside of the GBRWHA and the GBR Coast MP, are within the vicinity of these areas and are unavoidable as the ROW is located within the designated GSDA MTSC Precinct. In addition, the former DIP (now DSDIP) have nominated this portion of the GSDA corridor as being available for industrial development by LNG proponents. Movement to the north (outside of the corridor) is prohibited, while movement south is constrained by the pipeline alignment of the three other LNG proponents.

The implementation of mitigation measures, as outlined in Section 10.8 and management plans, during construction will ensure that the impacts are both temporary and minimal.

10.6.1 Vegetation clearing

Vegetation clearing for the Marine Crossing GTP Project will result in the removal of approximately 14.20 ha of remnant vegetation, and 3.72 ha of high value regrowth which could result in a reduction in flora genetic diversity.

Trenching activities are mainly restricted to the terrestrial environments; however works in the subtidal zone between Point A and Point C (refer Figure 10.6) will intercept marine plants associated with the tidal reaches of watercourses within this area (refer Section 10.5.7).

Construction activities will result in the removal of approximately 2,425 m^2 of marine plants as defined under the *Fisheries Act 1994*.

[2] http://www.nrm.qld.gov.au/pests/pest_animals/declared/index.html
[3] http://www.deh.gov.au/biodiversity/threatened/ktp/index.html

Clearing within the riparian zone of Humpy and Targinie Creeks, will be restricted to a 30 m ROW. Due to natural processes and zonation, marine plants are restricted to the riparian and instream habitats of these systems (~20 m wide).

A breakdown of the extent of disturbance to REs as a result of this clearing is presented in Table 10.21. Figure 10.3 shows the location of mapped REs within and adjoining the Marine Crossing GTP Project.

Table 10.21 Construction phase vegetation clearing extent for the Marine Crossing GTP Project

Regional Ecosystem code	VM Act Status	Biodiversity Status	Remnant area to be cleared (ha)	High value regrowth area to be cleared (ha)
Mainland				
11.3.4[1]	OC	OC	1.09	1.33
12.11.14[1]	OC	OC	0.82	N/A
11.11.15[1]	LC	NC	1.53	N/A
Not known	OC	OC	N/A	2.39
12.1.3[2]	LC	NC	0.18	N/A
11.3.26/11.3.4/11.11.15	LC/OC/LC	NC/OC/NC	6.13	N/A
Curtis Island				
12.1.3[1]	LC	NC	N/A	N/A
12.11.14[1]	OC	OC	2.17	N/A
12.11.6	NC	NC	2.28	N/A
Total			**14.20**	**3.72**

Table notes:
E = Endangered
NC = No Concern at Present
NoC = Not of Concern
LC = Least Concern
OC = Of Concern

1. Ground truthed by RPS in April 2012 (0.0629 ha ground truthed as non remnant)
2. Ground truthed by Downes in May 2012 (refer Section 10.5.7 for details)

As stated in Section 10.6.1, the disturbance of native vegetation is unavoidable, as GLNG Operations and the other proponents have been directed by DSDIP that the works must occur within the nominated areas of the GSDA and the alignment is constrained by the pipeline alignment of the three other LNG proponents to the south.

Further clearing of these RE types may exacerbate edge effects already present which have the potential to increase fire risk and weed species infiltrating into adjacent remnant vegetation. For example, weed species such as *Lantana camara* promote the spread of fire within the communities they invade via their physical structure, overall bulk and ability to shed their leaves and thus increase lower strata fuel loads.

In addition, vegetation clearing activities have the potential to impact on the fauna assemblages through:

- Mortality as a result of construction activities (eg vehicle strikes, removal and/or disturbance of nests, hollows and burrows)
- Loss of important habitats and habitat complexity
- Increased fragmentation and linear disturbances
- Reduction and loss of wildlife corridors
- Increased risk of “edge effects”

- Disturbance to species behaviour (ie some species are more susceptible to anthropogenic activity)
- Increased pressure from exotic and/or pest species
- Displacement/loss of some species as a result of habitat loss and a decrease in population viability of the remnant population
- Removal of stands of vegetation which act as important buffer systems (noise, light and visual)
- Increased predation pressure

The reduction of hollows and logs also means increased predation pressure, increased intra-specific competition and the loss of potential reproductive habitat for particular species.

Anthropogenic activities within the area have impacted on the ecological integrity of the habitat surrounding the Marine Crossing GTP Project. This includes the loss of biodiversity through land clearing fragmentation, invasion of weeds/introduced species and changes to habitat complexity and structure.

The implementation of mitigation measures during construction will reduce the potential ecological impacts of vegetation clearing (refer SSMP, SMP, PWMP (refer Appendix B) and LRMP (refer Appendix E)).

Environmentally sensitive areas

A breakdown of the maximum extent of the clearing of each ESA category for the construction of the Marine Crossing GTP Project is provided in Table 10.22.

Table 10.22 Environmental sensitive areas

Marine Crossing GTP Section	ESA Category A		ESA Category B		ESA Category C	
	Area (ha)	Comment	Area (ha)	Comment	Area (ha)	Comment
Mainland						
ROW (Point A to construction site pad)	0	-	1.66	Combination of WHMA under NC Act, marine plants under the *Fisheries Act 1994* and seaward side of HAT	5.06	Combination of referable wetlands, essential habitat under the VM Act, and 'of concern' RE under the VM Act
Construction site pad (mainland)	0	-	0	-	2.79	'Of concern' RE under the VM Act
Access Road	0	-	0.09	'Endangered' RE under the VM Act	0.68	Essential habitat under the VM Act and protected areas
Curtis Island						
Construction site pad (Curtis Island)	0	-	2.23	WHMA under NC Act	0	-
ROW (Construction site pad to Point E)	0	-	2.29	WHMA under NC Act	0	-
Total			**6.27**		**8.53**	

Table notes: Tunnelling under the intertidal area and The Narrows represents no clearing within the ESA Category B cover these areas
ESA = Environmentally Sensitive Area
WHMA = World Heritage Management Area

Carbon release/sequestration

Terrestrial ecosystems are considered to be major contributors to carbon sequestration (up to 75%). Of this biomass, up to 95% may be found in trees (Australian Rainforest Conservation Society (ARCS), 2010).

Key threatening processes to carbon sequestration within the area surrounding the Marine Crossing GTP Project include the clearing of vegetation and the disturbance of soil. Both impacts lead to oxidation and release of carbon dioxide into the atmosphere which in turn contributes to an increase in atmospheric temperatures.

However, it is difficult to accurately determine how much carbon may be released due to variation in age, composition and structure of the vegetation communities present. As suggested by Sales *et al.* (2004) *"Biomass and carbon density values are found to vary with age, type of species, site conditions and silvicultural treatments (in relation to forestry management)"*. It should be noted however, that large trees such as those eucalypts found within the Marine Crossing GTP Project disturbance footprint are considered significant due to their ability to sequester significant quantities of carbon.

The proposed location of the Marine Crossing GTP Project has been selected to minimise the clearing of vegetation and therefore minimise carbon sequestration loss.

Impact on plant-pollinator associations

Some wildlife such as invertebrates and plants co-exist in symbiotic relationships that are mutually advantageous to the perpetuation of both species. For example, the ability of a vegetation community to successfully regenerate is often highly dependent upon pollinators and seed dispersers such as beetles, bees, birds and ants.

Many pollinators rely on the sequential flowering of vegetation which in turn ensures food sources are available year round (with the exception of other environmental conditions, for example drought), whilst seed dispersers may nest, roost and forage within the vegetation community itself.

However, local populations of pollinators and seed dispersers are often highly susceptible to habitat degradation and fragmentation which is associated with vegetation clearing and the use of certain chemicals (eg pesticides and herbicides).

Reduced pollination and seed dispersal may result in reductions in flora reproductive outputs, modification of critical foodweb relationships and reduction in flora genetic diversity. These impacts may in turn result in a lack of food resources for dependant fauna.

The implementation of construction mitigation measures will reduce the potential ecological impacts of vegetation clearing (refer SSMP, SMP, PWMP (refer Appendix B) and LRMP (refer Appendix E)).

10.6.2 Conservation and threatened flora species

Based on flora surveys undertaken to date, no threatened flora species, as defined under the provisions of the NC Act and/or EPBC Act, have been identified from within the Marine Crossing GTP Project disturbance footprint. As such it is unlikely that the proposed works will have an impact on the threatened flora species.

10.6.3 Dust impacts on adjacent vegetation

In general, dust deposition from construction activities has the potential to impact upon vegetation if excessive quantities are deposited over extended periods of time. Excessive dust deposition on foliage reduces photosynthetic processes which in turn stunts floral growth rates and reduces the overall health of the remaining remnant communities within and adjacent to the Marine Crossing GTP Project. Dust may also carry nutrients which can lead to algal blooms in nearby watercourses and wetlands.

The implementation of dust mitigation measures will reduce the potential impacts of dust on adjoining vegetation communities.

10.6.4 Weeds

Weed proliferation is exacerbated by clearing activities that disturb and expose the soil. Activities of personnel and vehicles carried out within the Marine Crossing GTP Project disturbance footprint increases the potential for the movement and introduction of weed species into other locations where they do not currently occur.

Such activities include importing fill, slashing and soil disturbance from earthworks and grading. Weed propagules may also be introduced on footwear, machinery, vehicles and equipment moving in and out of the Project area as well as being translocated within the Marine Crossing GTP Project disturbance footprint.

Weeds may out-compete less disturbance-tolerant native species and/or smother native vegetation. This in turn may alter the species composition of the vegetation community they encroach upon, in addition to the faunal assemblages.

The implementation of weed mitigation measures during construction will reduce the potential weed impacts of the Marine Crossing GTP Project (refer PWMP in Appendix B).

10.6.5 Edge effects

Edge effects can penetrate from 15 to 50 m into an area of remnant and non-remnant woody vegetation depending on the topography, physical processes and vegetation type involved (Catteral *et al.*, 1991; Big Scrub Conservation Strategy, 1987). This reduces the interior (core) habitat through the migration of the communities 'edge' inwards.

Edge effects are likely to occur across all woody vegetation communities adjacent the Marine Crossing GTP Project direct disturbance footprint. In addition, edge effects have the potential to create changes to the species composition of woody vegetation communities and increase the presence of introduced and disturbance dependant native species in the area. Previously intact areas may also become exposed and vulnerable to threatening processes due to fragmentation.

When this occurs, the integrity of the floristic structure within the vegetation communities is likely to be compromised. This may create edge effects and attenuate areas of significance such as the riparian zones, remnant vegetation and communities adjacent to the areas of direct disturbance.

The potential impacts of the Marine Crossing GTP Project on increasing edge effects and thereby threatened fauna species will be minimised by implementing the SSMP, SMP, PWMP (refer Appendix B), and WMMP. In particular, the LRMP (refer Appendix E) will assist in minimising the long term impacts from edge effects by rehabilitating the construction site pads, Access Road and parts of the ROW not required for operational maintenance and safety of the GTP.

10.6.6 Changes to fire regimes

Bushfires may be the result of natural and/or anthropogenic processes. The Marine Crossing GTP Project is located in a low-medium risk bushfire area as defined by the Rural Fire Service, Queensland Fire and Rescue Service.

The impact of bushfire on a given ecosystem will vary depending upon its intensity, the season, the time since the last fire, the vegetation structure as well as the species composition. Some species and communities are extremely fire sensitive, however many plant species have developed specific mechanisms to survive periodic bushfire. Some species also depend on fire regimes to stimulate flowering, seed release or to provide optimal conditions for seed germination (eg *Eucalyptus* spp.).

Whilst bushfire is an important factor in shaping the dynamics and health of dry sclerophyll systems, a too high frequency of fire events can alter the species composition of communities and facilitate weed infestation and dieback. Uncontrolled fire also poses a significant risk to the pastures used by landholders and leasees to feed their stock.

Fuel load will affect fire intensity and the speed with which a fire spreads. The current land use practices within the area have already reduced fuel loads and reduced the mosaic structure of the area (eg significant areas of grasslands). The proposed construction activities associated with the Project are likely to reduce the fuel loads within the Marine Crossing GTP ROW.

Project activities which may potentially increase the risk and frequency of bushfires occurring from the Marine Crossing GTP Project, include stockpiling vegetation and mulching, the careless discarding of matches and cigarette butts, littering and the operation of equipment (eg sparks associated from heavy machinery).

The implementation of bushfire management measures during construction will reduce the potential impacts of bushfire within the Marine Crossing GTP Project (refer Section 10.8).

10.6.7 Erosion and sedimentation

There is potential for erosion of areas disturbed by works associated with the construction of the Marine Crossing GTP. Where these activities occur on erosive soils and/or on slopes, mobilisation of sediment into the marine environment can occur.

Potential impacts to aquatic ecosystems can include the build-up of sediment in estuarine and marine habitats (including the intertidal areas of Kangaroo Island wetlands) with a subsequent reduction in available habitat, smothering of aquatic plants and substrate.

Contamination through runoff can also lead to a loss of ecological values, reduced use of land and potential changes to ecological, economical and recreational values in the area.

Runoff from the construction site has the potential to introduce contaminants into downstream environments within the GBRWHA and also the GBR Coast MP. In addition, there will be localised clearing and substrate disturbance within tidal creeks that discharge into The Narrows and Port Curtis, which forms part of the GBRWHA and also the GBR Coast MP.

Increased turbidity may reduce light penetration thus lowering primary productivity especially within the seagrass communities. However, the naturally turbid Port Curtis waters provide an environment that is unlikely to be significantly impacted by any short term increase in sediment load.

Trenching on the mainland and Curtis Island has the potential to impact on downstream and adjacent local intertidal wetlands. This is due to the close proximity of the works to these intertidal wetlands (in some instances less than 50 m) and the type of works occurring (ie significant disturbance, albeit on a local scale, to vegetation and soils).

Control measures will be implemented to minimise erosion and sedimentation during the construction phase of the Marine Crossing GTP ROW. It is therefore expected that erosion and sedimentation related impacts during the construction phases will be low and manageable.

10.6.8 Loss of habitat

The loss of habitat associated with the Project has the potential to reduce the density and distribution of localised species. This may occur through the following mechanisms:

- The removal of large hollow bearing trees may result in the displacement/loss of hollow dependant fauna species, increased competition for nesting habitat and susceptibility to predation
- The loss of important feeding resources (eg flowering species are important to a range of species)
- Reducing invertebrate biodiversity thereby potentially reducing the prey availability of higher order trophic organisms (eg insectivorous birds and bats)
- Reducing plant-animal interaction and symbiotic relationships (eg the Mistletoebird is found wherever mistletoe grows and is important in the dispersal of this plant species)
- Reducing the core habitat available for some species, increasing the pressure from “edge effects” (refer Section 10.6.6) and reducing the capacity of habitats to support some species
- Reducing the number of microhabitats available within an area (eg leaf litter, loss of rocky outcrops)
- Reducing the capacity of some species to move through the landscape (eg small ground dwelling mammals prefer denser ground/under storeys)
- Changing understorey and ground storey habitat structure thereby reducing habitat availability (nesting feeding) and changing fire regimes
- Cumulative impacts to species resulting from factors eg erosion, exotic/pest species, and water quality degradation

Construction activities within the disturbance footprint will result in temporary removal of approximately 0.13 ha (out of a total 993.74 ha) of high quality Water mouse habitat. As the Marine Crossing GTP ROW will be constructed by tunnelling under the majority of the intertidal areas, the Marine Crossing GTP Project is unlikely to have a significant impact on this species or its associated habitat. Construction activities will be undertaken in accordance with the WMMP which will minimise impacts on the Water mouse.

Clearing for construction and other land use activities within the region is likely to increase the reliance of resident fauna on remaining habitat corridors. Many of the species displaced by construction activities are likely to persist in areas adjacent to the Marine Crossing GTP Project leading to an increase the competition for resources. However it is unlikely to have a significant impact on faunal biodiversity.

The proposed construction activities have the potential to impact on the movement and migration of species at both a local and regional scale. Impacts include temporary and permanent linear disturbances, removal of wildlife corridors, change in drainage patterns, gullies and cuttings, culverts, stockpiles, trenching, fencing, noise and dust generation, lighting and pollution.

The loss or reduction in the size of wildlife corridors will impact on the movement and dispersal of some species. The faunal groups most likely to be affected by reduced habitat linkages are:

- Gliders and possums that may inhabit small patches of vegetation communities as well as larger areas of vegetation
- Some forest-dependent birds
- Small reptiles (especially skinks) that do not move into open habitats
- Small secretive or forest dependent birds that prefer to travel across the landscape close to the shelter of thick vegetation
- Small marsupials that do not move far from, or are dependent on the shelter of thickets and/or dense vegetation

Some species of invertebrates (eg butterfly) are listed under the State legislation. The Marine Crossing GTP Project has the potential to impact on the microbial and invertebrate assemblages associated with the vegetation communities, including the loss of a particular group or a keystone species within the food web.

The extent to which construction activities produce long-term adverse impacts upon local fauna assemblages will be dependent upon the resilience/tolerance of the affected species and the viability of the retained habitat to further degradation post impacts.

Control measures to minimise the impacts associated with loss of habitat are outlined in Section 10.8.

10.6.9 Fragmentation and loss of movement opportunities

Construction activities within the Marine Crossing GTP ROW and Access Road are likely to create movement barriers for certain species. Fauna such as small mammals and birds are often deterred from crossing cleared/open areas, or areas subject to noise, vibration and lighting. In addition, the crossing of such areas can increase the potential for predation by native and introduced predators and increase predator access to fragmented habitat.

Fragmentation of remnant vegetation may result in a reduction of functional habitat. Habitat alteration may potentially result in certain species abandoning the area. Edge effects compound the impacts of fragmentation so that functional habitat is further reduced.

Reduced buffers to core habitat will result in disturbances to fauna and a further reduction in habitat quality. The disturbance of soil and increased light levels will potentially enhance conditions for weed infestations (edge effects).

Construction of the Marine Crossing GTP ROW is expected to have low to moderate long term terrestrial impacts with regard to fragmentation and loss of movement.

Control measures will be implemented to minimise potential impacts to faunal movement opportunities during construction of the Marine Crossing GTP Project. It is therefore expected that impacts relating to fauna movement will be low and manageable during the construction phase.

10.6.10 Threatened fauna

Conservation significant species known within the vicinity of the Marine Crossing GTP ROW include the Koala, Little pied bat, Coastal sheathtail bat, Squatter pigeon (*Geophaps scripta scripta*), Eastern curlew (*Numenius madagascariensis*), Beach stone-curlew (*Numenius neglectus*), Little tern (*Sternula albifrons*), Glossy-black cockatoo, Grey-headed flying fox, Black-necked stork, Square-tailed kite and Water mouse. As discussed in Section 10.5.6, a number of migratory birds are also known from the habitats within and adjacent to the Marine Crossing GTP Project.

Essential habitat for three fauna species has been identified within habitats contiguous with, and in close proximity to the area surrounding the Marine Crossing GTP Project. The essential habitats identified are for the following species:

- Koala – 'vulnerable' (EPBC Act) in SEQ Bioregion (least concern in other areas, including GTP ROW)
- Little pied bat – 'near threatened' (NC Act)
- Coastal sheathtail bat – 'near threatened' (NC Act)

During the field activities, thirteen species listed under Commonwealth and/or State legislation were identified within or adjoining the Marine Crossing GTP Project. The potential impacts of the Marine Crossing GTP Project are discussed below.

Potential impacts to threatened fauna species are likely to occur within the construction phase of the Marine Crossing GTP Project, where clearing of vegetation will result in the loss of habitat (ie hollows, foraging material and shelter), fragmentation and temporary increases in noise, vibration, dust and lighting. Sediment runoff from construction of the Marine Crossing GTP ROW may impact on the water quality of Port Curtis, where conservation significant migratory and resident shorebirds, dugongs, turtles, fish and cetaceans are known or are likely to occur during certain times of the year.

The SSMP specifically addresses potential impacts and mitigation measures for conservation significant fauna species that are known or are likely to occur in the vicinity of the Marine Crossing GTP Project. The adoption of appropriate management strategies contained in the SSMP, SMP, PWMP (refer Appendix B) and WMMP during construction will reduce any potential impacts to conservation significant fauna during construction. It is therefore expected that impacts relating to significant fauna will be moderate and manageable during construction of the Marine Crossing GTP Project.

Table 10.23 Summary of potential impacts on threatened fauna

Threatened fauna species	Potential impacts
Squatter pigeon*	• The main risk to individuals is vehicle and equipment movement during construction • Fauna injury and mortality due to this species being predominantly a ground dwelling species which when approached are unlikely to move • This species also nests on the ground usually laying two eggs in sheltered positions (Morecombe, 2006) • Small loss in habitat (refer Section 10.6.8) • Potential impacts on this species will be minimised by control strategies outlined in Table 10.26 and the SSMP, SMP and LRMP
Powerful owl	• Highly sensitive to disturbance from increases in noise, vibration and/or lighting (refer Section 10.6.13 and 10.6.14). Disturbance may result in individuals deserting a nest • Small loss in habitat and hollows (refer Section 10.6.8) • Potential impacts on this species will be minimised by control strategies outlined in Table 10.26 and the SSMP, SMP and LRMP
Koala*	• Injury and mortality due to loss of habitat and fragmentation which will increase predation and competition for food resources (refer Sections 10.6.8 and 10.6.11) • Potential impacts on this species will be minimised by control strategies outlined in Table 10.26 in and the SSMP, SMP and LRMP
Eastern curlew*, Beach stone-curlew and Little tern*	• Minor temporary impacts from increases in noise, vibration and lighting may occur to local movements and foraging patterns near construction activities • Noise, vibration and lighting (refer Section 10.6.13 and 10.6.14) • Potential impacts on this species will be minimised by control strategies outlined in Table 10.26 in and the SSMP, SMP and LRMP
Black-necked stork and Square-tailed kite	• No direct disturbance to roosting and foraging habitats associated with the Kangaroo island wetlands • Minor temporary impacts from increases in noise, vibration and lighting may occur to local movements and foraging patterns near construction activities • Potential impacts on this species will be minimised by control strategies outlined in Table 10.26 and the SSMP, SMP and LRMP
Glossy-black cockatoo	• Small loss of habitat (eg hollow-bearing trees) and feeding areas (refer Sections 10.6.1 and 10.6.8) • Increase in noise, vibration and lighting may impact on the species behaviour (refer Section 10.6.13 and 10.6.14) • Potential impacts on this species will be minimised by a minimum buffer of 50 m from feeding and watering sites and the GLNG SSMP, SMP and LRMP
Little pied bat	• No direct habitat loss • Small loss of roosting areas (eg hollow-bearing trees) and foraging (open woodlands) behaviour • Potential impacts on this species will be minimised by control strategies outlined in Table 10.26 in and the SSMP, SMP and LRMP
Grey-headed flying fox*	• No camps identified within and directly adjacent to the Marine Crossing GTP Project • Small loss in potential foraging habitat resulting in minimal impact due to the highly agile nature of this species • Potential impacts on this species will be minimised by control strategies outlined in Table 10.26 in Section 10.8 and the SSMP, SMP and LRMP

Threatened fauna species	Potential impacts
Coastal sheathtail bat	• Small loss in foraging habitat • No breeding habitat loss (ie rocky outcrops and crevices • Potential impacts on this species will be minimised by control strategies outlined in Table 10.26 and the SSMP, SMP and LRMP
Water mouse*	• Injury and mortality due to the temporary loss of approximately 0.13 ha of high quality Water mouse habitat (refer Section 10.6.8) • Increase in disturbance impacts from construction noise, vibration, dust and lighting (refer Section 10.6.13, 10.6.3 and 10.6.14) • Tunnelling under the intertidal areas south of Kangaroo Island will minimise the direct disturbance to the habitat and foraging areas for this species • The potential impacts on this species will be minimised by implementing the WMMP

Table note: * Denotes EPBC Act listed species

10.6.11 Fauna injury and mortality

Potential impacts relating to fauna mortality during construction of the Marine Crossing GTP are likely to occur during associated clearing and trenching/tunnelling activities within the ROW and construction site pads. Such activities may result in fauna mortality relating to displacement, resource competition and vehicle/boat/machinery strikes.

In addition to the possibility of some fauna mortality occurring during clearing activities, the loss of nesting resources may affect local prey and predator fauna populations into the future. Avian fauna may be less affected by the Project due to their ability to easily move from the zone of impact. However, it must be noted that the Powerful owl is known to abandon nests with minimal human disturbance, particularly early in the season (refer the SSMP for specific mitigation measures).

During the trenching phase of the Marine Crossing GTP ROW, the open trench will create an obstacle for fauna. The trench may effectively act as a large pitfall trap where fauna may fall in and fail to escape. The most serious implication for fauna is mortality related to heat stress and entrapment.

Vehicle and heavy machinery movement is another potential risk to fauna, particularly to the Water mouse and Squatter pigeon.

The works will result in an increase in the number of commercial vessels operating within The Narrows area. The increase in marine traffic has the potential to impact on the health and ecological value of the marine environment.

Turtles, dolphins and dugongs are surface-breathing marine animals and are susceptible to being injured or killed as a result of vessel strikes. These species are known to utilise the intertidal habitats of Kangaroo Island and also move through The Narrows.

Implementation of appropriate strategies will considerably reduce the potential for fauna mortality. It is therefore considered that impacts relating to fauna mortality during construction of the Marine Crossing GTP Project will be low and manageable.

10.6.12 Pests

During construction activities there is a risk of introducing and/or translocating pest/exotic species.

The works will result in an increase in the number of commercial vessels operating within The Narrows area. The increase in marine traffic has the potential to impact on the health and ecological value of the marine environment with the introduction of pest and/or introduced species.

Pest species can impact on the biodiversity of an area through increased competition for resources, habitat destruction, weed distribution, increase risk of diseases and predation.

Alternatively, the changes to the habitat structure as a result of exotic/invasive flora species may also have an impact on the fauna assemblages (ie some native species are susceptible to change and may be displaced by exotic/disturbance tolerant species).

The implementation of pest mitigation measures during construction will reduce the potential pest impacts of the Marine Crossing GTP Project (refer PWMP in Appendix B).

10.6.13 Noise and vibration

The level of sensitivity to disturbance has been shown to vary between migratory bird species (Burger, 1981; Thompson, 1992; Smit and Visser, 1993; and Lawler, 1995). A bird's response is likely to be influenced by a range of disturbance characteristics, including duration, frequency, volume and distance to disturbance source (Burger, 1981; Pfister *et al.*, 1992; and Lawler, 1995).

Potential impacts include increases in energy expenditure (through disturbance responses), reduction in food intake rates, reduced frequency of occurrence and abandonment of sites resulting in a reduction in habitat carrying capacity of a region (Hockin *et al.*, 1992; Pfister *et al.*, 1992 and Melvile, 1997). These impacts may ultimately influence the capacity of migratory marine species and shorebirds to successfully undertake migration and breeding (Hockin *et al.*, 1992 and Melville, 1997).

The adoption of the tunnelling construction technique will minimise the noise generation, especially compared to alternative marine crossing options (eg dredging works and HDD and associated construction access on the intertidal areas). However, noise and vibration generated during construction, may potentially impact on the distribution and behaviour of dugongs, marine turtles and cetaceans during the period that the noise and vibration are generated.

Marine turtles are capable of hearing vibrations that pass through their internal ear canals and they respond mostly to sounds between 200 to 700 Hz. Vibration has been demonstrated as causing negative impacts over several stages of embryonic development (Bartol and Musick, 2001). Jefferson *et al*. (2009) however highlighted that there is little information on how noise from pipe-laying and tunnel activities affects cetaceans, and no existing information is available on any potential noise and vibration impacts on dugongs.

Other marine mammals, for example dugongs and dolphins (both of which occur in the study area) may be disturbed through the construction process. This noise and vibration disturbance will occur during the sheetpile driving, tunnel boring and additional vessel movements during the construction period.

Impacts on fauna over two seasons may have further effects on populations due to a reduction on food reserve storage, increased energy consumption, reduced resting periods and increased competition for nesting and mating.

Potential noise and vibration impacts from the construction of the Marine Crossing GTP Project are not expected to impact upon commercial or residential sensitive receptors.

Construction activities on or near inter-tidal mudflats and roost sites, particularly when it is accompanied by intermittent loud noises (eg sheetpiling), have the potential to disturb migratory shorebirds within close proximity to those activities. As the operation of most key noise emitting construction equipment exceeds 100 dBA (refer Chapter 11 Table 11.8), there is the potential for some disturbance to shorebirds during construction although the impact is based on the noise level and duration of the activity and not on whether the activity occurs at night or during the day.

Tunnel shaft excavations and sheetpiling will occur 24 hours a day, seven days per week over a period of not more than 60 days between mid December 2012 and mid February 2013, reducing the duration of the related noise and vibration impacts to a shorter period. The 60 day construction window of the 24 hour activities includes an initial phase of sheet piling (approximately 15 days in total) followed by mechanical excavation of earth material for the launch shaft (approximately 45 days), continuing through to the commencement of the programmed tunnelling activities.

Also, it should be noted that the number of shorebirds that have the potential to be directly impacted upon during the construction of the GLNG GTP RoW are small compared to the total numbers of shorebirds supported by the Port Curtis shorebird area. This is due to the lack of suitable roosting habitats within close proximity to the GTP construction area.

It is likely that native fauna (eg Water mouse, birds roosting and feeding) in the adjacent intertidal and terrestrial habitats are likely to be temporarily disturbed as a result of noise impacts from Marine Crossing tunnel construction.

Some temporary disturbance of Water mouse and shorebirds may occur due to vibration from the TBM, however vibration levels are expected to be negligible.Regenerated underwater noise from vibration levels associated with the Marine Crossing tunnel in The Narrows will generally be at the lower range of background underwater noise levels and is considered to be negligible (refer Chapter 11).

10.6.14 Lighting

The use of lighting for both construction work and security may have both positive and negative impacts on migratory marine species and shorebirds in the area. DEWHA (2009b) refer to the impact of “excessive” lighting which may attract predators. The context with which excessive lighting could affect shorebirds is unclear. Light may improve the ability of foxes (*Vulpes vulpes*) and owls to detect roosting shorebirds, although neither of these species are major predators of migratory shorebirds in Australia.

Lights, particularly the creation of moonlight conditions on foraging habitat could attract additional shorebirds to the area at night. Some shorebirds, particularly sight feeding plovers, achieve higher food intake on moonlight nights (Turpie and Hockey, 1993 and Rohweder, 2000) and may capitalise on the improved visual conditions created by artificial light by actively moving to illuminated sites at night (Rohweder and Baverstock, 1996).

Artificial light may enable some species to increase feeding rates which could compensate for declines during the day through noise and movement disturbance.

The construction activities associated with the Marine Crossing GTP Project may alter the movement, roosting and feeding behaviour of those species identified within the vicinity of the Marine Crossing GTP Project. Commonly applied mitigation measures for shorebirds include minimising light spillage into intertidal areas and staging construction works outside of the migratory period when shorebirds are present in Australia.

Artificial lighting is known to affect marine species in a variety of ways. Species such as turtles have demonstrated disturbed and confused behaviour patterns (eg turtle hatchlings moving inland towards the light-source instead of swimming/moving out to sea) in the presence of artificial lighting. It should be noted however, that turtle hatchlings have only been recorded on the eastern side of Curtis Island and as such are unlikely to be disturbed by the artificial lighting from the Marine Crossing GTP Project.

Lighting pollution may potentially impact upon bat roosting sites within the immediate area.

Lighting impacts on fauna over two seasons may have further effects on populations similar to noise and vibration impacts. This is due to a reduction on food reserve storages, increased energy consumption, reduced resting periods and increased competition for nesting and mating.

It is considered that the potential impacts resulting from lighting used in the construction of the Marine Crossing GTP Project are expected to be acceptable and manageable as lighting will be undertaken in accordance with the control strategies outlined in Section 10.7.

10.6.15 Waste management

Potential impacts may include water contamination, land contamination from spills, increased occurrences of introduced/pest species and potential adverse effects to flora and fauna.

Due to the proximity of the works to the marine environment there is the potential for contaminants and pollutants to be introduced as a result of spills, leaks, runoff, inundation and also through wash-down activities. These contaminants and pollutants may impact on the local values of the marine environment. This is further detailed in Chapter 15.

The works will result in an increase in the number of commercial vessels operating within The Narrows area. The increase in marine traffic has the potential to impact on the health and ecological value of the marine environment with:

- Introduction of contamination (hydrocarbons, heavy metals)
- Ballast water discharge (biotic and abiotic parameters)
- Waste material

The Port currently operates in accordance with a number of legislative acts, policies and guidelines governing waste, ballast waters, discharges and maritime safety. All construction vessels associated with the Project will comply with the relevant legislation, policies and guidelines.

It is considered that the potential impacts resulting from construction of the Marine Crossing GTP Project are expected to be acceptable and manageable as construction works will be undertaken in accordance with the control strategies outlined in Chapter 14 and the WMP (refer Appendix F).

10.6.16 Acid sulfate soils

ASS are known to occur within the Marine Crossing GTP Project areas. The potential for this acidity to provide an enhanced impact on receiving environments is recognised in legislation (SPP 2/02). The generation of acid due to the oxidation of pyrite and/or monosulfidic material may have an impact on receiving environments through direct acidification and liberation of toxic metals. Impacts and risks can be avoided or reduced through the implementation of ASS management measures.

The proposed tunnel under the intertidal area and The Narrows will reduce the magnitude of surface disturbance of ASS and will reduce the amount of PASS material disturbed during construction to that associated with the subsurface marine clay sediment material directly removed during tunnelling. The proposed tunnel alignment will be in the geological units at depth (>5 m below ground level) beneath The Narrows. It is anticipated that ASS may also be encountered during the trenching work associated with the Marine Crossing GTP crossing of Humpy Creek and Targinie Creek, the construction of the tunnel launch and receptor shafts and construction site pads. ASS material and marine clay sediments disturbed during construction will be transported to the designated ASS treatment areas for treatment in accordance with the ASSMP. Groundwater seepage and rainfall runoff dewatering from construction activities will be pumped to designated water storage/treatment ponds for treatment in accordance with the ASSMP.

Further information on potential impacts from ASS is provided in Chapter 7.

10.6.17 Hydrological regimes

There are a number of water crossings that are intersected by the Marine Crossing GTP ROW. Altered flow regimes may impact on hydrology causing disturbance to marine and intertidal vegetation/habitat and impact on the health and movement of marine fauna.

The water crossings will be constructed by open trenching, with horizontal directional drilling used for the tunnelling underneath the intertidal areas south of Kangaroo Island and the marine waters of The Narrows where there is sensitive habitat.

There will be minor negative impacts on marine fauna through the alteration of hydrological regimes.

It is considered that the potential impacts resulting from construction of the Marine Crossing GTP Project are expected to be acceptable and manageable as construction works will minimise the permanent alteration of watercourse flow regimes.

10.6.18 Cumulative impacts

This cumulative impact assessment on terrestrial ecology is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EMP.

Clearing for the LNG projects may adversely impact on terrestrial flora and fauna through direct loss of species or by increasing fragmentation of terrestrial habitat and by creating edge effects. Terrestrial fauna may be impacted by increased noise and lighting and by injuries and fatalities from vehicle impacts. Marine flora and fauna may be affected by direct habitat loss, particularly salt marsh and mangroves, by water pollution from a variety of sources and by disturbance from night-time lighting, noise and vibration.

Terrestrial flora (Regional Ecosystems and threatened species)

The combined loss of vegetation communities and protected species resulting from the removal of vegetation within the ROW of each project is an additive impact that has already been considered in each project’s EIS. There may also be additional cumulative impacts such as fragmentation of habitats.

This impact will start to lessen after site rehabilitation is complete with re-colonisation taking place on cleared areas outside the permanent easements that are subject to ongoing vegetation management. There may be as a result of combined planning, opportunities to lessen the overall land disturbance required by shared use of cleared areas.

Terrestrial flora (altered hydrogeology, ASS acidification, dust and fuel spills)

Any vegetated areas that are retained within the ROW, and the areas of adjoining native vegetation may be exposed to increased edge effects as a result of the cumulative actions of the Marine Crossing GTP Project and other infrastructure projects, particularly where these result in extended timeframes for impacts.

Dust deposition impacts on this vegetation may also be intensified by overlapping construction activities which result in increased overall dust levels or prolonged where the construction programmes do not overlap. A prolonged impact over several seasons may be particularly detrimental to vegetation as natural growth and seeding cycles may be affected by dust deposition. Each project will need to strictly manage dust levels to minimise deposition on adjacent vegetation. If rainfall does not occur and remove dust from vegetation, each project should consider low pressure water sprays to remove dust from vegetation. Alternatively, retention of a vegetated buffer inside the infrastructure corridor would protect vegetation located outside of the corridor.

The potential for contamination of stormwater runoff, and contaminant levels in stormwater runoff are both potentially increased by overlapping construction activities. This will be addressed through the implementation of erosion and sediment control measures.

Cumulative impacts will be minimised if management measures undertaken by each proponent to manage these impacts for each individual project are effective. Hence, while additional management measures are not proposed in relation to cumulative impacts, the importance of management measures to address edge effects for each project must be highlighted.

There will be minor negative cumulative impacts on terrestrial flora from pipeline construction within the vicinity of the Marine Crossing GTP Project.

Terrestrial flora (weeds)

Potential for cumulative impacts from weed invasion is likely as multiple projects being constructed at similar times and locations will increase the amount of soil being disturbed. Hence vulnerability of native extant vegetation communities/species to exacerbation of existing weed problems in the area. The risk of introducing new weeds could also be exacerbated over and above that of each project due to the overall number of vehicles/machinery, spoil/topsoil and personnel entering the site, thereby increasing the risk of introduction of weed seeds to the ROW and distribution of seeds across the project footprints.

The weed procedures and actions used for each project will be reliant on the enforcement for all projects (ie if one project is not as diligent as others, there is an increased risk of weed infestation in other project areas).

Overlapping construction activities over approximately 21 months may also exacerbate the spread of weeds by encouraging the multiple reworking of excavated material and topsoil through successive phases of development.

Overall, the risk of weed invasion for multiple projects is exacerbated compared to individual projects, and each project must be more diligent in relation to weed prevention and management than would be the case for individual projects occurring in isolation.

There will be moderate negative cumulative impacts on terrestrial flora (weeds) from pipeline construction within the vicinity of the Marine Crossing GTP Project.

Terrestrial fauna (habitat loss)

Previous studies have identified a large diversity of terrestrial vertebrate fauna both native and introduced (refer Sections 10.5.4 and 10.5.8).

As discussed above, it is assumed that all habitats within the Marine Crossing GTP Project disturbance footprint as shown on Figure 10.3 will be cleared of existing vegetation communities. The combined loss of fauna habitat resulting from the removal of vegetation within the ROW of the projects is a simple additive impact that has already been considered in each projects' EISs. Hence, direct cumulative impacts on loss of habitat are not considered further.

With multiple projects, localised fragmentation (see below) and wider edge effects (weeds, dust, noise disturbance etc) effectively add to loss of habitat.

This impact would occur for the full 21 months of works on site and then reduce in scale as temporary areas (eg Access Road, construction site pads, ASS treatment area) are revegetated following construction. The corridors themselves would be subject to permanent vegetation control in accordance with the LRMP (refer Appendix F). The longer term habitat loss effects will generally be additive. Therefore, no additional mitigation measures to this EMP are required.

Terrestrial fauna (fragmentation, death and injury)

Potential cumulative impacts include increased fragmentation of terrestrial fauna habitat, particularly where this results in fauna moving across construction areas, either to escape from vegetation clearing, or to access other habitat areas. Cumulative impacts may also include the creation of multiple, potentially wider corridors that will further impede fauna movements.

The cumulative disturbance footprints of other proponent's infrastructure dissect a zone (which includes terrestrial woodland) identified by DEHP as a State Significant Bioregional Wildlife Corridor or their Biodiversity Planning Assessment (BPA) mapping, hence it is likely that animals will be seeking to move across the construction areas. These animals may be vulnerable to death or injury from construction vehicles and trench fall as they cross the construction area and the likelihood of death and injury will increase cumulatively with the three LNG projects due to increased hazards.

From the EIS and preclearing fauna survey data there do not appear to be any times of the year when native animals in the area are more vulnerable to fragmentation effects.

There will be moderate negative (permanent) cumulative impacts on terrestrial fauna (fragmentation, death and injury) from pipeline construction within the vicinity of the Marine Crossing GTP Project.

Terrestrial fauna (light, noise and vibration)

The level of fauna diversity identified by the surveys and the fact that the area is designated as a State Significant Bioregional Wildlife Corridor by the Biodiversity Planning Mapping (BPA) mapping indicates that large numbers of fauna movements across the footprint could be expected.

Impact of night time lighting, noise and vibration from multiple LNG project ROWs may potentially have a wider area of disturbance.

Activities could interfere with breeding and a 21 month period of construction activities in the area could worsen impacts on fauna in habitat adjacent to the corridor by disturbing two breeding cycles.

There will be minor negative cumulative impacts on terrestrial fauna (light, noise and vibration) from pipeline construction within the vicinity of the Marine Crossing GTP Project.

Marine and intertidal ecology

Marine flora and fauna may be affected by direct habitat loss, particularly salt marsh and mangroves, by water pollution from a variety of sources and by disturbance from night-time light, noise and vibration.

Marine and intertidal flora and fauna (loss of habitat, direct disturbance)

Works by other proponents in the intertidal areas and The Narrows will lead to a direct loss of habitat which forms part of the state significant Bioregional Wildlife Corridor (BPA), in particular:

- Mangroves
- Salt marshes
- Intertidal banks
- Wetland areas

The Marine Crossing GTP will not directly impact on the intertidal areas and The Narrows. Indirect impacts from construction noise, vibration and light spill will contribute to the cumulative impacts.

The combined loss of fauna habitat resulting from the removal of vegetation within the ROW of the projects is an additive impact that has already been considered in each projects' EISs. Hence, direct cumulative impacts on loss of vegetation, habitat or individual species are not considered further. Seagrass is a key source of food for species such as turtles and dugongs. As the Marine Crossing GTP Project is adopting a tunnelling approach to cross The Narrows, GLNG Operations will not contribute to the direct loss of seagrass and hence there is no cumulative impact on seagrass associated with this Project.

Marine/aquatic fauna (barriers to movement)

The creation of temporary bridges, culverts or temporary stream diversions across watercourses may create barriers to fish or other aquatic fauna movements in the creeks. The presence of more than one barrier on an individual watercourse put in place by different projects could represent a cumulative barrier to migration and/or isolate populations within a stretch of a watercourse.

Measures set out in this EMP and the AVMP will result in minor negative cumulative impacts on marine/aquatic fauna (barriers to movement) from pipeline construction within the vicinity of the Marine Crossing GTP.

Marine and intertidal flora (altered hydrology)

Changes to hydrology result in a change to the flow of freshwater and nutrients to mangroves which are susceptible to altered hydrological regimes. This impact will be exacerbated by an increased area of disturbance in the catchment area that supports adjacent mangroves.

Measures set out in this EMP and associated management plans will result in moderate negative cumulative impacts on marine and intertidal flora (altered hydrology) from pipeline construction within the vicinity of the Marine Crossing GTP.

Marine and intertidal flora (changes in water quality)

Mangroves, wetlands and seagrass may experience a variety of impacts from releases of pollutants associated with construction works, comprising:

- Increase in turbidity and sedimentation - Seagrass communities in The Narrows may suffer smothering from increases in sedimentation resulting from a variety of sources, which could include a relatively minor contribution from the Marine Crossing GTP construction activities
- Downstream creeks may be subject to increased suspended solids resulting from erosion by stormwater runoff on land
- Escape of tunnelling cutting fluid through substrate and release of bentonite to surface waters could lead to other localised increases in suspended sediment. Such releases would be accidental in nature and are not anticipated. They are avoidable through appropriate drilling techniques and pollution control measures as part of each projects' individual EMP
- Large scale acidification of surface waters could cause the mobilisation of phytotoxic compounds (in particular Aluminium) with resultant damage to marine plants. Provided appropriate ASS Management Plans form part of each projects' EMP this will not form a cumulative impact

These impacts will all be subject to project specific controls (eg ASS Management Plan, ESC Management Plan) and assuming these are effective, the cumulative impacts would be limited to the prolonging of low level impacts by the combined construction of three separate LNG projects.

Measures set out in this EMP will result in minor negative cumulative impacts on marine and intertidal flora due to changes in water quality, as a result of pipeline construction within the vicinity of the Marine Crossing GTP.

Marine and intertidal fauna (changes in water quality)

Marine and intertidal fauna may experience a variety of impacts from releases of pollutants associated with construction works comprising:

- Changes in water quality from ASS - Acidification of surface waters could result in fish kills and other impacts on the marine and intertidal ecology. However, well established methods exist to manage ASS and if these are implemented, significant impacts are unlikely
- Increases in toxicity as a result of accidental spills of fuels and oils and other contaminants from site works, which will be subject to individual project management controls
- Toxicity of hydrotest water discharge will be avoided by not using toxic ingredients
- Loss of benthic food sources (especially seagrass) resulting from cumulative impacts on water quality may result in a loss of viability of local fauna populations

These impacts will all be subject to project specific controls (eg ASS Management Plan, ESC Management Plan) and the cumulative impacts would be limited to the prolonging of low level impacts by the combined construction of three separate LNG projects.

Measures set out in this EMP and associated management plans will result in minor negative cumulative impacts on marine/intertidal fauna (changes in water quality) from pipeline construction within the vicinity of the Marine Crossing GTP.

Marine fauna (noise and vibration impacts on marine fauna)

Marine works may have an impact on the behaviour and health of marine fauna, including dolphins, dugong, fish and turtles. The source of this noise and vibration is expected to be:

- Marine piling
- Dredging (GPC and other LNG proponents)
- HDD activities (other LNG proponents)
- GLNG construction activities (eg tunnelling, sheetpiling for construction site pads)

While piling works and dredging could have noise and vibration impacts on marine fauna, the tunnelling works associated with the GLNG Marine Crossing GTP will not significantly contribute to marine noise and vibration impacts and hence not contribute to a cumulative impact. Light is not expected to affect turtle nesting as this occurs on the east side of Curtis Island (Worley Parsons, 2010a).

Measures set out in this EMP will result in negligible cumulative impacts, due to noise and vibration on marine fauna.

Marine fauna (boat movements)

Marine fauna may experience death, injury or disturbance from boat movements associated with the other LNG proponents' pipeline construction works in The Narrows, Laird Point, Friend Point and also with GPC Western Basin dredging works within Port Curtis.

Cumulative impacts from the increased number of boat movements are anticipated. Cumulative boat movements may result in:

- Increased disturbance of marine fauna and impact on the behaviour of marine species. In particular, the area is within a Dugong Protection Area and this may result in disruptions to dugong feeding on seagrass beds
- Increase in direct collisions with marine species potentially resulting in fatalities or severe injuries
- Disruptions to turtle feeding and breeding cycles as turtles may use The Narrows for feeding and resting prior to nesting on the eastern side of Curtis Island, particularly during the peak activity period which occurs between November and January

Cumulative impacts associated with boat movements will be more intense and for a longer duration as a result of the combined construction programmes of pipeline works. In total, it is anticipated that works will occur within the vicinity of the Marine Crossing GTP over a 21 month period potentially impacting more than one breeding season. However it should be noted that boat movements associated with Marine Crossings construction are a small subset of boat movements in the area and need to be managed as part of wider coordination of maritime traffic around Gladstone Harbour.

Measures set out in this EMP will result in moderate negative cumulative impacts on marine fauna (boat movements) from pipeline construction within the vicinity of the Marine Crossing GTP.

Migratory birds and shorebirds

Night time lighting, noise and vibration close to wetlands and intertidal areas may disturb migratory and other shorebirds feeding in The Narrows, particularly in the intertidal and sub tidal areas on the intertidal edge. This is described by DEHP as a major shorebirds feeding site.

Construction activities, which are potentially 24 hours per day will arise from all projects with certain activities such as tunnelling (ie GLNG) and sheetpiling (ie GLNG, QCLNG, APLNG) causing periodic peak noise and vibration emissions.

This may lead to cumulative impacts on migratory marine birds which are known to inhabit the edge of the Kangaroo Island wetlands between September and March. Larger areas will be potentially affected during periods of overlap. The overall programme covers a 6 to 9 month period during 2012 and 2013 where overlapping construction activities for all LNG projects is likely to occur.

Measures set out in this EMP and associated management plans will result in moderate negative cumulative impacts on migratory and shorebirds due to increases in light, noise and vibration impacts from pipeline construction within the vicinity of the Marine Crossing GTP.

10.7 Potential operational and decommissioning impacts

Tables 10.24 and 10.25 show impacts associated the Marine Crossing GTP Project during operation and decommissioning phases.

Table 10.24 Impacts associated with operational phase

Project aspect	Impacts
GTP general operations	Contamination of surface water and groundwater from leaks or spills
Operational monitoring – use of vehicle and plant	Introduction of weeds into the Marine Crossing GTP ROW
	Erosion and mobilisation of sediments into downstream areas
	Accidental spills of fuel, hydraulic fluids or other materials, and resultant contamination of land and/or water

Table 10.25 Impacts associated with decommissioning phase

Project aspect	Impacts
Purging and cleaning of pipe	Contamination of surface and groundwater
Use of vehicle and plant during decommissioning	Introduction of weeds into the Marine Crossing GTP ROW
	Erosion and mobilisation of sediments into downstream areas
	Accidental spills of fuel, hydraulic fluids or other materials, and resultant contamination of land and/or water

The operational and decommissioning impacts will be minimised by implementing mitigation measures in Tables 10.27 and 10.28, the OMP, PWMP (refer Appendix B) and the LRMP (refer Appendix E).

10.8 Environmental protection commitments, objectives and control strategies

Table 10.26 identifies the management measures and performance indicators that will be implemented during the pre-construction and construction phases of the Marine Crossing GTP Project to manage potential impacts on the flora and fauna and their habitat.

Table 10.27 identifies the management measure and performance indicators that will be implemented during the operational phase of the Marine Crossing GTP Project to manage the potential impacts on flora and fauna and their habitat.

Table 10.26 identifies the management measure and performance indicators that will be implemented during the decommissioning phase of the Marine Crossing GTP Project to manage potential impacts on flora and fauna and their habitat.

Construction, operational and decommissioning activities will be undertaken in accordance with the conditions of the CG Report, the EPBC Act controlled action approvals and other environmental approvals for the Marine Crossing GTP.

In the case of the significant flora and fauna species that have been determined to potentially exist within the habitats described above, specific management measures for the protection of these species are provided in the SSMP, SMP and WMMP.

Table 10.26 Construction mitigation measures for the management of flora and fauna impacts

Aspect	Outcome
Environmental Protection Objectives	• Avoid, minimise or manage direct and indirect ecological impacts from the Marine Crossing GTP Project • Rehabilitate disturbed areas to as close as practical to the pre-construction condition
Specific Objectives	• Minimal disturbance of terrestrial, intertidal and marine flora and fauna during construction of the pipeline, associated tracks, services and accommodation facilities • No unplanned or unapproved damage to flora and fauna • No overall net loss of threatened species or communities • Where practically possible restored ROW compatible with the surrounding conditions and pre-construction land use and compatible with the operation of the GTP • No spread of LP Act declared pest/weed species and compliance with the PWMP • Weed control programmes prioritised to high risk areas adjacent to land of conservation significance • Topsoil and vegetation material will be respread in the immediate vicinity of the area of origin to limit the potential spread of weeds and pathogens

Aspect	Outcome
Control Strategies	**General** • No invasive works (eg clearing, trenching) is to be undertaken until all local, State and Commonwealth approvals are obtained. The works will comply with the all relevant approval conditions (eg EPBC Act controlled action , NC Act approval, GTP EA) • Ensure that all the approval conditions have been addressed or adequate measures are included in the relevant management plans to address these conditions • Ensure that suitably qualified personnel are engaged to undertake specialist environmental investigations • Prior to carrying out field based activities, all relevant staff, contractors or agents carrying out those activities are to be aware of the location and environmental values of ESA Category A, B and C (refer Figure 10.1) • Prior to construction, an assessment will be undertaken of the condition, type and ecological value of any vegetation in such areas where the activity is proposed to take place. The assessment will be undertaken by a suitably qualified person(s) and include the carrying out of field validation surveys, observations and mapping of any ESA Category A, B or C. Ground truth, delineate and biocondition assess significant communities and the presence of species classed as 'endangered', 'vulnerable', or 'near threatened' under the provisions of the NC Act and any other species listed in the SSMP • Plan to commence clearing and bulk earthworks during the dry season wherever possible to avoid any unnecessary impacts on aquatic fauna • Prior to site entry, all site personnel, including contractors will be appropriately trained and made aware of the sensitive environs in which they will be working
	• All contractors and staff will be briefed on the environmental values of the area and that all native fauna are protected, including snakes prior to working within the ROW • All staff and contractors will be inducted for awareness of fauna management and relevant personnel will be trained in fauna management and handling. A fauna handling procedure will be developed and implemented during construction • Fauna will not be fed • Appropriate signage will be erected near sensitive habitats or nesting areas • Construction site plans will be finalised, including: – Extent of the clearing works – Environmentally sensitive areas – Identification of 'no go' zones – Where necessary, fencing requirements – Microhabitats, including habitats trees to retained **Vegetation clearing** • Prior to clearing activities beginning, detailed ecological surveys will be undertaken along the entire disturbance footprint of the Marine Crossing GTP Project, as well as any ancillary areas in accordance with conditions 5 to 10 of the EPBC Act controlled action approval. As a minimum, these surveys will target listed threatened species, migratory species and their habitats as well as ecological communities under the EPBC Act, VM Act and NC Act. Ground truthing of remnant communities listed under the VM Act will also be undertaken at this time to determine any discrepancies in State mapping which may in turn also apply to Commonwealth listed communities • These surveys will be undertaken in accordance with relevant Commonwealth survey guidelines and best practice. Where Commonwealth guidelines are not available, State guidelines will be adopted • All ecological surveys will be undertaken by suitably qualified ecologists who are approved by the Commonwealth prior to the survey period • Upon completion of the targeted surveys, a report detailing the survey methodologies and the field results will be provided, to the relevant State and Commonwealth agencies and additionally published on the Proponents website. This report will also include the potential impacts to the species as a result of clearing activities along with a quantification of the impacts

Aspect	Outcome
	• Appropriate permits for the clearing of vegetation, including any marine vegetation, will be obtained prior to the commencement of construction • All vegetation clearing will comply with clearing approval conditions (eg EPBC Act, EP Act, NC Act and other statutory approvals) • Clearing is a last resort – retention of vegetation, selective clearing, trimming and fauna spotting is the first priority • A programme to implement offsetting of cleared vegetation communities will be undertaken as required, in accordance with legislative criteria for the offsetting of significant vegetation communities. The Project biodiversity offset strategy and management plan will be developed • The location of vegetation to be retained will be clearly indicated on all construction drawings • Flagging of clearing boundaries though areas of significant vegetation will be completed during the pre-construction pegging of the pipeline alignment • Prior to the commencement of construction clearing, a suitably qualified and experienced EO will mark out with barricade webbing, flagging tape, fluorescent dye or similar, the approved clearing areas and both temporary and permanent 'no go' zones • High quality Water mouse habitat adjacent to the disturbance footprint is to be clearly marked a 'no go' zone prior to construction (refer WWMP for further details)
	• Ensure 'no go zones' are clearly sign-posted/ delineated on site prior to the commencement of works. The relevant EO will ensure that the clearing footprint and all 'no go' zones are adequately marked out for the clearing crew (with highly visible material) • Areas of vegetation to be cleared within the Marine Crossing GTP ROW will be restricted to a maximum width of 30 m • All vegetation clearing will be confined to the Marine Crossing GTP Project disturbance footprint unless relevant permits and/or licenses have been approved. Any unauthorised clearing will incur an immediate stop work and a rehabilitation plan will be developed and approved by GLNG prior to commencing that activity again. The rehabilitation plan will include timeframes • Access tracks, laydown areas and other associated clearing will be placed outside of significant RE areas, where possible (ie 'endangered', 'of concern', or those analogous to an EPBC threatened ecological community) • With the exception of the Marine Crossing GTP Project ROW, construction site pads and Access Road requirements, clearing of remnant vegetation will not exceed 10 m in width for the purposes of establishing tracks and 25 m in width for dual carriageway roads unless otherwise approved by the administrating authority in writing • Clearing and disturbance in riparian areas will be minimised to a width that is necessary to safely construct the pipelines and meet other environmental requirements (eg separation of stock piles, erosion control) and will be controlled by: – education of all personnel on procedures for working in these environments – reviewing and accepting detailed procedures to be submitted prior to commencing these activities – continuous monitoring of these sensitive operations to ensure compliance with the procedures • The relevant EO will coordinate with the spotter catchers and construction team during clearing activities

Aspect	Outcome
	• A licensed and suitably experienced spotter catcher(s) will be present at each clearing front. Spotter catcher(s) will have experience in the range of likely fauna to be encountered during clearing of vegetation (eg small fauna as per the SSMP requirements) • Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the activity and into adjacent natural areas • Where constructability allows, micrositing or selective clearing to avoid habitat trees (including hollow bearing trees) and other microhabitats identified during the preclearing surveys • Unless otherwise agreed by DNPRSR and SEWPaC, both active nests of significant species and their immediate surrounding area(s) will be declared temporary 'no go' zones until the chicks have left the nest. The spotter catcher or the EO will regularly check the status of active nests in a way that does not risk the nest being abandoned by the breeding pair (adult birds) • Due to the selective nature of Gliders and their food resources, Glider feeder trees will be retained wherever possible • Stockpiled material (including mulch, rocks and cleared timber) will be placed in an already cleared area • Cleared native vegetation and timber will be stacked in piles and/or respread over the ROW to provide fauna habitat and assist revegetation (subject to landholder agreement). A "no burning" policy will be implemented • The natural regeneration of native species will be encouraged (in particular, groundcover and shrub species). However, seeding will be utilised in areas where rapid restoration is required (eg watercourse crossings and areas of high erosion potential)
	• Wetlands will be regenerated naturally. This will be achieved through regular weed control, maintaining existing tidal regimes, and mitigating issues with ASS • Where reasonably practical, work with the landholder to exclude stock from ROW during rehabilitation and also ESAs adjacent the ROW • Where applicable, collection of local provenance seed from the listed communities will be carried out prior to the commencement of clearing activities throughout the time between contract award and commencing clearing **Conservation and commercially significant flora** • A pre clearing vegetation survey will be completed in targeted areas of the ROW to identify and flag individual 'endangered', 'vulnerable' and 'near threatened' (EVNT) species and trees that contain hollows that may be avoided during construction • Implement the WWMP during the pre-construction and construction phases • Where avoidance is not possible, the loss of EVNT environmental values will be offset in accordance with the requirement of the biodiversity offset strategy and the Queensland Government Environmental Offset Policy 2008 • The Project biodiversity offset strategy and management plan will be developed and implemented for significant vegetation communities over an appropriate timeframe to accomplish the following specific aims: – Identification of suitable potential offset areas with ecological values analogous to impacted ecological communities – Assessment of the ecological value and equivalence of offsets to ensure suitable offset extent, species assemblage, floristic structure and ecological integrity utilising an appropriate biometric field methodology – Development of appropriate management prescriptions to ensure long term viability of offsets (such as pest control, livestock management, access exclusion, ameliorative plantings and fire regime management) – Placement of appropriate covenants for future conservation and management of offsets – Development of appropriate monitoring and maintenance activities and performance review processes to ensure long term viability of the offsets – The process of developing a suitable biodiversity offset management plan for the Project will be an iterative process with State and Commonwealth regulatory bodies

Aspect	Outcome
	• The route has been selected to avoid disturbance to EVNT flora species as far as possible and to minimise fragmentation and habitat disturbance of protected fauna species • The Contractor is responsible for implementing the relevant requirements of the SSMP • The clearing of any EPBC listed threatened ecological communities will be undertaken in accordance with any approval conditions issued by the SEWPAC, DEHP, DNRM, DNPRSR and/or relevant regional councils (this will be particularly relevant because of fauna habitat that may be associated with the community) **Marine megafauna** • No marine animals will be harassed or physically moved on at any time • Sonar devices on vessels will have operating frequencies above 200 kHz to minimise the impact upon dolphins and dugongs that may be present in Port Curtis **Migratory birds and shorebirds** • Visual barriers between the construction site pad (mainland) and the identified roost areas will be erected when migratory birds are within 300 m of the construction site pad (mainland) to minimise disturbance to migratory birds. The design and erection of the barriers will be undertaken in consultation with both GLNG Operations and ecological specialists
	Lighting • Lighting for work related activities will comply with the Occupational Health and Safety guidelines and will be hooded and directed so that light spill on roosting birds and marine fauna is minimised • Where a listed migratory species roosting area or route is identified, working hours for trenching will be restricted to daylight hours • Direct temporary lighting away from light-sensitive areas. Light shades and low lighting will be applied to construction and operational areas located adjacent to remnant native vegetation and intertidal areas **Noise and Vibration** • Potential noise and vibration issues have been reduced as a result of construction methodologies and procedures. However as there is a risk that cumulative noise and vibration issues could have a potential impact on migratory listed species, seasonal monitoring will be undertaken to assess the populations and distribution of the listed migratory species in applicable areas surveyed during baseline/pre-clearance surveys **Vessel movement** • The Construction Contractor will comply with all vessel movement requirements within Port Curtis (ie EPBC Regulations 2000, Regulation Part 8 – Interaction with Cetaceans and Whale Watching, Port of Gladstone speed limits and approved routes) where safety allows • A risk assessment of potential marine pest introductions will be carried out for each proposed pipeline related vessel • For Project vessels that are considered high risk, inspections of the hulls and/or hoppers will be carried out, and, for overseas vessels, preferably before they depart for Australian waters • GLNG will require that all chartered vessels adhere to the International Maritime Organisation's voluntary ballast water management guidelines • Project related vessels will abide by the Port of Gladstone speed restrictions and exclusion zones • Project related vessels will be aware of marine mammals in Port Curtis and undertake works in accordance with the regulatory approvals and the relevant Management Plans (eg SSMP)

Aspect	Outcome
	Training and education • Training will be provided for all staff on the environmental values of the area, including threatened and migratory fauna and the sensitivity of wetlands • Construction crews working within the intertidal and marine zones will receive additional marine fauna training which will provide them with the necessary skills to spot/identify marine fauna and follow the procedures required when working in these environments (eg to reduce risk of boat strike etc). This additional training will also inform the work crews of intertidal and marine no go/exclusion zones • Signage will be used to notify construction staff of the reasons why trespassing on these ecosystems is prohibited and the impacts this might have • Barriers will be erected around ecologically sensitive areas to visually and physically enforce the need for avoidance of disturbance to these areas **Dust impacts on adjacent vegetation** • Dust suppression mechanisms will be put in place to ensure excessive dust deposition does not occur, especially in ESAs (including the foliage of significant plants and ecological communities adjacent the disturbance footprint and watercourses and wetland ecosystems) • Construction sites and Access Roads will be watered on an as required basis to minimise the potential for environmental nuisance due to dust. Watering frequency will be increased during periods of high risk (eg high winds) • The extent and period of exposure of bare surfaces will be minimised **Weeds** • The Construction Contractor will implement the PWMP (refer Appendix B) to minimise the risk of weed and pest species establishing within and adjacent to the ROW. The PWMP specifically addresses: – The location of areas requiring weed control – The prevention and management of weed disturbance to significant ecological communities
	• The weed Contractor will be appropriately licensed and experienced to implement the PWMP • Weed control measures will be designed to minimise impacts on native fauna (eg use of aquatic and frog friendly chemicals) (eg Roundup Bioactive ™) • All removed weeds, weed-affected materials and rubbish should be appropriately disposed of accordance with Local Council guidelines to ensure that propagules do not restabilise in infested areas **Edge effects** • Vehicle and pedestrian access to and from the Marine Crossing GTP Project will be restricted to the defined access tracks • Refer to the above weed related mitigation measures

Aspect	Outcome
	Fire • Fire risk will be minimised through evaluation processes and management of those risks • Activities with an increased risk of creating an ignition source will be restricted in accordance with local fire bans or in times of high fire danger • A plan for rapid and co-ordinated response to the outbreak of fire will be maintained through an established fire response plan in conjunction with the local metropolitan and rural fire brigades • Fire safety awareness training will be conducted as part of site inductions • Any fire bans will be adhered to • Fire fighting equipment will be maintained at all hot work sites • The following precautions will be taken to minimise the possibility of fire due to welding activities: – The construction area along the ROW (other than the designated stockpile areas) will be cleared of combustible vegetation to reduce the risk of fire – Stockpiled vegetation will be separated from welding activity – Water trucks (also used for dust suppression) will be available for use as fire trucks in the event of fire **Erosion and sedimentation** • Trench spoil will be stockpiled a minimum of 15 m from watercourses **Loss of habitat** • Prior to the commencement of construction clearing, a licensed and experienced spotter catcher(s) will undertake a preclearing survey of mapped habitat to ensure there are no active roost and/or nests within or immediately adjacent the disturbance footprint. This will be done to reduce the overall risk of injury or fatality to local inhabitants during clearing activities • Prior to the commencement of construction clearing, a licensed and experienced spotter catcher(s) will begin relocating fauna. This will be done to reduce the overall risk of injury or fatality to local inhabitants during clearing activities and will focus on key nests and hollows within the disturbance footprint • In designated areas (areas where hollow bearing trees are limited or the removal of habitat trees into this area are limited) install habitat nest boxes prior to clearing works • If colonial species roost(s) are located within or within close proximity to the Marine Crossing GTP Project all practical and reasonable steps will be taken to avoid disturbing these sites. This will include: – The investigation of alternative construction measures near known and/or high value roost areas (eg caves) that will not compromise the stability of sandstone ridges containing bat caves/roosts – The retention of habitat trees in particular known roosting sites through micrositing the ROW or looping branches
	• Where habitat is to be cleared, appropriate mitigation measures will be implemented including adopting a protocol to ensure that appropriately licensed (DEHP/DNPRSR approved) and experienced spotter catchers are onsite during all clearing • Unless otherwise agreed by DEHP and DNPRSR, both active nests of significant species and their immediate surrounding area(s) will be declared temporary ‘no go’ zones until the chicks have left the nest. The spotter catcher or the EO will regularly check the status of active nests in a way that does not risk the nest being abandoned by the breeding pair (adult birds)

Aspect	Outcome
	• Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the activity and into adjacent natural areas • Where constructability allows, micrositing or selective clearing will be undertaken to avoid habitat trees (including hollow bearing trees) and other microhabitats identified during the preclearing surveys • Due to the selective nature of Gliders and their food resources, Glider feeder trees will be retained wherever possible and practicable • Cleared native vegetation and timber will be stacked in piles and/or respread over the ROW to provide fauna habitat and assist revegetation (subject to landholder agreement). A "no burning" policy will be implemented • A licensed and experienced spotter catcher (s) will be present during earthworks to mitigate potential impacts to fauna (including fossorial species). Only trained personnel (eg qualified spotter catchers) will remove fauna from trenches • Clearing and disturbance in riparian and marine plants will be minimised to that necessary to safely install the pipelines and meet other environmental requirements (eg separation of stock piles, erosion control) and will be controlled by: – education of all personnel on procedures for working in these environments – reviewing and accepting detailed procedures to be submitted prior to commencing these activities – continuous monitoring of these sensitive operations to ensure compliance with the procedures • Timber will be stacked in piles to provide fauna habitat and assist revegetation (subject to landholder agreement). A "no burning" policy will be implemented • Regrowth of natural vegetation in parts of the pipeline corridor not required for routine operation and maintenance will be encouraged in order to partially address fragmentation of habitat for small animals including birds, mammals, reptiles and amphibians **Fragmentation and loss of fauna movement opportunities** • Regrowth of natural vegetation in parts of the ROW not required for routine operation and maintenance will be encouraged in order to partially address fragmentation of habitat for small animals including birds, mammals, reptiles and amphibians **Conservation significant fauna species** • Fauna management procedures will be developed as part of the EMP, and be made available to GLNG Operations as requested and will detail all fauna mitigation measures • Where required, notify DEHP, DNRM and/or SEWPaC of any new species not previously discussed in the EIS, SEIS, SSMP or the SMP • Pre-construction surveys will identify koala habitat as defined under the *Nature Conservation (Koala) Conservation Plan 2006* and any specific mitigation measures and habitat offsets for residual impacts to koala habitat will be identified and implemented • Where Access Roads, tracks and ROW traverse suitable koala habitat (including RE12.3.3), fence design will incorporate the need to allow movement of koalas and other fauna species

Aspect	Outcome
	• Expert advice will be sought to assist in identifying the need and location of crossing points for gliders and other arboreal species (eg Koalas) • Consult and brief local wildlife carers and vets on the Project timing and works. This will include finalising the identification of primary and secondary wildlife carers within an area and procedures for injured fauna • If significant fauna species are located within the ROW and cannot be avoided, individuals will, where practicable, be relocated using measures outlined as follows: – Individuals will be collected by a suitably licensed and experienced spotter catcher and placed in an appropriate container/bag for relocation – Individuals will be relocated to a location nearby providing similar habitat appropriate for that species – Numbers and location of individuals relocated will be recorded for reporting purposes – Hygiene protocols will be implemented and adhered to (eg measures for control of chytrid fungus which is a known pathogen of frogs) – The time taken for relocation must, where practicable, be kept to a minimum to minimise stress to the animal. A report outlining the potential relocation will be submitted to the DNPRSR prior to the commencement of construction activities • Where avoidance is not possible, the loss of EVNT environmental values will be offset in accordance with the requirement of the biodiversity offset strategy and the Queensland Government Environmental Offset Policy 2008 **Fauna injury and mortality** • Local wildlife carers and vets will be briefed on the Project timing and works. This will include finalising the identification of primary and secondary wildlife carers within an area and procedures for injured fauna • Protocols and/or actions for when a threatened species or significant species is encountered during the clearing or construction works will be developed (eg stop works, create a buffer zone and consultation with DNPRSR) • Staff will be educated on minimising risk to fauna, including restricting speeds, covering holes and pits and checking areas prior to clearing • Traffic speeds will be limited in areas of high habitat value or known movement corridors, especially during dusk and dawn. Vehicle and machinery speed limits will be restricted to a maximum speed limit of 50 km in the GTP ROW. • All native fauna is protected, including snakes, and will only be handled in accordance with the GLNG GTP Fauna Handling Procedure • Where a temporary 'no go' zone cannot be established, a qualified and experience spotter catcher(s) will relocate the nest or breeding place to suitable habitat • Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the activity and into adjacent natural areas

Aspect	Outcome
	• Any animals injured by clearing activities will be referred to an appropriate wildlife carer group or veterinarian. DNPRSR will also be notified within 24 hours of any injuries or deaths • A licensed and experienced spotter catcher (s) will be present during earthworks to mitigate potential impacts to fauna (including fossorial species). Only trained personnel (eg qualified spotter catchers) may remove fauna from trenches • Where practicable, temporary exclusion fencing to restrict fauna access to the trench will be installed • The following measures will be adopted to prevent fauna entrapment within the pipeline trench: – Trenching will occur progressively to minimise the period of time the trench is open, particularly in key habitat areas – Constructing trench plugs with slopes less than 45° will provide exit ramps for fauna. These will be provided as a minimum every 500 m
	– In areas of known or high habitat value additional ramps, trench plugs branches and hessian bags for shelter will placed within the trench at greater than normal frequencies – Branches, hessian sacks, ramped gangplanks or similar will be used to create ‘ladders’ to enable fauna to exit the trench. These will be provided as a minimum every 250 m – Water-soaked, sawdust filled hessian sacks (used to support pipes prior to lay-in) will be placed every 250 m along the open trench to harbour fauna that may become trapped in the open trench – Use of snake traps which can be retracted from trench – The open trench will be checked by appropriately trained personnel for trapped fauna at least twice daily (early morning/late afternoon) – Where there is a large number of animals being trapped additional measures will be implemented, including potentially exclusion fencing and increased frequency of checks • When an animal is noted as trapped, work in the immediate vicinity (ie 50 m) will stop immediately and the site supervisor notified • Fauna trapped in trenches will be removed as soon as possible by a suitably qualified person. No operations will commence or continue until fauna have been removed • Suitably qualified personnel will encourage the animal to leave, or physically capture/trap the animal where required • Landowner/owner will be immediately notified of trapped domestic species. These animals should then only be removed in collaboration with the landowner/owner, under direction of GLNG Operations • It may be necessary to use additional devices to remove fauna from the trench due to OH&S issues. This may include nets or mesh in conjunction with shelter which can be extracted via ropes, placement of branches or ropes which fauna can scale. The Construction Contractor is to submit a plan detailing how this activity is to occur and will cover all foreseeable problems prior to construction • Vehicle and pedestrian access to and from the ROW will be restricted to the defined access tracks • All Contractors will be made aware of the risks associated with fauna and vehicle movement • Erect appropriate signage near sensitive habitats, nesting and roosting areas and wildlife corridors • If practicable, the water intake pipes will include an effective screen or a similar device to prevent aquatic and semi-aquatic species from entering the pipe for the duration of the pipeline usage

Aspect	Outcome
	• All waste/rubbish will be correctly disposed of and will not pose a risk to fauna • All least concern animals, including injured animals, relocated or treated will be recorded in the wildlife register. The register will outline species encountered, number of individuals, are move from (including habitat if necessary), area moved to or appropriate wildlife carer group or vet. This report will be provided to DNPRSR following construction **Pests and Feral Animals** • The Construction Contractor will implement the PWMP (refer Appendix B) • All food scraps and other waste material will be correctly disposed of and stored in appropriate containers to prevent pest and other fauna from access • Fauna exclusion fencing will be utilised where necessary • If required, recommended active control methods will be employed including baiting, trapping, ground shooting and den fumigation
	Lighting • Where constructability allows, night works will be avoided in the vicinity of light and noise sensitive areas (eg intertidal areas, adjacent native vegetation) • If night works are required, wherever constructability allows, any night lighting associated with the construction phase of the Project will be directed landwards and facing away from the coastline. This includes the use of light shades and low lighting in construction and operational areas located adjacent to remnant native vegetation
Performance Indicators	• Minimal disturbance of terrestrial flora and fauna during construction of the pipeline, associated tracks, services and accommodation facilities. No clearing outside of the ROW • No unplanned or unapproved damage to flora and fauna • No spread of weeds; LP Act listed weeds of national significance • Compliance with the PWMP, SSMP and SMP • No new weed infestation in the ROW as a result of construction activities • Soils and vegetation stored appropriately to allow for restoration of disturbed areas to equivalent to surrounding area after construction • Not vegetation clearing without a qualified spotter catcher • No unauthorised clearing of ENVT flora species without written approval for the appropriate authority

Table 10.27 Operational mitigation measures for the management of flora and fauna impacts

Aspect	Mitigation measures
Erosion and sediment control	• Should erosion and sedimentation occur, appropriate corrective action will be undertaken, including installing temporary erosion and sediment controls (eg silt fences, berms and diversion drains) and rehabilitation/stabilising the area to minimise the risk of erosion • Vehicle access will be restricted to stable ground where practicable • Additional care will be taken near watercourses and drainage lines • The reinstated pipeline trench will be routinely checked for subsidence and exposure of the pipe, particularly at watercourse crossings and drainage depressions • Stability of the pipeline easement and, in particular, the condition of watercourse bed, banks and riparian vegetation will be inspected in accordance with an agreed inspection programme
Acid Sulfate Soils	• During pipeline operations, the disturbance of ASS will be avoided or minimised. Barriers or other control measures will be implemented to ensure such soils are not released to surrounding land and water
Traffic and access	• After the completion of works, appropriate measures will be installed to discourage use of de-commissioned access ways for safety reasons and for purposes of assisting site recovery. These may be temporary or permanent structures • The pipeline easement will only be used as an access for activities essential to ensuring the continued safe operation of the pipeline and protection of the local environment. The easement will not be used as a general thoroughfare • Access to the pipeline easement will, as far as is practicable, be via existing tracks • The width of access tracks will be kept to a minimum practicable to enable safe vehicular movement • Access to and along the pipeline easement will be minimised following periods of prolonged or heavy rainfall • Access to the pipeline easement will be managed to minimise potential weed impacts
Pests and weeds	• The risk of introducing weeds or other pests will be minimised through implementation of the PWMP (refer Appendix B) • Weed monitoring and subsequent weed control will be the responsibility of the Construction Contractor as per the contractual agreement • Monitoring during operation will determine the success of management measures or requirements for further actions. Any pest or weed species identified during site inspections and audits will be recorded, and appropriate management measures will be employed in response to the presence of these species • An Operational Weed Monitoring and Control Programme will be developed and implemented and will include (but not limited to): – The rate of monitoring and control post completion will be as follows: (a) Post rain event – once a month for three months (b) Otherwise, once every two months (c) In response to landholder or operator request – Weed monitoring and control activities will include all Project areas (eg tracks, ROW, storage areas) – Weed control will be undertaken by appropriately qualified and experienced Contractors who are appropriately licensed under the *Agricultural Chemicals Distribution Control Act 1966*
Flora and fauna	• A buffer of riparian vegetation will be maintained for watercourses. If regrowth trees within this buffer require removal, it will, where practicable, be done by hand • The relevant operational phase actions contained in the LRMP (refer Appendix E) will be implemented

Aspect	Mitigation measures
Pipeline integrity	• Pipeline integrity will be monitored and maintained to prevent the release of product to the environment
Waste	• The refuelling or maintenance of equipment and vehicles will be conducted in clearly designated areas to minimise risk of spills and approved by GLNG Operations. These areas will be far away as is reasonably practical from any surface water body and watercourses to reduce the risk of contamination in the event of accidental fuel or oil release • Hazardous wastes will not be stored or handled within the vicinity of any surface water • The WMP (refer Appendix F) will be implemented during operation
Pipeline Spill Prevention and Response	• Detailed Pipeline Spill Prevention and Response Plans will be developed for all operational pipelines where spills may be detrimental to public safety or the environment. Plans will address local issues, such as areas of particular environmental, social or cultural sensitivity • Pipeline Spill Prevention and Response Plans will address: – Monitoring and detections systems – Notification and reporting procedures (both internal and external) – Call-out procedures; contact lists and incident investigation procedures – Measures required to halt the spill (ie control of pumps, valves, etc) – Environmental impact assessment (high level to identify environmental risks) – Personnel responsibilities – Equipment requirements, location, storage, maintenance and transport – Communications and logistics • Spill response procedures will comply with all relevant regulatory requirements • Workforce training will be conducted in spill response and recovery procedures. Spill response exercises will be regularly conducted

Table 10.28 Decommissioning mitigation measures for the management of flora and fauna impacts

Aspect	Mitigation measures
Purging and flushing	• No flushing and discharging freshwater into estuarine and marine environments unless approved by administering authorities • Pipework will be flushed or purged using steam, water or inert gas • A project specific Water Source and Disposal Plan will be developed in consultation with the appropriate regulatory agencies • No water will be returned directly to watercourses without appropriate approvals • Water will be tested for hydrocarbon and chemical residue prior to disposal • Where contaminant levels exceed specified legislative values, flushed water will be disposed of at an approved waste facility
Traffic and access	• Upon decommissioning, appropriate measures will be installed to discourage use of decommissioned access ways for safety reasons and for purposes of assisting site recovery. These may be temporary or permanent structures • The easement will not be used as a general thoroughfare • Access to the pipeline easement for decommissioning activities will, as far as is practicable, be via existing tracks • The width of access tracks will be kept to a minimum practicable to enable safe vehicular movement • Access to the pipeline easement will be managed to minimise potential weed impacts
Erosion and sediment control	• Should erosion and sedimentation occur, appropriate corrective action will be undertaken, including installing temporary erosion and sediment controls (eg silt fences, berms and diversion drains) and rehabilitation/stabilising the area to minimise risk of erosion • Vehicle access will be restricted to stable ground where practicable • Additional care will be taken near watercourses and drainage lines
Rehabilitation	• Implement the relevant decommissioning phase actions contained in the LRMP (refer Appendix F) • On decommissioning of the pipeline, rehabilitation to pre-clearance conditions will be undertaken within all previously restricted vegetation growth areas, in accordance with EPBC Act Approval Condition 3d • Should there be a requirement to clear vegetation to access the ROW to remove above ground infrastructure, areas of impact will be rehabilitated to pre-clearance condition in accordance with the LRMP (refer Appendix F)
Waste	• All waste material generated from the decommissioning of the site will be recycled, re-used or disposed at a suitably licenced waste facility • The refuelling or maintenance of equipment and vehicles will be conducted as far away as is reasonably practical from any surface water body to reduce the risk of contamination in the event of accidental fuel or oil release

11. Noise and vibration

11.1 Chapter summary

The assessment of noise and vibration associated with the development of the Marine Crossing GTP Project is discussed in this chapter. The Marine Crossing GTP Project will be constructed using conventional open cut trenching and bored tunnelling techniques using a TBM.

The following activities associated with the Marine Crossing GTP Project have been assessed for potential noise and vibration impacts:

- Conventional open cut trenching on the mainland between Point A to Point C and on Curtis Island between Point D to Point E
- Bored tunnelling by TBM and associated construction activities for the tunnel under the intertidal area south of Kangaroo Island and The Narrows
- Sheetpiling activities associated with the TBM launch and receptor shafts
- Transportation of plant and equipment via Targinie Road
- Transportation of spoil from the construction site pad (mainland) along the Access Road and Forest Road

11.1.1 Summary of existing environment

No major roads or commercial sites are located within close proximity to the Marine Crossing GTP Project and hence existing background noise is considered to be typical of a rural area. The nearest active industrial site is the Fisherman’s Landing cement plant. Figure 11.1 illustrates the proximity of sensitive receptor locations to the Marine Crossing GTP Project. Noise from Gladstone industry and port operations is generally inaudible within the vicinity of the Marine Crossing GTP Project. Existing noise level measurements recorded in the Targinie area are provided in Table 11.2 and Table 11.3.

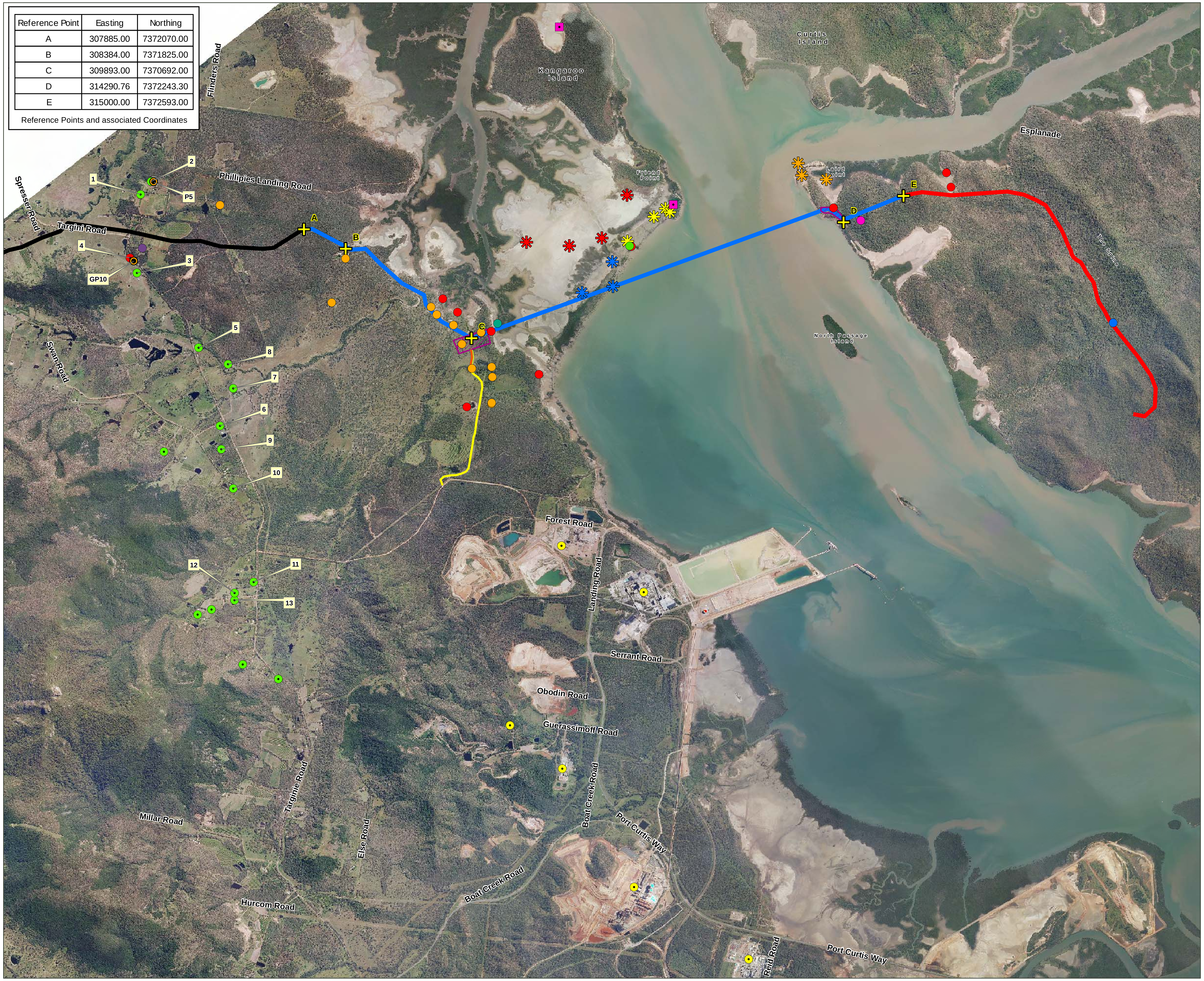
There are 13 noise receptor locations approximately 4 km from the Marine Crossing GTP Project, which includes both residential and commercial sensitive receptors. Pre-clearing fauna surveys have identified migratory shorebird roosting and Water mouse habitat within the intertidal area to the north of the Marine Crossing GTP Project. Noise receptor locations have been illustrated on Figure 11.1.

11.1.2 Summary of potential impacts on the environment from noise and vibration

Construction

The daily traffic volumes expected for the construction phase of the Marine Crossing GTP Project are too low to use in standard noise modelling. However, due to the rural nature of Targinie, construction traffic will increase the existing traffic volumes on Targinie Road. Heavy vehicles are likely to result in an increase in noise along the road associated with acceleration and deceleration on the narrow road.

Noise modelling was undertaken for four construction scenarios to investigate the potential noise levels resulting from various stages of construction for the Marine Crossing GTP Project, including, trenching, construction site pads, TBM launch and receptor shafts, operation of the TBM and ancillary activities (refer Section 11.4 and Section 11.5). Vibration levels from operation of the TBM were predicted using site laws for EPB TBMs.



Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road
- Acid Sulfate Soils Treatment Area

Sensitive Receptor
- Community Use
- Industrial
- Residence
- Ambient Noise Monitoring Locations

High Tide Roost
- Claypan Roost
- Friend Point Roost
- Kangaroo Island North Roost
- Laird Point Roost
- Narrows Roost
- Major Shorebird Roost Site

Threatened Fauna Species
- Beach Stone-curlew
- Little Tern
- Powerful Owl
- Raptor Nest possibly White-bellied Sea-eagle
- Square-tailed Kite
- Squatter Pigeon
- Water Mouse

Source:
Gas Transmission Pipeline (GTP): Santos, Mar 2012.
Aerial: Santos, Feb 2011.
Sensitive Receptors: Downes, Apr 2012.
Footprints Environmental Consultants, 2012a, GLNG GTP ROW Pre-Clearing Threatened Species Surveys, Water Mouse Assessment Report
Footprints Environmental Consultants, 2012b, GLNG GTP ROW Threatened Terrestrial Fauna Pre-clearing Surveys Assessment Report
Footprints Environmental Consultants, 2012c, GLNG GTP ROW Kangaroo Island Wetland Complex Migratory Bird Surveys, Baseline Assessment Report
Major Shorebird Roost Site:
Shorebirds and Turtles, Shorebirds and Turtles, Curtis Coast Regional Coastal Management Plan, Department of Environment and Resource Management, 2003

Sensitive Receptors (Human and Shorebird Roost Sites) Figure 11.1

A1 scale: 1:25,000

0 500 1,000 1,500 2,000 2,500 m

GLNG No: 3381-40-0564

Coordinate system: GCS_GDA_1994

Date: 20/06/2012

Version: c

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_055.mxd 20/06/2012 10:52

Potential noise and vibration impacts from the construction of the Marine Crossing GTP Project are not expected to impact upon commercial or residential sensitive receptors.

Construction activities on or near inter-tidal mudflats and roost sites, particularly when it is accompanied by intermittent loud noises (eg sheetpiling), have the potential to disturb migratory shorebirds within close proximity to those activities. As the operation of most key noise emitting construction equipment exceeds 100 dBA (refer Chapter 11 Table 11.8), there is the potential for some disturbance to shorebirds during construction although the impact is based on the noise level and duration of the activity and not whether the activity occurs at night or during the day.

Tunnel shaft excavations and sheetpiling will occur 24 hours a day, seven days per week over a period of not more than 60 days between mid December 2012 and mid February 2013, reducing the duration of the related noise and vibration impacts to a shorter period. The 60 day construction window of the 24 hour activities includes an initial phase of sheet piling (approximately 15 days in total) followed by mechanical excavation of earth material for the launch shaft (approximately 45 days), continuing through to the commencement of the programmed tunnelling activities.

Also, it should be noted that the number of shorebirds that have the potential to be directly impacted upon during the construction of the GLNG GTP RoW are small compared to the total numbers of shorebirds supported by the Port Curtis shorebird area. This is due to the lack of suitable roosting habitats within close proximity to the GTP construction area.

It is likely that native fauna (eg Water mouse, birds roosting and feeding) in the adjacent intertidal and terrestrial habitats will be temporarily disturbed as a result of noise impacts from sheetpiling activities associated with the TBM launch and receptor shafts, however this is a one of activity occurring over a two week period. Some temporary disturbance of Water mouse and shorebirds may occur due to vibration from the TBM, however vibration levels are expected to be negligible.

Vibration levels at the QCLNG pipeline as a result of the TBM operation will, at worst, be approximately 1/100th of the safe vibration level for steel pipes.

Regenerated underwater noise from vibration levels associated with the Marine Crossing tunnel under The Narrows will generally be at the lower range of background underwater noise levels, measured in the same area by SLR Consulting (2012) and is considered to be negligible.

Operation

Monthly inspections will be carried out along the Marine Crossing GTP ROW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Typically maintenance on the Marine Crossing GTP will be carried out by light vehicles and small maintenance crews as required.

Noise impacts from these operational activities are expected to be low and manageable due to the low number of vehicle movements, infrequent maintenance activities and long separation distances from the Marine Crossing GTP to the sensitive receptors.

11.1.3 Summary of proposed mitigation measures for noise and vibration

Table 11.1 Environmental protection commitments, objectives and control strategies – noise and vibration

Item	Outcome
Environmental Protection Objectives	• Minimal impact of construction related noise and vibration on surrounding residential and commercial sites • Minimal impact of construction related noise and vibration on shorebirds and the marine environment • Minimal impact of operational related noise and vibration on surrounding residences and industry
Specific Objectives	• Compliance with EA conditions and industry standards • No warranted complaints from residents and landholders, and all complaints responded to within 24 hours
Control Strategies	Refer Table 11.15 for noise and vibration control strategies to be implemented during construction and operation of the Marine Crossing GTP Project
Performance Indicators	• Complaints responded to within 24 hours • Compliance with EA conditions and industry standards

11.2 Existing noise environment

The Marine Crossing GTP Project is closest to the district of Targinie, which consists of rural farming and grazing land. No major roads or through-routes exist in the area so existing transportation noise is considered to be negligible. The nearest main road (Gladstone - Mount Larcom Road) is located approximately 9 km to south of the Marine Crossing GTP Project. Existing traffic volumes on local roads, including Targinie Road are negligible.

The nearest industry is the Fisherman's Landing cement plant, which is approximately 3.5 km from the Marine Crossing GTP Project construction site pad (mainland) at Point C. Noise from Gladstone industry and port operations is generally inaudible in this area.

Summaries of previous unattended (SLR, 2009) and attended (SLR, 2011) ambient noise monitoring in the Targinie area are provided in Table 11.2 and Table 11.3, respectively.

It should be noted that the ambient background noise levels presented are by definition representative of the lowest 10th percentile of background noise in an area (in accordance with DEHP's Ecoaccess guideline Planning for Noise Control (EPA, 2004)). This would be during periods of little or no breeze and negligible insect activity (accounted for by filtering out insect noise from the results). Background noise levels in quiet rural areas increase substantially with wind-induced vegetation noise and insect activity. While this cannot be relied upon to increase the Project noise criteria, it should be noted that wind-induced vegetation noise and insect activity will mask some of the construction noise to a degree when they are present.

The noise levels presented in Table 11.2 are for the L_{A90T} noise level, as noise objectives are to be set by comparing with the existing background noise level measured by the L_{A90T} parameter.

Table 11.2 Unattended ambient background noise levels

Location ID (refer Figure 11.1)	Measurement date	Site	Logger location description	Logger GPS coordinates	Rating background level (dBA)		
					Day 7am – 6pm	Evening 6pm – 10pm	Night 10pm – 7am
P5	20 Feb to 6 Mar 2008	Near bridge crossing (northern end of Flinders Road)	Logger located 7-8 m from home facing towards Gladstone (SE)	-23.745427° 151.097502°	31 [2]	31 [1, 2]	33 [1]
GP10	30 Sep to 6 Oct 2010	Targinie Road, Targinie	Located near Targinie Rural Fire Brigade, beside Targinie Road	-23.754659° 151.095176°	29[3] (≤ 25[1])	35[3] (≤ 25[1])	30[3] (≤ 25[1])

Table notes:
1 Adjusted to correct for enhanced noise levels as a result of insect noise
2 Adjusted to correct for elevated wind levels and increased noise levels due to movement of trees
3 Measured background noise level with no adjustment for insect noise

Table 11.3 Attended ambient noise monitoring – Targinie

Loc. ID (refer Figure 11.1)	Date	Time (end of 15 min period)	L_{A90}	L_{Aeq}	L_{A10}	Observations and comments	Photo (SLR 2010)
P5	06/03/08	3:15pm	45	49	52	Insect and birds noise audible; tree movement	
	05/03/08	7:15pm	50	51	52	Insects dominant noise source; tree movement	
	06/03/08	10:45pm	41	44	46	Insects dominant noise source; distant industry noise just audible; tree movement	
GP10	5/10/10	4:45pm	≤ 25[1]	49	40	Insects constant 35 dBA, f > 3150 Hz Birds 37-63 dBA Distant jet Distant car ~ 40 dBA Car pass-by 77 dBA (only car in 15 minutes)	
	5/10/10	9:45pm	≤ 25[1]	40	42	Insects and frogs constant 40-43 dBA, f > 1,000 Hz Flying foxes Distant low frequency noise. Possibly generator at residence or Yarwun alumina refinery Faint sound of water running	
	6/10/10	12:00am	≤ 25[1]	39	40	Insects, birds and frogs constant 37-41 dBA, f > 2000 Hz Distant low frequency noise A few flying foxes	

Table note: [1] Ambient sound in the area was dominated by animal noise, and particularly insects. Insect noise is seasonal, and generally is not present during the winter months. In order to obtain the ambient sound levels in the absence of insect noise, the measurements were carried out in 1/3 octave bands. This allows for the sound produced by insects (eg at high frequencies) to be filtered out. The L_{A90} noise levels presented are with insect noise removed. In many cases, the background noise level with insect noise removed was below the noise floor of the instrument and an accurate background noise level cannot be provided. However, in accordance with the DEHP *Planning for Noise Control* (EPA, 2004) Ecoaccess guideline, where the measured background noise level is less than 25 dBA, a minimum background noise level of 25 dBA is to be adopted.

11.3 Sensitive receptors

The measured ambient background noise levels and observations in the field were used to establish a background noise level for 13 sensitive receptors located approximately 4 km from the Marine Crossing GTP Project at Point C (refer Table 11.4). Figure 11.1 shows the location of all sensitive receptors.

Table 11.4 Sensitive receptors approximately 4 km from the Marine Crossing GTP Project

ID	Lot	Plan	Address	Receptor type	Distance to GTP alignment (m) (Shortest Distance)	Approx. distance to TBM site (m) (Point C)	Approx. distance to pipe stringing site (m) (Point C)	Daytime /night time background noise level (dBA[1])
1	72	DS628	63 Flinders Rd	Residential	499 m	4,300 m	3,900 m	≤ 25
2	101	RP866910	101 Flinders Rd	Residential	566 m	4,200 m	3,800 m	≤ 25
3	1305	MPH34872	1023 Targinie Rd	Residential	317 m	4000 m	3,400 m	≤ 25
4	1	MPH2955	1057 Targinie Rd	Commercial	318 m	4,100 m	3,400 m	≤ 25
5	1	MPH30856	908 Targinie Rd	Residential	1,302 m	3,200 m	2,400 m	≤ 25
6	1	RP615663	17 Swan Rd	Residential	2,316 m	3,000 m	2,300 m	≤ 25
7	41	DS290	820 Targinie Rd	Residential	1,804 m	2,800 m	2,200 m	≤ 25
8	58	DS290	Unnamed Rd	Residential	1,508 m	2,800 m	2,300 m	≤ 25
9	3	RP617399	749 Targinie Rd	Residential	2,950 m	3,250 m	3,000 m	≤ 25
10	3	DS710	17 Swan Rd	Residential	3,050 m	3,380 m	3,150 m	≤ 25
11	1	MPH3003	587 Targinie Rd	Residential	4,050 m	4,050 m	3,850 m	≤ 25
12	1	MPH2921	28 Wilson Rd	Residential	4,300 m	4,300 m	4,100 m	≤ 25
13	3	MPH23069	19 Wilson Rd	Residential	4,370 m	4,370 m	4,150 m	≤ 25

Table note: Noise levels have been measured in decibels A filter (dBA)

The intertidal area south of Kangaroo Island, as well as Kangaroo Island and Friend Point contain habitat suitable for migratory shorebird roosting and Water mouse (refer Chapter 10). Friend Point has been identified as a major shorebird roost site (Shorebirds 2020) and is located approximately 2.9 km northeast of the Marine Crossing GTP Project from Point C. The intertidal area extends to Mosquito Creek and surrounding area, which is adjacent to the Marine Crossing GTP Project disturbance footprint (Point C at its nearest point).

11.4 Noise modelling methodology

11.4.1 SoundPLAN

The predicted noise levels at the noise sensitive receptor locations have been calculated through environmental computer modelling SoundPLAN (Version 7.0), for both the construction and operation phases of the Marine Crossing GTP Project. SoundPLAN is a software package which enables compilation of a sophisticated computer model comprising a digitised ground map (containing ground contours), the location and acoustic sound power levels of potentially critical noise sources onsite and the location of receptors for assessment purposes.

The computer model can generate noise emission levels taking into account such factors as the source sound power levels and locations, distance attenuation, ground absorption, air absorption and shielding attenuation, as well as meteorological conditions, including wind effects.

11.4.2 CONCAWE

All noise predictions for this Project have been carried out utilising the CONCAWE prediction methodology within SoundPLAN.

The statistical accuracy of environmental noise predictions using CONCAWE was investigated by Marsh (1982). Marsh concluded that CONCAWE was accurate to ±2 dBA in any one octave band between 63 Hz and 4 kHz and ± 1 dBA overall.

Construction noise levels have been predicted based on the neutral meteorological condition parameters in Table 11.5.

Table 11.5 Neutral meteorological conditions

Parameter	Value
Temperature	25°C
Humidity	70%
Pasquill Stability Category	D
Wind Speed	0 m/s

11.4.3 Noise emission modelling scenarios

Potential noise emissions for construction of the Marine Crossing GTP Project have been predicted for the four scenarios identified in Table 11.6.

Table 11.6 Construction scenarios and assumptions typical plant

Scenario	Description of activities	Assumptions
1	Construction of open cut trenching, including ROW clearing and topsoil stripping	Dozers, loader, motorsaws, truck, grader
2	Access Road and TBM construction site pad development	Dozers, loaders, trucks, graders, sheet piling
3	24 hour (night-time) TBM operation	• ASS treatment machinery (truck, grader and loader) operating 24 hours • TBM and pipe stringing operating 24 hours • Spoil movement along the Access Road
4	Construction traffic along Targinie Road	• Five light and heavy vehicles • Travel speed of 60 km/h along Targinie Road • Peak 15 minute period

Potential noise impacts from the transport of tunnel spoil from the Access Road along Forest Road and other connecting roads (eg Gladstone - Mount Larcom Road) to the tunnel spoil disposal location (refer Chapter 2) are considered to be minor given the commercial nature of the land uses adjoining these roads, and as such no noise modelling has been undertaken for this. Implementing the noise mitigation measures contained in Section 11.10 will minimise the potential noise impacts associated with the transport of tunnel spoil. The transport of spoil will be undertaken in accordance with the RUMP.

11.4.4 Noise modelling assumptions

Construction of open cut trenching and associated activities

Noise emission levels from the construction of the Marine Crossing GTP Project have been predicted for the construction activities identified in Table 11.7. The separation distances from the construction activity to the 50 dBA, 45 dBA, 40 dBA, 35 dBA and 30 dBA noise contours are summarised in Table 11.7. The calculations have been based on the assumption of sound propagation over flat, soft ground (eg open grassland) to a typical receiver at height of 1.5 m and for neutral meteorological conditions.

Table 11.7 Predicted noise levels at corresponding separation distances for various construction activities used in noise modelling assessment

Construction activity	Predicted distance to L_{A10} noise level (m)				
	50 dBA	45 dBA	40 dBA	35 dBA	30 dBA
Clearing – ROW vegetation	360	600	940	1,400	1,990
Rock exposure	410	570	800	1,110	1,550
Stringing and bending	240	380	630	1,040	1,590
Trenching	340	480	690	1,000	1,460
Welding	400	610	890	1,290	1,840
Pipe lowering and trench backfilling	290	490	810	1,310	2,010
Clean up and restoration	330	490	740	1,070	1,550

Table note: Very steady state noise for some operational conditions will be limited by the $L_{A90, T}$, intermittent construction noise is limited by the $L_{A10, T}$ and some transient events may be limited by the $L_{A1, T}$. For this reason the construction noise has been assessed according to the $L_{A10, T}$ parameter

Construction and workforce traffic movements

Traffic to and from the construction site pad (mainland) and ROW have been estimated based on expected traffic volumes for the Marine Crossing GTP Project during construction. The expected traffic volumes are less than 200 vehicle movements per day. This traffic is expected to travel predominately via Targinie Road, Forest Road and, the Access Road to the construction site pad (mainland) and along the Marine Crossing GTP ROW.

Construction of the Marine Crossing tunnel

A TBM will be used to bore a tunnel under the intertidal area south of Kangaroo Island and The Narrows as shown in Figure 11.1. Details of the operation of the TBM are provided in Chapter 2 and noise modelling has been undertaken for boring of a 4.05 m external diameter tunnel, approximately 4.3 km length. Precast concrete segments to form the tunnel wall will be installed as the TBM progresses. The pipe will be strung in approximately 400 m lengths and pushed/pulled through the tunnel.

Launching of the TBM and pipe stringing works will be carried out from the construction site pad (mainland) at Point C. Tunnel shaft excavation, including sheetpiling and tunnelling works will be undertaken 24 hours per day, seven days per week.

Construction plant and equipment noise sources

The dominant noise sources used to model the construction activities were developed based on the preliminary construction site layouts, construction schedule and plant and equipment list provided in Chapter 2. Sound power levels used for the modelling are listed in Table 11.8.

Table 11.8 TBM, ASS treatment and pipe stringing equipment sound power levels

Plant Item	A-weighted sound power level LA10 in octave bands centre frequency (Hz)									Overall dBA
	31.5	63	125	250	500	1k	2k	4k	8k	
Dozers	77	91	100	104	113	114	114	107	98	119
Motorsaw	42	65	87	97	103	108	106	109	107	114
Excavator	65	86	94	95	96	98	96	91	83	103
Sheet piling	90	93	107	112	115	115	111	114	115	122
Front end loader	66	91	96	101	104	102	104	95	86	109
WTP	-	-	-	-	112	-	-	-	-	112
Truck	61	80	91	93	101	101	106	96	85	109
Generator	67	78	95	99	99	96	96	91	85	105
Crane	-	82	91	94	100	100	97	88	78	105
Lighting plant	96	103	106	96	97	100	96	95	88	110
Grader	-	85	94	97	99	107	102	98	87	109
Stringing and welding activities (combined source)	78	94	106	110	116	114	113	105	98	120
Tunnel portal (combined noise from TBM, tunnel fans and miscellaneous sources inside tunnel)	-	-	-	-	106	-	-	-	-	102

Table notes: - denotes not available
Very steady state noise for some operational conditions will be limited by the $L_{A90,T}$, intermittent construction noise is limited by the $L_{A10,T}$ and some transient events may be limited by the $L_{A1,T}$. For this reason the construction noise has been assessed according to the $L_{A10,T}$ parameter

11.5 Vibration prediction methodology

11.5.1 Prediction of TBM vibration levels

Various TBM vibration prediction equations have been published and some attempts at universal prediction equations have been made, however there is no definitive publication or industry standard in that regard.

Measurements by SLR Consulting from TBM operation in hard rock at various depths and lateral offsets have provided a site law for predicting ground vibration levels as follows:

- Peak particle velocity (PPV) = 15.498x-1.061
- Where x = distance from TBM to receiver location

This site law is applicable to hard rock and is therefore considered a conservative method of predicting vibration levels from TBM operation for construction of the Marine Crossing tunnel due to the much softer nature of the material expected to be excavated.

SLR Consulting also carried out a review of vibration measurement and prediction methods (Hiller & Crabb, 2000, and Saurenman, 1993) for EPB TBMs, which are the TBMs used in soft ground. The following site law was derived from that review and corrected using a 10xlog (area/area) relationship between the reviewed data and the 4.05 m diameter TBM for the Marine Crossing GTP Project:

- $PPV = 5.3849x^{-1.752}$
- Where x = distance from TBM to receiver location

The “hard rock” site law is considered to represent the absolute maximum vibration levels possible from TBM operation during construction of the Marine Crossing GTP Project, while the EPB site law is considered to more closely represent the likely levels of vibration, as the eastern side of The Narrows (near Curtis Island) is expected to be comprised of soft sedimentary rock, transitioning to clay with sand overburden beneath the channel (Hair, 2010).

11.5.2 Vibration criteria for sensitive receptors

A vibration criteria for sensitive receptors identified for the Marine Crossing GTP Project has been established by considering the effects of construction vibration in buildings as a point of comparison. Humans are far more sensitive to some types of vibration than has been commonly realised. They can detect and possibly even be annoyed at vibration levels which are well below those that can cause any risk of damage to a building or its contents.

The effects of construction vibration in buildings can be divided into three main categories:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed
- Those in which the integrity of the building or the structure itself may be prejudiced
- Those where the building contents may be affected

Figure 11.2 illustrates this difference in susceptibility by comparing widely accepted human disturbance criteria (British Standards (BS) 6472) with various threshold damage levels (DIN4150 (German Standard), US Bureau of Mines and BS7385).

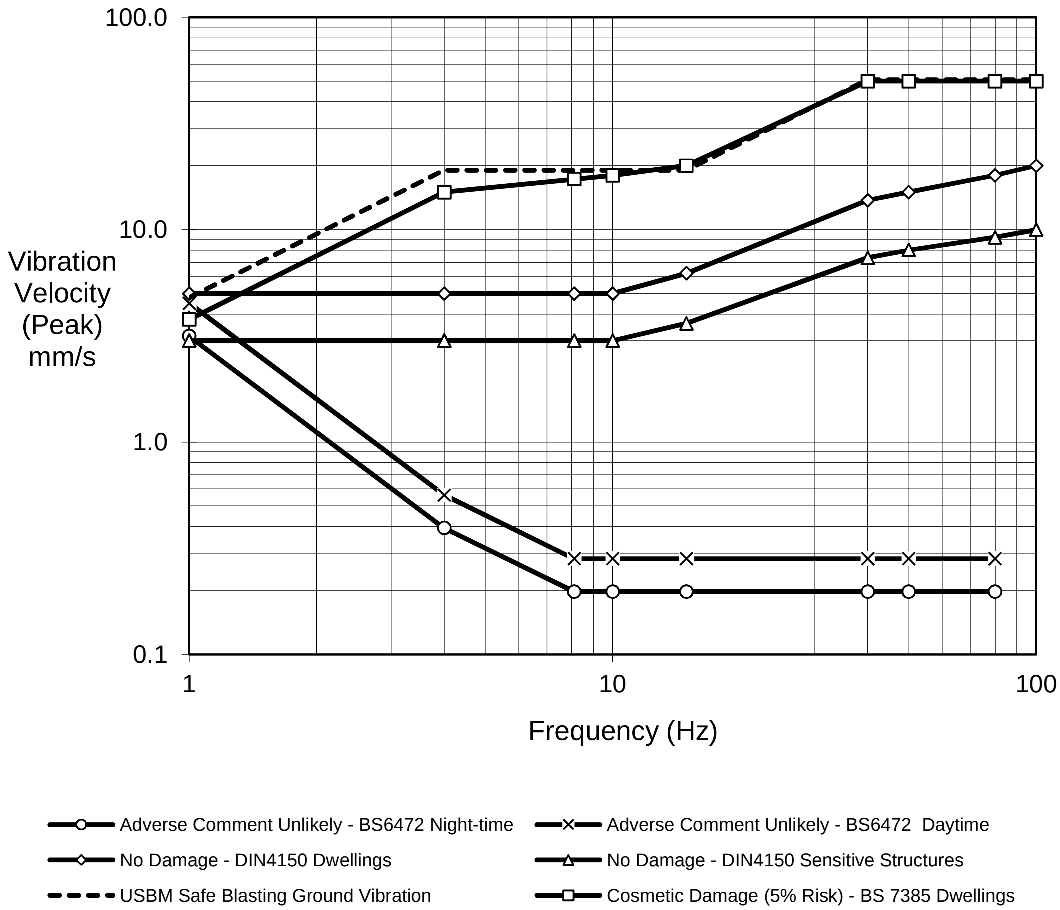


Figure 11.2 Human disturbance criteria and building damage limits

Note: BS6472 "Adverse Comment" disturbance criteria are for continuous vertical vibration at point of entry to body. DIN4150 "No Damage" threshold criteria are PPV on building footings. BS7385 "5% Risk of Cosmetic Damage" criteria are PPV on building footings (or in ground nearby). US Bureau of Mines Safe Blasting criteria are PPV in the ground.

11.5.3 Vibration criteria on other infrastructure

The only known infrastructure that is within the Marine Crossing tunnel disturbance footprint and that may be impacted by vibration levels from operation of the TBM is the other LNG proponents' pipeline (QCLNG) that will cross above the Marine Crossing tunnel at a point approximately 200 m to the east of Point B and at a point approximately 500 m west of the Curtis Island shoreline, beneath The Narrows (refer Figure 8.3c).

DIN4150.3-1999 "Structural Vibration, Part 3: effects of vibration on structures" provides guideline values to avoid damage to underground pipes as outlined in Table 11.9. The criterion for steel pipes is applicable to the QCLNG pipeline, which the TBM will excavate under.

Table 11.9 DIN4150 Part 3 "Table 2 – Guideline values for vibration velocity to be used when evaluating the effects of short term vibration on buried pipework"

Pipe material	Guideline values for velocity measured on the pipe (mm/s)
Steel (including welded pipes)	100
Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
Masonry, plastic	50

11.5.4 Vibration criteria for fauna

Various studies of vibration effects on birds such as Garcia, *et al*. (2008) have shown that no negative health effects were noted even under high vibration conditions. Alternatively, eggs are considered to be sensitive to vibration effects while the embryo is developing. There is limited information on the effects of vibration levels that may negatively impact developing bird embryos, therefore a precautionary approach will be adopted. .

No studies that provide an appropriate vibration criteria for the effects on other native fauna within the Marine Crossing tunnel disturbance footprint (eg Water mouse) have been identified.

11.6 Potential construction noise impacts

11.6.1 Human sensitive receptors

The results of the noise modelling for each construction scenario identified in Section 11.4.4, for the 13 sensitive receptors located approximately 4 km from the Marine Crossing GTP Project at Point C, are provided in Table 11.10 to Table 11.5

Predicted noise emission levels have been calculated on the assumption of sound propagation over soft ground to the receptor at a height of 1.5 m (single storey residences) and 4.5 m (double storey residences) above ground, under neutral meteorological conditions (refer Table 11.5).

Predicted noise levels from construction activities

Table 11.10 Scenario 1 - Calculated noise levels for ROW clearing and topsoil stripping – neutral meteorological conditions

ID	Receptor	Predicted L_{A10} – neutral meteorological conditions (dBA)
1	Lot 72 DS628 (63 Flinders Road)	38
2	Lot 101 RP866910 (101 Flinders Road)	38
3	Lot 1305 MPH34872 (1023 Targinie Road)	38
5	Lot 1 MPH30856 (908 Targinie Road)	37
6	Lot 1 RP615663 (17 Swan Road)	39
7	Lot 41 DS290 (820 Targinie Road)	42
8	Lot 58 DS290 (Unnamed Road)	42
9	Lot 3 RP617399 (749 Targinie Road)	37
10	Lot 3 DS710 (17 Swan Road)	30
11	Lot 1 MPH3003 (587 Targinie Road)	30

ID	Receptor	Predicted L_{A10} – neutral meteorological conditions (dBA)
12	Lot 1 MPH2921 (28 Wilson Road)	29
13	Lot 3 MPH23069 (19 Wilson Road)	28
	Targinie Rural Fire Brigade	37

Table note: Adverse meteorological conditions (eg under temperature inversions) and prevailing breezes from source to receptor may increase noise levels by up to 7dBA

Noise contours for Scenario 1 are illustrated in Figures 11.3a and 11.3b.

Table 11.11 Scenario 2 - Calculated noise levels for Access Road and mainland and Curtis Island construction site pad development – neutral meteorological conditions

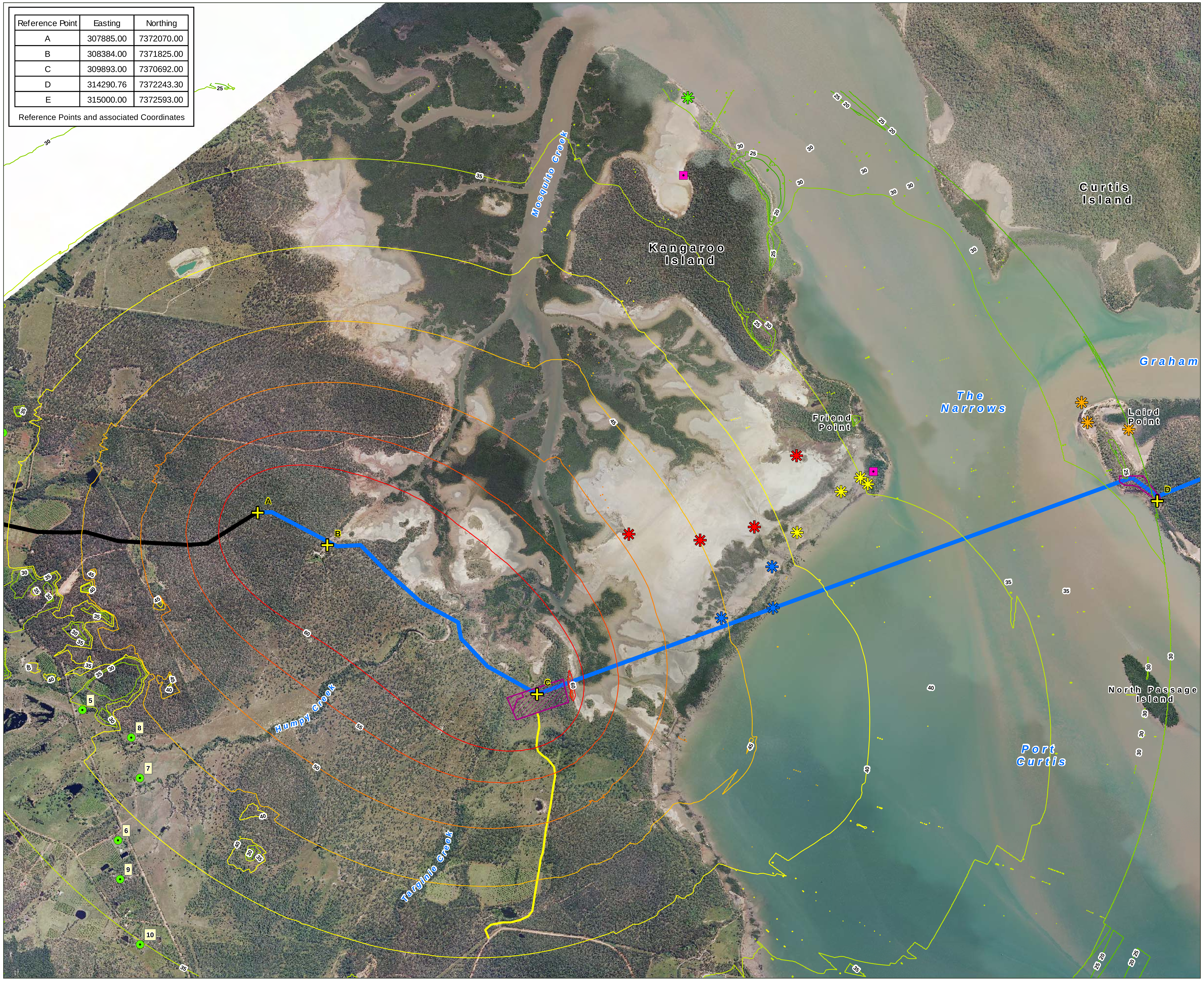
ID	Receptor	Predicted L_{A10} – neutral meteorological conditions (dBA)
1	Lot 72 DS628 (63 Flinders Road)	17
2	Lot 101 RP866910 (101 Flinders Road)	17
3	Lot 1305 MPH34872 (1023 Targinie Road)	19
5	Lot 1 MPH30856 (908 Targinie Road)	24
6	Lot 1 RP615663 (17 Swan Road)	24
7	Lot 41 DS290 (820 Targinie Road)	26
8	Lot 58 DS290 (Unnamed Road)	25
9	Lot 3 RP617399 (749 Targinie Road)	24
10	Lot 3 DS710 (17 Swan Road)	15
11	Lot 1 MPH3003 (587 Targinie Road)	21
12	Lot 1 MPH2921 (28 Wilson Road)	19
13	Lot 3 MPH23069 (19 Wilson Road)	19
	Targinie Rural Fire Brigade	17

Table note: Adverse meteorological conditions (eg under temperature inversions) and prevailing breezes from source to receptor may increase noise levels by up to 7dBA

Noise contours for Scenario 2 are illustrated in Figure 11.4.

Table 11.12 Scenario 3 - Calculated noise levels for 24 hour TBM operation – neutral meteorological conditions

ID	Receptor	Predicted L_{A10} – neutral meteorological conditions (dBA)
1	Lot 72 DS628 (63 Flinders Road)	17
2	Lot 101 RP866910 (101 Flinders Road)	18
3	Lot 1305 MPH34872 (1023 Targinie Road)	19
5	Lot 1 MPH30856 (908 Targinie Road)	24
6	Lot 1 RP615663 (17 Swan Road)	24
7	Lot 41 DS290 (820 Targinie Road)	25
8	Lot 58 DS290 (Unnamed Road)	25
9	Lot 3 RP617399 (749 Targinie Road)	24
10	Lot 3 DS710 (17 Swan Road)	15



Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

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A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0565

Coordinate system: GCS_GDA_1994

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Noise Contours (dBA)
- 20
- 25
- 30
- 35
- 40
- 45
- 50
- 55
- 60

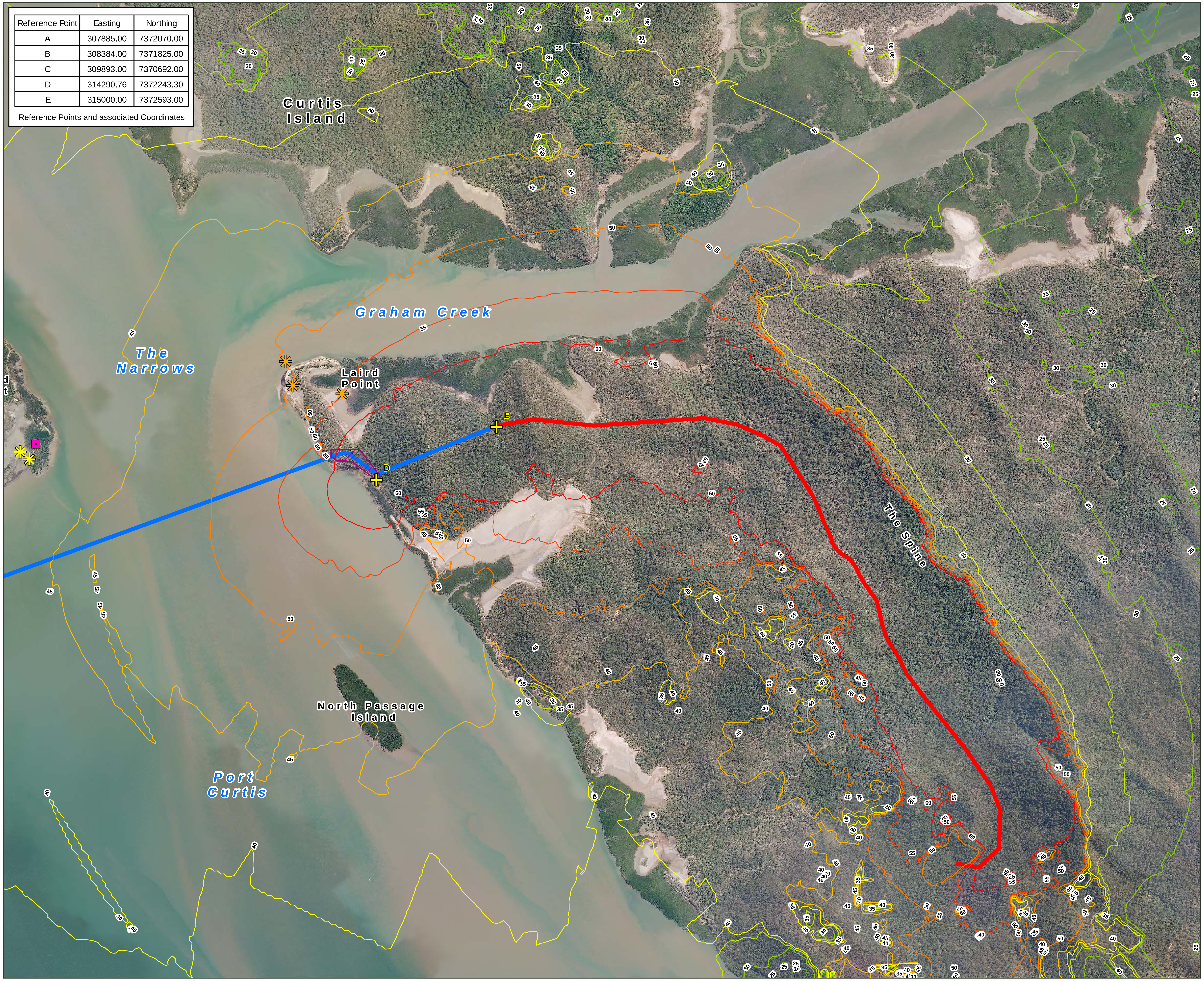
Sensitive Receptor
- Residence

High Tide Roost
- Claypan Roost
- Friend Point Roost
- Kangaroo Island North Roost
- Laird Point Roost
- Narrows Roost
- Major Shorebird Roost Site

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.
Noise Contours: SLR, Jun 2012.
Sensitive Receptors: Downes, Apr 2012
Footprints Environmental Consultants, 2012a, GLNG GTP ROW Pre-Clearing Threatened Species Surveys, Water Mouse Assessment Report
Footprints Environmental Consultants, 2012c, GLNG GTP ROW Kangaroo Island Wetland Complex Migratory Bird Surveys, Baseline Assessment Report
Major Shorebird Roost Site:
Shorebirds and Turtles, Shorebirds and Turtles, Curtis Coast Regional Coastal Management Plan, Department of Environment and Resource Management, 2003

Noise Contour Map for RoW Clearing and Topsoil Stripping (Mainland) (Scenario 1) Figure 11.3a

Date: 27/06/2012 Version: f



Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Noise Contours (dBA)
- 20
- 25
- 30
- 35
- 40
- 45
- 50
- 55
- 60

Sensitive Receptor
- Residence

High Tide Roost
- Claypan Roost
- Friend Point Roost
- Kangaroo Island North Roost
- Laird Point Roost
- Narrows Roost
- Major Shorebird Roost Site

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.
Noise Contours: SLR, Jun 2012.
Sensitive Receptors: Downes, Apr 2012
Footprints Environmental Consultants, 2012a, GLNG GTP ROW Pre-Clearing Threatened Species Surveys, Water Mouse Assessment Report
Footprints Environmental Consultants, 2012c, GLNG GTP ROW Kangaroo Island Wetland Complex Migratory Bird Surveys, Baseline Assessment Report
Major Shorebird Roost Site:
Shorebirds and Turtles, Shorebirds and Turtles, Curtis Coast Regional Coastal Management Plan, Department of Environment and Resource Management, 2003

Noise Contour Map for RoW Clearing and Topsoil Stripping (Curtis Island) (Scenario 1)
Figure 11.3b

A1 scale: 1:12,500

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0572

Coordinate system: GCS_GDA_1994

Date: 27/06/2012

Version: g

Map by: RB

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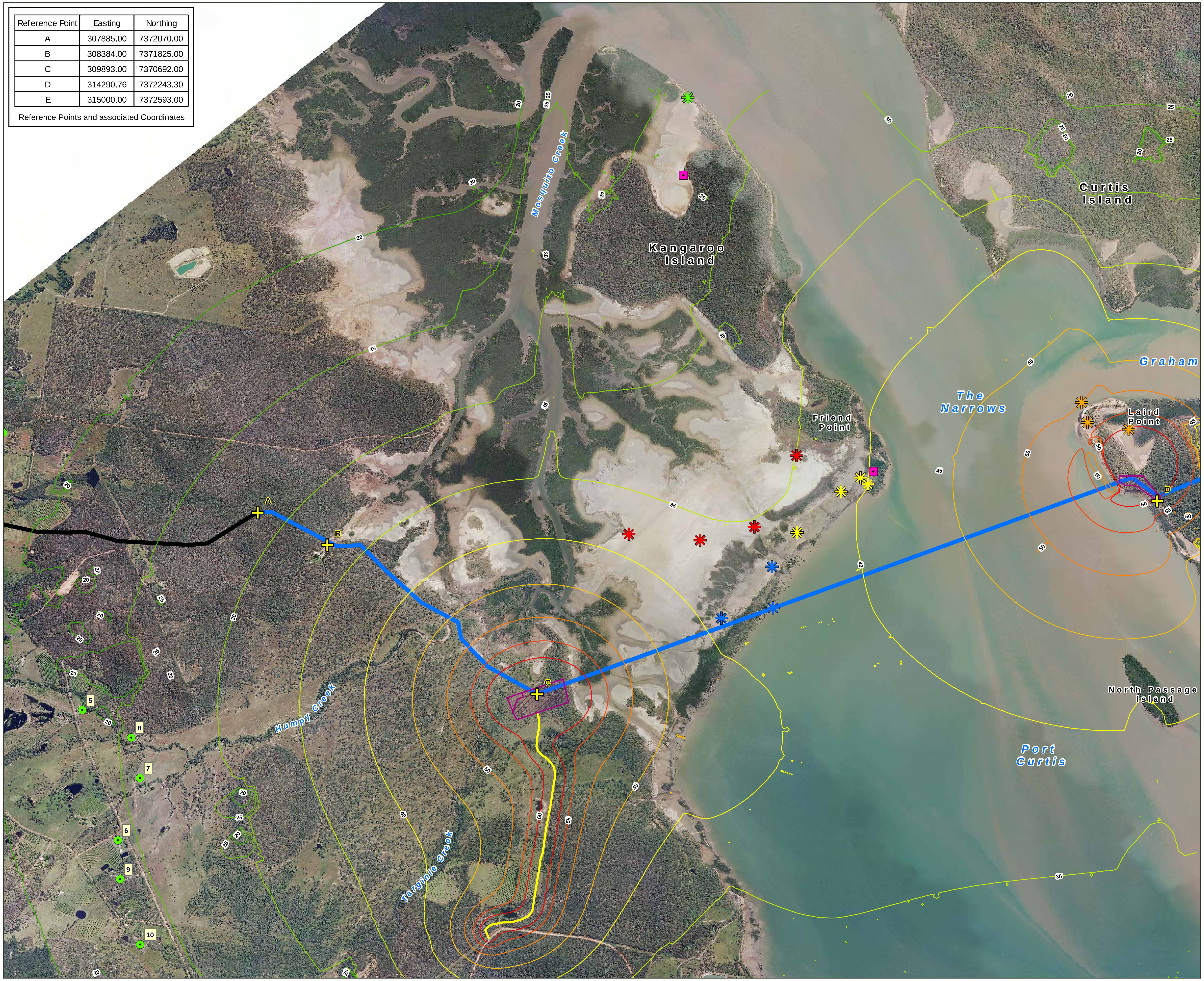
Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates



Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Noise Contours (dBA)
- 20
- 25
- 30
- 35
- 40
- 45
- 50
- 55
- 60

Sensitive Receptor
- Residence

High Tide Roost
- Claypan Roost
- Friend Point Roost
- Kangaroo Island North Roost
- Laird Point Roost
- Narrows Roost
- Major Shorebird Roost Site

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.
Noise Contours: SLR, Jun 2012.
Sensitive Receptors: Downes, Apr 2012
Footprints Environmental Consultants, 2012a, GLNG GTP ROW Pre-Clearing Threatened Species Surveys, Water Mouse Assessment Report
Footprints Environmental Consultants, 2012c, GLNG GTP ROW Kangaroo Island Wetland Complex Migratory Bird Surveys, Baseline Assessment Report
Major Shorebird Roost Site:
Shorebirds and Turtles, Shorebirds and Turtles, Curtis Coast Regional Coastal Management Plan, Department of Environment and Resource Management, 2003

Noise Contour Map for Access Road and Construction Site Pads Development (Scenario 2)
Figure 11.4

Date: 27/06/2012 Version: d

A1 scale: 1:15,000
0 250 500 750 1,000 1,250m

GLNG No: 3381-40-0566
Coordinate system: GCS_GDA_1994

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_057.mxd 27/06/2012 15:00

ID	Receptor	Predicted L_{A10} – neutral meteorological conditions (dBA)
11	Lot 1 MPH3003 (587 Targinie Road)	21
12	Lot 1 MPH2921 (28 Wilson Road)	19
13	Lot 3 MPH23069 (19 Wilson Road)	19
	Targinie Rural Fire Brigade	18

Table note: Adverse meteorological conditions (eg under temperature inversions) and prevailing breezes from source to receptor may increase noise levels by up to 7dBA

Noise contours for Scenario 3 are illustrated in Figure 11.5.

Noise from the construction of the Marine Crossing GTP Project is unlikely to significantly impact upon commercial or residential sensitive receptors due to the large separation distance between construction noise sources and residential sensitive receptors, and the implementation of noise mitigation measures (refer Section 11.10).

Predicted noise levels from construction traffic

The daily traffic volumes expected for the construction of the Marine Crossing GTP Project are too low for standard noise modelling. However, due to the rural nature of Targinie, construction traffic will be much greater than the existing traffic volumes on Targinie Road.

If the diurnal daily peak construction traffic occurs around 6.00 am and 6.00 pm, traffic noise impacts are not expected to cause any adverse community reaction. The predicted traffic noise levels in Table 11.13 are "peak" $_{LAeq,15\ minute}$ levels assuming five light and five heavy vehicles in 15 minutes, and are not considered to be adverse.

Table 11.13 Scenario 4 - Calculated noise levels for Targinie Road traffic – neutral meteorological conditions

ID	Receptor	Predicted L_{Aeq} – neutral meteorological conditions (dBA)
1	Lot 72 DS628 (63 Flinders Road)	20
2	Lot 101 RP866910 (101 Flinders Road)	16
3	Lot 1305 MPH34872 (1023 Targinie Road)	44
5	Lot 1 MPH30856 (908 Targinie Road)	44
6	Lot 1 RP615663 (17 Swan Road)	45
7	Lot 41 DS290 (820 Targinie Road)	32
8	Lot 58 DS290 (Unnamed Road)	30
9	Lot 3 RP617399 (749 Targinie Road)	37
10	Lot 3 DS710 (17 Swan Road)	25
11	Lot 1 MPH3003 (587 Targinie Road)	39
12	Lot 1 MPH2921 (28 Wilson Road)	30
13	Lot 3 MPH23069 (19 Wilson Road)	29
	Targinie Rural Fire Brigade	50

Noise contours for Scenario 4 are illustrated in Figure 11.6.

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_056.mxd 27/06/2012 14:59

A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0567

Coordinate system: GCS_GDA_1994

Santos GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Noise Contours (dBA)
- 20
- 25
- 30
- 35
- 40
- 45
- 50
- 55
- 60

Sensitive Receptor
- Residence

High Tide Roost
- Claypan Roost
- Friend Point Roost
- Kangaroo Island North Roost
- Laird Point Roost
- Narrows Roost
- Major Shorebird Roost Site

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.
Noise Contours: SLR, Jun 2012.
Sensitive Receptors: Downes, Apr 2012
Footprints Environmental Consultants, 2012a, GLNG GTP ROW Pre-Clearing Threatened Species Surveys, Water Mouse Assessment Report
Footprints Environmental Consultants, 2012c, GLNG GTP ROW Kangaroo Island Wetland Complex Migratory Bird Surveys, Baseline Assessment Report
Major Shorebird Roost Site:
Shorebirds and Turtles, Shorebirds and Turtles, Curtis Coast Regional Coastal Management Plan, Department of Environment and Resource Management, 2003

Noise Contour Map for 24-hour TBM Operation (Scenario 3)
Figure 11.5

Date: 27/06/2012 Version: e

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point

Noise Contours (dBA)
- 20
- 25
- 30
- 35
- 40
- 45
- 50
- 55
- 60
- Construction Site Pads
- Access Road

Sensitive Receptor
- Community Use
- Residence
- Major Shorebird Roost Site

High Tide Roost
- Claypan Roost
- Friend Point Roost
- Kangaroo Island North Roost
- Laird Point Roost
- Narrows Roost

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.
Noise Contours: SLR, Jun 2012.
Sensitive Receptors: Downes, Apr 2012
Footprints Environmental Consultants, 2012a, GLNG GTP ROW Pre-Clearing Threatened Species Surveys, Water Mouse Assessment Report
Footprints Environmental Consultants, 2012c, GLNG GTP ROW Kangaroo Island Wetland Complex Migratory Bird Surveys, Baseline Assessment Report
Major Shorebird Roost Site:
Shorebirds and Turtles, Shorebirds and Turtles, Curtis Coast Regional Coastal Management Plan, Department of Environment and Resource Management, 2003

Noise Contour Map for Targinie Road Traffic Figure 11.6

A1 scale: 1:25,000
0 500 1,000 1,500 2,000 2,500 m

GLNG No: 3381-40-0568
Coordinate system: GCS_GDA_1994

Date: 27/06/2012 Version: d

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_059.mxd 27/06/2012 14:52

Heavy vehicle transportation times will be considered during the construction scheduling process. These vehicles produce significantly more noise than light vehicles travelling normally, however they may potentially produce more noise along Targinie Road due to acceleration and deceleration requirements as a result of the narrow road and numerous floodway dips.

11.6.2 Noise impacts on shorebird roosting areas

A number of shorebird roosting sites have been identified within the intertidal area adjacent to the Marine Crossing GTP Project. The major shorebird roosting area at Friend Point is identified in the (former) Calliope Shire Council 2007 Coastal Management and Biodiversity Overlay Map B, and is approximately 2.9 km from the TBM launch shaft at the construction site pad (mainland) at Point C. This area is approximately 600 m laterally from the TBM alignment, and 1.9 km west of the TBM receptor shaft at the construction site pad (Curtis Island) at Point D.

Additional roosting sites identified include:

- Intertidal areas extending southwest for approximately 2.8 km from Friend Point and within approximately 300 m of the shoreline of The Narrows
- Sites at Laird Point on Curtis Island within approximately 400 m from the construction site pad (Curtis Island) at Point D

The predicted noise levels under neutral meteorological conditions during construction at the major known shorebird roost sites are summarised in Table 11.14.

Table 11.14 Estimated noise levels for construction scenarios – neutral meteorological conditions

Scenario	Description	Predicted L_{Aeq} – neutral meteorological conditions (dBA)		
		Kangaroo Island wetlands	Friend Point Major Shorebird Roost Site	Laird Point
1	ROW clearing and topsoil stripping	< 50	35	< 55
2	Access Road and construction site pads development	< 40	37	< 60
3	24-hour TBM operation	< 40	30	< 50

Birds tend to accept and/or adapt to constant steady noise levels even relatively high levels in the order of 70 dBA (Poole, 1982; Algers *et al.*, 1978). Poole (1982) found that continuous exposure to higher noise levels (from 70 dBA to 85 dBA and above) may cause some degree of behavioural changes in birds (non-specific to species). As such, the noise levels predicted at the bird roosting sites are not expected to have a long term impact on bird species.

Noise levels during sheetpiling for the TBM launch and receptor shafts (mainland and Curtis Island) will be higher than those predicted for the construction activity scenarios in Table 11.14. However, sheetpiling activities will be of short duration and birds will only be temporarily disturbed during this activity.

11.6.3 Other native fauna

Potential construction noise impacts on other native fauna that utilise the intertidal areas and nearby terrestrial habitats have been considered and are outlined in Chapter 10.

11.7 Potential construction vibration impacts

11.7.1 Potential vibration impacts from construction activities

No potential vibration impacts have been identified for conventional open cut trenching or associated activities on the mainland and Curtis Island at any sensitive receptor. The mobile plant operating during the construction of the Marine Crossing GTP Project will be mostly wheeled and travelling at low speeds, and will produce negligible ground vibration. No potential vibration impacts from construction activities (excluding TBM operation) have been considered minimal due to the significant distances from identified buildings, infrastructure and other sensitive receivers.

11.7.2 Potential vibration impacts from TBM operation

Potential impact on sensitive receivers

The major source of vibration for the Marine Crossing GTP Project is ground vibration produced by operation of the TBM. However, due to the distance from the Marine Crossing tunnel alignment and depth separation to the nearest identified human sensitive receptors, ground vibrations from such a low source level are too low to predict and are therefore predicted to be well below the vibration criteria for sensitive (human) receptors identified in Section 11.5.2.

Potential impact on fauna

Ground vibration is generally expected to be negligible (<0.05 mm/s) beyond 10 m of the TBM. It is possible that ground vibration levels may increase to a perceptible level directly over the TBM alignment, although this would be occasional and a “worst case” event and of short term duration.

A number of roosting areas have been identified above or near the TBM alignment (refer Figure 11.1), however the major shorebird roosting site identified (Calliope Shire Council, 2007) is at least 500 m from the TBM alignment, and “the majority of the observed waders, both in terms of species and number of individuals, were recorded foraging on more suitable habitat (sand/mudflats) 10 km to the east of the study area at South End” (BAAM, 2009). Ground vibration levels at Friend Point bird roosting habitat will be too small to measure or perceive, and can therefore be considered to have no potential to impact on fauna in that area.

No nesting sites have been identified within the Marine Crossing GTP Project disturbance footprint and therefore the potential for vibration effects having any impact on developing bird embryos, or long term effects on wading birds is therefore considered unlikely.

Other native fauna species (eg Water mouse) inhabiting the area directly adjacent to the Marine Crossing tunnel may experience slight vibration for a short period as the TBM passes under that specific location. Mobile animals like the Water mouse are expected to temporarily move away from the area, however any Water mouse nests that are located above the Marine Crossing tunnel may be temporarily impacted. It should be noted that no Water mouse nests have been identified in this location. The implementation of the WMMP during construction will minimise the potential vibration impact on this species.

Potential impact on other infrastructure

The Marine Crossing tunnel will cross under the proposed QCLNG pipeline with a separation of >10 m. The peak vibration level expected at the pipe is predicted to be 1.3 mm/s, or nearly 1/100th of the safe limit for steel pipes (refer Table 11.9) assuming a "worst case" scenario.

11.8 Potential construction noise and vibration impacts on the marine environment

Marine species that may be impacted within The Narrows are primarily dolphin, dugong and turtle species. Underwater noise impacts are primarily assessed from sources such as dredging, piling and seismic surveying, with typical management measures being the establishment of offset distances at which marine species must be beyond prior to commencing work. Risks associated with speed boat impacts on dugong and turtles are considered to increase when high levels of ambient noise are introduced to the marine environment, such as dredging (Gerstien, *et al.*, 2006).

However, underwater noise from frequently occurring vessels such as barges and tugboats is considered to be normal in a harbour environment and does not require a detailed assessment, particularly considering the number of vessel movements for the Marine Crossing GTP Project per day will be small and the vessel speeds low to moderate.

The vibration site law (refer Section 11.5.1) was used to predict vibration levels directly above the Marine Crossing tunnel to be 0.04 mm/s, up to 1.5 mm/s (worst case).

The transmitted energy (from the ground at the bottom of the channel to the water) is not expected to be greater than 35% (Lewis, 2002). The sound pressure at the channel floor directly over the TBM, is estimated to generally be <150 dB, and at worst no greater than 178 dB re 1µPa. The sound pressure level generally expected is at the lower range of underwater background noise levels measured in the Western Basin area by SLR Consulting (2012), and will rapidly decrease further from the channel bed and laterally away from the Marine Crossing tunnel alignment.

Underwater noise resulting from TBM induced vibration will be significantly lower than existing underwater noise sources in the Western Basin area, and is therefore considered to be negligible.

11.9 Operational impacts for noise and vibration

Monthly inspections will be carried out along the Marine Crossing GTP ROW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Typically maintenance on the Marine Crossing GTP will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required.

Noise and vibration impacts from these operational activities are expected to be low and manageable due to the low number of vehicles movements, infrequent maintenance activities and long separation distances from the Marine Crossing GTP ROW to sensitive receptors.

Furthermore, all activities and work associated with these operational activities will be in accordance with the OMP which will be developed prior to the completion of the construction phase.

11.10 Cumulative impacts for noise and vibration

This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EMP. Given the location of the Marine Crossing GTP Project, cumulative impacts from noise and vibration are anticipated to be negligible.

The nearest residential receptor is approximately 2 km from the Marine Crossing GTP Project and will be exposed to noise emissions from the ROW clearing and topsoil stripping activities associated with the cut and cover construction for trenching. It is considered that these noise levels will not be excessive and will be short-lived due to the short timeframe (approximately 7 days) that these activities will persist.

Noise impacts during 24 hour TBM tunnelling operations are predicted to achieve the noise criteria under neutral meteorological conditions and are unlikely to cause adverse effects.

Some potential noise impacts from construction traffic could be experienced by residents along Targinie Road. Impacts will be intensified by overlapping construction activities which may result in increased noise levels.

Mitigation measures set out in this EMP will result in minor negative cumulative impacts on human and native fauna receptors for noise and vibration resulting from the construction of the Marine Crossing GTP Project.

11.11 Environmental protection commitments, objectives and control strategies – noise and vibration (construction and operation)

Based on the noise and vibration impact assessment findings within this chapter, only minor and temporary construction noise and vibration levels are expected. Management measures to mitigate noise and vibration impacts which will be implemented are described in Table 11.15.

These noise and vibration mitigation and management measures are consistent with the type of recommendations described in AS2436-1981 “Guide to Noise Control on Construction, Maintenance and Demolition Sites”.

Table 11.15 Environmental protection commitments, objectives and control strategies – noise and vibration

Item	Outcomes
Environmental Protection Objective	• Minimal impact of construction related noise and vibrations on surrounding residential and commercial sites • Minimal impact of construction related noise and vibration on shorebirds and the marine environment • Minimal impact of operational related noise and vibration on surrounding residences and industry
Specific Objectives	• Compliance with EA conditions and industry standards • No warranted complaints from residents and landholders, and all complaints responded to within 24 hours

Item	Outcomes
Implementation Strategies	**Construction phase** *Pre-construction* • Construction Contractor to conduct a detailed assessment of potential vibration impacts on buried infrastructure prior to commencing construction • Construction Contractor to conduct detailed blast predictions for locations where blasting is required for the construction of the Marine Crossing GTP Project once the blast designs and parameters have been confirmed prior to commencing blasting activities *Construction* • All activities will be conducted in accordance with EA conditions and industry standards • Where heavy rock-breaking and/or drilling is necessary for rock removal for GTP trench excavation, the work will be carried out during normal daylight working hours to minimise the effects of noise impacts in built-up or established farming areas • Adequate community consultation will be provided of any scheduled atypical noise events and protection of third party infrastructure (eg for sheetpiling or blasting activities, if required) • Where approved out of hours work is to be conducted, construction work during evening and night-time periods (6.30 pm to 6.30 am) and on Sundays/Public Holidays will be undertaken in accordance with "best practice" noise management • Construction equipment will be fitted with noise control devices • Construction equipment will be inspected regularly to maintain optimal working conditions. Throughout construction, the contractor's environmental representative will undertake regular environmental audits and inspections of the site for compliance on a daily, weekly and monthly basis • Landholder complaints will be recorded in a complaints register and appropriate corrective actions will be implemented and closed out by the Environmental Manager • Maintain a Complaints Register that includes the following information - identification of the complainant, the identity of the person who is receiving the complaint, the manner in which the complaint was made, the time and date on which the complaint was made, addressed and closed out and description of the complaint. The Register must include identification of the entity responsible for addressing the complaint, a brief summary of any action taken to address the complaint, and a notation as to the satisfaction or dissatisfaction of the complainant with the outcomes **Operational phase** • Typical mitigation and controls for the operational phase of the Marine Crossing GTP Project will be detailed in the OMP, which will be developed during construction
Performance indicators	• No warranted complaints from residents and landholders, and all complaints responded to within 24 hours • Compliance with EA conditions and industry standards

12. Social

A Social Impact Assessment (SIA) was undertaken as part of the EIS to identify the potential impacts of the Project on the surrounding social environment.

12.1.1 Summary of existing social environment

- A draft SIMP was prepared for the Project. This Plan was submitted to the former DIP
- The GRC Local Government Area (LGA) comprises a number of townships, communities and islands and is referred to in this chapter as Gladstone and the local study area. The regional study area is the Fitzroy Statistical Division which includes both Gladstone and Rockhampton
- Gladstone experienced the strongest population change in the region study area of in the period to 2006 (16%). The estimated 2010 populations of Gladstone is 1.3% of the State population
- There was a trend of increasing unemployment rates over the last year, although there appears to be a slight decrease between the September and December quarters of 2011. In the December quarter 2011, unemployment rates for Gladstone ranged between 4.5% and 5.5%
- Mining and mineral processing and service industries are important industries, both within Gladstone and the regional study areas
- Gladstone supports a significant commercial fishing industry. The commercial fishing fleet operating out of Gladstone Harbour includes line fishers, net/crab fishers, trawl fishers and seasonal prawn fishers
- The major utility services operating in Gladstone include electricity and water
- Recreational fishing is a major recreational activity throughout Gladstone with the area having one of the highest rates of boat ownership of any community in Australia (GAPDL, 2008)

12.1.2 Summary of potential impacts on social environment

- The potential community and social impacts are anticipated to occur during construction and to a lesser extent the operational (decommissioning) phase
- Based on the small number of construction personnel required for the construction of the Marine Crossing GTP, there is not expected to be a significant impact on the demographic profile to the immediate area of Gladstone, including Curtis Island
- Overall the impact on income and affordability is anticipated to be low
- Construction personnel for the Marine Crossing GTP Project will be accommodated in a variety of housing types located in Gladstone. Given the small number of construction personnel required (approximately 90 personnel), it is not expected that the construction of the Marine Crossing GTP will impact on housing or accommodation demand within Gladstone
- There is the potential for a localised increase in the population of mosquitoes and midges during construction of the Marine Crossing Project, primarily due to the potential for increased areas of standing water during construction activities
- Should emergency services be required, it is unlikely that the temporary use of those services would adversely affect the Gladstone community health facilities
- Economic activity, particularly construction personnel expenditure associated Marine Crossing Project will have a positive impact on local businesses
- Due to the low number of operational vehicles movements, infrequent maintenance activities and remoteness of the Marine Crossing GTP Project, social and community impacts from these operational activities are not expected

- The Marine Crossing GTP Project represents less than 1% of the overall Santos GLNG GTP route and an equivalent small proportion of all LNG projects. Examined in isolation, the social impact of the Marine Crossing GTP Project is likely to be negligible in the context of all the LNG projects and other developments within the local and regional study areas

12.1.3 Summary of proposed mitigation measures for social environment

Table 12.1 Summary of environmental protection commitments, objectives and control strategies – Social

Item	Outcomes
Environmental protection objective	• Minimal social disruption to the local communities from the construction of the Marine Crossing GTP Project
Specific objectives	• No warranted complaints from landholders and the community, and warranted complaints responded to within 2 working days • No increased occurrence of potential mosquito and midge breeding sites and no substantial increase in the presence of adult mosquitoes and midges
Control strategies	• Development and implementation of a SIMP • Ongoing consultation with the community, agencies and representative groups to discuss the Santos GLNG GTP construction programme, operations, decommissioning and rehabilitation • Implementation of the MMMP • Typical mitigation and controls for the operational phase of the Project will be detailed in the OMP, which will be developed prior to operation Refer Table 12.6 for additional social control strategies to be implemented during construction and operation of the Marine Crossing GTP Project
Performance indicator	• No warranted complaints from landholders and the community • Warranted complaints responded to within 24 hours

12.2 Social impact management plan

A SIMP has been prepared for the Project and was approved by the State Government in May 2012.The purpose of the SIMP is to define how the social impacts and opportunities associated with the construction, operation and decommissioning of the Project will be managed.

The SIMP is a component of the SIA process followed for the Project (refer Figure 12.1). The process is comprised of four phases and activities which overlap and are iterative.

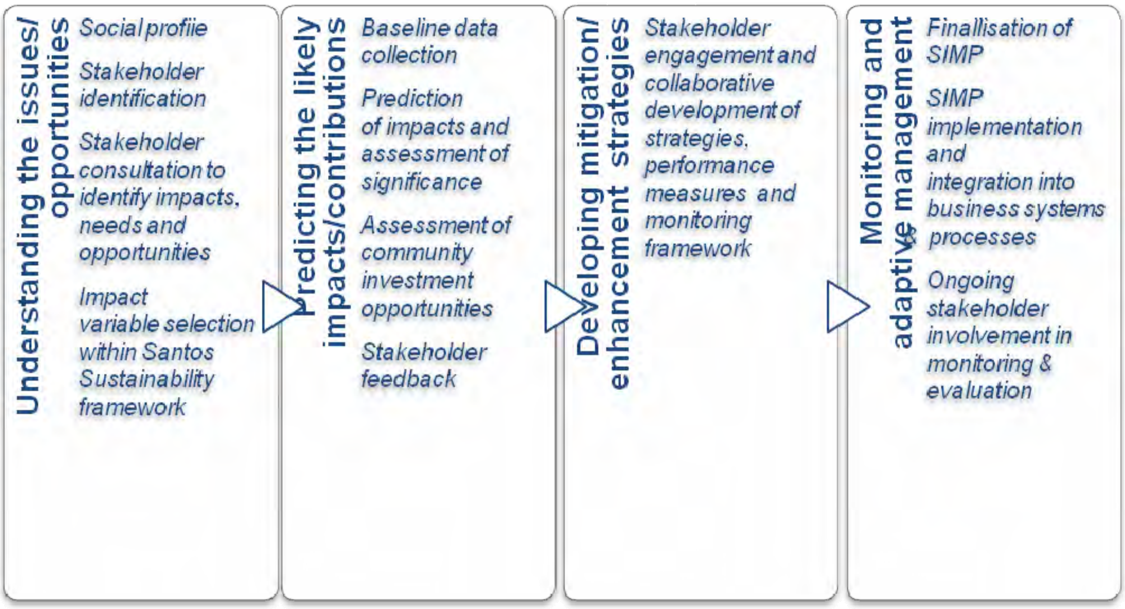


Figure 12.1 GLNG social impact assessment process

The SIMP has placed emphasis on a participatory approach to developing strategies. The stakeholder engagement programme has gone beyond the traditional compliance-based SIA focus of identifying perceived impacts associated with project activity. Perceptions relating to issues affecting the future sustainability of the affected regions have been sought, as well as suggestions for strategies that would benefit from GLNG Operations, government and community partnerships. Interested stakeholders were invited to input into strategy development and designing of performance measures for ongoing monitoring and review. Baseline assessment and consultation findings were shared with stakeholders for validation, to promote transparency, openness and a willingness to work collaboratively.

Secondly, the assessment and resultant mitigation and social investment programmes have been underpinned by the Santos Sustainability Framework. This framework has guided the selection of impact variables and management plans, seeking to avoid the risks associated with literal interpretations of lists of impacts identified by stakeholders. Figure 12.2 illustrates the link between the five ‘community’ dimensions of the Santos Sustainability Framework, which effectively serves as an umbrella for the SIMP. Three of these dimensions - Community Wellbeing; Indigenous and Cultural Heritage and Social Infrastructure – are addressed in the development of social context, social impact variables and the GLNG Operations performance measures. The dimensions relating to External Stakeholder Consultation and Transparency and Disclosure are addressed respectively in a Governance and Monitoring Plan and Community Engagement Plan.

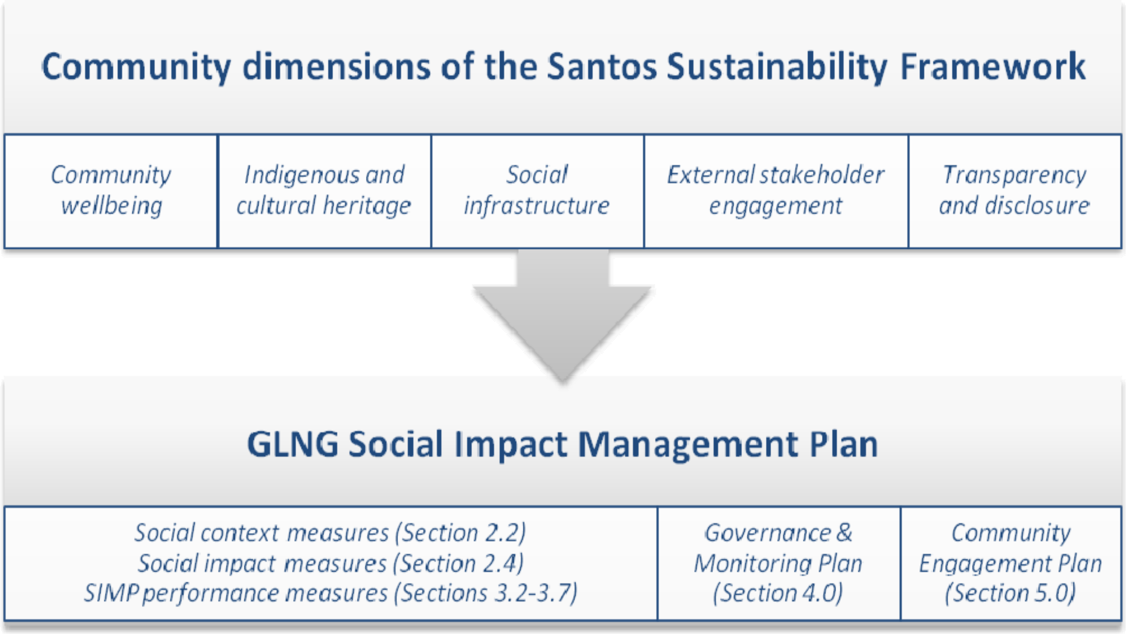


Figure 12.2 Relationship between the Santos Sustainability Framework and GLNG's SIMP

12.2.1 Description of study area

The local study area of the Marine Crossing GTP Project is the GRC LGA, referred to as Gladstone, which comprises a number of townships, communities and islands. Within this local study area, the Gladstone City functions as the major regional service centre for a hinterland that includes the towns of Boyne Island, Tannum Sands and Calliope. Smaller townships of Benaraby, Mount Larcom and Yarwun, and surrounding rural lands used for cropping, grazing, forestry and mining are also included within Gladstone.

The GRC consists of a publicly elected Mayor and eight Councillors which have an estimated operating budget of $84 million. The GRC LGA covers an area of 10,488 km^2, containing an estimated resident population of 60,316 (in 2010) and has no internal council boundaries/divisions.

Gladstone also comprises a significant light industrial hub complementing heavy industry and port related activities. The Gladstone Ports Corporation (GPC) land in Barney Point is largely committed to rail yards, freight activity and storage. Callemondah and the Hanson Road Precinct (west of the Central Business District) are a focus for light industry with some additional light industry north of the airport.

The Australian Bureau of Statistics (ABS) includes GRC LGA within the Fitzroy Statistical Division (SD) 330. This SD covers an area of 122,967 km^2, and contains the two major centres of Rockhampton and Gladstone City. For the purposes of comparison in this Marine Crossing EMP, the Fitzroy SD is referred to as the regional study area (refer Figure 12.3).

Figure 12.3 Regional study area

12.2.2 Demographic profile

The demographic profile is based on data from the 2010 Census of Population and Housing. The data has been retrieved from the basic community profiles for each of the local, regional and State study areas used for the SIA (refer Table 12.2). The basic community profiles in the 2010 census are based on place of usual residence.

Table 12.2 depicts the local, regional and State study area populations from 1981 to 2010. Figure 12.4 shows the population change from the previous period (five year intervals). All study areas experienced a slowing growth in the five year period to 2001, and an increased growth after this period. However, the local study area experienced the strongest population change of all study areas in the period to 2006 (16%). The estimated 2010 populations of the local and regional study areas correspond to 1.3% and 4.95% of the State study area population, respectively.

Table 12.2 Historical estimated residential population (1981 to 2010)

Study Area	1981	1986	1991	1996	2001	2006	2010
Local Study Area (GRC LGA)	33, 871	35, 170	38, 974	44,124	46,369	53,941	60,316
Regional Study Area (Fitzroy SD)	148,744	162,700	171,898	182,505	186,527	206,933	223,516
State Study Area	2,345,208	2,624,595	2,960,951	3,338,690	3,628,946	4,090,908	4,513,850

Source Queensland Government population projections to 2031, Local government areas 2011 edition, Appendix A: Historical estimated resident population, local government areas

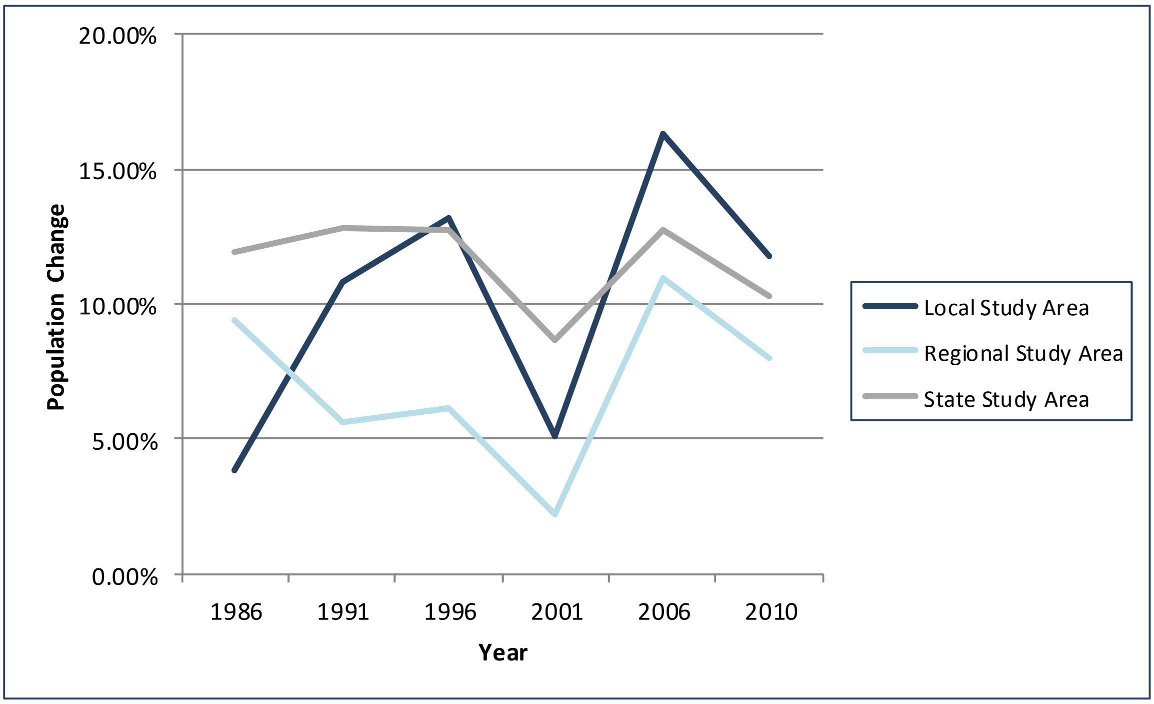


Figure 12.4 **Population change from previous period (five year intervals)**

Source: Queensland Government population projections to 2031, Local government areas 2011 edition, Appendix A: Historical estimated resident population, local government areas

Population projections

Table 12.3 and Figure 12.5 identify the projected population change for the local, regional and State study area (medium series). The local study area is projected to grow strongly to 2011 with an expected increase of 17% from 2006. After 2011, population growth is expected to slow down, but still remain between 10% and 20% per five year interval. Population growth is expected to follow a similar, although slightly slower, pattern in the regional and State study areas. The local study area is expected to be home to 111,690 people in 2031, an increase of 57,749 persons since 2006.

Table 12.3 **Projected population (medium series), local government areas**

Study Area	2006	2011	2016	2021	2026	2031
Local Study Area (Gladstone)	53,941	62,982	74,459	85,655	98,174	111,690
Regional Study Area (Fitzroy SD)	206,204	229,173	256,644	283,644	313,314	344,938
State Study Area	4,090,908	4,611,491	5,092,858	5,588,617	6,090,548	6,592,857

Source: Queensland Government population projections to 2031, Local government areas 2011 edition, Appendix B Estimated resident population and projected resident population (medium series)

Table note: The population figure for 2006 is estimated resident population. As such, it differs from the census data from the same year

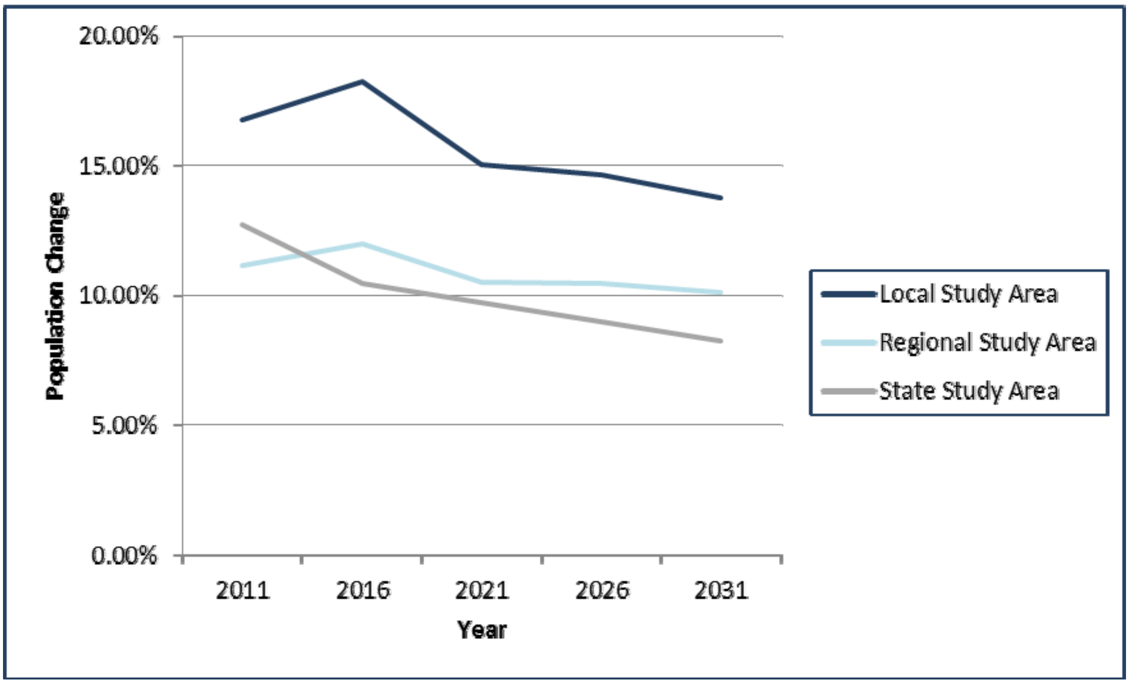


Figure 12.5 Projected population change (medium series), 2011 to 2031

Source: Queensland Government population projections to 2031, Local government areas 2011 edition, Appendix B Estimated resident population and projected resident population (medium series)

12.2.3 Socio economic profile

This section provides a socio-economic profile for the local region. ABS Census data is presented and analysed in relation to the local labour force profiles, income levels and education and general information is provided on local economic activity, particularly commercial fishing operations.

Labour force profile

The local, regional and state study areas had similar levels of employment and unemployment at December 2010 (refer Table 12.4). However, the local study area had a higher proportion of labour force participation and a lower percentage of people not in the labour force compared to the regional and State study areas in 2010.

More recent labour force data is published by the federal Department of Education, Employment and Workplace Relations in the quarterly publication Small Area Labour Markets. The most recent data available is from the December quarter 2011. Figure 12.6 shows the unemployment rates for the Statistical Local Areas (SLA) in the local study area. There is a trend towards increasing unemployment rates over the last year, although there appears to be a slight decrease between the September and December quarters 2011. In the December quarter 2011 unemployment rates in the local study area ranged between 4.5% and 5.5%.

Table 12.4 Labour force status

Study Area	Local (GRC LGA)		Regional (Fitzroy SD)		State	
	Total Number	**Percentage (%)**	**Total Number**	**Percentage (%)**	**Total Number**	**Percentage (%)**
Labour force	30,926	100%	228, 900	100%	2,472,900	100%
Of which employed	29,456	95%	217, 700	95%	2,336,200	94.5%
Of which unemployed	1,470	5%	11,200	5%	136,700	5.5%

Source: Labour force status by region (a), Queensland, 2008-09 to 2010-11 (b) (c) (d); Local & State Study Area source: Small Area Labour Markets Australia – December Quarter 2011

Table note: Regional Study Area for above table comprises Mackay – Fitzroy – Central West Statisticl Region

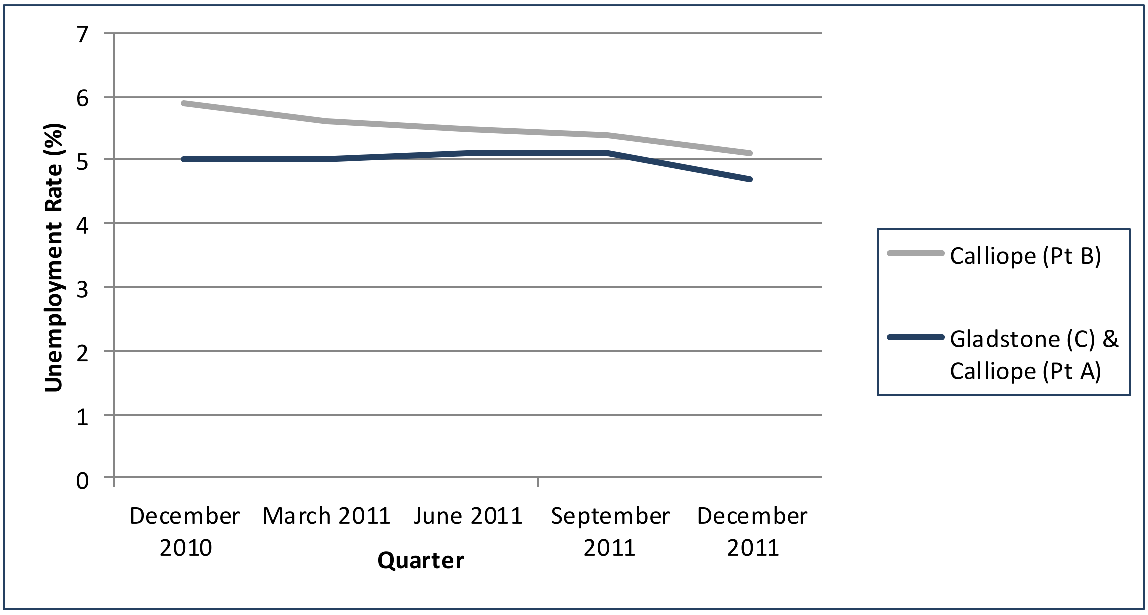


Figure 12.6 Unemployment rate for Statistical Local Areas within the Local Study Area

Note: The Unemployment Rates (%) for Calliope (S) Pt-A and Gladstone (C) are the same for these Quarters

Gladstone economic profile

Gladstone has a history of strong economic growth based around industrial development, port facilities and extraction of natural resources (Calliope Shire Council, 2004). The area is the most significant heavy industry area in Queensland, and prides itself as one of Australia's industrial 'powerhouses'. The regional study area has extensive mineral deposits, and mining, mineral processing and service industries are important industries, both in the local and regional study areas.

There is a broad range of infrastructure in place to support Gladstone's industrial development, with major projects implemented through associations with private entities, GRC and Queensland Government agencies such as QR National, DTMR and GPC. The Port of Gladstone is Australia's largest multi-commodity port and it houses the world's fourth largest coal export terminal.

While heavy industry has been, and is likely to remain, a crucial economic driver for Gladstone, the economy has matured and diversified. Emerging industries include service based industries and tourism (Futureye, 2008). Major heavy industrial projects located in Gladstone which are currently underway, committed and under investigation are listed in Table 12.5.

Table 12.5 Major heavy industrial projects located in Gladstone

Projects underway	Projects committed	Projects under investigation
Rio Tinto Alcan – Yarwun Alumina Refinery	Gladstone Pacific Nickel Limited – Stage 1 laterite nickel ore processing plant	Arrow Energy Limited and AGL Limited (Joint venture) – high pressure gas pipeline development
Boyne Smelters Limited – Construction of new baking furnace and upgrade of crane runway	Surat Basin Rail ATEC DVR, Xstrata Coal Anglo Coal and QR – Dawson Valley railway development	Arrow Energy Limited – Boyne River coal seam gas exploration and appraisal
Wiggins Island Coal Terminal – Stage 1	QR National – Stage 1 of the Wiggins Island Rail Project	LNG Limited – Fisherman's Landing LNG production facility development
Powerlink – infrastructure upgrades	Northern Oil Refineries Pty Ltd – oil refining facility at Yarwun	Australian Inland Rail Expressway – inland railway to link
Australian Pacific LNG (Origin and ConocoPhillips) – Curtis Island LNG production facility		Gladstone Area Water Board – Gladstone – Fitzroy Pipeline project
Gladstone Ports Corporation Limited – Western Basin Dredging and Disposal Project		Queensland Energy Resource Limited (QER) – Oil Shale technology development facility
Gladstone Ports Corporation Limited – Berth expansion on 153 ha of reclamation adjacent to existing Fisherman's Landing		Boulder Steel Limited – Blast furnace based steel plant development
GLNG – Curtis Island LNG production facility development		Fitzroy Terminal Limited (Mitchell Group) – Multipurpose port facility on the Fitzroy River
QCLNG – Curtis Island LNG production facility development		Sojitz Corp – Fisherman's Landing LNG production facility development
GRC and the Gladstone Area Water Board – Curtis Island Water and Sewerage Infrastructure Project		Tenement to Terminal Ltd (3TL) proposes to develop the Yarwun Coal Terminal Project and will assist in meeting the demand for additional coal terminal capacity in the Port of Gladstone

Tourism is also an important contributor to the economy in Gladstone. In 2006, 356,300 visitors travelled to the area, 86% of these being Australians (Futureye, 2008). Major tourist attractions include Heron Island, the historic Town of 1770 and easy access to the Great Barrier Reef.

In addition, Gladstone has extensive quality agricultural lands and agriculture is still one of the area's main industries. The region surrounding Gladstone supports a well-established cattle industry, supplemented by dairying, grain, fruit and vegetable growing and timber production (Travel Australia, 2008).

Various rural centres, such as Calliope, have gradually developed outside of Gladstone City. There is also a forestry industry in the region, based on softwood plantations.

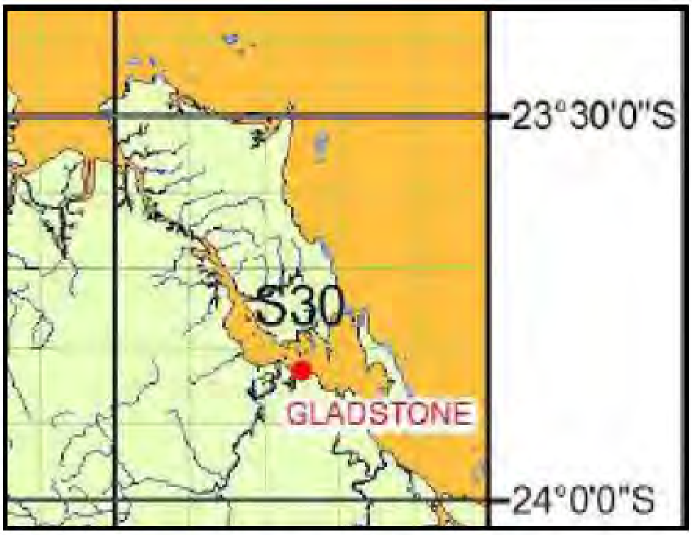
Commercial fishing in Gladstone

Gladstone supports a significant commercial fishing industry. The commercial fishing fleet operating out of Gladstone Harbour includes line fishers, net/crab fishers, trawl fishers and seasonal prawn fishers.

Commercial operators utilise various locations in and around Gladstone Harbour, Port Curtis and further off shore. Trawlers operate around and south of Gladstone Marina but are not allowed to trawl in various areas within Gladstone Harbour.

The Coastal Habitat Resources Information System (CHRIS) is a resource centre for Queensland coastal fish habitat, fisheries resources and environmental datasets (layers) developed by the former Queensland Primary Industries and Fisheries (QPIF) and other agencies. The CHRIS resource facilitates monitoring of the condition and trend of coastal fisheries habitats for the Commercial Fisheries Information System (CFISH).

For reporting purposes, the Australian coastline is divided by a grid system, with large grid squares divided into smaller compartments. Figure 12.7 shows grid S30, which captures the Gladstone Harbour and the local study area.



Source: http://chrisweb.dpi.qld.gov.au/CHRIS. Accessed: 04 March 2009.

Figure 12.7 Commercial fishing log book data collection grid system under the CFISH

Commercial activities operating in and around the Port of Gladstone include:

- Mud crabbing: conducted along the mainland coast north and south of the existing Fisherman's Landing facility
- Fish netting: commercial fishers do net 'shots' at various locations off the mainland coast adjacent to and north of the proposed Western Basin reclamation area. Specific sites are generally selected based on their ability to intercept coastal tidal flows on particular tide changes. Friend Point is a particularly productive site as it is generally highly turbid and can be fished on various tides due to the site's protection from the main currents

Trawlers also use the Port of Gladstone. However, they are not allowed to trawl in the Port area and mainly use the Port as a thoroughfare to access the ocean, The Narrows and northern Curtis Island areas.

12.2.4 Utilities and municipal services

The major utility services operating in Gladstone include electricity and water. Lake Awoonga is the main water source for the Gladstone (Travel Australia, 2008). The Gladstone Area Water Board supplies raw and treated water for industrial purposes to Gladstone and surrounding areas by pipeline from Lake Awoonga. The major electricity generating facility in Gladstone is the NRG Gladstone Power Station. The station is one of the biggest in Queensland, with a large proportion of the electricity produced going to industrial use, particularly local refineries.

12.2.5 Sport and recreation

In the following section, particular attention is given to recreational fishing in the Port Curtis and adjoining areas as dredging and reclamation activities from other projects have potential implications for recreational fishing in the area.

Recreational fishing and boating in the Gladstone

Fishing is a major recreational activity throughout the entire Gladstone, with Gladstone City having one of the highest rates of boat ownerships of any community in Australia (GAPDL, 2008). Mud crabs are harvested from the rivers and estuaries during the summer months and prawns are fished offshore (Travel Australia, 2008). Boat ramps are available at Gladstone Harbour, Boyne Island, Tannum Sands, Calliope River and The Narrows.

Popular fishing spots in close proximity to Gladstone include (Travel Australia, 2008 and GAPDL, 2008):

- Gladstone Harbour (including Cement Australia Wharf, Auckland Point Wharf, Barney Point Wharf, Queensland Alumina Ltd (QAL) Wharf and Boyne Smelter Wharf)
- Gladstone Power Station
- Barney Beach

Popular fishing spots in and surrounding Gladstone include (Travel Australia, 2008):

- Calliope River (offering barbecue facilities and 48 hour camping)
- Boyne River
- Wild Cattle Creek (at the southern end of Tannum Sands Main Beach)
- Gatcombe Head (at the south end of Facing Island and accessible by boat only)
- Farmers Point (at the northern end of Facing Island)
- South End (at the southern end of Curtis Island)
- Various estuaries
- Various offshore reefs, particularly Swains Reef and the Capricorn and Bunker Groups
- Lake Awoonga (offering Barramundi fishing assisted by the Gladstone Area Water Board which operates a fish hatchery breeding approximately 300,000 selected fish species for release each year)

12.2.6 Community facilities and services

Gladstone contains a broad range of services and facilities catering for local residents and surrounding communities. Community members generally travel to Gladstone or Rockhampton to access vital services, as there is a limited range of community services and facilities throughout the various regional towns and communities. The lack of any real hub of community services and facilities in the Yarwun and Targinie areas can mainly be attributed to the provision of these services in the Gladstone City and additional specialist services and retail facilities provided in Rockhampton.

12.3 Potential adverse or beneficial impacts on existing community values (construction and operation)

The potential community and social impacts are anticipated to occur during construction and to a lesser extent the operational and decommissioning phases.

The key social and community impacts associated with construction of the Marine Crossing GTP Project are primarily the inconvenience to the community in the immediate and surrounding areas (ie on Curtis Island, Mount Larcom and Yarwun). To a lesser extent this includes people that use the Port of Gladstone (including The Narrows) and live in Gladstone City.

Impacts to the community from the construction of the Marine Crossing GTP Project are not expected to be significant as it is located in a remote area away from populated areas and the construction duration is expected to be short term.

12.3.1 Potential impact on demographic profile

Construction personnel (approximately 90 personnel) working on the Marine Crossing GTP Project will be accommodated in Gladstone. It is anticipated that most of these personnel will not be locally hired. Based on the small number of construction personnel required for the Marine Crossing GTP Project, there is not expected to be a significant impact on the demographic profile to Gladstone, including Curtis Island.

12.3.2 Potential impact on employment

GLNG Operations aims to employ locals wherever possible. For the construction phase of the Marine Crossing GTP Project, this will not always be possible as there are certain skills required for the GTP and tunnel construction which may not be readily found in Gladstone or regional surrounding communities.

There may be opportunities for local employment for the following construction related activities:

- Traffic controllers
- Earth moving equipment operators
- General labourers

The potential for local employment for construction works will ultimately depend on the Contractor’s requirements and in-house capabilities. GLNG Operations will encourage the Contractor to employ locally whenever possible.

Unemployment levels for Gladstone range from 4.5% to 5.5% (ABS, 2011). Since the potential local employment opportunities are anticipated to be minor, there is not likely to be a measurable impact on the area’s employment rates associated with construction of the Marine Crossing GTP Project.

An outline of the Project’s SIMP to address employment is included in Section 12.5.

12.3.3 Potential impact on income and affordability

The level of income for locals who successfully gain employment with the Project would likely increase, as the construction salaries are anticipated to be at or above the average incomes for Gladstone (ABS, 2010). This is likely to have a minor impact on a small number of local residents within Gladstone that are hired for the construction of the Marine Crossing GTP Project. Overall this impact is anticipated to be low, and as such impacts to incomes for people within Gladstone are also expected to be minor. It is therefore considered that the construction of the Marine Crossing GTP Project is not likely to impact on the cost of living (affordability) within the local study area.

An outline of the Project's SIMP to address income and affordability is included in Section 12.5.

12.3.4 Potential impact on housing and accommodation

Construction personnel for the Marine Crossing GTP Project will be accommodated in a variety of housing types located in Gladstone. Given the small number of construction personnel required (approximately 90 personnel), it is not expected that the Marine Crossing GTP Project will impact on housing or accommodation within Gladstone.

12.3.5 Potential impact from mosquito and biting midges

There is the potential for a localised increase in the population of mosquitoes and midges due to the Marine Crossing GTP Project, primarily due to increased areas of standing water during construction activities. A MMMP will be implemented to control mosquitoes and midges during construction and operation. It is unlikely that any temporary increase in the population of mosquitoes and midges will be experienced within Gladstone or the Marine Crossing GTP Project.

An outline of the MMMP is included in Section 12.5 (refer Appendix H for more detail).

12.3.6 Potential impact on education and training

The construction personnel for the Marine Crossing GTP Project will be skilled and are unlikely to require additional training or education for this phase of the Project. Operational personnel required for the operational phase will be trained by GLNG Operations. As such the Marine Crossing GTP Project is not expected to create a demand on education and training facilities within Gladstone.

Specialised and targeted training for indigenous groups is included in the SIMP.

12.3.7 Potential impact on health and emergency services

First-aid facilities will be available at the Marine Crossing GTP Project. The facilities will have the capacity to treat non-serious injuries and stabilise more serious injuries prior to transport to hospitals. The construction personnel for the Marine Crossing GTP Project are not anticipated to have a significant demand on general health and medical services in Gladstone. This could include fire, police, ambulance or flying doctor. Due to the onsite capabilities of the emergency services for the construction personnel, a request for local emergency services is considered a low likelihood. Should such services be requested, it is unlikely that the temporary use of those services would adversely affect the Gladstone community health facilities.

An outline of the Project's SIMP to address health and emergency services is included in Section 12.5.

12.3.8 Potential impact on community facilities and services

Economic activity, particularly construction personnel expenditure associated with the Marine Crossing GTP Project will have a positive impact on local businesses. This is not anticipated to be significant, due to the short construction duration and limited workforce size.

In accordance with the SIMP, GLNG Operations will procure supplies and services locally where practicable in order to increase the local economy and provide employment opportunities.

An outline of the Project's SIMP to address community facilities and services is included in Section 12.5.

12.3.9 Potential impact on community values and lifestyle

The impacts on the community values and lifestyle within Gladstone associated with the Marine Crossing Project are expected to be minor due to the duration of construction, remoteness of the construction site itself and the minor local employment opportunities.

In addition, there is expected to be no impacts on community safety associated with the Marine Crossing GTP Project due to the remoteness of the works to populated areas.

The delivery of plant, equipment and pipe materials to Curtis Island will be limited and undertaken with certification from the Gladstone Harbour Master, and as such, it is unlikely that there will be any negative impacts on the users of the marine environment.

An outline of the Project's SIMP to address community values and lifestyle is included in Section 12.5.

12.3.10 Operational impacts

The operational workforce for the full length of the GTP is anticipated to be approximately 20 persons. Normal operational activities will include visual inspections along the Marine Crossing GTP ROW by vehicle and foot patrols. Due to the low number of operational vehicles movements, infrequent maintenance activities and remoteness of the Marine Crossing GTP ROW, social and community related impacts from these operational activities are not expected.

12.4 Cumulative impacts

The Marine Crossing GTP represents less than 1% of the overall GLNG GTP route and an equivalent small proportion of all LNG projects. Examined in isolation, social impacts for the Marine Crossing GTP are likely to be negligible in the context of all the LNG projects and other developments in Gladstone and the GTP routes beyond.

The cumulative social and community impacts that relate specifically to the impacts of the Marine Crossing GTP Project are described below. These do not include the larger cumulative social impacts likely to be caused by other development in the area. This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2.

12.4.1 Social and community (construction worker employment)

The Marine Crossing GTP Project may have a potential positive temporary impact on employment, skills training and demand on local goods and services. However, given the limited scale and duration of the works, and the very large scale of works associated with other components of the LNG projects, these impacts are likely to be minor. Measures set out in this EMP will result in positive cumulative impacts on social and community (construction worker employment) for the Marine Crossing GTP Project.

12.4.2 Social and community (local services and facilities)

Some additional demand for local services and facilities is likely to be generated during the construction of the Marine Crossing GTP, especially during the timeframe that construction of the Project occurs concurrently with other projects in the area. However, a variety of housing types, including construction accommodation camps will be provided for workers and given the limited scale and duration of the works, and the very large scale of works associated with other components of the LNG projects, these impacts are likely to be minor.

Measures set out in this EMP will result in negligible cumulative impacts on social and community (local services and facilities) from the Marine Crossing GTP Project.

12.4.3 Social and community (socio-economics)

While The Narrows is not used as a commercial fishery, the local mud crabbing industry and recreational fishing do utilise the area. The Marine Crossing tunnel beneath the intertidal areas and The Narrows will not directly impact on these recreational activities.

12.4.4 Traffic and transport (construction vehicle movements/construction pressure on local services)

Deliveries will be made to and from Gladstone by truck along local roads. Given the limited scale of the Marine Crossing GTP Project, impacts from deliveries are likely to be minor.

There is potential impact from the removal of spoil due to construction of the tunnel. Tunnel spoil will be removed by truck from the construction site pad (mainland) to the proposed disposal area. The potential impacts to roads from the Marine Crossing GTP Project has been addressed in the RUMP and road upgrade agreements have been made between GLNG Operations, DTMR and the local affected authorities.

Measures set out in this EMP will result in minor negative cumulative impacts on traffic and transport from the Marine Crossing GTP Project.

12.5 Environmental protection commitments, objectives and control strategies – social (construction and operation)

The conditions in Appendix 1, Part 3 of the CG Report impose requirements to manage the social impacts of the Project. In accordance with those conditions, measures are being taken to manage the social impacts of the Project (including the Marine Crossing GTP Project).

Environmental protection commitments, objectives and control strategies proposed are presented in Table 12.6.

Table 12.6 Environmental protection commitments, objectives and control strategies – for social

Item	Outcomes
Environmental protection objective	• Minimise any social disruption to the local communities from the construction of the Marine Crossing GTP Project
Specific objectives	• No warranted complaints from landholders and the community, and warranted complaints responded to within 2 working days • No increased occurrence of potential mosquito and midge breeding sites and no substantial increase to the presence of adult mosquitoes and midges
Control strategies	**Preconstruction phase** Implement relevant provisions of the SIMP. The SIMP will addresses the following: *Employment* • Prioritise local employment over non-local employment where possible and practical *Income and affordability* • Adopt local procurement policies in order to enhance local economic benefits • Where possible explore the potential to procure some supplies locally if possible *Health* • Inform local health services prior to commencing activity in the area *Heritage* • Minimise social impacts on indigenous persons in the area by the implementation of GLNG Operations' Aboriginal Engagement Plan *Emergency services, Strain on local facilities and services* • Inform local emergency services prior to commencing construction of the Marine Crossing GTP • Maintain an open dialogue with local service providers to understand the likely future demand for infrastructure and services *Consultation strategy* • GLNG Operations will maintain an open dialogue with local councils, which will help local service providers understand the likely future demand for infrastructure and services • GLNG Operations will consult with Council and community representative groups to discuss the Santos GLNG GTP construction programme, operations, and decommissioning and rehabilitation *Community values, lifestyle* • Contribute to local liveability programmes and initiate a community consultation and awareness campaign to promote project benefits to the community
	Construction phase • Implement the relevant provisions of the SIMP to monitor and communicate social impacts associated with the construction of the Marine Crossing GTP Project and work with local services and stakeholders to develop practical solutions • Consultation with the community, agencies and representative groups to discuss the Marine Crossing GTP Project construction programme, operations, and decommissioning and rehabilitation will be ongoing • Implement the MMMP(refer Appendix H)

Item	Outcomes
	Operational phase • Typical mitigation and controls for the operational phase of the Project will be detailed in the OMP, which will be developed prior to operation
Performance Indicators	No warranted complaints from landholders and the community, and warranted complaints responded to within 24 hours

13. Cultural heritage

13.1 Chapter summary

13.1.1 Summary of existing cultural heritage values

No Indigenous heritage places have been identified within the Marine Crossing GTP Project disturbance footprint, which includes the Access Road and construction site pads. No non Indigenous heritage places have been identified within the Marine Crossing GTP Project area.

13.1.2 Summary of potential impacts on cultural heritage values

As no Indigenous or non Indigenous cultural heritage sites have been identified within the Marine Crossing GTP Project, no impacts have been identified. However, construction has the potential to impact upon undiscovered cultural heritage artefacts within the Marine Crossing GTP Project disturbance footprint.

13.1.3 Summary of mitigation measure for cultural heritage

Table 13.1 Summary of proposed mitigation measures for the management of cultural heritage

Item	Outcome
Environmental protection objective	• Cultural heritage values of the Marine Crossing GTP Project are protected
Specific objectives	• Compliance with the requirements of the *Aboriginal Cultural Heritage Act 2003* (ACHA) and relevant CHMPs • No disturbance of any place on the Queensland Heritage Register (QHR) in accordance with the requirements of the *Queensland Heritage Act 1992*
Control strategies	• Implement CHMPs that identify protection, management and mitigation measures, in consultation with the relevant Aboriginal Parties • Relevant native title permissions will be gained for the pipeline via the negotiation and registration of Indigenous Land Use Agreements (ILUAs) or the grant of Ministerial permissions under the *Petroleum and Gas (Production and Safety) Act 2004* • Where potential non Indigenous heritage material is identified and likely to be disturbed, GLNG will determine the significance of the site in consultation with DEHP and undertake relocation/preservation of the material • In accordance with the CHMPs, a cultural heritage management compliance handbook will be prepared for contractors, including procedures for site discoveries during construction Refer to Table 13.3 for full details of management of heritage values and control strategies to be implemented during construction and operation
Performance indicators	• Compliance with the requirements of the ACHA, the Port Curtis Coral Coast (PCCC) CHMP and the relevant CHMPs • No disturbance of any place on the QHR in accordance with the requirements of the *Queensland Heritage Act 1992* • Procedures for identifying and managing previously unidentified cultural heritage sites are implemented, as described in the cultural heritage management compliance handbook (refer to Table 13.3)

13.2 Description of environmental values

This chapter describes the existing cultural environment within the Marine Crossing GTP Project disturbance footprint. The assessment has been based on a review of available information.

In order to identify the cultural heritage environmental values, the following registers and databases have been consulted.

Table 13.2 Search of heritage registers

Governing body	Register
DNRM	Aboriginal and Torres Strait Islander Cultural Heritage Database and Register
DEHP	Queensland Heritage Register

In addition to the above searches, onsite cultural heritage surveys were also undertaken for the Marine Crossing GTP area of interest (refer to Figure 13.1) to identify any additional heritage sites, over and above what has been accounted for in both state and local databases. Further details regarding these surveys are provided throughout the remainder of this chapter.

13.2.1 Indigenous

The Marine Crossing GTP Project disturbance footprint is situated partially within the external boundaries of the registered Port Curtis Coral Coast (PCCC) native title claim (QUD6026/01). The PCCC native title claim area takes in the small area of land in the south west of the Marine Crossing GTP area of interest along the HAT line. The claim area does not include waters of the Gladstone Harbour. The Port Curtis Coral Coast Aboriginal Corporation is also registered as an Aboriginal Cultural Heritage Body for the area of land covered by the PCCC native title claim.

The extent of vegetation and the nature of erosion and deposition regimes affect the visibility of cultural remains and hence the chances of their detection during ground surveys. Likewise, non Indigenous land use practices can disturb artifacts from their original context of deposition.

Site specific heritage

In March 2010, GLNG negotiated CHMPs with relevant Aboriginal Endorsed Parties for The Narrows crossing under the requirements of the ACHA.

During the negotiation of The Narrows CHMP, GLNG agreed for six Endorsed Party Elders to visit the site to consider the cultural impacts of the pipeline construction. A boat trip was undertaken on 28 October 2010. Each Elder had the opportunity to voice their opinions and concerns. There was a common concern relating to the environmental impacts.

13.2.2 Non Indigenous

The EIS did not identify any heritage sites of significance associated with the Marine Crossing GTP. The Marine Crossing GTP traverses beneath the GBRWHA.

Reference Point	Easting	Northing
A	307885	7372070
B	308384	7371825
C	309893	7370692
D	314290.76	7372243.3
E	315000	7372593

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Marine Crossing GTP Area of Interest
- Construction Site Pads
- Access Road

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.

Cultural Heritage Area of Interest Figure 13.1

A1 scale: 1:15,000
0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0569
Coordinate system: GCS_GDA_1994

Date: 20/06/2012 Version: c

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_050.mxd 20/06/2012 16:31

13.3 Potential impacts on existing cultural heritage values

13.3.1 Indigenous

No Indigenous heritage places have been identified within the Marine Crossing GTP Project disturbance footprint.

Any heritage sites encountered during construction works will be handled in accordance with the CHMP. In the event that cultural heritage items are identified during construction, work will cease at the location of the potential heritage items and reasonable efforts will be made to establish a 50 m buffer zone around the site to avoid further disturbance. Consultation will be undertaken with the Traditional Owner groups identified (if any) by the cultural heritage unit in DNRM and a qualified specialist to seek advice and agreement for further action, in accordance with duty-of-care guidelines.

13.3.2 Non Indigenous

Proposed works for the Marine Crossing GTP Project will not impact upon any known non Indigenous heritage sites. To date no non Indigenous heritage sites have been identified within the Marine Crossing GTP Project disturbance footprint. GLNG Operation's cultural heritage personnel participating in Aboriginal cultural heritage surveys have concurrently reviewed potential non Indigenous heritage impacts. Any impact to other sites of local significance will be minimised unless absolutely essential. In the case that a site of local significance will be impacted upon, archival recording by a qualified specialist will be undertaken in accordance with international standards.

In the event that a site is identified during construction:

- It will be demarcated
- Where construction works are close to the heritage site, access will be restricted
- Archival recording will be undertaken by a qualified specialist
- DEHP will be notified of the discovery of any archaeological artefact

13.3.3 Operational impacts

Operational activities will typically include monthly inspections along the Marine Crossing GTP ROW by vehicle and foot patrols to check on the condition of the GTP. Maintenance of the Marine Crossing GTP will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required. Potential cultural heritage (Indigenous and non Indigenous) related impacts from these operational activities are expected to be negligible and will be managed in accordance with the CHMP and OMP. The OMP will be implemented at the completion of the construction phase.

13.4 Cumulative impacts

No areas of cultural heritage significance have been identified within the Marine Crossing GTP area of interest (refer Figure 13.1), hence no potential cumulative impacts are expected.

13.4.1 Indigenous cultural heritage (disturbance to Indigenous cultural heritage places or materials)

The EIS does not identify evidence of Indigenous cultural heritage places or items within the footprint of the Marine Crossing GTP Project. Nonetheless there is a risk of finding and impacting Indigenous cultural heritage, given the extended activities that will occur in the area and the area of land subject to excavations.

If cultural heritage materials are identified during clearing of vegetation or disturbance of topsoil, these are likely to consist of scatters of material that may extend across construction footprints of different proponents.

13.4.2 Non Indigenous cultural heritage

There are no known non Indigenous heritage features present in the Marine Crossing GTP area of interest and hence no cumulative impacts are anticipated.

13.5 Environmental protection commitments, objectives and control strategies – Indigenous and non Indigenous

Environmental protection commitments, objectives and control strategies proposed are presented in Table 13.3.

Table 13.3 Proposed mitigation measures for the management of cultural heritage

Item	Outcomes
Environmental protection objective	• Cultural heritage values of the Marine Crossing GTP Project are protected
Specific objectives	• Compliance with the requirements of the ACHA and the CHMPs • No disturbance of any place on the QHR in accordance with the requirements of the *Queensland Heritage Act 1992*
Control strategies	**Preconstruction and Construction Phase** • GLNG Operations have developed CHMPs in consultation with the relevant Aboriginal Parties that identify protection management and mitigation measures. The CHMPs will be implemented and incorporated into the GLNG Operations' cultural heritage management system • GLNG Operations will seek to gain relevant native title permissions for the pipeline via the negotiation and registration of ILUAs or the grant of Ministerial permissions under the *Petroleum and Gas (Production and Safety) Act 2004* where ILUAs are not achievable • Infrastructure will be located to avoid known cultural heritage sites. All heritage sites shall be demarcated and access restricted where construction works are close to the heritage site • Where potential non Indigenous heritage material is identified and likely to be disturbed, GLNG Operations will determine the significance of the site in consultation with DEHP and undertake relocation/preservation of the material • Discussion of cultural heritage issues will be included in the Project induction program and involve representatives from the Aboriginal Parties in the development and implementation of such programs • GLNG Operations will educate their staff and contractors on the location and significance of the heritage sites to avoid disturbance, where required

Item	Outcomes
	Construction phase • Fencing and signage of sensitive areas/sites will be undertaken • In accordance with the CHMPs, a cultural heritage management compliance handbook will be prepared for contractors, including procedures for site discoveries during construction. This will include details of: – An approved alignment and corridor for construction within ESAs of 30 m – Specific cultural heritage management requirements (avoidance or monitoring) by site and by location in relation to: o Culturally sensitive areas o Areas with potential for sub-surface cultural heritage – Other cultural heritage management requirements, including site inductions and post-construction audits – Training materials to inform the workers as to what archaeological material and cultural heritage sites may look like – Procedures for previously unidentified sites located during construction – A detailed description of roles, responsibilities and procedures associated with: o Day-to-day communication with each group o The delivery of site inductions o Planning, mobilisation and supervision of cultural heritage officers undertaking monitoring or audits o Any other aspects of engagement with the Aboriginal groups – If personnel discover what may be cultural heritage material, the following will be undertaken: o Immediately cease any work that may disturb the site or artefact. o Do not touch or interfere with the possible site. o Notify Supervisor and a representative from the Cultural Heritage Team o Fill out the ‘Discovery of Cultural Heritage Form’ and submit o All reasonable effort to establish a buffer zone of 50 m around the site. Works may not commence in the buffer zone until the Cultural Heritage Team has provided an approval to do so. o Works may proceed outside of the 50 m buffer zone • Training materials will inform the workers as to what archaeological material and cultural heritage sites may look like and provide clear instructions on what to do if material or sites are identified • During construction, monitoring of earthworks by group representatives in areas of high heritage sensitivity or where sub-surface archaeological deposits are likely **Operational phase** • Routine operational activities will be limited to monthly inspections by vehicle and foot along the length of the Marine Crossing GTP ROW. Typical mitigation and controls for the operational phase will be detailed in the OMP, which will be developed prior to operation
Performance Indicators	• Compliance with the requirements of the ACHA, PCCC CHMP and the relevant CHMPs • No disturbance of any place on the QHR in accordance with the requirements of the *Queensland Heritage Act 1992* • Procedures for identifying and managing previously unidentified cultural heritage sites are implemented, as described in the cultural heritage management compliance handbook

14. Waste management

14.1 Chapter summary

This chapter addresses proposed waste management issues which relate to construction, operation and decommissioning of the Marine Crossing GTP.

14.1.1 Summary of information on waste generation

- The Marine Crossing GTP Project is not expected to generate large quantities of waste materials
- Anticipated waste streams from the Marine Crossing GTP Project during construction include:
  - General waste
  - Recyclable waste
  - Medical and first aid waste
  - Liquid waste (sanitary waste, hydrotest water, washdown facility wastewater)
  - WTP and washdown facility residue
  - Tunnel spoil and excess/out-of-specification grout
  - Hazardous and regulated waste
- Post construction rehabilitation of the Marine Crossing GTP ROW and associated infrastructure will generate waste concrete and road base from removal of site pad and roadways
- Minimal waste is expected to be generated from maintenance activities during operation of the Marine Crossing GTP

14.1.2 Summary of potential impacts of waste generation

Construction

Potential impacts may include water contamination, land contamination from spills, increased occurrences of vermin and potential adverse effects to flora and fauna.

It is considered that the potential impacts resulting from construction of the Marine Crossing GTP Project are expected to be acceptable and manageable as construction works will be undertaken in accordance with the control strategies outlined in Section 14.11 and the WMP (refer Appendix F).

Construction activities will generate chemicals and hazardous waste. Chemical and hazardous materials associated with the Marine Crossing GTP Project and will be handled and stored in accordance with the applicable State or Commonwealth legislation:

- *Work Health and Safety Act 2011*
- *Dangerous Goods Safety Management Act 2001*
- *Transport Operations (Road Use Management – Dangerous Goods) Regulation 2008*

Additionally, to minimise potential adverse environmental impacts, all chemicals will be stored in accordance with:

- AS 1940 – The storage and handling of flammable and combustible liquids
- AS 3833 – The storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers
- AS 3780 – The storage and handling of corrosive substances
- AS 4452 - The storage and handling of toxic substances

Operation

It is considered that waste related impacts resulting from the operation of the Marine Crossing GTP will be acceptable and manageable due to the low volumes of waste produced. Furthermore, operational activities will be undertaken in accordance with the WMP (refer Appendix F) and OMP that will be developed prior to operation.

During the operational phase all chemicals will be stored and handled in accordance with the Santos Environment Health and Safety Management System (EHSMS) - HSH08 (Chemical Management and Dangerous Goods) and Santos EHSMS.

14.1.3 Summary of proposed mitigation measures for waste

Table 14.1 Environmental protection commitments, objectives and control strategies for waste

Item	Outcomes
Environmental protection objective	• The construction of the Marine Crossing GTP adheres to the waste management and resource management hierarchy of avoid, reduce, re-use and recycle. Where this is not possible, waste is disposed of in the most appropriate manner • The quality of local land and water resources during pipeline hydrotesting is protected • Storage and handling of chemicals and dangerous goods does not cause environmental harm or harm to persons
Specific objectives	• No inappropriate disposal or management of waste • No contamination of soil, air or water as a result of waste handling • Petroleum activities do not result in the release or likely release of contaminants to the environment from the storage, conditioning, treatment and disposal of regulated waste materials • No adverse impacts on soil or surface water as the result of discharging hydrotesting water • Petroleum activities do not result in the release or likely release of a hazardous contaminant to the environment • Storage and handling procedures correct and as per industry best practice • Chemicals stored in secure areas in accordance with relevant standards • All containment systems must be designed to minimise rainfall collection within the system
Control strategies	• Implementation of the WMP • Implementation of the DHWLRMP (refer Appendix D) Refer Table 14.7, and Table 14.8 for additional waste mitigation measures to be implemented during construction and operation of the Marine Crossing GTP
Performance indicators	• Waste is being appropriately managed and disposed of • Waste handling is not resulting in the contamination of soil, air or water • Permits to draw water are in place • Discharge of hydrotest water does not adversely impact on soil or surface water • The environment is not being contaminated by hazardous goods • Correct and appropriate storage and handling procedures are in place • Chemicals are stored in compliance with relevant standards • Collection of rainfall is minimised in all containment systems

14.2 Background

This chapter covers the waste management issues which relate to construction, operation and decommissioning of the Marine Crossing GTP.

The waste chapter information has been developed in accordance with the EP Act, *Waste Reduction and Recycling Act 2011* and the CG Report (Queensland Government, 2010a) for the Project. This information has then been documented for the following key areas:

- The types and amounts of waste which are expected to be generated (refer Sections 14.1.1 and 14.5)
- Proposed environmental protection commitments, objectives and control strategies for wastes produced by the Marine Crossing GTP Project in accordance with the waste and resource management hierarchy
- Any potential impact on environmental values

The WMP (refer Appendix F) provides details on the management of waste for the Santos GLNG GTP, which encompasses the Mainland, Marine Crossing and Curtis Island GTP sections.

14.3 Waste and resource management hierarchy

The management of all waste and surplus material, resulting from construction and operation activities associated with the Marine Crossing GTP ROW, will be in accordance with the principles of the waste and resource management hierarchy[1] as described in the Queensland Waste Reduction and Recycling Strategy 2010 - 2020.

The waste and resource management hierarchy as shown in Figure 14.1 depicts disposal as the least desired option for managing waste. The most desired options of reduction, reuse and recycling are located at the top of the hierarchy. The waste and resource management hierarchy principles are addressed in more depth in the WMP (refer Appendix F).

[1] Prior to publishing of the Queensland Waste Reduction and Recycling Strategy 2010 – 2020, the Waste and resource management hierarchy was referred to in Queensland Legislation and other government documents as the Waste Management Hierarchy comprising waste avoidance, waste reuse, waste recycling, energy recovery and waste disposal

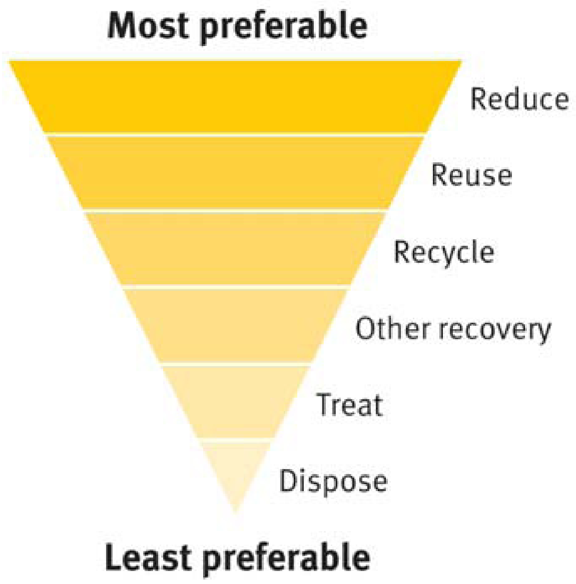


Figure 14.1 Waste and resource management hierarchy

Source: Queensland's Waste Reduction and Recycling Strategy 2010–2020 (Queensland Government, 2010c)

14.4 Waste inductions and training

All construction personnel associated with the Marine Crossing GTP construction will be required to complete an induction. The induction training will incorporate relevant aspects of the WMP (refer Appendix F) and each individual's obligations with regard to the management procedures for all waste items and materials. This training will outline the importance of managing waste materials in accordance with the principle of the waste and resource management hierarchy as outlined above.

14.5 Waste generation

Construction of the Marine Crossing GTP Project is not expected to generate large quantities of waste materials. The anticipated waste streams from the construction process generally fall into one of the following broad categories:

- General waste (including putrescible waste)
- Recyclable waste such as paper, cardboard, plastics, glass, scrap metals and timber
- Medical and first-aid waste
- Liquid waste
- Sanitary waste
- Hydrotest water
- Wash down facility wastewater and residue
- Tunnel spoil and excess or out of specification grout
- WTP residue
- Hazardous and regulated waste
- Waste concrete and road base

The waste and resource management hierarchy principles for the optimal management of all wastes generated from the Marine Crossing GTP Project will be adopted.

14.6 Marine Crossing GTP waste sources

14.6.1 Construction waste

The expected waste types and estimated quantities for the Marine Crossing GTP Project are listed in Table 14.2. Each construction worker will be responsible for transporting their recyclable materials and waste to the designated waste storage area located within the construction site pads. The workers will be required to separate their waste into the correct bin as per the bin label.

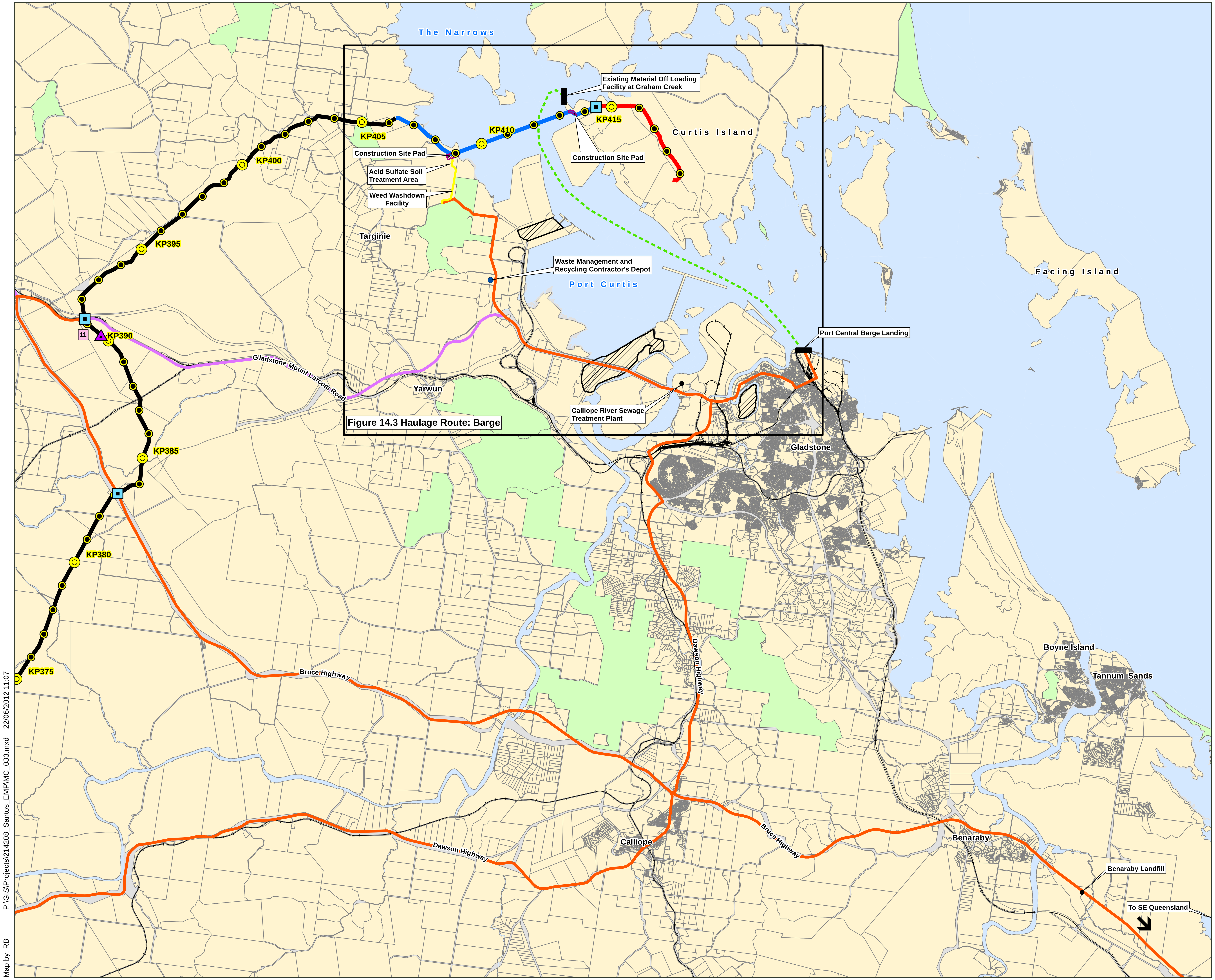
All waste and recyclable material from the Marine Crossing GTP Project waste storage area located within the construction site pad (mainland) will be collected and transferred by road to the Waste Management and Recycling Contractor's (WMRC) depot for further sorting or consolidation with other recyclable material and dispatch to markets or transported direct to the recycling or disposal destination.

All waste and recyclable material from the construction site pad (Curtis Island) will be collected and transferred by barge and then road to the WMRC's Landing Road depot for further sorting or consolidation with other recyclable material and dispatch to markets or transported direct to the licensed recycling or disposal destination. Where logistically more efficient (ie when waste quantities equate to a full hook lift or front lift collection vehicle), general waste may be hauled directly from the Marine Crossing GTP Project waste storage area at construction site pad (mainland) via road to Benaraby Landfill for sorting and appropriate disposal. Recyclable material may be collected and hauled from the Marine Crossing GTP Project waste storage area directly to the recycling service provider's yard for aggregation and dispatch to recycling markets.

Figure 14.2 and Figure 14.3 show the location of the Santos GLNG GTP, the construction site pads, proposed waste haulage routes and local waste and sewage disposal facilities. Post construction, the construction site pads and Access Road will be removed and managed as per the general management principles listed in Table 14.2.

Table 14.2 Waste generated from Marine Crossing GTP construction works

Marine Crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Mobilisation activities			
Weed control	Surplus herbicides and empty chemical containers and other consumables	Recyclable material to recycling facility (where available) General waste to local licensed landfill Unused herbicides will be retained by Weed Control subcontractor for use on other projects Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	20 m^3 per month of general construction waste during site establishment 4.5 m^3 per month of metal (recycled)
Site establishment - Delivery of plant, equipment and portable structures to site (ie vehicles, dongas, portable toilets, vehicle weed washdown facilities at ROW access points, sheet piling retaining walls)	Packaging (ropes and strapping, cardboard), timber skids, wooden crates, fibre/nylon rope spacers, pallets, drums and scrap metals		



A1 scale: 1:75,000

0 1,500 3,000 4,500 6,000 7,500 m

GLNG No: 3381-40-0458

Coordinate system: GCS_GDA_1994

Santos GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP

Kilometre Post Distance Marker
- 5km
- 1km
- Construction Site Pads
- Access Road

Road Haulage Route
- Waste to Benaraby Landfill; regulated waste and recyclables to SE Qld
- Other GLNG haulage route
- All waste and materials from Curtis Island
- Barge Landing (Indicative)
- Vehicle Washdown and RoW Access Point (Indicative)
- Temporary Pipe Storage Site
- Waste Management and Recycling Contractor's Depot
- Potential Beneficial Tunnel Spoil Reuse Options
- Protected Area
- Cadastre
- Rail

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, 2011.
Protected Areas: Department of Environment and Resource Management, Feb 2011.
Cadastre: Department of Environment and Resource Management, Oct 2011.
Temporary Pipe Storage Site: GLNG Pipeline Logistics Study, GHD, Nov 2009.
Vehicle Washdown Point: Aurecon, Feb 2011.

Note:
Barge landing and routes are approximate only.

Waste and Recovered Material Haulage Route: Overview
Figure 14.2

Date: 22/06/2012 Version: k

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Weed Washdown Facility (Indicative)
- Access Road

Road Haulage Route
- Waste to Benaraby Landfill; regulated waste and recyclables to SE Qld
- Other GLNG haulage route

Barge Haulage Route
- All waste and materials from Curtis Island
- Drill cuttings
- Barge Landing (Indicative)
- Vehicle Washdown and RoW Access Point (Indicative)
- Potential Beneficial Tunnel Spoil Reuse Options
- Rail

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, 2011.
Fishermans Landing and Western Basin Reclamation Area, Aurecon, Feb 2011.
Vehicle Washdown Point: Aurecon, Feb 2011.

Note:
Barge landing and routes are approximate only.

Waste and Recovered Material Haulage Route:Barge Figure 14.3

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A1 scale: 1:30,000

0 500 1,000 1,500 2,000 2,500 m

GLNG No: 3381-40-0459

Coordinate system: GCS_GDA_1994

Date: 22/06/2012 Version: k

Marine Crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Construction			
Construction site pads – import of hard standing materials for roadway and hardstand construction	Hard standing materials – gravel fill	Surplus imported clean material will be offered to local landowner for reuse, stored temporarily for use during the construction period, returned to the supplier or removed in accordance with the principles of the waste hierarchy	No waste materials are expected to be generated
Vehicle weed and mud washdown facility	Wastewater Sludge	Water is filtered and reused in washdown facility Sludge disposed at local licensed landfill or Wastewater Treatment Plant (WWTP)	1 m^3 sludge per week per washdown facility
Clearing and grubbing of the ROW, construction site pads, pipe laydown areas (temporary pipe storage sites) and Access Road (clear and grade)	Green waste (felled vegetation and plant matter) Topsoil and excavated material (stockpiled for backfilling and application to ROW) Installation of temporary fencing and gates (around construction site pads) Construction of access tracks as required Steel post offcuts (from signage installation)	Stockpiled/windrowed vegetation will be reapplied during restoration/rehabilitation of ROW (additional detail in Chapter 16) All topsoil and excavated material reused for backfilling in ROW Any surplus fencing material will be either removed for reuse by the fencing contractor, offered to local landowner for reuse or removed in accordance with the principles of the waste hierarchy	Included in general waste in mobilisation activities
TBM shaft construction	Surplus concrete Formwork (for concrete slabs) Damaged sheet piles Excavated material	Surplus concrete, damaged formwork and sheet piles to be treated as per the waste hierarchy with general waste to local licensed landfill Formwork and sheet piles are removed from site by the contractor for reuse on other projects Excavated material from the shaft will be stored in the site pad stockpile area for backfilling shaft at completion	No waste materials are expected to be generated

Marine Crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Tunnel boring by TBM	Tunnel and TBM shaft spoil	Tunnel spoil transported by road transport for disposal at proposed location as described in Chapter 2 Project Description. Spoil will meet the specific acceptance criteria	96,000 m^3
	Oily rags, spent absorbent material from TBM	Licensed contractor to transport regulated waste to a licensed recycling facility and residual material for disposal at a licensed regulated waste landfill	240 L per week
Lining tunnel with concrete segments, grouting and backfilling annulus	Damaged concrete segments Timber strips (packaging between concrete tunnel lining segments for transport) Out of specification grout or stabilised sand Glue/adhesive and empty containers	Concrete to be treated as per the waste hierarchy with general waste to local licensed landfill Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	12 m^3 per month of general construction waste 4.5 m^3 per month of metal (recycled) 100 m^3 in total of out of specification grout and stabilised sand
Dewatering	TBM shaft and tunnel dewatering	Refer to Chapter 15	Refer to Chapter 15
Construct pipe laydown areas (temporary pipe storage sites) – grading and levelled, hardstand, berm construction, and fencing where required	Polyethylene sheeting offcuts Cardboard or plastic tubes Plastic wrapping	Surplus clean material will be offered to local landowners for reuse or removed in accordance with the principles of the waste hierarchy	Included in general waste in pipe construction works
Erosion and Sediment Control installation and maintenance	Packaging material – cardboard, plastic wrapping, wooden pickets and geofabric sediment fencing Geofabrics "Bidim" A34 grade polyester filter off cuts	Sediment collected in devices stored in the ROW for re-spreading during rehabilitation works General waste to local licensed landfill	Quantities of waste dependent on climatic, site and topography conditions Included in general waste in mobilisation activities

Marine Crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Delivery of pipe construction materials and consumables to Marine Crossing GTP Project	Neoprene plastic wrapping Nylon rope Rubber matting Packaging – timber dunnage, pallets and crates, plastic wrapping, metal and plastic strapping around consumables Ropes and strapping, cardboard, timber skids, fibre /nylon rope spacers, pallets, drums and scrap metals	Materials to be treated as per the waste hierarchy with general waste to local licensed landfill	Included in general waste in pipe construction works
Pipe construction works • Pipe stringing and bending • Pipe cutting and trimming • Pipe welding (800 pipes) • Weld sandblasting • Tie-ins (above ground or in-the-trench) • Coating of field joints - application of rust proofing agent required to be applied when pipe is cut and a coating of epoxy-urethane over weld • Holiday detection survey and weld testing • Ducting for fibre optic cable	PVC or polyethylene pipe end caps 42” mild steel pipe off cuts and defective pipe; metal filings Timber skids and sand bags Off cuts – duct for future installation of fibre optic cable Marker tape Chemical containers (ie paint/epoxy coating cans, empty containers of rust proofing agents) Sandblasting grit (GMA Garnet) - Spent grit may contain some metal fragments and paint/surface coatings Welding residue – welding rod scraps and electrode butts Polypropylene bags Waste cement and concrete Nylon rope	PVC or polyethylene pipe end caps recycled Metal recycled Timber skids and sand bags reused General waste to local licensed landfill Licensed contractor to transport regulated waste to a licensed recycling facility and residual material disposal at licensed regulated waste landfill “Spent” Sandblasting grit disposed in accordance with Code of Environment Compliance (DERM, 2009a) Spent abrasive (ie spent sandblasting grit) will be tested (eg Toxicity Characteristics Leaching Procedures test) to check whether it requires treatment in an approved hazardous waste treatment facility	9.2 tonnes in total of pipe end caps (10 kg per pipe end) 1 tonne in total of steel pipe off cuts and defective pipe 1 tonne in total of metal filings General waste 0.5 tonnes per week 10 L per week of regulated waste (spent chemicals and chemical container)

Marine Crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Trenching and bulk earthworks Foam trench breakers and foam pillows installation	Excavated material Excess Rigid Polyurethane foam (Aptane P220/Isocyanate B900) and hose washings Spent absorbent material Drums/plastic bags (polypropylene) PPE - Protective gloves and disposable overalls PVC conduit offcuts	All non ASS excavated material reused for backfilling in ROW or offered to local landowner for reuse ASS material will be treated and disposed of as per the ASSMP (refer Appendix A) All materials will be treated as per the waste hierarchy with general waste disposed of the local licensed landfill	Included in general waste in pipe construction works
Pipe cleaning and gauging Pipe testing – hydrotesting and 48 hour leak test	Pipe cleaning waste (pigging grit - scale, rust, or other foreign material) Hydrostatic test water not treated with biocides, corrosion inhibitor and oxygen scavengers (approximately15,000 m³ of water required)	Pigging grit - licensed contractor to transport regulated waste to a licensed regulated waste landfill Hydrotest water released to land (refer Chapter 6)	Up to 4 m^3 pigging in grit total over construction period (assume 0.5 m^3/km) 15,000 m³ water
Infield servicing and maintenance of construction vehicles and equipment Fuel trucks, lubrication trucks and minor maintenance pick-ups provide on-site daily service and perform regular check-ups on equipment Daily field servicing, safety checks and refuelling in the field to be undertaken in the Marine Crossing GTP ROW	Oily rags, spent absorbent material from infield servicing and maintenance (minor servicing only, no service workshop). Waste oil and greases eg lube oil, hydraulic oil and engine oil Spent spill kit materials Packaging from replacement parts End of life vehicle parts (eg fan belts, hoses, other machinery parts) Tyres Batteries Used chemicals – chemicals, used tins from solvents, degreasing agents, lubricants Waste associated with diesel generator operation and maintenance	Licensed contractor to transport regulated waste to a licensed recycling facility Residual material dealt with in accordance with the principles of the waste hierarchy	All waste generated from infield servicing will be returned to waste storage area. 250 kg regulated waste per week 1 m^3 of waste oil per month

Marine Crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Site offices, crib room(s), site amenities (servicing of construction site amenities)	Office waste – paper, cardboard packaging Kitchen waste Rubbish bin waste in facilities (ie paper towels) First aid waste Kitchen and amenity wastewater	Recyclable material to recycling facility (where available) General waste to local licensed landfill Wastewater from crib rooms and amenities hauled via vacuum truck and disposed at a local WWTP in Gladstone (Calliope River Sewage Treatment Plant)	Recyclable material 50 kg per week 200 kg per week of general waste (approx one 6 m^3 skip bin per week) 0.25 m^3 of waste paper and cardboard per month 20 L wastewater per person per day
Spill clean up	Hydrocarbon contaminated soil (small quantities) Contaminated absorbent material from ROW	Licensed contractor to transport regulated waste to a licensed recycling facility and residual material disposal a licensed regulated waste landfill	10 L per week of regulated waste
WTP residue	Alum based sludges/filter cake	Residue to local licensed landfill Treated water from WTP will be used in grout batching and for other construction activities such as dust suppression (further information will be provided in the WTP Operational Manual)	1 m^3 per week
ROW rehabilitation			
Construction site pad removal	Gravel, hardstand, concrete foundations, clay material for pond lining	Clean hardstand, gravel and clay material will be offered to local landowner or GRC for reuse or removed for treatment or disposal in accordance with the principles of the waste hierarchy Surplus concrete to be treated as per the waste hierarchy if no reuse can be found then will be disposed to local licensed landfill	Approximate 10,000 m^3 from construction site pad (mainland) and 5,000 m^3 from construction site pad (Curtis Island)

Marine Crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Clean up and restoration: reinstatement of the ROW, removal of foreign material (construction material and waste), surface contouring Compaction, re-spreading topsoil, re-spreading felled vegetation(whole or mulched) and reseeding Removing any surplus materials, restoring services to their original condition, disposing of refuse, smoothing disturbed earth, removing temporary fills, culverts and bridges, and performing such work as may be necessary to restore ROW to original condition	Any recyclable or general waste items listed above Useable surplus line pipe will be delivered to a location designated by the Proponents	Clean hardstand material will be offered to local landowner or GRC for reuse or removed for treatment or disposal in accordance with the principles of the waste hierarchy Useable surplus line pipe and other reusable materials stored at location designated by the proponents Fencing may be removed from site by the contractor for reuse on other projects Residual material dealt with in accordance with the principles of the waste and resource management hierarchy	20 t timber skids 10 t sand bags
Demobilisation	General construction waste - timber, construction fines (incidental soil), plastic, cardboard, chemical drums, metal	Residual material dealt with in accordance with the principles of the waste hierarchy General waste to local licensed landfill Licensed contractor to transport regulated waste to an appropriately licensed recycling facility (if available locally) and residual material disposal at appropriately licensed regulated waste landfill	55 m^3 per month of general construction waste 25 m^3 per month of metal (recycled)
Shaft removal	Concrete slabs Sheet piles	Concrete to be treated as per the waste hierarchy with general waste to local licensed landfill Sheet piles will be removed for reuse by the contractor on other projects	5,000 m^3 concrete

Marine Crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Establishment of vegetation	Plastic pots Wooden stakes Packaging material Surplus herbicides and empty containers	Residual material dealt with in accordance with the principles of the waste hierarchy General waste to local licensed landfill Unused herbicides will be retained by Weed Control subcontractor for use on other projects Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	10 kg per week during vegetation establishment activities in the ROW Quantity dependent upon whether herbicides for weed control are required during establishment of vegetation

14.6.2 Operational waste

It is not anticipated that significant quantities of waste will be generated during operation of the Marine Crossing GTP. However, waste will still be generated from maintenance activities. These wastes will include putrescible waste and recyclable wastes (including paper, cardboard, plastics, glass and aluminium).

The activities that are expected to be undertaken during operation of the Marine Crossing GTP include maintenance and repairs of the pipeline and weed/vegetation management along ROW access tracks. The Marine Crossing tunnel will not be maintained throughout its operational life. A list of the waste types and an estimate of the waste quantities generated from operational activities is detailed in Table 14.3.

Table 14.3 Waste generated from Marine Crossing GTP operations

Marine Crossing GTP operation activity	Waste generated	General management principal	Estimated waste quantity/rate of generation[2]
Vegetation maintenance of the ROW	Green waste – felled/ trimmed vegetation and plant matter to maintain designated maximum vegetation heights	Green waste is to be chipped/mulched and reapplied to ROW for weed suppression	Nil as reapplied to ROW (quantity dependent upon soil type and weather conditions)
Maintenance of Marine Crossing GTP ROW	Filters (non-oily, oily and gas)	Collected and transported by a suitably licensed contractor for recycling or disposal to regulated waste landfill	Less than 10 kg per year (approximately 0.8 kg/km/year based upon 30 kg per month for Santos GLNG GTP)

[2] Estimated operational waste quantities are based upon proportions

Marine Crossing GTP operation activity	Waste generated	General management principal	Estimated waste quantity/rate of generation[2]
	Waste oils and greases	Collected and transported by a suitably licensed contractor for recycling where possible	100 L per year (about 10 L per km)
	Packaging	General waste for disposal at a licensed landfill	30 kg per year (approximately 3.6 kg/km/year based upon 30 kg per week for entire pipeline)
Cleaning of pipeline - pigging (if undertaken in the future)	Pipe cleaning waste (pigging grit - scale, rust, or other foreign material)	Pigging grit - Licensed contractor to transport regulated waste to a licensed regulated waste landfill	200 L of pigging grit per year (assume 20 L/km)

14.6.3 Decommissioning waste

The rehabilitation of the Marine Crossing GTP Project disturbance footprint is not expected to generate large volumes of waste.

The Marine Crossing GTP has a design and expected operational life of approximately 42 years.

Prior to final decommissioning or abandonment of any facilities associated with the Marine Crossing GTP, GLNG Operations will investigate potential environmental issues and impacts associated with decommissioning or abandonment. Infrastructure that is no longer required for the operation of the Marine Crossing GTP will be decommissioned as per the decommissioning methods discussed in Chapter 2.

Prior to the decommissioning of the Marine Crossing GTP, a detailed assessment of the types and quantities of waste materials which could be expected will be conducted. It is likely that above ground materials such as signs and some fencing would be disposed of in accordance with the principles of the waste and resource management hierarchy. Refer to Chapter 2 for an outline of decommissioning and abandonment.

14.7 Chemical use and management

The Marine Crossing GTP construction and operation activities will require the use of chemicals and hazardous materials, and generate waste chemicals and hazardous materials. A list of chemicals products likely to be used during the Marine Crossing construction is provided in the WMP.

Chemical and hazardous materials associated with Marine Crossing GTP Project will be handled and stored in accordance with the applicable State or Commonwealth legislation (refer Section 14.1 and Chapter 1), AS and guidelines, and the WMP (refer Appendix F). This will include the separate storage of waste chemicals in appropriate containers at designated storage areas to encourage reuse, recycling and enable correct transport, treatment and disposal.

Environmental protection commitments, objectives and control strategies for chemical and hazardous materials management have been developed, including flammable and combustible liquids.

Table 14.4 provides a list of the chemicals and hazardous materials to be stored and used during construction of the Marine Crossing GTP. A description of the relevant activity and the proposed storage location is also listed below.

Table 14.4 Summary of possible chemical and hazardous materials for use during construction

Chemical/hazardous material	Activity	Anticipated storage location
Diesel	Fuel for construction vehicles and machinery and diesel generators at construction camps and offices	Diesel fuel storage on the construction site pad (mainland), refuelling truck will collect diesel from a diesel vendor in Gladstone
Fuel dispenser pump and storage (gasoline) Fuel dispenser pump and storage (diesel)	Fuelling facilities for vehicles	Diesel and petrol fuel storage on the construction site pad (mainland) and construction site pad (Curtis Island)
Herbicides (chemicals registered for the specific weed to be controlled)	Chemical spraying of weeds	Brought to site only during weed control activities
Rigid Polyurethane foam (Aptane P220/Isocyanate B900)	Foam trench breakers and foam pillows installation – to hold the pipe off the trench invert (alternative material - sand bags)	Specialist subcontractors will mobilise foam components to site in storage containers on vehicles. Subcontractors to provide documentation regarding storage, handling and disposal arrangements prior to bringing to site
Oils and greases	Infield minor preventative vehicle servicing and maintenance of construction vehicles and equipment Note: major repair and maintenance of construction equipment will occur at the Preventative Vehicle Maintenance workshop at the Calliope Construction Camp	Construction site pad (mainland) and construction site pad (Curtis Island) in suitably sized tanks within appropriately bunded compounds as per AS1940
Waste Oil	Minor repairs and maintenance of construction equipment during Infield Servicing and Maintenance – minor servicing only at the Marine Crossing ROW	All waste oils will be collected and stored within appropriately sized and bunded storage containers at the construction site pad (mainland) and construction site pad (Curtis Island)
Paint	Painting welds and pipe coating defects	Hazardous materials storage at the construction site pad (mainland) and construction site pad (Curtis Island)
Fusion bond epoxy powder	Coating for welded field joints	
Polyurethane-tar coating compound	Field joint coating	
Oxygen scavenger	Chemical dosing during Hydrotesting	
Biocide	Hydrotesting	
Water treatment chemicals – aluminium sulphate, sulphuric acid	WTP	Hazardous materials storage at the construction site pad (mainland)
Lime	ASS treatment	

Table 14.5 provides a list of the chemicals and hazardous materials to be stored and used during operation of the Marine Crossing GTP, along with the relevant activity and the proposed storage location.

Table 14.5 Chemical and hazardous materials proposed for use during operation

Chemical/hazardous material	Activity	Storage location
Lubricants	Maintenance of mainline valve stations	GLNG Operations headquarters in Gladstone
Solvents	Cleaning pigging equipment and sumps	
Oils and greases	Maintenance of equipment for pipeline maintenance	

14.8 Potential adverse or beneficial impacts on existing environmental values (construction and operation)

Existing environmental values that may be impacted by the generation of waste as a result of the Marine Crossing GTP Project include:

- Life, health and wellbeing of people and the community
- Diversity of ecology and associated ecosystems
- Land use capability, having regard to economic considerations
- Management of finite resources

Liquid, solid and gaseous wastes will be produced as a result of the construction, operation and decommissioning phases of the Marine Crossing GTP. Typical wastes which will be generated include regulated, general, recyclable and inert waste.

The management of waste in accordance with the waste and resource management hierarchy and the relevant State and Commonwealth legislation and standards (refer WMP Appendix F), will reduce the risk of harm to staff, community and the environment. The potential impacts include the following:

- Water (surface water marine environment and groundwater) contamination from unsuitable storage, handling, spills and disposal of solid and liquid wastes
- Land contamination from spills during handling and transportation of liquids and solid waste
- Increased occurrences of vermin due to unsuitable storage and handling of putrescible wastes
- Wasteful use of finite resources
- Adverse effects to flora and fauna

Table 14.6 details the potential impacts of the waste management activities associated with the Marine Crossing GTP Project. Further details of the existing environmental values of the Marine Crossing GTP that have the potential to be affected by waste are provided in this EMP.

Table 14.6 Summary of impacts on the environmental values associated with the Marine Crossing GTP Project

Aspect/source/activity	Potential impacts
Inappropriate waste management and disposal	Soil, groundwater, surface water contamination, ambient air quality impact, marine environment
Tunnel spoil and grout from TBM	Soil, groundwater, marine environment and surface water contamination, health and safety
Disposal of sewage wastewater and other liquid wastes from project-related sources (eg equipment washdown stations, work area amenities)	Reduced water quality (particularly suspended solids/ turbidity, nutrients and microbiological contaminants) with consequent reduction in: • Suitability of water for drinking • Aquatic habitat quality including fish resources • Temporary loss of land use for economic use • Potential contamination of surface water and/or groundwater • Loss or damage to local ecosystem
Spillage of oil/ fuel/ chemical during transport, storage, handling or refuelling	Loss of oil/ fuel/ other hazardous material to air, surface water, marine environment, groundwater, soil and/or sediment with consequent adverse impacts on associated quality and beneficial values
Spillage of hazardous materials during transport, storage, handling and use	Loss of hazardous material to air, surface water, marine environment, groundwater, soil and/or sediment with consequent adverse impacts on associated quality and beneficial values
Spill during transfer of liquid and solid waste on/off Barge	Release of hazardous material to terrestrial and marine environment resulting in adverse environmental and health effects
Hydrotest water discharge	Accidental release of hydrotest water may impact on surface water, terrestrial and marine environment aquatic habitat quality, temporary loss of land use for economic use due to excessive erosion

14.8.1 Construction

Potential impacts may include water contamination, land contamination from spills, increased occurrences of vermin, and adverse effects to flora and fauna. These impacts are detailed in Table 14.6.

It is considered that the potential impacts resulting from the Marine Crossing GTP Project are expected to be acceptable and manageable as construction works will be undertaken in accordance with the control strategies as outlined in Section 14.11 and the WMP (refer Appendix F).

Additionally, construction activities will require the use of chemicals and hazardous materials and generate waste chemicals and hazardous materials. Chemical and hazardous materials associated with Marine Crossing GTP Project will be handled and stored in accordance with all applicable State and Commonwealth legislation.

14.8.2 Operation

It is considered that waste related impacts from the operation of the Marine Crossing GTP will be acceptable and manageable due to the low volumes of waste produced. Furthermore, operational activities will be undertaken in accordance with the WMP (refer Appendix F) and OMP that will be developed and implemented prior to the completion of construction.

14.9 Continuous improvement

GLNG Operations will work closely with the Construction Contractor to rectify any issues identified as a result of waste monitoring and auditing activities.

GLNG Operations will continue to investigate and implement actions to reduce impacts and deliver positive outcomes through the operation of the Marine Crossing GTP in relation to waste management.

The results of inspections, audits and incident reports will be used to drive continuous improvement along with other associated internal environmental performance reviews conducted by the Marine Crossing GTP management team.

Following any significant changes to the Marine Crossing GTP Project, design or operational processes, the WMP will be reviewed and updated to reflect any required changes.

Following an environmental incident resulting in environmental harm, the WMP will be reviewed and mitigation measures updated and improved to reduce the risk of incidents.

The WMP will be subject to annual review by GLNG Operations and its effectiveness in managing the waste streams associated with Marine Crossing GTP operations reported internally and to any relevant stakeholder.

14.10 Cumulative impacts

This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2. Potential impacts may arise from increased waste generation from the Project. These may include the generation of solid waste, liquid waste and vegetation waste.

14.10.1 Liquid waste- (hydrotest water, water treatment plant residues, sanitary wastewater, dewatering, waste chemicals)

Liquid waste will be managed in accordance with the proposed WMP and there will be negligible cumulative impacts from the generation of liquid waste during construction of the Marine Crossing GTP on environmental values.

Hydrotest water will be utilised, reused and disposed of in accordance with the DHWLRMP (refer Appendix D).

14.10.2 Solid waste (creation of spoil material/vegetation waste, general waste)

Cumulative solid waste streams may potentially impact on local landfill capacity and will include construction materials, vegetation and general waste. Construction materials will be re-used and recycled where possible. Vegetation waste from Marine Crossing GTP Project disturbance footprint is anticipated to be either used for timber or kept on site for use as mulch and is therefore not expected to be a significant volume. Likewise tunnel spoil will be transferred to one of the disposal locations identified in Chapter 2 for beneficial reuse as a fill material.

There will be negligible cumulative impacts from solid waste (creation of spoil material/vegetation waste, general waste) from the Marine Crossing GTP Project on environmental values.

14.11 Environmental protection commitments, objectives and control strategies – waste management (construction and operation)

Waste material generated as a result of the Marine Crossing GTP Project construction and operation activities will be managed in accordance with the principles of the waste and resource management hierarchy as described in the Queensland Waste Reduction and Recycling Strategy 2010 - 2020.

The following environmental protection commitments, objectives and control measures for each aspect of the Marine Crossing GTP Project have been described for the following areas:

- Waste management
- Hydrotest water
- Chemicals and hazardous materials

14.11.1 Waste management

Table 14.7 details the environmental protection objectives, strategies, monitoring and reporting requirements for the management of construction waste.

Table 14.7 Environmental protection commitments, objectives and control strategies for waste management

Item	Outcomes
Environmental protection objective	• The Marine Crossing GTP construction adheres to the waste management hierarchy of avoid, reduce, re-use and recycle. Where this is not possible, waste is disposed of in the most appropriate manner
Specific objectives	• No inappropriate disposal or management of waste • No contamination of soil, air or water as a result of waste handling • Petroleum activities do not result in the release or likely release of contaminants to the environment from the storage, conditioning, treatment and disposal of regulated waste materials
Control strategies	**General** • Prior to commencement of works, the appropriate methods for disposal of waste will be determined by consultation with the relevant administering authorities and DEHP • A WMP (refer Appendix F) has been developed in accordance with the *Waste Reduction and Recycling Act 2011* and will be implemented, it includes: – The types and amounts of waste generated – How the waste will be dealt with, including a description of the types and amounts of waste that will be dealt with under each of the waste management practices mentioned in the waste and resource management hierarchy (Section 9 of the *Waste Reduction and Recycling Act 2011*) – Procedures for dealing with accidents, spills and other incidents that may impact on waste management – How often the performance of the waste management practices will be assessed (ie at least annually) – The indicators or other criteria on which the performance of the waste management practices will be assessed • On completion of each section of pipeline, all waste material will be removed from the workplace. No wastes will be buried or disposed of onsite • The Construction Contractor will advise designated disposal areas for each section of the ROW • All welding waste will be managed appropriately and removed from the Marine Crossing GTP Project area on an as required basis • General waste will be collected and transported to local council approved disposal sites • Food wastes will be collected, where practicable, considering health and hygiene issues, for disposal off-site

Item	Outcomes
	• Refuse containers will be located at each worksite • Where practical, wastes will be segregated and reused/recycled (eg scrap metal) • All personnel will be instructed in project waste management practices and procedures as a component of the environmental induction process • Suppliers will be requested to minimise packaging where practicable • Emphasis will be placed on housekeeping and all work areas will be maintained in a neat and orderly manner • All equipment and facilities will be maintained in a clean and safe condition • All waste/rubbish will be correctly disposed of and will not pose a risk to marine fauna • Plastic bags will be banned from all site offices and project areas within the coastal zone (intertidal and marine zones) **Liquid Waste** • Wastewater from construction, cleaning and testing operations will be treated and managed in accordance with the relevant environmental authorities • The treatment method will be selected in consultation with a relevant local authority and DEHP and the relevant environmental authority obtained • Flammable and combustible liquids (including petroleum products and associated piping and infrastructure), must be stored, handled and maintained in accordance with AS1940 • Any liquids stored on site that have the potential to cause environmental harm will be stored in or serviced by an effective containment system that is impervious to the materials stored and managed to prevent the release of liquids to waters or land. Where no relevant Australian Standard is available, the following will be applied: – Storage tanks will be bunded so that the capacity and construction of the bund is sufficient to contain at least 110 per cent of a single storage tank or 100 per cent of the largest storage tank plus 10 per cent of the second largest storage tank in multiple storage areas – Drum storages will be bunded so that the capacity and construction of the bund is sufficient to contain at least 25 per cent of the maximum design storage volume within the bund **Hazardous Waste** • Chemical wastes will be collected in 200 L drums (or similar sealed container) and appropriately labelled for safe transport to an approved chemical waste depot or collection by a liquid waste treatment service • Storage, transport and handling of all chemicals will be conducted in accordance with all legislative requirements • Containment bunds and/or sumps will be drained periodically to prevent overflow and subsequent pollution of the surrounding land and/or water body • All hazardous wastes will be appropriately stored in bunded areas away from watercourses and in accordance with legislative requirements

Item	Outcomes
	• Where no Australian Standard is available, any liquid with potential to harm the environment will be: – Stored in impervious bunded tanks with bunded capacity at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas – Impervious drum storage will have a bunded capacity to contain at least 25% of the maximum design storage volume within the bund • Hazardous wastes, such as solvents, rust proofing agents and primers will be managed in accordance with the requirements of relevant legislation and industry standards • A hazardous materials inventory will be prepared • Material Safety Data Sheets (MSDS) for hazardous materials will be available at all work sites • Hydrocarbon wastes, including lube oils, will be collected for safe transport off-site for reuse, recycling, treatment or disposal at approved locations • As soon as practicable, all regulated waste will be removed and disposed of to a licensed waste disposal facility or recycling facility • All regulated waste removed from the site will be removed by a person who holds a current authority to transport such waste under the provisions of the EP Act and sent to a facility licensed to accept such waste • When regulated waste is removed from within the boundary of the petroleum tenure and transported by the holder of this authority, a record will be kept of the following: – Date of waste transport – Quantity of waste removed and transported – Type of waste removed and transported – Route selected for transport of waste – Quantity of waste delivered – Any incidents (eg spillage) that may have occurred on route • If a person removes regulated waste associated with activities within the operational land and disposes of such waste in a manner which is not authorised or is improper or unlawful then, as soon as practicable, the administering authority will be notified of all relevant facts, matters and circumstances known concerning the disposal • Hydrotest water will be disposed of in accordance with the DHWLRMP (refer Appendix D) • If a hazardous contaminant is released to waters or land the following steps will be taken: – Immediate action to stop any further release and make sure that the area is safe – 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
Performance indicators	• Waste handling is conducted in a way that minimises contamination of soil, air or water

14.11.2 Chemical and hazardous materials management

Table 14.8 details the environmental protection objectives, relevant control strategies, monitoring and reporting requirements for the management of chemical and hazardous materials.

Table 14.8 Environmental protection commitments, objectives and control strategies for chemical and hazardous materials management

Item	Detail
Environmental protection objective	• The storage and handling of chemicals and dangerous goods does not cause environmental harm or harm to persons
Specific objectives	• Petroleum activities do not result in the release or likely release of a hazardous contaminant to the environment • Storage and handling procedures as per the WMP • Chemicals stored as per the WMP • All containment systems must be designed to minimise rainfall collection within the system
Control strategies	• Spill control procedures (refer Chapter 3) will be prepared and personnel trained • Dangerous goods will be stored and handled as per the requirements of relevant Australian Standards • Areas where contaminants or wastes are stored or handled will be minimised or roofed • Dangerous goods will, where appropriate (eg outside locations), be stored in bunded areas away from watercourses • Stormwater will be diverted around disturbed areas and areas where contaminants or wastes are stored or handled • All explosives, hazardous chemicals, corrosive substances, toxic substances, gases and dangerous goods will be stored and handled in accordance with the relevant Australian Standard • Where no Australian Standard is available, any liquid with potential to harm the environment will be – Stored in impervious bunded tanks with bunded capacity at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas – Impervious drum storage will have a bunded capacity to contain at least 25% of the maximum design storage volume within the bund – If the bunded area is not covered, stormwater runoff from rainfall events will collect within bunded areas, and will be treated, reused or released in accordance with environmental and legal requirements and DHWLRMP and SMESCP • MSDS for chemicals and dangerous goods will be available onsite • Waste dangerous goods, which cannot be recycled, will be transported to a designated disposal site as approved by the local authority • Any spillage of hazardous waste or other contaminants that may cause environmental harm, will be effectively contained and cleaned up as quickly as practicable (refer Chapter 3). Such spillage must not be cleaned up by hosing, or otherwise thereby releasing such waste or contaminants to any land or waters • Spillages will be cleaned up using dry methods that minimise the release of wastes, contaminants or materials to any stormwater drainage system, roadside gutter or waters • Spills of dangerous goods will be rendered harmless and collected for treatment and

Item	Detail
	disposal at a designated site, including cleaning materials, absorbents and contaminated soils
	• Hydrocarbon spillage from storage areas, diesel and chemical spills from construction equipment, and industrial waste spill will be contained, reported, and treated/remediated in accordance with appropriate legislative and regulatory agency requirements. Drainage will be reinstated • Absorbent and containment material (eg absorbent matting) will be available where hazardous materials are used and stored and personnel trained in their correct use • Protective clothing, appropriate to the materials in use, will be provided • Relevant permits will be held and conditions of permits met • Servicing of equipment/machinery will not be permitted on the Marine Crossing GTP ROW. All planned services for all equipment is to occur in an approved workshop
Performance indicators	• The environment is not being contaminated by hazardous materials • Storage and handling procedures as per the WMP and relevant Australian Standards • Chemicals are stored in secure areas

15. Water

15.1 Chapter summary

This chapter provides a summary of the existing water environmental values. It identifies the potential surface water and groundwater impacts resulting from the construction and operation of the Marine Crossing GTP as well as the potential mitigation measures and management strategies for the protection of these values.

15.1.1 Summary of existing environment

A summary of existing water environment and the associated environmental values is provided in Table 15.1.

Table 15.1 Existing environmental values for water

Waters	Marine Crossing GTP Project disturbance footprint and surrounding area	Environmental values
Marine	• The Narrows • Northern section of Port Curtis	• High ecological value – marine flora (seagrasses) and fauna (mega fauna, fish, crustaceans, benthics) • Aquatic foods – human consumption • Recreation – secondary, visual • World and national heritage values associated with the GBRWHA • The Marine Crossing GTP Project disturbance footprint will not occur within the GBRMP, but will pass under The Narrows and involves trenching on Curtis Island which forms part of the GBRWHA
Wetlands	• The Narrows wetland (including intertidal area south of Kangaroo Island) • Port Curtis wetland	• High ecological value – marine flora (seagrasses), mangroves, habitat for fauna • Native fauna (wader and migratory birds, Water mouse, megafauna, fish, crustaceans, and benthics) • Aquatic food – human consumption • Recreation – secondary, visual • World and national heritage values associated with the GBRWHA • The Wetland Management Area intercepts the Marine Crossing GTP Project (Category C ESA) • The Narrows Wetland and Port Curtis Wetland provide habitat for migratory birds that are considered endangered or vulnerable at a national level, however there are no Ramsar wetlands within or adjacent to the Marine Crossing GTP Project
Groundwater	• Occurring as shallow unconfined aquifers along the terrestrial mainland and Curtis Island sections of the Marine Crossing GTP Project • Occurring as unconfined zones within the channel connected to the marine waters overlying the Marine Crossing tunnel	Terrestrial • Marginal quality for agricultural use • Not suitable for human consumption or industrial use Marine • Not suitable for agriculture, drinking water or industrial use

Waters	Marine Crossing GTP Project disturbance footprint and surrounding area	Environmental values
Watercourses	• Humpy Creek (minor northern tributary) Point B • Humpy Creek (southern creek line) • Unnamed drainage feature (connecting Humpy and Targinie Creek) • Targinie Creek	• Highly disturbed waters – from historical grazing activities • Ecological value – marine plants, minor habitats, riparian vegetation, drain to wetlands • Not suitable for agriculture, human consumption or industrial use
Overland flows and existing farm dams	• Surface water overland flow paths • Existing farm dams	• Ecological value – aquatic plants, minor • Highly disturbed waters – constructed dams • Suitable for agricultural use • Not suitable for human consumption or industrial use habitats, riparian vegetation
Local Water Supply	• Potable water supply	• Potable water for human use (consumption and hygiene) • Used for industry

15.1.2 Summary of potential impacts on water

Construction

The construction of the Marine Crossing GTP has the potential to impact on water environmental values from:

- Erosion and sediment movement
- Decreased surface water and groundwater quality due to contamination
- Changes to surface water flow and groundwater hydraulic characteristics
- Aquatic habitat disturbance
- Acidic runoff from ASS
- Untreated trench water discharging to the receiving environment

Soil disturbance will occur within the terrestrial sections of the Marine Crossing GTP Project disturbance footprint. Preliminary erosion risk assessed and mapped for this section has identified soils with very low erosion risk on the mainland section and soils with a moderate through to extreme risk on Curtis Island (O2, 2012b). Erosion and sedimentation control measures and devices will be implemented in accordance with the SMESCP (refer Appendix C) along the ROW, at watercourse crossings and within the construction site pads post-clearing to minimise the potential impact from soil erosion and sediment transport during construction.

Rehabilitation, including surface stabilisation will occur progressively after backfilling of trenches and following demobilisation of equipment from the construction site pads. This includes re-profiling surfaces, re-instating surface flow paths and establishing vegetation cover to disturbed areas. It is considered that potential impacts associated with soil erosion and sediment will be manageable and acceptable.

Surface waters (eg watercourses, farm dams, drainage lines) and groundwater may be subject to potential impacts from unauthorised discharges of contaminants, such as chemicals, wastewater and hydrocarbons. Correct storage and handling procedures will ensure any potential adverse impacts are preventable and manageable. Any spills will be contained, collected and disposed of in accordance with emergency plans.

Trenches and tunnel construction may impact on existing groundwater levels. It is expected that the volumes of water encountered within the trenching section will not be significant with any impact being confined to a discrete, localised area and temporary draw-down is unlikely to generate long-term impacts. Groundwater levels are likely to recharge after construction. Minimal groundwater seepage into the Marine Crossing tunnel during construction is expected, with a maximum design ingress rate of 1 L/100 m/h being adopted. Where high groundwater flows are encountered, the closed-face shielded configuration of the TBM combined with constant face pressure on the formation will minimise groundwater inflow.

Groundwater collected from within the Marine Crossing tunnel portal and TBM launch shaft will be pumped to the WTP located at the construction site pad (mainland) for treatment. Given the estimated low dewatering rates and volumes of groundwater during tunnel construction, no long term adverse impacts to groundwater flows or levels are expected.

It is proposed to flood the tunnel with seawater following commissioning of the pipeline eliminating the need for ongoing dewatering during the operational phase of the Project. A procedure for the flooding process will be developed prior to filling the tunnel with seawater.

Table 15.2 summarises construction aspects and environmental impacts for water-related issues.

Table 15.2 Aspects and impacts

Construction aspect	Environmental impact
Erosion & Sedimentation	• Reduced water quality in catchments for human, wildlife and agricultural use
Stormwater/ wastewater	• Direct soil/water pollution on receiving environments
Hydrocarbon Spills (waste generation)	• Contamination/pollution of local soils and waterways
Vegetation clearing (riparian and aquatic)	• Loss of native flora and fauna (terrestrial and aquatic)
Earthworks (grading/cut and fill)	• Loss of aquatic values • Alteration of surface water hydrology
Dewatering	• Alteration of groundwater quality and levels • Loss of native flora and fauna (terrestrial and aquatic)
ASS	• Acidic runoff to the receiving environment from ASS

Operation

Regular inspections during operation of the GTP will be carried out along the ROW to identify any activities that may have the potential to impact on the integrity of the Santos GLNG GTP. Inspections will also monitor the success of rehabilitation and stabilisation efforts to identify any areas of potential or actual erosion and sedimentation.

It is considered that surface water quality impacts from operational activities will be low and manageable due to the infrequency of maintenance activities and vehicle movements during rainfall events. Any chemicals or hydrocarbons used during maintenance activities will be stored and handled elsewhere and in accordance with procedures. No groundwater impacts resulting from operational activities are anticipated due to the shallow nature of the works.

15.1.3 Summary of mitigation measures for water management

Mitigation measures are proposed to manage potential impacts and to protect environmental values. The mitigation measures for water management are summarised in Table 15.3.

Table 15.3 Summary of proposed mitigation measures for water management

Item	Outcome
Environmental Protection Objective	• Potential impacts associated with erosion are minimised, the release of contaminants to surface waters is prevented, and the quality of the existing groundwater resources is protected
Specific Objectives	• Prevention of direct or indirect release of contaminants to surface waters • Minimal incidence of accelerated erosion as a result of construction activities • Groundwater quality is not impacted by development activities • Spill containment facilities constructed in accordance with AS 1940 (2004) and AS 3780 (2008) • Environmental impacts are within authorised limits
Control Strategies	Refer Table 15.15 for water-related control strategies to be implemented during construction and operation of the Marine Crossing GTP
Performance Indicators	• Control strategies outlined in the SMESCP are implemented • Groundwater quality is not being adversely impacted by development activities • Spill containment facilities are constructed in accordance with AS 1940 (2004) and AS 3780 (2008) • Discharges from release points meet water quality objectives as specified in EA conditions • Existing environmental values related to water are protected

15.2 Existing water environment

15.2.1 Marine waters

Curtis Coast Regional Coastal Management Plan

The Narrows and the northern section of Port Curtis are navigable marine waters and the water body is characterised as a tidal channel bordered by the Kangaroo Island intertidal wetlands to the west and Curtis Island to the east.

The marine waters associated with the Marine Crossing GTP Project fall under the Curtis Coast Regional Coastal Management Plan, developed under the *Coastal Protection and Management Act 1995* which provides regional direction for the implementation of the State Coastal Management Plan – Queensland's Coastal Policy in the Curtis Coast Region and describes how the coastal zone of the Curtis Coast Region is to be managed (URS, 2009a).

Under this plan the Curtis Coast is to be managed in an ecologically sustainable manner that allows for (URS, 2009a):

- The region's continued industrial and port development using best practice
- The protection and maintenance of natural ecosystems while allowing for responsible hunting, fishing and harvesting of resources
- Recognising and protecting the region's diverse cultural resources and values

- Recognising the importance of tourism and recreational facilities to accommodate the increasing population and visitors
- Maintaining and enhancing lifestyle, liveability and public access to the coast
- Strong local indigenous traditional owner community involvement in management and development

The environmental values in Table 15.5 reflect the Curtis Coast Regional Coastal Management Plan.

Marine water quality

The marine waters of Port Curtis and The Narrows have a high ecological value in terms of habitat for marine mammals such as dugongs, dolphins and sea turtles. These mammals rely on the seagrass habitats and fish stocks for survival. Fish present include commercial species caught by local fishing industry for human consumption and by recreational fishers. Further detail is provided in Chapter 10.

The background water quality of Port Curtis has been extensively monitored and studied in recent times. The majority of water quality studies within Port Curtis and The Narrows have been conducted to assess the health of the harbour's ecosystem and establish baseline water quality conditions. These studies have consisted of both short term and long term monitoring programmes capturing physicochemical parameters and metal concentrations.

Monitoring programs sponsored by the Queensland Government, industry and other stakeholders under the Port Curtis Integrated Monitoring Program (PCIMP) have been collecting and reporting physical and biological data to monitor the condition of Port Curtis and The Narrows (Storey, *et al*., 2007). GLNG Operations is a member of PCIMP and the data and any related studies or investigations are publicly available from the DEHP and PCIMP websites.

The studies and monitoring demonstrate Port Curtis is a naturally turbid area which is influenced by re-suspension of sediments through tidal movements and wet season flows from catchments discharging into Port Curtis. Physical and chemical water quality indicators such as temperature, electrical conductivity, acidity (pH), dissolved oxygen (DO) and turbidity are distributed throughout the water column indicating a vertically well mixed environment. Nutrient loads tend to fluctuate at different times and locations across monitoring sites with some results indicating elevated nutrients levels (nitrogen, phosphorus and chlorophyll *a*). However, it is inconclusive whether this is attributable to non-point sources from adjacent land use activities or naturally high levels within the system. (Vision Environment, 2011)

The Port Curtis Ecosystem Health Report 2008-2010 (Vision Environment, 2011), gave an overall ecosystem health grade of A for The Narrows and found in general that all physical parameters (temperature, electrical conductivity, pH, DO, turbidity, oxidation reduction potential) were homogenously distributed throughout the water column indicating a vertically well mixed environment which is in agreement with the water quality results for the wider Port Curtis area. The Narrows also tended to have lower pH, higher turbidity and slightly lower dissolved oxygen levels than the more estuarine sites in line with other mangrove dominated areas. When compared with the Port Curtis Ecosystem Health Report rating given in 2007, The Narrows appears to be in a similarly healthy condition. (Vision Environment, 2011)

In September 2011, the Queensland Government began monitoring water quality in Port Curtis as part of a response to fish illness reported from Gladstone waterways. The program started in September 2011 and has continued monthly in 2012. The program aims to determine if there have been major changes in water quality occurring in Gladstone waterways and investigate whether these changes are likely to cause or contribute to fish illness. Initial reports focussed on dredging as a potential source of contamination because of community concerns over this issue. Seven reports have been produced on water quality. (DEHP, 2012a)

Water quality investigated between September 2011 and March 2012 has shown that none of the water quality properties measured was of significant environmental concern. The latest available report presents the results of the water quality investigation program that occurred during the week of 2 April 2012. No evidence was found of any extreme or unusual physical-chemical parameters that could directly link water quality parameters in Gladstone waterways during April 2012 with fish health issues. (DEHP, 2012a)

Water quality datasets

Table 15.4 lists the publicly available datasets and studies identified and reviewed for this chapter. Information considered relevant and scientifically robust was extracted and forms the basis for describing the existing environment within and adjoining the Marine Crossing GTP Project.

Table 15.4 Marine water quality datasets for The Narrows and Port Curtis

Reference	Sampling locations	Sampling date	Parameters measures
Baseline and background survey undertaken by WBM Oceanics Australia (2002) in URS (2007;2003) Gladstone Nickel Project Environmental Impact Statement, Vol 1. (URS 2007) Chlor Alkali/Ethylene Dichloride Plant Gladstone, Environmental Impact statement, Vol.1. (URS, 2003)	Boat Creek Fisherman's Landing Fisherman's Landing Embayment Targinie Creek Curtis Island	1998 – 2001	In situ parameters (temperature, conductivity, salinity, pH, redox potential, dissolved oxygen (DO), turbidity, Secchi depth) Trace elements (Al, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Zn, F, Cn) Nutrients (TN, Total Kjeldahl Nitrogen (TKN), organic, ammonia, nitrite, nitrate, TP and Filterable Reactive Phosphate (FRP)) Suspended Solids
Cooperative Research Centre (CRC) for Coastal Zone, Estuary and Waterway Management – Technical Report 25: Contaminants in Port Curtis: screening level risk assessment (Apte *et al.*2005)	50 sites throughout Port	August – October 2001 (dry season) February 2002 (wet season)	Metals (Al, As, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Se, Zn) Tributyltin (TBT)
Assessing the Effects of Harbour Dredging using Transplanted Oysters as Biomonitors. (Andersen *et al*.2002)	Monitoring undertaken at RG Tanna reclamation decant point	3-4 January 2002 5-6 February 2002 11-15 March 2002 16 April 2002	Composite samples of 5 whole oyster soft tissues were analysed for metals (Cd, Cr, Ni, Pb Ag, Al, Cu, Fe, Zn, As and Se) Seagrass (Zostera capricorni) were analysed for metals (Cd, Cr, Ni, Pb, Ag, Al, Cu, Fe, Zn, As and Se)

Reference	Sampling locations	Sampling date	Parameters measures
Capital Dredging of the Fourth Berth at RG Tanna Coal Terminal, Protection of the Marine Environment During Dredging and Dewatering. GHD (2005)	RG Tanna Coal Terminal	February 2004 to April 2005	Turbidity (prior to works commencing)
Validation Study for Dredging of Fourth Berth, RG Tanna Coal Terminal (GHD 2006)	Cell 4 (final reclamation pond) Discharge Point Gladstone Harbour (receiving waters)	21 – 28 November 2005	Turbidity
RG Tanna Coal Terminal 4th Berth Dredge Management Plan, An Assessment of the Effects of Harbour Dredging (Andersen *et al.* 2006)	In vicinity of discharged reclamation water, middle and outer harbour sites within Port Curtis and reference sites outside the predicted range for sediment transport from Port Curtis	July/August 2005 (pre-dredge monitoring) 23 November 2005 – 6 January 2006 (dewatering of the reclamation cells)	Physicochemical water parameters (pH, temperature, dissolved oxygen, turbidity and conductivity) Biomonitors (transplanted oysters) to assess water metal concentrations (Cu, Zn, Al, Cd, Fe, Ag and Hg)
Wiggins Island Coal Terminal Environmental Impact Statement, Revision 3. Connell Hatch (2006)	Intertidal, marine areas adjacent to Wiggins Island and Mud Island Flying Fox Creek Sandfly Creek	14 – 15 May 2006 and September 2006	Wet and dry season data: Turbidity, Chlorophyll *a,* DO (%sat), pH, TSS
PCIMP, Port Curtis ecosystem Health Report Card (Storey *et al.* 2007)	Zone 2 Inner Harbour Fisherman's (includes Fisherman's landing Wharf)	2006/2007 data	Water chemistry, water contaminants, mangrove health, sediment contaminants, and seagrass biomass
Port Curtis Seagrass Water Quality (Wilson *et al*. 2008)	20 cm above sediment surface from three seagrass beds in Port Curtis	January to 18 April 2008	Temperature, turbidity and light
PCIMP Biomonitoring 2007, North Harbour Zones (Andersen *et al.* 2008a)	Estuarine, inner harbour and outer harbour areas of Port Curtis	July and September 2007	Water quality, including temperature, conductivity, dissolved oxygen, pH and turbidity Metal concentrations in oysters
An Assessment of the Effects of Dredging at Fisherman's Landing (Andersen *et al.* 2008b)	Fisherman's Landing: adjacent to the dredge head; northern seagrass meadow; reclamation cell; discharge point; eight sites in the harbour	Before dredging (18 February to 3 March 2008) During dredging (4 to 10 March 2008) During dewatering March to 8 April 2008)	In situ parameters (temperature, conductivity, TDS, DO, pH, turbidity, redox, light attenuation) Metals (total and dissolved)
WBM Turbidity Data from Fisherman's Landing 2008	Two sites: one at Fisherman's Landing tidal flats and one adjacent to tidal flats in deeper water	August to 9 September 2008	Turbidity, conductivity, temperature

Reference	Sampling locations	Sampling date	Parameters measures
Fisherman's Landing Baseline Turbidity Report (Wilson and Andersen 2009)	Fisherman's Landing Berth 5	Between June and October 2008	Temperature and turbidity
Report for Western Basin Dredging and Disposal Project; Water Quality Report (GHD, 2009b)	Western Basin Reclamation area Existing channels Various areas in the narrows, Fishermans Landing basin, pelican banks, southeast of Curtis Island	April – July 2009	In situ parameters (temperature, conductivity, dissolved oxygen, pH, oxidation, reduction potential, turbidity) Anthropogenic contaminants, metals, metalloids and nutrients Elutriate water quality data for anthropogenic contaminants, metals, metalloids and nutrients
PCIMP, Port Curtis ecosystem Health Report Card (Vision Environment, 2011)	Throughout Port Curtis (includes The Narrows)	2008 - 2010	Water chemistry, water contaminants, mangrove health, sediment contaminants, and seagrass biomass
Water Quality of Port Curtis and Tributaries (DEHP, 2012a)	Port Curtis and tributaries	2011 - 2012	Queensland Government began monitoring water quality in Port Curtis as part of their response to fish illness reported from Gladstone waterways Physical-chemical water quality data, chlorophyll-a, nutrients, dissolved metal concentrations

GLNG Operations is undertaking Marine water sampling research on a monthly basis as detailed in Section 15.8.

Environmental values

Specific environmental values under the EPP (Water) have not been identified for waters within the Curtis Coast region, such as Port Curtis and The Narrows. However, local government, industry and the Gladstone Port Authority involved in the Gladstone Harbour Protection and Enhancement Strategy have identified preliminary environmental values for some waterways in the Curtis Coast region. The environmental values adopted for Port Curtis and The Narrows are summarised in Table 15.5. (URS, 2009c)

Table 15.5 Environmental values for waters within and surrounding the Marine Crossing GTP Project

Environmental Values	Port Curtis and The Narrows	Watercourses within the Calliope River Basin
Protection of high ecological value waters	✓	-
Protection of slightly to moderately disturbed water	✓	✓
Protection of highly disturbed waters	-	-
Suitability for agricultural use	-	✓

Environmental Values	Port Curtis and The Narrows	Watercourses within the Calliope River Basin
Suitability for aquaculture (eg red claw, barramundi)	✓	-
Suitability for human consumers of aquatic food	✓	✓
Suitability for primary recreation (eg swimming)	✓	✓
Suitability for secondary recreation (eg boating)	✓	✓
Suitability for visual (no contact) recreation	✓	✓
Suitability for drinking water supplies	-	-
Suitability for industrial use (including manufacturing plants, power generation)	✓	✓
Protection of cultural and spiritual values	✓	✓

Source: URS, 2009a; URS, 2009c

Water quality objectives

No water quality objectives (WQOs) under the EPP (Water) have been determined for Port Curtis and The Narrows. The EIS (URS, 2009a) drafted marine WQOs that were adopted for the Project and these are listed in Table 15.6 along with WQOs from the Queensland Water Quality Guidelines (QWQG) for slightly to moderately disturbed enclosed coastal systems in the Central Coast Queensland region.

Table 15.6 WQOs adopted for the marine waters of Port Curtis and The Narrows

Species	WQO
Turbidity (NTU)[1]	6
TSS (mg/L)	15
Total Nitrogen (µg/L)	200
Total Phosphorus (µg/L)	20
Ammonia (µg/L)	8
Oxidised Nitrogen (Nitrate + Nitrite) (µg/L)	3[2]
Dissolved Oxygen	90% - 100%
pH	8 – 8.4
Filterable reactive phosphorus (FRP) (µg/L)	6
Metals	
Aluminium	Insufficient data
Arsenic	Insufficient data
Cadmium[3] (µg/L)	5.5
Copper (µg/L)	1.3
Chromium (VI) (µg/L)	4.4
Iron	Insufficient data
Lead (µg/L)	4.4

Species	WQO
Manganese[4]	Insufficient data
Mercury[3] (µg/L)	0.4
Nickel[3] (µg/L)	70
Zinc[3] (µg/L)	15

Source: URS, 2009a; URS, 2009c
Table notes: 1. Data from previous sections shows that this guideline value is regularly exceeded due to natural resuspension of bedload, so this WQO may not be appropriate for this system
2. Combined value for NO_x
3. May not necessarily protect all species with respect to chronic toxicity
4. A value of 140 µg/L has been used elsewhere in Port Curtis

Tide levels

Australian Height Datum (AHD) values have been sourced from the semidiurnal tidal planes figures for Gladstone from Maritime Safety Queensland (MSQ) as shown in Table 15.7.

Table 15.7 Tide levels for Gladstone (MSQ, 2012)

Semidiurnal Tide Planes	Level (m AHD)
HAT	2.562
MHWS	1.692
Mean High Water Neaps	0.842
Mean Sea Level	0.072
AHD	0.00
Mean Low Water Neaps	-0.698
Mean Low Water Springs	-1.548

15.2.2 Wetlands

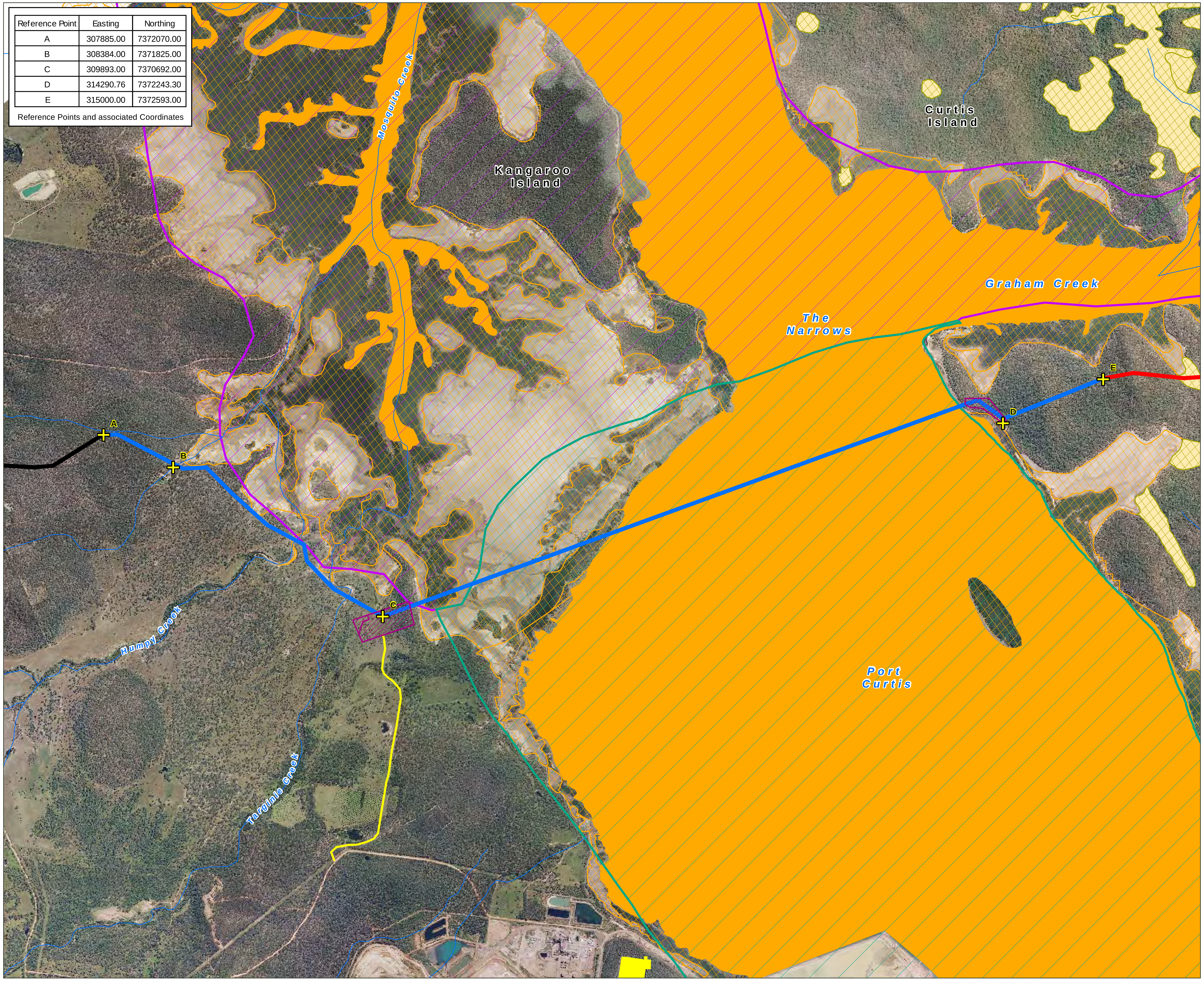
The national DIWA lists four nationally important wetlands within the adjacent regions (<15 km) of the Marine Crossing GTP Project (Environment Australia, 2001). These include The Narrows, Port Curtis, Great Barrier Reef Marine Park and the Colosseum Inlet-Rodds Bay area as discussed in Chapter 10. A map of referable wetlands for the Marine Crossing GTP Project illustrates the presence of WMAs and wetland management area triggers that intercept the Marine Crossing GTP Project (Category C ESA) (refer Figure 15.1a and Figure 15.1b). Within these catchments, a wetland management area characterises wetlands of general ecological significance within the GBR catchment and a trigger area represents the local hydrological zone that drains to the wetland.

The Marine Crossing GTP Project intercepts areas associated with The Narrows wetland, the intertidal mudflats south of Kangaroo Island, and Port Curtis wetland, the foreshore of Curtis Island and tidal areas of Graham Creek. Despite inclusion in DIWA, The Narrows and Port Curtis Wetlands are not classified as internationally important under the Ramsar Convention.

The intertidal area south of Kangaroo Island includes the tidal watercourse (Mosquito Creek) and mudflats that separate Kangaroo Island from the mainland. The large mudflat area is situated to the southeast of Kangaroo Island, an estuarine system with several tidal links to the marine environment south of Friend Point (Figure 15.1b). This area receives rainfall runoff from Humpy and Targinie Creeks, tributaries of Mosquito Creek and ultimately flows to The Narrows in a northerly direction.

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates



Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Directory of Important Wetlands
- Port Curtis
- The Narrows

Wetland Regional Ecosystem
- Estuarine

Water Body
- Estuarine
- Lacustrine

Areas that May Include Wetlands
- 1-50% wetland
- Watercourse

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Directory of Important Wetlands: Department of Environment, Resource and Management, Feb 2011.
Water Bodies and Wetland Regional Ecosystems: Queensland Wetland Data v1.2, Department of Environment and Resource Management, 2008.
Watercourses: Department of Environment and Resource Management, 2011.
Aerial: Santos, Feb 2011.

Wetland Systems
Figure 15.1a

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_045.mxd 20/06/2012 16:21

A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0460

Coordinate system: GCS_GDA_1994

Date: 20/06/2012

Version: j

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road

Referable Wetlands
- Wetland Management Area
- Wetland Management Area Trigger
- Watercourse

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Referable Wetlands: Department of Environment and Resource Management, 2010.
Watercourses: Department of Environment and Resource Management, 2011.
Aerial: Santos, Feb 2011.

Referable Wetlands and Watercourses Figure 15.1b

A1 scale: 1:15,000

0 250 500 750 1,000 1,250 m

GLNG No: 3381-40-0461

Coordinate system: GCS_GDA_1994

Date: 20/06/2012

Version: j

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Map by: RB

The primary environmental value of this intertidal area is its ecosystem function as a habitat for birds, fish, crustaceans and benthic organisms.

The Port Curtis wetland includes all tidal areas in the vicinity of Gladstone from a line between Laird Point and Friend Point (southern end of The Narrows), to a line between Gatcombe Head and Canoe Point, including the seaward side of Facing Island and Sable Chief Rocks, and southern Curtis Island, west of a line between North Point and Connor Bluff (Environment Australia 2001). The area also incorporates the Calliope River (approximately 7.5 km upstream), intertidal areas between Fishermans Landing and the Calliope River mouth, RG Tanna Spit, Gladstone Marina and Auckland Inlet.

15.2.3 Watercourses

The Marine Crossing GTP Project lies within the Calliope River Basin. This region is subject to a range of climatic regimes and is described as subtropical to semi-arid, with a summer-dominant but variable rainfall pattern. Environmental values for the watercourses within the Calliope River Basin were identified as part of the EIS (URS 2009a) and are summarised in Table 15.5.

The approximate pipeline crossing locations of the four tidal watercourses on the mainland are listed in Table 15.8.

Table 15.8 Watercourse crossing locations within the terrestrial mainland section of the Marine Crossing GTP Project

Watercourse name	Stream order number	Easting	Northing
Humpy Creek (minor northern tributary) at Point B	-	308373.88	7371859.67
Humpy Creek (southern creek line)	3	309233.77	7371273.63
Unnamed drainage feature (connecting Humpy Creek and Targinie Creek)	-	309378.77	7371054.77
Targinie Creek	2	309641.02	7370828.05

Notes: Stream order is typically a representation of stream size and is a numerical ordering system of each stream section based on its position in a catchment. Small streams that commence in the catchment headwaters are considered first order streams, and as they connect with other streams further down the catchment, they progressively get larger and become higher order streams

Description of watercourses

Humpy Creek (Minor northern tributary) at Point B

This northern anabranch of Humpy Creek and minor tributary of Mosquito Creek, located at Point B (refer Plates 15.1 and 15.2) was assessed as being tidally affected. The bank at its widest point was noted by Footprints (2012b) to be 12 m and bank height was estimated at 1 m at the crossing location with average erosion. Vegetation was minimal in the creek bed, which comprised of small to medium sized rounded pebbles and coarse, large grained, well sorted sand. River mangroves were present, as well as grass and eucalypts on the banks. (RPS Aquaterra, 2012)

Plate 15.1 **Humpy Creek (minor northern tributary) – Looking south from the northern boundary of the ROW**

Note: Pink flagging tape represents northern extent of ROW disturbance

Plate 15.2 **Humpy Creek (minor northern tributary) – Looking north from the pipeline crossing**

Humpy Creek (southern creek line)

Humpy Creek is a more significant watercourse than its northern anabranch (refer Plates 15.3 and 15.4) and was assessed as considerably tidally influenced at the edge of a salt flat with no freshwater flow. The bed at the crossing was noted to be sparsely vegetated, with banks having extensive grass cover, river mangroves were present and the banks were highly eroded. The creek bed had large grained, well graded, coarse sand, and small to medium rounded pebbles. Bank height was estimated at 3 m, becoming lower downstream. Channel width becomes wider upstream (approximately 20 m (Footprints, 2012b)), while at the crossing the estimated channel width was 3 to 5 m. (RPS Aquaterra, 2012)

Plate 15.3 Humpy Creek (southern creek line) Crossing – Looking east

Note: White measuring tape represents southern extent of the Marine Crossing GTP ROW disturbance

Plate 15.4 Humpy Creek (southern creek line) Crossing – Looking south

Unnamed drainage feature (connecting Humpy and Targinie Creeks)

The unnamed drainage feature connecting Humpy and Targinie Creeks (refer Plates 15.5 and 15.6) was considered to be frequently tidal with large amounts of river mangroves and salt couch present, and no freshwater flow. Small tidally influenced pools were noted, however the tidal influence while appearing consistent was only small. The creek banks were highly eroded with the bed made up of small rounded pebbles, marine mud and sediment, and large grained, well graded, coarse sand with a silty sandy substrate. Bank height was estimated as <0.5 m at the crossing, becoming smaller upstream while the channel width was estimated at 7 m. (RPS Aquaterra, 2012)

Plate 15.5 Unnamed Drainage Feature – Looking east

Plate 15.6 Unnamed Drainage Feature – Looking north across vehicle crossing point

Note: Pink flagging tape represents north-eastern boundary of the Marine Crossing GTP ROW

Targinie Creek

Targinie Creek (refer Plate 15.7) was assessed as marginally tidally influenced, with a gravelly sandy substrate and meandering form to a broader form consistent with tidal action downstream. Salt couch and river mangroves were present within the creek bed and partially up the banks, indicating the depth of tidal inundation. The creek bed width was estimated at 7–10 m and consisted of large rounded pebbles, rocks and boulders with large grained, well graded, coarse sand which was vegetated with grass. Bank height was estimated at 1.5 to 2 m at the crossing location and noted as highly eroded. Channel width also became narrower upstream. (RPS Aquaterra, 2012)

No flow was noted in Targinie Creek during an initial survey; however a second survey conducted at high tide noted the tidal influence extending up to about 1 to 2 m distance from the proposed watercourse crossing location, although flow rate was minimal. A stingray was seen and small fish noted. (RPS Aquaterra, 2012)

Plate 15.7 Targinie Creek Crossing – Looking south

Water quality and watercourse profile

Preliminary baseline field testing undertaken in March 2012 indicated physical indicators for the watercourses with pH ranging from 7–8, salinity levels ranging from fresh to brackish and flows less than 1m/s (GLNG, 2012a). Further field testing carried out by RPS Aquaterra on 31 May 2012 and 1 June 2012 indicated pH ranging from 6–11 and EC levels indicating saline to seawater (RPS Aquaterra, 2012). A summary of the measured water quality parameters and watercourse characteristics is provided in Table 15.9.

Table 15.9 Measured water quality and watercourses characteristics (RPS Aquaterra, 2012)

Measured watercourse parameter at crossing locations	Watercourse			
	Humpy Creek (minor) at Point B	Targinie Creek	Unnamed drainage feature	Humpy Creek (southern creek line)
pH	9.21	6.36	11.05	9.71
EC (ms/cm)	42.61	19.91	54.32	31.92
DO (mg/L)	19.11	10.20	10.96	10.38
Water depth (m)	< 0.1	0.2	< 0.5	< 0.1
Water depth (m) at high tide	0.2 – 0.3	0.3 – 0.5	< 0.5	0.5 – 1.0
Channel width (m)	1.5	7 – 10	1 - 2	1 – 2
Flow width (m) at high tide	3	8 – 12	7	5 – 7
Invert level (m AHD)	2.1	1.0	2.0	2.0

Aquatic habitat

An assessment of the aquatic habitat condition of the watercourses was undertaken using the Australian River Assessment System (AUSRIVAS) protocol described in the *Queensland AUSRIVAS Sampling and Processing Manual* (DNRM 2001), adapted where required to reflect the estuarine characteristics of the watercourses. In summary the assessments determined that light grazing was the dominant adjacent land use, in-stream habitat was limited to undercut banks and occasional woody debris and riparian zones included native open woodland (eucalypts) and grasses (disturbed by grazing activities) and marine plants such as mangroves and saltwater couch (GLNG, 2012a). The majority of the watercourses are considered to be ephemeral and contain limited habitat for aquatic species.

No suitable habitat for significant freshwater aquatic species (eg platypus or freshwater turtles) was identified within the watercourses and they are considered unlikely to support any significant marine and/or estuarine species (GLNG, 2012a). However, the lower reaches of the watercourses are likely to support other fish and crustacean species and the watercourses flow into the intertidal area south of Kangaroo Island and its habitat areas.

A detailed assessment of aquatic habitat and potential impacts is provided in Chapter 10.

Description of catchments

The catchment areas for each watercourse traversed in the mainland section of the Marine Crossing GTP Project (RPS Aquaterra, 2012) are provided in Table 15.10 and shown in Figure 15.2.

Table 15.10 Catchment areas (RPS Aquaterra, 2012)

Watercourse and KP	Catchment area (km^2)
Humpy Creek (minor northern tributary) at Point B	1.68
Humpy Creek (southern creek line)	14.8
Unnamed minor (connecting Humpy and Targinie Creeks)	3.96
Targinie Creek	9.55

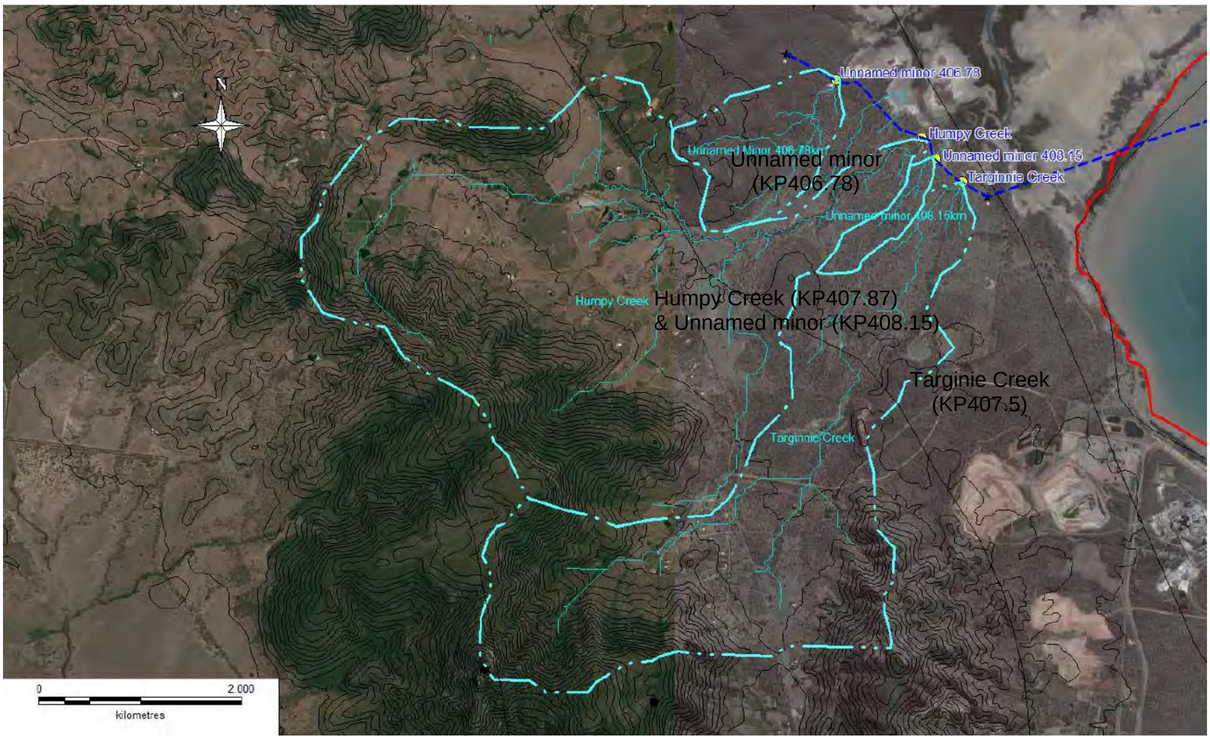


Figure 15.2 Watercourse catchments

Source: RPS Aquaterra, 2012

Flood hydrology

Hydrodynamic modelling results estimated a minor amplification of peak tide levels near the watercourse crossing locations of approximately 0.2 m higher than the estimated levels HAT at Gladstone (refer Table 15.7), indicating that all four watercourses would experience tidal inundation. Based on aerial laser survey (ALS) data, Humpy Creek at the crossing location was assessed as been most likely to be regularly affected by tides, as its bed level is below MHWS tide level. The other watercourses will be affected by tidal inundation during higher tides and was confirmed during field surveys (RPS Aquaterra, 2012).

An hydraulic assessment of peak discharge (Q_{peak}) and approximate water depth for a three month average recurrence interval (ARI) wet and dry season flood event was undertaken based on the assumption that the downstream water levels corresponded to the MHWS. The predicted flows in Table 15.11 demonstrate that only the crossing of Humpy Creek (southern creek line) is likely to be undertaken in a watercourse regularly inundated by tides. The other watercourse crossings are considered, generally, outside or on the margin of tidal influences and therefore inundation is only expected to occur only during significant tidal movements at HAT (RPS, 2012).

Additional hydrologic modelling for the 5 year, 20 year and 100 year ARIs was undertaken by O2 (2012b) for the SMESCP. A summary of the peak flow rates determined by O2 for the watercourses crossed by the Marine Crossing GTP Project is included in Table 15.11. It should be noted that the catchment area for the unnamed drainage feature was included in the total catchment area used for modelling the peak flows of Targinie Creek.

Table 15.11 Predicted peak flows and depths at watercourse crossing locations (RPS Aquaterra, 2012; O2, 2012b)

Crossing location	Invert level (m AHD)	Wet season (3 month ARI)			Dry season (3 month ARI)			5 y ARI	20 y ARI	100 y ARI
		Q_{peak} (m^3/s)	Water level (m AHD)	Water depth (m)	Q_{peak} (m^3/s)	Water level (m AHD)	Water depth (m)	Q_{peak} (m^3/s)	Q_{peak} (m^3/s)	Q_{peak} (m^3/s)
Humpy Ck (minor) at Point B	1.84	2.20	2.60	0.76	0.03	1.97	0.13	9.62	15.37	20.97
Humpy Ck (southern creek line)	0.78	9.90	2.29	1.51	0.14	1.90	1.12	57.10	90.50	123.44
Unnamed drainage feature	1.88	0.80	2.13	0.25	0.01	1.91	0.03	-	-	-
Targinie Ck	1.84	7.30	2.71	0.87	0.10	2.02	0.18	69.39	112.41	150.11

15.2.4 Existing farm dams

Four small farm dams or waterholes adjacent to the Marine Crossing GTP Project have been identified. These farm dams are associated with the agricultural and horticultural practices consistent with the land use of the area.

Three farm dams are adjacent to the Access Road, with the southern-most dam located adjacent to an orchard area and fed by an overland drainage line. The central dam is located to the west of the Access Road and the third dam is located to the east of the Access Road and to the south of the construction site pad (mainland).

The fourth farm dam is fed by flows from the upper extents of the Humpy Creek (minor northern tributary) catchment and located upstream of the watercourse crossing location at Point B.

The location of the existing farm dams is shown on Figure 15.3.

15.2.5 Groundwater and aquifers

The groundwater within the Marine Crossing GTP Project disturbance footprint occurs as shallow unconfined aquifers within the terrestrial mainland and Curtis Island sections and unconfined zones throughout the sedimentary formation within the channel connected to the overlying marine waters (The Narrows).

Desktop study

A desktop assessment of groundwater undertaken by RPS (2011) found that:

- Groundwater occurs at shallow depths, typically less than 1 m in the Quaternary age sediments
- Groundwater occurs at a relatively shallow depth in The Narrows and Curtis Island Group rocks typically between 1 m and 30 m below ground level (BGL)
- Groundwater flow in the Quaternary age sediments is locally controlled by Port Cutis tide elevations and cycles. Groundwater flow is landward at high tide and coastward at low tide
- Groundwater flow in the Narrows Group and Curtis Island Group rocks is likely to be dominated by groundwater recharge over the coastal uplands and discharge to The Narrows marine waters

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Access Road
- Existing Farm Dams

Descriptio
- Drainage Feature
- Humpy Creek (northern minor tributary of creek)
- Humpy Creek (southern creek line)
- Targinnie Creek
- Watercourse

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Referable Wetlands: Department of Environment and Resource Management, 2010.
Watercourses: Department of Environment and Resource Management, 2011.
Aerial: Santos, Feb 2011.
Watercourse Crossings: Downes, 2012.

Watercourse Crossings and Existing Farm Dams
Figure 15.3

A1 scale: 1:15,000
0 250 500 750 1,000 1,250 m

GLNG No: XXXX-XX-XXXX
Coordinate system: GCS_GDA_1994

Date: 12/07/2012 Version: c

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_081.mxd 12/07/2012 17:00

- Leakage from the overlying alluvial materials underlying Humpy Creek and Targinie Creek likely contributes to groundwater recharge in the Narrows Group rock
- Groundwater quality in all formations is dominated by saline water
- The soils underlying the intertidal areas south of Kangaroo Island are PASS and AASS (refer Chapter 7), accordingly areas of low pH groundwater with high iron and aluminium are likely to occur here
- The groundwater quality in the Narrows Group and Curtis Island Group rocks is unknown
- The Narrows Group rocks are hydrocarbon-bearing, so naturally occurring hydrocarbons may be anticipated in groundwater samples taken from bores completed in these formations. Groundwater discharge from the Narrows Group rocks could potentially carry hydrocarbons to aquifer systems overlying and underlying the Narrows Group rocks

Desktop studies of groundwater databases within the vicinity of the Marine Crossing GTP Project found that, in general, groundwater is suitable for livestock drinking purposes only (URS, 2007). The concentrations of dissolved arsenic and manganese exceeded the Australian Drinking Water Guidelines (ADWG) (2000) in all but one of the bores sampled, whilst dissolved cadmium, chromium, nickel and zinc levels exceeded Australian Water Quality Guidelines (AWQG) (2000) in some of the bores sampled. Elevated concentrations of dissolved solids, sodium, chloride, and sulphate were recorded in the majority of the groundwater samples compared to ADWG (2000). URS (2008) recommended that the groundwater, from both shallow (<8 m) and deep (>20 m) boreholes, was not suitable for discharge into the fresh or marine water environments.

There are no existing groundwater bores or users of groundwater resources identified within the Marine Crossing GTP Project ROW.

Groundwater survey

Terrestrial section

Investigations included boreholes drilled to the expected depth of excavation along the trench sections on the mainland and Curtis Island. Groundwater was initially encountered in all boreholes on the mainland during the investigation at depths of between 0.3 m and 1.9 m BGL (refer Figure 1 in Appendix A). Monitoring wells were installed at three locations. The results are shown in Table 15.12.

Table 15.12 Groundwater levels in May 2012 (Golder Associates, 2012b)

BH No.	Groundwater well	Ground level (m AHD)	Groundwater level (m AHD)	Estimated trench invert level (m AHD)
1	-	2.26	1.86	-0.24
2	GW1	3.06	2.76	0.56
3	GW2	2.35	1.95	-0.15
4	GW3	2.00	1.5	-0.5
6	-	2.39	2.09	-0.11
7	-	4.85	2.95	2.35

No groundwater was encountered in the boreholes along the trench section on Curtis Island to the depth of drilling, however a monitoring well installed by Australia Pacific LNG adjacent to BH10 was sampled. This well is referred to as CI1 for sampling purposes. The results of the groundwater sampled are listed below in Table 15.13.

Table 15.13 Groundwater monitoring results (Golder Associates, 2012a)

Well ID	Groundwater level (m BGL)	pH	Salinity (ppK)	EC (µS/cm)
GW1 (BH2)	1.9	4.1	32.2	49,400
GW2 (BH3)	1.2	5.0	59.4	87,500
GW3 (BH4)	1.53	6.2	21.7	34,600
CI1	4.2	6.5	8.48	14,270

The results indicate that the groundwater ranges from moderately acidic to mildly acidic and the salinity levels are consistent with low lying coastal estuarine areas. EC and salinity levels indicate the groundwater is brackish at the Curtis Island sample sites and salinity along the mainland trench section is influenced by tidal movements (Golder Associates, 2012a). It is noted the above monitoring represents a single sample that was conducted at low tide conditions and further sampling would be required to determine the full extent of tidal influence and the likely range of variation in groundwater levels.

The soil profiles indicate groundwater occurring as shallow unconfined aquifers within upper permeable sandy and gravelly profiles and perched on less permeable clays and weathered sedimentary formations. The flow of groundwater in estuarine areas is likely to be controlled by a combination of variable hydraulic gradients and density differences between fresh water recharge and salt water inundation (Worley Parsons, 2010a). The topography and catchments suggest flow rates would be generally low.

The ground levels along the Marine Crossing GTP ROW, grades from approximately 12.6 m AHD at Point A to 4.0 m AHD at the start of the construction site pad (mainland), with the exception of the watercourse invert levels. Based on the reported groundwater levels and assumed (max.) trench invert of 2.4 m BGL, it is estimated groundwater may be encountered within the depth of proposed trenching excavation within the terrestrial mainland section.

Tunnel section

The groundwater investigation included a shallow borehole (BH7 - refer Figure 1 in Appendix A) adjacent to the northern edge of the construction site pad (mainland) and groundwater was intercepted at 1.9 m BGL. No sampling of the groundwater to determine quality was undertaken.

No insitu permeability testing of the profiles within or above the Marine Crossing tunnel has been undertaken.

15.2.6 Local water supply

Raw and treated water is sourced from the Awoonga Dam located on the Boyne River, this supply of reticulated potable water to the Gladstone region is managed by Gladstone AreaWater Board. No reticulated potable water is available to the Marine Crossing GTP Project ROW.

15.3 Water impacts during construction

15.3.1 Stormwater

Erosion risk assessment

An erosion risk assessment was undertaken for the Marine Crossing GTP Project disturbance footprint as part of the SMESCP to determine the sediment control and erosion controls required. Soil loss rates were estimated across the Marine Crossing GTP Project disturbance footprint as part of this risk assessment and compared against the erosion risk category adopted from Best Practice Erosion and Sediment Control (IECA, 2008). A total of 25 areas within the Marine Crossing GTP Project ROW were assessed for erosion risk, namely 17 areas within the terrestrial mainland and eight on Curtis Island. A summary of the erosion risk category and number of areas that fall within that category is provided in Table 15.14.

Table 15.14 Erosion risk for Marine Crossing GTP Project disturbance footprint (IECA, 2008)

Soil loss (t/ha/y)	Erosion risk category	Mainland	Curtis Island
0 to 150	Very low	17	-
150 to 225	Low	-	1
225 to 500	Moderate	-	1
500 to 1,500	High	-	2
> 1,500	Extreme	-	4

The Marine Crossing GTP ROW within the terrestrial mainland was generally assessed as having a very low erosion risk. The terrestrial section of the Marine Crossing GTP Project ROW on Curtis Island was assessed as having a low to moderate erosion risk within the construction site pad (Curtis Island) and a high to extreme erosion risk within the ROW. (O2, 2012b)

Erosion and sediment controls

Erosion and sediment controls have been determined for the Marine Crossing GTP Project based on this erosion risk assessment and the appropriate integration of drainage, erosion and sediment control measures. The erosion and sediment controls proposed in the SMESCP include:

- Sediment basins
- Swale drain around construction site pad (mainland) to divert clean water from tunnel construction activities
- Separation of stormwater with clean and dirty stormwater drains along the ROW
- Sediment fencing
- Ground stabilisation

Sediment basins

Based on the erosion risk assessment undertaken in the SMESCP, five sediment basins are proposed on Curtis Island during the construction of the Marine Crossing GTP Project. Although the erosion risk assessment for the terrestrial mainland was assessed as having a very low erosion risk, three sediment basins for the ROW have also been proposed in the SMESCP due to the size of the catchments.

The sediment basins proposed in the SMESCP will operate as wet basins designed to retain sediment laden water, allowing adequate time for the settlement of fine particles. The sediment basins will be typically designed for a maximum five day cycle; that being for filling, treatment and discharge. Once water is above the five day sediment storage an additional two days storage will allow for monitoring, treatment and discharge of the clean water. (O2, 2012b) Clean water from the sediment basins will be allowed to overflow or be pumped out and discharged to the surrounding land depending on the final design of the sediment basins. Additional details are provided in the SMESCP (refer Appendix C).

Swale drain and sedimentation pond

Stormwater within the construction site pad (mainland) will be captured and diverted away from the TBM launch shaft and tunnel portal. A swale drain is proposed around the perimeter of the construction site pad (mainland) to capture clean stormwater and channel it to the sedimentation pond.

The sedimentation pond will also be located within the construction site pad (mainland) and has a storage volume of 1,463 m^3. Clean water from the sedimentation pond will discharge via spillway in accordance with the SMESCP (refer Appendix C).

Hardstanding and bunded areas

Refuelling activities as well as the storage of chemicals and hazardous materials will be restricted to dedicated hardstand areas within the construction site pad (mainland). Refuelling of equipment within the Marine Crossing GTP ROW will be undertaken by mobile refuelling tankers. Transferring of all chemicals, fuel and liquid waste will be undertaken by trained personnel using self-sealing/closing couplings on the transfer hose. Stormwater collected in any chemicals and hazardous materials bunded area will be monitored and pumped out by a licensed contractor as required or treated within the WTP.

15.3.2 ASS treatment areas

Construction of the Marine Crossing GTP Project has the potential to disturb ASS as described in Chapter 7. ASS treatment areas will be provided in accordance with the ASSMP (refer Appendix A).

Excavated ASS/PASS will be stockpiled on treatment pads for lime treatment and testing. All ASS treatment areas will be bunded and located adjacent to the proposed excavation area (where possible) with any leachate being directed to the sedimentation pond for quality correction prior to discharge or reuse onsite.

15.3.3 Marine Crossing tunnel

TBM launch shaft and tunnel dewatering

The TBM launch and receptor shafts will be excavated and progressively sheetpiled to exclude any encountered groundwater and to minimise the need for dewatering. Stormwater within the construction site pad (mainland) will be directed away from the TBM launch shaft and tunnel portal as described in Section 15.3.3.

The Marine Crossing tunnel alignment under the intertidal area and The Narrows is approximately -12.5 m AHD at its deepest point and some 4 km of the Marine Crossing tunnel is inundated during HAT. A two stage seal ring will be installed at the launch eye to prevent the ingress of groundwater, and during progress of the TBM, grout will be used to fill the annulus between the overcut and the concrete segment rings creating a waterproof lining, minimising any groundwater ingress into the tunnel (Theiss, 2012).

Minimal groundwater seepage into the Marine Crossing tunnel during construction is expected, with a maximum design ingress rate of 1 L/100 m/h being adopted. An EPB TBM operating in closed mode builds up enough pressure at the excavation face to equalise the pressure exerted by the earth and groundwater (Herrenknecht, 2012). Any groundwater inflow that occurs at the excavation face will be contained within the excavation chamber.

Spill response kits will be provided within the TBM launch shaft and tunnel for potential hydrocarbon spills prior to the chemical entering the dewatering system. All groundwater collected from the TBM launch shaft and within the tunnel portal will be pumped to the WTP for treatment.

Water treatment plant

The WTP will be located at the construction site pad (mainland) and will have a capacity of approximately 7 L/s to treat groundwater from the TBM launch shaft and tunnel. Stormwater from potentially contaminated areas of the construction site pad (mainland), such as workshops and generator bay will also be captured and treated at the WTP.

Primary settlement to reduce sediment load will be provided prior to secondary treatment of the groundwater for the removal of suspended solids, pH adjustment and separation of oil and grease through the addition of a flocculant and then aeration. The removal of suspended solids will also reduce levels of iron, manganese and other metals within the groundwater.

Treated water from the WTP will be continuously monitored for pH and turbidity prior to being pumped to the construction water tanks for storage and use in grout batching, washdown water and dust suppression. Any treated groundwater that cannot be reused onsite will be discharged in accordance with the ASSMP (refer Appendix A).

Sludge from the WTP will be extracted and removed from site by a licenced contractor for disposal as described in Chapter 14.

Water for TBM operation

Water is required for tunnelling activities, namely cooling of the TBM during operation and grout batching. Water for cooling purposes will be supplied to the TBM via a closed loop system sourced from the construction water tanks following treatment at the WTP.

15.3.4 Trench dewatering

Currently there is limited water quality data for groundwater within the Marine Crossing GTP ROW and as a precautionary measure water removed from the trench during construction will be treated as being acidic and managed in accordance with the ASSMP (refer Appendix A).

As required, water within the trenches during construction will be pumped into mobile tanks alongside the ROW where pH will be corrected and suspended solids settled out. The removal of suspended solids will also reduce the levels of iron, manganese and other metals within the groundwater.

Additional groundwater testing is currently being undertaken and it is expected that both saline and fresh groundwater will be present. As part of the CMP a detailed ASSMP will be prepared prior to construction that details the treatment and disposal options for saline groundwater.

15.3.5 Hydrotesting

Pipe integrity of the Marine Crossing GTP will be verified through hydrotesting as described in Chapter 2 (refer Section 2.5.2).

Commonwealth, Scientific and Industrial Research Organisation (CSIRO) (Tjandraatmadja *et.al*, 2005) conducted a study that found the quality of used hydrotest water did not represent a hazard to the environment, provided that the source water was of adequate quality. This study identified the primary driver of the quality of used hydrotest water as the quality of the source water.

Hydrotest water is planned to be sourced from bores to the west in the Arcadia Valley or near Bauhinia Downs. Once the Mainland GTP has been tested, the water will be transferred to the construction pond located within the construction site pad (mainland). This pond will have a capacity of approximately 15,000 m^3 and will be designed fit for purpose to minimise any infiltration of water or potential contamination from underlying ASS. On completion of the hydrotesting, the water will be recycled for testing the Curtis Island GTP. All hydrotest water will be managed in accordance with the HTMP.

The quality of the hydrotest water is essentially fresh water with dissolved solids <2,000 ppm. Prior to hydrotesting commencing, the GTP will be cleaned by a pig and compressed air andthere will be no biocide or corrosion inhibitors added to the hydrotest water.

Construction pond

The construction pond will store water for hydrotesting the pipeline within the Marine Crossing GTP Project. Hydrotesting is part of the testing and commissioning phase to verify pipeline integrity. The construction water pond specifications are provided in Chapter 2.

Hydrotesting will require approximately 1,000 m^3/h of water to fill the pipeline and 15,000 m^3 of water in total. To ensure an adequate water supply is available for the Marine Crossing GTP Project, it is proposed to construct a temporary construction pond within the construction site pad (mainland).

The water for hydrotesting will be sourced as part of the Mainland GTP Project from approved water extraction sources, typically from bores to the west in Arcadia Valley or near Bauhinia Downs. Hydrotest water will then be transferred from one test GTP section to another via a series of valves. Once the Mainland GTP has been tested, the water will be transferred to the Marine Crossing GTP Project and stored within the construction pond.

The construction pond has been designed with a freeboard of 1 m or greater to provide for a storm event up to a 10 year ARI. No stormwater from external catchments will drain to the construction pond. During abnormal operating conditions, such as a storm event that results in the freeboard being exceeded, water will overflow from the construction pond to land.

It is expected that filling of the construction pond will be undertaken in the second half of 2013, when testing of the Mainland GTP is complete. Once hydrotesting of the Marine Crossing GTP and Curtis Island GTP has been completed, the water will be pumped back to the construction pond for disposal to land. This will occur during the second half of 2014 in accordance with the DHWLRMP (refer Appendix D).

15.3.6 Potable water supply

Treated water needed to supply the construction staff for potable and hygiene purposes will be transported via road tankers and stored onsite in tanks. The total volume will be insignificant given the maximum staff on site will range between 20–45 people over an 18 month period.

While it is intended that all water for all other construction purposes will be from other sources, raw water from the local water supply may be required for uses such as dust suppression or hydrotesting.

15.3.7 Sewage treatment and disposal

No worker camps will be established in the vicinity of the Marine Crossing GTP Project. Portable toilets or equivalent will be used for ablution purposes only, with all sewage collected onsite and removed for subsequent treatment and disposal by an appropriately licensed contractor.

15.4 Discharge of water

All water generated from construction of the Marine Crossing GTP Project will be monitored and treated as required prior to discharging. Discharge to marine waters and land has been considered for the Marine Crossing GTP Project.

A separate management plan will be prepared prior to any direct discharge of waters from the Marine Crossing GTP Project to marine waters.

Potential water sources that may be released include:

- Clean stormwater from erosion and sediment controls along the Access Road, ROW and construction site pads
- Groundwater from trench dewatering
- Groundwater from TBM launch shaft and tunnel
- Hydrotest water from the construction pond
- Clean water from ASS treatment areas

15.4.1 Land release area

A dedicated land release area has been identified south of the construction site pad (mainland) on the west side of the Access Road (refer Figure 15.4). The boundary of this area is 100 m from Targinie Creek and the release area is approximately 36 ha.

Water balance modelling to determine the soils hydraulic and biological (eg salt) assimilative properties within the land release area will be undertaken prior to discharging of waters from the Marine Crossing GTP Project. It is expected that water will be released to the land release area via travelling irrigator or similar. Land release will generally occur during fine weather and flow rates will be controlled to minimise the potential for erosion and sedimentation and salt build up.

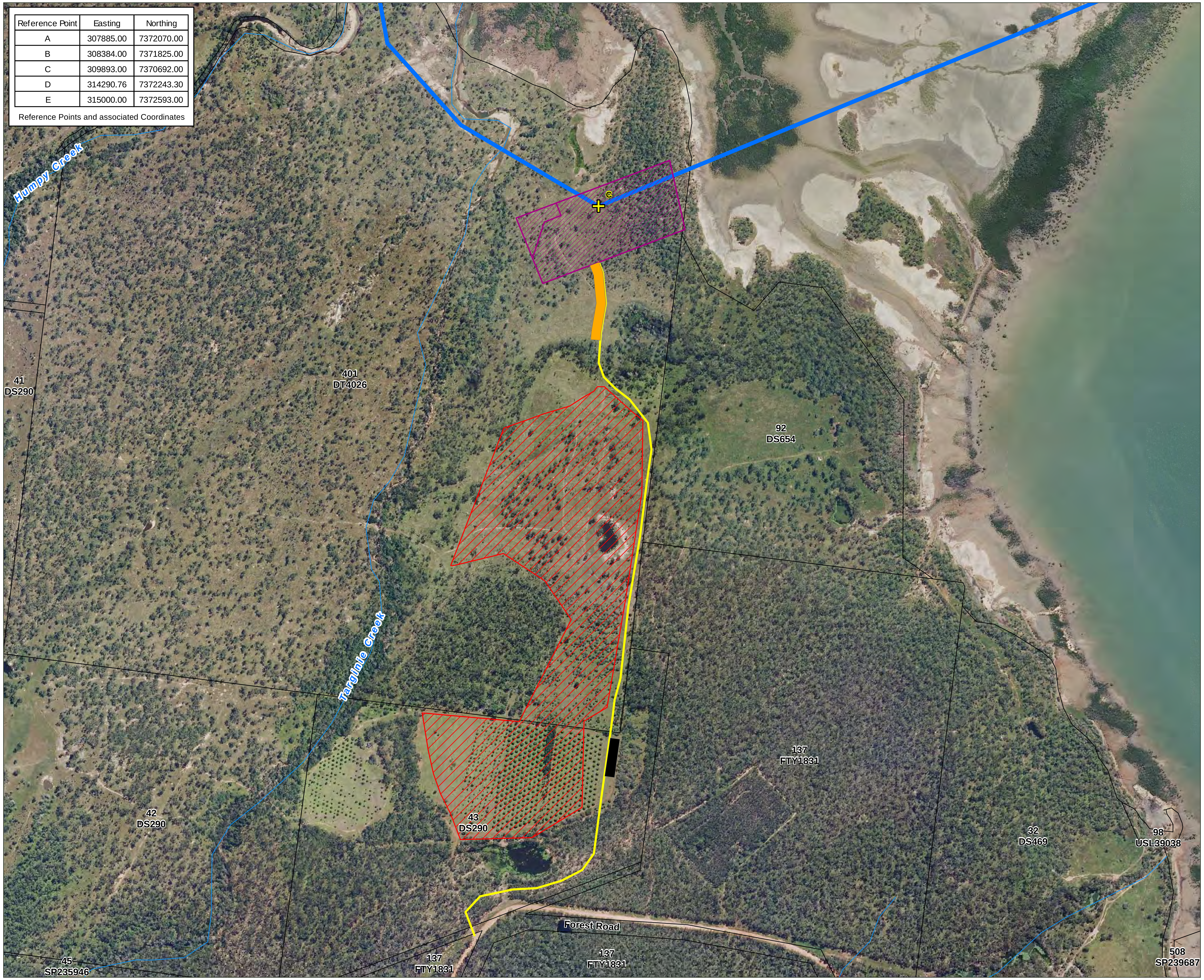
15.5 Potential construction impacts on water

15.5.1 Marine waters

Potential impacts from the construction of the Marine Crossing GTP Project result from the proximity of the works to the marine environment. There is the potential for contaminants and pollutants to be introduced as a result of spills, leaks, runoff, inundation and also

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates



Santos
GLNG Project

Marine Crossing GTP EMP

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Access Road
- Proposed Land Release Area
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Weed Washdown Facility (Indicative)
- Cadastre
- Watercourses

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.
Watercourses: Department of Environment and Resource Management, Sep 2011.
Cadastre: Department of Environment and Resource Management, Jul 2012.

A1 scale: 1:5,000

0 100 200 300 400 500 m

GLNG No: 3381-40-0554

Coordinate system: GCS_GDA_1994

Map by: RB P:\GIS\Projects\214208_Santos_EMP\MC_069.mxd 12/07/2012 17:02

Proposed Land Release Areas
Figure 15.4

Date: 12/07/2012 Version: f

through washdown activities. These contaminants and pollutants may impact on the local values of the marine environment. Control strategies to avoid or manage potential adverse environmental impacts are detailed in Section 15.8 and include:

- Siting the construction site pads outside of marine and tidal areas
- Tunnelling beneath The Narrows bed
- Erosion and sediment controls as proposed in the SMESCP (refer Appendix C)
- Treatment of water from dewatering activities associated with tunnel construction and trenching activities
- Stabilisation and rehabilitation of disturbed areas and re-establishment of overland surface flows to pre-disturbance conditions

Considering the proposed construction methodology for the Marine Crossing GTP, it is anticipated there will be no direct interaction with the marine waters other than vessel movements associated with the transport of construction equipment to the established jetty landing located at Laird Point on Curtis Island. The recreational or amenity values of the marine waters will not be impacted or reduced from the construction or operation of the GTP.

Furthermore, construction of the Marine Crossing GTP Project will not occur within the GBRMP and is sufficiently removed by distance that any indirect impacts are likely to be negligible. The Marine Crossing GTP will pass underneath The Narrows in tunnel and involve trenching on Curtis Island which forms part of the GBRWHA. Control strategies are proposed in Section 15.8.

15.5.2 Wetlands

The Marine Crossing GTP Project terrestrial mainland section (Point A to Point C) runs southeast along the interface between the wetlands and terrestrial areas and traverses the tidal reaches of the three mainland watercourses (ie Humpy Creek [minor northern tributary], Humpy Creek [southern creek line] and Targinie Creek).

The terrestrial mainland section of the Marine Crossing GTP Project on Curtis Island (Point D to Point E) starts from the construction site pad (Curtis Island) and runs adjacent to the extent of the tidal zone associated with Graham Creek.

The Marine Crossing tunnel is below the intertidal area of The Narrows wetlands and there is no direct disturbance of these wetlands.

There are potential indirect impacts to the wetlands systems from terrestrial construction activities for the Marine Crossing GTP Project, primarily from transport of sediments or contaminants via the watercourses and overland flow paths. Control strategies to minimise and manage potential adverse environmental impacts are included in Section 15.8.

15.5.3 Watercourses

Hydrodynamic modelling (refer Section 15.2.3) determined that all four watercourses would experience tidal inundation particularly during HAT, however only instream construction activities within Humpy Creek will be carried out in a zone regularly inundated by tides. The proposed method of construction within each watercourse is provided in Chapter 2.

Instream construction activities at the watercourse crossings have the potential to generate sediment plumes within the watercourse and may lead to an increase in both turbidity and bed load sediment (O2, 2012b). In addition, erosion or scour of watercourse beds and banks may occur following construction of the Marine Crossing GTP and reinstatement works.

Potential impacts associated with the construction of the Marine Crossing GTP Project may include contaminants and pollutants being introduced to watercourses as a result of spills, leaks, runoff, and also through washdown activities.

Control strategies to avoid or manage potential adverse impacts are detailed in Section 15.8 and include:

- Works scheduled for dry season during dry or low flow periods
- Erosion and sediment control measures implemented in accordance with the SMESCP (refer Appendix C) and permit/approval conditions
- Minimising the period of disturbance in watercourse
- Testing and monitoring of all stormwater and construction water prior to release to land in accordance with ASSMP (Appendix A), SMESCP (Appendix C) and DHWLRMP (Appendix D)
- Implementation of the AVMP

15.5.4 Overland flows and existing farm dams

The existing farm dams and overland flows draining to these features will not be disturbed as part of the construction or operation of the Marine Crossing GTP. However, there may be potential indirect impacts to the quality of water collected in the existing farm dams from construction activities and land release discharges associated with the Marine Crossing GTP Project. Control strategies to avoid or manage potential adverse environmental impacts are included in Section 15.8.

15.5.5 Stormwater

The transport of sediments offsite and water used during the construction of the Marine Crossing GTP Project may impact on the local values of surface water and groundwater, particularly on Curtis Island where the erosion risk assessment has assessed some areas as have an extreme erosion potential. However, the erosion risk assessment was used to specify suitable erosion and sediment controls and “dirty” stormwater will be collected and treated in accordance with the SMESCP (refer Appendix C) prior to release and will be separated from “clean” overland stormwater flows. Therefore, any potential impacts from the transport of sediment laden runoff offsite is considered very low given the proposed erosion and sediment controls.

A freeboard of 1 m or for a 1 in 10 year ARI storm event (whichever is the greater) will be provided for the construction pond to facilitate wet weather events. In normal operation hydrotest water from the construction pond will be released as detailed in Section 15.4. A high level alarm or float switch to activate the pump will be incorporated into the construction pond design so that sufficient freeboard is maintained. In the event that the freeboard is exceeded, overflows from the construction pond will be directed away from the intertidal area and the marine environment.

Refuelling activities as well as the storage of chemicals and hazardous materials will be restricted to dedicated hardstand areas within the construction site pad (mainland). Refuelling of equipment within the Marine Crossing GTP ROW will be undertaken by mobile refuelling tankers. Transferring of all chemicals, fuel and liquid waste will be undertaken by trained personnel using self-sealing/closing couplings on the transfer hose. Stormwater collected in any bunded area will be monitored and pumped out by a licensed contractor as required.

15.5.6 Discharge of waters to land

The proposed discharge of waters to the land release area will be managed in accordance with the DHWLRMP (refer Appendix D) and is not expected to result in any adverse impacts. There is potential for erosion and sedimentation of the land release area to occur, however care will be taken to manage this by controlling discharge rates and through visual monitoring of the land release area.

There is potential for salt build up within the soil, however the rate of irrigation determined by the water balance modelling will consider this and minimise salinity in the upper soil layers.

15.5.7 Groundwater and aquifers

Trenching section

The lowering of groundwater may generate impacts at a local level by allowing oxidation of PASS soils. Dewatering in these sections will be carried out in accordance with management measures outlined in the ASSMP (refer Appendix A).

It is expected that dewatering from trenches within the Marine Crossing GTP will not comprise significant volumes and will be managed with standard construction methods. Any impacts will be of short duration and localised. Furthermore it is predicted that pre-existing levels will naturally re-establish following backfilling of the pipeline trench.

Rates of groundwater seepage will vary depending on soil profile, rainfall and degree of tidal influence. To manage these variables, assessment of environmental conditions immediately prior to the commencement of trenching the section will be evaluated. A range of contingencies will be deployed according to the weather conditions. If there is unseasonal rain, or soils are saturated near the surface with groundwater, or there is excessive ingress of water into the trench from local underground sources, or the quality of water encountered makes it difficult to achieve the outcomes suggested above, then the construction method will be amended to take account of these contingencies. Contingencies include:

- Shoulders of excavations may be irrigated for short periods while works are undertaken to maintain groundwater levels
- The use of temporary storage to allow testing, treatment (if required) to meet the water quality criteria identified in the ASSMP (refer Appendix A) prior to discharge
- Temporary shoring using sheetpiling to minimise the extent of groundwater drawdown and limit seepage into the trench in areas of excessive groundwater flows and help mitigate the potential impacts associated with lowered groundwater levels and the oxidation of surrounding sediments
- Wet trenching of watercourses to be considered in the event that the volume of water in the watercourse is not adequately conveyed via the flow bypass (flumes) proposed in Chapter 2
- Wet trenching of the Marine Crossing GTP within the ROW to be considered if the volume or quality of groundwater is such that proposed treatment methods detailed in the ASSMP (refer Appendix A) are not able to achieve discharge limits proposed in this EMP (refer Section 15.8)

Marine Crossing tunnel section

Minimal groundwater seepage into the Marine Crossing tunnel during construction is expected, with a maximum design ingress rate of 1 L/100 m/h being adopted. In total, the estimated infiltration of water is expected to be approximately between 2,500 m^3 and 5,000 m^3 over the tunnel construction period. Where high groundwater flows are encountered, the closed-face shielded configuration of the TBM combined with constant face pressure on the formation will preclude groundwater inflow.

Groundwater collected from within the Marine Crossing tunnel portal and TBM launch shaft will be pumped to the WTP located at the construction site pad (mainland) for treatment as described in Section 15.3.3.

Given the estimated low dewatering rates and volumes of groundwater during tunnel construction, no long term adverse impacts to groundwater flows or levels are expected. However there may be localised drawdown creating a cone of depression at the TBM launch shaft and tunnel portal. It is proposed to install groundwater wells adjacent to the construction site pad (mainland) to monitor groundwater levels throughout tunnel construction. If required, recharging the aquifer will be undertaken by circulating groundwater from dewatering back behind the sheetpiles within the TBM launch shaft to negate the possible impacts of lowered groundwater levels and the potential oxidation of surrounding sediments (Golders, 2012a).

Additional, control strategies to avoid or manage potential adverse environmental impacts are included in Section 15.8.

15.5.8 ASS runoff

Construction of the Marine Crossing GTP Project has the potential to disturb ASS of which potential impacts have been considered in Chapter 7. Potential impacts to waters may include generation of acid runoff during disturbance of ASS and accidental release of ASS leachate from ASS treatment areas to the receiving environment.

However, as all ASS will be handled and treated in accordance with the ASSMP (refer Appendix A) impacts to waters in and surrounding the Marine Crossing GTP Project are considered unlikely. Additional, control strategies to avoid or manage potential adverse environmental impacts from ASS are included in Section 15.8.

15.5.9 Local water supply

Usage of large volumes of water during the hydrotesting process has the potential to diminish local water supply sources. Therefore, to minimise such impacts it is proposed to reuse the water previously used for hydrotesting the Mainland GTP and only “top up” the hydrotest water from local sources if required.

15.6 Operational impacts on waters

Monthly inspections will be carried out along the Marine Crossing GTP ROW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Typically maintenance on the Marine Crossing GTP will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required.

Potential impacts from these operational activities on waters are expected to be low and manageable as the Marine Crossing GTP ROW and ancillary construction areas will have been rehabilitated reducing any risk of potential for erosion, maintenance activities are unlikely to result in the contamination of waters.

Furthermore, all activities and work associated with these operational activities will be in accordance with the OMP which will be developed prior to the completion of the construction phase.

15.7 Cumulative impacts

15.7.1 Construction

There are expected to be no cumulative direct impacts to marine waters and wetlands resulting from the Marine Crossing GTP. There is potential for indirect impacts to these areas via watercourses and groundwater flows from construction activities however the risks are negligible due primarily to no direct interaction with these environments and secondly, the application of appropriate management strategies.

The construction of the Marine Crossing GTP has the potential to impact on water related environmental values of the tidal watercourses including reduction in water quality from increased erosion and sediment movement, discharge of contaminants and changes to surface water flow. Appropriate management and mitigation strategies will reduce the risk of any adverse impacts.

There is also potential for impacts to groundwater levels and quality from risks associated with contaminant discharge, dewatering activities and exposure of ASS. The risk of this occurring will be low by implementing the ESCP, SWMP, ASSMP and DHWLRMP. Any minor impacts to groundwater levels from dewatering will be localised and temporary. The tunnel construction may interfere with groundwater flows but this will be confined to the immediate vicinity of the tunnel path and unlikely to generate adverse environmental impacts on groundwater quality. Following completion the tunnel will be flooded with sea water.

The local water supply will not be impacted due to the minor volumes anticipated to be used during construction.

Existing farm dams will be avoided during construction. Any disturbance to surface overland flows will be re-established through progressive rehabilitation.

15.7.2 Operation

Regular inspections during operation of the Marine Crossing GTP will be carried out to check the condition of the GTP and identify any issues that may have the potential to impact on the integrity of the pipeline (eg localised erosion).

It is considered that surface water quality impacts from operational activities are low due to the infrequent inspection activities by vehicle transported personnel. No groundwater impacts resulting from operational activities are expected due to the small footprint of the works.

All works associated with these operational activities will be undertaken in accordance with the OMP which will be developed prior to construction.

15.8 Environmental protection commitments, objectives and control strategies – water (construction and operation)

Environmental protection objectives and control strategies proposed are outlined in Table 15.15.

Table 15.15 Environmental protection objectives and control strategies for water

Item	Outcome
Environmental Protection Objective	• Potential impacts associated with erosion are minimised, the release of contaminants that may adversely affect downstream surface water quality is prevented and the quality of the existing groundwater resources is protected
Specific Objectives	• Prevention of unlawful environmental harm being caused to surface waters • Minimisation of incidences of accelerated erosion as a result of construction activities • Groundwater quality will not be impacted by development activities • Spill containment facilities constructed in accordance with AS 1940 (2004) and AS 3780 (2008) • Environmental impacts are within authorised limits
Control Strategies	**Marine and Wetland Areas** • No unauthorised activities within marine and wetland areas • Regular visual observations of marine and wetland areas adjacent to construction activities • Design and construction of watercourse crossings in accordance with SMESCP • Monitoring downstream of watercourse crossings during construction activities **Watercourses** • Design and construction of watercourse crossings in accordance with the AVMP • No release of sediments in stormwater runoff to watercourses • Minimising period of construction within watercourse • Schedule works within watercourses at dry times or periods of low flow in so far as reasonably possible • No refuelling of plant, equipment or vehicles will occur within 50 m of any watercourse • Suitable spill clean-up kits will be kept available on site to manage any potential spills from the machinery and vehicles to be used during construction. Undertake rehabilitation and re-establish pre-existing surface flows as soon as practicable following completion of construction • Regular inspections with increased frequency following significant rainfall events • Stormwater discharges to flow through erosion and sediment control devices • All construction pad areas are bunded and have stormwater measures installed **Groundwater** • Installation of groundwater wells adjacent to launch and receiver pads to determine baseline levels and quality. Ongoing monitoring during construction to identify any impacts from the release of waters • Implement measures in ASSMP to minimise impacts from dewatering of ASS soils • Undertake pre-excavation sampling along trench sections to determine presence of ASS and groundwater baseline quality, flows and levels • Implement contingencies in areas of excessive groundwater flow, such as: - Re-scheduling of works to drier times - Use of temporary storage tanks - Use of temporary trench shoring - Trench excavation to be undertaken in shorter sections - Use wet trenching methodology for pipe laying

<table>
<tr><th>Item</th><th>Outcome</th></tr>
<tr><td></td><td>Local Water Supply
• Treated water sourced from local water supply to be used for potable and hygiene purposes. Tanks on site to have adequate capacity to service construction staff
• Local water supply (raw water) to be used for other construction activities (dust suppression, drilling operations, hydrostatic testing) only when other sources cannot provide adequate supply
Dams and Surface Flows
• Avoid disturbance of existing farm dams and drainage lines to dams
• No discharge of stormwater or hydrotest water to farm dams</td></tr>
<tr><td></td><td>Hydrotest water
• The hazard category of the construction pond will be determined and will be designed and constructed in accordance with the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (DERM, 2012b) to ensure its structural integrity
• All temporary water storage ponds will be constructed fit for purpose
• The release of hydrostatic test water authorised by CG Report will be located at least 100 m from the nearest watercourse and carried out in a manner that ensures that:
- Vegetation is not damaged
- Soil erosion and soil structure damage is avoided
- The quality of groundwater is not adversely impacted
- Hydrotest water does not migrate outside the nominated land discharge areas

Discharge to marine waters
• A separate management plan will be prepared prior to any direct discharge of waters from the Marine Crossing GTP Project to marine waters

Land release area
• Permeability testing will be undertaken onsite to confirm existing groundwater level and permeability of the soil prior to discharge from the ponds
• Water generated from construction activities, and testing and commissioning of the pipeline will be treated and managed in accordance with the EA
• The Construction Contractor will comply with all relevant authority requirements and procure all necessary permits and approvals
• Land release areas will be monitored and rotated as required to minimise any potential impacts of discharge or ponding
• Where required, sandbags, gabion or other scour protection measures will be installed, ensuring these are placed to conform as far as possible with existing natural contours
All land releases from temporary water storage ponds will be in accordance with the SMESCP (refer Appendix C) and DHWLRMP (refer Appendix D)</td></tr>
</table>

Item	Outcome
	General • The disturbance corridor for the bed, bank and approaches to watercourses will be the narrowest practicable for safe construction • Additional work areas may be required at crossing locations for equipment operation and stockpiling of excavated material. These will be located outside the riparian area • No refuelling of plant, equipment or vehicles will occur within 50 m of any watercourse • All construction vehicles will carry spill clean-up kits, commensurate with the size and type of vehicle • The maintenance and cleaning of any vehicles, plant or equipment will not be carried out in areas from which contaminants may be released into any waters, roadside gutter or a stormwater drainage system • Regional weather conditions and river flow levels will be monitored during construction to pre-empt changes in weather patterns and flow regimes to minimise impacts • Storage and loading/decanting areas for fuels and chemicals will be bunded and located outside the floodplain of the stream channels (ie approximately 50 m away from the top bank) • The staging areas will be limited to the narrowest area feasible and located outside the stream channel and riparian area • Large mature trees will be retained where practicable and trees will be trimmed in preference to removal to retain the root stock for stabilisation of the banks **Monitoring** • All discharges to comply with water quality criteria specified within monitoring section of this table • Records of monitoring to be kept • Daily monitoring upstream and downstream of watercourse crossings during construction • Regular monitoring of groundwater levels adjacent to construction site pads • Routine, regular and frequent visual monitoring of erosion and sediment control devices must be undertaken while carrying out construction work. Frequency to be increased following significant rainfall events in accordance with the SMESCP (refer Appendix C) • Records of site inspections to be kept **Operational phase** Typical mitigation and controls for the operational phase of the Project will be detailed in the Operational Management Plan, which will be developed post construction

<table>
<tr><th>Item</th><th>Outcome</th></tr>
<tr><td rowspan="2">Monitoring</td><td>Marine waters

Water quality monitoring and sediment sampling surveys have been undertaken by GLNG Operations at 21 sites (as described below) on a monthly basis over a period of two days. These monitoring activities occur in the vicinity of The Narrows between Friend Point, Kangaroo Island and Laird Point, Curtis Island at the following locations:

• Three sites on the pipeline alignment
• Three sites 500 m into the GBRCMP
• Three sites 1000 m into the GBRCMP
• Three sites 500 m south of the GBRCMP
• Three sites 1000 m south (and outside) of the GBRCMP
• Three sites within Graham Creek
• Three sites within Mosquito/Targinie Creek

Composite water quality samples have been collected at each location throughout the full depth of the profile. Samples collected within three hours of HAT. Profiling for in-situ parameters (eg temperature, dissolved oxygen, pH, turbidity) has also been undertaken. Sediment samples collected at each monitoring location using a grab sampler.

Sample analytes include the following:

• Water Quality – Turbidity, TSS, Total Nitrogen, Total Phosphorous, Ammonia, Nitrate + Nitrite, FRP, Aluminium, Arsenic, Cadmium, Copper, Chromium, Iron, Lead, Manganese, Mercury, Nickel, Zinc

• Sediment – Particle Size Distribution

All sampling procedures and methodologies adopted complied with the Monitoring and Sampling Manual 2009 (DERM, 2009b)</td></tr>
<tr><td>ASS treatment release criteria
<table>
<tr><th>Monitoring point</th><th>Parameter/ quality characteristic</th><th>Limit</th><th>Trigger value</th><th>Limit type</th><th>Minimum monitoring frequency</th></tr>
<tr><td rowspan="6">Sediment basins (Launch & Receiver Pads)</td><td>pH</td><td>6.5-9.0</td><td></td><td>Range</td><td rowspan="6">Monthly during periods of no release

Immediately prior to discharge and daily during discharge events

Periods of no discharge to be recorded</td></tr>
<tr><td>Total Suspended Solids (mg/L)*</td><td>50</td><td>N/A</td><td>Maximum</td></tr>
<tr><td>Total Petroleum Hydrocarbons (mg/L)</td><td>10</td><td>N/A</td><td>Maximum</td></tr>
<tr><td>Dissolved Oxygen (mg/L)</td><td>4</td><td>N/A</td><td>Minimum</td></tr>
<tr><td>Aluminium (total) (µg/L)</td><td>N/A</td><td>362</td><td>N/A</td></tr>
<tr><td>Iron (total) (µg/L)</td><td>N/A</td><td>387</td><td>N/A</td></tr>
</table>
Table note: * Equivalent Turbidity (NTU) can be adopted for field testing</td></tr>
</table>

Item	Outcome
	Ground dewatering release criteria

Monitoring point	**Parameter / quality characteristic**	**Limit**	**Trigger value**	**Limit type**	**Minimum monitoring frequency**
Dewatering points (trench section)	pH	6.5-9.0		Range	Immediately prior to discharge and daily during discharge events Periods of no discharge to be recorded
	Total Suspended Solids (mg/L)*	50	N/A	Maximum	
	Electrical Conductivity (µS/cm)	2000	N/A	N/A	

Table note: * Equivalent Turbidity (NTU) can be adopted for field testing

Stormwater release criteria

Monitoring point	**Parameter / quality characteristic**	**Limit**	**Trigger value**	**Limit type**	**Minimum monitoring frequency**
Sediment basins (trench section)	pH	6.5-9.0		Range	Monthly during periods of no release Immediately prior to discharge and daily during discharge events Periods of no discharge to be recorded
	Total Suspended Solids (mg/L)*	50	N/A	Maximum	

Table note: * Equivalent Turbidity (NTU) can be adopted for field testing

The limit for Total Suspended Solids of 50 mg/l has been set for the control and treatment of sediment in stormwater and groundwater prior to release. This standard is considered the most appropriate for the following reasons:

- This is the standard referred to in various relevant guidelines including the International Erosion Control Association (IECA, 2008) and the QWQG (2009) (Table 8.2.1 Construction Phase Stormwater Design Objectives for Disturbance)
- Water released under this specification will be released to land
- The standard represents best practice, being achievable with normally available techniques, avoiding excessive use of flocculants

Item	Outcome
	Hydrostatic test water release criteria

Parameter maximum value	**Parameter maximum value**	**Limit of Reporting (LOR)**
pH	pH 6.5 - 8.5 (Range)	
Arsenic (mg/L)	2	0.001 mg/L
Cadmium (mg/L)	0.05	0.0001 mg/L
Chromium (mg/L)	1	0.0001 mg/L
Copper (mg/L)	5	0.0001 mg/L
Iron (mg/L)	10	0.0001 mg/L
Lead (mg/L)	5	0.0001 mg/L
Manganese (mg/L)	10	0.0001 mg/L
Zinc (mg/L)	5	0.0001 mg/L
Nitrogen (mg/L)	5	0.1mg/L
Phosphorus (mg/L)	1	0.001 mg/L
Electrical Conductivity (µS/cm)	2000	N/A

Item	Outcome
Reporting	• Site inspection logs kept • Environmental reports to Company • Non-conformances reported to administering authorities
Performance Indicators	• ESCP, SWMP. ASSMP and DHWLRMP are being implemented • Groundwater quality is not being adversely impacted by dewatering or land release • Spill containment facilities are constructed in accordance with AS 1940:2004 and AS 3780:2008 • Discharges from release points meet water quality objectives • Existing environmental values related to water are protected
Corrective Actions	If the results of monitoring indicate water quality criteria are not met undertake one or all of the following: • Undertake investigation for any contaminant releases • Check erosion and sediment controls • Implement additional controls where required, such as pH correction or flocculation. Following testing, water that still does not meet the water quality criteria will be removed from site by a licenced contractor for disposal. • Notify administering authority within 24 hours of becoming aware of non-compliance or if: - Releases of any volume of contaminants to water - Releases of volumes of contaminants greater than 200 L of hydrocarbons to land - Releases of any volumes of contaminants where potential, serious or material - Environmental harm has occurred or may occur

16. Rehabilitation

16.1 Rehabilitation objective

The key objective of landscape and rehabilitation work is to ensure that all statutory requirements pertaining to rehabilitation and landscaping are met as part of the Marine Crossing GTP Project and disturbed areas re-established to a safe, non-polluting, stable and self-sustaining state.

16.2 Rehabilitation methodology

GLNG Operations have prepared a LRMP (refer Appendix E) which has been developed to provide details of rehabilitation management measures to be implemented during the construction, operation and decommissioning phases of the Marine Crossing GTP Project. The LRMP has been designed to act as a tool to guide GLNG Operations and the Construction Contractor with information about the regulations and guidelines applicable to the Project.

The LRMP is a live document and will be updated as required during all phases of the Project. It is designed to:

- Minimise the area of overall disturbance
- Create a stable landscape
- Guide a programme of comprehensive revegetation and rehabilitation for all disturbed areas
- Ensure revegetation and rehabilitation is undertaken in a timely manner
- Preserve downstream receiving environments
- Ensure compliance with relevant approval conditions specified by the CG Report, EPBC Act controlled action, EA and other environmental and planning approvals
- Ensure compliance with commitments under the EIS and the SEIS

A preliminary rehabilitation plan has been prepared and included in the LRMP (refer Appendix E). The preliminary rehabilitation plan identifies the site specific measures for the Marine Crossing GTP Project. A detailed site specific rehabilitation plan for the Marine Crossing GTP Project will be developed prior to commencing construction.

Table 16.1 identifies the landscaping and rehabilitation work proposed for the Marine Crossing GTP Project in order to meet the rehabilitation objectives described above.

Table 16.1 Proposed landscaping and rehabilitation works for the Marine Crossing GTP

Item	Outcome
Environmental protection objectives	• The Marine Crossing GTP Project disturbance footprint is restored and is compatible with the surrounding conditions and pre-construction land use and compatible with the pipeline's operation and/or adjoining land uses
Control strategies	**Pre-construction phase** • A detailed rehabilitation plan will be developed prior to commencing construction work in order to account for the collection of seeds in accordance with the LRMP. The plan will also detail site specific rehabilitation methods for each pre-existing vegetation type, plans and monitoring programmes demonstrating compliance with the LRMP and this EMP, all legal and regulatory conditions and soils management procedures. Seed collection will be planned to occur during the optimal times of the year for species to be collected under the Seed Collection Plan

Item	Outcome

	• Prior to clearing activities, fixed photo points at appropriate locations will be established and recorded on a map. These photo points will assist to:
	  - Determine the pre-clearing vegetation condition
	  - Monitor and assess the rehabilitation success throughout the Marine Crossing GTP Project
	Construction, operation and decommissioning phases – terrestrial trenched section
	• Progressive rehabilitation of disturbed areas will commence as soon as practicable following the completion of any construction or operational works associated with the authorised petroleum activities on the relevant petroleum authority
	• All land significantly disturbed by petroleum activities will be rehabilitated to:
	  - A stable landform with a self-sustaining vegetation cover with same species and density of cover to that of the surrounding undisturbed areas, with the exception of areas that must be maintained free of large flora species for pipeline integrity and access
	  - Ensure that all land is reinstated to the pre-disturbed land use and suitability class
	  - Ensure that the maintenance requirements for rehabilitated land are no greater than that required for the land prior to its disturbance by petroleum activities
	• For areas of native vegetation, revegetation will use seed sourced from local provenance native species
	• Subsoil will be respread and compacted over the trench and used for the construction of contour banks on steep slopes and above banks at water crossings
	• Areas of the ROW will be deep ripped prior to topsoil spreading in consultation with the landholder
	• The ROW will be re-profiled to original or stable contours, re-establishing surface drainage lines and other land features
	• Topsoil application will only take place after subsoil re-spreading and compaction and will be evenly spread and left with a slightly rough surface
	• Driving vehicles on freshly topsoiled ROW will be prohibited
	• Subsoil displaced by the pipe, and not utilised in backfill, may be stockpiled in locations approved by the landholder for use during operations
	• Flagging used to identify clearing boundaries and sensitive features will be removed in accordance with the LRMP (refer Appendix E)
	• Surface construction infrastructure within the ROW will be removed during the post construction rehabilitation work in accordance with the LRMP (refer Appendix E)
	• Erosion and sediment control measures will be installed in accordance with the SMESCP (refer Appendix C). Existing soil erosion measures will be reinstated to a condition at least equal to the pre-existing state
	• Where agreed to by the landholder, cleared native vegetation will be re-spread over the ROW to assist in the distribution of seed stock and provide shelter for fauna
	• Native groundcover and shrubs will be encouraged to revegetate to minimise habitat barrier effects in significant habitat areas
	• Operational safety requirements must be considered when determining rehabilitation criteria. Trees with large root balls (such as *Ficus sp*.) pose a risk to the structural integrity of buried infrastructure. To ensure compliance with AS2885 (part 3, section 6.4.4), vegetation will be restricted to allow free passage along the pipeline route. Vegetation species with roots that may damage the anti-corrosion coating of the GTP shall not be permitted in the vicinity if the pipeline (distance of >10 m from the GTP)

Item	Outcome
	• In order to ensure operational safety, vegetation species used to rehabilitate the ROW within 10 m of the GTP will be limited to species less than 10 m in height. In areas where RE communities are to be rehabilitated, understorey species and mid-level species of pre-disturbance RE communities will be returned to the ROW • Trees will be permitted to grow back on the ROW except in proximity to the GTP and on the travel lane • Environmental features such as rocks and dead timber will be replaced in the ROW where appropriate • The establishment of native vegetation will use natural regeneration as the preferred method in the first instance. This method relies on the soil seed bank, propagules in the soil and natural plant dispersal mechanisms for recolonisation of disturbed areas • Seeding will be utilised in areas where rapid restoration is required (eg watercourse crossings and areas of high erosion potential) • A reseeding plan based on soil types, existing local vegetation characteristics and landholder preferences will be developed • Where disturbed areas are to be re-planted or reseeded, preference will be given to local native species. However, non-native and non-invasive grass seed stock may be used where approved by the landholders to stabilise temporary banks/stockpiles and will be removed and re-established as native vegetation post construction unless stipulated in the landholder agreement • Rehabilitation must encourage the maximum re-establishment of native vegetation including the shrubby understorey and groundcover • Locally sourced species for rehabilitation will be used in riparian areas • Planting locations and densities for rehabilitation will comply with the LRMP • Rehabilitation work will incorporate the use of habitat/fodder trees for koalas and other key significant fauna species in the species selection in accordance with the LRMP (refer Appendix E), SMP (document number 3380-GLNG-3-1.3-0036) and SSMP (document number 3380-GLNG-3-1.3-0031) • Throughout rehabilitation work temporary drainage, and erosion and sediment control measures will be removed when they are no longer required in accordance with the SMESCP (refer Appendix C) • Wastes generated throughout rehabilitation will be managed and disposed in accordance with the waste and resource management hierarchy outlined in the WMP (refer Appendix F) • At the completion of construction on land identified as GQAL or potential Strategic Cropping Land, all temporary access tracks will be removed, land management and erosion control measures will be implemented and disturbed areas will be lightly ripped, topsoil replaced and surfaces returned to preconstruction land use condition • Sediment excavated from the base of watercourses prior to construction of the waterway barriers and watercourse crossing will be re-used during reinstatement work for the watercourse post-construction • Trees and shrubs will be allowed to regenerate naturally on cleared areas not required to be kept tree free for GTP protection and maintenance • In areas proposed for revegetation, seed will be evenly dispersed over the entire disturbed area through adopting approved methods in accordance with the LRMP (refer Appendix E) • Fertilisers and soil supplements will be used only as necessary. with the agreement of landholders and administering authorities • Permanent marker signs will be erected along the ROW • All waste materials and equipment will be removed from the ROW once backfilling and tie-ins are completed

Item	Outcome
	• Temporary access roads, ROW laydown areas and construction site pads will be closed and rehabilitated to a condition compatible with the surrounding land use or as agreed with the landholder • Where access routes are to be retained, but are not public access, the entry will be disguised (eg by dog-legging, brush spreading) • Fences or other barriers will be installed where appropriate and where approved by the landholder to minimise unauthorised access • Weather permitting, rehabilitation of areas containing Least Concern (including Type A) plants will begin within 3 months of completion of the Santos GLNG GTP construction. Revegetation will be consistent with the plant density, floristic composition and distribution of the surrounding regional ecosystem types and within the province of the vegetation being cleared, and in accordance with the LRMP (refer Appendix E)For clearing impacts that result in permanent loss of least concern native plants (cannot be re-established within 3 years of clearing or floristic modification), the Contractor must provide GLNG Operations with a written detailed report of permanent vegetation loss, including the area, species affected and mapping of affected areas, within 12 months of completion of the Santos GLNG GTP construction • Pasture areas will be re-sown with seed mix as agreed by GLNG Operations and adjoining land owners • Maintenance of seeded areas shall continue until: - At least an equivalent amount of ground cover has been achieved as in adjacent land over 95% of disturbed areas - Weed content is equivalent to or better than adjacent areas undisturbed by construction • Revegetation of cropland will generally not be required as landholders will have received compensation including re-sowing of disturbed areas • Areas vegetated with trees or shrubs on agricultural land will be revegetated with similar vegetation mix or with pasture as agreed with landowner • Roadside areas will be replanted in accordance with DTMR/Local Authority requirements and to the pre-construction standard or better • Native vegetation areas will be revegetated with like species from commercially available seed mixes or seeds collected in adjacent areas. Seed collection will be undertaken as per the Seed Collection Plan and in accordance with the seed collection guideline document: *Model Code of Practice, Florabank Guideline 6: Native Seed Collection Methods*, Available at http://www.florabank.org.au/ 5 Feb 2012', the LRMP (refer Appendix E), SMP (document number 3380-GLNG-3-1.3-0036) and SSMP (document number 3380-GLNG-3-1.3-0031) • ESAs as identified on the alignment sheets will be revegetated in accordance with the LRMP (refer Appendix E), SMP (document number 3380-GLNG-3-1.3-0036), SSMP (document number 3380-GLNG-3-1.3-00.31) and EA conditions as approved by the administering authority (DEHP) • Watercourse crossings will be rehabilitated in accordance with the AVMP, permits/approvals and construction specifications • For pasture areas rehabilitation will be undertaken so as: - An equivalent amount of ground cover to adjacent land has been achieved over 95% of disturbed areas - Weed content is less than adjacent areas undisturbed by construction • For native vegetation and stream areas rehabilitation will be undertaken so as: - Trees and shrubs are viable without further maintenance - Weed content is less than adjacent areas undisturbed by construction

Item	Outcome
	• Maintenance of rehabilitated areas will take place to ensure and demonstrate: - Stability of landforms - Erosion control measures remain effective - Stormwater runoff and seepage from rehabilitated areas does not negatively affect the environmental values of any waters - Plants show healthy growth and recruitment is occurring - Declared pest plants are controlled on rehabilitated areas to a level consistent with the surrounding property and prevented from spreading to unaffected areas through authorised petroleum activities • Rehabilitation can be considered successful when the site can be managed for its designated land use (either similar to that of surrounding undisturbed areas or as otherwise agreed in a written document with the landowner/holder and administering authority) without any greater management input than for other land in the area being used for a similar purpose and there is evidence that the rehabilitation has been successful for at least 3 years • Large tree species (eg >10 m in height) will be excluded from the area within 10 m of the GTP in order to protect the structural integrity of the pipeline • The tunnel launch shaft and tunnel receptor shaft will be backfilled, and soil will be compacted over the concrete at the bottom of the shaft to ensure minimal intrusive work of below ground infrastructure **Operational phase – The Narrows tunnelled section** • The tunnel will be flooded with sea water prior to operation to minimise the need for ongoing dewatering and maintenance works

16.3 Proposed decommissioning works

The overall rehabilitation objective at decommissioning is to rehabilitate land to a level consistent with the pre-disturbance land use activity and surrounding conditions.

As discussed in Chapter 2, decommissioning of the pipeline will be undertaken using the “in place” abandonment method, as this method has the least adverse environmental impact and will be undertaken in accordance with policies at the time of decommissioning and in line with best practice at the time. The various “in place” abandonment options that will be considered are:

- Abandon by air/inert gas displacement
- Abandon by water fill displacement
- Abandon ROW and above ground facilities

As the “in place” abandonment options identified above, result in minimal intrusive works during the decommissioning of below ground infrastructure. Rehabilitation works along the ROW will be undertaken in accordance with the LRMP (refer Appendix E). For the Marine Crossing tunnel, which will be flooded during the construction phase of the Marine Crossing GTP Project no specific decommissioning works are required.

Given there is no permanent above-ground infrastructure associated with the operation of the Marine Crossing GTP, no works will be required to remove permanent or ancillary plant, equipment, structures and buildings within this section at the time of decommissioning and abandonment.

During the decommissioning phase of the pipeline, vegetation with large root balls (ie trees greater than 10 m in height) will be re-established within the ROW. This type of vegetation will be restricted during the operational phase to protect the structural integrity of the pipeline. Revegetation of these species may be undertaken through passive (ie allow for the natural encroachment of the species) or active (ie planting/seeding) methods depending on best practice at the time of rehabilitation.

16.4 Rehabilitation completion criteria

Due to the variability in complexity of vegetation communities and use of different construction methodologies across the Marine Crossing GTP Project it is difficult to set criteria for determining when a site has been completely rehabilitated. In addition, the completion criteria will be dependent upon the land use prior to clearing, pre-existing health and integrity of the landscape and landholder requirements.

However, the aim is to rehabilitate impacted environs to their pre-existing condition (as a minimum). This is a particular prerequisite for all significant ecological communities, protected areas and other sensitive areas identified within the Marine Crossing GTP Project disturbance footprint.

In determining whether the completion criterion is met, the following factors will be used:

- The similarity between the rehabilitated landforms and the natural landforms in adjacent areas
- The stability of the landform and its resistance to erosion
- Whether appropriate drainage patterns have been developed, either naturally or through shaping activities during the rehabilitation programme
- The degree to which the surface conditions are conducive to plant establishment
- Whether the site conditions and existing habitat components provide resources, including for fauna movement, foraging habitat and/or shelter
- Compliance with the relevant standards
- Public safety issues (eg signage, fencing)

Table 16.2 provides a high level overview of the rehabilitation goals, objectives, indicators and completion criteria proposed for the Marine Crossing GTP Project.

The Construction Contractor will be responsible for implementing the LRMP (refer Appendix E).

Table 16.2 Rehabilitation goals, objectives, indicators and completion criteria

Rehabilitation goal	Rehabilitation objective	Indicators	Completion criteria
Safe	Site safe for humans	Landform similar to adjacent natural landforms	Land has been rehabilitated to its predevelopment stability condition
Non-polluting	No adverse impact to land and water quality values	All erosion and sediment control features implemented and functional Surface water monitoring	Erosion controlled and limited to that associated with natural processes Water quality monitoring meets release limits
Stable	Minimise erosion and sediment movement	Landform similar to adjacent natural landforms Vegetation cover	No subsidence or areas of major erosion Within 20 days after completion the minimum coverage for all erodible surfaces is 70%[1] and compliance with SMESCP

Rehabilitation goal	Rehabilitation objective	Indicators	Completion criteria
Self-sustaining	Construction areas are rehabilitated to a self-sustaining level	Surface conditions are conducive to plant establishment	At the end of year 2: • A minimum of 80% of planted stock have survived • Fast growing shrubs have achieved an average height of 1.0 m • Slow to medium growing shrubs have achieved an average height of 0.7 m • A minimum of 70% of mulched planting areas are free of weeds

Table note: 1 IECA, 2008 Best Practice Erosion and Sediment Control

16.5 Inspections and reporting

The following inspection schedules are proposed for the Marine Crossing GTP Project:

- Once rehabilitation has commenced, regular inspections will be carried out to monitor watering requirements (eg daily between rainfall events >10 mm) within rehabilitation areas for a period of 3 months. Weekly inspections will then commence for a further period of 6 months
- Where applicable, weekly inspections will also be conducted to monitor and record the success of planting regimes for a period of 6 months after plantings have commenced
- Bi-monthly photographs will be taken from the identified fixed photo monitoring points to determine the success or otherwise of the landscaping and rehabilitation works. These will be included in the monthly environmental report. This will be carried out for a minimum of 3 years after plantings have commenced

A monitoring and evaluation report will be prepared and will include details on species survival, natural recruitment, percentage coverage of the rehabilitation area and percentage and species of weeds in the rehabilitated areas. In addition, the following will also be recorded:

- Planning and impact assessment details
- Activity site location and site access details
- Commencement and completion dates
- The area of native vegetation removed, and the amounts of material excavated and fill placed
- The disposal location/s and quantity of spoil material removed
- The disposal location/s and quantity of native vegetation removed
- Impact management and rehabilitation details
- Before, during and post activity photographs of the site
- Any incidents of unanticipated failure of management methods and subsequent remedial action
- Any notable fauna activity will also be recorded

Where there is a permanent loss of native vegetation (cannot re-establish within 3 years of clearing or floristic modification), a written detailed report of permanent vegetation loss, including the area, individuals species affects and mapping of affected areas will be provided to DEHP.

16.6 Offsets

In accordance with the conditions of the CG Report and the EPBC Act approvals, GLNG Operations will develop an Environmental Offset Plan for the Project.

The Plan will outline the key approval requirements as they relate to the Marine Crossing GTP Project, impacts to significant vegetation communities and biodiversity as a result of the construction of the marine crossing and describe their associated offset requirements under both Queensland and Australian Government offset policies. The Offset Plan will also identify a suitable property to satisfy the offset requirements of the marine crossing and describe the:

- Details of the offset areas, including maps, and their connectivity with other habitats and biodiversity corridors
- Site descriptions and proposed rehabilitation programs
- Timing and arrangement for property acquisition
- Mechanisms for long term protection, conservation and management of the offset areas

16.6.1 Offset requirements

The EIS and SEIS outlined the proposed route alignment and construction methodology for the Santos GLNG GTP that was determined on a “Base Case” route alignment. The Santos GLNG GTP requires a broad range of environmental offsets for a diverse suite of environmental values. This is due to the extent of the geographic area that the Santos GLNG GTP spans and the diversity of ecosystems and habitats proposed to be impacted.

The offset requirements for the Marine Crossing GTP (and the remainder of the Santos GLNG GTP) have been estimated by Ecofund. These requirements are based on the following considerations:

- The environmental impacts from the construction of the GTP recorded in the EIS and SEIS
- The offset ratios provided in the EPBC Act approval
- The Queensland Government offset policies, including:
  - Vegetation management offsets under the Policy for vegetation management offsets (2009) under the VM Act
  - Protected flora and fauna offsets under *Nature Conservation (Protected Plants) Conservation Plan 2000* (Qld) under the NC Act
  - Marine plants and fisheries habitat offsets under the Mitigation and Compensation for Works and Activities Causing Marine Fish Habitat Loss 2002
  - Biodiversity offsets under the Draft Policy for Biodiversity Offsets 2008
  - Environmental offsets under the Draft Policy Statement: Use of environmental offsets under the EPBC Act

Table 16.3 shows the final ratios used to determine the offset requirements for the various protected matters potentially impacted by the proposed marine crossing (and the greater area of the Santos GLNG GTP).

Table 16.3 Ratios used to determine offset requirements

Protected matter	Offset ratio	Source
VM Act		
All values	1:1	CG Report
NC Act (flora)		
Near threatened	3:1	Offset rules for clearing of protected plant under the NC Act
Vulnerable	3.5:1	
Endangered	5:1	
NC Act (fauna)		
Near threatened	2:1 – 3:1	Appendix 2 draft *Policy for Biodiversity Offsets 2008*
Vulnerable	2.5:1 – 3.5:1	
Endangered	4:1 – 5:1	
Fisheries Act 1994		
All values	1:1	CG Report
EPBC Act		
Endangered ecological community	8:1	EPBC Act approval conditions
Endangered flora	6:1	
World heritage values	5:1	
Migratory birds	8:1	
Vulnerable reptiles	8:1	
Vulnerable birds	8:1	
Endangered birds	8:1	
Vulnerable mammals	8:1	
Endangered mammals	8:1	

Where offsets are required under more than one policy, where possible, a single offset will be secured to meet multiple policy requirements. Similarly, where possible, multiple offset requirements under a single offset policy will be acquitted with a single offset property.

16.6.2 Summary of offset requirements

Since the EIS and EPBC Act controlled action approvals for the Santos GLNG GTP, the pipeline route has been further refined and detailed pre-clearing surveys have been undertaken along the proposed ROW to map ESAs, remnant ecosystems, threatened ecological communities, identify essential habitat areas for listed species and potential impacts to protected flora and fauna species. In addition, the construction methodology has been amended for the marine crossing of the Kangaroo Island wetlands and The Narrows. The new tunnelling construction methodology will significantly reduce the impacts to both State and Commonwealth biodiversity values.

16.6.3 Strategic offset proposal

QCLNG, Santos GLNG and Australia Pacific LNG (the LNG proponents) are proposing to collaboratively secure a strategic offset property on Curtis Island to acquit environmental offset requirements for the LNG plants and marine facilities on Curtis Island, the respective GTP ROWs on Curtis Island, and the GTP Marine Crossing across the Kangaroo Island wetlands and The Narrows. Ecofund QLD will prepare a joint submission on behalf of the three LNG proponents.

17. References

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Abbreviations

Abbreviation	Description
$	Australian dollars
%	Percent
”	Inch
>	Greater than
AASS	Actual Acid Sulfate Soils
ABS	Australian Bureau of Statistics
ACHA	*Aboriginal Cultural Heritage Act 2003*
AFC	Approved for construction
AIM	Audit and Inspection Manager
AOPC	Area of Potential Concern
APIA	Australian Pipeline Industry Association
APIA Code	*Australian Pipeline Industry Association Code of Environmental Practice for Onshore Pipelines*
APLNG	Australia Pacific Liquefied Natural Gas
ARCS	Australian Rainforest Conservation Society
AS	Australian Standard
AS/NZS	Australian Standard/New Zealand Standard
ASS	Acid Sulfate Soils
ASSMP	Acid Sulfate Soil Management Plan
AVA	Aquatic Values Assessment
AVMP	Aquatic Values Management Plan
BAAM	Biodiversity Assessment and Management
BGL	Below Ground Level
BoM	Bureau of Meteorology
BPA	Biodiversity Planning Mapping
BS	British Standards
CAEMP	Contractors Award Environmental Management Plan
CAMBA	China-Australia Migratory Bird Agreement
CCRCMP	Curtis Coast Regional Coastal Management Plan
CEC	Cation Exchange Capacity
CEMP	Construction Environmental Management Plan
CFISH	Commercial Fisheries Information System
CG	Coordinator General
CH_4	Methane
CHMP	Cultural Heritage Management Plan
CHRIS	Coastal Habitat Resources Information System
CLR	Contaminated Land Register
cm	Centimetre
CMP	Construction Management Plan
CMS	Compliance Management System
CO_2	Carbon dioxide
$CO_{2\text{-}e}$	Carbon dioxide equivalents

Abbreviation	Description
CPIC	Common Pipeline Infrastructure Corridor
CSG	Coal Seam Gas
CSIRO	Commonwealth, Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry
dB	Decibel
dBA	Decibel A filter
DEEDI	Department of Employment, Economic Development and Innovation
DEHP	Department of Environment and Heritage Protection
DERM	Department of Environment and Resource Management
DEWHA	Department of Environment, Water, Heritage and the Arts
DEWS	Department of Energy and Water Supply
DHLGP	Department of Housing, Local Government and Planning
DHWLRMP	Dewatering, Hydrotest Water and Land Release Management Plan
DIP	Department of Infrastructure and Planning (now DSDIP)
DIN	German Standards
DIWA	Directory of Important Wetlands in Australia
DLGP	Department of Local Government and Planning
DMP	Dredge Management Plan
DNPRSR	Department of National Parks, Recreation, Sports and Racing
DNRM	Department of Natural Resources and Mines
DP	Decommissioning Plan
DPA	Dugong Protection Area
DPI&F	Department of Primary Industries and Fisheries (now DAFF)
DSDIP	Department of State Development, Infrastructure and Planning
DTMR	Department of Transport and Main Roads
E	Endangered
EA	Environmental Authority
EC	Electrical Conductivity
EHS	Environmental, Health and Safety
EHSMS	Environment, Health and Safety Management System
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMR	Environmental Management Register
EMS	Environmental Management System
EO	Environmental Officer
EP Act	*Environmental Protection Act 1994*
EP Reg	*Environmental Protection Regulation 2008*
EP(WM) Reg	*Environmental Protection (Waste Management) Regulation 2000*
EPB	Earth pressure balance
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPM	Exploration Permit (Minerals)
EPP Air	*Environmental Protection (Air) Policy 2008*
EPP Water	*Environmental Protection (Water) Policy 2009*

Abbreviation	Description
ERA	Environmentally Relevant Activity
ERP	Emergency Response Plan
ESA	Environmentally Sensitive Area
ESC	Erosion and Sediment Controls
ESP	Exchangeable Sodium Percentage
EVNT	Endangered, Vulnerable and Near Threatened
FA	Financial Assurance
FBE	Fusion bonded epoxy
FEC	Footprints Environmental Consultants
FHA	Fish Habitat Area
GBR Coast MP	Great Barrier Reef Coast Marine Park (Qld)
GBRR	Great Barrier Reef Region
GBRMP	Great Barrier Reef Marine Park (Cth)
GBRMPA	Great Barrier Reef Marine Park Authority
GBRWHA	Great Barrier Reef World Heritage Area
GHG	Greenhouse Gas
GLNG	Gladstone Liquefied Natural Gas
GPC	Gladstone Port Corporation
GPS	Global Positioning System
GQAL	Good Quality Agricultural Land
GRC	Gladstone Regional Council
GSDA	Gladstone State Development Area
GTP	Gas Transmission Pipeline
h	Hour
H_2S	Hydrogen Sulphide
ha	Hectares
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HERBRECS	Queensland Herbarium Plant Specimen Database
HSSM	Health Safety and Security Management Plan
HTMP	Hydrostatic Testing Management Plan
Hz	Hertz
IEA	International Energy Agency
ILUA	Indigenous Land Use Agreement
IMP	Integrity Management Plan
IMS	Incident Management System
JAMBA	Japan-Australia Migratory Bird Agreement
kg	Kilograms
km	Kilometres
LAT	Lowest Astronomical Tide
LC	Least Concern
LGA	Local government area
LNG	Liquefied Natural Gas

Abbreviation	Description
LP Act	*Land Protection (Pest and Stock Route Management) Act 2002*
LPG	Liquid Petroleum Gas
LRMP	Landscape Rehabilitation Management Plan
L/s	Litres per second
m	Metres
M	Million
Ma	Marine
MAOP	Maximum allowable operating pressure
MHWS	Mean High Water Springs
Mi	Migratory
ML	Megalitres
mm	Millimetres
MMMP	Mosquito and Midge Management Plan
MNES	Matters of National Environmental Significance
MPa	Megapascals
MSDS	Material Safety Data Sheet
Mt	Million tonnes
Mtpa	Million tonnes per annum
MTSC	Materials Transportation Services Corridor
N/A	Not applicable
NATA	National Association of Testing Authorities
NC Act	*Nature Conservation Act 1992*
NCPA Reg	*Nature Conservation (Protected Areas) Regulation 1994*
NDT	Non-destructive Testing
NGA	National Greenhouse Accounts
NGL	Natural Ground Level
NIC	Northern Infrastructure Corridor
NO_x	Nitrogen Oxides
NRM&E	Department of Natural Resources, Management and Energy
NRMW	Department of Natural Resources, Mines and Water
NRW	Department of Natural Resources and Water
NT	Near Threatened
OC	Of Concern
OH&S	Occupational Health and Safety
OMP	Operational Management Plan
P&G Act	Petroleum and Gas (Production & Safety) Act 2004
PASS	Potential Acid Sulfate Soil
PCCC	Port Curtis Coral Coast
PCIMP	Port Curtis Integrated Monitoring Program
pH	Potential of Hydrogen
PJ	Petrajoules
PM_{10}	Particulate Matter >10 µm
PPL	Petroleum Pipeline Licence
ppm	Parts Per Million

Abbreviation	Description
ppv	Peak Particle Velocity
PSI	Preliminary Site Investigation
PSL	Petroleum Survey Licence
PWMP	Pest and Weed Management Plan
QAL	Queensland Alumina Limited
QCLNG	Queensland Curtis Liquefied Natural Gas
QGP	Queensland Gas Pipeline
QHR	Queensland Heritage Register
Qld	Queensland
QLUMP	Queensland Land Use Mapping Program
QPIF	Queensland Primary Industries and Fisheries
QPS	Queensland Police Service
QR	Queensland Rail
QWSG	Queensland Wader Study Group
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database
RNE	Register of the National Estate
RoKAMBA	Republic of Korea-Australia Migratory Bird Agreement
ROW	Right of Way
RUMP	Road Use Management Plan
RUSLE	Revised Universal Soil Loss Equation
s	Second
Safety IMP	Safety Incident Management Plan
SALNG	The Shell CSG (Australia) Pty Ltd LNG
SAP	Special Area Plans
SCADA	Supervisory Control and Data Acquisition
SD	Statistical Division
SDPWO Act	*State Development and Public Works Act 1971*
SEIS	Supplementary Environmental Impact Statement
SEPM	Santos Environmental Pipeline Manager
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SIA	Social Impact Assessment
SIMP	Social Impact Management Plan
SLA	Statistical Local Areas
SMESCP	Stormwater Management and Erosion and Sediment Control Plan
SMP	Species Management Plan
SPP	State Planning Policy
SSMP	Significant Species Management Plan
TAF	Temporary Accommodation Facility
TBM	Tunnel Boring Machine
TCL	Transpacific Cleanaway Ltd
TEC	Threatened Ecological Community
TSP	Total Suspended Particles

Abbreviation	Description
TSS	Total Suspended Solids
Type A	Type A restricted plant under the provisions of the NC Act
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USL	Unallocated State Land
VM Act	*Vegetation Management Act 1999*
WHA	World Heritage Areas
WHMA	World Heritage Management Area
WMMP	Water Mouse Management Plan
WMP	Waste Management Plan
WMRC	Waste Management and Recycling Contractor
WONS	Weeds of National Significance
WRR Act	*Waste Reduction and Recycling Act 2011*
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

Appendix E
Landscape and Rehabilitation Plan (LRMP)

GLNG Project

Landscape Rehabilitation Management Plan for the GLNG Gas Transmission Pipeline Corridor

Document Number: 3380-GLNG-3-1.3-0037

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Table of Contents

1. Introduction

1.1 Background and context

The GLNG project involves the development of coal seam gas resources in the Bowen and Surat Basins around Roma, construction of a pipeline from the gas fields to the coast, and construction of up to three processing trains at a liquefied natural gas (LNG) plant and export facility on Curtis Island, off Gladstone.

On 16 July 2007, the Coordinator-General declared the Project to be a 'significant project' for which an environmental impact statement (EIS) is required in accordance with Part 4 of the *State Development and Public Works Organisation Act 1971* (Qld).

Following the preparation of the EIS and the SEIS, the CG Report for the GLNG Project was issued in May 2010, and the approvals of the four relevant referred components were granted under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Cth) in October 2010.

This Landscape Rehabilitation Management Plan (LRMP) has been prepared in accordance with the following conditions outlined in the CG Report, the EPBC Act approval and the DERM Environmental Authority.

<u>CG Report conditions</u>
- Appendix 3 - Gas Pipeline, Part 2 – General Conditions
  - Condition 3
  - Condition 17
- Appendix 3 – Gas Pipeline, Part 3 & 4 – Environmental Conditions
  - Condition 1(d)
  - Condition 3(d)
  - Condition 4(f-g)
  - Condition 5(a & e)
  - Schedule E14.7, E30-E36
  - Schedule J

<u>EPBC Act approval conditions</u>
- Condition 3a
- Condition 3d
- Condition 8(e)i

<u>DERM Environmental Authority No.: PEN102664411</u>
- Schedule E30 – E36
- Schedule H
- Schedule J22-J24

1.2 Purpose of this plan

This LRMP is applicable to the Gas Transmission Pipeline (GTP) component of the Project which commences approximately 40km east of Injune, then travels north along the eastern side of Arcadia Valley. The GTP will approach Gladstone from the south-west through the Callide Infrastructure Corridor State Development Area (CICSDA) and the Gladstone State Development Area (GSDA) before crossing Port Curtis between Friend Point and Laird Point to Curtis Island and the proposed LNG Facility. A number of associated ancillary sites comprising accommodation camps and stockpile facilities, in addition to access tracks and roads will be constructed and are also addressed within this LRMP.

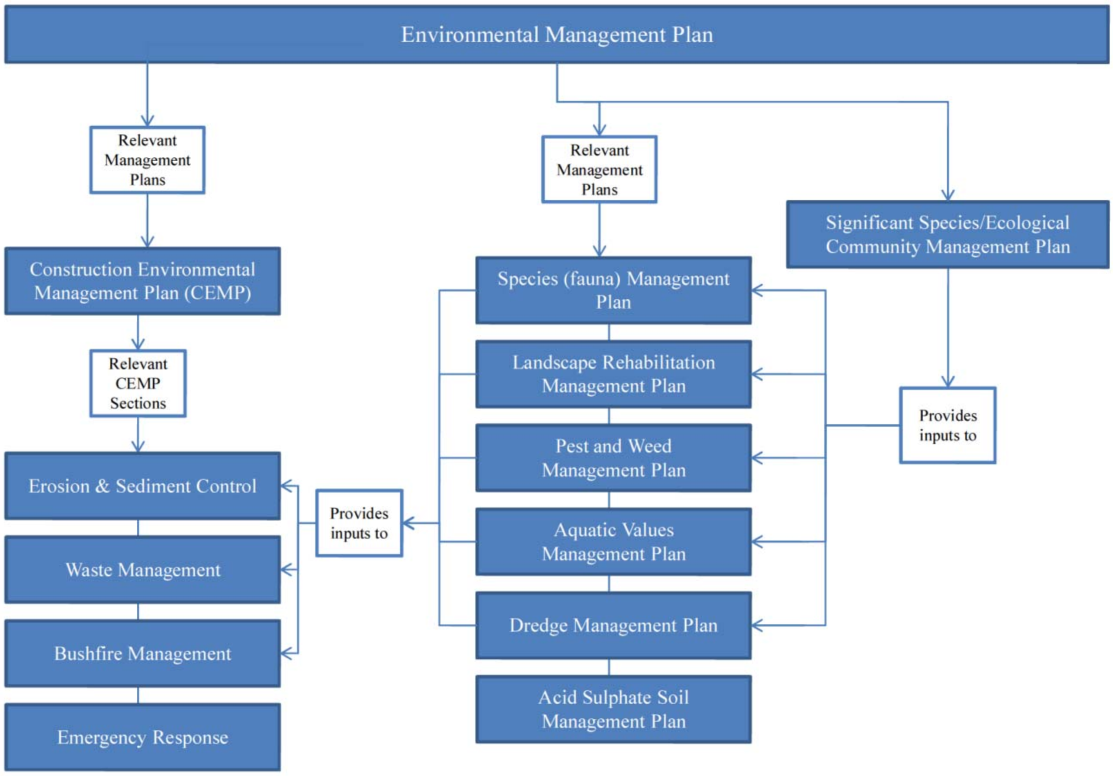
The purpose of this LRMP is to provide management measures to be implemented during and post construction of the GTP Corridor to rehabilitate the GTP Right of Way (ROW) to meet relevant approval conditions.

The LRMP will act as a tool to assist both the proponent and the Principal Contractor in determining the extent of compliance required by Principal Contractor's staff and sub-contractors with regards to the regulations and guidelines applicable to the GLNG pipeline project.

The LRMP is a live document and will be updated as required during construction of the Project. It is designed to:

- Minimise area of overall disturbance;
- Create a safe, stable and non-polluting landform;
- Undertake a comprehensive revegetation and rehabilitation program of all disturbed areas;
- Revegetation and rehabilitation undertaken in a timely manner;
- Preservation of downstream receiving environments;
- Ensure compliance with relevant approval conditions specified by the Coordinator-General, the Department of Environment and Resource Management (DERM), Queensland Primary Industries and Fisheries (QPIF) and DSEWPC; and
- Ensure compliance with commitments under the EIS and SEIS.

1.2.1 Relationship between this plan and other GTP Corridor Management Plans



2. Legislative and Regulatory Framework

It should be noted that the information provided in this plan regarding relevant legislation, policies, regulations, standards and guidelines might not be a complete representation of all statutory requirements relevant to landscaping and rehabilitation practices. It is the responsibility of Contractors to determine all statutory and other requirements relevant to their package of works.

2.1 Applicable Legislation

The rehabilitation and landscaping of disturbed areas are not legislated under any one specific Act. However, it is enforced by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC)[1], Department of Environment and Resource Management (DERM)[2] and the Department of Employment, Economic Development and Innovation (DEEDI)[3], often as a condition outlined in approvals for the disturbance and/or clearing of native vegetation.

Key environmental legislation relating to the LRMP includes the following:

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Nature Conservation Act 1992*
- *Nature Conservation (Wildlife) Regulation 2006*
- *Nature Conservation (Protected Plants) Conservation Plan 2000*
- *Nature Conservation (Protected Areas) Regulation 1994*
- *Nature Conservation (Koala) Conservation Plan 2005*
- *Nature Conservation (Forest Reserves) Regulation 2000*
- *Fisheries Act 1994*
- *Fisheries Regulation 2008*
- *Land Protection (Pest and Stock Route Management) Regulation 2003*
- *Great Barrier Reef Marine Park Act 1975*
- *Great Barrier Reef Marine Park Amendment Act 2007*
- *Animal Care and Protection Act 2001*
- *Coastal Protection and Management Act 1995*
- *Environmental Protection Act 1994*
- *Marine Parks Act 1982*
- *Water Act 2000*
- *Vegetation Management Act 1999*
- *Petroleum and Gas (Production and Safety) Act 2004*
- *Land Protection (Pest and Stock Route Management) Act 2002*

2.1.1 Policies, Standards and Guidelines

Activities will be undertaken in consideration of the relevant components of the following industry Codes of Practice:

- Australian Petroleum Production and Exploration Association's (APPEA) Code of Environmental Practice (2008); and
- Australian Pipeline Industry Association's (APIA) Code of Environmental Practice (Operations) (2005).

Relevant standards include:

- Australian Standard 4801:2000 Occupational Health and Safety Management Systems – Specification with guidance for use, and AS/NZS ISO 14001:1996 Environmental Management Systems;
- AS2885.1-1997 Gas and Liquid Petroleum - Design and Construction;
- Road Landscape Manual (Department of Main Roads (DMR), 2004) available for download from http://www.mainroads.qld.gov.au/. Consultation with the Project civil engineers and landscape architects is recommended when referring to this document;
- Ergon Energy has requirements pertaining to the amount of clearance required both under and directly adjacent to existing powerlines. This information is available for download at http://www.ergon.com.au/;
- These guidelines will be followed as a minimum around all powerlines regardless of ownership;
- Riparian Land Management Technical Guidelines Volumes 1 and 2 (Lovett & Price 2002);
- A Rehabilitation Manual for Australian Streams Volumes 1 And 2 (Rutherford *et al*. 2000);
- Guidelines for Protecting Australian Waterways (Bennett *et al.* 2002);
- Principles of Riparian lands Management (Lovett & Price 2007); and
- Code of Environmental Practice – Onshore Pipelines (APIA 2005).

[1] Formerly the Department of Environment, Water, Heritage and the Arts.
[2] Formerly the Environmental Protection Agency and the Department of Natural Resources and Water.
[3] Formerly the Department of Primary Industries and Fisheries.

- Soil Erosion and Sediment Control - Engineering Guidelines for Queensland Construction Sites (Institution of Engineers Australia 1996)
- Saltwater Wetland Rehabilitation Manual (Department of Environment and Climate Change 2008)
- Wetland Rehabilitation Guidelines for the Great Barrier Reef catchment (WetlandCare Australia 2008)
- Santos EHSMS Standards as per the CEMP.

2.2 EIS Commitments and Approval Conditions

In addition to the commitments outlined within the EIS and SEIS, this Plan will need to adopt any relevant statutory approval conditions. As of November 2010, this Plan has addressed all commitments within the EIS/SEIS and all relevant approval conditions determined by the Co-ordinator General.

2.2.1 Approvals, Licenses and Permits

A Coordinator-General's Report was provided for the Project in May 2010. Additional approvals/permits applicable to LRMP are as follows:

- Permit to collect seed / cuttings from a threatened species outside the corridor (NC Act);
- Permit to clear native vegetation (NC Act);
- Permit to clear marine plants (Fisheries Act);
- Licence to construct a waterway barrier within a defined watercourse;
- Environment Authority for the Pipeline Licence; and
- EPBC Act Approval.

2.3 Offsets Package

An Environmental Offset proposal for the GLNG Project has been developed by Ecofund Queensland on behalf of the Proponent. The proposal outlines the environmental offset requirements for each component of the Project under both Queensland and Australian Government offset policies. The extent of offsets was based on information contained in the EIS and SEIS. The Package also included options for offset delivery and examples of properties that may be suitable to meet the identified offset requirements.

3. Environmental Management Framework

3.1 Santos Environment Health, Safety and Management System (EHSMS)

This section provides an introduction to the EHSMS for operations. An overview of the Santos EHSMS is provided together with further information on key components of the system considered to be specifically relevant to the construction of the pipeline.

The framework has been developed to ensure compliance with Australian Standard 4801:2000 Occupational Health and Safety Management Systems – Specification with guidance for use, and AS/NZS ISO 14001:1996 Environmental Management Systems – Specification with guidance for use. The Santos EHSMS applies to all Santos operations.

3.2 Overall EHSMS Structure

The EHSMS framework consists of multiple layers, the key components being management and hazard standards.

The documents that make up each level of the EHSMS are maintained in electronic form on a central server (The Well) that is accessible to all GLNG employees.

3.3 EHSMS Management Standards

Management Standards are documents which define the requirements necessary to ensure that environmental, health and safety risk is systematically managed. Management standards have been developed as part of the EHSMS.

3.4 EHSMS Hazard Standards

Hazard Standards detail the controls required to manage the risks of specific hazards to acceptable levels. These apply to all Santos operations. They contain specific requirements for planning and undertaking activities and include checklists and references to internal and external approvals and controls.

4. Existing Environment

4.1 Flora

The design of the GTP RoW has considered the ecological values of the vegetation communities and habitat within and adjacent to the footprint. This has been achieved by positioning the GTP in areas which have already been historically cleared for agricultural activities or, where possible, co-positioning the GTP adjacent to existing linear infrastructure, such as the existing Jemena Gas Pipeline where it traverses remnant vegetation communities.

State Forests and Timber Reserves directly impacted by the GTP include the Expedition State Forest, Callide Timber Reserve and Targinie State Forest (refer to mapping provided within the SSMP for specific locations).

4.1.1 Species

As part of the GLNG EIS process, flora assessments of the mainland component of the GTP RoW were undertaken in 2008. The surveys identified the presence of approximately 320 flora species within the GTP RoW.

Additional surveys undertaken in 2010 targeted significant flora species (EPBC Act and *Nature Conservation Act 1992* [NC Act] listed Endangered, Vulnerable, Near Threatened [EVNT]; and NC Act Type A Restricted Plants) and ecological communities (including *Vegetation Management Act 1999* [VM Act] listed Endangered and Of Concern Regional Ecosystems [REs] and EPBC listed Threatened Ecological Communities [TECs]). These surveys resulted in the detection of an additional 14 significant plant species.

The majority of the species identified from the GTP RoW during the 2008/2010 survey periods are listed as Least Concern under the provisions of the NC Act and are not listed under the provisions of the EPBC Act. However, a number of conservation significant flora (ie Type A restricted plants and EVNT species), including *Cycas megacarpa* (Cycad), *Gonocarpus urceolatus* (Raspweed), *Acacia gittinsii* (Gittin's wattle) and *Solanum johnsonianum* (NCN) are known to occur within the Project footprint.

The EIS and SEIS surveys also noted a number of introduced weed species, of which 10 are declared species under the *Queensland Land Protection (Pest and Stock Route Management) Act 2002* (LP Act). Three of the species observed (*Cryptostegia grandiflora* [Rubber vine], *Lantana camara* [Lantana] and *Parthenium hysterophorus* [Parthenium weed] are also listed as Weeds of National Significance (WONS) under the provisions of the EPBC Act.

A summary of the vegetation communities, associated habitats and identified flora present within the GTP RoW is available in the EIS, SEIS, SSMP and the Weed Management Plan (WMP).

4.1.2 Regional Ecosystems

The majority of the Project area (approximately 80%) has been historically cleared for agriculture, and as such, a large portion of the GTP is considered pastoral grazing land (Fairview, Arcadia Valley and Calliope) or irrigated cropping (Zamia, Mimosa and Dawson catchments).

However, the GTP RoW also intercepts areas mapped as remnant vegetation under DERM's RE Mapping (approximately 60 RE communities). This includes REs which are also listed as TECs under the provisions of the EPBC Act. Table 1 outlines RE communities present within the GTP RoW.

Table 4.1 Regional Ecosystems within the GTP ROW

RE Code	RE Description
11.1.2	Very sparse samphire forbland on marine clay plains.
11.1.4	Mid-dense mangrove forest/woodland on marine clay plains.
11.3.1/11.3.2	Mid-dense *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains and sparse *Eucalyptus populnea* woodland on alluvial plains.
11.3.2	Sparse *Eucalyptus populnea* woodland on alluvial plains.
11.3.2/11.3.4/11.3.25	Sparse *Eucalyptus populnea* woodland on alluvial plains, sparse *E.tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains and mid-dense *E. tereticornis* or *E. camaldulensis* woodland fringing drainage lines.
11.3.2/11.3.25	Sparse *Eucalyptus populnea* woodland on alluvial plains and mid-dense *E. tereticornis* or *E. camaldulensis* woodland fringing drainage lines.
11.3.2/11.3.39	Sparse *Eucalyptus populnea* woodland on alluvial plains and sparse *E.melanophloia* +/- *E. chloroclada* open-woodland on undulating plains and valleys with sandy soils.
11.3.3/11.3.4	Sparse *E.coolabah* woodland on alluvial plains and sparse *E.tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.
11.3.4/11.3.25	Sparse *E.tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains and mid-dense *E. tereticornis* or *E. camaldulensis* woodland fringing drainage lines.
11.3.4/11.3.26	Sparse *E.tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains and mid-dense *E.moluccana* or *E.microcarpa* woodland to open forest on margins of alluvial plains.
11.3.4/11.3.26/11.11.15	Sparse *E.tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains, mid-dense *E.moluccana* or *E.microcarpa* woodland to open forest on margins of alluvial plains and sparse *E.crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics.
11.3.4/11.8.4	Sparse *E.tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains and sparse *E.melanophloia* woodland on Cainozoic igneous rocks (hillsides).
11.3.17	Sparse *E.populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains.
11.3.25	Mid-dense *E. tereticornis* or *E. camaldulensis* woodland fringing drainage lines.
11.3.25/11.11.4/11.11.15	Mid-dense *E. tereticornis* or *E. camaldulensis* woodland fringing drainage lines, sparse *E.crebra* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges and sparse *E.crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics.
11.3.26	Mid-dense *E.moluccana* or *E.microcarpa* woodland to open forest on margins of alluvial plains.
11.4.8	Mid-dense *E.cambageana* woodland to open forest with *Acacia harpophylla* or *Acacia argyrodendron* on Cainozoic clay plains.
11.4.9	Mid-dense *Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains.
11.5.2	Sparse *E.crebra, Corymbia* spp., with *E. moluccana* on lower slopes of Cainozoic sand plains/remnant surfaces.
11.5.2/11.9.1	Sparse *E.crebra, Corymbia* spp., with *E. moluccana* on lower slopes of Cainozoic sand plains/remnant surfaces and mid-dense *Acacia harpophylla-E.cambageana* open forest to woodland on fine-grained sedimentary rocks.
11.5.5	Sparse *E.melanophloia, Callitris glaucophylla* woodland on Cainozoic sand plains/remnant surfaces (deep red sands).
11.8.4	Sparse *E.melanophloia* woodland on Cainozoic igneous rocks (hillsides).
11.8.4/11.10.1	Sparse *E.melanophloia* woodland on Cainozoic igneous rocks (hillsides) and mid-dense *Corymbia citriodora* open forest on coarse-grained sedimentary

RE Code	RE Description
	rocks.
11.9.1/11.9.5	Mid-dense *Acacia harpophylla-E.cambageana* open forest to woodland on fine-grained sedimentary rocks and mid-dense *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks.
11.9.5/11.10.1	Mid-dense *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks and mid-dense *Corymbia citriodora* open forest on coarse-grained sedimentary rocks.
11.9.5	Mid-dense *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks.
11.10.1	Mid-dense *Corymbia citriodora* open forest on coarse-grained sedimentary rocks.
11.10.1/11.10.13	Mid-dense *Corymbia citriodora* open forest on coarse-grained sedimentary rocks and mid-dense *Eucalyptus* spp. and/or *Corymbia* spp. open forest on scarps and sandstone tablelands.
11.10.13	Mid-dense *Eucalyptus* spp. and/or *Corymbia* spp. open forest on scarps and sandstone tablelands.
11.11.3/11.11.15/11.11.18	Mid-dense *Corymbia citriodora, E.crebra, E.acmenoides* open forest on old sedimentary rocks with varying degrees of metamorphism and folding (coastal ranges), sparse *E.crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics and dense semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding.
11.11.4/11.11.15	Sparse *E.crebra* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges and sparse *E.crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics.
11.11.15/11.11.18	Sparse *E.crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics and dense semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding.
11.12.1/11.12.6	Sparse *E.crebra* woodland on igneous rocks and mid-dense *Corymbia citriodora* open forest on igneous rocks (granite).
12.1.3	Dense mangrove shrubland to low closed forest on marine clay plains and estuaries.
12.3.3/12.3.7	Mid-dense *E.tereticornis* woodland to open forest on alluvial plains and mid-dense *E.tereticornis, Melaleuca viminalis, Casuarina cunninghamiana* fringing forest.
12.3.7/12.3.11	Mid-dense *E.tereticornis, Melaleuca viminalis, Casuarina cunninghamiana* fringing forest and mid-dense *E. tereticornis, E.siderophloia, Corymbia intermedia* open forest on alluvial plains near coast.
12.11.6	Mid-dense *Corymbia citriodora, E.crebra* open forest on metamorphics +/- interbedded volcanics.
12.11.6/12.11.14	Mid-dense *Corymbia citriodora, E.crebra* open forest on metamorphics +/- interbedded volcanics and sparse *E.crebra, E. tereticornis* woodland on metamorphics +/- interbedded volcanics.

Refer to the SSMP for detailed information on significant ecological communities present within the GTP ROW as well as mapping highlighting the location of each RE and its status within the GTP ROW.

4.2 Fauna

As part of the EIS process, fauna assessments of the mainland component of the GTP RoW were undertaken in 2008. During the survey periods, a total of 98 native and 8 introduced fauna species were identified from the GTP RoW. Additional surveys undertaken in 2010 detected an additional 220 native and 4 introduced fauna species within, and adjacent to, the GTP RoW.

The majority of the fauna species identified from the GTP RoW are listed as Least Concern under the provisions of the NC Act, and are not listed under the provisions of the EPBC Act. However, there are a number of EVNT fauna species known within the Project footprint, including the Powerful owl (*Ninox strenua*), Squatter pigeon

(*Geophaps scripta scripta*), Golden-tailed gecko (*Strophurus taenicauda*) and Brigalow scaly-foot (*Paradelma orientalis*).

Further detail regarding the EVNT species known or likely to occur within the GTP RoW is provided in the EIS, SEIS, SMP and SSMP.

4.3 Watercourse and wetlands

The project area encompasses the catchment areas of Dawson, Comet and Calliope Rivers, and extends into tidal creeks and wetlands of Port Curtis.

Within these three catchments, the proposed corridor traverses 183 watercourses. DERM has assigned each watercourse a Stream Order (SO) number from 1 to 8, based on its position within the catchment. The major watercourses intersected include the Dawson River (SO 8 and 5) and Calliope River (SO 5) and Hutton (SO 6), Clematis (SO 5), Callide (SO 5), Baffle (SO 4) and Larcom (SO 3 and 4) Creeks.

The GTP RoW also intersects the estuarine environs of Targinie and Humpy Creek and the intertidal wetlands (including seagrass, mangrove and saltmarsh communities) of Port Curtis (e.g. Kangaroo Island and Curtis Island).

4.3.1 Environmentally sensitive areas

To assist in minimising the impacts on the existing environmental values of the area, the Environmentally Sensitive Areas (ESAs) have been mapped. The ESAs within and adjacent to the GTP RoW include:

- TECs under the EPBC Act;
- Areas known to support EVNT species under the provisions of the EPBC Act and/or NC Act;
- Areas mapped as Endangered or Of concern REs under the provisions of the VM Act;
- Areas mapped as Essential Habitat under the provisions of the VM Act;
- Areas protected under the provisions of the NC Act and/or Forestry Act; and
- Riparian zones of watercourses with a Stream Order equal to or greater than 3.

Where possible, these areas will be avoided, or measures will be implemented, prior to and during construction, to minimise potential impacts (e.g. a maximum clearing footprint of 30 m).

Specific management measures for ESAs are outlined in the SSMP.

4.3.2 Agricultural Land Use

An assessment of the agricultural land capability of the area was conducted during the EIS (URS, 2009) to provide a benchmark of existing/potential agricultural land use. Land within the study area was identified in accordance with State Planning Policy 1/92: Development and the Conservation of Agricultural Land. The assessment was based on the four class system for defining Good Quality Agricultural Land (GQAL) as detailed in the Planning Guidelines - Department of Primary Industries (DPI) and the Department of Housing Local Government and Planning (DPI/DHLGP - 1993).

All Class A land is considered to be GQAL. In some areas, Class B land (where agricultural land is scarce) and better quality Class C land (C1) (where pastoral industries predominate), are also considered to be GQAL. For the Mainland GTP RoW, Classes A, B and C1 are considered to be GQAL.

The Mainland GTP RoW traverses GQAL land classes A through to D. Significant lengths of Class A and B land is traversed in the Arcadia Valley and East of the Dawson Highway to North of Burnett Highway. The majority of land intercepted by the Mainland GTP RoW is classified as Class C.

It has been calculated that approximately 7.4% of the GTP RoW will pass through Class A land; approximately 9.6% will pass through Class B land; and approximately 77.6% will pass through Class C land (with 34.9% of that being Class C1). The remaining mainland GTP RoW will pass through Class D non-agricultural land.

5. Impacts

The construction of the GTP ROW will create a linear disturbance across several landscape types. The GLNG EIS and SEIS identify the adverse and beneficial impacts associated with the construction and operation of the GTP ROW. Key examples of the short and long term impacts pertaining to landscaping and rehabilitation within and adjacent the GTP ROW are summarised in table 2 below.

Table 5.1 Impacts

Aspect	Impacts
Negative Impacts	
Vegetation clearing as a result of bulk earthworks (e.g. excavation, clearing quarrying etc.).	• Potential to alter the biodiversity, distribution and dynamics of the existing environment through: - Fragmentation of vegetation communities - Loss of habitat and microhabitats (flora and fauna) - Loss of local faunal and floral populations, including threatened and significant species - Loss of riparian vegetation - Establishment of pest and weed species in sensitive environs (increase in weed proliferation) - Loss of topsoil and increased erosion - Sedimentation into waterways resulting in a decrease in water quality - Subsequent salinity issues or a rise in the watertable - Increase in likelihood of disturbing acid sulphate soils - Reduction in buffering capacity particularly in or adjacent sensitive areas.
Topsoil removal and/or loss as a result of bulk earthworks (e.g. excavation, clearing etc.).	• Loss of soil seed bank. • Sedimentation into waterways resulting in a decrease in water quality. • Increase in likelihood of disturbing acid sulphate soils.
Chemical use	• An increase in chemical use (i.e. pesticides) may reduce food sources for some fauna species (i.e. moth/insects and other invertebrates). • Potential for bioaccumulation within the food chain. • Impact on local pollinators which are required to help maintain ecosystem function.
Positive Impacts	
Propagation of endemic species for rehabilitation activities (e.g. revegetation, seeding, weeding etc.)	• Potential to enhance the local biodiversity of the area through: - Strategic revegetation of and provision of artificial fauna furniture, such as glider poles, bat boxes and nests in potential corridors (to re-create linkages) - Recreating vegetation communities lost as a result of construction clearing - The enhancement of habitat and associated foraging resources for native fauna.
General landscape works (revegetation, seeding, weeding etc.)	• The use of locally native plant species to minimise the risk of introducing 'problem' species. - Enhance soil stability and structure - Enhance water retention in soils to encourage water table stability - Improve aesthetic/visual value to the area - Improve air quality.

6. Pipeline operational and decommissioning phase rehabilitation objectives

Australian Standard AS2885, Part 3: Vegetation on or near the pipeline states:
Unless approved, vegetation shall be restricted to allow free passage along the pipeline route. Vegetation, whose roots may damage the anti-corrosion coating of the pipeline, shall not be permitted in the vicinity of the pipeline.

The APIA Code of Environmental Practice – Onshore Pipelines states: *Vegetation management – Environmental management; Management Measures: Regrowth vegetation on the pipeline easement shall be maintained to ensure root systems do not create a safety risk to the pipeline. The width of vegetation removal (i.e. the distance cleared on either side of the pipeline centreline) should be the minimum extent reasonable necessary to ensure the safe operation of the pipeline.*

In line with the Australian Standard and APIA Code of Environmental Practice requirements stated above, rehabilitation following construction of the pipeline must allow for the protection of the pipeline integrity and ensure permanent access to the pipeline for monitoring and maintenance purposes whilst it is in operation. Subsequently rehabilitation objectives for the operational phase will restrict vegetation growth to allow for understorey species and mid-level species to return within 10m of the pipeline.

On decommissioning of the pipeline, rehabilitation to pre-clearance conditions will be undertaken within all previously restricted vegetation growth areas, in accordance with EPBC Act Approval Condition 3d.

7. Implementation and Management Strategy

A rehabilitation strategy has been developed and is detailed below. The strategy ensures that rehabilitation objectives are met for the range of land uses and disturbance levels for the lifespan of the pipeline.

7.1 Pre-clearance Survey

Prior to construction, a pre-clearance survey will be undertaken in accordance with EPBC Act Approval Condition 3(a). During the pre-clearance survey, information to document the condition and value of a site prior to disturbance, including habitat resources, species composition and level of disturbance will be collected.

7.2 Benchmark Guidelines

A range of benchmarks will be selected to guide rehabilitation for broad ecosystems, including pasture grasses, identified in the RoW. Benchmark guidelines provide a summary of the key condition indicators of a range of vegetation and grazing communities.

Benchmarks provide information on the best condition on offer for each broad ecosystem, and are considered to be the minimum target for rehabilitation. This information is designed to be supplemented by the pre-clearance survey, and provide a means to rehabilitate disturbance areas to better than pre-clearance condition.

The pre-clearance survey includes methods to select the appropriate benchmark guideline.

7.3 Operational Safety requirements

In accordance with Australian Standard AS25884, Part 3 and The APIA Code of Environmental Practice – Onshore Pipelines (Refer to Section 6) operation safety requirements must be considered when determining rehabilitation criteria. Trees with large root balls (such as *Ficus sp.*) pose a risk to the structural integrity of buried infrastructure. To ensure compliance with AS2885 (Part 3, Section 6.4.4), vegetation will be restricted to allow free passage along the pipeline route. Vegetation who roots may damage the anti-corrosion coating of the pipeline shall not be permitted in the vicinity if the pipeline during the operational phase of the pipeline.

In order to ensure operational safety, vegetation species used to rehabilitate the RoW will be limited to species less than 10 to 12 m in height. In areas where RE communities are to be rehabilitated, understorey species and mid level species of pre-disturbance RE communities will be returned to the RoW.

To ensure compliance with EPBC Act Approval Condition 3d, pre-clearance conditions will be rehabilitated within these restricted areas on decommissioning of the pipeline.

7.4 Landholder Rehabilitation requirements

A Construction Line List (CLL) has been prepared detailing a number of commitments which GLNG has made to Landholders whose property is intersected by the GTP RoW (and/or ancillary sites). A number of the CLL commitments relate to specific site rehabilitation actions, which fall in to the following broad groups:

- Vegetation: Re-seeding (seed mix type); arrangements for relocation of cycads, grass trees and orchids, weed prevention;
- Disturbed soils: Restoration of land condition; prevention of soil erosion; soil compaction; soil inversion; soil subsidence; sink holes; surface disruption; provision of contour banks/whoo boys;
- Infrastructure: Fencing and gates; installation of Cathodic Protector posts; construction of water tank pad, relocation of dam) and
- Stockpiling of materials: Excess excavated materials and timber for reuse by landowner.

All CLL commitments must be actioned within the relevant land tenures prior to transferring decommissioned areas to Landholders. Where landholders have not specified additional rehabilitation requirements, land will be restored to its pre-disturbance land use.

7.5 Rehabilitation Schedules

Rehabilitation schedules will be developed based on benchmark guidelines for each disturbance type and broad land use (vegetation or agriculture), and include specific objectives and performance criteria to ensure disturbed sites are rehabilitated to a pre-disturbed condition.

The rehabilitation schedules will include performance measures and related monitoring actions to assess site rehabilitation, as well as provisions for reporting on the implementation of the LRMP including monitoring and performance to a standard which can be independently audited.

Rehabilitation schedules will include site remediation measures by stage of development (e.g. pre-construction, construction, post-construction, and decommissioning), as well as the inclusion of timeframes and standards for conducting rehabilitation activities.

The schedules will provide practical rehabilitation measures to support recovery of EVNT species habitat and recovery of TEC, in line with the SSMP, as well as recovery plans provided by SEWPaC and DERM.

7.5.1 Performance criteria

Performance criteria will be developed for each rehabilitation schedule in order to meet the overarching rehabilitation objectives of providing a safe, stable and non-polluting landform.

In order to comply with the EPBC Act Approval, CG Conditions and EA Conditions, standard performance criteria for vegetated sites (including TEC, RE and HVR vegetation) include the representativeness of species richness and diversity for the appropriate benchmark. Specific criteria to support the recovery of TEC, RE and significant species habitat will also be included within each rehabilitation schedule.

Standard performance criteria within agricultural sites across the Project area include:

- Plant survival, height, recruitment and richness;
- Stability of landform;
- No declared weeds occurring;
- Pasture species richness representative of pre-disturbed condition;

- The preservation of inherent GQAL agricultural land use classes; and
- Pasture diversity, quality and productivity rehabilitated to pre-disturbance benchmarks.

8. Management Requirements

While the rehabilitation schedules will determine the detailed management measures, the following general measures will be incorporated to the guidelines:

Table 7.1 Mitigation and Management Measures relevant to Landscape and Rehabilitation Works

Actions	Timing
• All landscaping and rehabilitation works will comply with relevant statutory conditions and guidelines (e.g. EPBC and NC Act approval).	At all times
• Where applicable, all landscaping and rehabilitation works will be consistent with measures outlined in the SSMP and SMP.	At all times
• Landscaping and rehabilitation personnel will be suitably qualified and experienced to undertake the works.	At all times
• Landscaping rehabilitation personnel will be educated on potential risks to native wildlife which may inhabit the area as per the SMP and SSMP.	Prior to and during works
• A pre-clearing survey of the GTP ROW will be undertaken to document the existing condition of the vegetation communities to be impacted as a result of clearing works. The survey will document (including photologging) all environments relevant to the landscape and rehabilitation works, including: - Topsoil and landforms - Drainage - Vegetation - Environmentally Sensitive Areas • The survey will also include undertaking cross sections to record existing surface level and contours.	Prior to works commencing
• Development of any Special Area plans will be undertaken in consultation with Councils, landowners, DERM, DTMR, DEEDI as necessary.	Prior to works commencing
• Consultation with the design civil engineers and landscape architects prior to finalising planting design will be undertaken where applicable.	Prior to works commencing
• Where applicable, compliance with the Road Landscaping Guidelines (DMR, 2004) will be undertaken within rehabilitation works within a road reserve.	At all times
• Where applicable, compliance with other stakeholder requirements including local government authorities (local government controlled roads), Energex and/or Powerlink and QR National (rail corridors) will be undertaken.	At all times
• The Principal shall organise for Type A flora pursuant to the NC Act to be translocated or salvaged. This may involve the relocation of specimens to an interim area (e.g. for orchids a bushhouse facility) until rehabilitation works are mature enough to accommodate translocated individuals.	Prior to works commencing
• The Principal Contractor will be responsible for organising the collection of any seeds and/or propagules from locally native flora (least concern) within the project area for use in the rehabilitation works. This includes flora associated with threatened ecological communities present within the GTP ROW. The Proponent will be responsible for the collection of any significant flora seeds and/or propagules for any translocation, offset and management works (those protected under the NC Act). Seed collection will be undertaken in accordance with seed collection guideline document: Model Code of Practice, Florabank Guideline 6: Native Seed Collection Methods.	Prior to works commencing
• All growing facilities must adhere to Australian phytosanitary standards and guidelines.	At all times
• Where enhancement plantings are required, a planting and/or seeding plan	Prior to works commencing

Actions	Timing
will be developed based on the geology, soil description, pre-existing and existing floristic composition and vegetation characteristics and landholder preferences.	
• Monitoring points will be strategically located and set up prior to rehabilitation works commencing. This will include but not be limited to the establishment of permanent photologging points for monitoring purposes. Monitoring and photologging stations will be set up at locations that include the locations where photos and data were collected prior to disturbance.	Prior to works commencing
• Clearing is a last resort. The retention of vegetation, selective clearing, trimming and fauna spotting is the first priority.	Construction Phase
Stockpiling of topsoil for reuse during rehabilitation works is to be undertaken. Ensure that stockpiles are separated from subsoils and covered as appropriate, or that appropriate erosion and sediment controls are in place to avoid erosion and sediment runoff.	Construction Phase
• Topsoil stockpiles shall preferably be no more than 2 m high and 50 m wide. Variation to this standard is subject to approval by the Environment Manager.	Construction Phase
• Topsoil that is stockpiled for greater than Six (6) months must be managed to minimise erosion.	Construction Phase
• Topsoil stockpiles shall be seeded if left for more than 12 months.	Construction & Operational Phases
• Relocate tree hollows and other microhabitats (e.g. rocky outcrops) to suitable sites outside the clearing footprint. This is to be determined in consultation with an ecologist and where necessary, landholders.	Prior to and during works
• Weather permitting, rehabilitation and reconsolidation of impacted watercourses shall commence immediately after the pipeline has been lowered in and backfilled. This will include early rehabilitation of riparian buffers will occur in order to restore natural stream functions and aquatic habitats	Construction & Operational Phases
• Where appropriate, rehabilitation of the bed and bank structure such that original dimensions and shape of the creek or spring are achieved. Bank re-contouring should include stabilisation methods (crib walls or soil wraps).	Construction & Operational Phases
• Where possible, promote a heterogeneous substrate in watercourse crossings, including : - Replace large woody debris to stabilise banks and also to provide in-stream complexity; and - Use a combination of rocks, gravel and/or cobbles, etc. in the stream bed. • The use of large rocks and logs to moderate flows.	Construction & Operational Phases
• Salvaging of existing bed material prior to the construction and placing it back into the creek or spring at completion of construction. If the existing bed material is unable to be salvaged, a comparable sediment sized material is recommended to cover the bed and should be approximately 10 cm thick. If the sediment is fine (mud/silt), it is recommended that the bed material be replaced with sand to prevent future erosion. If the sediment is coarser (gravel, cobble, pebbles), new material must be washed prior to placing in the creek (as usually, new coarse substrate is covered in a fine dust, which will become suspended in the water).	Construction & Operational Phases
• Soils will be graded away from the watercourses, not towards it. Graded soil shall not be stockpiled where it has the potential to result in sedimentation or acidification of land or surface water (e.g. on slopes which drain immediately to a watercourse).	Construction & Operational Phases
• Weather permitting, rehabilitation of the GTP ROW shall commence within 3 months from the completion of the pipeline construction. Revegetation shall be consistent with the plant density, floristic composition and distribution of the adjacent remnant communities and where possible, should encourage the	Construction & Operational Phases

Actions	Timing
natural re-establishment of significant species and ecological communities into the disturbed areas.	
• The GTP ROW will be re-profiled to original or stable contours, including re-establishing watercourses, wetlands, overland flow paths and other topographic features, immediately after the pipeline has been lowered in and backfilled.	Construction & Operational Phases
• Erosion and sediment control measures will be implemented in accordance with the Erosion and Sediment Control Plan.	At all times
• Activities will be conducted in accordance with EHS04 (*Waste Management*) to ensure appropriate mitigation measures are implemented in the management of waste.	At all times
• Areas of the GTP ROW may be deep ripped prior to reapplying topsoil.	Construction & Operational Phases
• Subsoil will be respread over the GTP ROW and compacted over the trench, including contouring works, immediately after the pipeline has been lowered in and backfilled.	Construction & Operational Phases
• After subsoil respreading and compaction, topsoil will be respread over the GTP ROW and left with a slightly rough surface.	Construction & Operational Phases
• Cleared native vegetation will be respread over the GTP ROW to assist in seed stock distribution. This action will be undertaken in a manner which does no promote erosion or subsidence.	Construction & Operational Phases
• Native woody debris, which is not to be used in habitat rehabilitation works, will be mulched and respread across the GTP ROW. The mulch material will be used to filter out sediments and also in planting works.	Construction & Operational Phases
• Where necessary imported topsoil, which is of appropriate quality and weed and fire ant free, will only be used with landholder approval.	Construction & Operational Phases
• Where necessary, fertilisers and soil supplements will be only be used with approval from local landholders and authorities.	Construction & Operational Phases
• A maximum of 10 m will be maintained along the GTP ROW for access. No planting of deep-rooted trees within 3 m of the pipe will occur to maintain pipe integrity (Refer to Section 6 & 7). • Within 10m of the pipeline, rehabilitation objectives for the operational phase will allow vegetation growth of understorey species and mid-level species to return.	Operational Phase
• Re-establish or enhance the habitat of a significant species known or likely to occur within the GTP ROW prior to clearing activities (especially where the construction clearing activities have affected such habitat (Refer SSMP)).	Construction & Operational Phases
• Preserve specific European and indigenous heritage that has been registered for the site (note that these values are managed under other legislation).	Construction & Operational Phases
• The natural regeneration of native species will be encouraged (in particular, groundcover and shrub species). However, seeding will be utilised in areas where rapid restoration is required (e.g. watercourse crossings and areas of high erosion potential).	Construction & Operational Phases
• Reseeding will be undertaken using native species only for areas of high value regrowth and regional ecosystems. Reseeding using non-native species may be used on pastoral grasslands and cropping land only and within these areas reseeding will be undertaken as per the landholder's requirements.	Construction & Operational Phases
• Where natural regeneration is not successful, establish vegetation communities to a condition at least equivalent to the ROW condition prior to commencement (especially where native vegetation is the proposed land use), taking into consideration the constraints.	Construction & Operational Phases
• Maintain a mosaic vegetation structure, including planting of different aged plants.	Operational Phase

Actions	Timing
• Any 'temporary'[4] vegetation is to be locally native. If this is not achievable, other native plants from the bioregion are to be used. Any proposed species substitutes are to be approved by the Principal prior to planting.	Construction & Operational Phases
• Vegetated buffers are to be established at sufficient height and width to provide a wind break and visual screening along the boundaries between stockpiles and sensitive receptors.	Construction & Operational Phases
• Use foraging and habitat tree species in planting works for fauna such as koalas, gliders and Glossy-black cockatoos.	Operational Phase
• Place artificial nest and/or bat boxes in suitable sites outside the clearing footprint and within rehabilitated areas.	Construction & Operational Phases
• In consultation with an ecologist, erect glider poles and other measures (e.g. timber poles to allow semi-arboreal and arboreal species to escape predators) in the GTP ROW (especially in areas of remnant vegetation adjoining the Jemena Pipeline) to facilitate fauna movement (e.g. Expedition Range).	Construction & Operational Phases
• Re-establish large woody debris and rocky outcrops within rehabilitated areas to create stepping stones for fauna and also microhabitats.	Construction & Operational Phases
• Planting of frangible species, where required, to comply with safety requirements will be undertaken.	At all times
• Where applicable, maintain adjacent high tide banks with intertidal species.	At all times
• It is considered that the most appropriate method to regenerate large areas of intertidal wetlands is through natural regeneration. This should be achieved through regular weed control, maintaining existing tidal regimes, and mitigating issues with ASS.	Construction & Operational Phases
• If natural re-colonisation of intertidal communities does not occur within 12 months, manual planting may be required. This will be subject to consultation from DEEDI.	Operational Phase
• Watering of revegetated areas shall be carried out to maintain soil moisture content to no less than PAW[5] during the establishment period.	Construction & Operational Phases
• Weed species will be managed as per the Weed and Pest Management Plan. However, as a general rule, weed management should occur prior to and during the rehabilitation planting to encourage rehabilitation success.	At all times
• All waste materials and equipment will be removed from the GTP ROW and associated laydown areas once construction is completed. This includes disused sediment fences.	Construction & Operational Phases
• Rehabilitated areas shall be clearly marked with appropriate signage, "Revegetation Area No Unauthorised Access".	Construction & Operational Phases
• Vehicles will be confined to designated maintenance access tracks within GTP ROW.	At all times
• Where appropriate, rehabilitation areas will be fenced to exclude cattle and other threatening processes. Fencing will only be undertaken with landholder approval.	Construction & Operational Phases
• Avoid the use of barb wire when erecting any Project related fencing. Where barb wire fencing is unavoidable the top strand will be high tensile steel (non-barbed wire) to avoid fauna getting caught and tangled in the barbs.	At all times
• Driving vehicles on freshly topsoiled sections of the GTP ROW will be prohibited.	Construction & Operational Phases
• Temporary access tracks have been selected to minimise or eliminate the need for any clearing, and are all based on the route of existing	Operational Phase

[4] 'Temporary' vegetation will be used to stabilise temporary banks/stockpiles and will be removed and re-established as native vegetation post construction.
[5] Plant available water. The portion of water in a soil that can be readily absorbed by plant roots. That soil moisture held in the soil between field capacity and permanent wilting point (DMR 2008).

Actions	Timing
tracks. Where a previously cleared alternative feasible route to a portion of an access track was identified as representing a lesser impact (e.g. around a patch of significant vegetation), this was selected in preference to the original route. The selection process for temporary access tracks has minimised any requirement for clearing of remnant vegetation in particular, by utilising alternative existing tracks where practicable, or by selecting routes which have previously been cleared. Where clearing is required, this is likely to be minimal, in the order of 0.5 m to 1.0 m width of clearing. Where clearing is required for the construction or maintenance of temporary access tracks, reinstatement and rehabilitation to pre-clearance conditions will be undertaken or, for cropping and pastoral land, as agreed with the landholder. Rehabilitation actions will consist of stabilisation of soils and reseeding, ensuring that the track is left in a stable condition. Where minor clearing of remnant or high value regrowth is necessary, any cleared areas will be revegetated with equivalent vegetation using locally collected seed.	Operational Phase
• Where non-public access routes are to be retained, the entrance will be disguised.	Construction & Operational Phases
• Monitoring the success of rehabilitation strategies will be undertaken as per the Principal Contractors LRMP with the findings reported to Principal. Monitoring and reporting should occur at the same time each month for the first 2 years.	Construction & Operational Phases
• Ongoing monitoring of the fauna measures implemented during construction to facilitate fauna movement and colonisation. This includes checking the nest and bat boxes, the success of gliders poles and the colonisation of fauna in rehabilitation areas.	Operational Phase
• Implement corrective actions where necessary if the performance objectives are not being achieved. This will include replanting of species which have not survived, installation of additional controls if erosion is occurring etc.	Operational Phase
• In accordance with EA condition E36, rehabilitation can be considered successful when the site can be managed for its designated land-use without any greater management input and there is evidence that the rehabilitation has been successful for at least 3 years.	Operational Phase
• A further review will be undertaken at the time of decommissioning to determine an appropriate rehabilitation policy in accordance with best practice at the time.	Decommissioning Phase
• On decommissioning, land will be rehabilitated to a level consistent with the pre-clearance condition.	Decommissioning Phase
• On decommissioning, the Pipeline will remain in situ and all above ground infrastructure will be removed by cutting at ground level. The decommissioned Pipeline will be inert and at atmospheric pressure, thus presenting negligible environmental impact and low environmental risk.	Decommissioning Phase
• During decommissioning phase rehabilitation, vegetation with large root balls (i.e. trees greater than 10 m) will be re-established within the RoW. This type of vegetation will be restricted during the operational phase to protect the structural integrity of the pipeline. Revegetation of these species may be undertaken through passive (i.e. allow for the natural encroachment of the species) or active (i.e. planting/seeding) methods depending on best practice at the time of rehabilitation.	Decommissioning Phase
• Risks and impacts during decommissioning of the pipeline will be limited to weed, vegetation and waste impacts. • Impacts will be managed in accordance with the Project Pest and Weed Management Plan and Waste Management Plan. • Should there be a requirement to clear vegetation to access the RoW to	Decommissioning Phase

Actions	Timing
remove above ground infrastructure, areas of impact will be rehabilitated to pre-clearance condition in accordance with the rehabilitation management plan. • Management plans will be reviewed and amended at the time of decommissioning to adopt current best practice.	

It should be noted that failure to comply with the mitigation measures outlined in this plan will result in the Principal Contractor being responsible for any and all mitigation costs associated with that non-conformance.

9. Constraints

Rehabilitation of the GTP ROW will vary between areas depending on the level of clearing, the vegetation and habitat complexity and composition within each area, landholder requirements as well as the ongoing operation and maintenance requirements.

In addition, there are several constraints that will influence the rehabilitation works along the GTP ROW. These constraints are outlined in Table 8.1 below.

Table 8.1 Constraints and Actions

Constraint	Action
Weather	The success of the rehabilitation strategy will be dependent on weather conditions during and post construction (e.g. recent flooding in the last year along sections of GTP ROW and prior to this the extended drought conditions).
Land Owner Negotiations/ Requirements.	Interference to landholder activities will vary according to the level of impact caused by the construction of the pipeline, type of activities being undertaken and the duration of the work on a landholder's property. Each landholder will be consulted prior to the works being undertaken to identify specific requirements and outcomes. Temporary provisions, such as fencing, driveways or stock access to water, will be discussed with each landholder. Reinstatement of cropping and pastoral grasslands will be as required by landowners. However rehabilitation of all Regional Ecosystems, high value regrowth areas and native vegetation not classified as either of these categories will be restored to its pre-disturbance condition during the decommissioning phase, in accordance with 3d of the EPBC Act conditions. Every effort will be made to minimise the impacts to landholders by limiting the area of works, using existing tracks which avoid homesteads and minimising the amount of time the trench is left open.
Off-set Distances from Pipeline (operational phase)	The Operator of the pipeline will need to ensure that the structural integrity of the pipeline is maintained (Refer to Section 6.3). In this regard, planting in close proximity to the pipeline must consider the root system of the chosen plant species. While trees and deep-rooted vegetation cannot be re-established directly across the pipeline (due to potential damage to the corrosion protection systems), grassland re-establishment and return of native understory/ mid level species will be undertaken. Habitat will be re-established as much as practicable through installation of glider poles, nest boxes, woody debris, logs, hollows etc.,
Other infrastructure	The GTP ROW intersects other linear infrastructure, including power lines, roads and rail lines. Rehabilitation in these areas will need to be in accordance with the relevant stakeholders requirements for operations and maintenance.

Fencing/ Property Boundaries	Dependent on the outcomes of discussion with relevant landholders. However, preference will be to use wire (non-barbed) fencing with a plain wire strand on the top.
Weed Infestation Areas	Some areas along and adjacent the GTP ROW are heavily infested with weeds. The level of rehabilitation will be assessed in site-specific rehabilitation plans to ensure no spread of infestation.
Maintenance Tracks	An access track will be required along the pipeline route within the ROW for ongoing operations and maintenance. Some additional works may be required to access the ROW - these will be determined as construction works progress.

10. Rehabilitation completion criteria

Rehabilitation completion criteria will be dependent on the vegetation communities and land uses prior to clearing, pre-existing health and integrity of the landscape and landholder requirements. Therefore specific completion criteria for determining when a site has been completely rehabilitated will be specified within specific rehabilitation schedules.

However, the overall aim of the rehabilitation works is to rehabilitate impacted environs to as a minimum, their pre-existing condition. This is a particular prerequisite for all significant ecological communities, protected areas and other sensitive areas identified within the GTP ROW.

General guidelines on heights, canopy cover and potential complexity have been briefly discussed below to provide direction for desired outcomes.

Barrier plantings
The objective of the barrier plantings is to minimise weed infiltration into areas of considerable conservation value. The width of these plantings should be a minimum of 20m with a minimum density of 70% foliage cover.

Riparian zone
The vegetation within the riparian zone of a watercourse should achieve high densities, particularly in the lower stratum in order to keep weed infiltration to a minimum. The upper stratum in some instances may take on the structure of an open or closed forest community.

Samphire and mangrove communities
Optimum outcome for these communities is to be free of introduced weed species and to be further enhanced through natural regeneration. The structural formation of a closed samphire community would consist of approximately >80% foliage and surface cover (Attiwill and Wilson 2003).

Woodland
The structural formation of woodland generally consists of approximately 10-30% foliage cover and 20-50% foliage cover in the canopy (Confinas and Creighton 2001). The species complexity of woodland communities is highly variable due to factors such as aspect, rainfall and soil type. However as a guide, sclerophyllus woodlands containing an acacia understorey are likely to achieve the 30% foliage cover if fire and other disturbance factors are maintained.

Open forest
The structural formation of an open forest generally consists of approximately 30-70% foliage cover, 50-80% crown cover in the canopy and tree heights ranging between 10-30m (Confinas and Creighton 2001).

Closed forest
The structural formation of a closed forest generally consists of approximately 70-100% foliage cover, 80-100% crown cover in the canopy and heights of <30m (Confinas and Creighton 2001).

Landforms

Pre-existing surface levels will be reinstated.

Open Areas and Agricultural Areas
The level of rehabilitation within these areas will be determined in consultation with the individual landholders. It is likely that rehabilitation will involve normal agricultural seeding, hydro-seeding or basic hydromulching techniques to return the pre-existing ground cover (or an appropriate or preferred replacement) to the site.

Habitat Rehabilitation
Habitat rehabilitation will be implemented along the GTP ROW to facilitate fauna movement and re-colonisation of the ROW. The following habitat features will be considered:

- Replacement of hollows, large woody debris in adjacent habitats and within the GTP ROW (subject to landholder permission);
- Placement of artificial structures, including bat and nest boxes and glider poles, at key locations to facilitate fauna movement and recolonisation;
- Bee hives for native bees dependent on the existing distribution and abundance; and
- Feeder and/or habitat trees for key species and migratory birds.

In determining whether the completion criterion is met, the following factors will be used:

- The similarity between the rehabilitated landforms and the natural landforms in adjacent areas;
- The stability of the landform and its resistance to erosion;
- Whether appropriate drainage patterns have been developed either naturally or through shaping activities during the rehabilitation programme;
- The degree to which the surface conditions are conducive to plant establishment;
- Whether the site conditions and existing habitat components provide resources, including for fauna movement, foraging habitat and/or shelter;
- Compliance with the relevant standards; and
- Public safety issues (e.g. signage, fencing etc.).

11. Training and awareness

11.1 Project Personnel induction

In accordance with Santos Management Standard EHSMS06, all personnel and visitors are required to undertake appropriate environmental training and induction programs.

As part of the training programme, all project personnel[6] are required to complete site specific environmental awareness training which is to be conducted by the EO. As a minimum, the training will consist of a presentation and an assessment questionnaire. The site induction will address the following.

- Fauna and flora likely to be present within the corridor, including significant species (awareness training);
- Location of sensitive areas (e.g. wetlands and habitat trees);
- Landholder constraints;
- Vegetation protection areas and no go zones;
- Procedures and actions associated with encountering fauna;
- Threatened species habitat areas;
- Weed identification and control; and
- Responses and reporting of environmental issues.

This training will be developed with the assistance of the project ecologist and delivered by the Environmental Construction Manager / Environmental Officer(s). This will be undertaken within the initial induction process, ongoing toolbox meetings and relevant Construction Method Statements.

[6] Project personnel include all staff, contractors and consultants that may undertake onsite works.

Where possible, personnel will also be shown photographs and given general information on significant species and ecological communities identified within and adjacent the GTP ROW, this will enable them to identify these species should they be encountered.

12. Monitoring and Maintenance

A rehabilitation monitoring and maintenance plan will be developed to complement each rehabilitation schedule. Monitoring of the rehabilitated GTP RoW is required every 20 days for the first 120 days, and annually for the first five (5) years following completion of rehabilitation, in accordance with the EA, Schedule J22-J24. The monitoring and maintenance plan is designed to be flexible to allow adaptations for natural disasters such as fire, drought and flood.

All monitoring will be undertaken by a suitably qualified person (EA Schedule H12).

Monitoring periods may require extension in the case of ineffective rehabilitation or natural disasters impeding rehabilitation efforts. Where monitoring extensions are required, it will be recorded and implemented by GLNG.

Specific monitoring criteria will be outlined within each rehabilitation schedule, reflective of the performance criteria. Generally, the following indicators will be monitored:

- Indicators of growth and survival of all plantings;
- Plant height;
- Native species richness;
- Evidence of recruitment;
- Native species cover;
- Weed control – extent of declared and environmental weeds and adequacy of treatment, as well as any secondary weed responses to treatments;
- Indicators of the presence of EVNT species and / or key habitat features (as per SSMP);
- Adequacy of site preparation, mulching, tree (and plant) protection and maintenance; and
- Landform stability – evidence of soil erosion as per the Soil MP and ESCM.

Monitoring will consist of vegetation surveys and photologging, monitoring locations established within representative areas of the GTP RoW and for each ancillary site. Monitoring locations are to be determined by the suitably qualified ecologist using BioCondition assessment methods (Nelder et al. 2011). This will include but not be limited to the establishment of permanent photologging points for monitoring purposes. Monitoring and photologging stations will be set up at locations that include the locations where photos and data were collected prior to disturbance. Where possible, monitoring plots will be established within the core of rehabilitation areas to avoid edge effects. Monitoring will take the impacts from seasonal variation into consideration.

Performance criteria to monitor the progress of each rehabilitation site will comprise of a combination of pre-clearing data and benchmark guidelines. It is noted that while three (3) years is insufficient time for rehabilitation to meet the benchmark guidelines, it is sufficient to ensure that rehabilitation is well established and regenerating, and an improvement in BioCondition scoring should be clearly evident. The progression and improvement of key rehabilitation indicators such as species composition and diversity, weed cover, and plant densities will be evident over a three (3) year period.

All monitoring results and records will be compiled and stored for a minimum of five (5) years and made available for inspection upon request, in accordance with CG Condition, Appendix 3, Part 4, Schedule J3.

13. Reporting and Record Keeping

A monitoring and evaluation report will include details on species survival, natural recruitment, percentage coverage of the rehabilitation area and percentage and species of weeds in the rehabilitated areas. In addition the following will also be recorded:

- Planning and impact assessment details;
- Activity site location and site access details;
- Commencement and completion dates;
- The area of native vegetation removed, and the amounts of material excavated and fill placed;
- The disposal location/s and quantity of spoil material removed;
- The disposal location/s and quantity of native vegetation removed;
- Impact management and rehabilitation details;
- Before, during and post activity photographs of the site;
- Any incidents of unanticipated failure of management methods and subsequent remedial action; and
- Any notable fauna activity will also be recorded.

In accordance with EA condition E36, rehabilitation can be considered successful when the site can be managed for its designated land-use without any greater management input and there is evidence that the rehabilitation has been successful for at least 3 years.

The Coordinator General Conditions, Appendix 3, Part 3, Condition 4g, state that:

For clearing impacts that result in permanent loss of least concern native plants (cannot be re-established within three (3) years of clearing or floristic modification), the permit holder must provide DERM with a written detailed report of permanent vegetation loss, including the area, species affected and mapping of affected areas, within twelve (12) months of completion of the pipeline construction (Note: this is in addition to the required Return of Operations).

In addition to complying with the above requirement, GLNG shall undertake a review of unsuccessful vegetation areas and provide management measures and revised timeframes to rectify issues and allow pre-clearance conditions to be achieved.

Species of Conservation Interest (SOCI) logbook
Species of conservation interest encountered during the landscape and rehabilitation works will be recorded in the Species of Conservation Interest (SOCI) logbook and mapped in the supporting ecological GIS database. The information collated in the SOCI will include:

- Location of the community or species;
- Person reporting the sighting;
- Habitat type the species was inhabiting or adjoining the area where;
- Total area cleared and time f the clearing works;
- Where necessary, where the species was relocated or translocated to;
- Incidents; and
- Remedial actions.

The records will also be made available to the DSEWPC and DERM upon request.

Annual Environmental Return
This information will support the Annual Environmental Return, which will be submitted to DSEWPaC electronically, within 20 business days of each anniversary date from the date of Commonwealth approval. The Annual Environmental Return will document the following information:

- Addresses compliance with these conditions;
- Detail any rehabilitation work undertaken in connection with any unavoidable impact on MNES;
- Detail all non-compliances with these conditions; and
- Detail any amendments needed to plans to achieve compliance with these conditions.

Any other landscape and rehabilitation related reporting will be conducted in accordance with the relevant approval conditions.

Incidents
Any incident that results in the injury or fatality of an animal will be recorded on Accident, Injury and Incident Reports. Details of the incident including time and date of incident, cause of injury/ mortality and the species (if known) will be recorded and reported to DSEWPaC and DERM within 24 hours of its occurrence.

Revision
All environmental management plans, including the LRMP will be reviewed and updated as required during the life of the Project. When the LRMP is updated, the reviewed plans will be submitted to SEWPaC for approval (EPBC Act Condition 31). Updates to the LRMP may be required due to:

- Changes in EVNT flora and fauna species;
- Changes in TECs;
- Updates to related plans, including the SSMP, SMP, and ESCM;
- Revisions to databases and datasets, including data provided by DERM such as REs, High Value Regrowth (HVR), and Wildlife Online records;
- Amendments to EAs;
- Amendments to legislation;
- At the request of the State or Commonwealth Governments; and
- Following periodic internal review of the LRMP.

Data collected as part of rehabilitation monitoring will be used to satisfy the reporting requirements of the EPBC Act, EA and CG approval requirements. The information collected as part of monitoring will be assessed and summarised to provide an overview of rehabilitation progress within the GTP. Additionally, assessment of collected data will be used to identify any amendments required to the LRMP.

Table 12.1 outlines a review and reporting program for the LRMP document. The program includes provision for periodic review and revision as required. A revision register has been included at the beginning of this document to ensure all amendments are documented. Reporting timeframes will be tracked by GLNG.

Table 13.1 LRMP Review and Reporting Program

Timing	Requirement	Responsibility
Review		
Annual	Revision of LRMP framework, benchmark guidelines and schedules to ensure: • additional requirements / amendments to conditions are updated • changes in 'best practice' methods are included • feedback from rehabilitation successes and failures are reflected in the LRMP to ensure effective methods are highlighted	• GLNG • Suitably Qualified Restoration Ecologist
As requested by SEWPaC	• SEWPaC may request in writing for revisions to made to the LRMP	• As per SEWPaC request
Reporting		
Annual Environmental Return (AER) as per EPBC Act Approval (2008/4096) (Condition 62)	• Address compliance with the conditions • Include record of any unavoidable adverse impacts on Matters of National Environmental Significance (MNES), mitigation measures applied to avoid adverse impacts on MNES, and any rehabilitation work undertaken in connection with unavoidable adverse impact on MNES • Identify all non-compliance with the conditions and provide details regarding complaints • Identify any amendments needed to plans to achieve compliance with the conditions	• GLNG

Timing	Requirement	Responsibility
Annual Return for EA Conditions to DERM (Schedule J, Condition 8)	• Summary of rehabilitation actions, including monitoring and maintenance completed	• GLNG • Suitably Qualified Restoration Ecologist (or similar), that is either 'independent', or an 'other expert approved by SEWPaC
DERM Permanent Vegetation Loss report (CG Conditions: Appendix 3, Part 3, Condition 4(g))	• Where pipeline construction will result in the permanent loss of vegetation, a detailed report must be provided to DERM within twelve (12) months of the completion of pipeline construction	• GLNG • Suitably Qualified Restoration Ecologist (or similar), that is either 'independent', or an 'other expert approved by SEWPaC

14. Correction and Prevention

14.1 Preventative Actions

Preventative actions will be managed as follows.

- Environmental Incidents along with their corrective and preventative actions will be recorded in the Incident Management System. Corrective and preventative actions will be updated into the relevant EMP. Future audits will check for compliance with the EMP (s) and that the necessary preventative actions are in place;
- Reviews of environmental performance will be undertaken through consideration of key performance indicators, objectives and targets, and benchmark performance; and
- Where assessed by the relevant EO (as necessary), a preventative action will be raised and action undertaken as a Corrective Action. Preventative actions may include changes to specific procedures or training requirements, or other management areas.

14.2 Non-conformance

For clarity, environmental non-conformances will be referred to as environmental issues to differentiate them from Project non-conformances, which typically relate to quality defects in items of plant or materials. An environmental issue will be detected through verification processes such as monitoring, inspections, audits and receipt of complaints.

The process for managing environmental issues will be in accordance with GLNG's Internal and Project Policies and Procedures. When an environmental issue is detected, the following actions will occur.

- The incident will recorded in the Incident Management System (IMS);
- The nature of the event will be investigated by the relevant EO;
- Advice may be sought from a specialist where the extent of the issue is beyond the expertise of the in-house resource;
- Monitoring will be undertaken where the issue is complaint driven and the impact may be outside the project parameters;
- The effectiveness or need for new/additional controls will be reviewed;
- An appropriate preventative and corrective action will be entered into the environmental IMS and implemented;
- Strategies will be identified to prevent reoccurrence;
- The IMS will be closed-out; and
- Environmental documentation (i.e. CEMP) will be reviewed and revised.

Where the issue impacts on a 3rd party (i.e. is outside the project area or in breach of regulatory conditions) the relevant EO will also issue an Incident Report. In addition to the above, where an issue of a more serious nature has been identified, the following will apply.

- Stop work;
- Implement an immediate action to rectify the incident and stop further damage;
- Report the incident;
- Identify corrective and preventative actions;

- If the incident impacts upon state or commonwealth interests, the incident report will also be forwarded to the relevant authority;
- The incident will be reported in monthly management reports; and
- Associated environmental issues and corrective actions will be tracked.

14.3 Contingency measures

The Proponent recognises that contingency measures and adjustments to the management strategies may need to be considered in the event that a detrimental impact is recorded, and/or performance measures or targets are not met. Where this occurs, DSEWPC, DERM and/or DEEDI will be consulted and contingency measures determined and implemented (where required).

14.4 Environmental incidents and Corrective Actions

All incidents in breach of state or commonwealth policy/regulations will be reported to the relevant regulatory authority within 5 business days.

Non-specific environmental incidents are discussed in detail in Section 9.5 of the relevant EMP. The incident reporting form will be located in the EMP.

Detailed below are actions that will be taken should an event relating to directly to flora and fauna occur.

14.4.1 Flora

If vegetation outside the approved GTP ROW is incorrectly cleared the following actions must occur:

- The EO must be notified immediately and a stop work must occur until the situation has been assessed and is given approval to proceed by the proponent;
- The Spotter catcher(s) will conduct a search for any injured or orphaned wildlife; and
- If native vegetation was impacted a report will be provided to DERM and management measures agreed.

14.4.2 Fauna

If a native animal is injured on site and where it is safe for staff and the animal, the animal will be bundled in a dry warm blanket or jacket and taken to a vet or approved wildlife carer (do not attempt to handle marine animals or platypus). If it is unsafe or not possible to bundle the animal then:

- The location of the injured animal will be identified/ marked so it can be found again. If the animal is moving, a note will be made of the direction in which it was headed;
- The species of animal will be identified if possible and its approximate size determined;
- The type of injury sustained will be identified if possible (without handling or causing the animal further stress); and
- The relevant EO will be contacted immediately to capture or organise the possible capture of the animal for transportation to a specialist veterinarian or wildlife carer.

The relevant EO shall immediately contact the following organisations listed in Table 7.1 and provide details of the last known location of the injured/dead animal.

Table 14.1 Contact Details in the Event of an Injury to or Death of Native Wildlife (incl. marine)

Organisation	Contact Details
The Proponent PEM	07 3838 3666
QPWS Gladstone Office or DERM	(07) 4971 6500 or 1300 130 372 (Option 3)

Following the capture/recovery of the animal, an investigation into the cause of the event will be undertaken within 72 hours including an assessment of the effectiveness of corrective and preventative actions currently in place.

Any corrective and preventative actions identified will be implemented. The risk register, relevant procedures and documentation (including this plan) will be reviewed and revised as is necessary.

In the event that a control measure appears to be ineffective, the measure will be adjusted in consultation with the DEWHA and/or DERM. This Plan will be updated if necessary to reflect any significant changes to control measures.

Prior to construction a list of suitably licensed and experienced wildlife carers, hospital and/or vets local to the project area will be developed and included within the SMP.

14.5 Emergency preparedness and response

An Incident Response Plan will be prepared for the project and will be outlined in the CEMP. This plan will document suitable incident procedures to ensure effective response in the event of an emergency (including environmental emergencies such as fire, flood and large fuel spills).

The emergency procedures shall be tested on a six-monthly basis. Records of all site emergencies will be maintained (incl. results of emergency practice drills). The Emergency Response Controller for the project will be defined within the Incident Response Plan. This will also include the use contingency measures to check open trenches during and after rainfall events.

An up-to-date list of emergency response personnel and organisations will be maintained at each site office and compound.

15. Compliance and Evaluation

The compliance component of this Plan will be developed in accordance with the CEMP and State and Commonwealth Approvals.

15.1 Monitoring (Landscape and Rehabilitation)

Upon completion of the Management (monitoring) Strategy by the Principal Contractor, compliance and evaluation measures will be developed and incorporated into this Plan.

15.1.1 Inspection and surveillance

The monitoring of the landscaping and rehabilitation works will be ongoing from the first planting. Visual inspections will be undertaken regularly during construction and operational phases of the Project.

Following construction monitoring will be undertaken on a quarterly basis over the first 2 years of the Project and the monitoring will focus on key performance criteria developed for project and where necessary specific areas, including but not limited to:

- The physical stability of the rehabilitated areas;
- The biological structure of the vegetation community in rehabilitated areas (including the establishment of weed species);
- Water drainage from the site;
- Any public safety aspects;
- Non-conformances; and
- Monitoring of the rehabilitated areas shall ensure that any areas requiring remedial work are identified.

The rehabilitation programme shall be modified, as required, to address any conditions of approval and/or depending upon the findings of the monitoring programme results, including remedial works to action any non-conformances.

15.2 Ecological performance auditing

All monitoring required under this Plan will be compliant with relevant section of the CEMP and will be conducted by suitably qualified person, as per the Coordinator-General's Report.

The Proponent will conduct internal compliance audits of the implementation of Project environmental management commitments during the construction and operational phases, including.

- On-site audits of compliance with this management plan;
- Audits of contractors environmental management; and
- Work area inspections and monitoring.

Non-conformances identified during inspections will be documented, addressed with appropriate corrective and preventive actions and rectified within an agreed time frame.

The regulatory agencies associated with environmental matters may also conduct regular works inspections. The relevant EO shall attend these inspections.

15.2.1 External audits

External audits will be undertaken on an annual basis by an independent auditor approved by the minister. The audits will be conducted in accordance with AZ/NZ ISO9011.2003 *Guidelines for Quality and/or Environmental Systems Auditing* and/or section 458 of the EPBC Act and may be used to verify compliance with the Commonwealth conditions.

The external auditors report must document the following:

- The components of the project being audited;
- The conditions that were activated during the period covered by the audit;
- A compliance/non-compliance table;
- A description of the evidence to support audit findings of compliance or noncompliance;
- Recommendations on any non-compliance or other matter to improve compliance;
- A response by the proponent to the recommendations in the report (or, if the proponent does not respond within 20 business days of a request to do so by the auditor, a statement by the auditor to that effect); and
- Certification by the independent auditor of the findings of the audit report.

Audits or summaries of audits carried out under these conditions, or under section 458 of the EPBC Act, may be posted on the Department's website. The results of such audits may also be publicised through the general media.

If during the auditing process, any non-compliance with the Commonwealth conditions are identified, DSEWPC will be provided with written advice within 20 business days of the audit report. The written advice will outline:

- Actions taken by the proponent to ensure compliance with these conditions; and
- Actions taken to prevent a recurrence of any non-compliance, or implement any other recommendation to improve compliance, identified in the audit report.

15.3 Non-compliance

Where non-compliance occurs with regard to the Commonwealth or any State conditions of approval, a report must be submitted to DSEWPC within 5 business days. The report will outline the type of non-compliance and the remedial actions taken to ensure that the matter is resolved within a reasonable time frame. The time frame will be specified in writing by DSEWPC.

Where non-compliance occurs with regard to the other relevant conditions of approval (e.g. NC Act), a report must be submitted to the relevant governing agency within the designated timeframe. The report will outline the type of non-compliance and the remedial actions taken to ensure that the matter is resolved within a reasonable time frame. The time frame will be specified in writing by the relevant agency.

15.4 Variations to the LRMP

Once the LRMP has been approved by the relevant state and commonwealth agencies, a revised plan will need to be submitted for approval, if the works are to be undertaken other than in accordance with the approved plans and governing conditions. This will include any changes to the LRMP requested by the Commonwealth and/or the State.

For any revision to the approved LRMP, ensure the relevant assessment agencies are provided at least 20 business days for review and consideration of the revised plan, unless otherwise agreed in writing between the proponent and the agencies.

- Until the revised LRMP is re-approved, works must continue in accordance with the original LRMP. Once the revised LRMP is approved, this plan will supersede the original LRMP.

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Saipem Australia Pty Ltd	SAIPEM JOB 032118	AREA 3380	Santos GLNG Project
	SPC. 10-AZ-E-85832		
	Sh. 1 of 48	Doc. class: 2	
	Rev. 0		
Contract No. 897315	GLNG GAS TRANSMISSION PIPELINE		
	Company Doc. No. 3380-SAIP-4-3.3-1832		
	Document Title: Acid Sulfate Soil Management Plan, Gas Transmission Pipeline Route and Launch Pad		

ACID SULFATE SOIL MANAGEMENT PLAN

Gas Transmission Pipeline Route and Launch Pad

0	APPROVED FOR CONSTRUCTION (AFC)	Olivi, F	Chetty,S	Rapiti, D	17/09/12
A	ISSUED FOR REVIEW (IFR)	Olivi, F	Chetty,S	Rapiti, D	30/08/12
Revision	**Reason For Issue**	**Prepared**	**Checked**	**Approved**	**Date**

Saipem Australia Pty Ltd	SAIPEM JOB 032118	AREA 3380	Santos GLNG Project
	SPC. 10-AZ-E-85832		
	Sh. 2 of 48 / Rev. 0	Doc. class: 2	
Contract No. 897315	GLNG GAS TRANSMISSION PIPELINE		
	Company Doc. No. 3380-SAIP-4-3.3-1832		
	Document Title: Acid Sulfate Soil Management Plan, Gas Transmission Pipeline Route and Launch Pad		

COMPANY REVIEW CODE		
Code	**Description**	**Tick**
1	No comment. Proceed to AFC.	
2	Revise as noted and re-submit.	
3	Revise as directed and re-submit. Works may NOT proceed.	
4	Information Only. Re-submission not required.	
5	Approved for Construction (AFC)	
Signed:	**Dated:**	
Contractor remains responsible for the due and proper performance in accordance with the Contract. Comments do not limit or relieve Contractor of any obligation or liability under the Contract or give rise to any claim.		

Prepared by:
Lyndon Gordon BEnvSc (Hons)

Reviewed By:
Silvana Santomartino BEnvSc (Hons) PhD CPSS

Golder Associates

CONTENTS

1. INTRODUCTION

This Acid Sulfate Soils Management Plan (ASS MP) has been prepared by Golder Associates Pty Ltd (Golder) at the request of Saipem Australia Pty Ltd on behalf of GLNG, to provide details on management of ASS during the construction of the proposed GLNG pipeline route through the Kangaroo Island Wetlands and Curtis Island in Gladstone. It focuses on the construction of the gas transmission pipeline (GTP) through the creek crossing section of the pipeline route and the Launch Pad that will house the tunnel boring operations. It encompasses Kilometre Points (KPs) KP406 on the mainland section of the pipeline route through to KP414.5 on Curtis Island (refer Figure 1). A separate ASS MP will be prepared to address the tunnel boring operations.

A Phase 1 ‘preliminary’ ASS investigation has been undertaken on the creek crossing section of the pipeline route to provide some basis for ASS management strategies during construction within this area (refer Figure 1). The investigation was undertaken by Golder in May 2012 (refer Golder report 127683005-005-R-RevA, dated May 2012).

The Phase 2 ASS Investigation was undertaken by Golder in July 2012 (refer Golder report 127683005-008-R-Rev0, dated August 2012) and concentrated on the proposed site to be excavated and filled during the construction of the Launch Pad (refer Figure 2).

During a consultation meeting with the Department of Environment and Heritage Protection (DEHP, formerly the Department of Environmental Resource Management-DERM) on 6 July 2012 regarding the proposed Phase 2 ASS investigation it was agreed by DEHP (John Ross/Angela Hendry/Peter Bourke) that no further ASS investigations were required to be undertaken at the Tunnel Boring Exit Pad.

Based on the results of the Phase 1 and Phase 2 ASS investigations and the size of the proposed development, management of the net acidity at the site is classified as ***Extra High level of treatment (Category XH)*** as per the State Planning Policy 2/02 Guideline[1] (SPP 2/02) Table 4. As such, the SPP 2/02 Guidelines require that a ‘stand alone’ ASS Environmental Management Plan (EMP) must be prepared. This ASS MP has been written in accordance with the SPP 2/02 Guidelines and to satisfy the Environmental Authority Conditions (Schedule D- Acid Sulfate Soils) and further conditions stipulated by Department of Environment and Heritage Protection. A summary table which discusses how each condition has been addressed is included in Appendix A.

[1] State Planning Policy SPP 2/02 “Planning and Managing Development Involving Acid Sulfate Soils.

2. DEFINITIONS AND ABBREVIATIONS

2.1. DEFINITIONS

Environmental Protection Act 1994

Environmental Harm - Any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

Environmental Nuisance - Any unreasonable interference or likely interference with an environmental value caused by

(a) noise, dust, odour, light; or

(b) an unhealthy, offensive or unsightly condition because of contamination; or

(c) another way prescribed by regulation.

Material Environmental Harm - Is environmental harm (other than environmental nuisance)

(a) that is not trivial or negligible in nature, extent or context; or

(b) that causes actual or potential loss or damage to property of an amount of, or amounts totalling, more than the threshold amount but less than the maximum amount; or

(c) that results in costs of more than the threshold amount but less than the maximum amount being incurred in taking appropriate action to

(i) prevent or minimise the harm; and

(ii) rehabilitate or restore the environment to its condition before the harm.

“Maximum amount” means the threshold amount for serious environmental harm.

“Threshold amount” means $5000 or, if a greater amount is prescribed by regulation, the greater amount.

Serious Environmental Harm - Is environmental harm (other than environmental nuisance)

(a) that causes actual or potential harm to environmental values that is irreversible, of a high impact or widespread; or that causes actual or potential harm to environmental values of an area of high conservation value of special significance; or

(b) that causes actual or potential loss or damage to property of an amount of, or amounts totalling, more than the threshold amount; or

(c) that results in costs of more than the threshold amount being incurred in taking appropriate action to

(i) prevent or minimise the harm; and

(ii) rehabilitate or restore the environment to its condition before the harm.

"Threshold amount' means $50,000 or, if a greater amount is prescribed by regulation, the greater amount.

2.2. GLOSSARY

ANZECC - Australian & New Zealand Environmental Conservation Council

ARMCANZ - Agricultural and Resource Management Council of Australia and New Zealand

ASS - Acid Sulfate Soils

AASS - Actual Acid Sulfate Soil

ASS MP - Acid Sulfate Soil Management Plan

DEHP - Queensland Department of Environment and Heritage Protection

DERM - Former Queensland Department of Environment and Resource Management; now DEHP

DO - Dissolved Oxygen

EIS - Environmental Impact Statement

EMP - Environmental Management Plan

GLNG - Gladstone Liquefied Natural Gas

GTP - Gas Transmission Pipeline

KP - Kilometre Point

LNG - Liquefied Natural Gas

NRM - [Queensland] Department of Natural Resource and Mines

PASS - Potential Acid Sulfate Soil

ROW - Right of Way

SS - Suspended Solids

3. OBJECTIVES

The objectives of the ASS MP are to:

- Protect life, health and well being of human and other forms of life;
- Protect the local amenity;
- Base the environmental management of ASS material from the development in accordance with the principles of Ecologically Sustainable Development (ESD);
- Inform staff, contractors and consultants of appropriate safeguards and control measures to be implemented to minimise the environmental impact caused by Actual and Potential ASS (AASS and PASS respectively) material;
- Comply with all statutory environmental requirements in relation to ASS material;
- Provide strategies aimed at minimising environmental harm during the construction stage potentially caused by ASS material; and
- Provide an Environmental Management System of ASS material, generally based on the key elements of AS/NZS IS0 14001-1996 Environmental Management Systems – Specification with Guidance for use.

A copy of the ASS MP and associated forms and registers will be kept at the site office during earthworks / construction.

4. SITE DESCRIPTION

The mainland section of the proposed pipeline corridor for this project is approximately 3 km in length (KP406 –KP409) and includes the tidally inundated Creek and Marshland sections between the eastern end of the Phillipies Landing Road Section and Friend Point on the western side of the Narrows. There are two major creek systems which are crossed within this section of the pipeline, being Humpy and Targinie Creeks.

The surrounding vegetation is primarily comprised of native and improved grasses within a patchwork of open woodland and woodland (eucalypts being predominant species), with some sections having been partially cleared for grazing.

The launch pad, which marks the start of the GTP marine crossing, is located south of the mudflats of the Kangaroo Island Wetlands and is anticipated to comprise an area of approximately 74,690 m^2. The northern and eastern boundaries of the launch pad area are boarded by tidal mudflats which are interspersed with tidal creek crossings. The site slopes gently from a small ridge located along the eastern boundary (approximately 15 m AHD) to low lying discontinued creek sections to the west of the site (approximately 5 m AHD).

From the launch pad (KP409) the pipeline will go underground (to be achieved by tunnel boring operations), beneath a low lying intertidal mudflat section through the Kangaroo Island Wetlands fringed by coastal mangrove species and further extending across the sea bed and to Curtis Island (refer Figure 1). The pipeline re-emerges at the location of the receptor pad on Curtis Island (KP413). The stretch of pipeline section on Curtis Island up to KP414.5, are again generally woodland areas comprised of primarily eucalypt species.

4.1. Receiving Environment

The aquatic receiving environment comprises the adjacent Targinie and Humpy Creeks, the immediate Targinie Channel and the fringe of the Pacific Ocean, including Seagrass meadows, with regional receiving waters including the Great Barrier Reef Marine Park. The Great Barrier Reef Marine Park is located on the eastern coast of Curtis Island. General Use, Island Cay, and Marine National Park and Habitat Protection Zones, declared Fish habitats also exist within about 15 km of the project area (to the south).

During construction, excavations in shallow Holocene sediments could result in oxidation of PASS and the migration of acidic fines into receiving waters. Additionally, any significant depths of filling over any thick deposits of soft Holocene sediments will need to be managed to prevent displacement of PASS above the water table causing in-situ generation of acid, which would have an immediate adverse impact on the receiving environment.

Where disturbance of confirmed ASS is required, specific management measures [included herein] need to be followed, in order to prevent or minimise the generation of acid run off. In areas confirmed as containing ASS, the quality of any retained water is to be monitored and if necessary the water treated to comply with adopted water quality ‘acceptance criteria’ before release off-site.

5. PROPOSED DEVELOPMENT

Santos GLNG is proposing to develop coal seam gas (CSG) resources in the Surat and Bowen Basins in Queensland. The CSG field will supply gas for the liquefied natural gas (LNG) liquefaction and export facility (LNG facility) on Curtis Island. A high pressure gas transmission pipeline is proposed to be constructed to link the CSG field to the LNG facility.

This ASS MP addresses the Marine Crossing section of the Santos GLNG gas transmission pipeline (GTP) (refer Figure 1) which includes construction of the following components:

- Establishment and construction of the construction launch pad (Mainland) and tunnel launch shaft, comprising an area of approximately 74,690 m^2.
- Establishment and construction of the construction site pad (Curtis Island) and the tunnel receptor shaft, comprising an area of approximately 22,252m^2. It is estimated that the total volume of spoil from the tunnel boring launch and reception shafts in addition to the tunnel spoil itself is in the vicinity of 80,000-100,000m^3.

- Conventional open cut trenching for the final 2.5 kilometres to the Mainland GTP (between reference points KP406 and KP409) and 900 metres of trenching on Curtis Island to join with the Curtis Island GTP section of the project (between reference points KP413.6 and KP414.5). For the purposes of the ASS investigation it has been assumed that the trenching for the pipeline will have an average depth of cover of 1.2 m (1.5 m watercourses) and that the pipeline is 1.067 m in diameter. This translates into an average trench invert level of around 2.5 m.
- Ancillary work within the Marine Crossing GTP Right of Way (RoW) (30 m wide) includes the establishment of access tracks for trenching work, pipe stringing areas and designated laydown areas within the RoW.

6. OVERVIEW OF ENVIRONMENTAL ISSUES

This section provides a brief overview of the environmental issues associated with the construction of the GTP in conjunction with the tunnel boring launch and exit pads on the mainland and Curtis Island.

6.1. Acid Sulfate Soil Investigation

6.1.1. Phase 1 Investigation

Results from the preliminary Phase 1 investigation indicate the presence of some soils with existing acidity (actual plus retained) and potential acidity at various creek crossing locations along the Kangaroo Island Wetlands section of the proposed pipeline route (BH1 to BH7) as per Figure 1while the soil samples analysed from the Curtis Island locations indicated the presence of soils with existing acidity only (BH8 to BH10).

Based on the testing carried out to date, soils with actionable levels of actual acidity appear to be limited to BH1, BH7 and BH8, and soils with potential acidity appears limited to moderate levels in BH3 and BH4. However, there appears to be sufficient acid neutralizing capacity within the soils at BH3 to neutralise the potential acidity. It should also be noted that the soils with actual acidity also recorded negligible levels of potential acidity, suggesting the acidity in these soils is naturally inherent and not of a sulfidic origin.

Liming rates have been calculated in kg Aglime /m^3 using a factor of safety and fineness factor of 1.5 and an assumed bulk density of 1.8 tonne/m^3 and an assumed neutralising value of 97%. Liming rates are presented in Table 1 and are applicable in any instance where soils are to be disturbed in the vicinity of each location. The 95 percentile treatment rates are not available to be utilised within the creek crossing section due to the reduced number of samples analysed within this area.

Table 1; Liming Rates: Creek Crossing Section

Location	Depth	Soil Type	Treatment Rate
BH01	0 - 0.5m BGL	Gravel with trace Sand and Silt	4 kg Aglime/m^3
BH04	0.5 - 1.0 m BGL	Sandy Clay, generally grey, highly plastic	27 kg Aglime/m^3
BH08	0 - 0.5 m BGL	Silt Clay grey brown, medium plastic	9 kg Aglime/m^3
	0.5 - 1.25 m BGL	Gravelly Silt Clay pale grey, low plastic	5 kg Aglime/m^3

6.1.2. Phase 2 Investigation

The Phase 2 ASS investigation of the proposed Launch Pad indicates the presence of soils with actual acidity at all locations across the area with some minor retained acidity in BH14, BH16, BH17, BH18 and BH20. Based on the testing carried out to date, soils with actionable levels of actual acidity appear to be distributed uniformly laterally and vertically across the site (refer Figure 2). As with soils from Phase 1, soils with actual acidity recorded negligible levels of potential acidity, suggesting the acidity in most of the soils is naturally inherent and not of a sulfidic origin. While the flora and fauna of the local environment have adapted to these soils in their undisturbed condition, the excavation and placement of these materials can mobilise the acid and result in the release of acid leachate to the surrounding environment. A draft QASSIT discussion paper recommends lime treatment of these soils although thorough mixing of the soil with lime is not required. It is recommended that this approach be adopted for the management of naturally acidic, non-ASS excavated from the Launch Pad area if the naturally acidic, non-ASS will be used on site as 'fill' material. If these soils are to be transported off-site, lime neutralisation with mixing and verification testing, is required to be undertaken at a constructed lime treatment pad.

Where any excavated material is to be re-used on site as 'fill', a liming rate of 5 kg Aglime/m^2 is required to be adopted and shall be placed as a basal layer under residual soil fill zones. This value has been adopted based on the average net acidity across the site (with a factor of safety of 2.5). This lime guard layer shall be repeated for each fill layer of a thickness of 1 m or part thereof (e.g. where the fill height is 3.5 m, a basal layer of 5kg Aglime/m^2 and three intermediate layers of 5kg Aglime/m^2 are required). Further to the application of lime guard layers all fill placed on the site will be compacted under controlled conditions to reduce soil permeability, minimising infiltration and further reducing the potential for mild acid leachate.

Where excavated soil material from the Launch Pad area is designated to be transported 'off-site' nominal lime treatment, mixing and verification is required to be undertaken prior to transportation. Lime treatment rates have been calculated based on the 95th percentile of 'net acidity' results and the maximum 'net acidity' rates (refer to Table 2). Liming rates, based on the 95th percentile maximum 'net acidity' results at the Launch Pad have been calculated to be 13 kg Aglime/m^3 for the North East corner and 7 kg Aglime/m^3 for the remainder of the site (refer Figure 3). Utilising the reduced treatment rates is considered adequate given that the majority of the acidity is natural and not sulfur-derived and that there is negligible oxidisable sulfur in the samples.

Liming rates have been calculated in kg Aglime/t and kg Aglime/m^3 using a factor of safety and fineness factor of 1.5 and an assumed bulk density of 1.8 tonne/m^3. Liming rates are presented in Table 2 and are only applicable in any instance where soils are to be disturbed within the nominated areas are designated to be transported off site.

Table 2: Liming Rates Launch Pad Area (for off-site disposal)

Location	Depth	Soil Type	Treatment Rate 95 Percentile	Treatment Rate Maximum
North East Corner (BH16, BH17, BH18 and BH19)	0.0 m BGL to depth of excavation	All soil types encountered	13 kg Aglime/m^{3*}	16 kg Aglime/m^3
Remainder of Launch Pad	0.0 m BGL to depth of excavation	All soil types encountered	7 kg Aglime/m^{3*}	9 kg Aglime/m^3

* Calculated at 95 percentile.

Given the likely volume of soil to be excavated during the proposed development and the preliminary neutralisation rates indicated by ASS investigations, the site would be classified as requiring ***Extra High treatment*** (> 25 tonnes of agricultural lime (Aglime)) in accordance with Table 4 of the SPP 2/02 Guideline. ASS management procedures for the development are presented in Appendix C.

Provided all relevant issues are identified, and the proposed management technique is effectively implemented and monitored throughout the construction phase of the development, it is considered that there should be limited internal or external environmental impacts attributable to soils with existing or potential acidity.

The relevant issues, which are of significance when considering existing and potential acidity management for the construction phase of this development, are:

- Soils excavated for use as fill on or off site;
- Exposure of dewatered soils in open excavation;
- Temporary stockpile storage;
- Disposal of acidic water into non-acidic waterways; and

- Transport and handling of AASS/PASS for treatment.

Following construction, the issues relating to soils with existing acidity or potential acidity, which may cause environmental impacts in the long term, are largely related to water quality. The severity of these impacts will often depend on the success of the construction phase management techniques. It is anticipated that with appropriate implementation and monitoring of the ASS MP, there would be little or no detectable long-term impacts in the operational phase.

7. WATER QUALITY

During rainfall events or dewatering activities, uncontrolled runoff leaving the site could potentially cause turbid and acidic water to enter the stormwater system and adjacent waterways. Stockpiles, un-vegetated and unsealed ground are examples of sources with the potential to contaminate stormwater from the exposure of soil material with existing or potential acidity.

In the event that surface water is stored on site and requires discharging, a water quality monitoring program shall be adopted (outlined in Appendix D). A water quality sampling record form is presented as Form 2, Appendix B. Performance criteria for surface water exiting the site have been established using the generally adopted industry standards for surface water discharge into marine environments.

Baseline monitoring of the receiving environment at the release points will be undertaken as per the Receiving Environment Monitoring Program (REMP).

It should be noted that groundwater levels may fluctuate, depending on tides and especially during and following periods of heavy or prolonged rainfall. Groundwater will be monitored using a number of existing groundwater monitoring wells located across the site (Refer Figures 1 and 2).

8. CONTRACTOR MANAGEMENT

Contractors and their staff are required to comply with the provisions of the ASS MP at all times. During the project Environmental Induction and Training, all project personnel will be provided with an understanding of ASS responsibility, as outlined in the project 'Environmental Induction and Training Plan' (3380-SAIP-4-1.3-7002).

The 'Environmental Induction and Training Plan' will aim to instil environmental awareness in personnel and:

- Introduce and explain the duty of care required under the Environmental Protection Act 1994.
- Introduce the ASS MP and responsibilities it places on all contractors and consultants.

- Explain the various subordinate components of the ASS MP and the reporting and monitoring procedures of the ASS MP and how they work.

- Explain how to use the environmental procedures and plans in the ASS MP.

The content of the induction program will be endorsed and presented by the Environmental representative. The Contractor's environmental performance obligations shall be incorporated into the Contractor's conditions of work for the proposed development.

9. INSPECTION AND MANAGEMENT

ASS inspections will be carried out daily by the field environmental officer. This will be used to identify any areas of non-conformance or opportunities for improvement. Any environmental issues (non conformances) will be reviewed immediately and addressed in the weekly environmental report.

Monitoring is to be documented as outlined in Section 11.1 and monitoring programs will be modified as required based on the findings of site inspections and/or results of testing.

10. AUDITING OF THE ASS MP

10.1. Responsibilities

The pipeline and launch pad construction works will be audited for compliance with the ASS MP and its procedures by the environmental auditor (e.g. Golder). The environmental auditor will be appointed by Saipem.

It is the environmental auditor's responsibility to:

1. Provide an independent assessment of compliance with the Environmental Procedures in Appendices C and D.

2. Report on observed activities that have, or may cause an impact to the environment or non-conformance to regulation.

3. Provide recommendations to Saipem regarding practical initiatives that can be employed to improve the effectiveness of environmental management at the development site.

4. Provide a copy of the Audit Report to Saipem.

11. DOCUMENTATION AND REPORTING FRAMEWORK

The following documents relate to environmental performance and form part of the ASS MP.

1. Inspection and Monitoring Records (Appendix B of the ASS MP).
2. Environmental Procedures (Appendices C and D of the ASS MP).
3. Environmental Audit Reports.

11.1. Inspection and Monitoring Records

The frequency of Inspection and Monitoring from commencement of pipeline construction activities will be as follows:

- Daily until the excavation works for the pipeline and launch pad are completed.
- Within 24 hours of a significant rainfall event[2].

The outcome of the daily site walk through will be recorded on the Inspection and Monitoring form attached in Appendix B. Any monitoring that requires more frequent attention will be completed as required and recorded on the Inspection and Monitoring form.

Environmental issues (non-conformances) identified by field environmental officers in their daily inspection and monitoring programme will be reviewed and addressed immediately. Non-conformances identified during an audit are different from the daily inspection and monitoring and will be documented via an audit report. This is addressed in section 10.

The originals of these sheets shall be kept at the site office with copies maintained by the Environmental Administrative Officer. (Form 1 Appendix B).

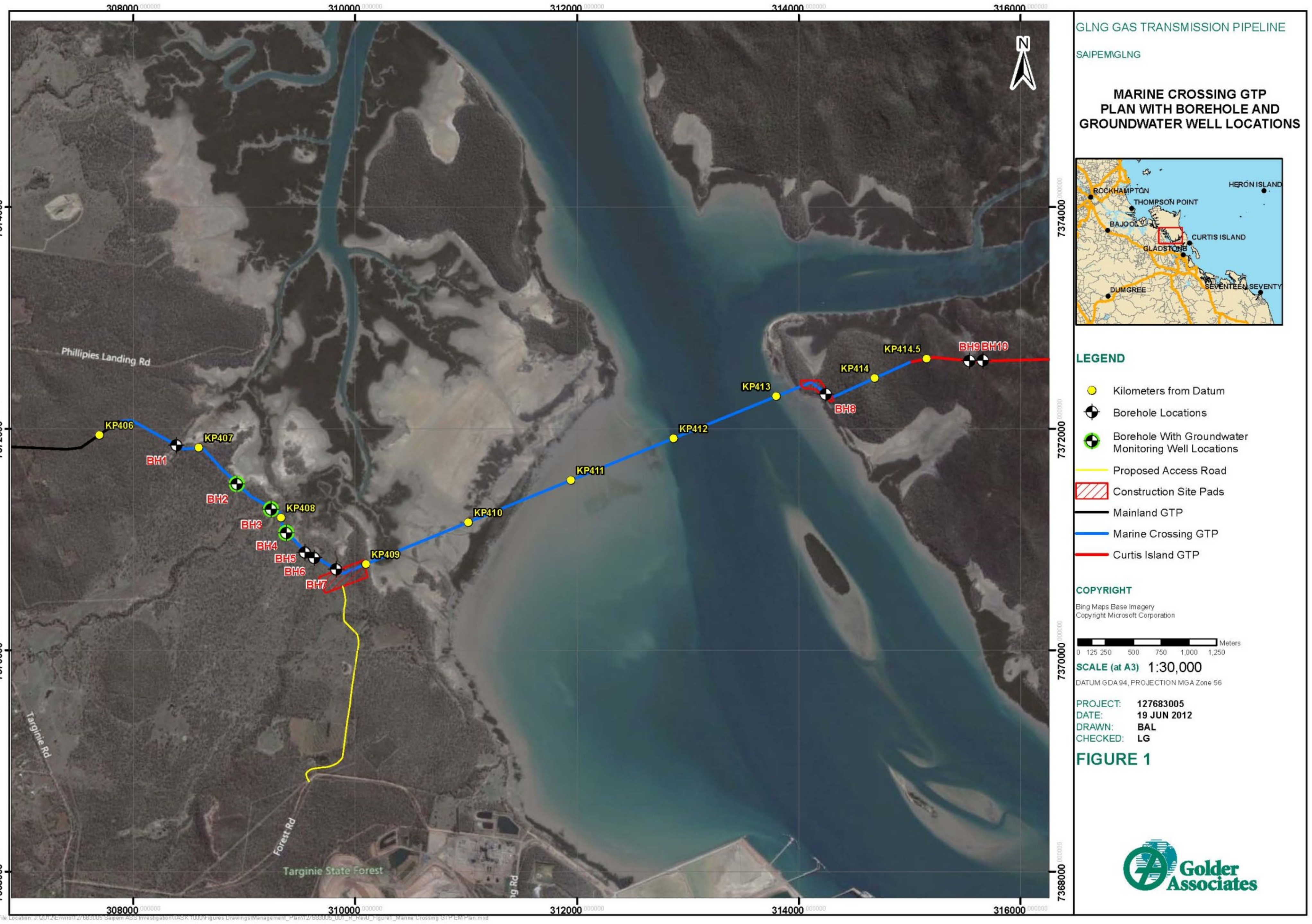
11.2. Audit Reports

Saipem will conduct internal audits and will appoint an independent auditor to carry out third party audits of the implementation of the ASS MP as required by the conditions set out in Environmental Authority No. PEN103428811.

A copy of the environmental audit report shall be provided to Saipem and a copy will be kept at the Site office and filed for future reference, if required.

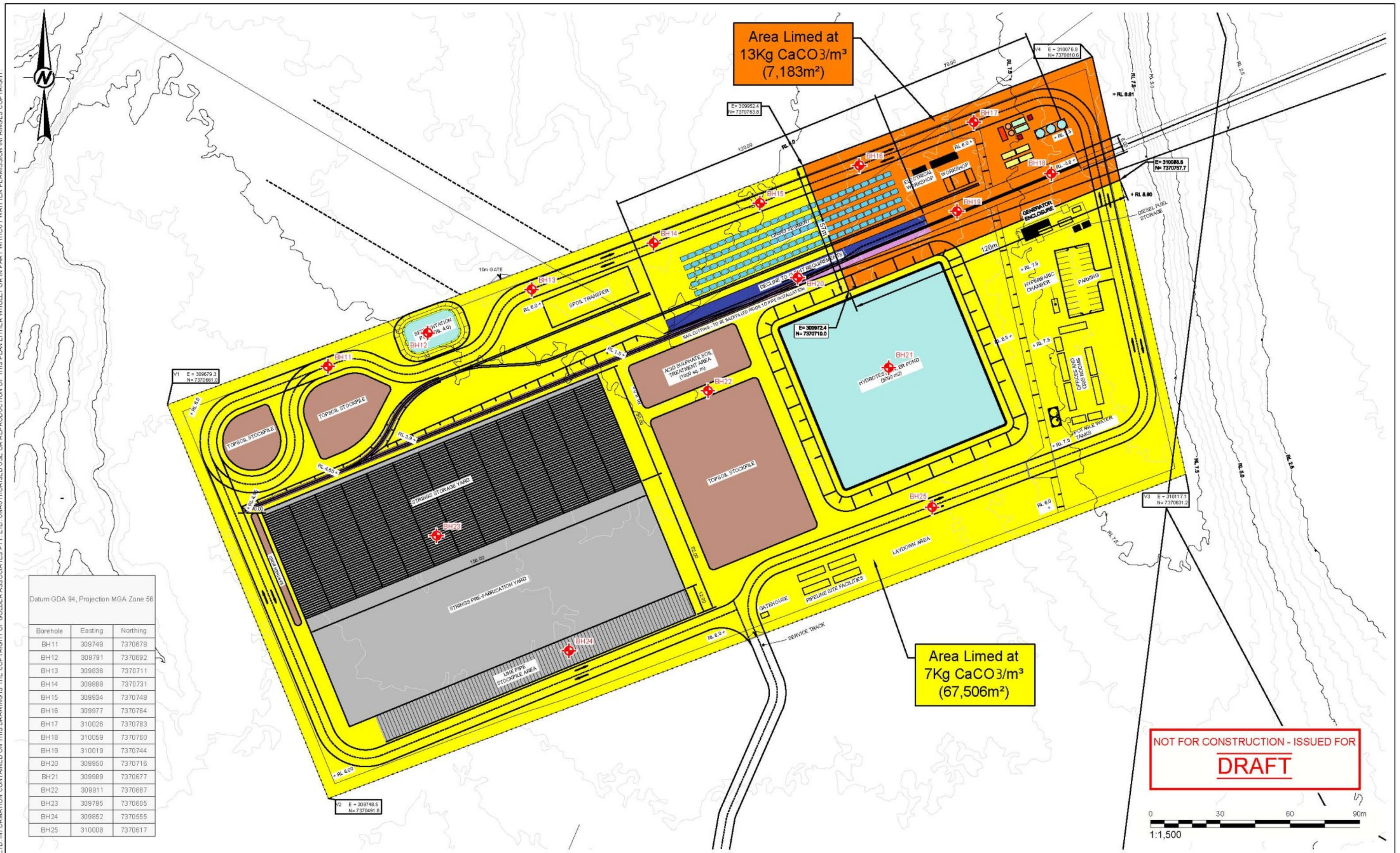
[2] Greater than 25mm of rainfall in 24 hours.

Saipem Australia Pty Ltd	SAIPEM JOB 032118	AREA 3380	Santos GLNG Project
	SPC. 10-AZ-E-85832		
	Sh. 16 of 48 / Rev. 0	Doc. class: 2	
Contract No. 897315	GLNG GAS TRANSMISSION PIPELINE		
	Company Doc. No. 3380-SAIP-4-3.3-1832		
	Document Title: Acid Sulfate Soil Management Plan, Gas Transmission Pipeline Route and Launch Pad		



Saipem Australia Pty Ltd	SAIPEM JOB 032118	AREA 3380	Santos GLNG Project
	SPC. 10-AZ-E-85832		
	Sh. 17 of 48	Doc. class: 2	
	Rev. 0		
Contract No. 897315	GLNG GAS TRANSMISSION PIPELINE		
	Company Doc. No. 3380-SAIP-4-3.3-1832		
	Document Title: Acid Sulfate Soil Management Plan, Gas Transmission Pipeline Route and Launch Pad		

Saipem Australia Pty Ltd	SAIPEM JOB 032118	AREA 3380	Santos GLNG Project
	SPC. 10-AZ-E-85832		
	Sh. 18 of 48 / Rev. 0	Doc. class: 2	
Contract No. 897315	GLNG GAS TRANSMISSION PIPELINE		
	Company Doc. No. 3380-SAIP-4-3.3-1832		
	Document Title: Acid Sulfate Soil Management Plan, Gas Transmission Pipeline Route and Launch Pad		



Datum GDA 94, Projection MGA Zone 56

Borehole	Easting	Northing
BH11	309748	7370678
BH12	309791	7370692
BH13	309836	7370711
BH14	309888	7370731
BH15	309934	7370748
BH16	309977	7370764
BH17	310026	7370783
BH18	310059	7370760
BH19	310019	7370744
BH20	309950	7370716
BH21	309989	7370677
BH22	309911	7370667
BH23	309795	7370605
BH24	309852	7370555
BH25	310008	7370617

LEGEND

- Borehole Location
- Area Limed at 7Kg $CaCO_3/m^3$ (67,506m²)
- Area Limed at 13Kg $CaCO_3/m^3$ (7,183m²)

NOTE:
Original Drawing provided by THIESS PTY LTD.

Golder Associates, www.golder.com, GOLDER ASSOCIATES PTY. LTD.	CLIENT: SAIPEM AUSTRALIA PTY LTD			PROJECT: SAIPEM ASS INVESTIGATION				
	DRAWN BY: BAL	DATE: 14.08.2012		DRAWING TITLE: DEVELOPMENT PLAN WITH TREATMENT RATES AND LOCATIONS				
	CHECKED BY: LG	DATE: 14.08.2012						
	SCALE: 1:1,500		SHEET SIZE: A3	PROJECT No: 127683005	DOC No: 001	DOC TYPE: R	FIGURE No: F003	REVISION: 0 FIGURE 3

Plot Date: 14 August 2012 Time 1:10:10 PM By: Lowes, Ben Path: J:\2012\Enviro\127683005 Saipem ASS Investigation\TASK 1000\Figures Drawings\CADD\Figures - File Name:127683005-001-R-Rev0-1000-Narrows_Crossing.dwg
Xref: GAP_LOGO-A3.dwg;

APPENDIX A
Petroleum Pipeline Licence (PPL) 167
Environmental Authority Conditions, Schedule D- Acid Sulfate Soils
And
Further Conditions stipulated by Department of Environment and Heritage Protection

GLNG – Marine Crossing Pipeline: Petroleum Pipeline Licence (PPL) 167, Permit Number; PEN103428811, Schedule D – Acid Sulfate Soils		
Item No.	**Condition**	**ASSMP reference**
D1	Acid Sulfate Soil Management Plans must be developed and implemented for the construction, decommissioning and rehabilitation of each section of the project as listed in *Schedule A – Table 1: Authorised Petroleum Activities*.	Doc. No. 3380-SAIP-4-3.3-1832
D2	The Acid Sulfate Soil Management Plans required by Condition (D1) must include, but not be limited to:	
(a)	The final construction methodology for the project based on the detailed design;	To be included once methodology is confirmed
(b)	Management, treatment and disposal of any excavated material potentially containing potential acid sulphate soils (PASS), including management of spilled material from excavation and transport;	Appendix C: C3, C4, C5, C6, C7 and C8
(c)	Management of any material potentially containing PASS that is displaced or dewatered by works to an extent that may result in oxidation through exposure to air or through loss of saturation, including any accidental disturbance of areas containing ASS and vertical or lateral displacement of sediment containing ASS;	Appendix C: C3, C4, C5, C6, C7 and C8
(d)	Management of any material potentially containing PASS excavated or disturbed during decommissioning or rehabilitation;	Appendix C: C3, C4, C5, C6, C7 and C8
(e)	Management of water within pits and trenches during construction, decommissioning and rehabilitation, including any treatment; source of water, treatment location, storage capacity, storage design, monitoring, discharge quality limits, discharge point, discharge management, monitoring, records and reporting to the administering authority;	Appendix D: D3, D4 and D5 Other specifics to be included once details are confirmed
(f)	Where disposal of material containing PASS relies on permanent saturation details of the following; I. Location and depth of disposal; II. Handling to prevent spillage or oxidation; and III. Existing or necessary permits and relevant information to support such permits	Not Applicable
(g)	Where disposal of material containing PASS will be by neutralisation, details of the following; I. Location; II. Design;	Appendix C & Appendix D Specific details

<table>
<tr><td></td><td>III. Neutralisation techniques (guard layer, liming rates, and process, contingencies, verification, records and reporting);
IV. Water management (storage capacity, monitoring, discharge quality limits, discharge point, discharge management, monitoring, records and reporting to the administering authority);
V. Disposal of treated material;
VI. Disposal of drain water; and
VII. Final rehabilitation of the site.</td><td>are still to be confirmed.</td></tr>
<tr><td>(h)</td><td>For PASS treatment pads, provide design drawings for PASS storage and treatment pads and the surrounding area to demonstrate;
I. Capacity to contain treated and untreated PASS plus a 100 year ARI daily rainfall event at the location throughout the period of use of the storage and treatment pads; and
II. Bund and storm water management system design to prevent failure of the bunds or sediment export resulting from erosion of the bunds or disturbed areas;</td><td>Appendix C: C3.
To Be Confirmed</td></tr>
<tr><td>(i)</td><td>Where disposal of material containing PASS will be by neutralisation, provide a commitment to competent specialist operators and supervision, with periodic strategic third party auditing and reporting to the administering authority.</td><td>Section 11.2 & C4, C5, C6, C7 and C8, Appendix C</td></tr>
<tr><td>(j)</td><td>A survey of all areas subject to excavation or disturbance consistent with;
I. State Planning Policy 2/02 Guideline: Acid Sulfate Soils;
II. Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland 1998 (CR Ahern, MR Ahern and B Powell 1998);
III. Acid Sulfate Soils Lbaoratory Methods Guidelines (CR Ahern, AE McElnea, LA Sullivan 2004); and</td><td>To Be Confirmed</td></tr>
<tr><td>(k)</td><td>The management of acid sulphate soils, as detailed in the Acid Sulfate Soils Management Plans, shall be consistent with the Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines (2002).</td><td>The ASS MP has been developed in accordance with Soil Management Guidelines (2002)</td></tr>
<tr><td>D3</td><td>The holder of the environmental authority must ensure petroleum activities are undertaken in accordance with the Acid Sulfate Soil Management Plans required by condition (D1)</td><td>Appendix C / Appendix D</td></tr>
<tr><td>D4</td><td>PASS or ASS material must only be placed in the designated Acid Sulfate Soils Treatment Area</td><td>Appendix C / Appendix D</td></tr>
<tr><td>D5</td><td>All areas used for storage or treatment of excavated material containing acid sulphate soil must be bunded, constructed, installed and maintained to;
(a) Prevent any release of contaminants through the bed or banks of the bunded area to any land or waters including ground water.
(b) Ensure a freeboard to retain a 100 year ARI 24 hour rainfall event; and</td><td>C3, Item 9 Appendix C</td></tr>
</table>

	(c) Ensure the stability of the bunds during a 100 year ARI 24 hour rainfall event.	

GLNG – Marine Crossing Pipeline ASS MP: Department of Environment and Heritage Protection (DEHP) Conditions

Item No.	Condition	ASSMP Reference
14.	At least thirty (30) business days prior to commencement of construction works applicable to this approval the proponent must submit to the administering authority for approval an ASSMP consistent with the following documents: a) State Planning Policy 2/02 Guideline: Acid Sulfate Soils; b) Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland 1998; and c) Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines, 2002	Doc. No. 3380-SAIP-4-3.3-1832
15.	The ASSMP must be approved by the administering authority prior to construction works commencing.	To Be Advised
16.	The ASSMP must be implemented over the full period of construction, and for a period after completion construction as defined by the ASSMP.	To Be Advised
17.	Any amendments made to the ASSMP must be approved by the administering authority prior to implementation, unless the change is essential to prevent environmental harm in which case the administering authority must be notified of the change within 24 hours.	To Be Advised
18.	Construction activities shall not directly or indirectly cause the release of acidic water (pH less than 6.5) from the site to waters as a result of oxidation of potential acid sulphate soils resulting from excavation, displacement, or changes to groundwater levels.	Appendix D: D3

APPENDIX B

FORMS

FORM 1: INSPECTION AND MONITORING

Environmental Procedure:--		
Responsible Person:________________________________		
The following items are to be addressed during the weekly management inspection.		
Date of Inspection:		
Weather during preceding 24 hours (to include mm rainfall):		
Personnel present during inspection:		
ITEM	**INSPECTION AND MONITORING/ENVIRONMENTAL ACTIVITY**	**CHECKED**
1.		
2.		
3.		
4.		
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11.		

FORM 2: WATER SAMPLING RECORD FORM

Date:	
Time:	
Sampled By:	
Location:	
Volume of Discharge:	
Turbidity (NTU)	
Surface Scum / Oil (Visual)	
Suspended Solids (Lab analysis)	
pH	
Conductivity mS/cm	
Temperature °C	
Salinity ppk	
Dissolved Oxygen % sat	
Aluminium (dissolved) mg/L	
Iron Total mg/L	
Iron (dissolved) mg/L	
Comments	
Do these results conform with those outlined within Appendix D Water Quality Monitoring Procedure (Y/N)	
If not, action taken:	

FORM 3: EXCAVATED MATERIAL LIMING VERIFICATION FORM

Date:	
Time:	
Recorded By:	
Excavation Location:	
Treatment Required	Yes / No (circle)
If 'Yes', treatment Location:	At treatment pad In basal layers (circle)

For soils to be treated at the lime treatment pad, complete form 3A. For soils excavated from the Launch Pad area that will remain on-site, complete Form 3b.

FORM 3A: LIME TREATMENT PAD - LIME TREATMENT AND VERIFICATION FORM

Stockpile Location and Number:	
Volume of stockpile:	
Nominated liming rate:	
Date of Treatment:	
Volume of Aglime added:	
No of verification tests and sample name	
Date verification tests taken	
Results of Verification	
Net Acidity (mole H+/t)	
Required liming rate (lab results)	
Is further liming required (y/n)	
Liming rate required**	

**Further liming rate required = liming rate required (above) multiplied by factor of safety (1.5) by bulk density (1.8 t\m3)*

FORM 3B: ON- SITE REUSE – LIME APPLICATION TO BASAL LAYERS

Volume of excavated soil:	
Details of long-term location of excavated soil :	
Date of material transfer:	
Dimensions of re-interred material	
Rate of Aglime added:	

APPENDIX C

ACID SULFATE SOILS MANAGEMENT PROCEDURES

C1. ENVIRONMENTAL VALUES

To avoid potential adverse effects on the natural and built environment (including infrastructure) and human health.

C2. OBJECTIVES

To meet the requirements of State and Local Government Legislation and Regulations, specifically:

1. Environmental Protection Act, 1994.
2. Environmental Protection (Water) Policy, 2009.
3. The ANZECC 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality - 2000'.
4. State Planning Policy 2/02, 'Planning and Managing Development involving Acid Sulfate Soils'.
5. Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines 1 (Version 3.8).
6. QASSIT "Guidelines for Sampling and Testing Lowland Acid Sulfate Soils in Queensland - 1998"

C3. ENVIRONMENTAL CONTROL MEASURES

The following provides a list of the environmental control measures for the management of soils with existing or potential acidity at the site.

Environmental Control Measure	Responsibility
1. Saipem is to appoint a full time Environmental Representative to supervise and report on environmental management of the construction works.	Environmental Officer
2. Any complaints, sightings of indicators of acidic soil damage or other environmental incidents, are to be recorded together with any resulting investigation or response and reported to Saipem.	Environmental Officer
3. Site access and all records must be made available to regulators on official business at all times (if requested).	Environmental Officer
4. Induction training/awareness to be provided to all site staff and contractors engaged in pipeline and launch pad construction works. An emphasis should be placed on the field recognition of soils with existing or potential acidity on the site. The scope of training should also include: ■ An outline of the sensitivity of the area to environmental harm; ■ The potential for acid generation on the site and its potential impacts; ■ Details of the management strategies in place for soils with existing or potential acidity; ■ Responsibilities of individuals in the implementation of the management strategies; ■ Descriptions of soils with existing or potential acidity and how to identify them on site;	Environmental Officer

■ ASS sampling and handling techniques; ■ Steps to be taken if soils with existing or potential acidity are to be disturbed; and ■ Details of reporting and monitoring responsibilities.	
5. Accurate and current records must be maintained for all testing, treatment and site monitoring undertaken in the management of soils with existing or potential acidity. Records are to consist of: ■ Volumes of excavated soil; ■ Laboratory testing results; ■ Liming dosage rates; ■ Location of placement of fill on or off-site; and ■ Surface water and groundwater water testing results.	Environmental Officer
6. All surface water run-off and groundwater seepage within excavations is to undergo treatment, if required, for quality correction prior to off-site discharge, or reuse on site.	Environmental Officer
7. Maintain an adequate supply of Aglime ($CaCO_3$) on-site at all times. The supply should be stored in a covered and bunded area to prevent accidental release and located away from any footpaths, stormwater drains and vehicle and pedestrian traffic areas. *A secondary supply of ~10 kg of hydrated lime shall be kept on-site for the treatment of acidic waters (i.e. pH<6). Treatment rate of acidic water is to be in accordance with SPP 2/02. Small amounts of lime should be trialled to prevent over dosing.	Environmental Officer
8. Wherever practical, earthworks handling is to involve transport directly from cut to treatment/fill area.	Environmental Officer
9. Treatment pads are to be contained by bund walls, constructed and maintained with clean material (i.e. not ASS or acidic soils of fully lime treated soils). ■ Excavated PASS/AASS soil will be stockpiled on treatment pads for lime treatment and testing. ■ Treatment pads are to be located adjacent to the proposed excavation area (where possible) with any leachate being directed to the sedimentation pond for quality correction prior to off-site discharge or re-use on site. ■ Treatment Pads are to ensure a freeboard to retain a 100 year ARI 24 hour rainfall event (extrapolated from Bureau of Metrology (BoM) *Rainfall Intensity Frequency Duration* (IFD) program as an intensity of approximately 18mm/hr); and ■ Treatment Pad bund walls should also be constructed and maintained to withstand a 100 year ARI 24 hour rainfall event.	Environmental Officer
10. Verification Testing and Monitoring - Movement of stockpiles and lime treatment are to be recorded in Form 3 (Appendix A). A copy of this form shall be provided by the Environmental Officer to Saipem on a weekly basis or immediately in the case of emergencies or significant non-conformance. Appropriate management and verification of all soil is to undertaken with appropriated records kept.	Environmental Officer
11. Weekly water monitoring reports are to be maintained on site for review by the regulators, at their request with a copy provided to Company on a weekly basis or immediately in the case of	Environmental Officer

emergencies or significant non-conformance.

C4. LIME APPLICATION RATES AND METHODOLOGY

The following procedure applies to the treatment of excavated soils on site, either to be exported from the site, or reused as fill.

A number of key assumptions will be considered in calculating liming rates from test results, via:

- Material dry bulk density of 1.8 t/m^3
- Use of a minimum safety factor of 1.5.
- Use of a minimum finess factor of 1.5.
- The neutralising value of 97% the selected liming product.

Indicative liming rates, formulated from the results of the Phase 1 and Phase 2 investigations, are provided below and are applicable in any instance where soils are to be disturbed.

Within the creek crossing section of the pipeline route, liming rates are applicable to a 50 m radius of each corresponding borehole location. Excavations outside each radius will require further investigations/analysis to determine liming rates. Excavations that occur below the preliminary investigation depth of 2.0 m BGL will also require additional field testing and laboratory analysis to determine appropriate lime treatment rates.

Liming Rate; Pipeline Route, Creek Crossing Section			
Location	**Depth**	**Soil Type**	**Treatment Rate**
BH01	0 - 0.5m BGL	Gravel with trace Sand and Silt	4 kg Aglime/m^3
BH04	0.5 - 1.0 m BGL	Sandy Clay, generally grey, highly plastic	27 kg Aglime/m^3
BH08	0 - 0.5 m BGL	Silt Clay grey brown, medium plastic	9 kg Aglime/m^3
	0.5 - 1.25 m BGL	Gravelly Silt Clay pale grey, low plastic	5 kg Aglime/m^3

Within the Launch Pad site the following procedures apply to the treatment of excavated soils on site, either to be exported from the site, or reused as fill.

Where excavated soils are to be re-used on site for 'fill', a liming rate of 5 kg Aglime/m^2 is required to be adopted and shall be placed as a basal layer under residual soil fill zones. This lime guard layer shall be repeated for each fill layer of a thickness of 1 m or part thereof (e.g. where the fill height is 3.5 m, a basal layer of 5kg Aglime/m^2 and three intermediate layers of 5kg Aglime/m^2 are required) (refer figure C4). Further to the application of lime guard layers, all fill placed on the site will be compacted under controlled conditions to reduce soil permeability, minimising infiltration and further reducing the potential for mild acid leachate.

For excavated soils from within the Launch Pad site that are designated to be exported from the site, the indicative liming rates provided below apply.

Liming Rate: Launch Pad (Off-site Disposal)				
Location	**Depth**	**Soil Type**	**Treatment Rate (95 Percentile)**	**Treatment Rate (Maximum)**
North East Corner (BH16, BH17, BH18 & BH19)	0.0 m to depth of excavation	Silty CLAY generally yellow brown to pale grey, highly plastic	13 kg Aglime/m^3**	16 kg Aglime/m^3
Remainder of the Launch Pad	0.0 m to depth of excavation	Silty CLAY generally grey to brown, medium to highly plastic	7 kg Aglime/m^3**	9 kg Aglime/m^3

** Calculated at 95 percentile.

Lime treatment is to be undertaken in accordance with Figure C1, Figure C2, Figure C3, and Figure C4 below.

Figure C1: Lime Application for Soils with Existing Acidity and Potential Acidity

Existing Acidity / Potential Acidity

↓

Soil Spreading
Spread excavated soil in layers with a maximum 300 mm loose thickness.

↓

Mechanical Mixing
Mechanically turn the soil to promote thorough mixing through the full depth of the layer.

↓

Maintain Moisture
Maintain soil moisture through:(i) controlled irrigation or (ii) covering with plastic (reduce evaporation) or (iii) application of lime soon after excavation of moist soils. These measures will improve the dispersion of lime throughout the soil profile

↓

Lime Application
* Add and thoroughly mix lime (again using appropriate mechanical means eg. a disk plough or harrows) using the calculated liming rate

Maximum Exposure Time Before Treatment – 18 hours (overnight)

Figure C2 Schematic cross-section of a treatment pad, including a compacted clay layer, guard layer, leachate collection system and containment with bund

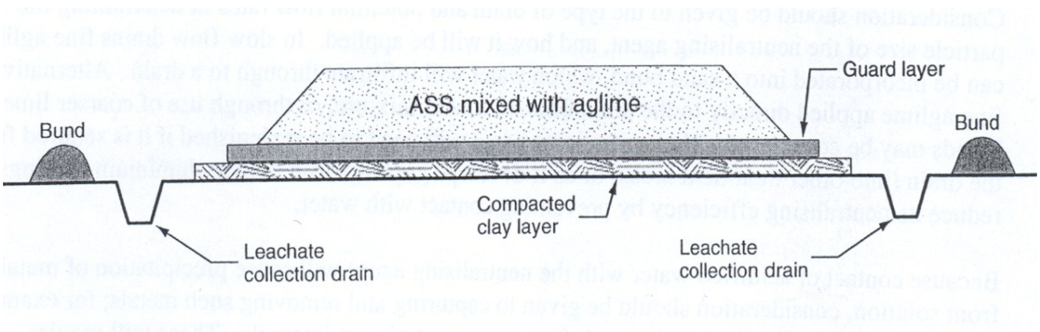


Figure C3 Lime Guard Application – Trenching

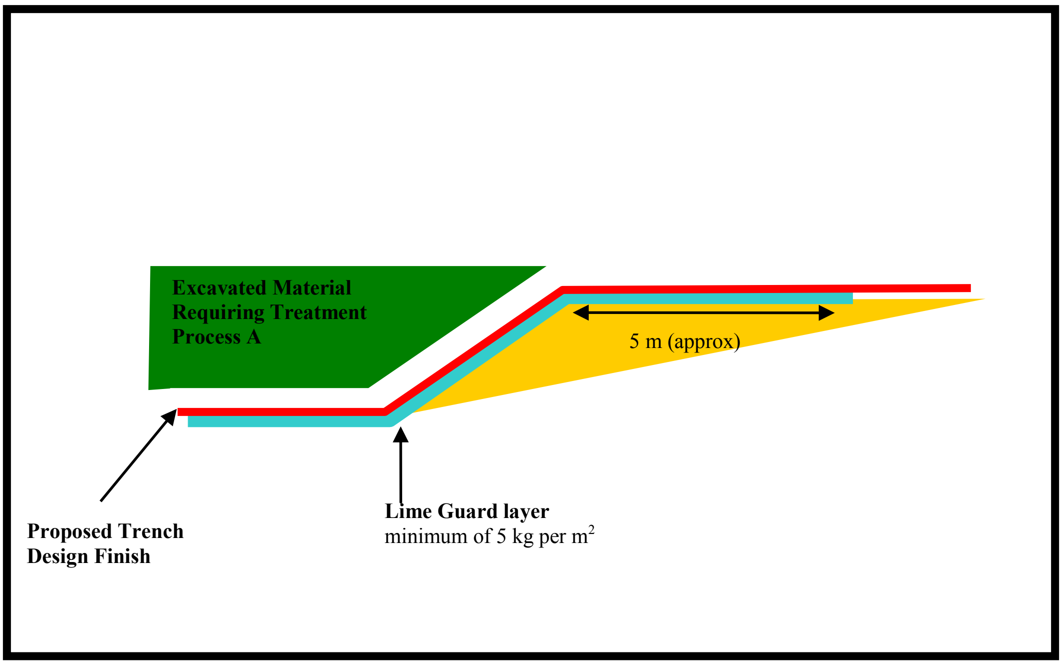
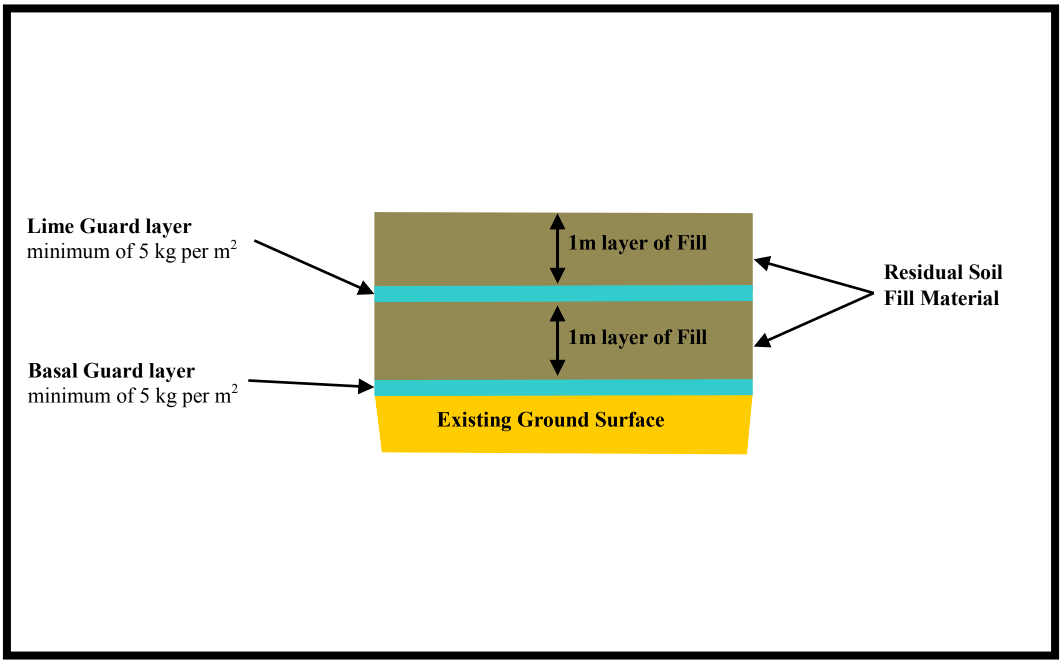


Figure C4; Application of Lime Guard Layers – Residual Soil Fill



C5. MANAGEMENT FOR STOCKPILES, HANDLING AND TRANSPORT

The following provides a list of the management strategies, in addition to those detailed in section C3 for the stockpiling and handling of soils with existing or potential acidity at the site.

Management Strategy	Responsibility
1. Wherever practical the earthworks handling should involve transport directly from cut to treatment/fill areas and stockpiling of untreated soils with existing or potential acidity should be avoided. The recommended maximum time period for which soils can be temporarily stockpiled without treatment is 18 hours (overnight).	Environmental Officer
2. Where it is necessary to transport AASS/PASS material to the proposed treatment facility the following management measures must be followed: ■ Due care is to be taken when transporting saturated /supersaturated soils and sediments (e.g. wet silty/sandy material). Where practicable a restricted maximum load (i.e. 2/3 of skip) is to be adopted with excavated material (saturated /supersaturated soils) is transported in an appropriately lined and covered muck skip to avoid spilling and sloughing. ■ The transport contractor will be responsible for maintaining the site and the transport route free of spilled and sloughed ASS sediments. All such spilled sediments are to be regularly (daily) collected and transported to the designated treatment area for neutralisation.	Environmental Officer
3. Where it is necessary to stockpile untreated soil for moderate periods (up to 1 week) the following additional management measures must be followed: ■ Stockpiles are to be contained by bunds with stormwater runoff directed to a collection sump. Bunds are to be constructed from low permeability materials that are not ASS or have been fully lime treated. ■ A guard layer of neutralising agent (5 kg/m^3) should be spread across the soil surface prior to placement of the stockpile. The rate of neutralising agent applied should be based on 0.3 times the average total potential plus existing acidity for every 1 m height of soil in the stockpile. ■ The surface area of the stockpile is to be minimised by shaping and possibly capping or covering to prevent moisture loss and rainfall entry. ■ Keep the surface of the stockpile moist using a spray of water or neutralising solution with care to avoid over-wetting.	Environmental Officer

C6. MANAGEMENT FOR EXCAVATIONS

The following provides a list of management strategies for trenching and excavations.

Management Strategy	Responsibility
1. As a general practice in trenching operations, stockpiles of excavated material should be left exposed for the minimum practical time before being treated and/or replaced beneath the permanent groundwater table before oxidation can occur. ■ The Guidelines recommend reburial below the permanent water table within 18 hours (overnight). This can be effectively managed by staging excavation operations into short sections of work that are kept open for limited time periods (i.e. overnight or <18 hours). ■ Any trenches left exposed at the end of shift must have a lime guard layer applied at a nominal rate of 5kg/m^2 to prevent the oxidation of any pyritic sediment and mitigation of leachate.	Environmental Officer
2. For minor trenching excavations the following backfilling techniques will be adopted; ■ A guard layer applied at a nominal rate of 5kg/m^2 shall be applied adjacent to and on the up-side gradient of the proposed trench excavation works prior to placement of excavated materials. ■ Excavated materials will be stockpiled for the shortest possible time on the limed area adjacent to the trench. ■ Lime shall be applied to the base of the excavation at a rate of 5 kg/m^2 prior to backfilling with limed materials. ■ Excavated material shall be limed at the nominated rate during backfilling to achieve mixing. The highest liming rate, as determined by laboratory analysis within location, shall be adopted for backfilling of representative materials for a 50 m length. ■ Excess material that cannot be backfilled into the trench to below ground level shall be transported to the designated bunded stockpile/treatment area for lime treatment. ■ Where practicable, stockpiling and liming should not be conducted in areas directly adjacent to watercourses or drainage channels.	Environmental Officer
3. Due to the anticipated variable depth of groundwater throughout the site, there is a level of uncertainty in relation to batter slope angles during excavations. This has the potential to increase excavation quantities and the volume of ASS treatment required, while also slowing excavation production rates and extending ASS exposure times. This can be effectively managed by staging excavation operations into short sections of work (in so far	Environmental Officer

as is reasonable) that are kept open for limited durations.	
4. To counteract the effect of drawdown on the surrounding soil (cone of depression) during excavations, it is recommended that re-watering strategies are implemented (such as recharge) circulating groundwater back behind sheet piles (if required) to negate the possible impacts of lowered groundwater levels and the potential oxidation of surrounding sediments.	Environmental Officer
5. The rate of groundwater seepage is expected to vary depending on the subsurface conditions, prevailing weather conditions, the proximity to local watercourses and tidal phases. Should groundwater inflow be considered too excessive during excavations, alternative construction methodologies will be considered, such as; adopting buoyancy control on the pipe to enable it to be laid in a wet trench or temporary shoring using sheet piling to minimise the extent of groundwater drawdown and limit seepage into the trench. This helps mitigate the possible impacts of lowered groundwater levels and the potential oxidation of surrounding sediments.	Environmental Officer
6. All waters collected from groundwater and surface water inflow into excavations via seepage and runoff must be retained, monitored and appropriately treated to comply with the appropriate discharge criteria (Appendix C) prior to discharge off site or re-use on site.	Environmental Officer
7. Where practicable groundwater levels and water quality within the cone of depression should be monitored during and after dewatering activities (if applicable).	Environmental Officer

C7. INSPECTION AND MONITORING

The results of the following activities are to be recorded.

Activity	Frequency	Responsibility
1. Maintain photographic record of site development works associated with soil movements.	As required	Environmental Officer
2. Maintain records tracking soil movements around the site including diagrams, volumes and soil descriptions for stockpiles in temporary storage areas as well as final placement sites.	As required	Environmental Officer
3. Inspect the condition of stockpile batters, drains, open trenches and structure excavations.	Weekly or following rainfall	Environmental Officer
4. Maintain record of lime dosing and quantities of lime brought onsite.	Per dose	Environmental Officer
5. Undertake testing of surface water and groundwater in accordance with Appendix D Section D4 and D5.	Weekly	Environmental Officer

C8. PERFORMANCE INDICATORS

Item	Performance Indicator
1. Verification of lime treatment	Verify the effectiveness of lime treatment by undertaking Chromium Reducible Sulphur (CRS) analysis of treated soils at a rate of 1 test per 250 m^3. The lime-treated material is to have a 'net acidity' of no greater than 10 mole H+/t, acid neutralising capacity (ANC) of not less than 1.5 times the existing plus potential acidity and a pH after neutralisation (pH_{KCl})of greater than or equal to 6.5. CRS analysis is to be undertaken by suitability equipped NATA accredited laboratory.
2. Surface water and groundwater	Refer Environmental Measures in Appendix C.
3. Photographic Record	No obvious degeneration of the aesthetic value of the open-space that may be possibly attributed to acid leachate.
4. Non-conformance	All non-conformances are to be reported to the Environmental Officer and rectified as soon as is practical.

APPENDIX D

WATER QUALITY MANAGEMENT PROCEDURES

D1. ENVIRONMENTAL VALUES

The protection of surrounding surface water and groundwater.

D2. OBJECTIVES

1. Limit environmental impact on adjacent properties.

2. Control potential sources of contaminated stormwater.

3. Limit the quantity of soil lost during earthworks activities.

4. Manage all discharges of water from the earthworks site.

5. Comply with Environmental Protection (Water) Policy 2009, and local council laws, codes and policies.

6. Use the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 for the protection of environmental values.

7. International Erosion Control Association Australasia, Best Practice Erosion and Sediment Control, Book 1 to 3 (November 2008).

D3. ENVIRONMENTAL CONTROL MEASURES

The following provides a list of the environmental control measures for management of surface water and groundwater at the site.

Environmental Control Measure		Responsibility
1)	The velocity of stormwater over the site will be reduced where gradients exist by the installation of retarding structures, such as silt fences.	Environmental Officer
2)	Release of water off-site will take place at the approved release points only (Table D1). Water quality monitoring will be undertaken in accordance with D4.	Environmental Officer
3)	All surface water run-off and groundwater seepage within excavations is to undergo treatment, if required, for quality correction prior to off-site discharge, or reuse on site.	Environmental Officer
4)	[Small amounts of] Hydrated lime will be kept on site at all times for pH adjusting of waters before discharging.	Environmental Officer
5)	Surface water not meeting suspended solids discharge performance criteria will be filtered, or flocculated before discharge.	Environmental Officer

6)	All waters being discharged off site must not cause discoloration of receiving waters.	Environmental Officer
7)	Discharges of water from site must not cause measured levels of water pollutants (other than specified in D5) in the receiving waters to fall outside acceptable ranges specified in the ANZECC 2000[3] guidelines.	Environmental Officer
8)	Stockpiles when not in use will be watered to minimise dust emissions and not placed on paths, or stormwater drains.	Environmental Officer
9)	Assess baseline receiving water quality (including dissolved Fe and Al) at release point as part of the REMP prior to commencement of soil disturbance activities.	Environmental Officer

Table D1: Contaminant Release Points, Sources and Receiving Environments

Release Points	Coordinates		Contaminant Source and Location	Description of Receiving Environment
	Northing	Easting		
HCN	308390.7	7371840.3	Pipeline trench water, Stormwater from the Mainland Construction Pad	Humpy Creek, The Narrows, Port Curtis
HCS	309262.9	7371269.4	Pipeline trench water, Stormwater from the Mainland Construction Pad	Humpy Creek, The Narrows, Port Curtis
TC	309639.5	7370837.9	Pipeline trench water, Tunnel seepage water, Stormwater from the Mainland Construction Pad, acid sulfate soil leachate from Treatment Pad Area	Targinie Creek, The Narrows, Port Curtis
CI	314168.0	7372302.8	Stormwater from the Port Curtis Construction Site Pad area	The Narrows, Port Curtis

[3] Australian and New Zealand Guidelines for Fresh & Marine Water Quality, 2000.

D4. INSPECTION AND MONITORING

The following inspection and monitoring program will be conducted at the site.

Activity	Frequency	Responsibility
1) Inspect disturbed areas for signs of land erosion or deterioration	■ Daily ■ After each major rainfall event[4]	Environmental Officer
2) Inspect stockpiles for sediment loss	■ Daily	Environmental Officer
3) Inspect location, design and stormwater protection of stockpiles so that sediment is not deposited into the stormwater system	■ Daily ■ After each major rainfall event[5]	Environmental Officer
4) Check that all sediment fences and erosion control mechanisms are working during rain periods	■ Daily ■ After each major rainfall event[5]	Environmental Officer
5) ASS Treatment Pad Water monitoring (locations to be confirmed i.e. release points, sedimentation pond and treatment tanks) ■ Turbidity (NTU) ■ Total Petroleum Hydrocarbons (visual) e.g. hydrocarbon film, oil, floating scum and litter ■ pH, Electrical Conductivity, Dissolved Oxygen ■ Aluminium and Iron (dissolved)	Minimum monitoring frequency: ■ Immediately prior to discharge and daily during discharge events ■ Monthly during periods of no release ■ Periods of no release must be recorded	Environmental Officer
	Minimum monitoring frequency	

[4] >25mm of a rainfall within a 24 hour period

■ Petroleum Hydrocarbons C6 – C9 (mg/L) ■ Petroleum Hydrocarbons C10 – C36 (mg/L) ■ Total Petroleum Hydrocarbons (mg/L) ■ Total Suspended Solids All results to be kept in the site office and presented to NRM on request	■ Monthly during periods of no release ■ Immediately prior to discharge and weekly during discharge events ■ Periods of no release must be recorded	
6) Trench Water monitoring (locations to be confirmed i.e. release points, sedimentation pond and treatment tanks) ■ Turbidity (NTU) ■ Total Petroleum Hydrocarbons (visual) e.g. hydrocarbon film, oil, floating scum and litter ■ pH ■ Dissolved Oxygen (mg/L)	Minimum monitoring frequency: ■ Immediately prior to discharge and daily during discharge events ■ Monthly during periods of no release ■ Periods of no release must be recorded	Environmental Officer
■ Petroleum Hydrocarbons C6 – C9 (mg/L) ■ Petroleum Hydrocarbons C10 – C36 (mg/L) ■ Total Petroleum Hydrocarbons (mg/L) ■ Total Suspended Solids All results to be kept in the site office and presented to NRM on request	Minimum monitoring frequency ■ Monthly during periods of no release ■ Immediately prior to discharge and weekly during discharge events ■ Periods of no release must be recorded	

7) During construction groundwater (locations and numbers of monitoring wells yet to be determined) will be tested for: pH, conductivity, Aluminium (dissolved), Iron (dissolved) and Groundwater Level All results to be kept in the site office and presented to NRM on request	■ 6 times over 1 month prior to earthworks (baseline) ■ Weekly during earthworks ■ 4 times over 4 weeks following completion of works	Environmental Officer

D5. PERFORMANCE CRITERIA

Item	Performance Indicator	
1. Release Water from ASS Treatment Pad at Contaminant Release Points (refer to Table D1)	pH	Within the range of 6.5–9 pH units
	Dissolved Oxygen	>4.0 mg/L
	Total Suspended Solids (mg/L)	Monitor Only
	Turbidity (NTU)	<60 NTU
	Dissolved Iron*	<0.3 mg/L
	Dissolved Aluminium*	<0.2 mg/L
	Oil, Grease, floating scum, litter	No visible plume or hydrocarbon film
	Total Petroleum Hydrocarbons (mg/L)	<10 mg/L
	Petroleum Hydrocarbons C6-C9 (mg/L)	Monitor Only
	Petroleum Hydrocarbons C10-C36 (mg/L)	Monitor Only

2. Release Water from Trenching Operations at Contaminant Release Points (refer to Table D1)	pH Dissolved Oxygen Total Suspended Solids (mg/L) Turbidity (NTU) Oil, Grease, floating scum, litter Total Petroleum Hydrocarbons (mg/L) Petroleum Hydrocarbons C6-C9 (mg/L) Petroleum Hydrocarbons C10-C36 (mg/L)	Within the range of 6.5–9 pH units >4.0 mg/L Monitor Only <60 NTU No visible plume or hydrocarbon film Monitor Only Monitor Only Monitor Only
3. Groundwater	pH Aluminium (dissolved) Iron (dissolved)	Baseline (pH<5.5) - 0.3 pH unit change below the lower baseline range and an upper limit of 8.5. Baseline (pH 5.5 to 8.5)-1 pH unit change below the lower baseline range and an upper limit of 8.8 Baseline (pH >8.5)- 0.3 pH unit change above the upper baseline range and a lower limit of 6.5 +/- 10% of baseline range +/- 10% of baseline range
4. Surface Water Control System	All control systems are maintained in good working order. Surface water is separated from disturbed and undisturbed areas.	
5. Stockpiles	Location and design of stockpiles meets all control measures. Stormwater protection of stockpiles is maintained, effective and in good working order.	
6. Non conformance	All non-conformances are reported and rectified.	

D6. CORRECTIVE MEASURES

Item	Corrective Measure
1. Release of contaminants to waters	The release of contaminants to waters from the release points must be monitored at the locations specified in Table 1: Contaminant Release Points, Sources and Receiving Environment (as per the EA) for each quality characteristic and at the frequency specified in D4.
2. Iron and Aluminium	If the concentration of iron and aluminium exceed the trigger values specified in D5 when measured at the monitoring points specified in Table 1: Contaminant Release Points, Sources and Receiving Environment, the following action must be taken; a) Where the receiving environment results are the same or higher than the measured concentration of iron and/or aluminium no action is to be taken; or b) Where the measured concentration of iron and/or aluminium exceed the receiving environment results an investigation in accordance with the ANZECC and ARMCANZ 2000 guidelines must be undertaken, with a written report provided to the administering authority within 30 business days of obtaining written confirmation of results, outlining: i. details of the investigation carried out; and ii. actions taken to prevent environmental harm.
3. Iron and Aluminium Trigger value exceedances	Where an exceedance of a trigger value for investigation has occurred and is being investigated, in accordance with D6 (2) (b) (ii), no further reporting is required for subsequent trigger events for that quality characteristic.

APPENDIX E
PHASE 2 - ACID SULFATE SOIL INVESTIGATION REPORT

August 2012

PHASE 2 - ACID SULFATE SOIL INVESTIGATION

Santos GLNG Launch Pad - The Narrows, Gladstone

Submitted to:
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PO Box 10501
Brisbane Qld 4000
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REPORT

Report Number. 127683005-008-R-Rev0

Distribution:

1 Copy - Saipem Australia Pty Ltd (email)

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Golder Associates

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FIGURES

APPENDICES

Glossary

AASS	Actual Acid Sulfate Soils
AHD	Australian Height Datum
ALS	Australian Laboratory Services
ANC	Acid Neutralising Capacity
ANC_E	Excess Acid Neutralising Capacity
ASS	Acid Sulfate Soils
CSG	Coal Seam Gas
DERM	[Former] Queensland Department of Environment and Resource Management
DEHP	Department of Environment and Heritage Protection
EMP	Environmental Management Plan
GLNG	Gladstone Liquefied Natural Gas Project
GTP	Gas Transmission Pipeline
NATA	National Association of Testing Authorities
PASS	Potential Acid Sulfate Soils
pH_F	Field pH
pH_{FOX}	Field Oxidised pH
pH_{OX}	Oxidised pH
QASSIT	Queensland Acid Sulfate Soils Investigation Team
ROW	Right of Way
S_{CR}	Chromium Reducible Sulfur
S_{NAS}	Net Acid Soluble Sulfur
S_{POS}	Peroxide Oxidisable Sulfur
SPOCAS	Suspension Peroxide Oxidation Combined Acidity and Sulfate
SPP 2/02	State Planning Policy 2/02 - "Planning and managing development involving acid sulfate soils"
TAA	Titratable Actual Acidity
TPA	Titratable Peroxide Acidity
TSA	Total Sulfidic Acidity

1.0 INTRODUCTION

This report details the results of a Phase 2 Acid Sulfate Soil (ASS) investigation undertaken by Golder Associates Pty Ltd (Golder) of the proposed Launch Pad area of the Santos Gladstone Liquefied Natural Gas Project (GLNG) gas transmission pipeline (GTP) at Gladstone, Queensland ('the site'; refer to Figure 1). The Launch Pad area will house the tunnel boring operations for the marine crossing component of the pipeline to Curtis Island. The investigation was undertaken at the request of Saipem Australia Pty Ltd (Saipem) on behalf of Santos GLNG.

At the request of Saipem, the ASS investigation of the marine crossing gas transmission pipeline was programmed into 2 phases. The Phase 1 ASS investigation was conducted under Saipem's existing Pipeline Survey License (PSL) conditions while the Phase 2 ASS investigation was conducted under a private land holder agreement. The Phase 1 ASS investigation was undertaken in May 2012 and was primarily focused on the areas to be excavated during trenching operations for the proposed pipeline route (refer to Golder document No. 127683005-005-R-RevA-ASS).

1.1 Objectives

The overall aim of the Phase 2 ASS investigation work is to:

- Conduct an ASS investigation at the site in general accordance with the requirements of the State Planning Policy 2/02 Guideline '*Planning and Managing Development involving Acid Sulfate Soils'* (SPP 2/02)) and the '*Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland – 1998'* (Ahern *et al.,* 1998), developed by the Queensland Acid Sulfate Soils Investigation Team (QASSIT);
- Use the results from the investigation to assess the likelihood of ASS occurrence in the proposed site to be excavated and filled during the construction of the Launch Pad area for tunnel boring operations as part of the proposed GTP.
- Undertake an appraisal of the lateral and vertical extent of ASS in the Launch Pad area.
- Recommend appropriate strategies for the management of ASS during earthworks of the Launch Pad.
- Advise whether a stand-alone ASS Environmental Management Plan is required for the proposed works.

1.2 Scope of Works

The scope of works for this investigation was based on the outcomes of a meeting with the Department of Environment and Heritage Protection (DEHP [formerly the Department of Environmental Resource Management]; John Ross/Angela Hendry/Peter Bourke) on 6 July 2012, where the proposed ASS investigation methodologies for the above project were agreed upon. It was also agreed that no further ASS investigations would be required to be undertaken within the Exit Pad or the section of the GTP located on Curtis Island.

2.0 ACID SULFATE SOILS OVERVIEW

The formation of ASS is commonly the result of marine or estuarine deposition of sulfate and iron bearing sediments in the presence of an abundant source of readily decomposable organic matter resulting in the deposition of pyrite. This pyrite is stable within the soil so long as anoxic conditions prevail. Oxidation of this material produces acidic conditions. Oxidation typically occurs when the material below the water table is exposed to air following excavation, or is drained by lowering the water table during dewatering processes.

Previous experience and available guidelines indicate that ASS are normally restricted in extent to recent (Holocene to Pleistocene age) soil horizons deposited in a saline environment below RL 5 m, with actual ASS (AASS) often occurring at the top of the soil profile overlying potential ASS (PASS). ASS are common in low lying coastal floodplains in riverine and delta sediments and occur throughout much of coastal Queensland.

2.1 Legislation

The State Planning Policy 2/02 'Planning and Managing Development Involving Acid Sulfate Soils' (SPP 2/02) applies to land, soil and sediment at or below 5 m AHD where the natural ground level is less than 20 m AHD. Within such areas the SPP applies to development involving any of the following:

- Excavating or otherwise removing 100 m^3 or more of soil or sediment; or
- Filling of land involving 500 m^3 or more of material with an average depth of 0.5 m or greater.

The topography of the proposed Launch Pad area is generally consistent with the above criteria (i.e. part of Launch Pad area has a surface elevation of below RL 5 m AHD) and the proposed development involves excavations of greater than 100 m^3. Thus, the SPP 2/02 is applicable to this site and an assessment of ASS is required.

3.0 SITE DESCRIPTION

This Phase 2 ASS investigation has been undertaken within the construction footprint of the Launch Pad for the proposed tunnel boring operations area. The Launch Pad marks the start of the gas transmission pipelines marine crossing and will extend from the mainland north of Gladstone to the Queensland Curtis LNG project located on the southwest corner of Curtis Island. The Launch Pad is located south of the mudflats of the Kangaroo Island Wetlands and is anticipated to comprise an area of approximately 74,690 m^2.

The northern and eastern boundaries of the area are boarded by tidal mudflats which are interspersed with tidal creek crossings. The site slopes gently from a small ridge located along the eastern boundary (approximately 15 m AHD) to low lying discontinued creek sections to the west of the site (approximately 6 m AHD). The surrounding vegetation is primarily comprised of native and improved grasses within a patchwork of open and closed woodland (eucalypts being predominant species), with some sections having been partially cleared for grazing. The eastern half of the site is predominantly closed woodland, with the vegetation becoming more open to the west of the site.

Plate 1: Borehole 17 location, towards the east of the Launch Pad site.

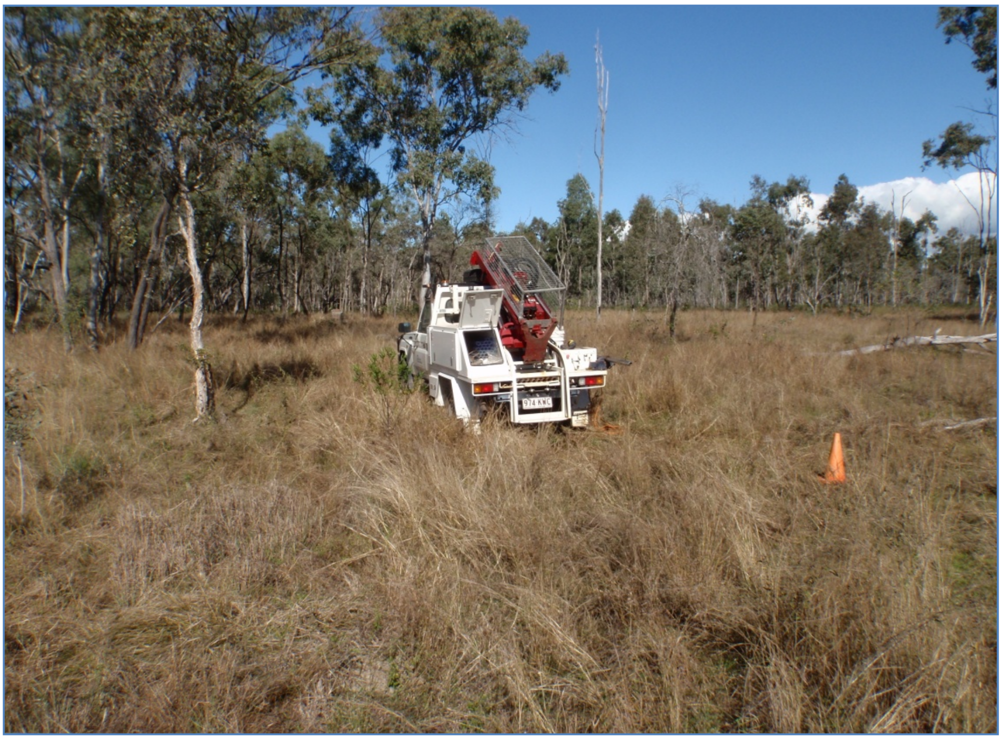

Plate 2: Borehole 23 location, towards the west of the Launch Pad site.

Plate 3: Looking across the Launch Pad site from west to east.

4.0 PROPOSED DEVELOPMENT

Santos GLNG is proposing to develop coal seam gas (CSG) resources in the Surat and Bowen Basins in Queensland. The CSG field will supply gas for the liquefied natural gas (LNG) liquefaction and export facility (LNG facility) on Curtis Island. A high pressure gas transmission pipeline is proposed to be constructed to link the CSG field to the CSG facility on Curtis Island, Gladstone.

It is understood that a 30 m wide Right of Way (ROW) corridor has been selected on the results of detailed studies and it is expected the gas transmission line will be constructed within this ROW corridor. The proposed GTP construction methodology includes tunnelling below low lying mudflats through the Kangaroo Island Wetlands and across the sea bed to Curtis Island at 'The Narrows' at the Gladstone end of the corridor.

Tunnel boring operations will be used for the alignment that extends beneath the mudflats, across and under the sea bed and through to Curtis Island. It is proposed that the Launch Pad area for tunnel boring operations will comprise an area of approximately 74,690 m^2. A corresponding exit point and operations area has been proposed for Curtis Island just south of Laird Point and will comprise an area of approximately 22,252 m^2.

Based on discussions with Saipem, we understand that the maximum depth excavations for the tunnel boring launch shaft and associated access ramp is 11 m below ground level (bgl). A hydrotest water pond is also planned for construction within the Launch Pad operations area with an estimated excavation depth of 5 m bgl.

5.0 METHODOLOGY

5.1 Site Reconnaissance

An initial site reconnaissance was undertaken between 24 March and 26 March 2012 to assess potential site accessibility issues and drilling methodologies to be adopted along the various sections of the proposed pipeline route. The site reconnaissance revealed that several locations along the proposed pipeline route had the potential to contain AASS/PASS at depths throughout the soil profile requiring further subsurface investigation. The potential for AASS/PASS to exist along the low lying areas to the north and west of the proposed Launch Pad was also highlighted.

5.2 Subsurface Investigation

The ASS investigation was undertaken in general accordance with QASSIT guidelines which require a minimum of 2 test locations per hectare (for sites > 1ha in area). Given that the proposed construction footprint for the Launch Pad covers an area of approximately 74,690 m^2 (7.5 ha) a total of fifteen test locations were investigated.

Fifteen boreholes (BH11 to BH26) were drilled to depths of up to 6.5 m below ground level (bgl) using an Ezi-Probe drill rig producing continuous undisturbed cores across the Launch Pad construction footprint. The target depth for two boreholes within the proposed tunnel boring entry shaft was 12m bgl, however, drill rig refusal was encountered in very stiff residual clay at a depth of 6.5 m bgl. The fieldwork was carried out by an experienced environmental scientist from Golder. The borehole locations are shown on Figure 2 and borehole reports are included in Appendix A along with explanatory notes and photographs.

To enable groundwater monitoring, and allow for future sampling, boreholes BH15, BH19 and BH20 were completed as groundwater monitoring wells (GW6, GW5 and GW4 respectively). The construction of the standpipes is detailed on the borehole reports in Appendix A.

Soil samples were recovered from the boreholes at approximately 0.25 m intervals to the depth of investigation. ASS sampling protocols outlined in the *"Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1988"* (Ahern *et al*., 1998) were observed in the field in order to minimise oxidation of the samples prior to laboratory testing.

The approximate location of each borehole was recorded using a hand-held GPS unit with a differential correction signal, having an accuracy of ± 1 m. Borehole coordinates are presented on the borehole reports in Appendix A.

5.3 Water Monitoring

5.3.1 Groundwater

Groundwater quality monitoring was undertaken at GW4, GW5 and GW6 in order to provide a 'snap shot' of the water quality of the site for future reference (e.g. 'baseline' data) and to enable an appraisal of the influence of ASS (if any) on water quality.

The groundwater levels in all standpipes were measured by an experienced environmental scientist on 31 July 2012. Groundwater samples were then recovered and screened in the field, after initial purging. Water samples were tested in field for temperature, pH, salinity and electrical conductivity (EC) using a TPS WP81 model water quality analyser. Samples were then dispatched to Australian Laboratory Services (ALS) to undergo further analysis. Results of groundwater monitoring are summarised in Section 6.3. ALS laboratory results are attached in Appendix B.

Groundwater sampling, field testing, sample handling and dispatch procedures were performed in accordance with Golder Quality Assurance procedures for laboratory testing, the Department of Environment and Resource Management Monitoring and Sampling Manual (DERM 2010), and the Murray Darling Basin Groundwater Quality Sampling Guidelines (MBDC,1997).

5.3.2 Insitu Permeability

Rising head tests were undertaken to assess the permeability rates of the subsurface profile at three locations across the proposed Launch Pad (GW4, GW5 and GW6; refer to Figure1). The rising head test provides an estimate of the hydraulic conductivity (K) of the soil profile. Launch PadAs the bottom 1.5 to 3.0 m of the standpipes was slotted, the rising head test will estimate the overall hydraulic conductivity of the soil profile, rather than an individual soil layer. The results of the rising head tests are discussed in Section 6.5 and are presented in Appendix C.

5.4 ASS Laboratory Testing

A total of 257 samples were screened at Golder's Gladstone laboratory to assess field pH (pH_F) and pH after oxidation (pH_{FOX}) using 30 % hydrogen solution buffered to between pH 4.5 to pH 5.5.

The pH_F/pH_{FOX} screening method consists of two steps. In the first step, the field pH of a 1:5 soil/water suspension is measured (pH_F). In the second step, a 30% Hydrogen Peroxide solution is added to the sample which is then heated to accelerate the oxidation of the sample. The pH after oxidation (pH_{FOX}) is then measured. A significant difference the pH_F and pH_{FOX} results is indicative of PASS; however, test results may be affected by other inclusions such as shell material and organics.

Based upon the results of these screening tests, 62 samples (approximately one sample per metre per borehole) were selected and dispatched to ALS to undergo quantitative analysis by the Chromium Reducible Sulfur suite in accordance with ASS Method 23F and 22B laboratory procedures.

The Chromium Reducible Sulfur suite has been adopted by QASSIT in Queensland for the testing of ASS in Queensland. This method includes analysis of 'inherent buffering capacity' from naturally occurring alkaline materials (i.e. calcite, coral debris, fine shell fragments) and 'retained acidity' which includes sulfur held in stable oxidation minerals such as 'jarosite' and allows for calculation of 'net acidity'. The Chromium Reducible Sulfur test method was selected in preference to the Suspension Peroxide Oxidation Combined Acidity & Sulfur (SPOCAS) method as is gives more accurate indications of pyrite content where significant amounts of organic matter (and organic derived acidity) are present in the soil samples.

An overall acid-base accounting method was used to calculate a 'net acidity' value which is used to qualify analytical test results and calculate liming rates. This equation is given by:

Net Acidity = Actual Acidity (as TAA) + Retained Acidity (as S_{NAS}) + Potential Acidity (as S_{CR}) - insitu Acid Neutralising Capacity (ANC).

The ALS laboratory certificates of analysis, chain of custody documents and laboratory quality control documents are attached in Appendix D and the results are summarised in Table D1. Observations and discussion on the laboratory findings are given in Section 6.5 and 6.6.

6.0 INVESTIGATION FINDINGS

6.1 Desktop Assessment

6.1.1 Local Geology

The Queensland 1:100,000 Special Geology Map indicates that the western portion of the proposed Launch Pad is underlain by Quaternary (Pleistocene) age "Alluvium" and Late Tertiary–Quaternary "Colluvium" comprising "*sands, silt, mud, gravel and soil, colluvial & residual deposits"* and is inferred to be underlain by the older *Wandilla Formation*. The underlying geology of the eastern portion of the site is mapped as Tertiary aged "Arenite-Rudite" comprising "*semi-consolidated clayey sandstone and conglomerate, commonly associated with deep weathering profiles and local duricrusts*" from the *Wandilla Formation* (refer Figure 4).

Due to the siliceous content of sandstone (62-72%) and moderately low base content, soils produced from the weathering of these rocks (residual soils) can be naturally acidic with a pH in water of below 5.5 *(*Gray and Murphy, 1999).

6.1.2 ASS Mapping

The Narrows Area NRM ASS map indicates that the majority of the Launch Pad site is mapped as being **Not Assessed** or as **LP**, being "*Land predominantly below 5 m AHD with low probability of Acid Sulfate Occurrence. Limited Field Investigation*" (refer Figure 5). The latter mapped unit is generally associated with the Late Tertiary–Quaternary "Colluvium".

6.2 Subsurface Conditions

The soil profiles encountered in the boreholes drilled were generally found to be in line with the Queensland 1:100,000 Geology Map with the majority of the site being comprised of Pre-Holocene residual silty clay alluvial deposits generally to the depth of excavation. The eastern portion of the site has a similar upper profile but is underlain by clayey weathered sandstone material. General spatial consistency was observed across the locations with soil layer depths being comprised as below.

The soil profiles encountered in the boreholes drilled in the western section of the site (BH11, BH12, BH13, BH14, BH15, BH20, BH22, BH23 and BH24) generally comprised:

- A thin layer of dark brown clayey loamy sand to depths of 0.05 m to 0.1 m bgl, underlain by;
- Firm to stiff, alluvial silty clay, yellowish brown, medium to highly plastic, generally with a trace of fine sub-angular gravel to depths of 0.4 m to 1.0 m bgl, underlain by;
- Stiff to very stiff / hard, alluvial silty clay, greyish brown to dark brown, highly plastic, with a trace of fine sub-angular gravel to depths of 0.4 m to 4.5 m bgl (depth of testing in boreholes BH11, BH12, BH15, BH23 and BH24), and underlain by;
- Stiff, residual kaolonitic silty clay, pale grey to white, highly plastic, to the depth of investigation in BH13, BH14, BH20 and BH22.

While the soil profiles encountered in the boreholes drilled within the eastern section of the site (BH16, BH17, BH18, BH19, BH21 and BH25) generally comprised:

- A thin layer of dark brown clayey loamy sand to depths of 0.25 m bgl, underlain by;

- Firm to stiff, alluvial silty clay, yellowish brown, medium to highly plastic, with a trace of fine sub-angular gravel to depths of 0.6 to 1.2 m bgl, underlain by;
- Very stiff to hard, silty clay, grey, highly plastic, to depths of 1.5 to 2.5 m bgl, underlain by;
- Firm, kaolonitic silty clay or silty clayey sand, pale grey highly plastic to the depth of investigation in boreholes BH17, BH18, BH19 and BH25, or as in BH16 and BH21 underlain by pale grey / white, friable, weathered siltstone/mudstone.

6.3 Groundwater

Groundwater was not encountered in the boreholes at any locations during drilling operations of the investigation. Standing water levels were recorded on 31 July 2012 in standpipes GW4, GW5, and GW6 at depths between 3.76 m and 5.06 m bgl.

The results of pH (pH range 3.2 to 4.3) indicate that the groundwater is moderately acidic. Electrical conductivity (EC) and salinity (ppk) values indicate that the groundwater is saline at all locations suggesting a strong tidal influence. It is recommended that further groundwater sampling events are scheduled with tidal phases to better ascertain the effect of tidal fluctuations on groundwater quality at these locations.

The Chloride:Sulfate ($Cl^-:SO_4^{2-}$) ratio provides an indication of whether the environment is influence by ASS. A $Cl^-:SO_4^{2-}$ ratio of sea water is approximately 7, a $Cl^-:SO_4^{2-}$ ratio below this value can indicate that excess sulfur may be present as sulfides. The $Cl^-:SO_4^{2-}$ ratio at GW4, GW5 and GW6 range from 10.4 to 9.7 which indicates no past ASS influence of the groundwater at these locations.

Results of alkalinity testing indicate that the groundwater at all locations has little or no buffering capacity and is likely to be a contributing factor to the low pHs of these waters.

Dissolved metals are present in the groundwater at all three locations. Dissolved aluminium concentrations are relatively low to negligible in samples collected from GW4 and GW6, while the dissolved aluminium concentration is elevated in the sample collected from GW5. This elevated concentration is unexpected given the pH of GW5 (pH 5.06) as aluminium has a low solubility at this pH level. Dissolved aluminium has the potential for adverse environmental impacts. Dissolved iron is present at relatively low concentrations at all locations. Dissolved iron is present at all locations, but at concentrations significantly less than that of total iron which ranged from 42.5 mg/L at GW4 to 191 mg/L at GW5.

True colour was found to be relatively low in all groundwater samples ranging from 2 – 10 PCU indicating the absence of tannins which are a separate source of acidity (organic acidity) that can inflate apparent ASS impacts.

Summarised in Table 1 are the results of groundwater analysis undertaken on the samples recovered.

Table 1: Results of Groundwater Monitoring

Parameter	GW4	GW5	GW6
Groundwater level (m from TOC)	3.83	5.06	3.76
Salinity (ppk)	23.9	-	-
Field pH	3.6	3.2	4.3
Electrical Conductivity (mS/cm)	36.7	34.6	37.2
Temperature (°C)	24.4	23.8	23.7
Apparent Colour	light olive grey	red brown	brown
Clarity	Turbid	turbid	turbid
Hydroxide Alkalinity as $CaCO_3$ (mg/L)	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$ (mg/L)	<1	<1	<1
Bicarbonate Alkalinity as $CaCO_3$ (mg/L)	<1	<1	3
Total Alkalinity as $CaCO_3$ (mg/L)	<1	<1	3
Dissolved Sulfate (mg/L)	1340	1410	1530
Dissolved Chloride (mg/L)	14000	13900	14900
$Cl:SO_4$ Ratio	10.4	9.9	9.7
Dissolved Calcium (mg/L)	352	134	409
Dissolved Magnesium (mg/L)	1070	845	1210
Dissolved Aluminium (mg/L)	5.54	59.4	0.48
Dissolved Arsenic (mg/L)	<0.01	<0.01	<0.01
Dissolved Barium (mg/L)	0.056	0.059	0.062
Dissolved Beryllium (mg/L)	<0.01	0.012	<0.01
Dissolved Cadmium (mg/L)	<0.001	<0.001	<0.001
Dissolved Cobalt (mg/L)	0.072	0.028	0.110
Dissolved Chromium (mg/L)	<0.01	<0.01	<0.01
Dissolved Copper (mg/L)	0.017	0.085	0.014
Dissolved Manganese (mg/L)	0.486	0.181	0.269
Dissolved Nickel (mg/L)	0.055	0.055	0.075
Dissolved Lead (mg/L)	<0.01	<0.01	<0.01
Dissolved Vanadium (mg/L)	<0.10	<0.10	<0.10
Dissolved Zinc (mg/L)	0.078	0.169	0.128
Dissolved Mercury (mg/L)	<0.0001	<0.0001	<0.0001
Dissolved Iron (mg/L)	<0.50	3.96	<0.50
Total Iron (mg/L)	42.5	191.0	55.0
True Colour (PCU)	10	5	2

6.4 Soil Permeability

Results of the permeability testing are presented in Table 2 below, with permeability calculation worksheets for each location attached in Appendix C.

Table 2: Permeability Testing 31 July 2012

Location	Method	Results (K)	
		m/sec	m/day
GW4	Rising Head	3.7×10^{-7}	0.032
GW5	Rising Head	5.5×10^{-7}	0.048
GW6	Rising Head	9.3×10^{-7}	0.08

The field test results summarised in Table 2, indicate an insitu permeability of the order of 5×10^{-7} m/sec for GW4 and GW5 suggesting moderate permeability. This value is a little high for clay soils, which are typically less than 1×10^{-8} m/sec, unless fissured. The insitu permeability result of 9×10^{-7} for GW6 is more generally in line with the typical range expected for clay soils. The insitu permeability measured should be treated as indicative only, as significant changes to the subsurface profile can occur over short distances and may alter permeability by one or more orders of magnitude. It should be noted that at the time of testing these groundwater locations were under low tide conditions. Further testing is recommended to ascertain soil permeability throughout the full tidal cycle (e.g. high and mid tide).

6.5 Preliminary Screening

Results of preliminary screening are summarised in Table D1 (Appendix D).

Existing soil pH (represented by pH_F results) was found to range between pH 3.4 and pH 8.2 (acidic to slightly alkaline), with the majority of the samples being above pH 6.0, indicating a low probability of the presence of actual ASS at most locations. The existing low soil pH is believed to be attributable to the presences of naturally acidic soils, and not ASS, at some locations.

A mixture of low to extreme level reactions to addition of hydrogen peroxide was also observed in all samples. The pH_{FOX} ranged from pH 2.5 to pH 8.3 and was generally above pH 4.5 in most samples indicating a low probability of potential acidity in the majority of samples. One sample from BH17 and five samples from BH18 had a pH_{FOX} below 3.0 indicating probable potential acidity at these locations. However it should be noted that the pH_F of these sample locations were all between pH 3.5 to pH 4.0 suggesting the presence of existing natural acidity in the soils at these locations.

6.6 Quantitative Soils Analysis

Table 3 below shows the ASS action levels adopted in Queensland. These categories are used to identify whether action / management of ASS spoil is required, based on 'net acidity'. For major fill works and disturbances of more than 1,000 tonnes, an action criterion of 18 moles / tonne is adopted for all soil types.

Table 3: ASS Action Criteria

Type of Material		Action Criteria 1-1000 tonnes disturbed		Action Criteria > 1000 tonnes disturbed (and major fill projects)	
		Existing + Potential Acidity		Existing + Potential Acidity	
Texture range McDonald et al. (1990)	Approx clay content (%)	Equivalent sulfur %S oxidisable	Equivalent acid mol H^+/ tonne	Equivalent sulfur %S oxidisable (oven-dry basis)	Equivalent acid mol H^+/ tonne (oven-dry basis)
Coarse Texture Sands to loamy sands	≤5	0.03	18	0.03	18
Medium Texture Sandy loams to light clays	5 – 40	0.06	36	0.03	18
Fine Texture Medium to heavy clays and silty clays	≥40	0.10	62	0.03	18

Results of quantitative analysis carried out are summarised in Table D1, attached. Laboratory result certificates are included in Appendix D.

Results of the 62 samples analysed are summarised below:

- 58 samples returned S_{CR} results less than the laboratory detection limit (0.005%S).
- No samples returned a S_{CR} result equal to or above the Action Criteria (0.03%S).
- Oxidisable Sulfur is present at levels above detection limits in only four samples The highest S_{CR} result was 0.02% at BH23 (0.0-0.10 m bgl).
- 40 samples returned TAA results equal to or above the Action Criteria of 18 mol H^+/t, ranging between 18 mol H^+/t and 103 mol H^+/t. These results generally represent alluvium sediments but include underlying residual soils.
- 32 samples returned a TAA result less than the Action Criteria, ranging from less than the laboratory detection limit of 3 mol H^+/t up to 17 mol H^+/t.
- No samples returned pH_{KCl} values of greater than pH 6.5 so no samples were subjected to analysis for acid neutralising capacity (ANC).
- 21 samples returned pH_{KCl} values of less than pH 4.5 and were, therefore, tested for retained acidity (S_{NAS}). A total of 19 samples returned S_{NAS} values below the action criteria level of 0.03%S, with 13 of these returning values less than the laboratory detection limit, the remaining two samples displayed values equal to the action criteria level of 0.03%S.

The test results indicate that combined actual and retained acidity present in the samples analysed ranged from negligible to moderate. Negligible to low levels of actual acidity were identified in boreholes BH13 and BH23 while low to moderate levels of actual and retained acidity were found within the remaining sites at levels ranging from 18 to 103 mol H^+/t in samples analysed.

The actual acidity levels were generally 100% of the net acidity (except for some very minor contributions from retained acidity in 7 samples) indicating that complete oxidation of sulfidic fines in Pleistocene soils has already occurred

Results of S_{CR} tests indicate negligible potential ASS within the samples analysed. None of the test results were above the QASSIT 'Action Criteria'.

Of the 62 samples analysed, net acidity (primarily due to actual acidity) exceeded the appropriate QASSIT 'Action Criteria' (for bulk earthworks) in 43 samples taken from various depths in boreholes from across the site. The highest 'net acidity' values (i.e. > 50 mol H^+/t) were detected in samples of silty clay from BH14, BH16, BH17, BH18 and BH19 which are located in the north east corner of the site.

6.7 Extent and Severity of ASS

The results from this investigation indicate the presence of soils with actual acidity across the Launch Pad with some minor retained acidity identified at BH18. Based on the testing carried out to date, soils with actionable levels of actual acidity appear to be distributed uniformly laterally and vertically across the site. In the majority of soils actual acidity does not appear to be attributed to oxidisable sulfur and is likely to be associated with naturally acidic properties of the siliceous parent rock...

The SPP 2/02 require that the level of treatment for management of ASS is based on treatment of all existing, potential and retained acidity. Acid-Base Accounting using the laboratory test results has been undertaken to calculate the Net Acidity for each sample in units of mol H^+/t as presented in the Table D1 attached.

Liming rates have been calculated in kg $CaCO_3/m^3$ using a factor of safety and fineness factor of 1.5 and an assumed bulk density of 1.8 tonne/m^3. Liming rates are presented in Table 4 and are applicable in any instance where soils are to be disturbed in the vicinity of each location.

Table 4: Liming Rates

Location	Depth	Soil Type	Treatment Rate (95th Percentile)	Treatment Rate (Maximum)
North East Corner (BH16,BH17, BH18 & BH19)	0.0 m to depth of excavation	Silty CLAY generally yellow brown to pale grey, high plasticity	13 kg $CaCO_3/m^3$ *	16 kg $CaCO_3/m^3$
Remainder of the Launch Pad	0.0 m to depth of excavation	Silty CLAY generally grey to brown, medium to high plasticity	7 kg $CaCO_3/m^3$ *	9 kg $CaCO_3/m^3$

* Calculated at the 95 percentile.

Lime treatment rates have been calculated based on the 95th percentile of 'net acidity' results and the maximum 'net acidity' rates. Utilising the reduced treatment rates of 13 kg $CaCO_3/m^3$ for the north east corner of the site and 7 kg $CaCO_3/m^3$ for the remaining of the Launch Pad is considered adequate given that the majority of the acidity is natural and not sulfur-derived and that there is negligible oxidisable sulfur in the samples.

6.8 Risk Assessment

Given the size of the Launch Pad area (74,690 m^2), the proposed extent of excavation for the tunnel boring launch shaft and access ramp and the ASS test results, management of existing acidity would be classified as ***XH (extra high level)*** treatment in accordance with SPP 2/02 Guideline - Table 4 (i.e. greater than 25 tonnes of aglime required for neutralisation) and as such the SPP 2/02 Guidelines requires that a 'stand alone' ASS Environmental Management Plan (EMP) must be developed.

The full extent of earthworks (i.e. cut and fill plans, trenching depths, widths and excavation volumes) for the construction of the Launch Pad have not been finalised at this stage. However, it is anticipated that excavations in natural soils for the Launch Pad construction and the tunnel boring launch shaft and access ramp may result in the generation of low to moderate levels of net acidity. The risk of impact to the surrounding environment is moderate (unless further assessment indicates otherwise). Provided that the management measures outlined in Section 7.2 this report are adhered to and an ASS EMP is prepared for the project and implemented, the environmental risk will be reduced.

7.0 RECOMMENDATIONS

7.1 Further Work

No further ASS investigations are required to be undertaken within the Launch Pad area. However, further investigations are required for other works associated with Phase 2. These works will be focused on the mudflat section of the tunnel corridor. The scope of works of will comprise the drilling of two boreholes (20 m / refusal) across the Mud Flat Section of the proposed tunnel boring route, sampling and analysis of soil laboratory results. The results will be incorporated into this Phase 2 ASS report..

7.2 Future Site Management

Recommendations on strategies to be included (as a minimum) in any such EMP include:

- Soil excavated below RL 5 m AHD must be managed by neutralisation of net acidity. Good quality agricultural lime should be thoroughly mixed with the spoil at the required rates. Any lime treatment should be carried out in accordance with Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines (Ver 3.8 Nov. 2002).

- Treatment should be carried out on prepared pads. The earthworks strategy should be formulated to provide a number of pads of appropriate size to enable practical spreading, mixing and drying, so that adequate time is available to complete the treatment and verification before placing the next layer of soil.
- Verification sampling and analysis is to be carried out on the treated soil to confirm that adequate amounts of the neutralising agent have been incorporated into the soil.
- Stormwater should be diverted away from treatment/excavation areas by clay bunds and/or grassed swales.Baseline and ongoing groundwater quality monitoring will be required for the project and specified in any EMP.
- Management of groundwater seepage and rainfall collected in excavations and other work areas on site, including treatment areas, must be incorporated into the EMP.
- During construction, it is recommended that all water collected from groundwater or surface water inflow, together with runoff from treatment areas, be retained, monitored and if needed, treated to comply with the appropriate discharge criteria prior to discharge offsite.

8.0 REFERENCES

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State Planning Policy 2/02 Guideline. Planning and Managing Development Involving Acid Sulfate Soils Version 2.

Report Signature Page

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LG/HP/lg

A.B.N. 64 006 107 857

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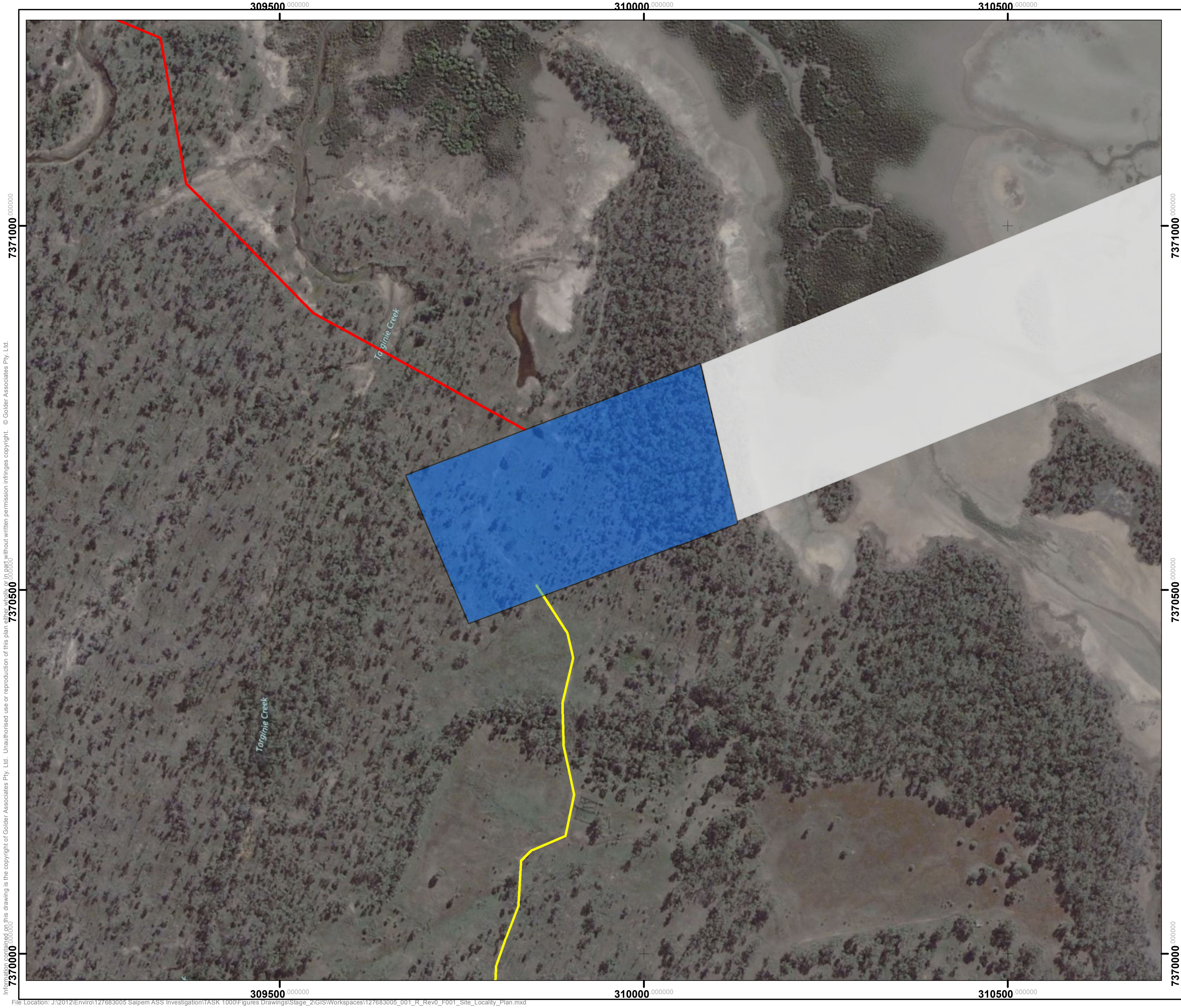
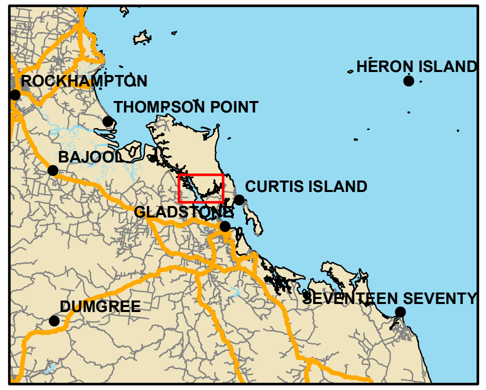


GLNG GAS TRANSMISSION PIPELINE

SAIPEM\GLNG

SITE LOCALITY PLAN



LEGEND

- Pipeline Route
- Access Tracks
- Tunnel Boreing Launch Pad
- Tunnel Corridor

COPYRIGHT

0 25 50 100 150 200 Meters

SCALE (at A3) 1:5,000

DATUM GDA 94, PROJECTION MGA Zone 56

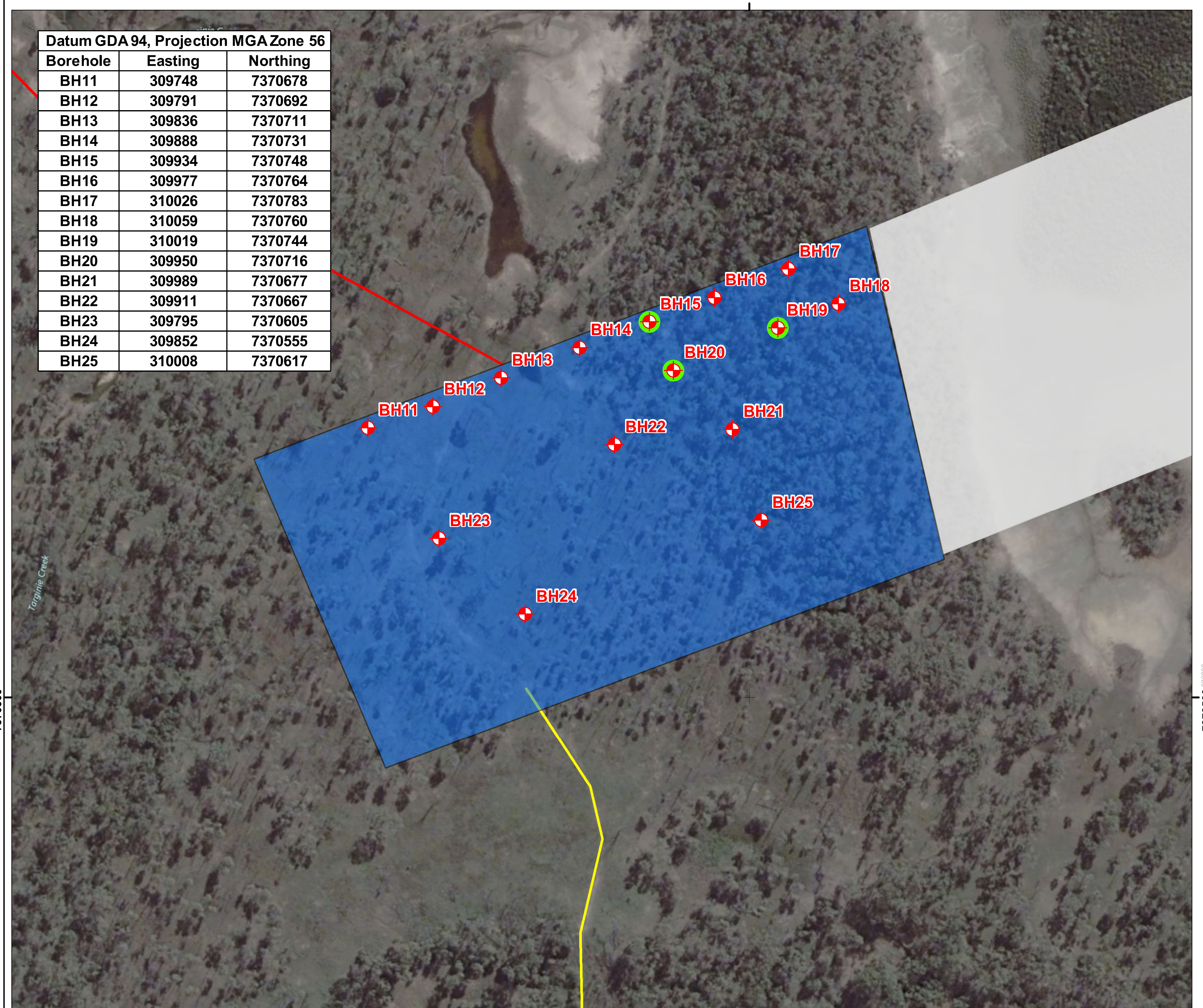
PROJECT:	**127683005**
DATE:	**07 AUG 2012**
DRAWN:	**BAL**
CHECKED:	**LG**

FIGURE 1

Golder Associates

310000

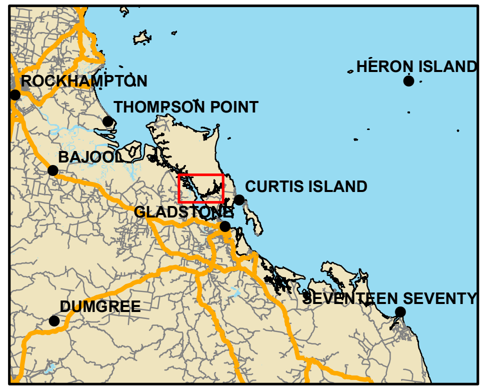
Datum GDA 94, Projection MGA Zone 56		
Borehole	Easting	Northing
BH11	309748	7370678
BH12	309791	7370692
BH13	309836	7370711
BH14	309888	7370731
BH15	309934	7370748
BH16	309977	7370764
BH17	310026	7370783
BH18	310059	7370760
BH19	310019	7370744
BH20	309950	7370716
BH21	309989	7370677
BH22	309911	7370667
BH23	309795	7370605
BH24	309852	7370555
BH25	310008	7370617



GLNG GAS TRANSMISSION PIPELINE

SAIPEM\GLNG

SITE LOCALITY PLAN & BOREHOLE LOCATIONS



LEGEND

- Borehole Locations
- Monitoring Well Locations
- Pipeline Route
- Access Tracks
- Tunnel Boreing Launch Pad
- Tunnel Corridor

COPYRIGHT

0 12.5 25 50 75 100 Meters

SCALE (at A3) 1:2,500

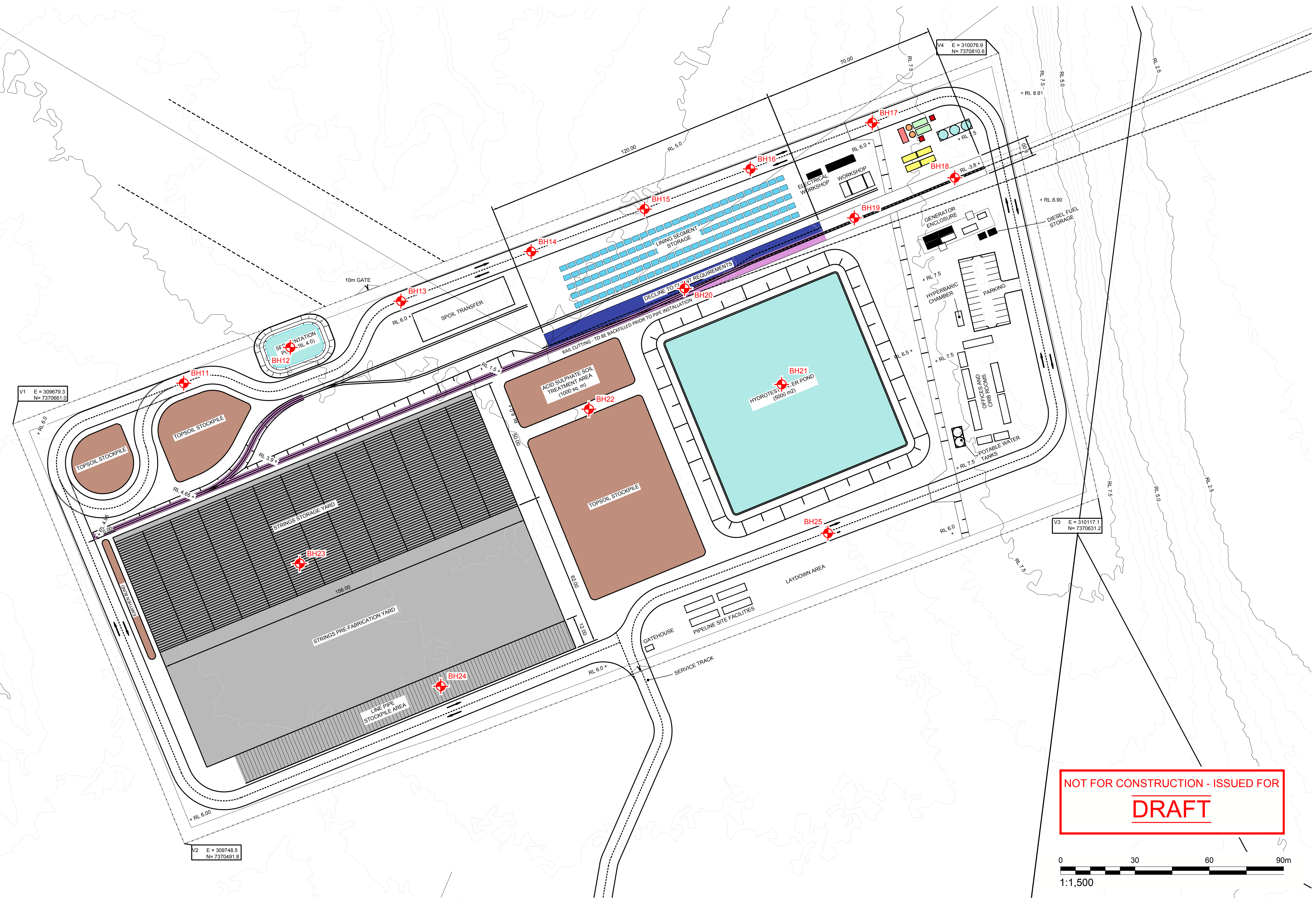
DATUM GDA 94, PROJECTION MGA Zone 56

PROJECT: 127683005
DATE: 07 AUG 2012
DRAWN: BAL
CHECKED: LG

FIGURE 2

Golder Associates

File Location: J:\2012\Enviro\127683005 Saipem ASS Investigation\TASK 1000\Figures Drawings\Stage_2\GIS\Workspaces\127683005_001_R_Rev0_F002_Sample_Locations.mxd



Datum GDA 94, Projection MGA Zone 56		
Borehole	Easting	Northing
BH11	309748	7370678
BH12	309791	7370692
BH13	309836	7370711
BH14	309888	7370731
BH15	309934	7370748
BH16	309977	7370764
BH17	310026	7370783
BH18	310059	7370760
BH19	310019	7370744
BH20	309950	7370716
BH21	309989	7370677
BH22	309911	7370667
BH23	309795	7370605
BH24	309852	7370555
BH25	310008	7370617

NOT FOR CONSTRUCTION - ISSUED FOR
DRAFT

0 30 60 90m
1:1,500

LEGEND

Borehole Location

NOTE:

Original Drawing provided by THIESS PTY LTD.

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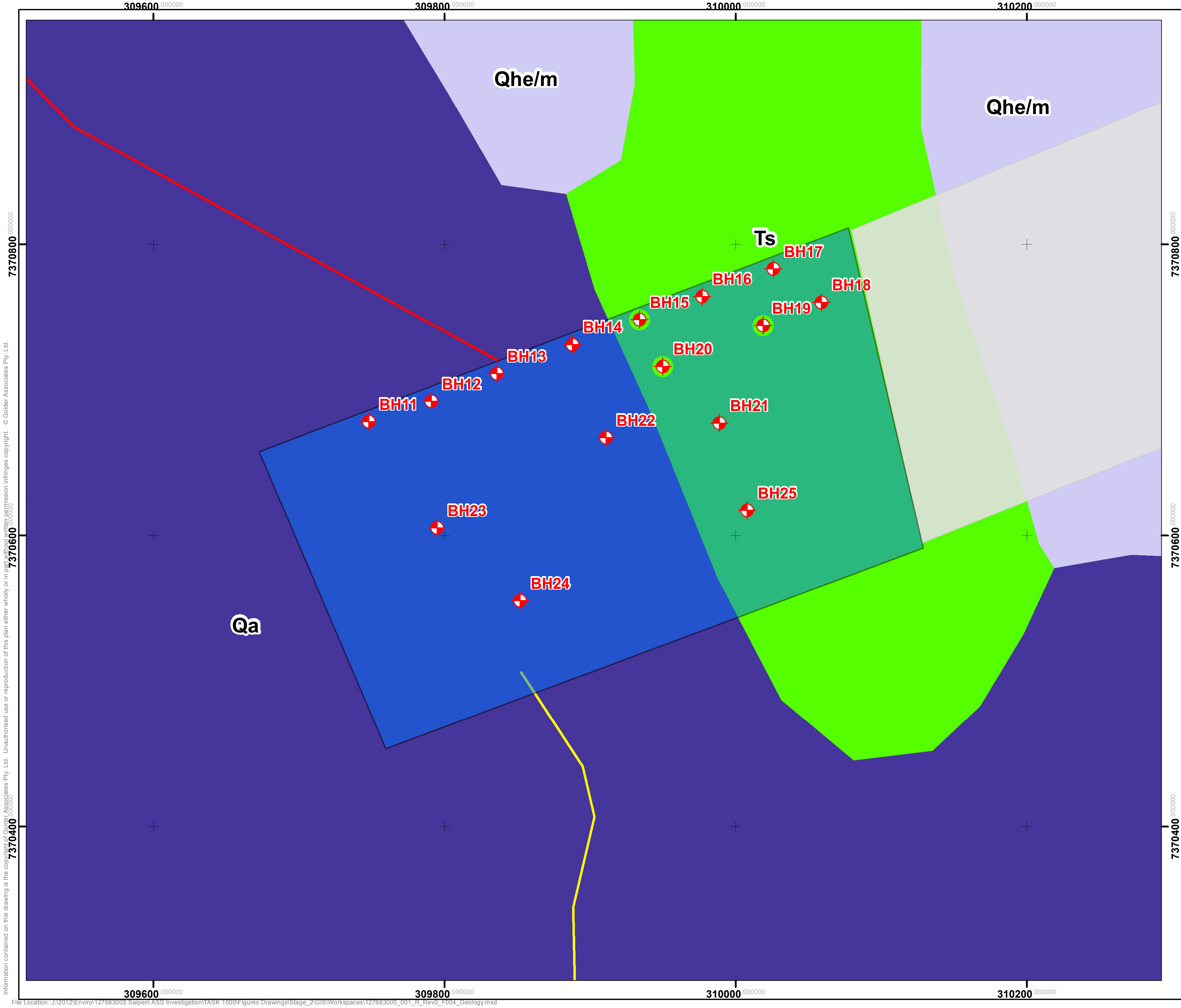
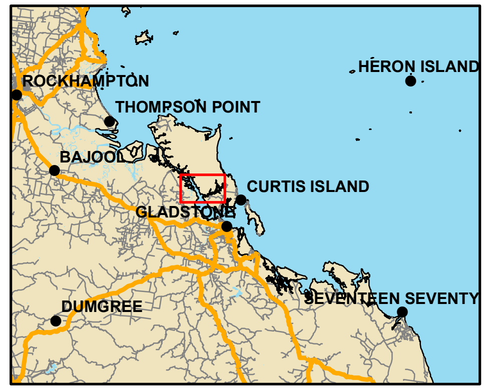
CLIENT: SAIPEM AUSTRALIA PTY LTD			PROJECT: SAIPEM ASS INVESTIGATION					
DRAWN BY: BAL	DATE: 07.08.2012		DRAWING TITLE: SAMPLE LOCATIONS AND DEVELOPMENT PLAN					
CHECKED BY: LG	DATE: 07.08.2012							
SCALE: 1:1,500		SHEET SIZE: A3	PROJECT No: 127683005	DOC No: 001	DOC TYPE: R	FIGURE No: F003	REVISION: A	FIGURE 3



GLNG GAS TRANSMISSION PIPELINE

SAIPEM\GLNG

DETAILED GEOLOGY



LEGEND

- Borehole Locations
- Monitoring Well Locations
- Pipeline Route
- Access Tracks
- Tunnel Boreing Launch Pad
- Tunnel Corridor

Detailed Geology

- Arenite-Rudite
- Alluvium
- Miscellaneous Unconsolidated Sediments

0 12.5 25 50 75 100 Meters

SCALE (at A3) 1:2,500

DATUM GDA 94, PROJECTION MGA Zone 56

PROJECT: 127683005
DATE: 09 AUG 2012
DRAWN: BAL
CHECKED: LG

FIGURE 4

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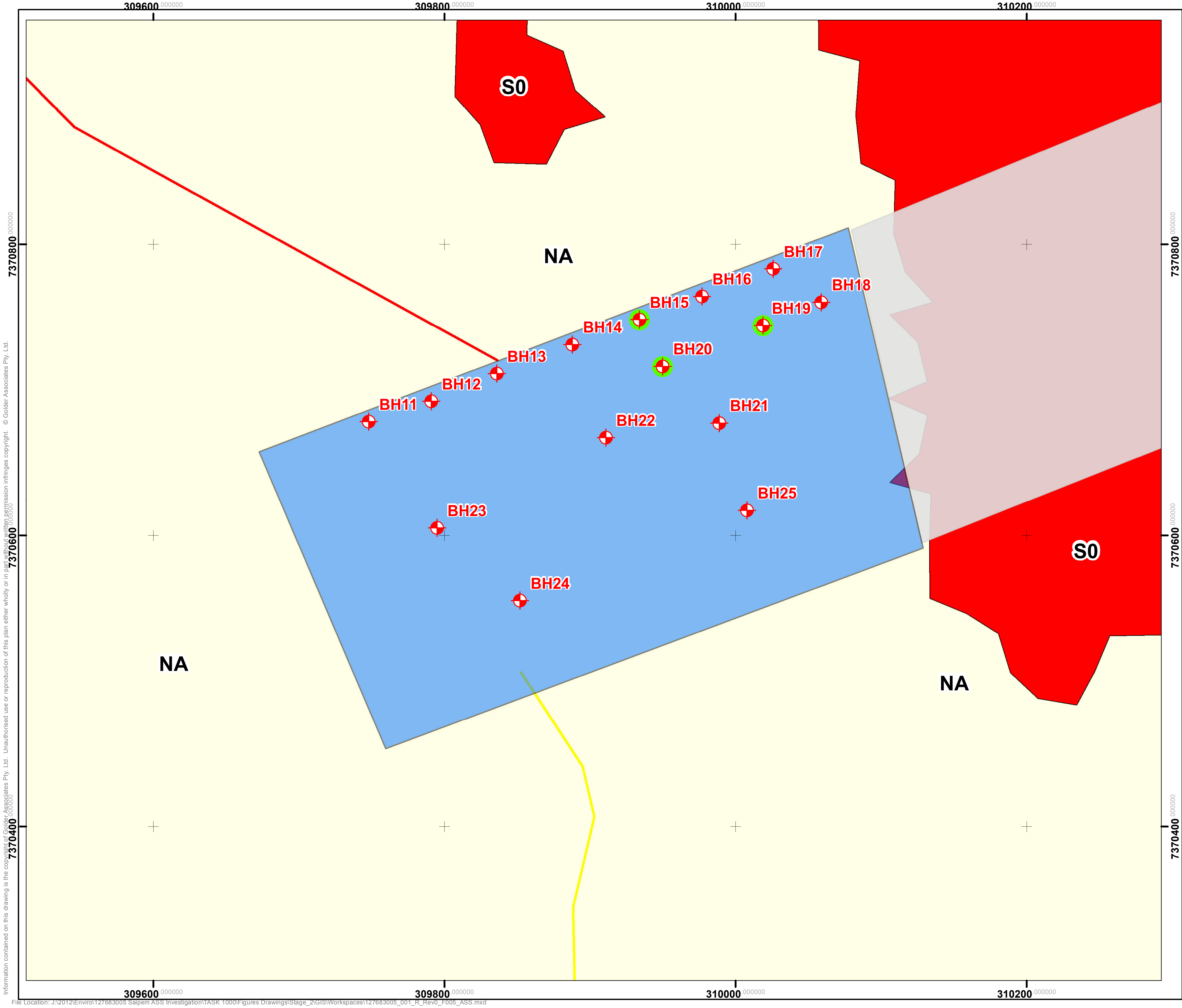
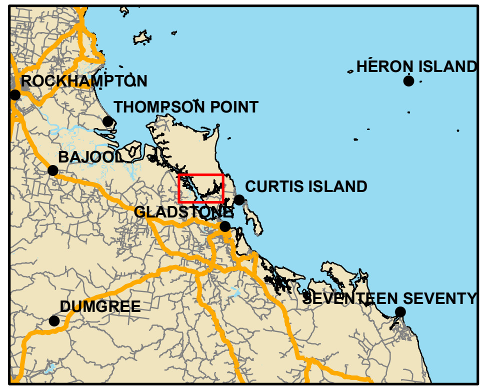
File Location: J:\2012\Enviro\127683005 Saipem ASS Investigation\TASK 1000\Figures Drawings\Stage_2\GIS\Workspaces\127683005_001_R_Rev0_F004_Geology.mxd



GLNG GAS TRANSMISSION PIPELINE

SAIPEM\GLNG

ACID SULFATE SOILS



LEGEND

- Borehole Locations
- Monitoring Well Locations
- Pipeline Route
- Access Tracks
- Tunnel Boreing Launch Pad
- Tunnel Corridor

Acid Sulfate Soils

- Acid Sulfate Soils on relatively undisturbed land at a depth of 0 - 0.5 m
- Land Not Assessed

0 12.5 25 50 75 100 Meters

SCALE (at A3) 1:2,500

DATUM GDA 94, PROJECTION MGA Zone 56

PROJECT: 127683005
DATE: 09 AUG 2012
DRAWN: BAL
CHECKED: LG

FIGURE 5

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File Location: J:\2012\Enviro\127683005 Saipem ASS Investigation\TASK 1000\Figures Drawings\Stage_2\GIS\Workspaces\127683005_001_R_Rev0_F005_ASS.mxd

APPENDIX A

Reports of Boreholes
Reports of Groundwater Wells
Explanation of Notes, Abbreviations & Terms Used on Borehole Reports
Method of Soil Description Used on Borehole Reports

REPORT OF BOREHOLE: BH11

SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 26/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 4.50 m	CHECKED: JM	DATE: 24/8/12

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-4.00 m ASS Samples taken at 0.25m Intervals				Silty CLAY high plasticity, yellow brown, trace of fine size subangular gravel, with organic matter	M		Residual
			0.5	0.50					Silty CLAY high plasticity, grey brown, trace fine to medium size subangular gravel			
			1.5	1.50					Gravelly Silty CLAY high plasticity, dark brown, trace fine to medium size subangular gravel			
				2.40					some fine to medium grained sand			
			2.5	2.50					Silty CLAY high plasticity, dark brown, with some fine to medium grained sand, trace of fine size subangular gravel			
			3.5									some Fe Staining and Mottling
			4.5	4.50					END OF BOREHOLE @ 4.50 m			

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

GAP gINT FN. F01a
RL2

REPORT OF CORE PHOTOGRAPHS: BH11

		SHEET: 1 OF 1
CLIENT: Saipem	COORDS: 309748 m E 7370678 m N MGA94 56	DRILL RIG: EziProbe
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG DATE: 26/7/2012
JOB NO: 127683005	HOLE DEPTH: 4.50 m	CHECKED: JM DATE: 24/8/2012

0.0 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

1.50 m – 2.50 m

1.50 m ***2.00 m*** ***2.50 m***

2.50 m – 3.50 m.

2.50 m ***3.00 m*** ***3.50 m***

3.50 m – 4.50 m.

3.50 m ***4.00 m*** ***4.50 m***

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered.
As such it should not be relied upon for geotechnical purposes.

REPORT OF BOREHOLE: BH12

Golder Associates

SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 26/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 4.00 m	CHECKED: JM	DATE: 24/8/12

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-4.00 m ASS Samples taken at 0.25m Intervals				Clayey LOAM dark brown, with organic matter	M		Residual
									Silty CLAY high plasticity, yellow brown, with fine size subangular gravel, trace fine to medium grained sand, with organic matter			
			0.75	0.75					Silty CLAY high plasticity, grey brown, with fine to medium size subangular gravel			
			1.5									some Fe Nodules present
			3.0	3.00					with fine to medium grained sand			
			3.5									occasional Fe Mottling
			4.0	4.00					END OF BOREHOLE @ 4.00 m			

Depth scale: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

REPORT OF CORE PHOTOGRAPHS: BH12

		SHEET: 1 OF 1
CLIENT: Saipem	COORDS: 309791 m E 7370692 m N MGA94 56	DRILL RIG: EziProbe
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG DATE: 20/7/2012
JOB NO: 127683005	HOLE DEPTH: 4.00 m	CHECKED: JM DATE: 24/8/2012

0.0 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

1.50 m – 2.50 m

1.50 m ***2.00 m*** ***2.50 m***

2.50 m – 4.00 m.

2.50 m ***3.00 m*** ***3.50 m*** ***4.00 m***

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered.
As such it should not be relied upon for geotechnical purposes.

Golder Associates

REPORT OF BOREHOLE: BH13

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 25/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 4.50 m	CHECKED: JM	DATE: 24/8/12

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-4.00 m ASS Samples taken at 0.25m Intervals				Silty CLAY medium plasticity, dark brown, with organic matter	M		Residual
				0.10					Silty CLAY high plasticity, dark brown			
				2.50					Gravelly Silty CLAY high plasticity, grey brown, fine size subangular gravel			some Fe Modules and Mottling
				4.00					Silty CLAY high plasticity, pale grey			some Fe Mottling
				4.50					END OF BOREHOLE @ 4.50 m			

Depth scale: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

REPORT OF CORE PHOTOGRAPHS: BH13

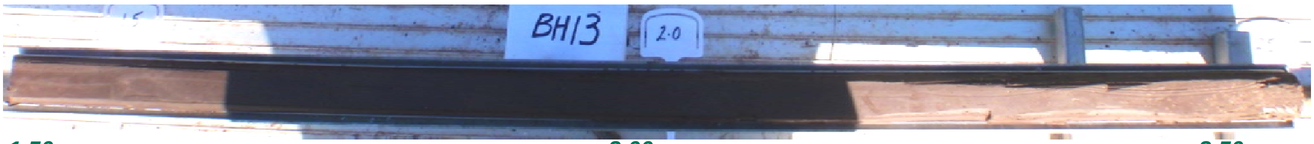
SHEET: 1 OF 1

CLIENT: Saipem	COORDS: 309836 m E 7370711 m N MGA94 56	DRILL RIG: EziProbe
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG DATE: 25/7/2012
JOB NO: 127683005	HOLE DEPTH: 4.50 m	CHECKED: JM DATE: 24/8/2012

0.0 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

1.50 m – 2.50 m



1.50 m ***2.00 m*** ***2.50 m***

2.50 m – 3.50 m.

2.50 m ***3.00 m*** ***3.50 m***

3.50 m – 4.50 m.

3.50 m ***4.00 m*** ***4.50 m***

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered.
As such it should not be relied upon for geotechnical purposes.

REPORT OF BOREHOLE: BH14

SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 25/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 4.50 m	CHECKED: JM	DATE: 24/8/12

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-4.00 m ASS Samples taken at 0.25m Intervals				Silty CLAY medium plasticity, dark grey, with organic matter	M		Alluvial
			0.5	0.50					Silty CLAY medium to high plasticity, grey brown, trace fine size subangular gravel, with organic matter	M		Residual with Ochre Mottling
			2.75	2.75					Gravelly Silty CLAY high plasticity, grey brown, fine size subangular gravel	D-M		Fe Mottling and Nodules
			3.25	3.25					Silty CLAY high plasticity, pale grey	M		
			4.5	4.50					END OF BOREHOLE @ 4.50 m			

Depth scale: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

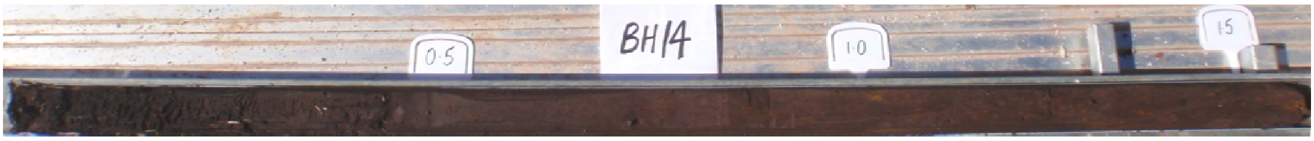
GAP gINT FN. F01a RL2

REPORT OF CORE PHOTOGRAPHS: BH14

SHEET: 1 OF 1

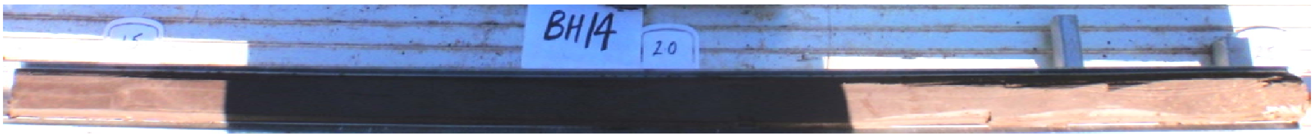
CLIENT: Saipem	COORDS: 309888 m E 7370731 m N MGA94 56	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG	DATE: 25/7/2012
JOB NO: 127683005	HOLE DEPTH: 4.50 m	CHECKED: JM	DATE: 24/8/2012

0.0 m – 1.50 m



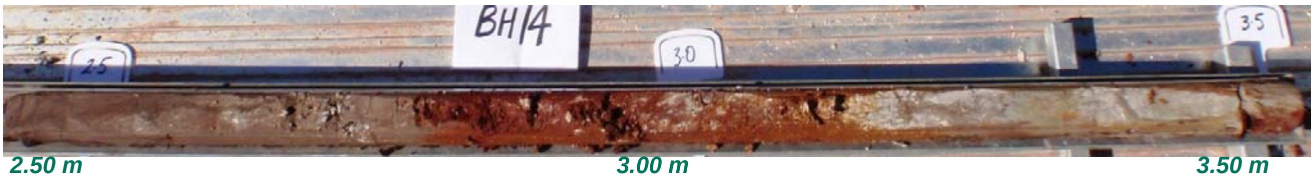
0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

1.50 m – 2.50 m



1.50 m ***2.00 m*** ***2.50 m***

2.50 m – 3.50 m.



2.50 m ***3.00 m*** ***3.50 m***

3.50 m – 4.50 m.

3.50 m ***4.00 m*** ***4.50 m***

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered.
As such it should not be relied upon for geotechnical purposes.

REPORT OF BOREHOLE: BH15/GW6

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SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 30/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 4.50 m	CHECKED: JM	DATE: 24/8/12

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-4.00 m ASS Samples taken at 0.25m Intervals				Loamy SAND fine grained, dark brown, with organic matter	M		Backfill
									Silty CLAY high plasticity, yellow brown, trace of fine size subangular gravel, with organic matter			Bentonite
			0.5	0.50					Silty CLAY high plasticity, with fine size subangular gravel			Blank
			1.5	1.50					Sandy Silty CLAY high plasticity, brown, fine to medium grained sand, trace of fine size subangular gravel			Sand, Slotted
			4.5	4.50					END OF BOREHOLE @ 4.50 m			

Depth scale: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

GAP gINT FN. F01d RL2

REPORT OF CORE PHOTOGRAPHS: BH15

		SHEET: 1 OF 1
CLIENT: Saipem	COORDS: 309934 m E 7370748 m N MGA94 56	DRILL RIG: EziProbe
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG DATE: 30/7/2012
JOB NO: 127683005	HOLE DEPTH: 4.00 m	CHECKED: JM DATE: 24/8/2012

0.0 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

1.50 m – 2.50 m

1.50 m ***2.00 m*** ***2.50 m***

2.50 m – 3.50 m.

2.50 m ***3.00 m*** ***3.50 m***

3.50 m – 4.50 m.

3.50 m ***4.00 m*** ***4.50 m***

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered.
As such it should not be relied upon for geotechnical purposes.

REPORT OF BOREHOLE: BH16

SHEET: 1 OF 1

CLIENT:	Saipem	POSITION: Refer to Site Plan		DRILL RIG: EziProbe	
PROJECT:	LNG Pipeline	SURFACE RL: m	DATUM: AHD71	DRILLER: AB	
LOCATION:	Launch Pad, The Narrows	INCLINATION: -90°		LOGGED: LG	DATE: 29/7/12
JOB NO:	127683005	HOLE DIA: 50 mm	HOLE DEPTH: 2.00 m	CHECKED: JM	DATE: 24/8/12

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-2.00 m ASS Samples taken at 0.25m Intervals				Silty SAND fine grained, grey brown, trace of fine size subangular gravel, with organic matter	M		Alluvial
			0.5	0.60					Silty SAND fine to medium grained, pale grey brown, trace of fine size subangular gravel			
			1.0	1.00					Silty Gravelly CLAY high plasticity, yellow brown, fine size subangular gravel			Residual Fe Mottling and Nodules
				1.25					Silty CLAY high plasticity, grey, trace of fine size subangular gravel			
			1.5	1.85					becoming grey, white	D		extremely weathered rock, strong Ochre Mottling
			2.0	2.00					END OF BOREHOLE @ 2.00 m Drill Rig Refusal			
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									
			5.0									
			5.5									
			6.0									
			6.5									
			7.0									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

GAP gINT FN. F01a
RL2

REPORT OF CORE PHOTOGRAPHS: BH16

		SHEET: 1 OF 1	
CLIENT: Saipem	COORDS: 309977 m E 7370764 m N MGA94 56	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG	DATE: 29/7/2012
JOB NO: 127683005	HOLE DEPTH: 2.00 m	CHECKED: JM	DATE: 24/8/2012

0.0 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

1.50 m – 2.00 m

1.50 m ***2.00 m***

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered.
As such it should not be relied upon for geotechnical purposes.

REPORT OF BOREHOLE: BH17

Golder Associates

SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 26/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 4.50 m	CHECKED: JM	DATE: 24/8/12

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-4.00 m ASS Samples taken at 0.25m Intervals				Silty SAND fine grained, olive brown, trace of fine size subangular gravel, with organic matter	M		Alluvial abundant Fe Mottling and occasional Fe Nodules
				0.25					Silty CLAY high plasticity, yellow brown, trace of fine size subangular gravel			
			0.5									
				0.75					becoming grey			Residual
			1.0									
												becoming friable
			1.5									
			2.0									
			2.5	2.50					Silty CLAY high plasticity, pale grey			some Fe Mottling and common Ochre Mottling
			3.0									
			3.5	3.50					Silty Clayey SAND fine grained, pale grey, high plasticity clay			with abundant Fe and Ochre Mottling
			4.0									
				4.40					Silty CLAY high plasticity, pale grey			
			4.5	4.50					END OF BOREHOLE @ 4.50 m			
			5.0									
			5.5									
			6.0									
			6.5									
			7.0									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

REPORT OF CORE PHOTOGRAPHS: BH17

		SHEET: 1 OF 1	
CLIENT: Saipem	COORDS: 310026 m E 7370783 m N MGA94 56	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG	DATE: 26/7/2012
JOB NO: 127683005	HOLE DEPTH: 4.50 m	CHECKED: JM	DATE: 24/8/2012

0.0 m – 1.50 m

0.00 m **0.50 m** **1.00 m** **1.50 m**

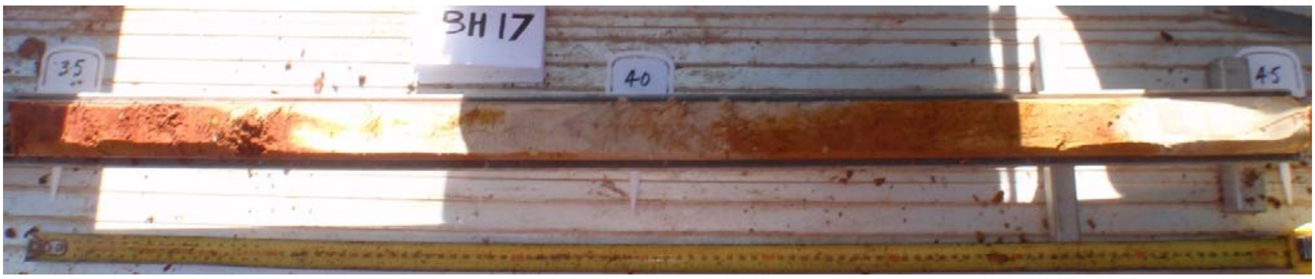
1.50 m – 2.50 m

1.50 m **2.00 m** **2.50 m**

2.50 m – 3.50 m.

2.50 m **3.00 m** **3.50 m**

3.50 m – 4.50 m.



3.50 m **4.00 m** **4.50 m**

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REPORT OF BOREHOLE: BH18

Golder Associates

SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 25/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 6.50 m	CHECKED: JM	DATE: 24/8/12

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0	0.10	0.00-6.50 m ASS Samples taken at 0.25m Intervals				Loamy SAND fine grained, brown, trace of fine to medium size subangular gravel, with organic matter	D		Alluvial with Fe Nodules and mottling
									Silty Sandy GRAVEL fine to coarse size, subangular, brown, fine grained sand			
			0.5	0.50					Silty CLAY medium to high plasticity, pale brown, trace of fine size subangular gravel	M		Residual
			1.0	1.25					Silty CLAY medium to high plasticity, pale grey			
			2.5	2.50					Sandy CLAY medium to high plasticity, pale grey, fine to medium grained sand, some fine size subangular to angular gravel			
			3.0	3.25					CLAY medium plasticity, white, pale grey			
			5.5	5.50					Silty CLAY medium plasticity, pale grey			Friable
			6.5	6.50					END OF BOREHOLE @ 6.50 m Refusal			

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

GAP gINT FN. F01a
RL2

Golder Associates

REPORT OF CORE PHOTOGRAPHS: BH18

SHEET: 1 OF 1

CLIENT: Saipem	COORDS: 310059 m E 7370760 m N MGA94 56	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG	DATE: 25/7/2012
JOB NO: 127683005	HOLE DEPTH: 6.50 m	CHECKED: JM	DATE: 24/8/2012

0.0 m – 1.50 m

0.00 m **0.50 m** **1.00 m** **1.50 m**

1.50 m – 2.50 m

1.50 m **2.00 m** **2.50 m**

2.50 m – 3.50 m.

2.50 m **3.00 m** **3.50 m**

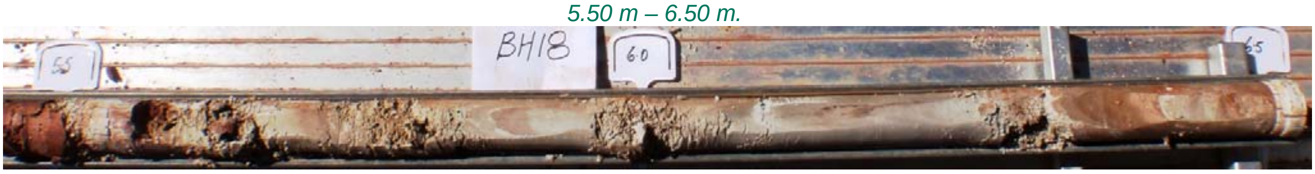
3.50 m – 4.50 m.

3.50 m **4.00 m** **4.50 m**

4.50 m – 5.50 m.

4.50 m **5.00 m** **5.50 m**

5.50 m – 6.50 m.



5.50 m **6.00 m** **6.50 m**

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REPORT OF BOREHOLE: BH19/GW5

SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 30/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 6.50 m	CHECKED: JM	DATE: 24/8/12

Drilling: METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	Sampling: SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-6.00 m ASS Samples taken at 0.25m Intervals				Silty SAND fine to medium grained, dark grey, with organic matter	M		Backfill
				0.25					Silty SAND fine to medium grained, pale grey			Bentonite
			0.5	0.50					Gravelly Silty CLAY high plasticity, yellow brown, fine to medium size subangular gravel			
									Silty Gravelly CLAY high plasticity, grey brown, fine to medium size subangular gravel, trace of fine to medium grained sand			
			1.0									
			1.5									Blank
				1.75					Silty CLAY high plasticity, pale grey			
			2.0									
				2.25					Silty CLAY high plasticity, pale grey, friable			
			2.5									
			3.0									Sand
			3.5									
				3.75					Silty CLAY high plasticity, pale green grey			
			4.0									
			4.5	4.50					Silty CLAY high plasticity, pale grey/white, with fine to medium grained sand lenses			Slotted
			5.0									
			5.5									
			6.0									
			6.5	6.50					END OF BOREHOLE @ 6.50 m			
			7.0									

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GAP gINT FN. F01d
RL2

REPORT OF CORE PHOTOGRAPHS: BH19

		SHEET: 1 OF 1
CLIENT: Saipem	COORDS: 310019 m E 7370744 m N MGA94 56	DRILL RIG: EziProbe
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG DATE: 30/7/2012
JOB NO: 127683005	HOLE DEPTH: 6.50 m	CHECKED: JM DATE: 24/8/2012

0.0 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

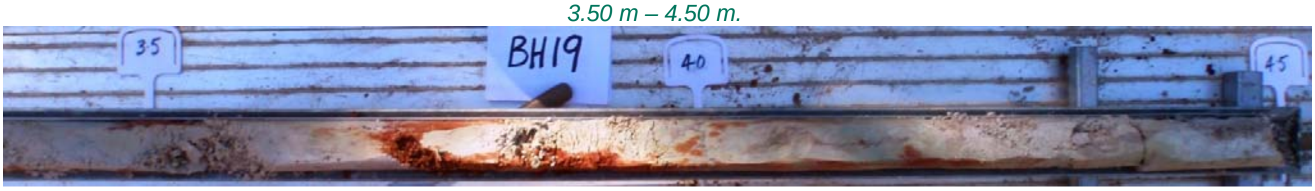
1.50 m – 2.50 m

1.50 m ***2.00 m*** ***2.50 m***

2.50 m – 3.50 m.

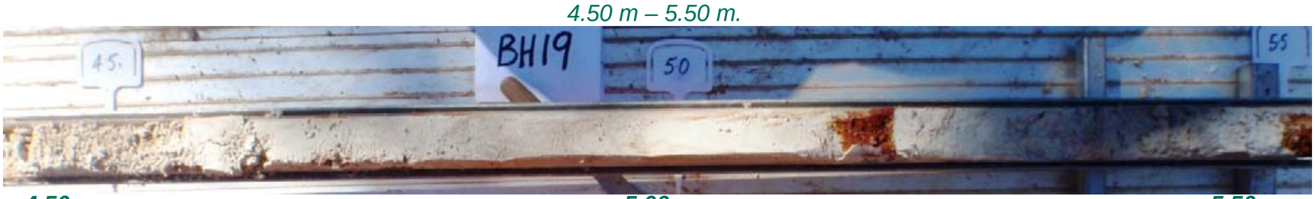
2.50 m ***3.00 m*** ***3.50 m***

3.50 m – 4.50 m.



3.50 m ***4.00 m*** ***4.50 m***

4.50 m – 5.50 m.



4.50 m ***5.00 m*** ***5.50 m***

5.50 m – 6.50 m.

5.50 m ***6.00 m*** ***6.50 m***

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Golder Associates

REPORT OF BOREHOLE: BH20/GW4

SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 29/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 6.50 m	CHECKED: JM	DATE: 24/8/12

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-6.00 m ASS Samples taken at 0.25m Intervals	Silty CLAY high plasticity, dark yellow brown, trace of fine to medium size subangular gravel, with organic matter	M	
			0.5	0.50		Silty CLAY high plasticity, dark brown, trace of fine size subangular gravel, trace of organics		
			3.75	3.75		Silty CLAY high plasticity, pale green grey, brown		
			5.75	5.75		Silty CLAY high plasticity, green grey		
			6.5	6.50		END OF BOREHOLE @ 6.50 m		

PIEZOMETER DETAILS: Backfill; Bentonite; Blank; Sand; Slotted

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GAP gINT FN. F01d RL2

REPORT OF CORE PHOTOGRAPHS: BH20

		SHEET: 1 OF 1	
CLIENT: Saipem	COORDS: 309950 m E 7370716 m N MGA94 56	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG	DATE: 29/7/2012
JOB NO: 127683005	HOLE DEPTH: 6.50 m	CHECKED: JM	DATE: 24/8/2012

0.0 m – 3.50 m

No Core Photos Available

3.50 m – 4.50 m.

3.50 m ***4.00 m*** ***4.50 m***

4.50 m – 5.50 m.

4.50 m ***5.00 m*** ***5.50 m***

5.50 m – 6.50 m.

5.50 m ***6.00 m*** ***6.50 m***

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REPORT OF BOREHOLE: BH21

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 29/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 2.50 m	CHECKED: JM	DATE: 24/8/12

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0	0.15	0.00-2.50 m ASS Samples taken at 0.25m Intervals				Silty SAND fine grained, dark grey, with organic matter	M		Alluvial
				0.50					becoming grey, silty sand	D		
			0.5	1.00					Silty CLAY high plasticity, dark yellow brown, trace of fine size subangular gravel	M		Residual Fe Mottling and Ochre
			1.0	1.75					Silty CLAY high plasticity, dark grey brown	M		
			1.5	2.00					Silty CLAY high plasticity, grey	M		
			2.0	2.50					MUDSTONE/SILTSTONE pale grey, extremely weathered	D		
			2.5						END OF BOREHOLE @ 2.50 m			

Depth scale: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0

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GAP6_0-BETA - CORRECT LOGO.GLB FULL PAGE J:\2012\ENVIRO\127683005 SAIPEM ASS INVESTIGATION\TASK 1000\TECHNICAL DOC\GINT\127683005 BH11-25.GPJ GAP5_1.GDT 27/08/2012 3:53:29 PM

REPORT OF CORE PHOTOGRAPHS: BH21

SHEET: 1 OF 1

CLIENT: Saipem	COORDS: 309989 m E 7370677 m N MGA94 56	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG	DATE: 29/7/2012
JOB NO: 127683005	HOLE DEPTH: 2.50 m	CHECKED: JM	DATE: 24/8/2012

0.00 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

1.50 m – 2.50 m

1.50 m ***2.00 m*** ***2.50 m***

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As such it should not be relied upon for geotechnical purposes.

REPORT OF BOREHOLE: BH22

SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 28/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 4.00 m	CHECKED: JM	DATE: 24/8/12

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-4.00 m ASS Samples taken at 0.25m Intervals				Sandy CLAY high plasticity, dark brown, fine grained sand, with organic matter	M		~~Alluvial~~ Residual
									Silty CLAY high plasticity, dark yellow brown, trace of fine size subangular gravel			
			0.5	0.50					Silty CLAY high plasticity, dark brown, trace of fine size subangular gravel			some light Fe Mottling and Ochre mottling
			2.5	2.50					Silty CLAY high plasticity, dark brown, trace of fine size subangular gravel, trace of fine to medium grained sand			
				3.25					Silty CLAY high plasticity, dark brown			
			3.5	3.50					Silty CLAY high plasticity, pale grey, white			
			4.0	4.00					END OF BOREHOLE @ 4.00 m			

Depth scale: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0

GAP6_0-BETA - CORRECT LOGO.GLB FULL PAGE J:\2012\ENVIRO\127683005 SAIPEM ASS INVESTIGATION\TASK 1000\TECHNICAL DOC\GINT\127683005 BH11-25.GPJ GAP5_1.GDT 27/08/2012 3:53:32 PM

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

REPORT OF CORE PHOTOGRAPHS: BH22

SHEET: 1 OF 1

CLIENT: Saipem	COORDS: 309911 m E 7370667 m N MGA94 56	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG	DATE: 28/7/2012
JOB NO: 127683005	HOLE DEPTH: 4.00 m	CHECKED: JM	DATE: 24/8/2012

0.00 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

1.50 m – 2.50 m

1.50 m ***2.00 m*** ***2.50 m***

2.50 m – 3.50 m

2.50 m ***3.00 m*** ***3.50 m***

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As such it should not be relied upon for geotechnical purposes.

REPORT OF BOREHOLE: BH23

Golder Associates

SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 26/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 4.50 m	CHECKED: JM	DATE: 24/8/12

Drilling					Sampling				Field Material Description			
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-4.00 m ASS Samples taken at 0.25m Intervals				SAND fine to medium grained, dark brown, with organic matter	M		Alluvial
									Clayey GRAVEL fine to coarse size, subangular, grey and yellow brown			
			0.5	0.50					Silty Gravelly CLAY high plasticity, grey brown, fine size subangular gravel			Residual
			1.0									
			1.5									
				1.75					Gravelly CLAY high plasticity, yellow grey brown, trace of fine size subangular gravel			some organic staining
			2.0									
			2.5	2.50					Silty CLAY high plasticity, dark brown, trace fine size subangular gravel			some Ochre staining
			3.0									
			3.5									
			4.0									
			4.5	4.50					END OF BOREHOLE @ 4.50 m			
			5.0									
			5.5									
			6.0									
			6.5									
			7.0									

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GAP gINT FN. F01a
RL2

REPORT OF CORE PHOTOGRAPHS: BH23

		SHEET: 1 OF 1
CLIENT: Saipem	COORDS: 309795 m E 7370605 m N MGA94 56	DRILL RIG: EziProbe
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG DATE: 26/7/2012
JOB NO: 127683005	HOLE DEPTH:4.50 m	CHECKED: JM DATE: 24/8/2012

0.00 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

1.50 m – 2.50 m

1.50 m ***2.00 m*** ***2.50 m***

2.50 m – 3.50 m

2.50 m ***3.00 m*** ***3.50 m***

2.50 m – 3.50 m

3.50 m ***4.00 m*** ***4.50 m***

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As such it should not be relied upon for geotechnical purposes.

REPORT OF BOREHOLE: BH24

SHEET: 1 OF 1

CLIENT: Saipem	POSITION: Refer to Site Plan	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90°	LOGGED: LG	DATE: 26/7/12
JOB NO: 127683005	HOLE DIA: 50 mm HOLE DEPTH: 5.00 m	CHECKED: JM	DATE: 24/8/12

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0		0.00-4.00 m ASS Samples taken at 0.25m Intervals				Silty CLAY high plasticity, yellow brown, trace of fine size subangular gravel, with organic matter	M		Residual
				0.40					Silty CLAY high plasticity, olive brown, trace of fine to medium size subangular gravel			
				1.60					becoming dark brown, trace of fine to medium grained sand			
				5.00					END OF BOREHOLE @ 5.00 m			

Depth scale: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0

GAP6_0-BETA - CORRECT LOGO.GLB FULL PAGE J:\2012\ENVIRO\127683005 SAIPEM ASS INVESTIGATION\TASK 1000\TECHNICAL DOC\GINT\127683005 BH11-25.GPJ GAP5_1.GDT 27/08/2012 3:53:36 PM

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

REPORT OF CORE PHOTOGRAPHS: BH24

		SHEET: 1 OF 1
CLIENT: Saipem	COORDS: 309852 m E 7370555 m N MGA94 56	DRILL RIG: EziProbe
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG DATE: 26/7/2012
JOB NO: 127683005	HOLE DEPTH:4.50 m	CHECKED: JM DATE: 24/8/2012

0.00 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

1.50 m – 2.50 m

1.50 m ***2.00 m*** ***2.50 m***

2.50 m – 3.50 m

2.50 m ***3.00 m*** ***3.50 m***

3.50 m – 4.50 m

3.50 m ***4.00 m*** ***4.50 m***

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered.
As such it should not be relied upon for geotechnical purposes.

REPORT OF BOREHOLE: BH25

SHEET: 1 OF 1

CLIENT:	Saipem	POSITION: Refer to Site Plan		DRILL RIG: EziProbe	
PROJECT:	LNG Pipeline	SURFACE RL: m DATUM: AHD71		DRILLER: AB	
LOCATION:	Launch Pad, The Narrows	INCLINATION: -90°		LOGGED: LG	DATE: 29/7/12
JOB NO:	127683005	HOLE DIA: 50 mm	HOLE DEPTH: 1.50 m	CHECKED: JM	DATE: 24/8/12

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT		GROUNDWATER NOT ENCOUNTERED	0.0	0.10	0.00-1.50 m ASS Samples taken at 0.25m Intervals				SAND fine grained, dark grey, with organic matter	M		Alluvial
				0.45					becoming grey			
			0.5	0.80					Silty CLAY high plasticity, yellow brown, trace of fine size subangular gravel			Residual
			1.0	1.50					Silty CLAY medium to high plasticity, grey			with common Fe Mottling
			1.5						END OF BOREHOLE @ 1.50 m Refusal			
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									
			5.0									
			5.5									
			6.0									
			6.5									
			7.0									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered. As such it should not be relied upon for geotechnical purposes.

REPORT OF CORE PHOTOGRAPHS: BH25

		SHEET: 1 OF 1	
CLIENT: Saipem	COORDS: 310008 m E 7370617 m N MGA94 56	DRILL RIG: EziProbe	
PROJECT: LNG Pipeline	SURFACE RL: m DATUM: AHD71	DRILLER: AB	
LOCATION: Launch Pad, The Narrows	INCLINATION: -90	LOGGED: LG	DATE: 29/7/2012
JOB NO: 127683005	HOLE DEPTH:1.5 m	CHECKED: JM	DATE: 24/8/2012

0.00 m – 1.50 m

0.00 m ***0.50 m*** ***1.00 m*** ***1.50 m***

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for environmental purposes only, without attempt to consider geotechnical properties or the geotechnical significance of the materials encountered.
As such it should not be relied upon for geotechnical purposes.

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT REPORTS

Golder Associates

DRILLING/EXCAVATION METHOD

AS*	Auger Screwing	RD	Rotary blade or drag bit	NQ	Diamond Core - 47 mm
AD*	Auger Drilling	RT	Rotary Tricone bit	NMLC	Diamond Core - 52 mm
*V	V-Bit	RAB	Rotary Air Blast	HQ	Diamond Core - 63 mm
*T	TC-Bit, e.g. ADT	RC	Reverse Circulation	HMLC	Diamond Core – 63mm
HA	Hand Auger	PT	Push Tube	BH	Tractor Mounted Backhoe
ADH	Hollow Auger	CT	Cable Tool Rig	EX	Tracked Hydraulic Excavator
DTC	Diatube Coring	JET	Jetting	EE	Existing Excavation
WB	Washbore or Bailer	NDD	Non-destructive digging	HAND	Excavated by Hand Methods

PENETRATION/EXCAVATION RESISTANCE

L **Low resistance.** Rapid penetration possible with little effort from the equipment used.

M **Medium resistance.** Excavation/possible at an acceptable rate with moderate effort from the equipment used.

H **High resistance** to penetration/excavation. Further penetration is possible at a slow rate and requires significant effort from the equipment.

R **Refusal or Practical Refusal.** No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.

These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.

WATER

▽	Water level at date shown	◁	Partial water loss
▷	Water inflow	◀	Complete water loss

GROUNDWATER NOT OBSERVED — The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.

GROUNDWATER NOT ENCOUNTERED — The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water Sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (s_v = peak value, s_r = residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure tests
DCP	Dynamic cone penetration test
CPT	Static cone penetration test
CPTu	Static cone penetration test with pore pressure (u) measurement

Ranking of Visually Observable Contamination and Odour (for specific soil contamination assessment projects)

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible contamination	R = B	Slight non-natural odours identified
R = 2	Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)

$$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$$

SCR = Solid Core Recovery (%)

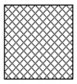
$$= \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100$$

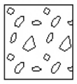
RQD = Rock Quality Designation (%)

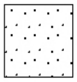
$$= \frac{\sum \text{Axial lengths of core} > 100 \text{ mm}}{\text{Length of core run}} \times 100$$

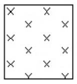
Golder Associates

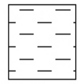
METHOD OF SOIL DESCRIPTION
USED ON BOREHOLE AND TEST PIT REPORTS

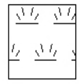
 FILL

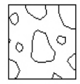
 GRAVEL (GP or GW)

 SAND (SP or SW)

 SILT (ML or MH)

 CLAY (CL, CI or CH)

 ORGANIC SOILS (OL or OH or Pt)

 COBBLES or BOULDERS

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

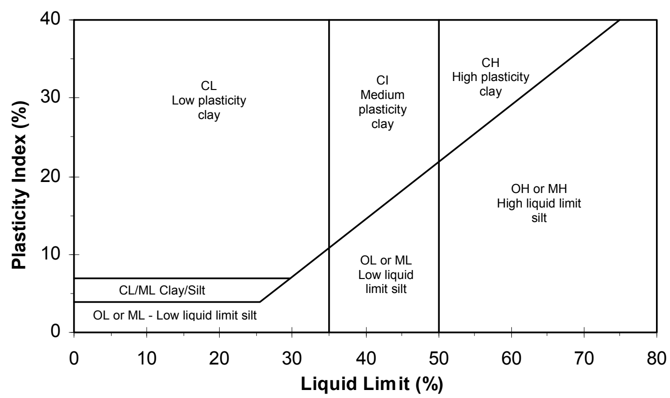
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS1726 – 1993, (Amdt1 – 1994 and Amdt2 – 1994), Appendix A. The material properties are assessed in the field by visual/tactile methods.

Particle Size

Major Division	Sub Division	Particle Size
BOULDERS		> 200 mm
COBBLES		63 to 200 mm
GRAVEL	Coarse	20 to 63 mm
	Medium	6.0 to 20 mm
	Fine	2.0 to 6.0 mm
SAND	Coarse	0.6 to 2.0 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties



MOISTURE CONDITION

AS1726 - 1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays & Silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition & may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726 - 1993

Symbol	Term	Undrained Shear Strength	Symbol	Term	Density Index %	SPT "N" #
VS	Very Soft	0 to 12 kPa	VL	Very Loose	Less than 15	0 to 4
S	Soft	12 to 25 kPa	L	Loose	15 to 35	4 to 10
F	Firm	25 to 50 kPa	MD	Medium Dense	35 to 65	10 to 30
St	Stiff	50 to 100 kPa	D	Dense	65 to 85	30 to 50
VSt	Very Stiff	100 to 200 kPa	VD	Very Dense	Above 85	Above 50
H	Hard	Above 200 kPa				

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.
SPT correlations are not stated in AS1726 – 1993, and may be subject to corrections for overburden pressure and equipment type.

TERMS FOR ROCK MATERIAL STRENGTH & WEATHERING AND ABBREVIATIONS FOR DEFECT DESCRIPTIONS

Golder Associates

STRENGTH

Symbol	Term	Point Load Index, $Is_{(50)}$ (MPa)	Field Guide
EL	Extremely Low	< 0.03	Easily remoulded by hand to a material with soil properties.
VL	Very Low	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	0.1 to 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	0.3 to 1	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	1 to 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

ROCK STRENGTH TEST RESULTS

▼	Point Load Strength Index, $I_s(50)$, Axial test (MPa)
◀	Point Load Strength Index, $I_s(50)$, Diametral test (MPa)

Relationship between $I_s(50)$ and UCS (unconfined compressive strength) will vary with rock type and strength, and should be determined on a site-specific basis. UCS is typically 10 to 30 x $I_s(50)$, but can be as low as 5.

ROCK MATERIAL WEATHERING

Symbol		Term	Field Guide
RS		Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
EW		Extremely Weathered	Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.
DW	HW MW	Distinctly Weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. In some environments it is convenient to subdivide into Highly Weathered and Moderately Weathered, with the degree of alteration typically less for MW.
SW		Slightly Weathered	Rock is slightly discoloured but shows little or no change of strength relative to fresh rock.
FR		Fresh	Rock shows no sign of decomposition or staining.

ABBREVIATIONS FOR DEFECT TYPES AND DESCRIPTIONS

Defect Type

B	Bedding parting
X	Foliation
C	Contact
L	Cleavage
J	Joint
SS/SZ	Sheared seam/zone (Fault)
CS/CZ	Crushed seam/zone (Fault)
DS/DZ	Decomposed seam/zone
IS/IZ	Infilled seam/zone
S	Schistocity
V	Vein

Coating or Infilling

Cn	Clean
Sn	Stain
Vr	Veneer
Ct	Coating or Infill

Planarity

Pl	Planar
Un	Undulating
St	Stepped

Roughness

Sl	Slickensided
Sm	Smooth
Ro	Rough

Vertical Boreholes – The dip (inclination from horizontal) of the defect is given.

Inclined Boreholes – The inclination is measured as the acute angle to the core axis.

GAP Form No. 7
RL6

APPENDIX B

Results of Groundwater Laboratory Testing

ALS Group

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES1218921**	Page	: 1 of 3
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Sydney
Contact	: MR JOSH MITCHELL	Contact	: Jennifer Cullen
Address	: P O BOX 5569 55 KINGSFORD SMITH PARADE MAROOCHYDORE QLD, AUSTRALIA 4558	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: jmitchell@golder.com.au	E-mail	: jennifer.cullen@alsglobal.com
Telephone	: +61 07 5475 5900	Telephone	: +61 2 8784 8509
Facsimile	: +61 07 5475 5901	Facsimile	: +61 2 8784 8500
Project	: 127683005(GW PHASE 2) SAIPEM ASS MARINE CROSSING GTP	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: MQ7268		
C-O-C number	: ----	Date Samples Received	: 02-AUG-2012
Sampler	: LG	Issue Date	: 08-AUG-2012
Site	: ----		
		No. of samples received	: 3
Quote number	: EN/002/11	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Sarah Millington	Senior Inorganic Chemist	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EG020A: LOR 's have been raised due to matrix interference (High sample salinity)**

Analytical Results

Sub-Matrix: **WATER**			Client sample ID	**GW4**	**GW5**	**GW6**	----	----
			Client sampling date / time	31-JUL-2012 15:00	31-JUL-2012 15:00	31-JUL-2012 15:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES1218921-001**	**ES1218921-002**	**ES1218921-003**	**----**	**----**
EA041: Colour (True)								
Colour (True)	----	1	PCU	**10**	**5**	**2**	----	----
pH Colour	----	0.01	pH Unit	**3.60**	**3.29**	**4.57**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	<1	**3**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	<1	<1	**3**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**1340**	**1410**	**1530**	----	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**14000**	**13900**	**14900**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**352**	**134**	**409**	----	----
Magnesium	7439-95-4	1	mg/L	**1070**	**845**	**1210**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**5.54**	**59.4**	**0.48**	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.010	<0.010	<0.010	----	----
Barium	7440-39-3	0.001	mg/L	**0.056**	**0.059**	**0.062**	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.010	**0.012**	<0.010	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0010	<0.0010	<0.0010	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.072**	**0.028**	**0.110**	----	----
Chromium	7440-47-3	0.001	mg/L	<0.010	<0.010	<0.010	----	----
Copper	7440-50-8	0.001	mg/L	**0.017**	**0.085**	**0.014**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.486**	**0.181**	**0.269**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.055**	**0.055**	**0.075**	----	----
Lead	7439-92-1	0.001	mg/L	<0.010	<0.010	<0.010	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.10	<0.10	<0.10	----	----
Zinc	7440-66-6	0.005	mg/L	**0.078**	**0.169**	**0.128**	----	----
Iron	7439-89-6	0.05	mg/L	<0.50	**3.96**	<0.50	----	----
EG020T: Total Metals by ICP-MS								
Iron	7439-89-6	0.05	mg/L	**42.5**	**191**	**55.0**	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----

Golder Associates

Forward to:

TESTING REQUEST FORM

ALS ENVIRONMENTAL

32 SHAND STREET STAFFORD QLD 4053

GOLDER ASSOCIATES PTY LTD
55 Kingsford Smith Parade Phone: : (07) 5475 5900
Maroochydore Qld 4558 Fax : (07) 5475 5901

Order No.: MQ7268 **Project No.:** 127683005 (GW Phase 2)

Task:

Project: Saipem ASS Marine Crossing GTP

Quotation No: EN/011

Sampled By: LG **Contact Name:** Josh Mitchell

Email Report to: lgordon@golder.com.au
jmitchell@golder.com.au

	SAMPLE ID	Media	Plastic Black	Plastic Green	Plastic Purple	Plastic Red	1 Litre White	SAMPLE DATE	colour	Calcium	Manganese - Dissolved	Carbonate	Bicarbonate	Sulphate	Chloride	Iron - Dissolved	Iron - total	Aluminium - Dissolved	Magnesium	W-3 (Dissolved)				
1	GW4	water		1		2		31/07/2012	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
2	GW5	water		1		2		31/07/2012	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
3	GW6	water		1		2		31/07/2012	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				

Checked by: LYNDON GORDON
Date Sent: 1/8/12

Please Return Signed Copy By Facsimile:
Date Received By ALS: ALS Signature:

Environmental Division
Sydney
Work Order
ES1218921

Telephone : + 61-2-8784 8555

Received by:
David
ALS Sydney
2/8
1030

05683018tr2

Environmental Division

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **ES1218921**		
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Sydney
Contact	: MR JOSH MITCHELL	Contact	: Jennifer Cullen
Address	: P O BOX 5569 55 KINGSFORD SMITH PARADE MAROOCHYDORE QLD, AUSTRALIA 4558	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: jmitchell@golder.com.au	E-mail	: jennifer.cullen@alsglobal.com
Telephone	: +61 07 5475 5900	Telephone	: +61 2 8784 8509
Facsimile	: +61 07 5475 5901	Facsimile	: +61 2 8784 8500
Project	: 127683005(GW PHASE 2) SAIPEM ASS MARINE CROSSING GTP	Page	: 1 of 2
Order number	: MQ7268		
C-O-C number	: ----	Quote number	: EM2011GOLASS0405 (EN/002/11)
Site	: ----		
Sampler	: LG	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 02-AUG-2012	Issue Date	: 02-AUG-2012 14:05
Client Requested Due Date	: 08-AUG-2012	Scheduled Reporting Date	: **08-AUG-2012**

Delivery Details

Mode of Delivery	: Carrier	Temperature	: 2.1'C - Ice present
No. of coolers/boxes	: 4 HARD	No. of samples received	: 3
Security Seal	: Intact.	No. of samples analysed	: 3

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EA041 Colour (True)	WATER - ED093F Dissolved Major Cations	WATER - EG020F Dissolved Metals by ICPMS	WATER - EG020T Total Recoverable Metals by ICPMS	WATER - NT-02 Major Anions (Chloride, Sulphate, Alkalinity)	WATER - W-03 13 Metals (NEPM Suite)
ES1218921-001	31-JUL-2012 15:00	GW4	✓	✓	✓	✓	✓	✓
ES1218921-002	31-JUL-2012 15:00	GW5	✓	✓	✓	✓	✓	✓
ES1218921-003	31-JUL-2012 15:00	GW6	✓	✓	✓	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

MR JOSH MITCHELL		
- *AU Certificate of Analysis - NATA (COA)	Email	jmitchell@golder.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	jmitchell@golder.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	jmitchell@golder.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	jmitchell@golder.com.au
- A4 - AU Tax Invoice (INV)	Email	jmitchell@golder.com.au
- Chain of Custody (CoC) (COC)	Email	jmitchell@golder.com.au
- EDI Format - ENMRG (ENMRG)	Email	jmitchell@golder.com.au
- EDI Format - EQUIS V5 Generic (EQUIS_V5)	Email	jmitchell@golder.com.au
- EDI Format - ESDAT (ESDAT)	Email	jmitchell@golder.com.au
- EDI Format - GOLDER_EXCEL (GOLDER_EXCEL)	Email	jmitchell@golder.com.au
MR LYNDON GORDON		
- *AU Certificate of Analysis - NATA (COA)	Email	lgordon@golder.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	lgordon@golder.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	lgordon@golder.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	lgordon@golder.com.au
- A4 - AU Tax Invoice (INV)	Email	lgordon@golder.com.au
- Chain of Custody (CoC) (COC)	Email	lgordon@golder.com.au
- EDI Format - ENMRG (ENMRG)	Email	lgordon@golder.com.au
- EDI Format - EQUIS V5 Generic (EQUIS_V5)	Email	lgordon@golder.com.au
- EDI Format - ESDAT (ESDAT)	Email	lgordon@golder.com.au
- EDI Format - GOLDER_EXCEL (GOLDER_EXCEL)	Email	lgordon@golder.com.au

ALS Group

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **ES1218921**	Page	: 1 of 7
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Sydney
Contact	: MR JOSH MITCHELL	Contact	: Jennifer Cullen
Address	: P O BOX 5569 55 KINGSFORD SMITH PARADE MAROOCHYDORE QLD, AUSTRALIA 4558	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: jmitchell@golder.com.au	E-mail	: jennifer.cullen@alsglobal.com
Telephone	: +61 07 5475 5900	Telephone	: +61 2 8784 8509
Facsimile	: +61 07 5475 5901	Facsimile	: +61 2 8784 8500
Project	: 127683005(GW PHASE 2) SAIPEM ASS MARINE CROSSING GTP	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 02-AUG-2012
Sampler	: LG	Issue Date	: 08-AUG-2012
Order number	: MQ7268		
		No. of samples received	: 3
Quote number	: EN/002/11	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Sarah Millington	Senior Inorganic Chemist	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA041: Colour (True) (QC Lot: 2431444)									
ES1218776-001	Anonymous	EA041: Colour (True)	----	1	PCU	<1	<1	0.0	No Limit
		EA041: pH Colour	----	0.01	pH Unit	6.70	6.68	0.3	0% - 20%
ES1218776-010	Anonymous	EA041: Colour (True)	----	1	PCU	2	2	0.0	No Limit
		EA041: pH Colour	----	0.01	pH Unit	6.06	6.08	0.3	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 2431885)									
ES1218725-008	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	8	3	80.0	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	8	3	80.0	No Limit
EW1202108-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	25	24	0.0	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	25	24	0.0	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2431367)									
ES1218779-006	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	6	6	0.0	No Limit
ME1201258-003	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.0	No Limit
ED045G: Chloride Discrete analyser (QC Lot: 2431366)									
ES1218779-006	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	50	51	0.0	0% - 20%
ME1201258-004	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	6	6	0.0	No Limit
ED093F: Dissolved Major Cations (QC Lot: 2431364)									
ES1218779-005	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	14	14	0.0	0% - 50%
		ED093F: Magnesium	7439-95-4	1	mg/L	10	10	0.0	0% - 50%
ME1201258-004	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	1	1	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	2	2	0.0	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2433499)									
ES1218688-003	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0002	0.0003	45.1	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.018	0.017	0.0	0% - 50%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2433499) - continued									
ES1218688-003	Anonymous	EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.324	0.320	1.0	0% - 20%
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
ES1218921-002	GW5	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0010	<0.0010	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	0.012	0.011	0.0	0% - 50%
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.059	0.062	4.8	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	0.028	0.028	0.0	0% - 20%
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.085	0.086	0.0	0% - 20%
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.181	0.178	1.6	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.055	0.053	2.3	0% - 20%
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.169	0.172	1.9	0% - 20%
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	59.4	60.1	1.2	0% - 20%
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.10	<0.10	0.0	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	3.96	3.93	0.9	0% - 20%
EG020T: Total Metals by ICP-MS (QC Lot: 2433487)									
ES1218716-001	Anonymous	EG020A-T: Iron	7439-89-6	0.05	mg/L	0.53	0.49	7.9	No Limit
EW1202132-003	Anonymous	EG020A-T: Iron	7439-89-6	0.05	mg/L	0.23	0.21	7.4	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 2433498)									
ES1218688-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	**CAS Number**	**LOR**	**Unit**	**Result**	**Concentration**	**LCS**	**Low**	**High**
EA041: Colour (True) (QCLot: 2431444)								
EA041: Colour (True)	----	1	PCU	<1	20 PCU	100	70	130
ED037P: Alkalinity by PC Titrator (QCLot: 2431885)								
ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	----	200 mg/L	95.1	75	107
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2431367)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	96.7	77	121
ED045G: Chloride Discrete analyser (QCLot: 2431366)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	1000 mg/L	108	79	123
ED093F: Dissolved Major Cations (QCLot: 2431364)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	99.9	88	110
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	102	90	110
EG020F: Dissolved Metals by ICP-MS (QCLot: 2433499)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	107	92	112
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	106	88	110
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	97.8	80	114
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	104	85	109
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	106	89	107
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	104	91	111
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	106	89	109
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	105	87	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	104	90	110
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	99.6	87	113
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	106	89	109
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	101	91	109
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	108	85	115
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	106	84	114
EG020T: Total Metals by ICP-MS (QCLot: 2433487)								
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	107	84	118
EG035F: Dissolved Mercury by FIMS (QCLot: 2433498)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.010 mg/L	94.6	86	116

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	Spike Recovery (%) MS	Recovery Limits (%) Low	Recovery Limits (%) High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2431367)							
ES1218779-006	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	107	70	130
ED045G: Chloride Discrete analyser (QCLot: 2431366)							
ES1218779-006	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	127	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 2433499)							
ES1218688-004	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	114	70	130
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	129	70	130
		EG020A-F: Barium	7440-39-3	0.2 mg/L	118	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	121	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	126	70	130
		EG020A-F: Cobalt	7440-48-4	0.2 mg/L	116	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	118	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	115	70	130
		EG020A-F: Manganese	7439-96-5	0.2 mg/L	124	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	113	70	130
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	124	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	122	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 2433498)							
ES1218688-002	Anonymous	EG035F: Mercury	7439-97-6	0.0100 mg/L	80.1	70	130

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report

The quality control term Matrix Spike (MS) and Matrix Spike Duplicate (MSD) refers to intralaboratory split samples spiked with a representative set of target analytes. The purpose of these QC parameters are to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report Spike Concentration	Spike Recovery (%) MS	Spike Recovery (%) MSD	Recovery Limits (%) Low	Recovery Limits (%) High	RPDs (%) Value	RPDs (%) Control Limit
ED045G: Chloride Discrete analyser (QCLot: 2431366)										
ES1218779-006	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	127	----	70	130	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2431367)										
ES1218779-006	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	107	----	70	130	----	----
EG035F: Dissolved Mercury by FIMS (QCLot: 2433498)										
ES1218688-002	Anonymous	EG035F: Mercury	7439-97-6	0.0100 mg/L	80.1	----	70	130	----	----
EG020F: Dissolved Metals by ICP-MS (QCLot: 2433499)										
ES1218688-004	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	114	----	70	130	----	----
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	129	----	70	130	----	----
		EG020A-F: Barium	7440-39-3	0.2 mg/L	118	----	70	130	----	----
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	121	----	70	130	----	----

Sub-Matrix: **WATER**

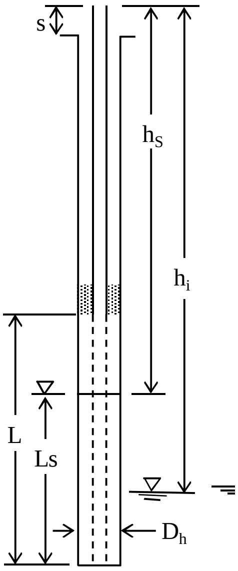
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Spike Concentration	Spike Recovery (%) MS	Spike Recovery (%) MSD	Recovery Limits (%) Low	Recovery Limits (%) High	RPDs (%) Value	RPDs (%) Control Limit
EG020F: Dissolved Metals by ICP-MS (QCLot: 2433499) - continued										
ES1218688-004	Anonymous	EG020A-F: Chromium	7440-47-3	0.2 mg/L	126	----	70	130	----	----
		EG020A-F: Cobalt	7440-48-4	0.2 mg/L	116	----	70	130	----	----
		EG020A-F: Copper	7440-50-8	0.2 mg/L	118	----	70	130	----	----
		EG020A-F: Lead	7439-92-1	0.2 mg/L	115	----	70	130	----	----
		EG020A-F: Manganese	7439-96-5	0.2 mg/L	124	----	70	130	----	----
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	113	----	70	130	----	----
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	124	----	70	130	----	----
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	122	----	70	130	----	----

APPENDIX C

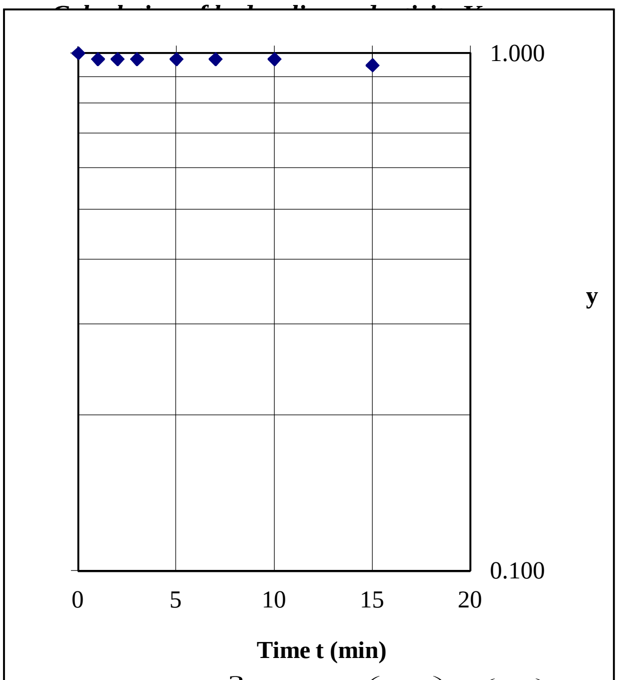
Rising Head Permeability Test Results

RISING HEAD PERMEABILITY TEST

Client	Saipem Australia Pty Ltd	**Bore No**	**BH15-GW6**
Project	GLNG Marine Crossing GTP Phase 2	**Test Date**	July 31, 2012
Location	Narrows, Gladstone	**Project No.**	127683005
Tested by	LG	**Checked**	JM/SS
Remarks			



Depth of borehole (H)	4.00	m	(measured from ground surface)
Depth to bottom of seal (Hb)	0.30	m	(measured from ground surface)
Test section length (L)	1.5	m	
Diameter of pipe (D_p)	0.05	m	Note **:
Diameter of test section (D_h)	0.10	m	1. d = D_p or D_h if no gravel pack
Dia. of water surface (d)**	0.067	m	2. $d = \sqrt{D_p^2 + 0.3\left(D_h^2 - D_p^2\right)}$
Static depth to gw (h_s) (tos)	3.76	m	if water surface is within gravel pack
Depth of water in screen (Ls)	0.78	m	
Bore inclination	0	°	
Stickup of pipe (s)	0.54	m	



$$K = \frac{d^2}{8 \times 60\left(t^* - t_1\right)Ls} \ln\left(\frac{2Ls}{D_h}\right) \ln\left(\frac{y_1}{y^*}\right)$$

where
t^*, y^*, $t_1 = 0$, $y_1 = 1$ define slope of a straight line fitted to the observations

t_1(min) =	0.00	t*(min) =	50.00
y_1(m) =	1.00	y*(m) =	0.250
K =	9.3E-07 m/sec		

i = 1, 2, 3, ...n

i	Time t (min)	Depth to water h_i (m)	Diff. in water levels $h_S - h_i$ (m)	$y = \frac{h_S - h_i}{h_S - h_1}$
1	0	4.150	0.390	1.000
2	1.00	4.140	0.380	0.974
3	2.00	4.140	0.380	0.974
4	3.00	4.140	0.380	0.974
5	5.00	4.140	0.380	0.974
6	7.00	4.140	0.380	0.974
7	10.00	4.140	0.380	0.974
8	15.00	4.130	0.370	0.949
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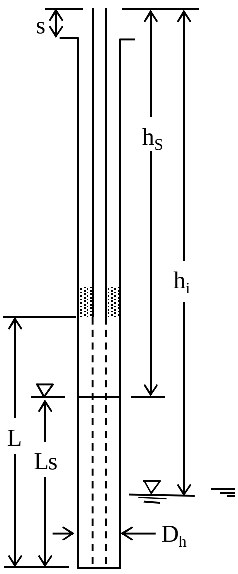
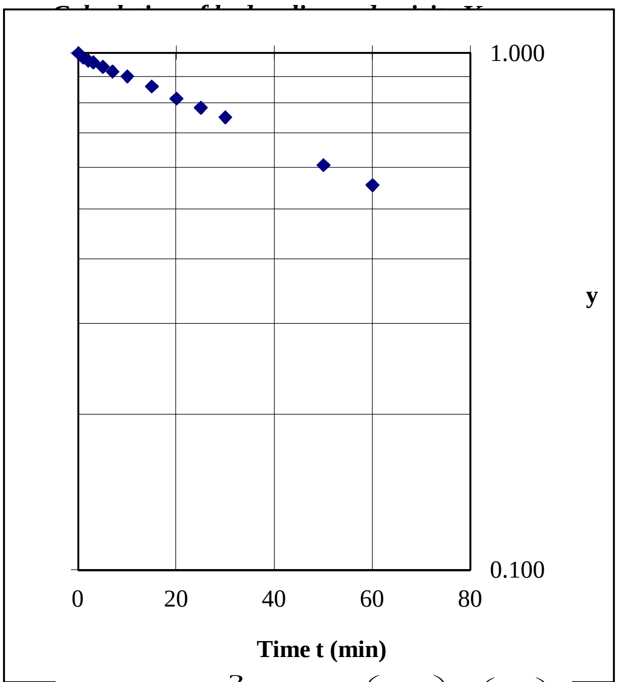
RISING HEAD PERMEABILITY TEST

Client	Saipem Australia Pty Ltd	**Bore No**	**BH19-GW5**
Project	GLNG Marine Crossing GTP Phase 2	**Test Date**	July 31, 2012
Location	Narrows, Gladstone	**Project No.**	127683005
Tested by	LG	**Checked**	JM/SS
Remarks			



Depth of borehole (H)	6.00	m	(measured from ground surface)
Depth to bottom of seal (Hb)	0.30	m	(measured from ground surface)
Test section length (L)	3.0	m	
Diameter of pipe (D_p)	0.05	m	Note **:
Diameter of test section (D_h)	0.10	m	1. d = D_p or D_h if no gravel pack
Dia. of water surface (d)**	0.067	m	2. $d = \sqrt{D_p^2 + 0.3\left(D_h^2 - D_p^2\right)}$
Static depth to gw (h_s) (tos)	5.06	m	if water surface is within gravel pack
Depth of water in screen (Ls)	1.67	m	
Bore inclination	0	°	
Stickup of pipe (s)	0.73	m	



$$K = \frac{d^2}{8 \times 60\left(t^* - t_1\right)Ls} \ln\left(\frac{2Ls}{D_h}\right) \ln\left(\frac{y_1}{y^*}\right)$$

where
t^*, y^*, $t_1 = 0$, $y_1 = 1$ define slope of a straight line fitted to the observations

t_1(min) =	0.00	t*(min) =	50.00
y_1(m) =	1.00	y*(m) =	0.250
K =	5.5E-07 m/sec		

i = 1, 2, 3, ...n

i	Time t (min)	Depth to water h_i (m)	Diff. in water levels $h_S - h_i$ (m)	$y = \frac{h_S - h_i}{h_S - h_1}$
1	0	6.590	1.530	1.000
2	1.00	6.560	1.500	0.980
3	2.00	6.540	1.480	0.967
4	3.00	6.530	1.470	0.961
5	5.00	6.500	1.440	0.941
6	7.00	6.470	1.410	0.922
7	10.00	6.440	1.380	0.902
8	15.00	6.380	1.320	0.863
9	20.00	6.310	1.250	0.817
10	25.00	6.260	1.200	0.784
11	30.00	6.210	1.150	0.752
12	50.00	5.990	0.930	0.608
13	60.00	5.910	0.850	0.556
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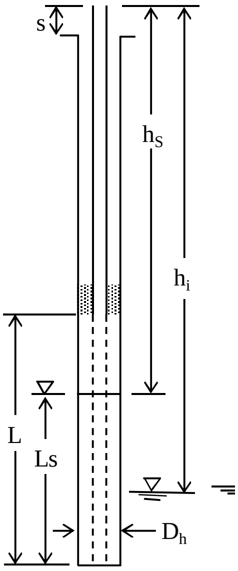
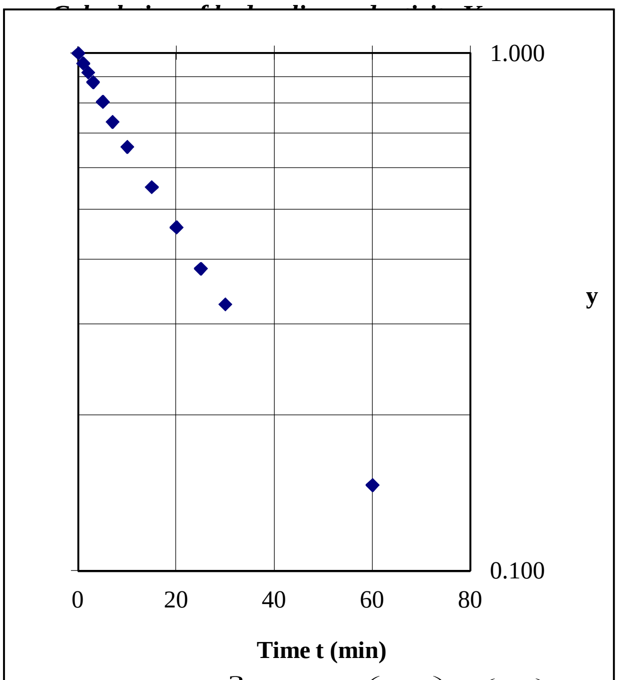
RISING HEAD PERMEABILITY TEST

Client	Saipem Australia Pty Ltd	**Bore No**	**BH20-GW4**
Project	GLNG Marine Crossing GTP Phase 2	**Test Date**	July 31, 2012
Location	Narrows, Gladstone	**Project No.**	127683005
Tested by	LG	**Checked**	JM/SS
Remarks			



Depth of borehole (H)	6.00	m	(measured from ground surface)
Depth to bottom of seal (Hb)	0.30	m	(measured from ground surface)
Test section length (L)	1.5	m	
Diameter of pipe (D_p)	0.05	m	Note **:
Diameter of test section (D_h)	0.10	m	1. d = D_p or D_h if no gravel pack
Dia. of water surface (d)**	0.067	m	2. $d = \sqrt{D_p^2 + 0.3\left(D_h^2 - D_p^2\right)}$
Static depth to gw (h_s) (tos)	3.83	m	if water surface is within gravel pack
Depth of water in screen (Ls)	2.83	m	
Bore inclination	0	°	
Stickup of pipe (s)	0.66	m	



$$K = \frac{d^2}{8 \times 60(t^* - t_1)Ls} \ln\left(\frac{2Ls}{D_h}\right) \ln\left(\frac{y_1}{y^*}\right)$$

where
t^*, y^*, $t_1 = 0$, $y_1 = 1$ define slope of a straight line fitted to the observations

t_1(min) =	0.00	t*(min) =	50.00
y_1(m) =	1.00	y*(m) =	0.250
K =	3.7E-07 m/sec		

i = 1, 2, 3, ...n

i	Time t (min)	Depth to water h_i (m)	Diff. in water levels $h_S - h_i$ (m)	$y = \frac{h_S - h_i}{h_S - h_1}$
1	0	6.150	2.320	1.000
2	1.00	6.050	2.220	0.957
3	2.00	5.960	2.130	0.918
4	3.00	5.870	2.040	0.879
5	5.00	5.700	1.870	0.806
6	7.00	5.540	1.710	0.737
7	10.00	5.360	1.530	0.659
8	15.00	5.110	1.280	0.552
9	20.00	4.900	1.070	0.461
10	25.00	4.720	0.890	0.384
11	30.00	4.590	0.760	0.328
12	60.00	4.170	0.340	0.147
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APPENDIX D

Table D1: Summary of ASS Field & Laboratory Analysis Results
ASS Laboratory Testing Results

BH ID	Depth (m)	Description	Quick Screening Test						Existing Acidity		Potential Acidity		Acid Neutralising Capacity			Retained Acidity					Acid Base Accounting			Required Lime Rate	
			pH_F	AASS likelihood[1]	pH_{FOX}	PASS likelihood[2]	Reaction	Remark	pH KCl	Titratable Actual Acidity	Chromium Reducible Sulfur	acidity - Chromium Reducible Sulfur	Acid Neutralising Capacity	acidity - Acid Neutralising Capacity	sulfidic - Acid Neutralising Capacity	Net Acid Soluble Sulfur	acidity - Net Acid Soluble Sulfur	sulfidic - Net Acid Soluble Sulfur	KCl Extractable Sulfur	HCl Extractable Sulfur	ANC Fineness Factor	Net Acidity (sulfur units)	Net Acidity (acidity units)		
			pH Unit		pH Unit				pH Unit	mole H+ / t	% S	mole H+ / t	% CaCO3	mole H+ / t	% pyrite S	% S	mole H+ / t	% pyrite S	% S	% S		% S	mole H+ / t	kg CaCO3/t	kg $CaCO_3/m^3$
BH11	0.10	Silty CLAY, high plasticity, yellow brown, trace of fine gravel, trace of organic material (rootlets).	6.8	L	4.6	M	M																		
	0.25		6.7	L	4.7	M	M		4.6	42	<0.005	<10									1.5	0.07	42	3	5
	0.50	Silty CLAY, high plasticity, grey brown, trace of fine to medium gravel, some coarse gravel	6.8	L	6.0	L	L																		
	0.75		7.4	L	6.0	L	L																		
	1.00		7.2	L	6.3	L	L																		
	1.25		7.4	L	6.4	L	H																		
	1.50	Gravelly silty CLAY, high plasticity, dark brown, fine to medium gravel	7.6	L	8.4	L	X																		
	1.75		7.4	L	6.7	L	X																		
	2.00		7.5	L	5.5	M	L		5.9	6	<0.005	<10									1.5	<0.02	<10	0	0
	2.25		7.2	L	6.2	L	L																		
	2.50	becoming silty CLAY, high plasticity, dark brown with some fine to coarse sand and fine gravel	7.2	L	6.1	L	L																		
	2.75		7.2	L	5.5	L	L		5.9	7	<0.005	<10									1.5	<0.02	<10	0	0
	3.00		7.0	L	5.7	L	L																		
	3.25		7.0	L	5.7	L	L																		
	3.50		6.7	L	5.7	L	L																		
	3.75	occasional Iron staining	7.0	L	5.7	L	L		5.9	7	<0.005	<10									1.5	<0.02	<10	0	0
	4.00		7.0	L	5.8	L	L																		
BH12	0.10	Clayey LOAM, fine to medium grained, dark brown with organic material	6.5	L	3.2	M	H																		
	0.25	Silty CLAY, high plasticity, yellow brown, with some fine quartz gravel, fine to medium sand and organic material (rootlets)	6.5	L	5.0	L	L		4.6	46	<0.005	<10									1.5	0.07	46	3	5
	0.50		6.5	L	4.7	L	L																		
	0.75		6.9	L	5.7	L	L																		
	1.00	Silty CLAY, high plasticity, grey brown, with some fine gravel	6.9	L	6.0	L	L																		
	1.25		6.9	L	5.9	L	L																		
	1.50		7.1	L	8.0	L	X		6.3	3	<0.005	<10									1.5	<0.02	<10	0	0
	1.75	becoming silty CLAY, high plasticity, with some fine to medium gravel and trace of Iron nodules	7.6	L	8.1	L	X																		
	2.00		7.5	L	5.7	L	L																		
	2.25		7.0	L	5.7	L	L		6.0	6	<0.005	<10									1.5	<0.02	<10	0	0
	2.50		6.9	L	5.9	L	L																		
	2.75		7.1	L	7.3	L	M																		
	3.00		7.2	L	5.3	L	L																		
	3.25	with some fine to medium Sand	7.1	L	5.6	L	L																		
	3.50		7.0	L	5.6	L	L																		
	3.75	occasional Iron staining	6.8	L	5.5	L	L																		
	4.00		7.0	L	5.6	L	L		6.0	7	<0.005	<10									1.5	<0.02	<10	0	0
BH13	0.10	Silty CLAY, medium plasticity, dark brown with	7.6	L	5.6	M	M																		
	0.25	Silty CLAY, medium plasticity, dark brown	7.7	L	6.1	L	M																		
	0.50		7.7	L	6.2	L	M		6.2	5	<0.005	<10									1.5	<0.02	<10	0	0
	0.75		7.3	L	5.8	L	L																		
	1.00		6.7	L	5.2	L	L																		
	1.25		6.4	L	5.4	L	L																		
	1.50		6.6	L	5.7	L	L		5.3	18	<0.005	<10									1.5	0.03	18	1	2
	1.75		6.6	L	5.2	L	L																		
	2.00		6.8	L	5.6	L	L																		
	2.25		6.6	L	5.4	L	L																		
	2.50		6.6	L	5.4	L	L																		
	2.75	Gravelly Silty CLAY, high plasticity, pale grey and Iron staining	6.5	L	5.4	L	L		5.6	12	<0.005	<10									1.5	<0.02	12	0	0
	3.00		6.5	L	5.4	L	L																		
	3.25		6.4	L	5.5	L	L																		
	3.50		6.2	L	5.2	L	L																		
	3.75		6.6	L	5.3	L	L		5.7	12	<0.005	<10									1.5	<0.02	12	0	0
	4.00		6.2	L	5.3	L	L																		
BH14	0.10	Silty CLAY, medium plasticity, dark grey, with organic material	6.6	L	4.3	M	L																		
	0.25		6.4	L	3.9	M	L		4.4	62	<0.005	<10				<0.02	<10	<0.02	<0.02	<0.02	1.5	0.11	67	5	9
	0.50		5.4	L	3.8	L	L																		
	0.75	Silty CLAY, high plasticity, grey brown, trace of fine gravel, trace of organic material, some ochre staining	5.7	L	3.5	M	L																		
	1.00		5.8	L	4.3	L	L																		
	1.25		5.4	L	4.4	L	L																		
	1.50		5.8	L	4.0	L	L		4.4	35	<0.005	<10				<0.02	<10	<0.02	0.02	0.03	1.5	0.06	38	3	5
	1.75		5.6	L	4.1	L	L																		
	2.00		6.1	L	4.1	M	L																		
	2.25		5.8	L	4.1	L	L																		
	2.50		5.9	L	4.0	L	L																		
	2.75	Gravelly silty CLAY, high plasticity, grey brown, fine gravel, some Iron staining	6.1	L	3.8	M	L		4.6	29	<0.005	<10									1.5	0.05	29	2	4
	3.00		7.9	L	4.0	M	L																		
	3.25		5.1	L	3.6	L	L																		
	3.50	Silty CLAY, high plasticity, pale grey and some Iron staining, some silty kaolonitic with trace of Iron nodules	5.0	M	4.3	L	L																		
	3.75		5.7	L	4.5	L	L																		
	4.00		4.8	M	4.3	L	L		4.8	21	<0.005	<10									1.5	0.03	21	2	4

Notes:

1. Actual Acid Sulfate Soil (AASS) likelihood is indicated by Low (L & no shade)($pH_F > 5$), Medium (M & yellow shade)(pH_F 5 ≤ pH_F < 4) and High (H & red shade)(pH_F ≤ 4).
2. Potential Acid Sulfate Soil (PASS) likelihood is indicated by Low (L & no shade)(Δ pH from pH_F to pH_{FOX} is < 2 pH units), Medium (M & yellow shade)(Δ pH from pHF to pH_{FOX} is ≥ 2 pH units OR pHFOX is <3)) and High (H & red shade)(Δ pH from pHF to pH_{FOX} is ≥ 2 pH units AND pHFOX is <3)
3. Reaction L = Low strength, M = Medium strength, H = High strength, X = Extreme strength.
4. The letter in the remark column indicates the presence of the following. O - Organic; S - Shells;iron- Iron/Iron Oxide; P - Pyrite; and C - Coral.
5. Shaded TAA & S_{CR} results are those exceeding the QASSIT action levels of 18 mol H^+/t or 0.03 %S.
6. Acid-Base Account = Total Acidity (i.e.. Potential + Actual + Retained) - Total ANC, but not less than TSA
7. Shaded Net Acidity (sulfur units) %S and Net Acidity (acidity units) /t results are those exceeding the QASSIT action levels of 0.03 %S or 18 mol H+/t
8. Required Lime Rate is calculated from the net Acid-Base Account with a factor of safety = 1.5 and bulk density of 1.8 t/m^3

BH ID	Depth (m)	Description	Quick Screening Test						Existing Acidity		Potential Acidity		Acid Neutralising Capacity			Retained Acidity					Acid Base Accounting			Required Lime Rate	
			pH_F	AASS likelihood[1]	pH_{FOX}	PASS likelihood[2]	Reaction	Remark	pH KCl	Titratable Actual Acidity	Chromium Reducible Sulfur	acidity - Chromium Reducible Sulfur	Acid Neutralising Capacity	acidity - Acid Neutralising Capacity	sulfidic - Acid Neutralising Capacity	Net Acid Soluble Sulfur	acidity - Net Acid Soluble Sulfur	sulfidic - Net Acid Soluble Sulfur	KCl Extractable Sulfur	HCl Extractable Sulfur	ANC Fineness Factor	Net Acidity (sulfur units)	Net Acidity (acidity units)		
			pH Unit		pH Unit				pH Unit	mole H+ / t	% S	mole H+ / t	% CaCO3	mole H+ / t	% pyrite S	% S	mole H+ / t	% pyrite S	% S	% S		% S	mole H+ / t	kg CaCO3/t	kg $CaCO3/m^3$
BH15	0.10	Loamy SAND, dark brown, fine to medium grained,	6.1	L	5.0	L	L																		
	0.25	Silty CLAY, high plasticity, yellow brown, with some fine gravel, trace organic material	6.9	L	5.1	L	L																		
	0.50		6.7	L	5.3	L	L		5.8	8	<0.005	<10									1.5	<0.02	12	0	0
	0.75	Silty CLAY, high plasticity, brown, with some fine gravel	6.8	L	5.3	L	L																		
	1.00		6.7	L	5.2	L	L																		
	1.25		6.9	L	5.3	L	L																		
	1.50		6.9	L	5.1	L	L		5.2	14	<0.005	<10									1.5	0.02	14	0	0
	1.75	Silty CLAY, high plasticity, brown, some fine quartz gravel, trace of fine sand, iron and ochre staining	6.5	L	5.1	L	L																		
	2.00		6.4	L	5.1	L	L																		
	2.25		6.0	L	5.0	L	L																		
	2.50		6.2	L	5.0	L	L																		
	2.75		6.3	L	4.9	L	L		4.8	22	<0.005	<10									1.5	0.04	22	2	4
	3.00		6.1	L	5.0	L	L																		
	3.25		6.4	L	5.0	L	L																		
	3.50		6.1	L	4.9	L	L																		
	3.75		5.8	L	4.6	L	L																		
	4.00		6.0	L	4.9	L	L		4.7	23	<0.005	<10									1.5	0.04	23	2	4
BH16	0.10	Silty SAND, fine to medium grained, grey brown, trace of fine gravel, with organic material	6.3	L	4.3	M	L																		
	0.25		5.8	L	4.7	L	L																		
	0.50		6.3	L	3.9	M	L		5.2	15	<0.005	<10									1.5	0.02	15	0	0
	0.75	becoming pale grey, no organic material	5.9	L	4.9	L	L																		
	1.00		5.9	L	4.5	L	L																		
	1.25	Silty Gravelly CLAY, high plasticity, yellow brown, fine gravel with iron staining	6.8	L	5.0	L	L																		
	1.50	Silty CLAY, high plasticity, grey, trace of fine gravel, with some iron nodules and iron staining present	6.3	L	4.4	L	L																		
	1.75		6.1	L	3.5	M	L		4.1	81	<0.005	<10				<0.02	<10	<0.02	0.02	0.03	1.5	0.13	84	6	11
	2.00	refusal at 2 m	6.7	L	7.1	L	L																		
BH17	0.10	Silty SAND, fine to medium grained, trace of fine gravel, trace of organic material (rootlets)	7.0	L	4.2	M	L																		
	0.25		6.9	L	4.7	M	L																		
	0.50	Silty CLAY, high plasticity, yellow brown, trace of fine gravel, with some iron nodules and iron staining.	6.8	L	4.5	M	L																		
	0.75	becoming silty CLAY, high plasticity, grey, very stiff.	5.8	L	4.9	L	L																		
	1.00		5.2	L	3.9	L	L		4.0	103	<0.005	<10				0.02	13	0.03	<0.02	0.03	1.5	0.19	116	9	16
	1.25		5.2	L	3.9	L	L																		
	1.50		5.0	M	4.0	L	L																		
	1.75		6.2	L	3.9	M	L		3.9	98	<0.005	<10				<0.02	<10	<0.02	<0.02	<0.02	1.5	0.16	98	7	13
	2.00		4.4	M	3.8	L	L																		
	2.25		4.7	M	3.9	L	L																		
	2.50		4.4	M	3.5	L	L		4.1	68	<0.005	<10				0.02	14	0.03	0.03	<0.02	1.5	0.13	83	6	11
	2.75	Silty CLAY, high plasticity, pale grey, iron and ochre staining	4.5	M	3.8	L	L																		
	3.00		4.4	M	3.2	L	L																		
	3.25		5.5	L	3.6	L	L																		
	3.50		4.0	H	3.2	L	L																		
	3.75	Silty Clayey SAND, fine grained, pale grey	3.7	H	2.8	M	L		4.4	38	<0.005	<10				<0.02	<10	<0.02	0.04	0.03	1.5	0.06	40	3	5
	4.00		4.0	H	3.1	L	L																		
BH18	0.10	Loamy SAND, fine grained, brown, trace of fine to medium sub angular gravel with some organic mater (rootlets)	6.0	L	4.3	L	M																		
	0.25	Silty sandy GRAVEL, fine, sub angular, fine grained sand, with some quartz and iron nodules	5.8	L	4.3	L	M		5.0	20	<0.005	<10									1.5	0.03	20	2	4
	0.50		6.7	L	4.5	M	L																		
	0.75	Silty CLAY, medium to high plasticity, pale brown, trace of fine gravel, iron and ochre staining	6.3	L	4.8	L	L																		
	1.00		6.4	L	4.1	M	L																		
	1.25		6.6	L	4.0	M	L																		
	1.50	Silty CLAY, high plasticity, pale grey, very stiff, with some iron staining	4.0	H	3.1	L	L																		
	1.75		3.5	H	2.5	L	L		4.2	58	<0.005	<10				<0.02	<10	<0.02	0.02	0.03	1.5	0.10	63	5	9
	2.00		3.5	H	2.6	L	L																		
	2.25		3.4	H	2.7	L	L																		
	2.50	Sandy CLAY, medium to high plasticity, pale grey, very stiff, with some iron staining	3.5	H	2.7	L	L		4.1	84	<0.005	<10				0.02	11	<0.02	<0.02	0.02	1.5	0.15	95	7	13
	2.75		4.1	L	3.1	L	L																		
	3.00		4.1	L	3.2	L	L																		
	3.25		4.4	L	3.5	L	L																		
	3.50	Clay, medium plasticity, pale grey, soft, with some iron nodules and some iron staining	4.0	H	3.9	L	L																		
	3.75		4.5	M	3.4	L	L		4.2	83	<0.005	<10				0.02	12	<0.02	<0.02	0.02	1.5	0.15	95	7	13
	4.00		4.5	M	2.8	H	L																		
	4.25		4.5	M	3.1	L	L																		
	4.50		4.6	M	3.7	L	L																		
	4.75		4.7	M	3.9	L	L																		
	5.00		4.8	M	3.1	L	L		4.2	65	<0.005	<10				0.03	15	0.02	<0.02	0.03	1.5	0.13	80	6	11
	5.25		4.6	M	3.9	L	L																		
	5.50		4.8	M	3.7	L	L																		
	5.75	Silty CLAY, pale grey, very hard.	3.9	H	3.6	L	L																		
	6.00		4.6	M	3.3	L	L		4.1	78	<0.005	<10				0.03	13	0.02	<0.02	0.03	1.5	0.14	91	7	13
	6.25		4.5	M	3.6	L	L																		
	6.50		4.7	M	3.4	L	L		4.1	74	<0.005	<10				0.02	10	<0.02	<0.02	0.02	1.5	0.14	84	6	11

1. Actual Acid Sulfate Soil (AASS) likelihood is indicated by Low (L & no shade)($pH_F > 5$), Medium (M & yellow shade)(pH_F 5 ≤ $pH_F < 4$) and High (H & red shade)($pH_F \leq 4$).
2. Potential Acid Sulfate Soil (PASS) likelihood is indicated by Low (L & no shade)(Δ pH from pH_F to pH_{FOX} is < 2 pH units), Medium (M & yellow shade)(Δ pH from pHF to pH_{FOX} is ≥ 2 pH units OR pHFOX is <3)) and High (H & red shade)(Δ pH from pHF to pH_{FOX} is ≥ 2 pH units AND pHFOX is <3)
3. Reaction L = Low strength, M = Medium strength, H = High strength, X = Extreme strength.
4. The letter in the remark column indicates the presence of the following. O - Organic; S - Shells;iron- Iron/Iron Oxide; P - Pyrite; and C - Coral.
5. Shaded TAA & S_{CR} results are those exceeding the QASSIT action levels of 18 mol H^+/t or 0.03 %S.
6. Acid-Base Account = Total Acidity (i.e.. Potential + Actual + Retained) - Total ANC, but not less than TSA
7. Shaded Net Acidity (sulfur units) %S and Net Acidity (acidity units) /t results are those exceeding the QASSIT action levels of 0.03 %S or 18 mol H+/t
8. Required Lime Rate is calculated from the net Acid-Base Account with a factor of safety = 1.5 and bulk density of 1.8 t/m^3

BH ID	Depth (m)	Description	Quick Screening Test: pH_F (pH Unit)	AASS likelihood[1]	pH_{FOX} (pH Unit)	PASS likelihood[2]	Reaction	Remark	Existing Acidity: pH KCl (pH Unit)	Titratable Actual Acidity (mole H+ / t)	Potential Acidity: Chromium Reducible Sulfur (% S)	acidity - Chromium Reducible Sulfur (mole H+ / t)	Acid Neutralising Capacity: Acid Neutralising Capacity (% CaCO3)	acidity - Acid Neutralising Capacity (mole H+ / t)	sulfidic - Acid Neutralising Capacity (% pyrite S)	Retained Acidity: Net Acid Soluble Sulfur (% S)	acidity - Net Acid Soluble Sulfur (mole H+ / t)	sulfidic - Net Acid Soluble Sulfur (% pyrite S)	KCl Extractable Sulfur (% S)	HCl Extractable Sulfur (% S)	Acid Base Accounting: ANC Fineness Factor	Net Acidity (sulfur units) (% S)	Net Acidity (acidity units) (mole H+ / t)	Required Lime Rate (kg CaCO3/t)	Required Lime Rate (kg CaCO3/m^3)
BH19	0.10	Silty SAND, fine to medium grained, dark grey, with organic material.	7.2	L	4.6	M	M		5.9	8	<0.005	<10									1.5	<0.02	<10	0	0
	0.25	Silty SAND, fine to medium grained, pale grey	6.8	L	5.3	L	L																		
	0.50	Gravelly Silty CLAY, high plasticity, yellow brown, stiff, fine to medium sub angular gravel, with some iron nodules and iron staining	6.9	L	4.4	M	L																		
	0.75		6.0	L	3.9	M	L																		
	1.00	Silty Gravelly CLAY, high plasticity, grey brown, with some iron nodules, trace of fine to medium sand, some iron staining	5.3	L	3.9	L	L																		
	1.25		5.2	L	3.6	L	L		3.9	100	<0.005	<10				<0.02	<10	<0.02	<0.02	<0.02	1.5	0.16	100	7	13
	1.50		4.9	M	3.8	L	L																		
	1.75		4.7	M	4.0	L	L																		
	2.00	Silty CLAY, high plasticity, pale grey, stiff, some iron staining	4.2	M	4.3	L	L																		
	2.25		5.0	M	4.0	L	L																		
	2.50	Silty CLAY, high plasticity, pale grey, friable	5.0	M	3.7	L	L		4.7	33	<0.005	<10									1.5	0.05	33	2	4
	2.75		5.0	M	3.8	L	L																		
	3.00		4.9	M	3.1	L	L																		
	3.25		5.0	M	3.8	L	L																		
	3.50		5.1	L	3.9	L	L		4.2	49	<0.005	<10				<0.02	<10	<0.02	<0.02	<0.02	1.5	0.08	49	4	7
	3.75		4.3	M	3.9	L	L																		
	4.00	Silty CLAY, high plasticity, pale green grey, with iron staining	4.5	M	3.7	L	L																		
	4.25		4.7	M	3.8	L	L																		
	4.50		4.6	M	3.6	L	L																		
	4.75	Silty CLAY, high plasticity, pale grey, with some fine grained sandy lenses,	4.6	M	3.6	L	L		4.4	46	<0.005	<10				<0.02	<10	<0.02	<0.02	<0.02	1.5	0.07	46	3	5
	5.00		4.3	M	3.8	L	L																		
	5.25		4.9	M	4.2	L	L																		
	5.50		5.5	L	4.2	L	L																		
	5.75		5.1	L	3.6	L	L		4.5	38	<0.005	<10									1.5	0.06	38	3	5
	6.00		4.6	M	3.5	L	L																		
BH20	0.10	Silty CLAY, high plasticity, dark yellow brown, trace fine to medium sub angular gravel, with some organic material (rootlets)	5.8	L	4.6	L	M		4.6	45	<0.005	<10									1.5	0.07	45	3	5
	0.25		5.2	L	4.5	L	L																		
	0.50		5.5	L	4.2	L	L																		
	0.75	Silty CLAY, high plasticity, dark brown, trace of fine gravel, with iron and ochre staining	6.1	L	3.8	M	L																		
	1.00		6.0	L	4.6	L	L																		
	1.25		5.3	L	4.3	L	L		4.4	45	<0.005	<10				<0.02	<10	<0.02	0.02	0.02	1.5	0.08	48	4	7
	1.50		5.3	M	4.6	L	L																		
	1.75	becoming stiff	5.8	M	3.7	M	L																		
	2.00		6.2	M	3.5	M	L																		
	2.25		5.1	M	4.3	L	L																		
	2.50		5.5	M	4.1	L	L		4.1	41	<0.005	<10				<0.02	<10	<0.02	0.02	0.03	1.5	0.07	44	3	5
	2.75		4.8	M	4.2	L	L																		
	3.00		5.6	M	4.6	L	L																		
	3.25		5.4	M	4.3	L	L																		
	3.50		5.5	L	4.2	L	L																		
	3.75		5.4	M	4.2	L	L		4.4	34	<0.005	<10				0.02	10	<0.02	<0.02	0.02	1.5	0.07	44	3	5
	4.00	Silty CLAY, high plasticity, pale green grey and brown with iron staining	5.4	M	4.4	L	L																		
	4.25		5.1	M	4.6	L	L																		
	4.50		5.1	M	3.3	L	L		4.3	35	<0.005	<10				0.02	<10	<0.02	<0.02	0.02	1.5	0.07	45	3	5
	4.75		5.2	M	4.3	L	L																		
	5.00		5.4	M	4.6	L	L																		
	5.25		5.6	M	4.8	L	L																		
	5.50		5.9	L	4.5	L	L																		
	5.75		5.4	L	3.6	L	L		5.2	13	<0.005	<10									1.5	0.02	13	0	0
	6.00		5.5	M	4.3	L	L																		
BH21	0.10	Silty SAND, fine to medium grained, dark grey with some organic material.	6.0	L	4.5	L	H		5.5	12	<0.005	<10									1.5	0.02	12	0	0
	0.25	becoming silty SAND, fine to medium grained, grey	5.8	L	4.7	L	L																		
	0.50		5.4	L	4.1	L	L																		
	0.75	Silty CLAY, high plasticity, dark yellow brown, trace of fine gravel, with ochre staining	6.6	L	4.8	L	L																		
	1.00		5.7	L	3.8	L	L																		
	1.25	Silty CLAY, high plasticity, dark grey brown, stiff, with ochre staining	5.8	L	4.6	L	L		4.6	29	<0.005	<10									1.5	0.05	29	2	4
	1.50		5.8	L	4.8	L	L																		
	1.75		5.5	L	4.7	L	L																		
	2.00	Silty CLAY, high plasticity, grey	5.6	L	4.8	L	L																		
	2.25	becoming extreamly weathered rock	5.7	L	4.9	L	L		4.6	26	0.005	<10									1.5	0.05	29	2	4
	2.50		6.8	L	5.3	L	L																		
BH22	0.10	Sandy Clay, fine to coarse grained, dark brown, high plasticity Clay, with organic material	7.0	L	4.8	M	M																		
	0.25	Silty CLAY, high plasticity, dark yellow brown, trace of fine gravel	6.8	L	4.4	M	L																		
	0.50		5.7	L	3.8	L	L		4.7	36	<0.005	<10									1.5	0.06	36	3	5
	0.75	Silty CLAY, high plasticity, dark brown, trace of fine gravel, some iron staining	6.0	L	3.5	M	L																		
	1.00		6.0	L	4.3	L	L																		
	1.25		6.1	L	4.4	L	L																		
	1.50		5.2	L	4.6	L	L		4.5	33	<0.005	<10									1.5	0.05	33	2	4
	1.75		5.3	L	4.7	L	L																		
	2.00		5.8	L	4.7	L	L																		
	2.25		5.3	L	4.2	L	L																		
	2.50		5.8	L	3.6	M	L		4.4	28	<0.005	<10				<0.02	<10	<0.02	<0.02	<0.02	1.5	0.04	28	2	4
	2.75	Silty CLAY, high plasticity, dark brown, trace of fine to medium grained Sand, trace of fine grained gravel, some iron stainin and some SAND lenses, coarse grained, pale grey	6.4	L	4.7	L	L																		
	3.00		5.2	L	4.5	L	L																		
	3.25		5.1	L	4.0	L	L																		
	3.50	Silty Clay, high plasticity, dark brown, with some Iron, ochre and pale grey lenses	5.6	L	4.3	L	L		4.3	32	<0.005	<10				<0.02	<10	<0.02	<0.02	<0.02	1.5	0.05	32	2	4
	3.75		5.7	L	4.6	L	L																		
	4.00	Silty CLAY, high plasticity, pale grey	5.1	L	3.9	L	L																		

1. Actual Acid Sulfate Soil (AASS) likelihood is indicated by Low (L & no shade)($pH_F > 5$), Medium (M & yellow shade)(pH_F 5 ≤ pH_F < 4) and High (H & red shade)($pH_F \leq 4$).
2. Potential Acid Sulfate Soil (PASS) likelihood is indicated by Low (L & no shade)(Δ pH from pH_F to pH_{FOX} is < 2 pH units), Medium (M & yellow shade)(Δ pH from pHF to pH_{FOX} is ≥ 2 pH units OR pHFOX is <3)) and High (H & red shade)(Δ pH from pHF to pH_{FOX} is ≥ 2 pH units AND pHFOX is <3)
3. Reaction L = Low strength, M = Medium strength, H = High strength, X = Extreme strength.
4. The letter in the remark column indicates the presence of the following. O - Organic; S - Shells;iron- Iron/Iron Oxide; P - Pyrite; and C - Coral.
5. Shaded TAA & S_{CR} results are those exceeding the QASSIT action levels of 18 mol H^+/t or 0.03 %S.
6. Acid-Base Account = Total Acidity (i.e.. Potential + Actual + Retained) - Total ANC, but not less than TSA
7. Shaded Net Acidity (sulfur units) %S and Net Acidity (acidity units) /t results are those exceeding the QASSIT action levels of 0.03 %S or 18 mol H+/t
8. Required Lime Rate is calculated from the net Acid-Base Account with a factor of safety = 1.5 and bulk density of 1.8 t/m³

BH ID	Depth (m)	Description	Quick Screening Test						Existing Acidity		Potential Acidity		Acid Neutralising Capacity			Retained Acidity					Acid Base Accounting			Required Lime Rate	
			pH_F	AASS likelihood[1]	pH_{FOX}	PASS likelihood[2]	Reaction	Remark	pH KCl	Titratable Actual Acidity	Chromium Reducible Sulfur	acidity - Chromium Reducible Sulfur	Acid Neutralising Capacity	acidity - Acid Neutralising Capacity	sulfidic - Acid Neutralising Capacity	Net Acid Soluble Sulfur	acidity - Net Acid Soluble Sulfur	sulfidic - Net Acid Soluble Sulfur	KCl Extractable Sulfur	HCl Extractable Sulfur	ANC Fineness Factor	Net Acidity (sulfur units)	Net Acidity (acidity units)		
			pH Unit		pH Unit				pH Unit	mole H+ / t	% S	mole H+ / t	% CaCO3	mole H+ / t	% pyrite S	% S	mole H+ / t	% pyrite S	% S	% S		% S	mole H+ / t	kg CaCO3/t	kg $CaCO3/m^3$
BH23	0.10	SAND, fine to coarse grained, dark brown, with organic material	7.7	L	3.5	M	X		6.0	8	0.020	13.00									1.5	0.03	21	2	4
	0.25	Clayey GRAVEL, fine to coarse sub angular, grey brown, medium plasticity clay	7.0	L	5.0	M	M																		
	0.50		6.9	L	4.3	M	L																		
	0.75	Silty CLAY, high plasticity, stiff, grey brown with fine sub angular quartz gravel	6.5	L	4.7	L	L																		
	1.00		6.5	L	6.2	L	X																		
	1.25		6.7	L	5.5	L	L																		
	1.50		7.1	L	5.7	L	L																		
	1.75		7.2	L	5.9	L	L		6.2	4	0.012	<10									1.5	<0.02	11	0	0
	2.00		8.2	L	6.4	L	M																		
	2.25		7.7	L	8.1	L	X																		
	2.50		7.7	L	8.3	L	X																		
	2.75	Silty CLAY, high plasticity, dark brown, trace of fine gravel, trace of organic staining	7.4	L	7.9	L	X		6.2	5	<0.005	<10									1.5	<0.02	<10	0	0
	3.00		7.9	L	8.2	L	X																		
	3.25		7.5	L	6.1	L	M																		
	3.50		7.3	L	6.1	L	H																		
	3.75		7.3	L	5.7	L	L		6.1	7	<0.005	<10									1.5	<0.02	<10	0	0
	4.00		7.3	L	5.7	L	L																		
BH24	0.10	Silty CLAY, high plasticity, yellow brown, with organic material (rootlets), trace of fine sub angular gravel	7.4	L	4.2	M	X																		
	0.25		6.3	L	4.4	L	M		4.6	44	0.007	<10									1..5	0.08	48	4	7
	0.50		6.6	L	4.6	M	L																		
	0.75	Silty CLAY, high plasticity, Olive brown, trace of fine to medium sub angular gravel	6.8	L	5.0	L	L																		
	1.00		7.1	L	5.5	L	L																		
	1.25		6.5	L	5.2	L	L																		
	1.50		6.9	L	5.3	L	L		5.2	14	0.011	<10									1.5	0.03	21	2	4
	1.75		6.6	L	5.0	L	L																		
	2.00	becoming silty CLAY, high plasticity, stiff, dark brown, trace of fine to medium sub angular gravel and fine to medium Sand.	6.6	L	5.2	L	L																		
	2.25		6.7	L	5.0	L	L																		
	2.50		5.8	L	4.8	L	L																		
	2.75		6.3	L	4.8	L	L		5.1	17	<0.005	<10									1.5	0.03	17	1	2
	3.00		6.4	L	4.9	L	L																		
	3.25		6.5	L	4.9	L	L																		
	3.50	trace of pale grey	6.7	L	4.9	L	L		4.7	24	<0.005	<10									1.5	0.04	24	2	4
	3.75		6.6	L	5.1	L	L																		
	4.00		6.0	L	4.9	L	L																		
BH25	0.10	SAND, fine to medium grained, dark grey, with Organic material (rootlets)	7.3	L	5.3	M	L																		
	0.25	becoming silty clayey SAND, grey	6.7	L	5.3	L	L		5.6	10	<0.005	<10									1.5	<0.02	<10	0	0
	0.50		5.9	L	5.2	L	L																		
	0.75	Silty CLAY, high plasticity, yellow brown, trace of fine gravel	5.6	L	4.9	L	L																		
	1.00	Silty CLAY, medium plasticity, hard, grey, with some iron staining	6.8	L	5.3	L	L																		
	1.25		6.5	L	4.9	L	L		4.7	25	<0.005	<10									1.5	0.04	25	2	4
	1.50		5.8	L	4.7	L	L																		

Notes:

1. Actual Acid Sulfate Soil (AASS) likelihood is indicated by Low (L & no shade)($pH_F > 5$), Medium (M & yellow shade)(pH_F 5 ≤ pH_F < 4) and High (H & red shade)($pH_F \leq 4$).
2. Potential Acid Sulfate Soil (PASS) likelihood is indicated by Low (L & no shade)(Δ pH from pH_F to pH_{FOX} is < 2 pH units), Medium (M & yellow shade)(Δ pH from pHF to pH_{FOX} is ≥ 2 pH units OR pHFOX is <3)) and High (H & red shade)(Δ pH from pHF to pH_{FOX} is ≥ 2 pH units AND pHFOX is <3)
3. Reaction L = Low strength, M = Medium strength, H = High strength, X = Extreme strength.
4. The letter in the remark column indicates the presence of the following. O - Organic; S - Shells;iron- Iron/Iron Oxide; P - Pyrite; and C - Coral.
5. Shaded TAA & S_{CR} results are those exceeding the QASSIT action levels of 18 mol H^+/t or 0.03 %S.
6. Acid-Base Account = Total Acidity (i.e.. Potential + Actual + Retained) - Total ANC, but not less than TSA
7. Shaded Net Acidity (sulfur units) %S and Net Acidity (acidity units) /t results are those exceeding the QASSIT action levels of 0.03 %S or 18 mol H+/t
8. Required Lime Rate is calculated from the net Acid-Base Account with a factor of safety = 1.5 and bulk density of 1.8 t/m^3

ALS Group

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1219974**	Page	: 1 of 9
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Brisbane
Contact	: MR JOSH MITCHELL	Contact	: Carsten Emrich
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Telephone	: +61 07 5475 5900	Telephone	: +61 7 3243 7123
Facsimile	: +61 07 5475 5901	Facsimile	: +61 7 3243 7218
Project	: 127683005	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: SOIL	Date Samples Received	: 31-JUL-2012
Sampler	: Lyndon Gordon	Issue Date	: 06-AUG-2012
Site	: Saipem GTP Phase 2 ASS		
		No. of samples received	: 31
Quote number	: EN/002/11	No. of samples analysed	: 31

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Myles.Clark	Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ASS: EA033 (CRS Suite): ANC not required because pH KCl less than 6.5**
- **ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	BH23 0.0-0.1m	BH23 1.5-1.75m	BH23 2.5-2.75m	BH23 3.5-3.75m	BH24 0.1-0.25m
Client sampling date / time				26-JUL-2012 15:00	26-JUL-2012 15:00	26-JUL-2012 15:00	26-JUL-2012 15:00	26-JUL-2012 15:00
				EB1219974-001	EB1219974-002	EB1219974-003	EB1219974-004	EB1219974-005
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**6.0**	**6.2**	**6.2**	**6.1**	**4.6**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**8**	**4**	**5**	**7**	**44**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	**0.07**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.020**	**0.012**	<0.005	<0.005	**0.007**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**13**	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.03**	<0.02	<0.02	<0.02	**0.08**
Net Acidity (acidity units)	----	10	mole H+ / t	**21**	**11**	<10	<10	**48**
Liming Rate	----	1	kg CaCO3/t	**2**	<1	<1	<1	**4**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH24 1.25-1.5m	BH24 2.5-2.75m	BH24 3.25-3.5m	BH18 0.1-0.25m	BH18 1.5-1.75m
			Client sampling date / time	26-JUL-2012 15:00	26-JUL-2012 15:00	26-JUL-2012 15:00	25-JUL-2012 15:00	25-JUL-2012 15:00
Compound	CAS Number	LOR	Unit	EB1219974-006	EB1219974-007	EB1219974-008	EB1219974-009	EB1219974-010
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	5.2	5.1	4.7	5.0	4.2
Titratable Actual Acidity (23F)	----	2	mole H+ / t	14	17	24	20	58
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.02	0.03	0.04	0.03	0.09
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.011	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	----	0.02
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	----	----	----	0.03
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	----	----	----	<0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	----	----	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	----	----	----	<0.02
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.03	0.03	0.04	0.03	0.10
Net Acidity (acidity units)	----	10	mole H+ / t	21	17	24	20	63
Liming Rate	----	1	kg CaCO3/t	2	1	2	2	5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	BH18 2.25-2.5m	BH18 3.5-3.75m	BH18 4.75-5.0m	BH18 5.75-6.0m	BH18 6.25-6.5m
Client sampling date / time				25-JUL-2012 15:00	25-JUL-2012 15:00	25-JUL-2012 15:00	25-JUL-2012 15:00	25-JUL-2012 15:00
				EB1219974-011	EB1219974-012	EB1219974-013	EB1219974-014	EB1219974-015
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	4.1	4.2	4.2	4.1	4.1
Titratable Actual Acidity (23F)	----	2	mole H+ / t	84	83	65	78	74
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.14	0.13	0.10	0.12	0.12
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
HCl Extractable Sulfur (20Be)	----	0.02	% S	0.02	0.02	0.03	0.03	0.02
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	0.02	0.02	0.03	0.03	0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	11	12	15	13	10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	<0.02	0.02	0.02	<0.02
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.15	0.15	0.13	0.14	0.14
Net Acidity (acidity units)	----	10	mole H+ / t	95	95	80	91	84
Liming Rate	----	1	kg CaCO3/t	7	7	6	7	6

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	BH11 0.1-0.25m	BH11 1.75-2.0m	BH11 2.5-2.75m	BH11 3.5-3.75m	BH17 0.75-1.0m
			Client sampling date / time	26-JUL-2012 15:00	26-JUL-2012 15:00	26-JUL-2012 15:00	26-JUL-2012 15:00	26-JUL-2012 15:00
				EB1219974-016	EB1219974-017	EB1219974-018	EB1219974-019	EB1219974-020
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**4.6**	**5.9**	**5.9**	**5.9**	**4.0**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**42**	**6**	**7**	**7**	**103**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.07**	<0.02	<0.02	<0.02	**0.16**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	----	<0.02
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	----	----	----	**0.03**
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	----	----	----	**0.03**
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	----	----	**13**
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	----	----	----	**0.02**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.07**	<0.02	<0.02	<0.02	**0.19**
Net Acidity (acidity units)	----	10	mole H+ / t	**42**	<10	<10	<10	**116**
Liming Rate	----	1	kg CaCO3/t	**3**	<1	<1	<1	**9**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH17 1.5-1.75m	BH17 2.25-2.5m	BH17 3.5-3.75m	BH14 0.1-0.25m	BH14 1.25-1.5m
			Client sampling date / time	26-JUL-2012 15:00	26-JUL-2012 15:00	26-JUL-2012 15:00	25-JUL-2012 15:00	25-JUL-2012 15:00
Compound	CAS Number	LOR	Unit	EB1219974-021	EB1219974-022	EB1219974-023	EB1219974-024	EB1219974-025
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**3.9**	**4.1**	**4.4**	**4.4**	**4.4**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**98**	**68**	**38**	**62**	**35**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.16**	**0.11**	**0.06**	**0.10**	**0.06**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	**0.03**	<0.02	**0.02**
HCl Extractable Sulfur (20Be)	----	0.02	% S	<0.02	**0.03**	**0.04**	<0.02	**0.03**
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	**0.03**	<0.02	<0.02	<0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	**14**	<10	<10	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	**0.02**	<0.02	<0.02	<0.02
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.16**	**0.13**	**0.06**	**0.11**	**0.06**
Net Acidity (acidity units)	----	10	mole H+ / t	**98**	**83**	**40**	**67**	**38**
Liming Rate	----	1	kg CaCO3/t	**7**	**6**	**3**	**5**	**3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	BH14 2.5-2.75m	BH14 3.75-4.0m	BH13 0.25-0.5m	BH13 1.25-1.5m	BH13 2.5-2.75m
Client sampling date / time				25-JUL-2012 15:00	25-JUL-2012 15:00	25-JUL-2012 15:00	25-JUL-2012 15:00	25-JUL-2012 15:00
				EB1219974-026	EB1219974-027	EB1219974-028	EB1219974-029	EB1219974-030
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**4.6**	**4.8**	**6.2**	**5.3**	**5.6**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**29**	**21**	**5**	**18**	**12**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.05**	**0.03**	<0.02	**0.03**	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.05**	**0.03**	<0.02	**0.03**	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	**29**	**21**	<10	**18**	**12**
Liming Rate	----	1	kg CaCO3/t	**2**	**2**	<1	**1**	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH13 3.5-3.5m	----	----	----	----
			Client sampling date / time	25-JUL-2012 15:00	----	----	----	----
Compound	**CAS Number**	**LOR**	**Unit**	**EB1219974-031**	**----**	**----**	**----**	**----**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**5.7**	----	----	----	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**12**	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	----	----	----	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	**12**	----	----	----	----
Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----

3/8 Mg 259.

SAMPLE CHAIN OF CUSTODY DOCUMENTATION - SOIL

Sheet....... of......

	127683005	Quote/Order No.:	BN/156/12
	Saipem GTP Phase 2 ASS Investigation	Lab Name:	ALS
Sampled By:	Lyndon Gordon		
Turnaround (Days)		BY:	

Report Format: HARD ☐ FAX ☐ DISK ☐ EMAIL ☑ BULLETIN BOARD ☐

Email Format: PDF ☑ Excel ☑ Other ☐ Email Address: lgordon@golder.com.au

GOLDER ASSOCIATES PTY LTD Phone: (07) 5475 5900

55 Kingsford Smith Parade, Maroochydore QLD 4558 Fax: (07) 5475 5901

Golder Associates

Invoice to be sent to Accounts Brisbane: jmitchell@golder.com.au

Project Manager: Josh Mitchell

Contact Phone: 07 5475 5900 Email: jmitchell@golder.com.au

Comments/Special Instructions: Excel required format ENMRG
Please also send e-mail to jmitchell@golder.com.au and lgordon@golder.com.au
FAST TRACK 3 days TAT

Samples from a declared Fire Ant Area: N
Samples taken from a known Weed and or Pest Area: N

ANALYSIS REQUIRED

	SAMPLE ID	Location & Depth	SAMPLE MATRIX	SAMPLE DATE	SAMPLE TIME	CONTAINER/ PRESERVATIVE		No CONTAINERS	POSSIBLE HIGH CONCENTRATION	EA033 CRS
1	BH23	0.0-0.1m	soil	26/07/2012		bag	Ice		N	x
2	BH23	1.5-1.75m	soil	26/07/2012		bag	Ice		N	x
3	BH23	2.5-2.75m	soil	26/07/2012		bag	Ice		N	x
4	BH23	3.5-3.75m	soil	26/07/2012		bag	Ice		N	x
5	BH24	0.1-0.25m	soil	26/07/2012		bag	Ice		N	x
6	BH24	1.25-1.5m	soil	26/07/2012		bag	Ice		N	x
7	BH24	2.5-2.75m	soil	26/07/2012		bag	Ice		N	x
8	BH24	3.25-3.5m	soil	26/07/2012		bag	Ice		N	x
9	BH18	0.1-0.25m	soil	25/07/2012		bag	Ice		N	x
10	BH18	1.5-1.75m	soil	25/07/2012		bag	Ice		N	x
11	BH18	2.25-2.5m	soil	25/07/2012		bag	Ice		N	x
12	BH18	3.5-3.75m	soil	25/07/2012		bag	Ice		N	x
13	BH18	4.75-5.0m	soil	25/07/2012		bag	Ice		N	x
14	BH18	5.75-6.0m	soil	25/07/2012		bag	Ice		N	x
15	BH18	6.25-6.5m	soil	25/07/2012		bag	Ice		N	x
16	BH11	0.1-0.25m	soil	26/07/2012		bag	Ice		N	x
17	BH11	1.75-2.0m	soil	26/07/2012		bag	Ice		N	x
18	BH11	2.5-2.75m	soil	26/07/2012		bag	Ice		N	x
19	BH11	3.5-3.75m	soil	26/07/2012		bag	Ice		N	x
20	BH17	0.75-1.0m	soil	26/07/2012		bag	Ice		N	x
21	BH17	1.5-1.75m	soil	26/07/2012		bag	Ice		N	x
22	BH17	2.25-2.5m	soil	26/07/2012		bag	Ice		N	x
23	BH17	3.5-3.75m	soil	26/07/2012		bag	Ice		N	x
24	BH14	0.1-0.25m	soil	25/07/2012		bag	Ice		N	x
25	BH14	1.25-1.5m	soil	25/07/2012		bag	Ice		N	x
26	BH14	2.5-2.75m	soil	25/07/2012		bag	Ice		N	x
27	BH14	3.75-4.0m	soil	25/07/2012		bag	Ice		N	x
28	BH13	0.25-0.5m	soil	25/07/2012		bag	Ice		N	x
29	BH13	1.25-1.5m	soil	25/07/2012		bag	Ice		N	x
30	BH13	2.5-2.75m	soil	25/07/2012		bag	Ice		N	x
31	BH13	3.25-3.5m	soil	25/07/2012		bag	Ice		N	x

Environmental Division
Brisbane
JLP
Work Order
EB1219974 WL

Telephone : + 61-7-3243 7222

SAMPLE MATRIX = Soil/Sediment/Fill/Other **SAMPLE TYPE** = Core(CR) **HIGH CONCENTRATION:** Tick box and circle expected parameters in analysis list

Container Type and Preservative Codes: P = Natural Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinsed Jar; S = Solvent Washed Acid Rinsed Glass Bottle; VC = Hydrochloric Preserved Vial; VS = Sulphuric Acid P

	SIGNATURE	COMPANY	DATE	TIME
RELEASED BY	L GORDON	GOLDER	27/7/12	
RECEIVED BY		ALS	27/7/12	
RELEASED BY	T. CRAKER	ALS.	30.7.12.	1600
RECEIVED BY		ALS	31/07/12	08:25
RELEASED BY				
RECEIVED BY				

	SIGNATURE	COMPANY	DATE	TIME	Shipment Method
RELEASED BY					Shipping Ref:
RECEIVED BY					

To Be Filled Out By Analysing Laboratory

				LAB. BATCH NUMBER	
Security Seal		Chilled		Bill to:	
Suitable Containers		Frozen		Address	
Cool Box		Ambient			

THIS FORM IS TO BE SIGNED BY GOLDER STAFF; COURIER/S; LABORATORY ON RECEIPT OF SAMPLES.

ALS Group

Environmental Division

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **EB1219974**		
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Brisbane
Contact	: MR LYNDON GORDON	Contact	: Carsten Emrich
Address	: P O BOX 5569 55 KINGSFORD SMITH PARADE MAROOCHYDORE QLD, AUSTRALIA 4558	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: lgordon@golder.com.au	E-mail	: carsten.emrich@alsenviro.com
Telephone	: +61 07 5475 5900	Telephone	: +61 7 3243 7123
Facsimile	: +61 07 5475 5901	Facsimile	: +61 7 3243 7218
Project	: 127683005	Page	: 1 of 3
Order number	: ----		
C-O-C number	: SOIL	Quote number	: EB2012GOLASS0413 (BN/156/12)
Site	: Saipem GTP Phase 2 ASS		
Sampler	: Lyndon Gordon	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 31-JUL-2012	Issue Date	: 31-JUL-2012 18:13
Client Requested Due Date	: 03-AUG-2012	Scheduled Reporting Date	: **03-AUG-2012**

Delivery Details

Mode of Delivery	: Carrier	Temperature	: 1.1, -0.8°C - Ice present
No. of coolers/boxes	: 2 MEDIUM	No. of samples received	: 31
Security Seal	: Intact.	No. of samples analysed	: 31

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- Samples received in appropriately pretreated and preserved containers.
- A 25% surcharge is applicable for results returned within 3 days.
- **Samples received in appropriately pretreated and preserved containers.**
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Matt Goodwin.
- Analytical work for this work order will be conducted at ALS Brisbane.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - EA033 Chromium Suite for Acid Sulphate Soils
EB1219974-001	26-JUL-2012 15:00	BH23 0.0-0.1m	✓
EB1219974-002	26-JUL-2012 15:00	BH23 1.5-1.75m	✓
EB1219974-003	26-JUL-2012 15:00	BH23 2.5-2.75m	✓
EB1219974-004	26-JUL-2012 15:00	BH23 3.5-3.75m	✓
EB1219974-005	26-JUL-2012 15:00	BH24 0.1-0.25m	✓
EB1219974-006	26-JUL-2012 15:00	BH24 1.25-1.5m	✓
EB1219974-007	26-JUL-2012 15:00	BH24 2.5-2.75m	✓
EB1219974-008	26-JUL-2012 15:00	BH24 3.25-3.5m	✓
EB1219974-009	25-JUL-2012 15:00	BH18 0.1-0.25m	✓
EB1219974-010	25-JUL-2012 15:00	BH18 1.5-1.75m	✓
EB1219974-011	25-JUL-2012 15:00	BH18 2.25-2.5m	✓
EB1219974-012	25-JUL-2012 15:00	BH18 3.5-3.75m	✓
EB1219974-013	25-JUL-2012 15:00	BH18 4.75-5.0m	✓
EB1219974-014	25-JUL-2012 15:00	BH18 5.75-6.0m	✓
EB1219974-015	25-JUL-2012 15:00	BH18 6.25-6.5m	✓
EB1219974-016	26-JUL-2012 15:00	BH11 0.1-0.25m	✓
EB1219974-017	26-JUL-2012 15:00	BH11 1.75-2.0m	✓
EB1219974-018	26-JUL-2012 15:00	BH11 2.5-2.75m	✓
EB1219974-019	26-JUL-2012 15:00	BH11 3.5-3.75m	✓
EB1219974-020	26-JUL-2012 15:00	BH17 0.75-1.0m	✓
EB1219974-021	26-JUL-2012 15:00	BH17 1.5-1.75m	✓
EB1219974-022	26-JUL-2012 15:00	BH17 2.25-2.5m	✓
EB1219974-023	26-JUL-2012 15:00	BH17 3.5-3.75m	✓
EB1219974-024	25-JUL-2012 15:00	BH14 0.1-0.25m	✓
EB1219974-025	25-JUL-2012 15:00	BH14 1.25-1.5m	✓
EB1219974-026	25-JUL-2012 15:00	BH14 2.5-2.75m	✓
EB1219974-027	25-JUL-2012 15:00	BH14 3.75-4.0m	✓
EB1219974-028	25-JUL-2012 15:00	BH13 0.25-0.5m	✓
EB1219974-029	25-JUL-2012 15:00	BH13 1.25-1.5m	✓
EB1219974-030	25-JUL-2012 15:00	BH13 2.5-2.75m	✓
EB1219974-031	25-JUL-2012 15:00	BH13 3.5-3.5m	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

MR JOSH MITCHELL		
- *AU Certificate of Analysis - NATA (COA)	Email	jmitchell@golder.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	jmitchell@golder.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	jmitchell@golder.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	jmitchell@golder.com.au
- A4 - AU Tax Invoice (INV)	Email	jmitchell@golder.com.au
- Chain of Custody (CoC) (COC)	Email	jmitchell@golder.com.au
- EDI Format - ENMRG (ENMRG)	Email	jmitchell@golder.com.au
- EDI Format - EQUIS V5 Generic (EQUIS_V5)	Email	jmitchell@golder.com.au
- EDI Format - ESDAT (ESDAT)	Email	jmitchell@golder.com.au
- EDI Format - GOLDER_EXCEL (GOLDER_EXCEL)	Email	jmitchell@golder.com.au
MR LYNDON GORDON		
- *AU Certificate of Analysis - NATA (COA)	Email	lgordon@golder.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	lgordon@golder.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	lgordon@golder.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	lgordon@golder.com.au
- Chain of Custody (CoC) (COC)	Email	lgordon@golder.com.au
- EDI Format - ENMRG (ENMRG)	Email	lgordon@golder.com.au
- EDI Format - EQUIS V5 Generic (EQUIS_V5)	Email	lgordon@golder.com.au
- EDI Format - ESDAT (ESDAT)	Email	lgordon@golder.com.au
- EDI Format - GOLDER_EXCEL (GOLDER_EXCEL)	Email	lgordon@golder.com.au
THE ACCOUNTS PAYABLE (BRISANE)		
- A4 - AU Tax Invoice (INV)	Email	apbrisbane@golder.com.au

ALS Group

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **EB1219974**	Page	: 1 of 6
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Brisbane
Contact	: MR JOSH MITCHELL	Contact	: Carsten Emrich
Address	: P O BOX 5569 55 KINGSFORD SMITH PARADE MAROOCHYDORE QLD, AUSTRALIA 4558	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: jmitchell@golder.com.au	E-mail	: carsten.emrich@alsenviro.com
Telephone	: +61 07 5475 5900	Telephone	: +61 7 3243 7123
Facsimile	: +61 07 5475 5901	Facsimile	: +61 7 3243 7218
Project	: 127683005	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Saipem GTP Phase 2 ASS		
C-O-C number	: SOIL	Date Samples Received	: 31-JUL-2012
Sampler	: Lyndon Gordon	Issue Date	: 06-AUG-2012
Order number	: ----		
		No. of samples received	: 31
Quote number	: EN/002/11	No. of samples analysed	: 31

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Myles.Clark	Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key :
- Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
- CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
- LOR = Limit of reporting
- RPD = Relative Percentage Difference
- # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA033-A: Actual Acidity (QC Lot: 2431484)									
EB1219974-001	BH23 0.0-0.1m	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	8	8	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.0	6.0	0.0	0% - 20%
EB1219974-011	BH18 2.25-2.5m	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.14	0.13	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	84	82	2.7	0% - 20%
		EA033: pH KCl (23A)	----	0.1	pH Unit	4.1	4.1	0.0	0% - 20%
EA033-A: Actual Acidity (QC Lot: 2431485)									
EB1219974-021	BH17 1.5-1.75m	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.16	0.15	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	98	96	2.3	0% - 20%
		EA033: pH KCl (23A)	----	0.1	pH Unit	3.9	3.9	0.0	0% - 20%
EB1219974-031	BH13 3.5-3.5m	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	12	11	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	5.7	5.7	0.0	0% - 20%
EA033-B: Potential Acidity (QC Lot: 2431484)									
EB1219974-001	BH23 0.0-0.1m	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.020	0.021	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	13	13	0.0	No Limit
EB1219974-011	BH18 2.25-2.5m	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-B: Potential Acidity (QC Lot: 2431485)									
EB1219974-021	BH17 1.5-1.75m	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EB1219974-031	BH13 3.5-3.5m	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-D: Retained Acidity (QC Lot: 2431484)									
EB1219974-011	BH18 2.25-2.5m	EA033: sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	0.02	0.0	No Limit
		EA033: Net Acid Soluble Sulfur (20Je)	----	0.02	% S	0.02	0.03	0.0	No Limit
		EA033: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: HCl Extractable Sulfur (20Be)	----	0.02	% S	0.02	0.03	0.0	No Limit
		EA033: acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	11	13	16.1	No Limit
EA033-D: Retained Acidity (QC Lot: 2431485)									
EB1219974-021	BH17 1.5-1.75m	EA033: sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA033-D: Retained Acidity (QC Lot: 2431485) - continued									
EB1219974-021	BH17 1.5-1.75m	EA033: Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: HCl Extractable Sulfur (20Be)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	<10	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA033-A: Actual Acidity (QCLot: 2431484)								
EA033: pH KCl (23A)	----	0.1	pH Unit	----	4.5 pH Unit	102	94	120
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	30 mole H+ / t	112	93	115
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 2431485)								
EA033: pH KCl (23A)	----	0.1	pH Unit	----	4.5 pH Unit	102	94	120
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	30 mole H+ / t	110	93	115
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 2431484)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	.28 % S	87.3	80	120
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-B: Potential Acidity (QCLot: 2431485)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	.28 % S	89.4	80	120
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-D: Retained Acidity (QCLot: 2431484)								
EA033: Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	----	----	----	----
EA033: acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	0.0346110 % S	92.4	90	110
EA033: HCl Extractable Sulfur (20Be)	----	0.02	% S	<0.02	.042 % S	98.1	90	110
EA033-D: Retained Acidity (QCLot: 2431485)								
EA033: Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	----	----	----	----
EA033: acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	0.0346110 % S	92.4	90	110
EA033: HCl Extractable Sulfur (20Be)	----	0.02	% S	<0.02	.042 % S	98.1	90	110

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) Results are required to be reported.**

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report

The quality control term Matrix Spike (MS) and Matrix Spike Duplicate (MSD) refers to intralaboratory split samples spiked with a representative set of target analytes. The purpose of these QC parameters are to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

ALS Group

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1220258**	Page	: 1 of 9
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Brisbane
Contact	: MR JOSH MITCHELL	Contact	: Carsten Emrich
Address	: P O BOX 5569 55 KINGSFORD SMITH PARADE MAROOCHYDORE QLD, AUSTRALIA 4558	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: jmitchell@golder.com.au	E-mail	: carsten.emrich@alsenviro.com
Telephone	: +61 07 5475 5900	Telephone	: +61 7 3243 7123
Facsimile	: +61 07 5475 5901	Facsimile	: +61 7 3243 7218
Project	: 127683005	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 02-AUG-2012
Sampler	: Lyndon Gordon	Issue Date	: 07-AUG-2012
Site	: Saipem GTP Phase 2 ASS		
		No. of samples received	: 31
Quote number	: BN/156/12	No. of samples analysed	: 31

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
SATISH.TRIVEDI	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ASS: EA033 (CRS Suite): ANC not required because pH KCl less than 6.5**
- **ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH12 0.1-0.25m	BH12 1.25-1.5m	BH12 2.0-2.25m	BH12 3.75-4.0m	BH15 0.25-0.5m
			Client sampling date / time	28-JUL-2012 15:00	28-JUL-2012 15:00	28-JUL-2012 15:00	28-JUL-2012 15:00	30-JUL-2012 15:00
Compound	CAS Number	LOR	Unit	EB1220258-001	EB1220258-002	EB1220258-003	EB1220258-004	EB1220258-005
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**4.6**	**6.3**	**6.0**	**6.0**	**5.8**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**46**	**3**	**6**	**7**	**8**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.07**	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.07**	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	**46**	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	**3**	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH15 1.25-1.5m	BH15 2.5-2.75m	BH15 3.75-4.0m	BH16 0.25-0.5m	BH16 1.5-1.75m
			Client sampling date / time	30-JUL-2012 15:00	30-JUL-2012 15:00	30-JUL-2012 15:00	28-JUL-2012 15:00	28-JUL-2012 15:00
Compound	CAS Number	LOR	Unit	EB1220258-006	EB1220258-007	EB1220258-008	EB1220258-009	EB1220258-010
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	5.2	4.8	4.7	5.2	4.1
Titratable Actual Acidity (23F)	----	2	mole H+ / t	14	22	23	15	81
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.02	0.04	0.04	0.02	0.13
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	----	0.02
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	----	----	----	0.03
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	----	----	----	<0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	----	----	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	----	----	----	<0.02
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.02	0.04	0.04	0.02	0.13
Net Acidity (acidity units)	----	10	mole H+ / t	14	22	23	15	84
Liming Rate	----	1	kg CaCO3/t	1	2	2	1	6

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH19 0.0-0.1m	BH19 1.0-1.25m	BH19 2.3-2.5m	BH19 3.25-3.5m	BH19 4.5-4.75m
			Client sampling date / time	30-JUL-2012 15:00	30-JUL-2012 15:00	30-JUL-2012 15:00	30-JUL-2012 15:00	30-JUL-2012 15:00
Compound	CAS Number	LOR	Unit	EB1220258-011	EB1220258-012	EB1220258-013	EB1220258-014	EB1220258-015
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**5.9**	**3.9**	**4.7**	**4.2**	**4.4**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**8**	**100**	**33**	**49**	**46**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	**0.16**	**0.05**	**0.08**	**0.07**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	<0.02	----	<0.02	<0.02
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	<0.02	----	<0.02	<0.02
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	<0.02	----	<0.02	<0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	<10	----	<10	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	<0.02	----	<0.02	<0.02
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	**0.16**	**0.05**	**0.08**	**0.07**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	**100**	**33**	**49**	**46**
Liming Rate	----	1	kg CaCO3/t	<1	**7**	**2**	**4**	**3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	BH19 5.5-5.75m	BH20 0.0-0.1m	BH20 1.0-1.25m	BH20 2.25-2.5m	BH20 3.5-3.75m
Client sampling date / time				30-JUL-2012 15:00	29-JUL-2012 15:00	29-JUL-2012 15:00	29-JUL-2012 15:00	29-JUL-2012 15:00
				EB1220258-016	EB1220258-017	EB1220258-018	EB1220258-019	EB1220258-020
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**4.5**	**4.6**	**4.4**	**4.1**	**4.4**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**38**	**45**	**45**	**41**	**34**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.06**	**0.07**	**0.07**	**0.07**	**0.05**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	**0.02**	**0.02**	<0.02
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	----	**0.02**	**0.03**	**0.02**
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	----	<0.02	<0.02	**0.02**
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	<10	<10	**10**
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	----	<0.02	<0.02	<0.02
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.06**	**0.07**	**0.08**	**0.07**	**0.07**
Net Acidity (acidity units)	----	10	mole H+ / t	**38**	**45**	**48**	**44**	**44**
Liming Rate	----	1	kg CaCO3/t	**3**	**3**	**4**	**3**	**3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	BH20 4.25-4.5m	BH20 5.5-5.75m	BH21 0.0-0.1m	BH21 1.0-1.25m	BH21 2.0-2.25m
Client sampling date / time				29-JUL-2012 15:00	29-JUL-2012 15:00	29-JUL-2012 15:00	29-JUL-2012 15:00	29-JUL-2012 15:00
				EB1220258-021	EB1220258-022	EB1220258-023	EB1220258-024	EB1220258-025
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	4.3	5.2	5.5	4.6	4.6
Titratable Actual Acidity (23F)	----	2	mole H+ / t	35	13	12	29	26
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.06	0.02	0.02	0.05	0.04
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	----	----	----	----
HCl Extractable Sulfur (20Be)	----	0.02	% S	0.02	----	----	----	----
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	0.02	----	----	----	----
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	----	----	----	----
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.07	0.02	0.02	0.05	0.05
Net Acidity (acidity units)	----	10	mole H+ / t	45	13	12	29	29
Liming Rate	----	1	kg CaCO3/t	3	<1	<1	2	2

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	BH22 0.25-0.5m	BH22 1.25-1.5m	BH22 2.25-2.5m	BH22 3.25-3.5m	BH25 0.1-0.25m
Client sampling date / time				28-JUL-2012 15:00	28-JUL-2012 15:00	28-JUL-2012 15:00	28-JUL-2012 15:00	29-JUL-2012 15:00
				EB1220258-026	EB1220258-027	EB1220258-028	EB1220258-029	EB1220258-030
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	4.7	4.5	4.4	4.3	5.6
Titratable Actual Acidity (23F)	----	2	mole H+ / t	36	33	28	32	10
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.06	0.05	0.04	0.05	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	<0.02	<0.02	----
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	----	<0.02	<0.02	----
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	----	<0.02	<0.02	----
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	----	<10	<10	----
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	----	<0.02	<0.02	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.06	0.05	0.04	0.05	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	36	33	28	32	<10
Liming Rate	----	1	kg CaCO3/t	3	2	2	2	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH25 1.0-1.25m	----	----	----	----
			Client sampling date / time	29-JUL-2012 15:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1220258-031	----	----	----	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**4.7**	----	----	----	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**25**	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.04**	----	----	----	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	----	----	----	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	**0.04**	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	**25**	----	----	----	----
Liming Rate	----	1	kg CaCO3/t	**2**	----	----	----	----

Sheet...... of......

SAMPLE CHAIN OF CUSTODY DOCUMENTATION - SOIL

Project ID:	127683005	Quote/Order No.:	BN/156/12
Site Location:	Saipem GTP Phase 2 ASS Investigation	Lab Name:	ALS
Sampled By:	Lyndon Gordon		
Turnaround (Days):		BY:	

Report Format: HARD ☐ FAX ☐ DISK ☐ EMAIL ☑ BULLETIN BOARD ☐

Email Format: PDF ☑ Excel ☑ Other ☐ Email Address: lgordon@golder.com.au

GOLDER ASSOCIATES PTY LTD Phone: (07) 5475 5900
55 Kingsford Smith Parade, Maroochydore QLD 4558 Fax: (07) 5475 5901
Golder Associates
Invoice to be sent to Accounts Brisbane: jmitchell@golder.com.au
Project Manager: Josh Mitchell
Contact Phone: 07 5475 5900 Email: jmitchell@golder.com.au

Comments/Special Instructions: Excel required format ENMRG
Please also send e-mail to jmitchell@golder.com.au and lgordon@golder.com.au
FAST TRACK 3 days TAT

Samples from a declared Fire Ant Area: N
Samples taken from a known Weed and or Pest Area: N

ANALYSIS REQUIRED

	SAMPLE ID	Location & Depth	SAMPLE MATRIX	SAMPLE DATE	SAMPLE TIME	CONTAINER/ PRESERVATIVE		No CONTAINERS	POSSIBLE HIGH CONCENTRATION		EA033 CRS Suite
1	BH12	0.1-0.25m	soil	28/07/2012		bag	Ice		N		x
2	BH12	1.25-1.5m	soil	28/07/2012		bag	Ice		N		x
3	BH12	2.0-2.25m	soil	28/07/2012		bag	Ice		N		x
4	BH12	3.75-4.0m	soil	28/07/2012		bag	Ice		N		x
5	BH15	0.25-0.5m	soil	30/07/2012		bag	Ice		N		x
6	BH15	1.25-1.5m	soil	30/07/2012		bag	Ice		N		x
7	BH15	2.5-2.75m	soil	30/07/2012		bag	Ice		N		x
8	BH15	3.75-4.0m	soil	30/07/2012		bag	Ice		N		x
9	BH16	0.25-0.5m	soil	29/07/2012		bag	Ice		N		x
10	BH16	1.5-1.75m	soil	29/07/2012		bag	Ice		N		x
11	BH19	0.0-0.1m	soil	30/07/2012		bag	Ice		N		x
12	BH19	1.0-1.25m	soil	30/07/2012		bag	Ice		N		x
13	BH19	2.3-2.5m	soil	30/07/2012		bag	Ice		N		x
14	BH19	3.25-3.5m	soil	30/07/2012		bag	Ice		N		x
15	BH19	4.5-4.75m	soil	30/07/2012		bag	Ice		N		x
16	BH19	5.5-5.75m	soil	30/07/2012		bag	Ice		N		x
17	BH20	0.0-0.1m	soil	29/07/2012		bag	Ice		N		x
18	BH20	1.0-1.25m	soil	29/07/2012		bag	Ice		N		x
19	BH20	2.25-2.5m	soil	29/07/2012		bag	Ice		N		x
20	BH20	3.5-3.75m	soil	29/07/2012		bag	Ice		N		x
21	BH20	4.25-4.5m	soil	29/07/2012		bag	Ice		N		x
22	BH20	5.5-5.75m	soil	29/07/2012		bag	Ice		N		x
23	BH21	0.0-0.1m	soil	29/07/2012		bag	Ice		N		x
24	BH21	1.0-1.25m	soil	29/07/2012		bag	Ice		N		x
25	BH21	2.0-2.25m	soil	29/07/2012		bag	Ice		N		x
26	BH22	0.25-0.5m	soil	28/07/2012		bag	Ice		N		x
27	BH22	1.25-1.5m	soil	28/07/2012		bag	Ice		N		x
28	BH22	2.25-2.5m	soil	28/07/2012		bag	Ice		N		x
29	BH22	3.25-3.5m	soil	28/07/2012		bag	Ice		N		x
30	BH25	0.1-0.25m	soil	29/07/2012		bag	Ice		N		x
31	BH25	1.0-1.25m	soil	29/07/2012		bag	Ice		N		x

SAMPLE MATRIX = Soil/Sediment/Fill/Other SAMPLE TYPE = Core(CR) HIGH CONCENTRATION: Tick box and circle expected parameters in analysis list

Container Type and Preservative Codes: P = Natural Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinsed Jar; S = Solvent Washed Acid Rinsed Glass Bottle; VC = Hydrochloric Preserved Vial; VS = Sulphuric Acid P

	SIGNATURE	COMPANY	DATE	TIME
RELEASED BY	LYNDON GORDON	GOLDER	1/8/12	
RECEIVED BY	T.CRAKER	ALS	1.8.12	1000
RELEASED BY				
RECEIVED BY	PHO	ALS	02/08/12	08:30
RELEASED BY				
RECEIVED BY				

	SIGNATURE	COMPANY	DATE	TIME	Shipment Method
RELEASED BY					Shipping Ref:
RECEIVED BY					

To Be Filled Out By Analysing Laboratory — LAB. BATCH NUMBER

Security Seal		Chilled		Bill to:	
Suitable Containers		Frozen		Address	
Cool Box		Ambient			

Environmental Division
Brisbane
Work Order
EB1220258
Telephone : +61-7-3243 7222
JLP

THIS FORM IS TO BE SIGNED BY GOLDER STAFF; COURIER/S; LABORATORY ON RECEIPT OF SAMPLES.

ALS Group

Environmental Division

Food& Environmental Pharmaceutical

ALS Life Sciences

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **EB1220258**		
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Brisbane
Contact	: MR JOSH MITCHELL	Contact	: Carsten Emrich
Address	: P O BOX 5569 55 KINGSFORD SMITH PARADE MAROOCHYDORE QLD, AUSTRALIA 4558	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: jmitchell@golder.com.au	E-mail	: carsten.emrich@alsenviro.com
Telephone	: +61 07 5475 5900	Telephone	: +61 7 3243 7123
Facsimile	: +61 07 5475 5901	Facsimile	: +61 7 3243 7218
Project	: 127683005	Page	: 1 of 3
Order number	: ----		
C-O-C number	: ----	Quote number	: EB2012GOLASS0413 (BN/156/12)
Site	: Saipem GTP Phase 2 ASS		
Sampler	: Lyndon Gordon	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 02-AUG-2012	Issue Date	: 02-AUG-2012 20:09
Client Requested Due Date	: 07-AUG-2012	Scheduled Reporting Date	: **07-AUG-2012**

Delivery Details

Mode of Delivery	: Carrier	Temperature	: -0.1°C - Ice present
No. of coolers/boxes	: 1 MEDIUM	No. of samples received	: 31
Security Seal	: Intact.	No. of samples analysed	: 31

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **A 25% surcharge is applicable for results returned within 3 days.**
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Matt Goodwin.
- Analytical work for this work order will be conducted at ALS Brisbane.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - EA033 Chromium Suite for Acid Sulphate Soils
EB1220258-001	28-JUL-2012 15:00	BH12 0.1-0.25m	✓
EB1220258-002	28-JUL-2012 15:00	BH12 1.25-1.5m	✓
EB1220258-003	28-JUL-2012 15:00	BH12 2.0-2.25m	✓
EB1220258-004	28-JUL-2012 15:00	BH12 3.75-4.0m	✓
EB1220258-005	30-JUL-2012 15:00	BH15 0.25-0.5m	✓
EB1220258-006	30-JUL-2012 15:00	BH15 1.25-1.5m	✓
EB1220258-007	30-JUL-2012 15:00	BH15 2.5-2.75m	✓
EB1220258-008	30-JUL-2012 15:00	BH15 3.75-4.0m	✓
EB1220258-009	28-JUL-2012 15:00	BH16 0.25-0.5m	✓
EB1220258-010	28-JUL-2012 15:00	BH16 1.5-1.75m	✓
EB1220258-011	30-JUL-2012 15:00	BH19 0.0-0.1m	✓
EB1220258-012	30-JUL-2012 15:00	BH19 1.0-1.25m	✓
EB1220258-013	30-JUL-2012 15:00	BH19 2.3-2.5m	✓
EB1220258-014	30-JUL-2012 15:00	BH19 3.25-3.5m	✓
EB1220258-015	30-JUL-2012 15:00	BH19 4.5-4.75m	✓
EB1220258-016	30-JUL-2012 15:00	BH19 5.5-5.75m	✓
EB1220258-017	29-JUL-2012 15:00	BH20 0.0-0.1m	✓
EB1220258-018	29-JUL-2012 15:00	BH20 1.0-1.25m	✓
EB1220258-019	29-JUL-2012 15:00	BH20 2.25-2.5m	✓
EB1220258-020	29-JUL-2012 15:00	BH20 3.5-3.75m	✓
EB1220258-021	29-JUL-2012 15:00	BH20 4.25-4.5m	✓
EB1220258-022	29-JUL-2012 15:00	BH20 5.5-5.75m	✓
EB1220258-023	29-JUL-2012 15:00	BH21 0.0-0.1m	✓
EB1220258-024	29-JUL-2012 15:00	BH21 1.0-1.25m	✓
EB1220258-025	29-JUL-2012 15:00	BH21 2.0-2.25m	✓
EB1220258-026	28-JUL-2012 15:00	BH22 0.25-0.5m	✓
EB1220258-027	28-JUL-2012 15:00	BH22 1.25-1.5m	✓
EB1220258-028	28-JUL-2012 15:00	BH22 2.25-2.5m	✓
EB1220258-029	28-JUL-2012 15:00	BH22 3.25-3.5m	✓
EB1220258-030	29-JUL-2012 15:00	BH25 0.1-0.25m	✓
EB1220258-031	29-JUL-2012 15:00	BH25 1.0-1.25m	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

MR JOSH MITCHELL		
- *AU Certificate of Analysis - NATA (COA)	Email	jmitchell@golder.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	jmitchell@golder.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	jmitchell@golder.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	jmitchell@golder.com.au
- Chain of Custody (CoC) (COC)	Email	jmitchell@golder.com.au
- EDI Format - ENMRG (ENMRG)	Email	jmitchell@golder.com.au
- EDI Format - EQUIS V5 Generic (EQUIS_V5)	Email	jmitchell@golder.com.au
- EDI Format - ESDAT (ESDAT)	Email	jmitchell@golder.com.au
- EDI Format - GOLDER_EXCEL (GOLDER_EXCEL)	Email	jmitchell@golder.com.au
MR LYNDON GORDON		
- *AU Certificate of Analysis - NATA	Email	lgordon@golder.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep)	Email	lgordon@golder.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA	Email	lgordon@golder.com.au
- A4 - AU Sample Receipt Notification - Environmental HT	Email	lgordon@golder.com.au
- Chain of Custody (CoC)	Email	lgordon@golder.com.au
- EDI Format - ENMRG	Email	lgordon@golder.com.au
- EDI Format - EQUIS V5 Generic	Email	lgordon@golder.com.au
- EDI Format - ESDAT	Email	lgordon@golder.com.au
- EDI Format - GOLDER_EXCEL	Email	lgordon@golder.com.au
THE ACCOUNTS PAYABLE (MRCHYDRE)		
- A4 - AU Tax Invoice (INV)	Email	apmaroochydore@golder.com.au

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **EB1220258**	Page	: 1 of 6
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Brisbane
Contact	: MR JOSH MITCHELL	Contact	: Carsten Emrich
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Project	: 127683005	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Saipem GTP Phase 2 ASS		
C-O-C number	: ----	Date Samples Received	: 02-AUG-2012
Sampler	: Lyndon Gordon	Issue Date	: 07-AUG-2012
Order number	: ----		
		No. of samples received	: 31
Quote number	: BN/156/12	No. of samples analysed	: 31

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
SATISH.TRIVEDI	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key :
- Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
- CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
- LOR = Limit of reporting
- RPD = Relative Percentage Difference
- # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA033-A: Actual Acidity (QC Lot: 2435870)									
EB1220089-001	Anonymous	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	8.8	8.8	0.0	0% - 20%
EB1220258-009	BH16 0.25-0.5m	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.02	0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	15	14	7.1	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	5.2	5.2	0.0	0% - 20%
EA033-A: Actual Acidity (QC Lot: 2435871)									
EB1220258-019	BH20 2.25-2.5m	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.07	0.06	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	41	40	2.9	0% - 20%
		EA033: pH KCl (23A)	----	0.1	pH Unit	4.1	4.1	0.0	0% - 20%
EB1220258-029	BH22 3.25-3.5m	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.05	0.05	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	32	29	8.0	0% - 50%
		EA033: pH KCl (23A)	----	0.1	pH Unit	4.3	4.3	0.0	0% - 20%
EA033-B: Potential Acidity (QC Lot: 2435870)									
EB1220089-001	Anonymous	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.115	0.115	0.0	0% - 20%
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	72	72	0.0	No Limit
EB1220258-009	BH16 0.25-0.5m	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-B: Potential Acidity (QC Lot: 2435871)									
EB1220258-019	BH20 2.25-2.5m	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EB1220258-029	BH22 3.25-3.5m	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-D: Retained Acidity (QC Lot: 2435871)									
EB1220258-019	BH20 2.25-2.5m	EA033: sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: KCl Extractable Sulfur (23Ce)	----	0.02	% S	0.02	<0.02	0.0	No Limit
		EA033: HCl Extractable Sulfur (20Be)	----	0.02	% S	0.03	0.03	0.0	No Limit
		EA033: acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EB1220258-029	BH22 3.25-3.5m	EA033: sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	0.0	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EA033-D: Retained Acidity (QC Lot: 2435871) - continued									
EB1220258-029	BH22 3.25-3.5m	EA033: HCl Extractable Sulfur (20Be)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	<10	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA033-A: Actual Acidity (QCLot: 2435870)								
EA033: pH KCl (23A)	----	0.1	pH Unit	----	4.5 pH Unit	102	94	120
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	30 mole H+ / t	111	93	115
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 2435871)								
EA033: pH KCl (23A)	----	0.1	pH Unit	----	4.5 pH Unit	102	94	120
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	30 mole H+ / t	103	93	115
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 2435870)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	.28 % S	88.0	80	120
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-B: Potential Acidity (QCLot: 2435871)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	.28 % S	90.7	80	120
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-D: Retained Acidity (QCLot: 2435870)								
EA033: Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	----	----	----	----
EA033: acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	0.036110 % S	94.2	90	110
EA033: HCl Extractable Sulfur (20Be)	----	0.02	% S	<0.02	.06 % S	100	90	110
EA033-D: Retained Acidity (QCLot: 2435871)								
EA033: Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	----	----	----	----
EA033: acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	0.036110 % S	94.2	90	110
EA033: HCl Extractable Sulfur (20Be)	----	0.02	% S	<0.02	.06 % S	98.3	90	110

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) Results are required to be reported.**

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report

The quality control term Matrix Spike (MS) and Matrix Spike Duplicate (MSD) refers to intralaboratory split samples spiked with a representative set of target analytes. The purpose of these QC parameters are to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

APPENDIX E

Limitations

LIMITATIONS

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Golder Associates

Santos
GLNG Project

Appendix B
Pest and Weed Management Plan

Santos | PETRONAS | TOTAL | KOGAS

GLNG
Gas Transmission Pipeline

Pest and Weed Management Plan

Document Number: 3380-GLNG-3-1.3-0006

PREPARED BY:

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DATE	REV	REASON FOR ISSUE	AUTHOR	CHECKED	APPROVED
04/08/10	1	For Use	AW	BF	NC
23/11/10	2	For Contract Award	AW	BF	NC
02/06/11	3	Re-issued for Use	BH	IB	NC
15/07/11	4	For Agency Review	CC		
29/03/12	5	Revised for SEWPaC Review	AW	BF	NC
16/05/12	6	Revised for SEWPaC Second Review	AW	BF	NC

TABLE OF CONTENTS

Attachments

1. Introduction

1.1 Purpose

The purpose of this Pest and Weed Management Plan (PWMP) is to detail the requirements for the management of weeds associated with the construction of the GLNG Gas Transmission Pipeline (GTP). The PWMP is applicable to GLNG Operations (the Company) employees, Contractors and all personnel associated with the planning and construction of the pipeline.

1.2 Scope

The scope of this document is to outline the pest and weed management protocols for the various stages of the GLNG GTP and to provide the Contractor with a baseline set of weed data and management strategies to assist the Contractor in developing an acceptable CPWMP.

Pre-construction:

Clearly define the boundaries and procedures throughout the Project Area to ensure all preconstruction activities (surveys, landholder access, site visits, infrastructure upgrades and preparation) to not transfer Class 1 or 2 weeds from areas currently infested to new "clean" areas.

Construction

To provide the physical and procedural parameters and boundaries to the EPC Contractor from which they can develop their project specific 'Contractors Pest and Weed Management Plan'. Together, these plans will provide the procedures and guidelines on how the spread of weeds throughout the Project Area will be prevented and compliance with this document will be maintained.

Post Construction

To establish the boundaries and procedures for weed management along the Pipeline for all monitoring and maintenance procedures for the Project life.

This document has been prepared in accordance with the EIS and SEIS for the GLNG Project, as well as the Project Environmental Management Plans

1.3 Objectives and Performance Criteria

The objectives and performance criteria for the PWMP (Pest and Weed Management Plan), as detailed in the GLNG Project EIS, are:

Objective

- To prevent the introduction and spread of weed and pest species throughout areas associated with the construction of the GLNG Transmission pipeline

Performance Criteria

- No new weed infestations in the Project Area (pipeline, access tracks and ancillary Project Areas (laydown areas, camps, water points, quarries etc) as a result of construction activities
- No spread of weeds from infested areas to previously weed free areas
- No mature or seeding weeds located within the Project Area during construction

- Right of Way (ROW) restored to a state that minimises the potential for weed colonisation of disturbed areas
- No net increase in the abundance or distribution of pest animal species in the Project Area

1.4 Definitions

Term	Definition
Certified Clean	Washed down vehicle Certified clean by Weed Inspector
Class 1 Declared Plant or Declared Animal	A plant or animal that: • Is not commonly present in Queensland and, if introduced, would cause an adverse economic, environmental or social impact • Are subject to eradication from the state Landowners must take reasonable steps to keep land free of Class 1 pests It is a serious offence to introduce, keep or supply a Class 1 pest without a permit issued by the Department of Primary Industries and Fisheries
Class 2 Declared Plant or Declared Animal	A plant or animal that: • Is established in Queensland and have, or could have, an adverse economic, environmental or social impact • Requires coordination and are subject to programs led by local government, community or landowners Landowners must take reasonable steps to keep land free of Class 2 pests It is a serious offence to introduce, keep or supply a Class 2 pest without a permit issued by the Department of Primary Industries and Fisheries
Class 3 Declared Plant[1] or Declared Animal	A plant or animal that: • Is established in Queensland and has, or could have, a substantial adverse economic, environmental or social impact Landowners may be required to manage Class 3 weeds in or near environmentally significant areas such as protected areas, important habitats for threatened species or areas of interest only
Declared Pest	A live animal or plant confirmed to be a declared pest under the *Land Protection (Pest and Stock Route Management) Act 2002*
Infested Area	An area infested with a declared pest. These areas can be defined by local council, the regulatory body or local landholders – depending on the size of the infestation
Inspection	Inspection carried out by a trained Weed Inspector in compliance with the Queensland Government *Queensland Checklist for Inspection Procedures*

[1] This class has been inserted for information purposes only as weed surveys to date have not included Class 3 plants. However, as noted, Class 3 plants may need to be managed within environmentally significant areas and it is recommended that pre-construction surveys record the locations of such species in such areas.

Term	Definition
Project Area	Includes the pipeline ROW, access tracks and ancillary Project Areas (laydown areas, camps, water points, quarries)
Washdown Log	Log of washdowns completed for a specific vehicle/plant/equipment. The Log is maintained by the vehicle/equipment operator
Washdown	Washdown carried out, using the provisions of the Queensland Government *Queensland Checklist for Cleandown Procedures* as a Guideline, to remove organic matter and material from vehicles and equipment that may lead to the introduction or spread of weed species
Washdown Register	Washdown Facility specific Register of all washdowns completed at the particular Washdown Facility. The Register is maintained by the Weed Inspector for the particular facility
Weed Inspector	Person who has completed Weed Inspector Training and is trained in the following nationally recognised units: • RTD2312A Inspect Machinery of Plan Animal and Soil Material • RTD2313A Clean Machinery of Plant Animal and Soil Material OR Person accepted by the Company as having the appropriate training to undertake the role as outlined in the PWMP e.g. nominated Environmental Officer(s)
Weed Management Zones	The Project Area has been divided into Weed Management Zones to assist with the implementation of this PWMP. Refer to Section 2.2.1

1.5 Abbreviations

ACDC Act	Agricultural Chemicals Distribution Control Act 1966
CICSDA	Callide Infrastructure Corridor State Development Area
CPWMP	Contractor Weed Management Plan
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPC	Engineering, Procurement and Construction
GLNG	Gladstone Liquefied Natural Gas
GRT	Giant Rats Tail Grass
GSDA	Gladstone State Development Area
GTP	Gas Transmission Pipeline
ROW	Right of Way
WMP	Weed Management Plan (this document)

2. Background

2.1 Identification of Key Risks

2.1.1 Weed Survey

Weed surveys of the pipeline route and associated Project Area have been completed. Further weed surveys will be completed by the Contractor to further refine the nature and extent of weeds within the Project Area, such that the information is current at the time construction activities commence.

In addition to consultation with local authorities and landholders, weed surveys undertaken during 2009, 2010 and a field revision in 2011 have identified the following weeds to be of major concern within the Project Area and surrounds:

- *Parthenium hysterophorus* (Parthenium) – Class 2 weed
- *Sporobolus pyramidalis* (Giant rats tail grass) – Class 2 weed
- *Eragrostis curvula* (African love grass) – major concern to landholders

Details of all species identified during the field surveys along with their location are provided as Attachment D.

2.1.2 Pest animal survey

Fauna surveys of the pipeline route and associated Project Area were undertaken between 2008 and 2010 with the following pest animals were recorded:

Canis lupus dingo and *Canis familiaris* (Dingo and wild dog) – Class 2 pest animals
Vulpes vulpes (red fox) – Class 2 pest animal
Sus scrofa (feral pig) – Class 2 pest animal
Felis catus (feral cat) – Class 2 pest animal
Oryctolagus cuniculus (rabbit) – Class 2 pest animal
Rhinella marinus (cane toad) – not a declared pest animal

Note The National Management Group, Australia´s key decision-making body on emergency pests, has officially declared that red imported fire ant has been eradicated from the area, following a successful eradication and pest freedom verification program carried out by Biosecurity Queensland. This means that the movement restrictions on high-risk materials can now been lifted. This is a big win for the fire ant eradication program and the Yarwun community. However, fire ants still pose a threat and restrictions remain in place in South East Queensland. Fire ants are easily spread in soil, mulch, plants and landscaping equipment, so movement controls must be adhered to in order to reduce the risk of further spread.

Source http://www.dpi.qld.gov.au/4790_18539.htm

2.1.3 Review of Activities

A review has been undertaken of the pipeline construction activities. Activities considered to pose the highest risk of introducing or spreading weeds and pest animals are listed below and will be subject to specific controls:

- Pre-construction route field studies (eg geotechnical studies, route review with landholders, route inspection with contactors)
- Activities on pipeline route prior to clearing and grading of the ROW
  - Survey Crew

- Fencing Crew
- Clear and grade activities
- First arrival of construction vehicles, equipment and supplies
- Accessing ROW and travelling back to camps
- Movement of vehicles between crews/activities
- Deliveries of materials to the ROW
- Travelling away from Project Area after accessing the ROW

2.2 Overview of Management Strategies

The Company's strategy is controls focused on preventing the introduction and/or spread of weed and pest animal species during the construction of the GLNG GTP. The Company has determined that the controls to prevent the introduction and/or spread of Parthenium and Giant Rats Tail Grass (GRT) will also be effective in controlling the introduction and/or spread of the other weed species.

There are numerous strategies available for weed management however it must be noted that individually, they cannot adequately manage or control the spread of weeds. The effective management of weed will only be attained through the combination of a series of weed management strategies. (i.e. vehicle washdowns will not get every seed off a vehicle). Weed spraying will not kill every plant and there is no chemical that kills seeds effectively. Isolating certain vehicles to certain areas is effective, however this relies on the integrity of project personnel, which is not a factor that this project is going to rely on. In addition, the pest animal species detected in the Project Area are widespread and established across the region, so their management will require an integrated, catchment-scale approach.

2.2.1 Weed Management Zones

It will be the responsibility of the Contractor to determine appropriate weed management zones for the Project Area and manage the zones accordingly. However as a minimum, the information and mapping provided in Attachment D should be used to determine 'clean' and 'dirty' locations and develop appropriate weed management protocols.

2.2.2 Summary of Strategies

The major strategies to be implemented in the PWMP to control the identified risks are:

a) Ongoing weed surveys and weed spraying
b) Training of personnel in the requirements of this PWMP
c) Establishment of weed management zones
d) **Control vehicle and equipment movements** between zones via a sticker identification system
e) Establishment of weed washdown facilities staffed by appropriately qualified and experienced Weed Inspectors
f) Ensuring all vehicles, equipment and supplies brought to the Project Area and departing are **certified clean**
g) Implementation of inspection and monitoring protocols
h) Post-construction weed monitoring and control strategy

Note The weed control strategies outlined in this PWMP are based upon weed surveys completed during 2009, 2010 and 2011. Upon completion of any additional surveys, the weed control strategies may be further revised

Pest animals

- Ensure all vehicles, equipment and supplies brought to the Project Area are free of pest animals
- Report all sightings of pest animals and monitor changes in abundance or distribution within the Project Area
- Secure waste organic material (eg food scraps) to deter scavenging by pest animals
- Avoid creating artificial water sources (eg depressions) that provide a source of drinking water to vertebrate pests or breeding habitat to invertebrate pests
- Support a broad scale, integrated pest management approach as identified in regional and state pest management strategies

3. General provisions

3.1 Responsibilities

Company – Implementation of the PWMP up to the point of the issue of the EPC contractor. The Company is also responsible for review and acceptance of the Contractor's CPWMP, monitoring compliance of the Contractor to the requirements of the WMP and CEMP, and management of the EPC contract which contains KPI's associated with implementation of this PWMP.

Contractor – Development and implementation of a Contractor Weed Management Plan (CPWMP) to comply with the PWMP. This will include (but not limited to) completion of pre-construction survey(s) and pre-construction weed control, training of personnel (see below), provision and maintenance of equipment, facilities and associated services and consumables and the monitoring of compliance to the CPWMP[2].

Supervisors (Contractors and the Company) – establishment of a best practice culture and monitoring, and enforcement of the requirements of this PWMP and the CPWMP. This will include ensuring that all sub-Contractors are aware of the requirements of the CPWMP prior to entering the Project.

Plant / vehicle operators – ensuring plant/equipment is certified as clean prior to arrival to the Project Area, undertaking washdown at required locations, maintaining a Washdown Log and ensuring activities are completed in accordance with WMP and CPWMP.

Weed/Pest inspector – inspection of vehicles, certification to cleanliness, administer weed zone stickers, maintain Washdown Register for the facility and ensure serviceability of washdown equipment on site.

Note The CPWMP will be designed to demonstrate the Contractors systems and procedures by which they will ensure compliance with this document. Where the CPWMP or any other contractual document refers to the PWMP, this will imply compliance with the Company PWMP through the complete implementation of the CPWMP. A breach of the CPWMP will be a breach of the PWMP and will imply a failure to meet a Key Performance Indicator.

3.2 Training

The Company and the Contractor are responsible for ensuring that the following training is completed.

Weed/Pest Inspector(s) – Completed Weed Inspector Training and is trained in the following nationally recognised units.

- RTD2312A Inspect Machinery of Plan Animal and Soil Material
- RTD2313A Clean Machinery of Plant Animal and Soil Material
- Alternate training and/or experience accepted by the Company (refer to Section 1.4)

All personnel – inducted to requirements of the PWMP including:

- Identification of key weed species and pest animal species
- Washdown requirements (on specific vehicles and where to clean)
- Access protocols (between the specified zones)
- Certification process (stickers, Washdown Log, Washdown Register, Weed Inspector)

[2] Records of all induction and training completed shall be maintained to demonstrate compliance with this PWMP. The CPWMP will be designed *to demonstrate the Contractors systems and procedures by which they will ensure compliance with this document. Where the CPWMP or any other contractual document refers to the PWMP, this will imply compliance with the GLNG PWMP through the complete implementation of the CPWMP. A breach of the CPWMP will be a breach of the PWMP and will imply a failure to meet a Key Performance Indicator.*

4. Company Pre-Construction Weed and Pest Animal Management

This section applies to all activities undertaken by the Company and associated Contractors or consultants prior to award of the EPC contract.

Upon award of the contact and approval of the CPWMP by the Company, all Project personnel shall comply with the requirements of the CPWMP.

4.1 Weed Identification and Control

4.1.1 Requirements

Weed Identification

- Weed surveys of the Project Area (including ROW, access tracks and any known ancillary areas) were undertaken by trained personnel/contractors in June and September of 2009 (dry season) and February and June of 2010 (post wet season). An additional review has been undertaken in April 2011 and the results have been attached in the update plans and material
- Weeds identified were recorded and have been mapped accordingly (refer Attachment D)
- The Company personnel will continue to liaise closely with local Council officers and landholders for existing weed information
- Survey findings will be utilised by Project personnel and Contractors to define the specific weed control measures for construction and the targeted weed control program

Weed Control

- Prior to the appointment of the Contractor, weed control of the Project Area (ROW, camps, storage areas, access) will be undertaken by appropriately qualified and experienced contractors who are appropriately licensed under the *Agricultural Chemicals Distribution Control Act 1966* (ACDC Act)
- Where possible, weed control will be scheduled to occur prior to weed seeding
- Prior to weed spraying, relevant land holders will be consulted
- Significant weed infestation areas will be monitored after treatment and repeat treatment undertaken as required

4.1.2 Performance Indicators

- Weed surveys undertaken during at least one dry and one wet season.
- Weed outbreaks recorded in GIS
- Weed control completed and recorded
- Weed zones established, monitored and marked on project maps (updated as applicable)
- No mature weeds or seeding plants within Project Area

4.2 Pre-Construction Access to Project Area

This section applies to all vehicles accessing the Project Area and travelling off sealed public roads.

4.2.1 Requirements

- Planning for access to the Project Area will include:
  - Identification of existing vehicle washdown facilities and planning work around the location of washdown facilities (refer to Attachment A for a list of public facilities)
- If applicable, fixed washdown facilities and washdown procedures shall comply with:
  - *Queensland Guideline for the Construction of Vehicle and Machinery Washdown facilities* (refer to Section 8)
  - *Queensland Government Checklist for Clean-down* (refer to Section 8)
- When moving between 'dirty' and 'clean' areas, within the Project Area, vehicles, plant and/or equipment will:
  - Be washed down and certified clean
  - Provide/be issued with a Weed Hygiene Declaration Form
  - All vehicles/equipment/plant shall have a Washdown Log (refer to Attachment B for an example of a washdown log) that must be maintained by the vehicle operator. This includes washdowns that require certification and washdowns completed by the vehicle operator. Washdown Logs are auditable and shall be provided upon request
- Vehicle operators:
  - Shall remain on designated access tracks and avoid driving through weeds as far as possible
  - Must not drive though flowering or seeding plants
- The location of any mature and/or seeding weed species is to be reported to the Company Pipeline Environmental Manager within 24 hrs

4.2.2 Performance Indicators

- Weed locations marked on Project maps
- Washdown Logs implemented and maintained
- Washdown Logs demonstrate washdown occurring to coincide with vehicle/equipment/plant movements
- Washdown facilities are available at all times (mobile/temporary units are available prior to establishment of fixed facilities)
- Weed Inspectors present at active washdowns
- No driving through seeding or flowering weed plants

5. EPC Contractor Pre-Construction Weed and Pest Animal Management

This section applies to all activities undertaken by the EPC Contractor prior to the commencement of construction. The only field activities that may be carried out under this section prior to the establishment of washbays and other weed control infrastructure will be weed surveys, or weed management work and/or work associated with the establishment of fixed weed washdown facilities.

5.1 Project Establishment

5.1.1 Requirements

Development of Construction Weed Management Plan

- CPWMP shall:
  - Be prepared by the Contractor and submitted to the Company for approval <u>prior to any work under the EPC contract commencing</u>
  - Comply with the requirements of this PWMP
  - Establish a system to control the movement of vehicles and equipment between weed management zones (refer to Section 2.2.1)
  - Provide the procedures that detail how compliance will be implemented
  - Establish a system to monitor and report on pest animal abundance and distribution
  - Identify the control measures that will be adopted to manage the impacts of existing pest animals within the Project area

Weed Zones

- Weeds management zones will be developed and implemented by the Contractor
- The construction area will be divided into weed management zones for the purpose of defining and preventing the unrestricted movement of vehicles from 'dirty' to 'clean' zones
- The zones shall be clearly identified both in the CPWMP and on the ground and work programs and flow designed around the zones
- Zones shall be clearly marked on construction drawings and within the field

Establishment of Washdown Facilities

- The location of project specific weed washdown facilities will be determined in consultation with weed management zone maps
- These washdown facilities shall be established to enable the efficient movement of vehicles between the weed zones whilst ensuring material that may facilitate the introduction or spread of weeds is removed. This may include the use of mobile washdown facilities where appropriate
- As a minimum, these washdown facilities shall be installed at the following locations:
  - At each construction camp
  - Boundaries of each weed zone
  - Major access points to the ROW, corresponding with weed zone boundaries
- Additional washdown facilities shall be constructed/resourced as required
- Each active washdown facility that is established for certification of vehicles shall be permanently staffed by an appropriately experienced and qualified Weed Inspector (when works are not occurring in that area there will be no need for an

inspector, however arrangements will be required to be made for an inspector to certify the vehicle if movement through the facility is required)

- Washdown facilities shall:
  - Be sized and equipped to facilitate the quick movement of vehicles and equipment within the Project Area whilst ensuring compliance with the CPWMP or this PWMP
  - *Comply with Queensland Guideline for the Construction of Vehicle and Machinery Washdown facilities* (refer to Section 8)
  - Include equipment to remove material from within the vehicle
- The location of Washdown Facilities shall be recorded in the project GIS, clearly marked on project maps and included in the inspection and monitoring program

Location of Infrastructure and Access routes

- It is recommended that construction camps be established such that crews can work within a defined zone and travel to and from camp without crossing a zone
- The location of construction access routes, delivery areas, stockpiles and laydown areas shall take into consideration the location of these zones and weed management strategies outlined in this PWMP
- Access routes shall be planned to achieve the following:
  - Vehicles operate in such a manner as to limit crossing of weed zone boundaries
  - Vehicles start in clean areas and then move into the dirty areas
  - Vehicles do not drive though or contact any seeding or flowering weeds
  - Vehicles are subject to washdown and certification to move between zones

5.1.2 Performance Indicators

- CPWMP developed and approved by the Company prior to entry to the field (HOLD POINT)
- Weed zones established and marked on project maps
- Project specific weed washdown facilities are immediately established and identified on project maps
- Weed Inspectors are present at designated washdown facilities

5.2 Weed and Pest Animal Identification and Control

5.2.1 Requirements

Weed Identification

- Prior to construction, regular weed surveys of the Project Area (including ROW, access tracks and any known ancillary areas) shall be undertaken
- Weed surveys shall be:
  - Undertaken by trained personnel or Contractors
  - Scheduled for times of high weed growth ie within 2 weeks or as soon as possible after first significant rainfall event and/or after periods of high rainfall
- Weeds identified shall be recorded in project GIS and included in project mapping

Pest animal identification

- Prior to construction, regular pest animal surveys of the Project Area (including ROW, access tracks and any known ancillary areas) shall be undertaken;
- Pest animal surveys shall be: Undertaken by appropriately qualified and experienced personnel or Contractors. Scheduled for both night (spotlight

searches) and day. Undertaken incidentally dependent on environmental conditions (eg pest predator populations may irrupt following periods of high rainfall):
  - Incidental sightings of pest animals should be recorded and included in weekly Environmental Reports
  - Pest animals identified shall be recorded in project GIS and included in project mapping

Weed Control

- Prior to construction, weed control of the Project Area (ROW, camps, storage areas, access) shall be undertaken by appropriately qualified and experienced Contractors who are appropriately licensed under the ACDC Act
- Weed control shall be scheduled to occur prior to weed seeding
- Prior to any weed spraying, permission shall be obtained from the Company
- Significant weed infestation areas shall be monitored after treatment and repeat treatment undertaken as required

Pest animal control

- If deemed necessary (ie where infestations occur), prior to construction, pest animal control of the Project Area (ROW, camps, storage areas, access) shall be undertaken by appropriately qualified and experienced Contractors who are authorised persons under the *Land Protection (Pest and Stock Route Management) Act 2002*
- Pest animal control shall be humane, strategic, integrated and adopt best practice principles as outlined in the following publications:
  - NSW Department of Primary Industries Humane Pest Animal control: Code of Practice and Standard Operating Procedures and related Model Codes of Practice for the Humane Control of Vertebrate Pests which are available at the following link http://www.feral.org.au/tag/COP/
  - The Animal Care and Protection Act 1994 specifically in relation to the appropriate treatment and euthanasia of pest animals. Any euthanasia will be undertaken in accordance with the Australian Code of Practice for the Care of Animals for Scientific Purposes, 7th Edition, 2004
  - Threat Abatement Plans for key species. GLNG will act within the requirements of threat abatement plans. Specifically the plans require a property management plan; in this case the pest and weed management plan will fulfil this requirement. The threat abatement plan requires input to local and regional databases for pest animal distribution. GLNG will collect data on pest species captured and will make this data available for reporting
  - The QLD government pest animal fact sheets
- The approach will be to manage pests encountered within the RoW during trenching activities. The Fauna Handler is to euthanise the animal as per the Fauna Handling Procedure. Where pest numbers are a concern to human safety (e.g. high numbers of feral pigs), a suitably qualified vertebrate pest field officer is to be contacted to implement a mitigation strategy (i.e. culling activities).Prior to any pest animal control, permission shall be obtained from GLNG
- Significant pest animal infestation areas shall be monitored after treatment and repeat treatment undertaken as required

5.2.2 Performance Indicators

- Weed and pest animal surveys monthly or more frequently after rain events
- New weed outbreaks recorded in GIS

- Weed control completed and recorded
- No flowing or seeding weeds within Project Area
- Company approval obtained prior to spraying
- Incidental sightings of pest animals recorded

6. Project Weed Management

6.1 Management of Access to the Project Area

6.1.1 Requirements

The Contactor shall establish a system for the control of vehicles within and between weed management zones and this system shall be documented in the CPWMP submitted to the Company for approval. The minimum requirements are outlined below.

- Prior to entering or leaving the Project Area vehicles, plant and/or equipment shall:
  - Be washed down and certified clean
  - Provide/be issued with a Weed Hygiene Declaration Form
- Additional washdown and certification will be required:
  - When travelling from a 'dirty' weed management zone to a 'clean' weed management zone (refer to Section 2.2.1). Vehicles will require the old sticker to be removed and a new one issued
  - All vehicles shall display the appropriate sticker(s) to define the zone they are approved to access and travel within
  - Different stickers shall represent authorisation for different zones and each sticker shall be numbered
  - Signage shall be installed at key points within the Project Area clearly outlining the Zone and certification requirements for entry and exit
  - Site specific washdown facilities shall be established in accordance with Section 5.1 and operated in accordance with Section 6.3
  - Boundary fence lines shall be marked both on alignment sheets and in the field, and crews shall not transfer anything across these lines unless authorised by the relevant Supervisor
  - No organic material shall be moved between zones
  - No haybales or equivalent materials shall be used on the project

Clear and Grade Crew

- Clear and grade crew will be subject to additional washdown at defined locations along the ROW where the specific weed infestation changes occur (eg Prickly Acacia, Mother of Millions and Rubber Vine)
- This will apply between specified properties within relevant zones
- The location of additional washdown points shall be clearly identified both on alignment sheets and in the field
- Washdowns in this situation shall be recorded by the Environmental Officer or the Weed Inspector in the relevant Washdown Log

6.2 Road Vehicles and Deliveries

The protocols for access to the Project Area outlined in Section 6.1 shall apply to all vehicles, including delivery vehicles, buses etc, even if they are only travelling on sealed public roads. The Contractor may propose an alternate system (must be approved by the Company prior to implementation) that includes the following requirements:

- Vehicles that are limited to travel on public roads must not leave a public road unless it is washed down and certified again prior to re-entering that public road

- Delivery vehicles travelling off sealed public roads must wash down and be certified for all travel from a ‘dirty’ to a ‘clean’ zone

6.3 Operation of Washdown Facilities

6.3.1 Requirements

- Site specific weed facilities shall be established in accordance with Section 5.1
- Stickers designating vehicle cleanliness and zone authorisation shall only be administered:
  - By a Weed Inspector
  - Once a vehicle is certified clean
  - For the zone where access is required
- Stickers may only be removed by a Weed Inspector
- Procedures for the washdown and inspection of vehicles shall:
  - Be established and documented in the CPWMP
  - Comply with the *Queensland Government Checklist for Clean-down and Inspections* (refer to Section 8)
- The vehicle/plant/equipment operator shall maintain the Washdown Log for all washdowns completed (refer to Attachment B)
- The Weed Inspector shall maintain a Washdown Register of all washdowns and vehicle/plant/equipment certifications completed at their allocated facility (refer to Attachment C for an example of a washdown register)
- Stickers shall be numbered and the corresponding number recorded on the Washdown Logs and Washdown Registers
- Upon departure from the Project Area, all stickers shall be removed by a Weed Inspector

Both a washdown log and washdown register are shown in Attachments B and C respectively. The washdown log is for the vehicles and is carried around in each piece of machinery. Signoff will be by the person operating the machinery. The washdown register is for the washdown bays themselves and will have signoff by a certified inspector.

6.3.2 Performance Indicators

- Washdown Registers and Washdown Logs consistent and correspond to vehicle movements
- Vehicles displaying correct stickers
- Weed Inspectors present and certifying to appropriate standard at active washdowns
- Washdown facilities are maintained and fully operable
- No mature weeds in flower or seed throughout the ROW and Ancillary works areas

6.4 Inspection and Monitoring

The Contractor shall establish an Inspection and Monitoring Program defining the scope, the interval and responsibility. The program shall be documented within the CPWMP.

As a minimum, the inspection and monitoring program shall include:

- Random checks on cleanliness of vehicles/plant/equipment and completion of Washdown Logs

- Daily inspection of vehicles within each zone to ensure correct stickers are displayed
- Weekly inspection/monitoring of Project Area for evidence of weeds
- Spraying of weed infestations by licensed Contractors (as approved by the Company)
- Random inspection of Washdown Logs and facility Washdown Registers – for consistency and correspond to vehicle movements
- Inspection of facility Washdown Registers and random cross checking of Washdown Registers versus Vehicle Washdown Logs

Corrective Action

- Equipment/vehicles failing inspections will be subject to be rewashed prior to certification
- Weed spraying of weed outbreaks
- Incident report or non-conformance report raised for non-compliances identified
- Contractor will assume responsibility for future management of weeds in an area of non-compliance
- Repeated non-compliance will result in stop-work, recertification of equipment and retraining of individuals

6.5 Records to be Maintained

The Contractor shall document within the CPWMP, the records that will be maintained to demonstrate compliance with this PWMP. This shall include the title, responsible person and the storage location for that record. As a minimum, this shall include:

- Washdown Logs for vehicles/plant/equipment
- Washdown Registers for facilities
- Records of Inspections completed as outlined in Section 6.4
- Induction and Training Records
- Incident Reports
- Non-compliance reports
- Audit Reports
- Evidence of weed surveys and monitoring activities
- Records of weed control activities

7. Project Pest Management

7.1 Prevent establishment of pest animals

7.1.1 Requirements

Pest animals known to occur in the Project Area are listed in section 2.1.2. Any new pest animals detected are to be reported immediately to Company and recorded in the Project GIS.

7.1.2 Performance indicators

- Pest animals are not proliferated in the Project Area

7.2 Management of existing pest animals

7.2.1 Monitoring

Spotlight and diurnal surveys

The Contractor will establish a regular monitoring program of nocturnal (spotlight) and diurnal ground pest animal surveys. These surveys shall:

- Occur at least every two months
- Be either on foot or by slow moving vehicle
- Be representative of all regions of Project Area (ROW, camps, storage areas, access)
- Be undertaken by appropriately qualified and experienced personnel
- Follow accepted survey methodology for transect surveys of ground-dwelling vertebrate fauna (see for example, EPA (1999) and Eyre et.al (1997))
- Be recorded in the Project GIS

Incidental and opportunistic sightings

All staff shall report all sightings of the pest animal species listed in section 2.1.2 to the Environmental Manager (see Attachment E to aid identification), which will be included in weekly environmental reporting and recorded in the Project GIS. 'Sightings' include:

- Seeing the actual animal
- Tracks and scats
- Indicative habitat disturbance (eg digging/uprooting by pigs)
- Evidence of habitat use (eg Den sites of foxes, rabbit burrows)

Indirect evidence of incidental pest animal sightings should be confirmed by appropriately qualified and experienced personnel wherever possible.

Regular monitoring will be used to estimate relative abundance and distribution of pest animals, and identify areas that may require control measures.

7.2.2 Performance indicators

- Regular transect surveys are undertaken and reported in the Project GIS
- Incidental sightings are reported and recorded in the Project GIS and weekly environmental reports. Relative abundance and distribution of pest species is closely monitored to detect increases and/or areas requiring control measures

7.3 Pest animal control

7.3.1 Legislative definitions and requirements

The pest animals listed in section 2.1.2. are declared as class 2 pests under schedule 2 of the *Land Protection (Pest and Stock Route Management) Regulation 2003,* with the exception of the cane toad (*Bufo marinus*) which is not a declared pest. Class 2 pests are defined under section 38 of the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act), as:

> "Established in the State and (is) causing, or has the potential to cause, an adverse economic, environmental or social impact in the State".

Under section 77 of the LP Act, landowners must take reasonable steps to keep their land free of Class 2 pests.

Under The *Pest Management Act 2001*, any pest control or fumigation activity must be carried out by an appropriately qualified and licensed technician.

Section 42 of the *Animal Care and Protection Act 2001* instructs that any act to control a pest animal must be done in a way that causes the animal as little pain as is reasonable. The Australian Government Department of Sustainability, Environment, Water, Population and Communities provide model codes of practice for the humane control of each of the class 2 pests listed in section 2.1.2., which may be accessed at the following links:

http://www.environment.gov.au/biodiversity/invasive/publications/humane-control.html

This Department has also published threat abatement plans for rabbits, feral cats and foxes, available here:

http://www.environment.gov.au/biodiversity/threatened/tap-approved.html

and has drafted a threat abatement plan for cane toads, which may be accessed here:

http://www.environment.gov.au/biodiversity/threatened/tap-drafts.html

The Queensland Government Department of Employment, Economic Development and Innovation publish operational guidelines for the management of each of the class 2 pests listed in section 2.1.2., which may be accessed here:

http://www.dpi.qld.gov.au/4790_8422.htm

This list of legislative requirements is not exhaustive, and there are many other pieces of State and Commonwealth legislation that may influence pest animal management in Queensland.

Pests and Weeds will be managed throughout the life of the project (including both operational and decommissioning phases) in accordance with the legislative requirements and guidelines listed above.

7.3.2 Pest management planning framework

A range of pest management planning instruments exist at the National, State, Regional and Local Government level. Those that relate to pest animal management in the Project Area are listed in Table 1.

Table 1 Pest Management Planning Framework

National	State	Regional	Local Government
Australian Pest Animal Strategy 2007	Qld Pest Animal Strategy 2002-2006	Capricorn Pest Management Group Regional Pest Management Strategy 2004-2009	Calliope Shire Council Pest Management Plan 2005-2008*
Threat Abatement Plan for Competition and Land Degradtion by Rabbits 2008	Wild Dog Management Stratgey 2010-2015 (Consultation Draft		Gladstone City Council Pest Management Plan 2005-2008
Threat Abatement Plan for Predation by European Red Fox 2008	Feral Pig Management Strategy 2004		Banana Shire Council Pest Management Plan 2005-2009
Threat Abatement Plan for Predation by European Feral Cats	Rabbit Management Strategy 2001-2006		
	Pest Management Plan Areas Managed by Qld Parks and Wildlife Service July 2003-2008		

**Calliope Shire Council and Gladstone City Council amalgamated in 2008 to form Gladstone Regional Council*

This PWMP is consistent with the principles of the relevant planning instruments outlined above. The contractor will ensure that the CPWMP is also aligned with these principles.

7.3.3 Active control of pest animals

Effective control of pest animals may include any or a combination of the following methods:

- Killing/removal (eg trapping, baiting)
- Exclusion (eg fencing)
- Habitat manipulation (eg rabbit warren ripping)

Control of the pest animal species listed in Section 2.1.2 will occur according to the legislative instruments in Section 7.3.1 and the planning documents in Section 7.3.2. Permission must be sought from The Company before undertaking any of the control methods in this section.

Killing/removal

Only to be undertaken by authorised personnel as prescribed by the relevant Acts (see section 7.3.1) where outbreaks are known to have occurred and control is mandatory under the legislation listed in section 7.3.1.

Exclusion

All areas that contain organic waste material (e.g. food scraps) will be fenced or otherwise adequately secured to prevent scavenging by pest animals.

All areas of significant water ponding that are created during the course of construction will be enclosed by temporary fencing to prevent access by pest animals.

Habitat manipulation

Wherever practicable, and subject to the approval of the Company and compliance with all relevant legislation, any rabbit warrens or fox dens that are encountered will be destroyed.

7.3.4 Performance Indicators

All relevant legislation is complied with :

- CPWMP is consistent with Commonwealth, state, regional and local pest management planning instruments
- Pest animal control methods adhere to recommended guidelines and best practice principles according to the documents in Section 7.3.1
- Pest animal outbreaks are contained and managed effectively and in a timely manner
- All pest animal control actions are recorded in the Project GIS and reporting tools
- The distribution and abundance of pest animals in the Project Area does not increase

8. Post Construction

8.1 Monitoring and Control Program

Pests and Weeds will be managed as required throughout the life of the project, including during operational and decommissioning phases of the pipeline.

Monitoring will determine the success of management measures or requirements for further actions. Any pest or weed species identified during site inspections and audits will be recorded, and appropriate management measures will be employed in response to the presence of these species.

A Weed Monitoring and Control Program (to be included as part of the CPWMP) will be development and implemented and will include (but not limited to):

- The rate of monitoring and control post completion will be as follows:
  - Post rain event – once a month for three months
  - Otherwise, once every two months
  - In response to landholder or operator request
- Weed monitoring and control activities shall include all Project Areas (eg tracks, ROW, camps, laydown and storage areas)
- Weed control shall be undertaken by appropriately qualified and experienced Contractors who are appropriately licensed under the ACDC Act

Weed monitoring and subsequent weed control will continue under the control of the Contractor for 2 years after completion of pipeline construction. During pipeline operation and decommissioning this responsibility will be handed to the Pipeline Operator.

Reference Material

Queensland Checklist for Clean Down Procedures

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Cleandown-Procedures.pdf

Queensland Checklist for Inspection Procedures
http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Inspection-Procedures.pdf

Queensland Guideline for the Construction of Vehicle and Machinery Washdown facilities
http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Washdown-Fac-Guidelines.pdf

Weed Hygiene Declaration Form
http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Weed-Hygiene-Declaration.pdf

2009 Pipeline Weed Survey
GLNG Pipeline FEED – Weed Survey Report August 2009, prepared by GHD., GLNG DOC No. 3380-GHD-3-3.3-0323.

2010 Weed Survey Report June 2010
GLNG Pipeline FEED – Weed Survey Report June 2010, prepared by GHD.DOC No. 21386-D-RP-012 REV A.

Coordinator-General's Evaluation Report for an EIS May 2010 – Appendix 3 Gas Transmission Pipeline – Part 4 Schedule E – Pest and Weed Management Conditions (E37) a, b and c

DSEWPC – EPBC Approval No2008/4096, Conditions (3) f and g.

Attachments

Attachment A Existing Washdown Facilities

Taken from
http://www.dpi.qld.gov.au/cps/rde/dpi/hs.xsl/4790_8243_ENA_HTML.htm

Baralaba **Landmark**: near showground and old saleyards **Address**: Rannes Road **Contact**: Banana Shire Council **Telephone**: (07) 4992 9512 Maximum vehicle size: machinery Height limit: no Hose detail: high pressure; high volume hose Cost: $2 for 15 minutes Surface: concrete slab with tilt Hours: n/a	**Biloela** **Landmark**: adjacent to water treatment plant **Address**: Quarry Road **Contact**: Gordon Twiner, Banana Shire Council **Telephone**: 0427 148783 Maximum vehicle size: road train Height limit: no Hose detail: high pressure; high volume hose Cost: $2 for 15 minutes Surface: concrete slab with tilt Hours: n/a
Bingegang **Landmark**: near substation and pump station **Address**: Mackenzie River Capella Road Maximum vehicle size: semitrailer Height limit: no Hose detail: high pressure hose Cost: free Surface: concrete slab Hours: 24 hours	**Calliope** **Landmark**: Country Club turnoff **Address**: Stowe Road **Contact**: Gladstone Regional Council **Telephone**: (07) 4975 8100 Maximum vehicle size: semitrailer Height limit: no Hose detail: high volume hose Cost: tokens ($2 for 15 minutes) available from Choice Service Station: Calliope Cross Roads CQP service station Gladstone Regional Council Surface: concrete slab/bitumen
Injune **Landmark**: saleyards **Address**: Roma Road, Injune **Contact**: Steve Murray, Roma Regional Council **Telephone**: (07) 4622 1144 Mobile: 0428 261290 Maximum vehicle size: body truck and car (side-by-side); road trains or headers Height limit: no Hose detail: high pressure water; high pressure air and Town pressure Cost: 50 cents per minute Surface: cement slab with ramp Hours: 7 am - 5 pm with key access operational 24 hours	**Gladstone** **Landmark**: Gladstone Superwash **Address**: 154 Goondoon Street **Telephone**: (07) 4972 9202 Maximum vehicle size: cars and 4WDs Height limit: n/a Hose detail: high pressure spray Cost: $1 for 2 minutes Surface: n/a Hours: n/a

Moura **Landmark**: west of town near water treatment plant **Address**: Dawson Highway **Contact**: Gordon Twiner, Banana Shire Council **Telephone**: 0427 148783 Maximum vehicle size: road train (also has a facility for smaller vehicles) Height limit: no Hose detail: high pressure; high volume hose Cost: $2 for 15 minutes Surface: concrete slab with tilt Hours: n/a	**Rolleston** **Landmark**: near sports ground; cattle dip and old saleyards **Address**: One Mile Road **Contact**: Central Highlands Regional Council **Telephone**: (07) 4984 1166 Maximum vehicle size: semitrailer with prime mover Height limit: no Hose detail: high pressure low volume hose 20 L per minute Cost: $2 per 30 minutes Surface: 23 m concrete slab Hours: 24 hours

Attachment B – Example Washdown Log for Vehicles/Plant/Equipment

Vehicle / Plant and Rego/ID Number : ____

Date	Driver	Washdown Location	Sticker Number Added	Sticker Number Removed	Authorised Signature
			eg Zone 2 #234	eg Zone 1 #123	

Attachment C – Example Washdown Register

Washdown Facility Name : ____

	Vehicle/Plant	Rego/ID No	Sticker number Added	Sticker number Removed	Authorised officer's Name and Signature

Attachment D – Weed Management Plans

Attachment E – Pest Animal Profiles

Declared Species

Species Name: *Canis lupus* / *Canis familiaris* (*Dingo* / Wild dog)
Status: Class 2 pest (LP Act)
Description: The dominant coat colours are red, ginger and sandy-yellow, although they can also be pure white, black and tan or solid black. Dingoes have a more heavily boned skull and larger teeth (especially the canine) than domestic dogs of similar size. They are naturally lean with large ears pricked,a white tip on the tail and white socks (DPIF 2007a). Adults can reach up to 60cm in height, with females weighing approximately 12kg and males 15kg (DPIF 2007a) Wild dogs refers collectively to dingoes, hybrid dingoes and domestic dogs that have escaped or been deliberately released
Distribution: Although thought to have arrived between 3,500-4000 years ago, it is not part of the ancestral fauna of Australia (DPIF 2007a)

Source: (EPA 2007a)

Dingoes/wild dogs are present in all parts of Queensland however the distribution of the wild dog in relation to purebred dingoes varies
Impact: Dingoes/wild dogs can carry diseases such as distemper and parvovirus. Their majority of their diet consists of native species such as kangaroos, wallabies, rabbits and possums (DPIF 2007a). However, wild dogs can kill, harass or maim livestock and other native fauna
Management Requirements: The operational objectives for the management of wild dogs include reducing their numbers throughout the Project Area
Monitoring Process: Report any dingo/wild dog sightings in the weekly Environmental Report
Control Actions: Fauna exclusion fencing to be utilised where necessary. If required, recommended active control methods include baiting, trapping and ground shooting

Species Name: *Felis catus* (Feral cat) Status: Class 2 pest (LP Act) Description: A feral cat is one that is not fed and kept by someone. The word 'kept' specifically means that is cat is housed in a domestic situation The feral cat differs little in appearance from its domestic counterpart, however when in good condition is displays overall muscle development, particularly noticeable around the head, neck and shoulders (DPIF 2007d) Feral cats are predominantly short-haired with coat colour range including ginger, tabby, tortoiseshell, grey and black. Males weigh between 3-6 kg and females 2-4 kg depending on condition. Feral cats are most active at night, with peak hunting activity occurring soon after sunset and in the early hours before sunrise (DPIF 2007d). During the day it will rest in any number of den sites including hollow logs, dense clumps of grass, piles of debris, rabbit burrows and hollow limbs of standing trees (DPIF 2007d)	Source: (DPIF 2008b, Invasive Animals CRC 2007b) 

Distribution: The feral cat is now present Australia-wide in a variety of habitats
Impact: Feral cats are opportunistic predators of small mammals, birds, reptiles, amphibians, insects and fish (DPIF 2007d). They can be particularly harmful in island situations and have caused the extinction of a number of species. Feral cats also compete for prey with native predatory species such as quolls, eagles, hawks and reptiles
Feral cats may contain a parasite (toxoplasmosis) that can be particularly harmful to marsupials, causing blindness, respiratory disorders, paralysis and loss of offspring (DPIF 2007d)
Management Requirements: The operational objective for the management of feral cats is to reduce their numbers throughout the Project Area.
Monitoring: Reporting all cat sightings in the weekly Environmental Report
Control Actions: Fauna exclusion fencing to be utilised where necessary. If required, recommended active control methods include trapping and ground shooting

Species Name: ***Vulpes vulpes*** **(European red fox)** Status: Class 2 pest (LP Act) Description: Foxes have pointed muzzles, a flattened and slender skull, large ears and long bushy tails (DPIF 2007c). Adult males weigh approximately 6kg and females approximately 5 kg Foxes are usually active at night and rest during the day in an earth den, thicket, hollow log or stick-rake pile. However, in winter when less food is available, foxes may hunt and scavenge during the day Distribution: The most common and widespread of the world's fox species, the European red fox has adapted to a variety of habitats ranging from deserts to urban environments. However, they are not found in tropical areas of Australia (DPIF 2007c). Competition with dingoes, climatic preferences and food supply are thought to determine their distribution (DPIF 2007c) Impact: Foxes are considered to be the greatest threat to the long-term survival of many small mammal species in Australia and play a major role in the decline of ground-nesting birds, critical weight mammals and reptiles such as the green turtle (DPIF 2007c). The European red fox is also thought to have caused a severe reduction in populations of many other threatened species throughout Australia	Source: (EPA 2008 and Invasive Animals CRC 2007a)  

Management Requirements: The operational objective for the management of European foxes is to reduce their numbers throughout the Project Area
Monitoring: Report all fox sightings in the weekly Environmental Report
Control Actions: Fauna exclusion fencing to be utilised where necessary. If required, recommended active control methods include baiting, trapping, ground shooting and den fumigation
.

Species Name: *Sus scrofa* (Feral pig)
Status: Class 2 pest (LP Act)
Description: Feral pigs are predominantly black, buff-coloured or spotted black and white, while juveniles can be striped. Mature boars have a large head and shoulders and a raised and prominent back bone which slopes steeply down to small hams and short hind legs (DPIF 2007e)
Feral pigs are smaller, leaner and more muscular than domestic pigs, with well-developed shoulders and neck and smaller, shorter hindquarters (2007e). Feral pigs have sparser,longer and coarser hair than domestic pigs and have longer, larger snouts and tusks, straight tails, smaller mostly pricked ears and narrower backs (DPIF 2007e)
Feral pigs are generally nocturnal, spending daylight hours sheltered in dense cover. They are shy animals and will avoid human contact
Distribution: Feral pigs inhabit approximately 40% of Australia and are found in all habitat types in Queensland (DPIF 2007e).
Estimations of numbers range up to 24 million with the greatest concentrations of feral pigs found in the larger drainage basins and swamp areas of the coast and inland (DPIF 2007e)
Impact: Feral pigs impact the environment through predation on native animal species, consumption of native flora and damage to watercourses and wetlands. They can also carry many infectious diseases and internal and external parasites. Many of these diseases can spread to humans and livestock (DPIF 2007e)

Source: (DPIF 2008c, EPA 2006, IACRC 2007)

Management Requirements: The operational objective for the management of feral pigs is to reduce their numbers throughout the Project Area
Monitoring: Report all pig sightings in the weekly Environmental Report
Control Actions: Fauna exclusion fencing to be utilised where necessary. If required, recommended active control methods include trapping, baiting and ground shooting

Species Name: *Bufo marinus* (Cane toad) Status: The cane toad is not a declared pest in Queensland and such there is no legal requirement to control them Description: In comparison with the native frog and toad species, adult cane toads have a distinctive head and face and are large, heavily built creatures (DPIF 2007f). A high angular bony ridge extends from the eyes to the nose (DPIF 2007f). Adult cane toads have large glands that carry toxin on the shoulder behind the tympanum (ear opening) (DPIF 2007f). The hands and feet are relatively small and lack webbing between the fingers but is present between the toes (DPIF 2007f). In comparison to native frogs, cane toads assume an upright, rigid posture Colouring of cane toads on the upper surface may be brown, olive-brown or reddish-brown with the underneath surface varying from white to yellow with mottled brown (DPIF 2007f). The surface of the skin is warty (DPIF 2007f) Distribution: Cane toads currently inhabit at least four of the mainland Australian states including Queensland and generally occur wherever there is water (DPIF 2007f)	Source: (DPIF 2008d)  
Impact: Cane toads produce highly toxic venom from glands in its skin that can cause death if ingested by domestic and most native animals. The Cane toad consumes a wide variety of insects, frogs, small reptiles, mammals and birds. They also compete with native frogs for breeding habitat (DPIF 2007f) Management Requirements: It is recommended that Cane toads be managed in order to reduce their abundance across the Project Area, particularly where water and native frogs are found Control Actions: Fencing is recommended to keep toads out of ponds intended for native fish and frogs, with a height of 50 cm being sufficient (DPIF 2007f). Freezing is considered a humane form of disposal, as a reaction to the cold causes the animal to initiate dormancy and dies while senseless (DPIF 2007f) Monitoring Process: Report all sightings and relative abundance in the weekly Environmental Report	

Species Name: *Oryctolagus cuniculus* (European rabbit) Status: Class 2 pest (LP Act) Description: They are usually grey-brown with a pale belly, black or ginger can also be common, with long hind legs, short front legs, long ears and large eyes (DPIF 2007b). Rabbits usually weigh between 1.3-2.3 kg Distribution: Rabbits occur across Australia and have spread throughout Queensland with the largest populations found in the granite belt, south-western Darling Downs, Maranoa, southern Warrego and the far south-west (DPIF 2007b). Moderate populations are located in the north-western Darling Downs and North Burnett and low populations in the remainder of the state (DPIF 2007b) Impact: Rabbits compete with native wildlife for food and shelter and increase the exposure of native wildlife to the dangers of predators such as cats and foxes (DPIF 2007b). Rabbits are implicated in the local extinction of some native species, as well as many native species, such as the Bilby (now threatened)	Source: (DPIF 2008a)  
Management Requirements: The operational objectives for the management of rabbits include reducing their numbers throughout the Project Area Monitoring: Report all rabbit sightings in the weekly Environmental Report Control Actions: Fauna exclusion fencing to be utilised where necessary. If required, recommended active control methods include baiting, trapping, ground shooting, warren destruction and/or fumigation and biological control	

Appendix C
Stormwater Management and Erosion and Sediment Control Plan (SMESCP)

CONCEPT STORMWATER MANAGEMENT & EROSION AND SEDIMENT CONTROL PLAN

Marine Crossing – Gas Transmission Pipeline

CLIENT:
GLNG Operations P/L

STATUS:
FINAL

REPORT NUMBER
SC12-0029/R001631a

ISSUE DATE:
July 2012

Important Note

This report has been prepared for the sole use of the **GLNG Operations P/L** (herein, 'the client'), for a specific site (herein 'the site', the specific purpose specified in Section 1 of this report (herein 'the purpose'). This report is strictly limited for use by the client, to the purpose and site and may not be used for any other purposes.

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Version Register

Version	Status	Author	Reviewer	Change from Previous Version	Authorised for Release	
					Signature	Date
-	Draft	Steve Dudgeon (CPESC # 4398 & CPSS # 1879) and Steven Chamberlain (CPESC # 6599)	Terry Clark (CPESC # 6089)		T. Clark	9/05/2012
	Final	Steve Dudgeon (CPESC # 4398 & CPSS # 1879) and Steven Chamberlain (CPESC # 6599)	Terry Clark (CPESC # 6089)	Amendments as per agreed GLNG comments sheet (1/6/2012)	T. Clark	6/06/2012

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1. Introduction

O2 was commissioned by Downes Group on behalf of GLNG Operations P/L (herein the Client) to prepare a Storm Water Management Plan (SWMP) and concept Erosion and Sediment Control Plan (ESCP) for the proposed works associated with the Gas Transmission Pipeline Marine Crossing construction.

The area of interest is located approximately 16km north of Gladstone. The location is commonly called the 'Marine Crossing section'.

This plan was developed generally in accordance with the *International Erosion Control Association, Best Practice Erosion and Sediment Control Guideline* (IECA, 2008). The ESCP describes physical controls and processes, that if applied are expected to result in general compliance with the objectives and targets nominated in **Section 1.2**. Should the controls indicated in this document not achieve the identified performance criteria for any reason, it is the responsibility of the earthworks contractor to notify the ESC specialist so that a revision of the ESCP can be undertaken.

Some limitations to strict compliance with IECA (2008) occurred due to limited timeframes and data including;

- Limited soil sampling

1.1. Environmental Approvals and Legislative Requirements

This SWMP and ESCP is provided to meet the Department of Environment and Resource Management (DERM) Request for Further Information (PPL167/PEN103428811 Sections 5.2, 8.2 and 8.4, dated 1st December 2011) and EPBC Approval (2008/4096 Condition 37 (c, d and e)) for Mainland GTP (Excluding Narrows), dated 22nd October 2010.

1.2. Purpose of Plan

GLNG have indicated that this Concept Stormwater and Erosion and Sediment Control Plan been produced as site specific, but still a general scheme arrangement for the purpose of obtaining approvals (e.g. the Environmental Authority and the EPBC). This plan is not approved for construction.

Prior to the commencement of works, a subsequent version of the Stormwater and Erosion and Sediment Control Plan will be produced for construction by the contractor, Saipem.

An Operational Works application for Tidal Works will detail ESC at the tidal creek crossings.

1.3. Objectives and Targets

This Erosion and Sediment Control plan has been developed in accordance with the following guidelines:

- Best Practice Erosion and Sediment Control (IECA, 2008)
- State Planning Policy for Healthy Waters (DERM, 2010)
- Queensland Water Quality Guidelines (DERM, 2009)

The objective of this ESCP is to minimise erosion and sediment discharge and impacts on the environmental values of receiving waters during the construction period.

The following targets, if achieved are expected to achieve the abovementioned objective.

Coarse Sediment (>0.02mm)	Retain all coarse sediment on site
Fine sediment (<0.02mm)	Drain all disturbed areas on the site to sediment basins. Size and operate sediment basins so that all water from the site is captured and treated to achieve 50mg/L (estimated by 75NTU) in rainfall events up to the design event (80%ile, 5 day event). In storms greater than the design event take all other reasonable and practicable measures to minimise erosion and sediment discharge.
pH	Size and operate sediment basins so that all water from the site is captured and treated to achieve a pH in the range of 6.5 – 8.5.

1.4. Proposed works

The summary of relevant works below is based on information provided by GLNG Operations Pty Ltd in a File Note titled 'Preliminary Narrows Crossing Information for Environmental Studies (Ref: 3301-GLNG-3-4-3.3-0004).

The GLNG GTP will transport CSG year-round from the existing and future fields in the Roma, Fairview and Arcadia Valley areas. The pipeline system is comprised of a 42-inch (1.07 m) GTP and associated infrastructure and a telecommunications FOC which will be buried and covered by at least 750 mm of soil.

The eastern end of the GLNG pipeline crosses from the mainland to Curtis Island across a channel of tidal sea water. The section of pipe that crosses the channel is referred to as the "Marine Crossing". The marine crossing is divided into three sections, the two so called "open cut" sections on either side and the tunnel section between them. The mainland open cut section is approximately 2.7 km long, the tunnel crossing approximately 4.5 km long and the open cut section on Curtis Island approximately 1 km long.

The areas included in this ESCP:

- Access track - The travelled width of the access track on a straight will be 7 m (3.5 m per lane). The travelled width of the access track on a curve will be increased from 7 m to account for overhang of vehicles at the corner. The total length will be 1.85 km long and width of the track ROW is 25 m. Total area of disturbance is 4.6 ha.
- Site pads – 7.5 ha (launch pad) and 2.25 ha (receptor pad)
- ROW for pipeline on the mainland – The pipeline will be buried and covered by at least 750 mm of soil, along the specified open cut trenched sections of the pipeline the area of disturbance is 8.1 ha (30m wide x 2.7km)
- ROW for pipeline on the Island – The area of disturbance on the Island is 3 ha (30m wide x 1km).

The approximate combined area of disturbance is **25.5** ha.

The construction program timeline is provided below in **Figure 1.** The site layout plan provided by client is shown below in **Figure 2,** with layout details of the launch and receptor pads provided in **Figure 3** and **Figure 4** respectively.

This report provides ESC planning, design and implementation guidance relevant to construction activities associated with the site. At the time of finalising the ESCP cut and fill plans had not been provided therefore the plan currently only represents clear and grub stage and further plans may need to be provided for subsequent stages.

1.4.1. Open-cut trenched section construction methodology summary

Construction works for the open-cut trench sections will be carried out as an extension of Mainland / Curtis Island GTP Right of Way and will be carried out in accordance with the requirements of AS 2885 Pipelines – Gas and Liquid Petroleum, the Australian Pipeline Industry Association Code of the Environmental Practice (2009) and GLNG Project Specifications.

Works will progress applying the conventional pipeline construction phases working in sequence. The following are the main pipeline construction phases:

a. Site Survey
b. Clearing
c. Grading and Right of Way (RoW) preparation
d. Stringing Pipe
e. Pipe Bending

f. Welding
g. NDT (non-destructive testing)
h. Field Joint Coating
i. Trenching
j. Lowering
k. Tie-ins
l. Padding/Backfilling
m. Cable installation
n. Cathodic Protection
o. Clean-up and Reinstatement
p. Hydrotest & Precommissioning

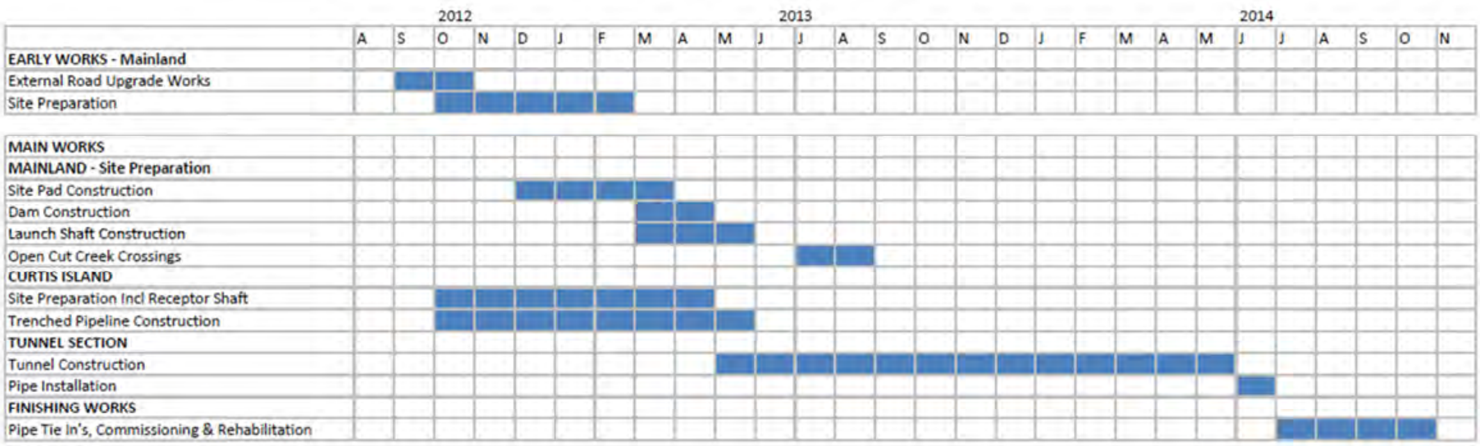


Figure 1: GLNG GTP Marine Crossing Construction Program

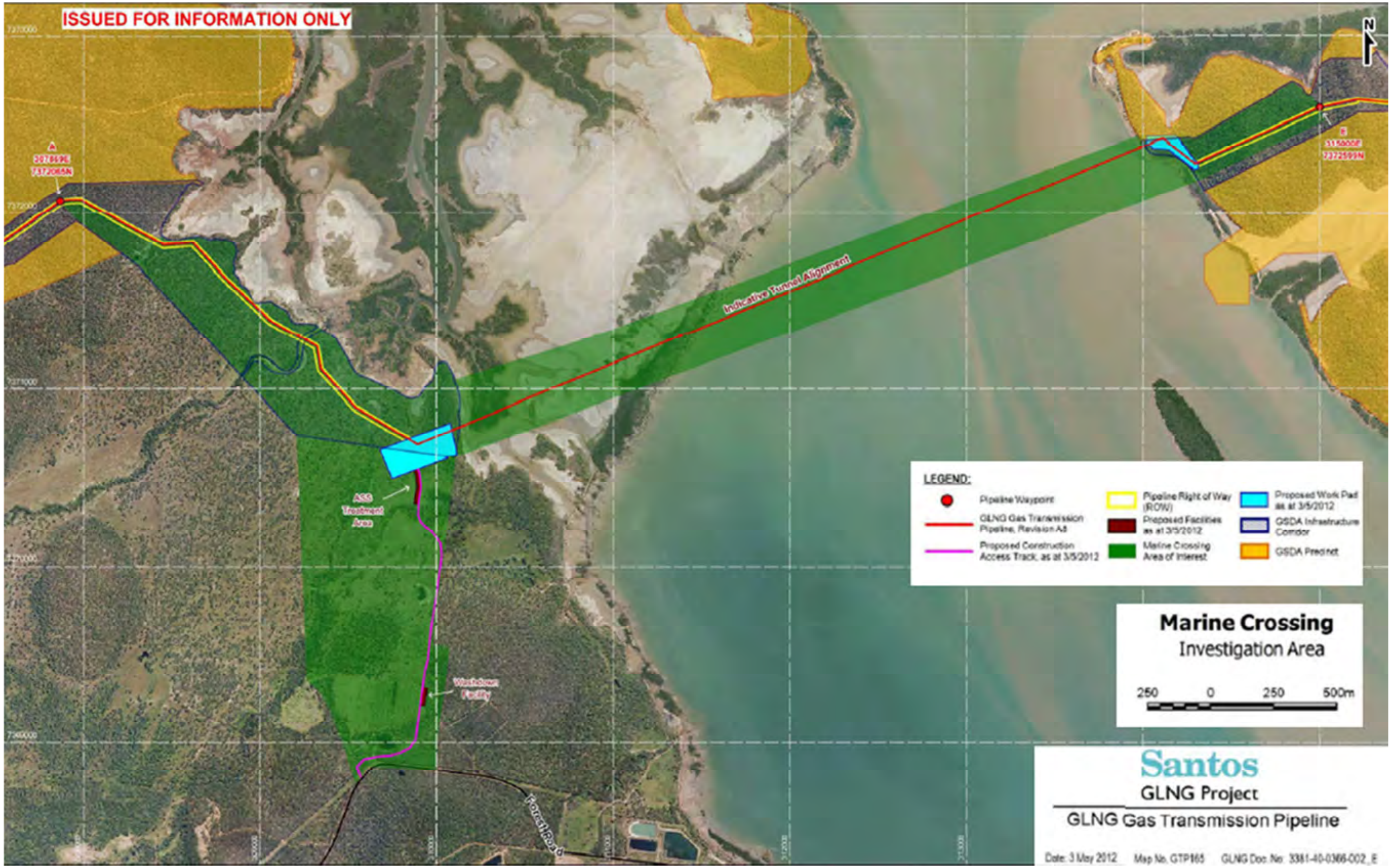


Figure 2: Site Layout Plan (3 May 2012)

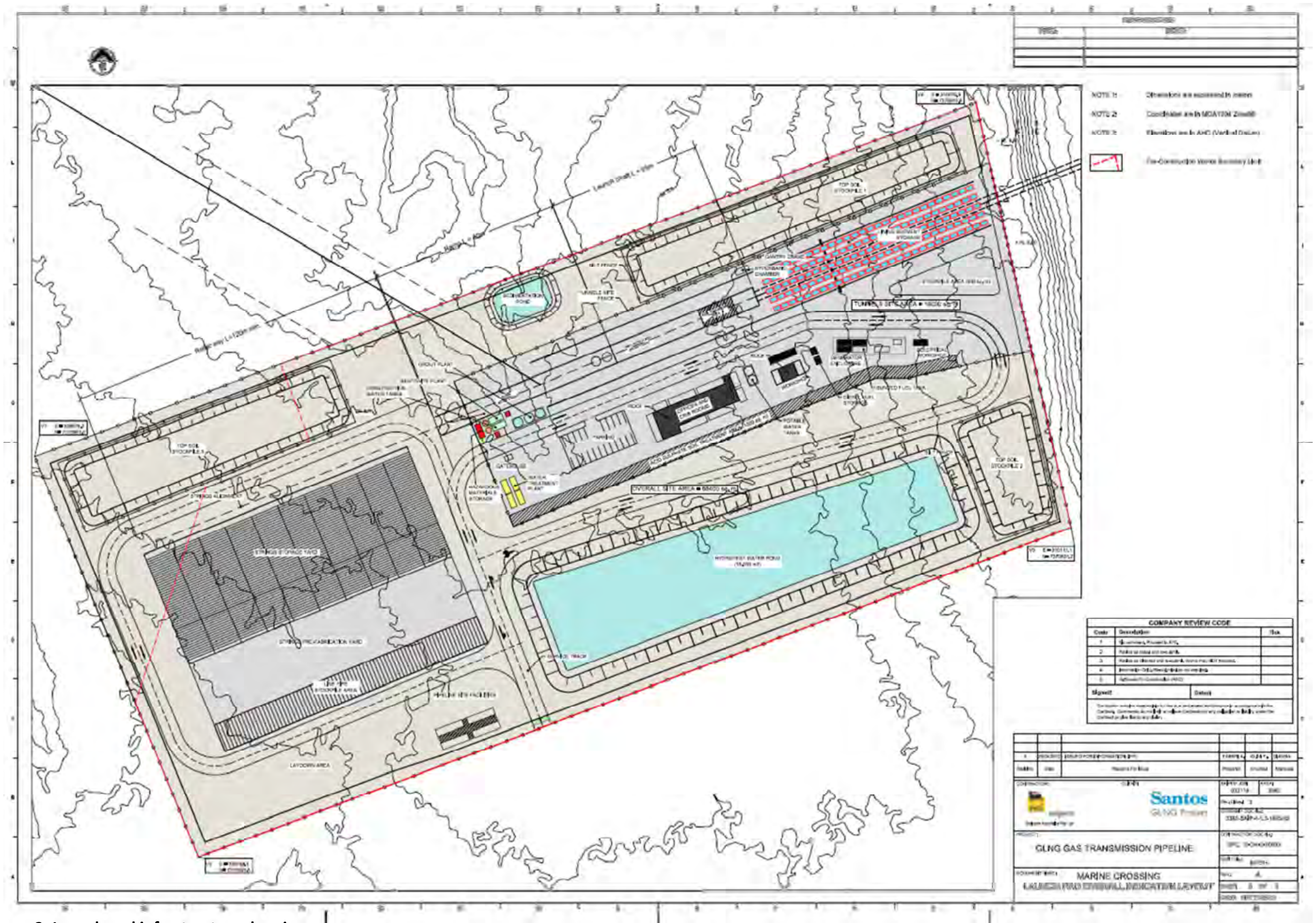


Figure 3: Launch pad infrastructure drawing

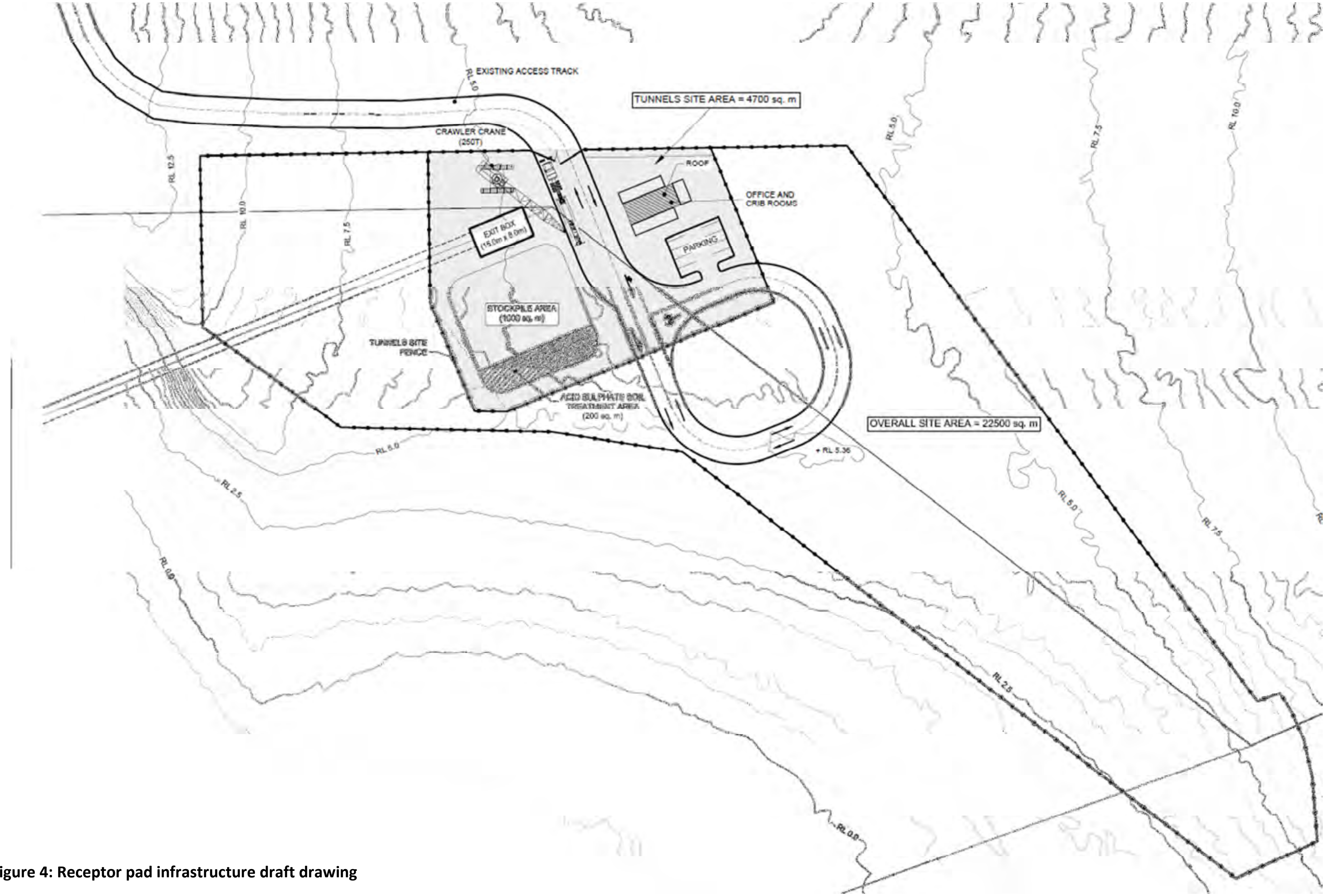


Figure 4: Receptor pad infrastructure draft drawing

2. Existing Site Description

2.1. Inspection

The site was inspected by 2 Certified Professionals in Erosion and Sediment Control (CPESC) from O2 Environmental + Engineering on the 4th and 13th of April 2012. Most areas were able to be accessed with the exception of the pipeline and associated ROW from the launch pad to Humpy Creek (marked in yellow dotted line). **Figure 5** displays all photo points and sites inspected (red dots).

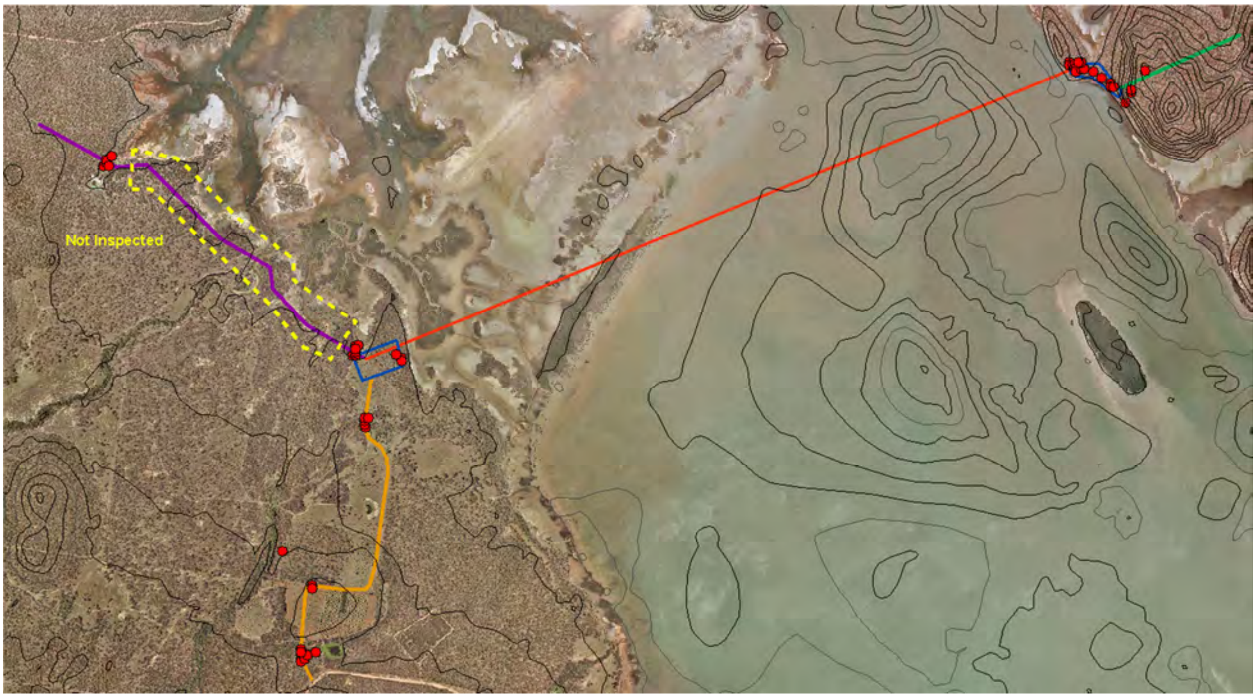


Figure 5: Photo and inspection points

2.2. Environmental aquatic values

2.2.1. Site Drainage

Downes Group provided a report 'Site Value Assessment and Water Mouse Habitat Assessment Report (2012)'. The following information is an extract from their findings in regard to aquatic values.

The site has four constructed waterholes / dams which are all very stable and mostly well vegetated with a range of macrophytes and aquatic plants (native and exotic).

Areas from the access gate and southern parts of the "orchard" appear to drain towards a drainage line (shown on track log as point WC1). This drainage line was flowing at the time of inspection following significant rainfall in the week prior to the site visit. This drainage line flows into the southern dam.

The second dam will be bypassed (in fairly close proximity) by the proposed access track with no impacts anticipated. This area is open and relatively flat with good opportunities to manage surface erosion and stormwater impacts.

The third larger central dam capture runoff from areas from within and to the south of the proposed pad and is a large and well established landscape feature. Drainage patterns for the pad area appear to flow mostly from the east either north to the small *Baumea articulata* and *Eleaocharis* packed waterhole, or south to the large third central dam. Areas draining to the southern dam are presently wet on the site with numerous sedges and wetland plants interspersed with grazing grasses.

Water birds and ducks were observed in all dams and an active and inquisitive population of Double Barred Finches (*Taeniopygia bichenovi*) observed in the northern *Baumea* dam. The northern dam is unique in that it remains freshwater despite the estuarine influence observable in lower lying areas around the landscape feature to the east and north.

2.2.2. Launch Pad

The existing proposed location of the pad is well positioned avoiding both drainage features (dams) to the north and south, and positioned such that the seaward edge of the clearing is perched on the top of the existing natural ridgeline. Due to the topography and possibly soil type there is minimal intertidal zone with the open forest dropping immediately into tidal mudflats. A mangrove community is located approximately 50m from the edge of the mudflats

2.3. Topography

The inflow pipeline generally runs north west to south east over low undulating land, perpendicular to the catchments alignment and crosses Humpy and Targinie Creek tributaries and minor gullies. Site levels vary from approximately RL 9m AHD to the north to RL 2m AHD to the south.

The launch pad drains inland North West to a dam from elevation 8m AHD to 4 m AHD with an average slope of 1.54%.

The access track generally slopes north to the launch pad from approximately 18m AHD to 6m AHD. Slopes are generally low and vary from approx. <1% over the initial 450m of the track, to 2% over a small hill and the majority of the site over low lying land with a slope of 0.2%. The track crosses 2 minor gullies.

Curtis Island receptor pad generally drains to the low point in the centre of the site from 12m AHD to 3m AHD. The site is steepest to the south east and north west with slopes of approximately 9% and 6% respectively.

The pipeline exits the site pad at an elevation of 7m AHD and climbs steeply eastward to the upper slope of the north side of the hill at an elevation of 4.8m AHD then traverses steeply down the northern other side of the hill to a valley floor of elevation 8m AHD. The ROW will drain north for most of the length. Average slopes are approximately 12% on the western side of the hill and up to 25% on the eastern side.

2.4. Hydrology and Hydrologic Modeling

The XP-SWMM runoff-routing model been has used to estimate design flow rates within the site. The model represents the sub-catchments as a network of nodes linked to a 1D open channel drainage network. Each node is defined by its pervious (undeveloped) and impervious (developed), fraction impervious and average catchment slope. The net rainfall is routed through the network after appropriate losses (initial and continuing) and roughness factors are applied, resulting in a surface runoff hydrograph for each sub-catchment. The XP-SWMM model was used to estimate the 1, 2, 5, 20, and 100 year ARI discharges.

2.4.1. Hydrologic Routing

Hydrologic modelling has been undertaken using the Laurenson Runoff Routing Method. The Laurenson method requires the catchment to be divided into a pervious and an impervious portion. A fraction impervious of 0% has been applied to the pervious portion and 100% to the impervious portion.

2.4.2. Catchment Delineation and Fraction Impervious

The catchments contributing runoff into the pipeline corridor have been divided into 8 catchments to represent the portions of the study area that flow to each proposed culvert crossing. As a conservative approach, a fraction impervious of 5% has been assumed for each catchment to account for any existing roadways and compacted areas. A copy of the catchment plan is included as **Figure 6**.

2.4.3. Manning's Roughness

Manning's n values have been applied to represent the pervious and impervious portions of the catchment. The following values have been applied:

- Pervious portion n = 0.035; and
- Impervious portion n = 0.014.

2.4.4. Rainfall Losses

Initial Loss (IL) and Continuing Losses (CL) have been applied to the modelling, and again these values have been varied for the impervious (developed) and pervious (undeveloped) portions of the catchment. The following loss rates have been applied:

- Impervious catchment IL = 1mm CL = 0mm/hr;
- Pervious catchment IL = 10mm CL = 2mm/hr

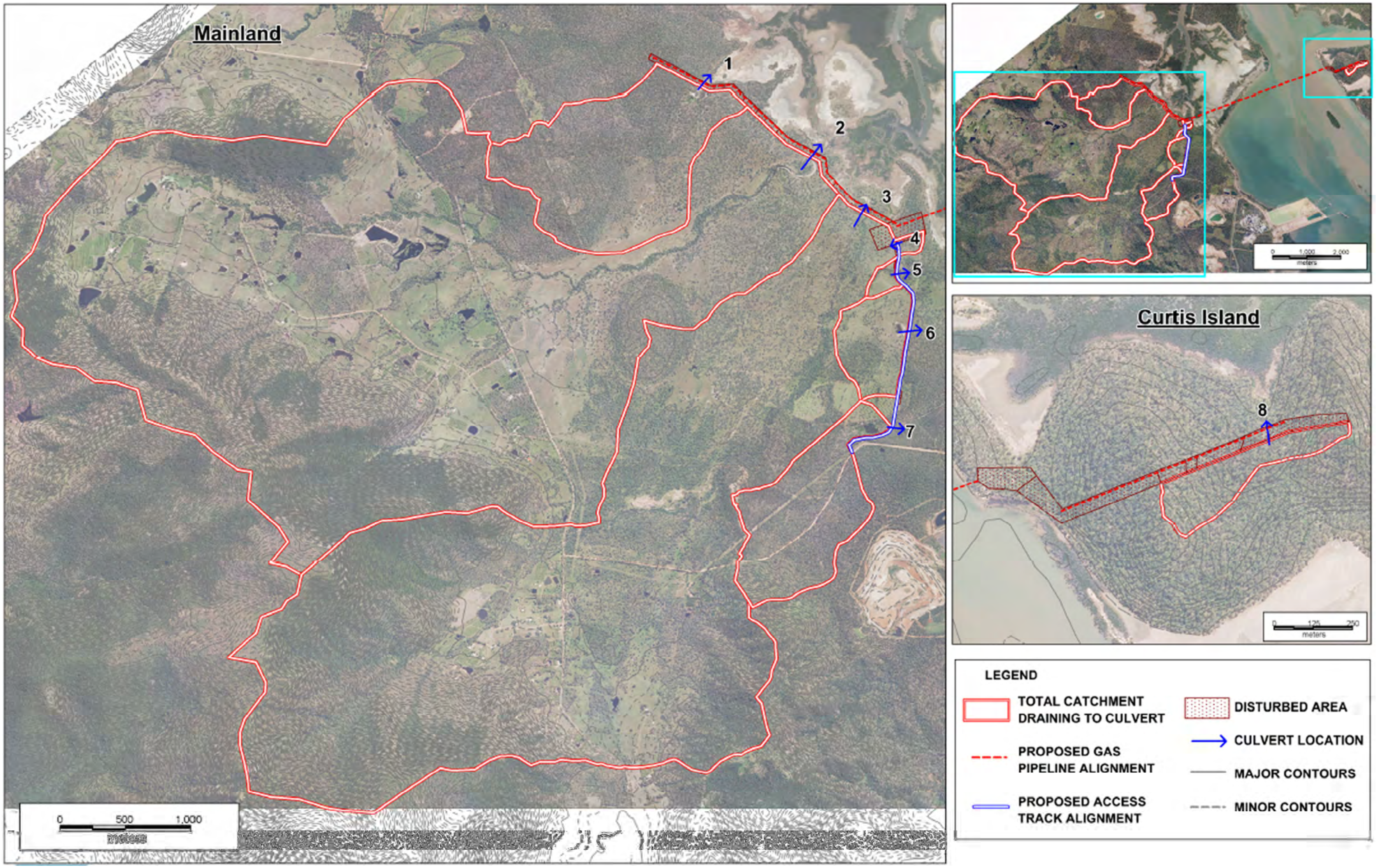


Figure 6: Site catchments

2.4.5. Peak Flow Rate

The hydrologic model has been simulated for a range of storm durations ranging from 15 minutes to 720 minutes. Results of the assessment indicate the 60 minute storm is the critical storm duration for the catchment and produces the peak flow rates for the areas under consideration. A summary of the peak flow rate for the areas of interest are contained in **Table 1**.

Table 1: Peak Flow Rate for Pipeline and Access Track Crossings

Location	Total Catchment Area (ha)	Peak Flow Rate (m^3/s)				
		1 year ARI	2 year ARI	5 year ARI	20 year ARI	100 year ARI
1	173.9	4.88	6.89	9.62	15.37	20.97
2	1,415	29.36	41.25	57.10	90.50	123.44
3	1,109	35.68	50.41	69.39	112.41	150.11
4	2.25	0.10	0.27	0.38	0.55	0.84
5	5.0	0.29	0.44	0.65	1.11	1.44
6	25.7	1.68	2.36	3.90	6.67	9.21
7	104.7	4.23	6.48	9.07	13.11	19.93
8	7.6	0.46	0.74	1.51	2.25	3.22

2.4.6. Soils

The most detailed soil map available for the study area is that of Isbell and Hubble (1964) which was compiled on field sheets at 1:250,000 scale and published at 1:1,000,000 scale as a contribution to an Australia-wide soil mapping program undertaken by CSIRO Division of Soils. The information was incorporated into part of Sheet 4, which was one of the ten sheets comprising the 'Atlas of Australian Soils' (Northcote et al. 1960–68) and published at 1:2,000,000 scale (20 km to 1 cm). This is the only soil map that provides consistent information about the soils of the whole of Australia.

A digital version of the maps of the 'Atlas of Australian Soils' was created by the Bureau of Rural Science from scanned tracings of the published hardcopies (http://www.asris.csiro.au/themes/ Atlas.html).

Soil sampling was limited to general reconnaissance and shallow holes dug with a hand trowel.

Three soils samples of ESC suites were taken within the major soil mapping units and representing the dominant land units (**Figure 7**).

Figure 7 shows the soil mapping units for the area of investigation and soil sample sites. The soil mapping displays two (2) soil units' Tb97 and J5.

No geotechnical results or reports were available for the relevant area of interest.

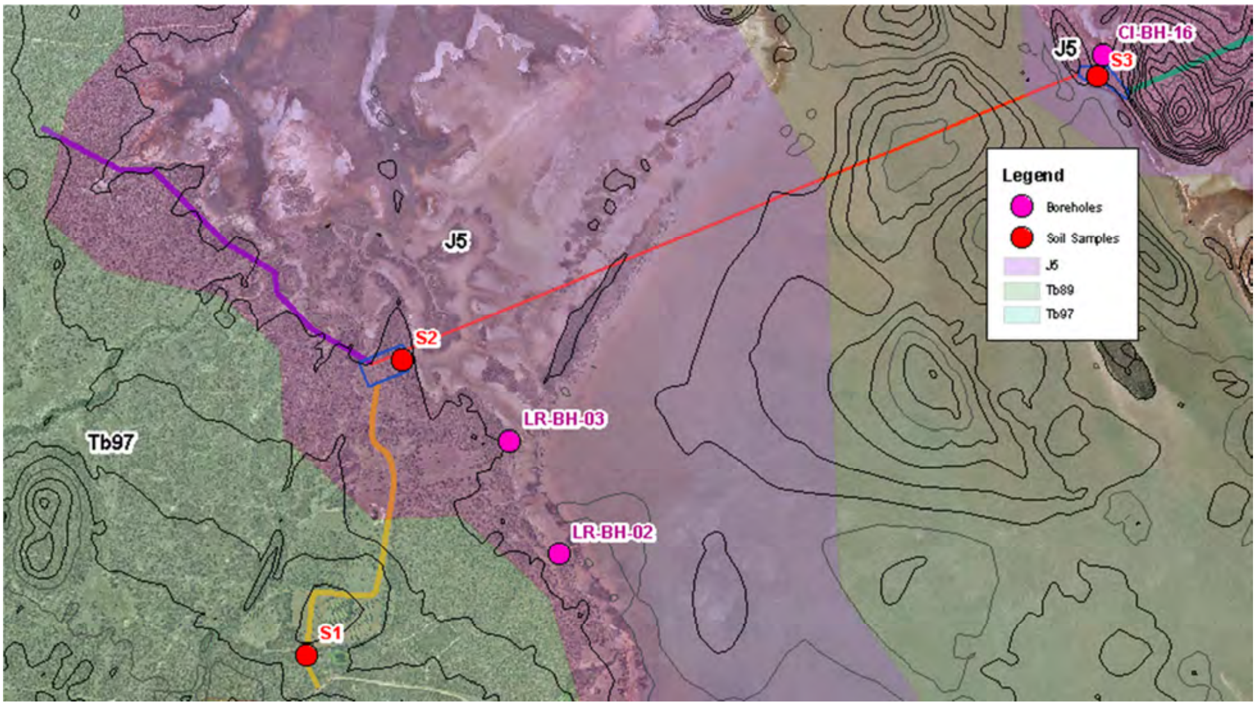


Figure 7: Soil units, soil sample sites and local boreholes

2.4.7. Soil mapping unit Tb97

Found on low rounded hills on metasediments and granites with slopes of not more than 6 degrees. Chief soils are hard acidic yellow mottled soils (Dy3.41) on the slopes with shallow (Um6.43) soils on some crests. Associated are (Dy2.21), (Dy2.11), and (Dy2.41) soils on granitic slopes with (Uc1.21 and Uc1.22) soils on sandy accumulations in some lower slope positions. Small areas of (Gn3.13) and (Uf6.31) soils are found on basic rocks.

The Dy refers to Duplex yellow-grey Clayey Subsoils. The soil type have surface textures ranging from sandy to clay loam, overlying yellow-grey coloured subsoils of significantly higher clay content, commonly light to heavy.

The 3.41 number indicate that:

- (3) A horizon is hard setting and the B horizon is mottled and soil is hard setting
- (.4) A2 horizon is present and conspicuously bleached
- (.41) Acid Soil Reaction Trend.

Figure 8 from soil sample site 1 shows the conspicuously bleached A2 horizon.

Some areas of potential Um6.43 within the vicinity of the hill and access track were likely to be present based on the red colour of the exposed soil (**Figure 9**). These soils are loamy or clay loam throughout.

One shallow hole to 300mm was dug on the launch pad site. The soil is potentially a Uniform Course (Uc) soil. These soils are sandy throughout having textures of sand, loamy sand, clayey sand and fine sandy loam.

Figure 8: Sample site 1 displaying a potential Dy3.41 soil type

Figure 9: Potential Um6.43 soil type

2.4.8. Soil mapping unit J5

Found in tidal mangrove mud flats and salt pans flanking tidal inlets and local creeks. Chief soils are shallow saline clays (Uf) over strongly gleyed (Um2.23) soils. Associated are (Gn1.83), and (Dd1.13) and similar (D) soils in marginal areas.

2.4.9. Lab results and amelioration recommendations

Lab results are summarized in **Table 2** below. Samples were not taken of subsoils on the launch pad or receptor pad due to limited soil sampling equipment and no cut and fill plans being available to provide guidance to sample location and depth. Detailed lab results are provided in **Appendix D**.

Table 2: Lab recommendations

Sample	Recommendations
S1 – Subsoil	This soil sample was analysed for properties related to healthy plant growth. It was found to be slightly acidic, not saline and not sodic. The cation balance is highly magnesic. The effective cation exchange capacity (eCEC) is low, indicating poor nutrient retention and holding capacity. This sample is a light clay with low permeability. Combined with the magnicity, it may be prone to dispersion. Magnesium is elevated and may lead to an induced potassium deficiency. To buffer against deficiencies, incorporate potassium chloride at 20 g/sqm and gypsum at 200 g/sqm. The gypsum will help to raise the low calcium levels. These additions will further help to improve permeability and negate any tendency to disperse. The soils had an Emerson Aggregate Test result of 3.2.
S2 Topsoil	This soil sample was analysed for properties related to healthy plant growth. It was found to be moderately acidic, not saline and not sodic. The cation balance is dominated by hydrogen, leading to the strong acidity. The effective cation exchange capacity (eCEC) is very low, indicating poor nutrient retention and holding capacity (as expected of sandy soils). This sample is a highly permeable loamy sand. Of the plant available nutrients analysed, all were deficient. N in particular will prove limiting at these low levels. Split applications of urea at 20 g/m2 (i.e. 2 x 20 g/sqm applications) will improve the nitrate levels. To improve levels of other nutrients, apply a multipurpose low P NPK fertiliser such as “native plant food”. This product should be applied at 15 - 25 g/sqm. Current phosphate levels will not be harmful to P-sensitive plantings. Incorporating lime at 200 g/sqm will help to raise the pH and increase nutrient availability. Incorporating composted organic matter at 20% by volume will assist in improving the water holding capacity and CEC of the soil.
S2 Subsoil	This soil sample was analysed for properties related to healthy plant growth. It was found to be strongly acidic, not saline and not sodic. The cation balance is dominated by hydrogen, leading to the strong acidity. The high acidity has increased the availability of aluminium, which is at levels likely to result in plant toxicities. The effective cation exchange capacity (eCEC) is very low, indicating poor nutrient retention and holding capacity. This is normal for sandy soils. This sample is a highly permeable loamy sand. Calcium and magnesium are both deficient, and can be improved through additions of

Sample	Recommendations
	lime at 150 g/sqm. This will help to raise the pH and increase the availability of many nutrients. Raising the pH will reduce the risk of aluminium toxicity. The soils had a Emerson Aggregate Test result of 3.2
S3 Topsoil	This soil sample was analysed for properties related to healthy plant growth. It was found to be moderately acidic, not saline and not sodic. The cation balance is highly magnesic. The effective cation exchange capacity (eCEC) is moderate, indicating good nutrient retention and holding capacity. This sample is a highly permeable loamy sand. Of the plant available nutrients analysed, all except magnesium were deficient. N in particular will prove limiting at these low levels. Use split applications of urea at 20 g/m2 (i.e. 2 x 20 g/sqm applications) to improve the nitrate levels. Magnesium is elevated and may lead to an induced potassium deficiency. Incorporate composted organic matter at 20% by volume and gypsum at 200 g/sqm to raise the low calcium levels and improve the water holding capacity of the soil. These additions will further help to improve permeability and negate any tendency to disperse. To improve nutrient levels, apply a multipurpose low P NPK fertiliser such as “native plant food”. This product should be applied at 15 - 25 g/sqm. Current phosphate levels will not be harmful to P-sensitive plantings. Incorporating lime at 200 g/sqm will help to raise the pH and increase nutrient availability.

3. Erosion Risk Assessment

Erosion risk assessment provides an indicator tool to determine the sediment control and erosion control standards that should be applied to a project.

3.1. Methodology

A quantitative erosion risk assessment for the site has been conducted using the Revised Universal Soil Loss Equation (RUSLE) **Equation 1**. RUSLE aims to predict the potential long term average soil loss rate from a given site based on the following parameters.

A = K x R x LS x P x C **Equation 1 (IECA 2008)**

Where:

A is the predicted soil loss per hectare per year
K is the soil erodibility factor (0.058 – Refer to Section 3.1.1)
R is the rainfall erosivity factor (4421 – Refer to Section 3.1.3)
LS is the slope length/gradient factor (varies)
P is the erosion control practice factor (1.3)
C is the ground cover and management factor (1)

Application of the RUSLE is based on site and soil characteristics determined by others.

3.1.1. Soil Erodibility

The soil erodibility factor (K factor) is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. Soil texture is the principle component affecting the K factor, but soil structure, organic matter and profile permeability also contribute.

Due to limited soil sampling a conservative K factor was estimated by using the default value in Table E5 of IECA (2008) and increasing by 20% to allow for potential dispersiveness. The K factor estimated was to be **0.058**.

3.1.2. Steepness

Slope length and slope gradient have substantial effects of soil erosion by water. The two effects are represented by the slope length factor (L) and the slope steepness factor (S). In application of RUSLE the two are evaluated together as a numerical representation of the length-slope combination (LS factor).

3.1.3. Rainfall Erosivity

The rainfall erosivity factor (R factor), is a measure of the ability of rainfall to cause erosion. It is the product of two components (1) total energy and (2) intensity for each rainfall event. R factors are published for some locations throughout Queensland, however interpolation of published results is considered inappropriate for the subject area, given the geographical differences between the closest published locations (i.e. Rockhampton and Bundaberg). As a result a localised R factor was determined. This value is constant over the length of the alignment, unlike the K and LS factors which are variable.

An annual erosivity factor was calculated using the following equation (Rosewell & Turner, 1992):

$R = 164.74\ (1.1177)^{S}\ S\ 0.6444$

Where, S is the 2-year ARI, 6-hour ARI rainfall event (mm)

Design rainfall events for the project area have been produced from the BOM Rainfall IFD system (http://www.bom.gov.au/hydro/has/cdirswebx/cdirswebx.shtml) with results presented below in **Figure 10**.

Intensity-Frequency-Duration Table

Location: 23.750S 151.150E NEAR.. Narrows Crossing Issued: 6/10/2010

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

	Average Recurrence Interval						
Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	110	143	184	209	243	290	327
6Mins	103	133	172	196	229	273	308
10Mins	84.8	110	142	161	188	224	252
20Mins	63.3	81.7	104	118	137	163	183
30Mins	51.9	67.0	85.5	96.8	112	133	149
1Hr	35.3	45.6	58.5	66.4	77.1	91.5	103
2Hrs	22.8	29.6	38.4	43.8	51.2	61.2	69.2
3Hrs	17.3	22.6	29.6	34.0	39.9	48.0	54.4
6Hrs	10.8	14.2	19.0	22.0	26.1	31.7	36.2
12Hrs	6.78	8.99	12.3	14.5	17.4	21.5	24.7
24Hrs	4.32	5.81	8.25	9.91	12.1	15.2	17.7
48Hrs	2.71	3.70	5.51	6.79	8.45	10.9	12.9
72Hrs	1.99	2.74	4.20	5.26	6.62	8.66	10.4

(Raw data: 46.7, 9.12, 2.8, 87.54, 20.18, 8.12, skew=0.21, F2=4.26, F50=17.84)

Figure 10: Design Rainfall Events for the Marine Crossing Section Pipeline Alignment

Based on the above 2 year ARI, 6 hour rainfall event an R factor of **4421** has been adopted

3.1.4. Site Management

Within RUSLE, the C and P factors are used to describe management of the site with respect to reducing soil loss. The C factor measures the combined effect of all the interrelated cover and management variables adopted over the site. It also represents non-structural methods for controlling erosion (i.e. covering exposed areas with various matting products; use of chemical stabilisers or by-products to bind soil particles or provide a barrier from raindrop impact; or stabilisation by temporary or permanent vegetation).

The P factor measures the combined effect of all support practices and management variables. P factor is reduced by practices that reduce both the velocity of runoff and the tendency of runoff to flow directly downhill. It also represents structural methods for controlling erosion.

Industry accepted default values of 1 and 1.3 have been adopted as C and P factors respectively in soil loss estimations.

3.2. Results

Estimated soil loss rates (tonnes/ha/year) have been calculated using RUSLE for each catchment across the site. The output of the erosion risk assessment is presented below in **Table 4** and mapped in **Appendix A**.

Each catchment erosion risk is categorised and coloured to allow overview as per **Table 3** (adopted from IECA 2008).

Table 3: Erosion Risk Category

Soil Loss (t/ha/yr)	Erosion Risk Category
0 to 150	Very Low
150 to 225	Low
225 to 500	Moderate
500 to 1500	High
> 1500	Extreme

Table 4: Calculated Erosion Risk

Construction Area	Exposed Area (ha)	R	K	Equal Area Slope (%)	LS	P	C	A (t/ha/yr)	Soil Loss (t/yr)
Catchments – West of the Marine Crossing Section									
D01	1.38	4421	0.058	1.89	0.38	1.3	1	126	174
D02	0.53	4421	0.058	1.15	0.23	1.3	1	77	40
D03	0.60	4421	0.058	1.09	0.22	1.3	1	73	43
D04	0.42	4421	0.058	1.50	0.30	1.3	1	100	42
D05	0.28	4421	0.058	1.69	0.34	1.3	1	113	32
D06	0.39	4421	0.058	1.85	0.37	1.3	1	123	48
D07	1.03	4421	0.058	1.54	0.31	1.3	1	103	106
D08	0.95	4421	0.058	0.92	0.18	1.3	1	61	58
D09	0.95	4421	0.058	0.98	0.20	1.3	1	65	62
D10	0.67	4421	0.058	1.01	0.20	1.3	1	67	45

Construction Area	Exposed Area (ha)	R	K	Equal Area Slope (%)	LS	P	C	A (t/ha/yr)	Soil Loss (t/yr)
D11	7.46	4421	0.058	1.42	0.28	1.3	1	95	707
D12	0.60	4421	0.058	0.76	0.15	1.3	1	51	31
D13	0.36	4421	0.058	1.71	0.29	1.3	1	97	35
D14	0.62	4421	0.058	0.50	0.10	1.3	1	33	21
D15	0.96	4421	0.058	1.55	0.31	1.3	1	103	99
D16	0.52	4421	0.058	1.96	0.39	1.3	1	131	68
D17	0.73	4421	0.058	1.24	0.25	1.3	1	83	60
Catchment – Curtis Island									
D18	0.77	4421	0.058	11.07	3.54	1.3	1	1,181	905
D19	0.24	4421	0.058	5.56	1.36	1.3	1	453	108
D20	0.51	4421	0.058	12.26	4.41	1.3	1	1,471	747
D21	0.11	4421	0.058	21.28	4.68	1.3	1	1,561	174
D22	0.28	4421	0.058	19.94	8.37	1.3	1	2,792	785
D23	0.96	4421	0.058	12.87	4.63	1.3	1	1,544	1,483
D24	1.04	4421	0.058	6.27	1.54	1.3	1	512	534
D25	1.19	4421	0.058	5.05	1.36	1.3	1	455	541

3.3. Application

A summary of best practice erosion management techniques for various erosion risk ratings is presented in **Table 5**. The minimum sediment control standard based on erosion risk rating and corresponding soil loss rate is shown in **Table 6**. The pipeline west of the Marine Crossing is mainly very low erosion risk. The receptor pad is assessed as very low to moderate erosion risk and a conservative approach should be applied with the application of moderate management approach. The pipeline on Curtis Island is assessed as high to extreme erosion risk.

Table 5: Erosion Risk Rating Based on Soil Loss and Required Management (adapted from Table 4.4.7 of IECA 2008)

Erosion Risk Rating	Soil Loss Rate (t/ha/year)	Advance Land Clearing Allowed (wks work)	Max days to Stabilisation	Staged Construction and Stabilisation of Earth Batters >6H:1V	Stockpiles stabilised
Very Low	0 to 150	8	30 (60%)		
Low	150 to 225	8	30 (70%)		
Moderate	225 to 500	6	20 (70%)	✓	
High	500 to 1500	4	10 (75%)	✓	✓
Extreme	> 1500	2	10 (80%)	✓	✓

Table 6: Minimum Sediment Control Standards Based on Soil Loss

Soil Loss Rate (t/ha/year)	Sediment Control Technique	Default Sediment Control Treatment Measure
0 to 75	Type 3	Sediment fence, sediment trap
75 to 150	Type 2	Filter tube dam, rock filter dam, sediment trench, sediment weir, compost/mulch berm
> 150	Type 1	Sediment basin (sized in accordance with design standard)

Note: Based on Tables 4.5.1 and 4.5.3 of IECA (2008)

4. Design Standards and Assumptions

4.1. Introduction

A Conceptual Erosion and Sediment Control Plan (ESCP) has been developed for the sites and presented in **Appendix B.**

Design calculations and sizing for the sediment basin, emergency spillway and temporary clean and dirty water drains is provided in **Appendix C**.

The operation of the sediment basin is to be in accordance with the Sediment Basin Operating Procedure within **Appendix E**. This document provides guidance to site personnel on the management, operation, monitoring, treatment, discharge and maintenance of sediment basins located onsite.

Technical notes regarding the implementation of erosion and sediment control measures on site are provided in **Appendix F**.

Construction of temporary watercourse crossings should be undertaken as per guidelines within **Appendix G**.

Standard design drawings and factsheets for nominated erosion and drainage controls can be sourced from **www.austieca.com.au**.

The application of best practice erosion and sediment control is based upon the appropriate integration of three groups of control measures:

- Drainage control measures;
- Erosion control measures (including revegetation measures); and
- Sediment control measures.

Discussion is provided below with regard to each group of control measures to be applied onsite. Wherever reasonable and practical, control measures from all three groups must be integrated in a total treatment system.

4.2. Drainage

Drainage standards adopted are shown below in **Table 7** below. Standards were adopted as per Table 4.3.1 of IECA (2008).

Temporary drain alignment is to be incorporated into the final drainage design layout as much as possible. Details of temporary drainage design are provided in **Appendix C**.

Table 7: Design Standards Drainage

Structure	Conveyance/stability	Notes
Temporary Drainage Structures	2 year ARI + 150mm freeboard	Assumes <12 month design life
Emergency Spillway Basin	20 year ARI + 300mm freeboard	Assumes <12 month design life
Diversion of clean water around the site	2 year ARI + 150mm freeboard	Assumes <12 month design life
C_{10}	0.70	Low soil permeability assumed, [1]I_{10} = 66.4 mm/hr

4.2.1. Flow Diversion

Where possible, provision for the diversion of up-slope stormwater runoff for catchments above exposed areas, including temporary stockpile locations, stringing yards, access roads and compounds shall be made.

4.2.2. Spacing of Lateral Drains Long Continuous Slopes

Long unstable slopes must be divided into manageable drainage areas to prevent the formation of rill erosion. Catch drains or flow diversion banks should be placed at regular intervals down the slope to collect and divert surface runoff to properly designed drains bounding the disturbance area. Contour bunds should to be constructed to the spacing's shown below in **Table 8**.

Table 8: Recommended "Maximum" Drain or Bench Spacing on Non-Vegetated Slopes

Batter Slope			Horizontal Spacing (m)	Vertical Spacing (m)
Percentage	(Degrees)	(H):(V)		
1%	0.57	100:1	90	0.9
2%	1.15	50:1	60	1.2
4%	2.29	25:1	40	1.6
6%	3.43	16.7:1	32	1.9
8%	4.57	12.5:1	28	2.2
10%	5.71	10:1	25	2.5
12%	6.84	8.33:1	22	2.6
15%	8.53	6.67:1	19	2.9
20%	11.3	5:1	16	3.2
25%	14.0	4:1	14	3.5
30%	16.7	3.33:1	12	3.5
35%	19.3	2.86:1	10	3.5
40%	21.8	2.5:1	9	3.5
50%	26.6	2:1	6	3.0

4.3. Erosion Control

Various applicable stabilisation measures are presented in **Table 9**. Such measures should be considered if the proposed permanent revegetation and stabilisation measures in **Section 4.5** are delayed beyond 30 days.

Table 9: Application of Erosion Control Measures to Soil Slopes (reproduced from Table 4.4.13 of IECA 2008)

Flat Land (<1 in 10)	Mild Slopes (1 in 10 – 1 in 4)	Steep Slopes (steeper than 1 in 4)
Erosion Control Blankets	Bonded Fibre matrix	Bonded Fibre Matrix
Gravelling	Compost Blankets	Cellular Confinement Systems
Mulching	Erosion Control Blankets, Mats and Mesh	Compost Blankets
Revegetation	Mulching well anchored	Erosion Control Blankets, Mats and Mesh
Rock Mulching	Revegetation	Revegetation
Soil Binder	Rock Mulching	Rock Armouring
Turfing	Turfing	Turfing

It is understood that when earthworks are complete, the launch and receptor pads are to have gravel placed along trafficked areas including between the pipe storage lines, in parking and equipment laydown areas, and around the washdown area.

4.4. Sediment Control

The need for sediment basins was triggered due to the need to protect the terminal receiving environment from suspended solids in most rainfall events, and the requirement of:

- *State Planning Policy for Healthy Waters* (DERM, 2010) to direct all water to a sediment basin if total estimate soil loss is greater than 150t/yr (total) from the site.
- *Queensland Water Quality Guidelines* (DERM, 2009) during the construction phase for disturbances greater than 1 hectare, it is a requirement to take all reasonable and practicable measures to collect all runoff from disturbed areas and drain to a sediment basin.

A sediment basin was not triggered for the mainland proportion of the site under IECA (2008) due to the fact that the aerial soil loss from the site is estimated to be less than 150t/ha/yr.

Table 10: Design Standard Sediment Control

Element	Conveyance/stability	Notes
Basin Type	F/D-type basin	Fine/dispersive soils
Basin Batter slopes	3 (h) : 1(V)	
Sediment Storage Volume	Calculated Using RUSLE	Considers 2 month clean out frequency
Cv	0.56	Group D (low permeability soils, 32.8mm design rainfall depth)
80%ile 5 day rainfall (Adopted for basins with design life greater than 6 months, Table B4 of IECA, 2008)	32.8mm	Published rainfall intensity for Gladstone (Table B5 of IECA, 2008)
Design size for all other treatment devices	3mnth ARI (0.5 x Q1)	IECA 2008

Calculations undertaken to determine the sediment basin size are attached in **Appendix C**. The Sediment Basin Construction and Operation Procedure is attached in **Appendix E**.

4.4.1. Sediment Control Standard

As detailed within **Section 3.3**, the IECA (2008) provides a risk based standard for selection of sediment control techniques (see **Table 6** of **Section 3.3**). The type of control is determined depending on soil loss rate and area of disturbance. Estimates of soil loss due to erosion from each sub-catchment along the Marine Crossing pipeline alignment have been calculated to determine the minimum sediment control standard to be applied. The results of soil loss estimations are presented in below in **Table 11**.

Based on the estimated soil loss calculations and the need to protect receiving environment, 11 of 25 catchments trigger the need for Type 1 sediment control measures, namely a Type D/F sediment basin.

Table 11: Catchment Areas, Soil Loss and Treatment Types

Construction Area	Exposed Area (ha)	A (t/ha/yr)	Soil Loss (t/yr)	Minimum Control Standard	Comment
Catchments – West of the Marine Crossing					
D01	1.38	126	174	Type 1	Type 1 nominated due to proximity to waterway
D02	0.53	77	40	Type 3	Type 1 nominated due to proximity to waterway
D03	0.60	73	43	Type 3	Type 2 nominated due to proximity to water
D04	0.42	100	42	Type 3	
D05	0.28	113	32	Type 3	
D06	0.39	123	48	Type 3	
D07	1.03	103	106	Type 2	
D08	0.95	61	58	Type 3	
D09	0.95	65	62	Type 3	
D10	0.67	67	45	Type 3	
D11	7.46	95	707	Type 1	Type 1 nominated due size of disturbed catchment
D12	0.60	51	31	Type 3	
D13	0.36	97	35	Type 3	
D14	0.62	33	21	Type 3	
D15	0.96	103	99	Type 2	
D16	0.52	131	68	Type 3	
D17	0.73	83	60	Type 3	
Catchment – Curtis Island					
D18	0.77	1,181	905	Type 1	
D19	0.24	453	108	Type 2	Type 1 nominated due to high erosion risk

Construction Area	Exposed Area (ha)	A (t/ha/yr)	Soil Loss (t/yr)	Minimum Control Standard	Comment
D20	0.51	1,471	747	Type 1	
D21	0.11	1,561	174	Type 2	Type 1 nominated due to extreme erosion risk
D22	0.28	2,792	785	Type 1	
D23	0.96	1,544	1,483	Type 1	
D24	1.04	512	534	Type 1	
D25	1.19	455	541	Type 1	

4.4.2. Sediment Control Measures in Areas of Sheet Flow

Table 12 outlines the typical use of various sheet flow sediment control techniques.

Table 12: Sheet Flow Sediment Control Techniques

Technique	Typical Use
Buffer Zones	• Type 3 sediment trap. • Most suited to sandy soils. • Can provide some degree of turbidity control while the *Buffer Zone* remains unsaturated.
Filter Sock	• Type 2 sediment trap. • Suitable for all soil types.
Filter Fence	• Type 3 sediment trap. • Very small catchment areas (e.g. stockpiles). • Better capture of the finer (sand/silt) sediments compared to woven *Sediment Fence.*
Mulch Berm	• Type 2 sediment trap. • Suitable for all soil types.
Sediment Fence (woven fabric)	• Type 3 sediment trap. • Suitable for all soil types. • Long duration construction sites likely to experience several storm events.
Sediment Fence (non-woven composite fabric)	• Type 3 sediment trap. • Suitable for all soil types. • Preferred type of *Sediment Fence* when placed adjacent critical habitats such as waterways. • Short duration construction sites or sites likely to experience only

Technique	Typical Use
	a few storm events.

It should be noted that the use of existing grasses to 'filter' sediment runoff are not effective enough to be classified as Type 3 systems. Grass filter strips are defined as supplementary sediment control techniques (ie below the minimum Type 3 control and as such cannot be relied solely on without preceding controls).

4.4.3. Sediment Control Structures in Areas of Minor Concentrated Flow

Table 13 outlines the typical use of sediment control techniques for minor concentrated flows, such as roadside drains.

Table 13: Minor Concentrated Flow Sediment Control Techniques

Technique	Typical use
Check Dam Sediment Trap	• Supplementary sediment trap. • Trapping sediment in table drains and other minor drainage lines. • Check dams may be constructed from rock, sand bags, or compost filled socks. • Compost-filled socks can adsorb some dissolved and fine particulate matter.
Coarse Sediment Trap	• Type 3 sediment trap. • Best used on sandy soils. • Commonly used as sediment trap at the low point of a Sediment Fence. • Used as an alternative to a spill through weir on a Sediment Fence.
Filter Tube Dam	• Type 2 sediment trap. • Trapping sediment in minor drainage lines. • Generally provides greater treatment of low flows than a U-shaped Sediment Trap. • Filter Tubes can be integrated into a variety of Type 2 and 3 sediment traps (such as rock check dam, U-shaped sediment trap, rock filter dam and sediment weir) to improve efficiency during minor flows.
Modular Sediment Trap	• Type 3 sediment trap. • Modern replacement for straw bale barriers. • Capability of accepting concentrated flows depends on construction technique.
U-Shaped Sediment Trap	• Type 3 sediment trap. • Minor concentrated flows such as table drains. • The sediment fence must be constructed in a U-shape with an appropriate spill through weir. • Filter tubes can be integrated into a U-shaped sediment trap to increase the effective hydraulic capacity and to improve the

Technique	Typical use
	treatment of low flows.

4.4.4. Sediment Control Structures in Areas of Concentrated Flow

Table 14 outlines the attributes of relevant sediment control techniques used in concentrated flow, such as roadside drains.

Table 14: Concentrated Flow Sediment Control Techniques

Technique	Typical use
Rock Filter Dam: Filter cloth used as the primary filter medium.	• Type 2 sediment trap. • Locations where there is sufficient room to construct a relatively large rock embankment. • The incorporation of filter cloth is the preferred construction technique if the removal of fine-grained sediment is critical. De-silting and replacement of the fabric can be difficult.
Sediment Trench	• Type 2 or 3 sediment trap. • Used in long, narrow spaces. • At the base of fill batters where there is limited space between the toe of the batter and the property boundary.

4.5. Revegetation and Stabilisation

Revegetation or temporary stabilisation should be completed within the timeframes nominated in **Table 5** depending on erosion risk. If works are likely to be suspended for an extended period, stabilisation of exposed areas will also be required within the specified timeframes.

In accordance with IECA (2008) options for temporary stabilisation are presented in **Table 9**.

Wherever practicable dispersive soils should be treated and/or completely buried under a layer of non-dispersive soil before placing any erosion control measures, including vegetation. Gypsum application should be applied at a rate of 10kg/cubic meter.

4.6. Instream Works

It is understood that the appointed Contractor (Saipem) has prepared a Watercourse Crossing Procedure (Construction Method Statement B6) to detail the proposed construction methodology, sequencing and duration of works within waterways and controls to be employed to manage risks posed by any such works. Said document has not been reviewed as part of preparing this SWMP and ESCP.

There are four areas identified as “Special Management Areas”. In total there are four tidal creeks and three non-tidal creeks. The tidal creeks will be subject to a subsequent application for Operational Works for Tidal Works which will detail ESC for those crossings. The non-tidal creeks will be detailed in the subsequent Saipem ESC Plan.

Creek crossings methodology will to be generally as per Saipem’s Construction Method Statement B6 in subsequent Saipem ESC Plan.

Instream construction activities and the removal of existing watercourse crossings have the potential to generate sediment plumes within the work area (i.e. waterways). Sediment released from a work site into a waterway or water body can cause an increase in both turbidity and bed load sediment.

During works within waterways two sources of water flow will need to be managed. Firstly, stream flows passing through the work area, and secondly lateral flows consisting of local stormwater runoff flowing towards the channel. Practical measures need to be employed to convey the lateral inflow of stormwater runoff around or through the work area in a non-erosive manner. This inflow of ‘clean’ water should not mix with any ‘dirty’ water generated within the work area.

The diversion of lateral inflow will be required in the following cases:

- When rainfall is expected or likely;
- Lateral inflows are likely to flow over exposed soil or cause bank erosion within the work area; and
- Material stockpiles on the side of the waterway which may wash into the system.

The primary objectives when trenching through water crossings include:

- Timing of works to coincide with periods of no/low flow and a low probability of significant rainfall;
- Staging of works to divert creek flows around work area;
- Stockpiles should be positioned above flood levels with appropriate sediment control measures installed; and

- Rapid rehabilitation and stabilisation of waterway bed and banks.

Once the method of construction, sequencing and timing of works is known for all activities occurring in and in close proximity to waterways a review of the risks posed will need to be conducted prior to commencing any works.

5. Waterway Crossing Hydraulic Assessment

5.1. Culvert Design

Based on the results of the hydrologic assessment undertaken (detailed in **Section 2.4**), hydraulic modeling has been undertaken to assess the necessary drainage infrastructure required as part of the pipeline corridor and access tracks to ensure the movement of machinery and vehicles can continue through periods of rainfall.

For temporary works (i.e. during construction), the appropriate ARI rainfall event needs to be nominated as the design rainfall event, in accordance with IECA (2008) and associated Catchment to Creek Pty Ltd fact sheet titled 'Temporary Watercourse Crossings: Culverts (2010)'. The design standard of the culverts will be dependent on the in-bank hydraulic capacity of the watercourse and the timing of works (i.e. dry or wet season).

However, for permanent drainage structures, the 20 year ARI rainfall event has been nominated as the design rainfall event and the velocity-depth product specified by QUDM applied as the limiting factor for any permanent waterway crossing.

Application of these design criteria has enabled culvert infrastructure to be sized for Locations 1 to 8 (previously illustrated in **Figure 6**) for a range of design standards. The results of this preliminary assessment are summarised in **Table 15**.

Table 15: Culver Configuration for Waterway Crossings

Location	Crossing Design - 1 year ARI	Crossing Design - 2 year ARI	Crossing Design - 5 year ARI	Crossing Design - 20 year ARI
1[(1)]	3 x 1200mm RCP	3 x 1200mm RCP	3 x 1200mm RCP	3 x 1200mm RCP
2	3x1500mm RCP	7x1500mm RCP	11 x 1500mm RCP	11 x 1800 x 1500 RCBC
3	4x1500mm RCP	9x1500mm RCP	13 x 1500mm RCP	24 x 1800 x 1500 RCBC
4	1 x 275mm RCP	1 x 275mm RCP	1 x 300mm RCP	1 x 450mm RCP
5	1x450mm RCP	1x600mm RCP	2 x 600mm RCP	3 x 600mm RCP
6	1x600mm RCP	1 x 900mm RCP	2 x 900mm RCP	3 x 900mm RCP
7	2x900mm RCP	4x900mm RCP	6 x 900mm RCP	8 x 900mm RCP
8	1x450mm RCP	2x450mm RCP	4 x 450mm RCP	3 x 600mm RCP

NOTE: (1) The culverts at Location 1 have already been constructed as part of the works undertaken by QGC. Three culverts were observed during the site inspection but it remains unclear as to what size these units were.

5.1.1. Minor Culvert Design

Three additional waterway crossings will be required. The size of the contributing catchments at these locations is considerably less than those previously assessed and the necessary drainage infrastructure much less. Again, the appropriate ARI rainfall event needs to be nominated as the design rainfall event, in accordance with IECA (2008) and associated Catchment to Creek Pty Ltd fact sheet titled 'Temporary Watercourse Crossings: Culverts (2010)'. The design standard of the culverts will be dependent on the in-bank hydraulic capacity of the watercourse and the timing of works (i.e. dry or wet season). Based on the hydrologic and hydraulic modeling undertaken at these locations, the following culverts will be required:

- 5 year ARI event 1050mm RCP,
- 2 year ARI event 900mm RCP, or
- 1 year ARI event 750mm RCP

The results of the modelling indicate the critical storm duration can be conveyed by these culverts without flows passing over the ROW.

6. Roles and Responsibilities

Table 16 outlines the responsibilities of parties with respect to ESC.

Table 16: Roles and Responsibilities

Role	Responsibility
Project Superintendent	• Overall responsibility of ESC implementation; • Notify the Environmental Manager immediately of any non-compliance with ESCP; • Ensure the prompt implementation of measures to mitigate erosion and sediment generation;
Project Engineer	• Provide design information as required; • Inspect ESC installation and maintenance; • Inspect offsite impacts and management;
Site Supervisor/Foremen	• Monitor daily rainfall; • Notify Environmental Advisor/Consultant when runoff generating rainfall occurs in the previous 24 hours; • Treat, test and dispose of captured runoff as per operating procedures; • Maintain current records of rainfall, storage volumes, water quality, treatment practices, discharge volumes;
Environmental Advisor/Consultant	• Conduct in-situ monitoring; • Collect and submit samples to laboratory; • Collate results and prepare reports as required; • Sample basin water quality and authorise discharge; • Conduct site inspections and audits as required;
Erosion and Sediment Control Auditor / Advisor (CPESC)	• Conduct site inspections and audits as required; • Prepare audit reports; • Provide advice regarding ESC site improvement;
All Personnel	• Report any damage to ESC devices and any potential or actual environmental harm in line with Duty to Notify under the requirements of the Environmental Protection Act 1994;

7. Corrective and Preventative Action

An environmental incident with respect to the ESCP is defined as any occurrence where sediment is released from the site, whether controlled or uncontrolled, or where stormwater is released (controlled) from site which does not meet the water quality requirements.

All incidents and non-conformances are to be reported and investigated and corrected in accordance with the ESCP to ensure effective soil and water quality management practices at all times.

Best practice site management requires all ESC measures to be inspected by the Contractors nominated representative at least daily when rain is occurring, within 24 hours prior to expected rainfall, and within 18 hours of a rainfall event of sufficient intensity and duration to cause onsite runoff (IECA, 2008). Such inspections must check:

- **Daily site inspections** (during periods of runoff producing rainfall)
  - All drainage, erosion and sediment control measures
  - Occurrences of excessive sediment deposition (whether on-site or off-site)
  - All site discharge points

- **Weekly site inspections** (even if work is not occurring on-site)
  - All drainage, erosion and sediment control measures
  - Occurrences of excessive sediment deposition (whether on-site or off-site)
  - Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements
  - Litter and waste receptors
  - Oil, fuel and chemical storage facilities

- **Prior to anticipated runoff producing rainfall**
  - All drainage, erosion and sediment control measures
  - All temporary flow diversion and drainage works

- **Following runoff producing rainfall**
  - Treatment and de-watering requirements of sediment basins
  - Sediment deposition within sediment basins and the need for its removal
  - All drainage, erosion and sediment control measures
  - Occurrences of excessive sediment deposition (whether on-site or off-site)
  - Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements
  - Occurrences of excessive erosion, sedimentation, or mud generation around the site office, car park and/or material storage areas.

8. Surface Water Monitoring Program

The requirements of the surface water quality monitoring program are subject to an Environmental Management Plan as stipulated within the various project Conditions of Approval. At a preliminary level **Table 17** outlines possible requirements for surface water monitoring with respect to ESC. The operation and monitoring of sediment basins is to be conducted in accordance with the sediment basin operating procedure contained within **Appendix E**.

Table 17: Preliminary Surface Water Monitoring Program (excluding Sediment Basins)

Responsibility	**Contractor to carry out sampling.**
Analytes	As per EMP. At a minimum: • pH • Turbidity • Dissolved Oxygen (DO) • Electrical Conductivity (EC) • Temperature (^{o}C)
Monitoring Locations	As per EMP. At a minimum: • Upstream and downstream of works; • Drainage discharge points; and • Sediment basin discharge points
Timing	As per EMP. At a minimum, on any day when stormwater run-off discharges from the site, or immediately after a rainfall event of nominated intensity and duration.
Methodology	Samples are to be collected by a suitably qualified party and submitted to NATA accredited laboratory for analysis. Samples to be collected in accordance with Qld EPAs “Water Quality Sampling Manual” December 1999 (or later version).

9. Auditing, Corrective and Preventative Action

9.1. Inspection Requirements

Best practice site management requires all ESC measures to be inspected by the Site Manager, responsible ESC officer or contractors nominated representative at least daily when rain is occurring, weekly, within 24 hours prior to expected rainfall, and within 18 hours of a rainfall event of sufficient intensity and duration to cause onsite runoff (IECA, 2008). Such inspections must check:

- **Daily site inspections** (during periods of runoff producing rainfall)
  - All drainage, erosion and sediment control measures
  - Occurrences of excessive sediment deposition (whether on-site or off-site)
  - All site discharge points

- **Weekly site inspections** (even if work is not occurring on-site)
  - All drainage, erosion and sediment control measures
  - Occurrences of excessive sediment deposition (whether on-site or off-site)
  - Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements
  - Litter and waste receptors
  - Oil, fuel and chemical storage facilities

- **Prior to anticipated runoff producing rainfall**
  - All drainage, erosion and sediment control measures
  - All temporary flow diversion and drainage works

- **Following runoff producing rainfall**
  - Treatment and de-watering requirements of sediment basins
  - Sediment deposition within sediment basins and the need for its removal
  - All drainage, erosion and sediment control measures
  - Occurrences of excessive sediment deposition (whether on-site or off-site)
  - Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements
  - Occurrences of excessive erosion, sedimentation, or mud generation around the site office, car park and/or material storage areas.

9.2. Audits

Site inspections are to be undertaken in accordance with the Site Inspection Checklist provided on page 7.19 – 7.31 of the IECA, *Best Practice Erosion and Sediment Control Guidelines* (2008) by the Contractors nominated representative. The Contractor must ensure that appropriate procedures and personnel are engaged to plan and conduct site inspections and water quality monitoring throughout the construction and maintenance phase.

In accordance with the IECA, *Best Practice Erosion and Sediment Control Guidelines* (2008), audits are to be conducted at intervals of not more than one (1) calendar month commencing from the day of site disturbance until all disturbed areas have been adequately stabilised against erosion to the acceptance of the relevant regulatory authority. Such audits must be:

- Undertaken by a person suitably qualified and experienced in erosion and sediment control (ie. CPESC) that can be verified by an independent third party (this person must not be an employee or agent of the principal contractor); and
- Conducted on the next business day following a rainfall event in which greater than 10mm of rainfall has been recorded by the Bureau of Meteorology rain gauge nearest to the site.

Due to the remoteness of the site, it is recommended that site audits are only undertaken on a monthly basis by a suitably qualified independent third party (ie. CPESC). It is recommended that site inspections following a 10mm rainfall event (as specified by IECA (2008)) are undertaken by the Contractors nominated representative.

It is recommended audits include:

- Copies of all original completed ESC site audit checklists, non-conformance and corrective action reports;
- Rainfall records, sediment basin flocculation, site discharge water quality monitoring results and assessment of performance of ESCP Objectives and Targets;
- A current ESC Plan showing those areas of site stabilization and the percentage completion of all soil stabilization/erosion control works;
- Identified Corrective Actions from the site inspection and update on status of previous corrective actions (over and above internal corrective action process);
- Representative date-stamped color photographs, clearly identifying and locating each primary ESC device on the site and showing its condition and use including, as a minimum:
    - Sediment basin embankments, basin water levels, inflow points, depth marker and emergency spillway outlets
    - Sediment fencing
    - Each catch drain and diversion channel
    - Stormwater inlet and outlet protection
    - Stabilized site entry/exit point/s
    - All ESC related corrective action requests
    - Ground stabilization areas and the stabilization media used, such as sheet mulching, hydromulching etc.

The audit must include:

- Copies of all original completed ESC site audit checklists, non-conformance and corrective action reports;
- Rainfall records, sediment basin flocculation and water quality results, site discharge water quality monitoring results and interpretation of results against the Site Water Quality Objectives;
- A current ESC Plan showing those areas of site stabilization and the percentage completion of all soil stabilization/erosion control works;
- A table showing the completion of all actions (or percentage thereof) required by the compliance program;

- Representative date-stamped color photographs, clearly identifying and locating each primary ESC device on the site and showing its condition and use including, as a minimum:
  - Sediment basin embankments, basin water levels, inflow points, depth marker and emergency spillway outlets
  - Sediment fencing
  - Each catch drain and diversion channel
  - Stormwater inlet and outlet protection
  - Stabilized site entry/exit point/s
  - All ESC related corrective action requests
  - Ground stabilization areas and the stabilization media used, such as sheet mulching, hydromulching, concrete etc.

9.3. Audit Reporting

Audit reports are to be compiled within 5 business days of completion of the site inspection, and submitted to the Project Engineer.

10. Reference List

BOM. (2010). Rainfall IFD Data System. Retrieved 11 29, 2010, from Bureau of Meteorology: http://www.bom.gov.au/hydro/has/cdirswebx/cdirswebx.shtml

DERM. (2009). Department of Environment and Resource Management. Retrieved 11 30, 2010, from Draft Urban Stormwater - Queensland Best Practice Environmental Management Guidelines 2009: http://www.derm.qld.gov.au/environmental_management/water/environmental_values_environmental_protection_water_policy/draft_urban_stormwater_qbpem_guideline.html

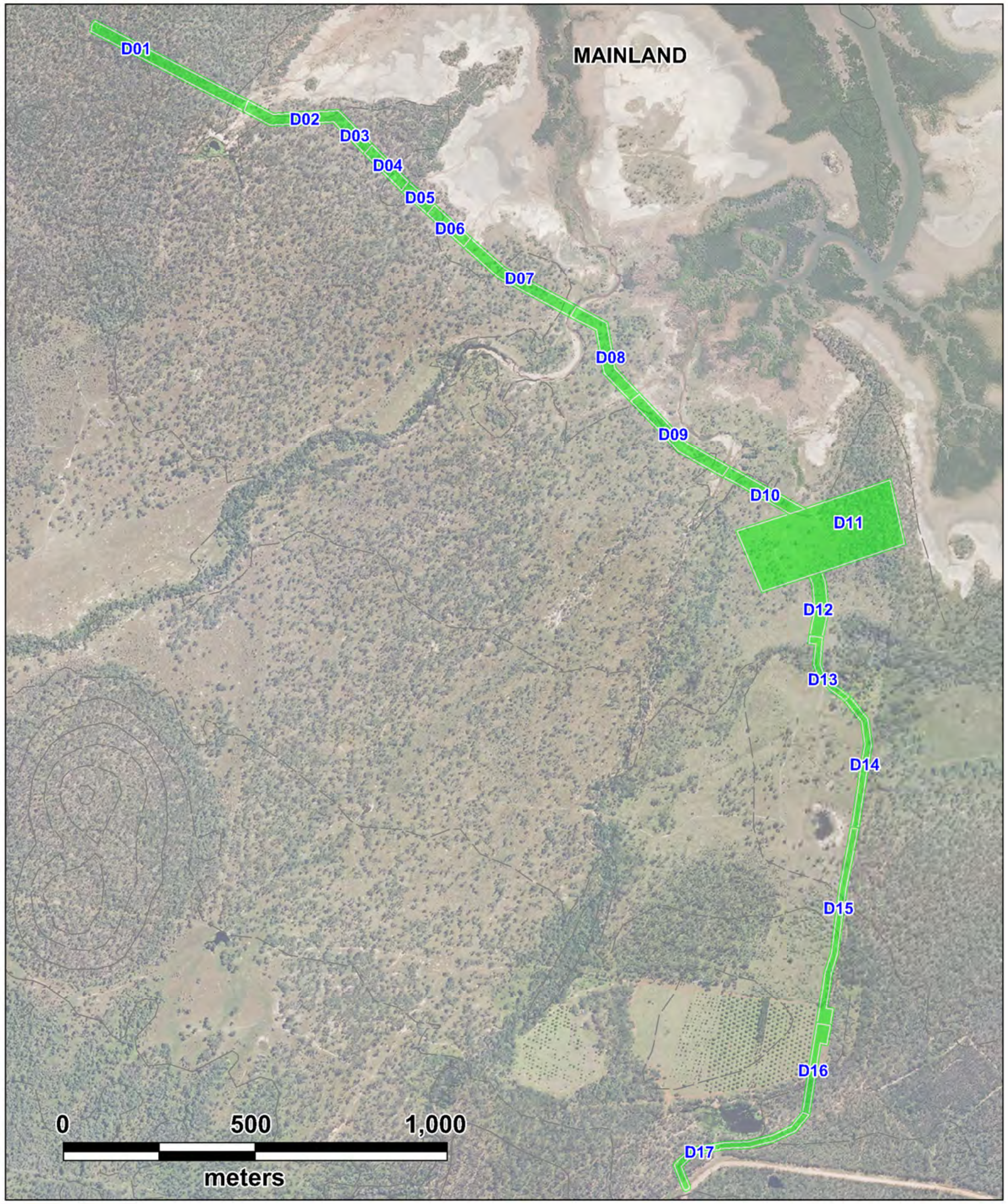
DERM. (2009). Environmental Protection (Water) Policy.

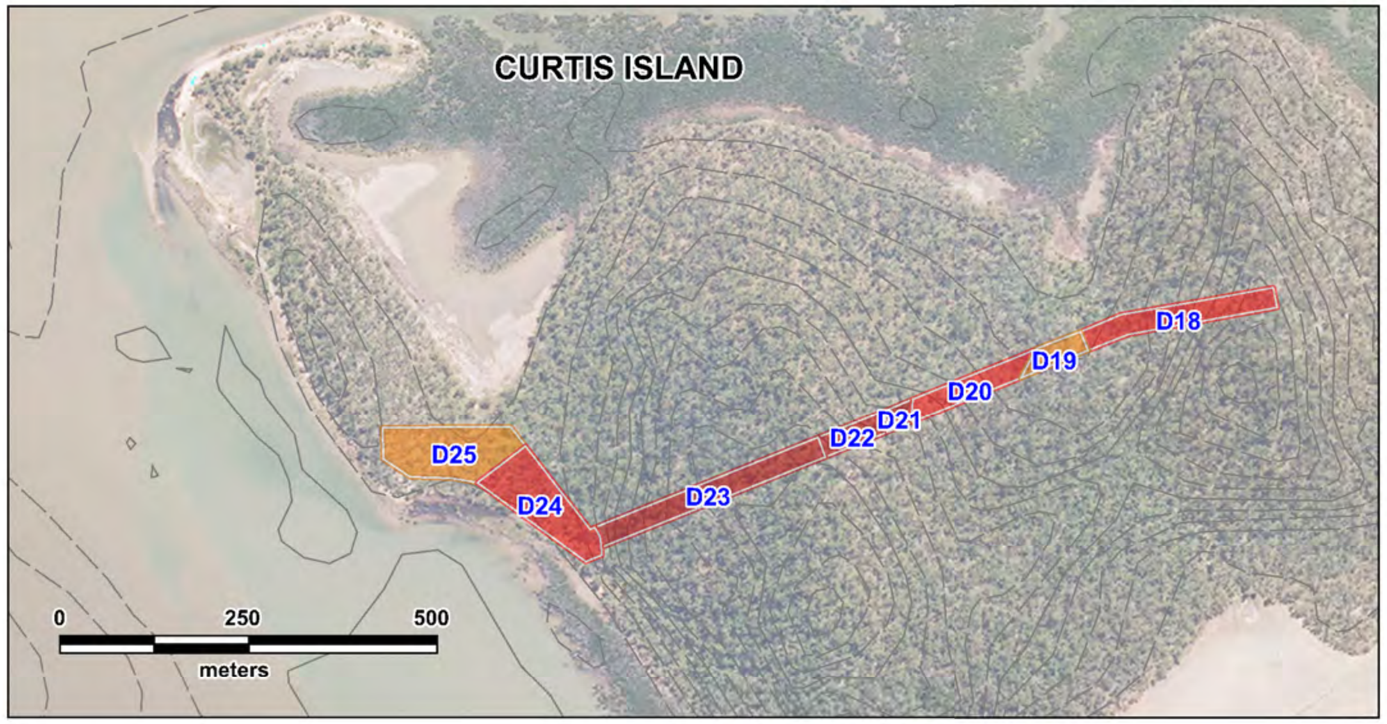
DERM. (2009). Queensland Water Quality Guidelines 2009.

DERM. (2010, 10 20). Department of Environment and Resource Management. State Planning Policy for Healthy Waters: http://www.derm.qld.gov.au/environmental_management/water/environmental_values_environmental_protection_water_policy/urban_water_quality_and_flow_management.html

IECA. (2008). Best Practice Erosion and Sediment Control - for building and construction sites. Picton, NSW: International Erosion Control Association (Australasia).

Appendix A Erosion Risk Mapping





EROSION RISK ASSESSMENT

Catchment ID	Risk Rating	Catchment ID	Risk Rating
D01	Very Low	D14	Very Low
D02	Very Low	D15	Very Low
D03	Very Low	D16	Very Low
D04	Very Low	D17	Very Low
D05	Very Low	D18	High
D06	Very Low	D19	Moderate
D07	Very Low	D20	Extreme
D08	Very Low	D21	Extreme
D09	Very Low	D22	Extreme
D10	Very Low	D23	Extreme
D11	Very Low	D24	High
D12	Very Low	D25	Moderate
D13	Very Low		

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EROSION RISK ASSESSMENT PLAN

date APRIL 2012
job # SC12-0029
drawing 018

Appendix B ESC Drawings

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Sheet location

date	MAY 2012
job #	SC12-0029
drawing	002

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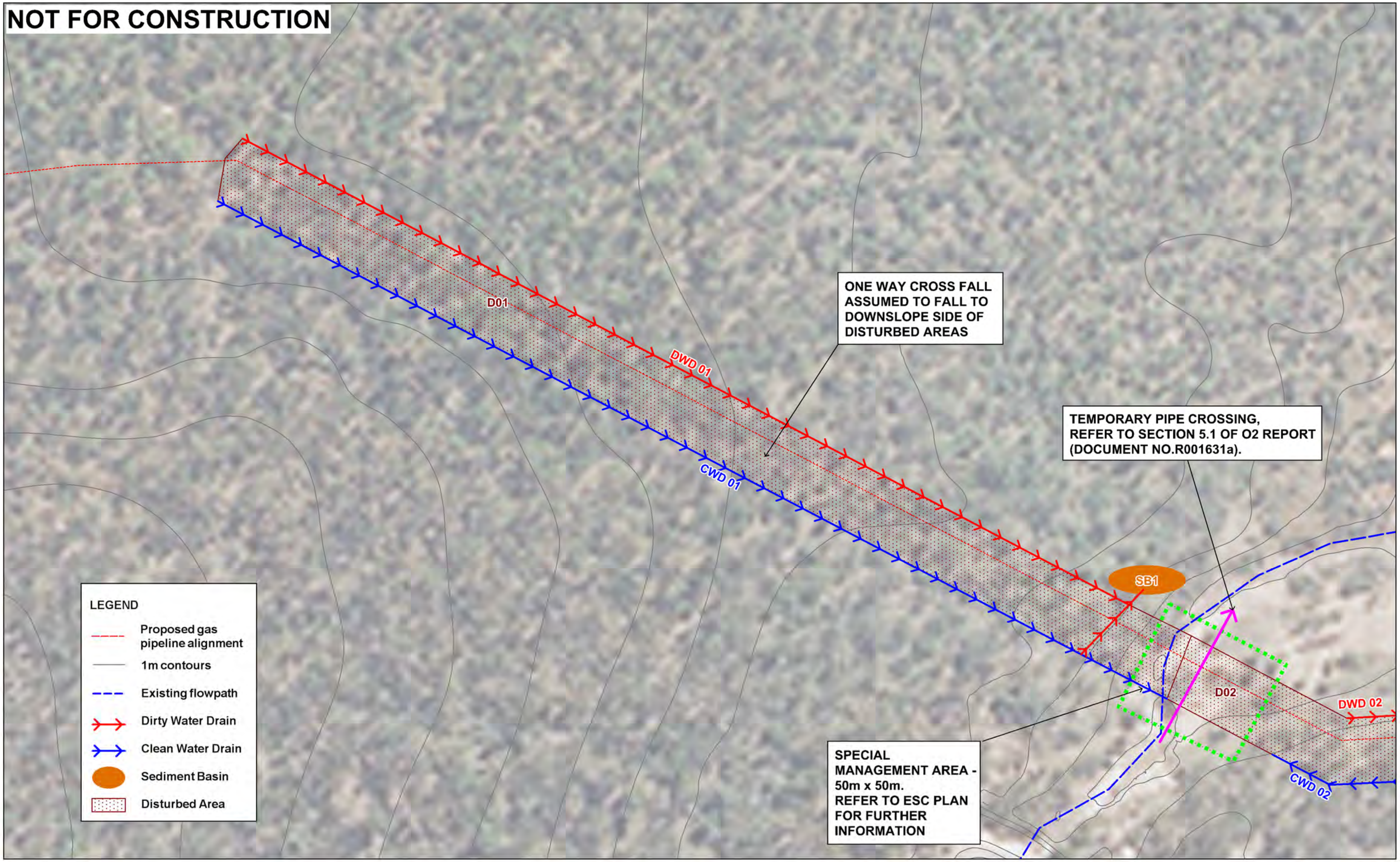

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CLEAR & GRUB ESC PLAN - SHEET 1

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job #	SC12-0029
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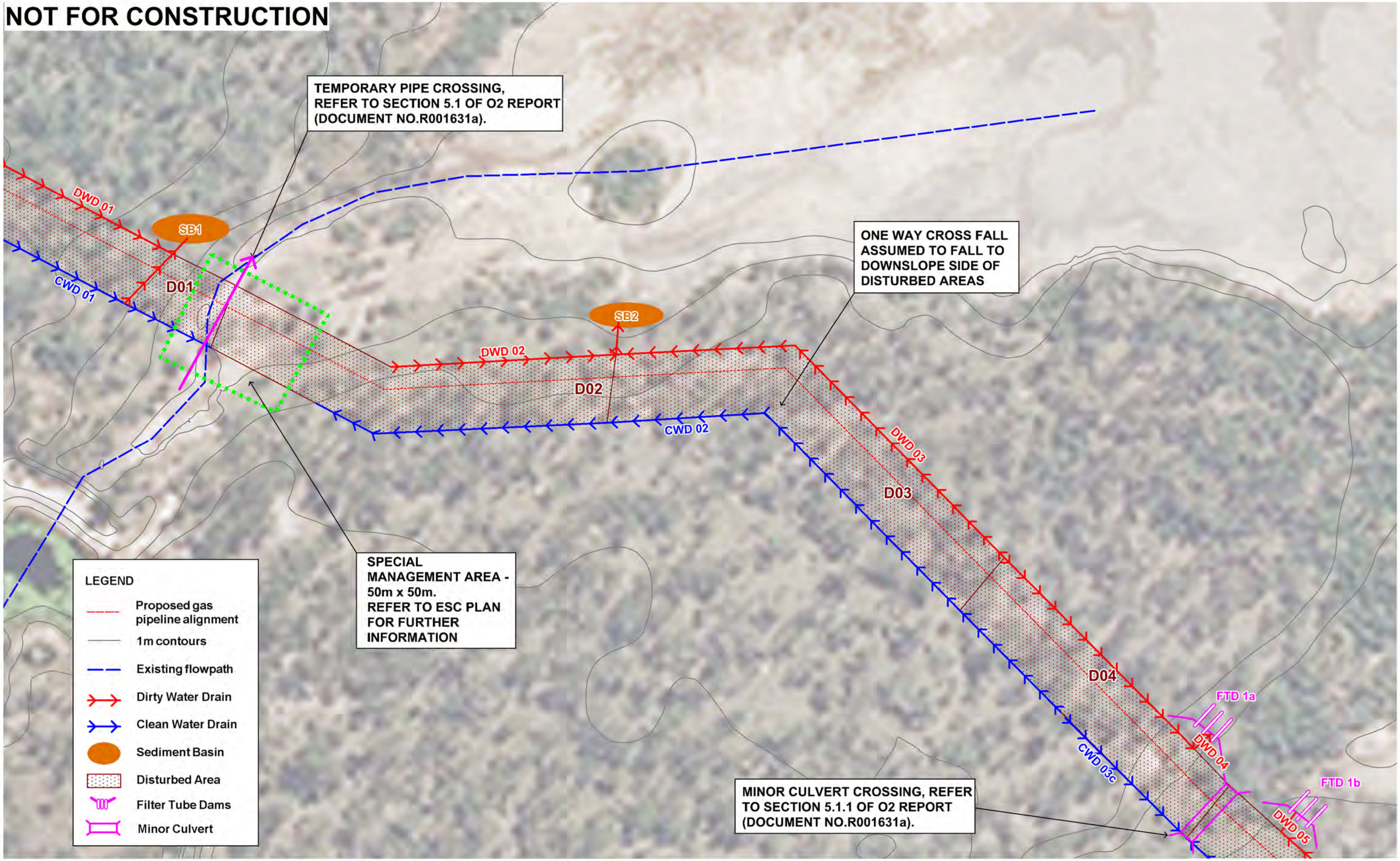

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CLEAR & GRUB ESC PLAN - SHEET 2

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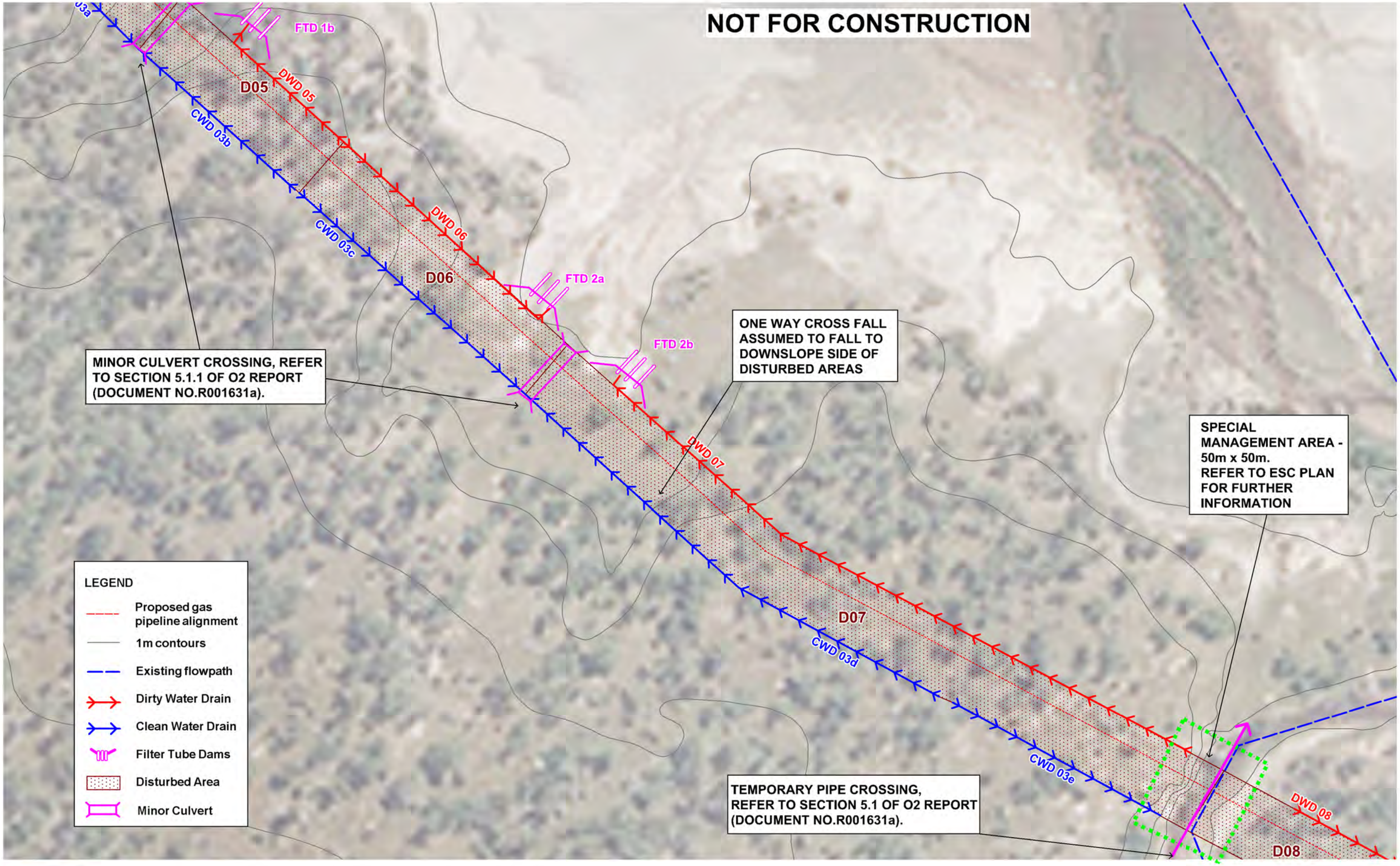

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CLEAR & GRUB ESC PLAN - SHEET 3

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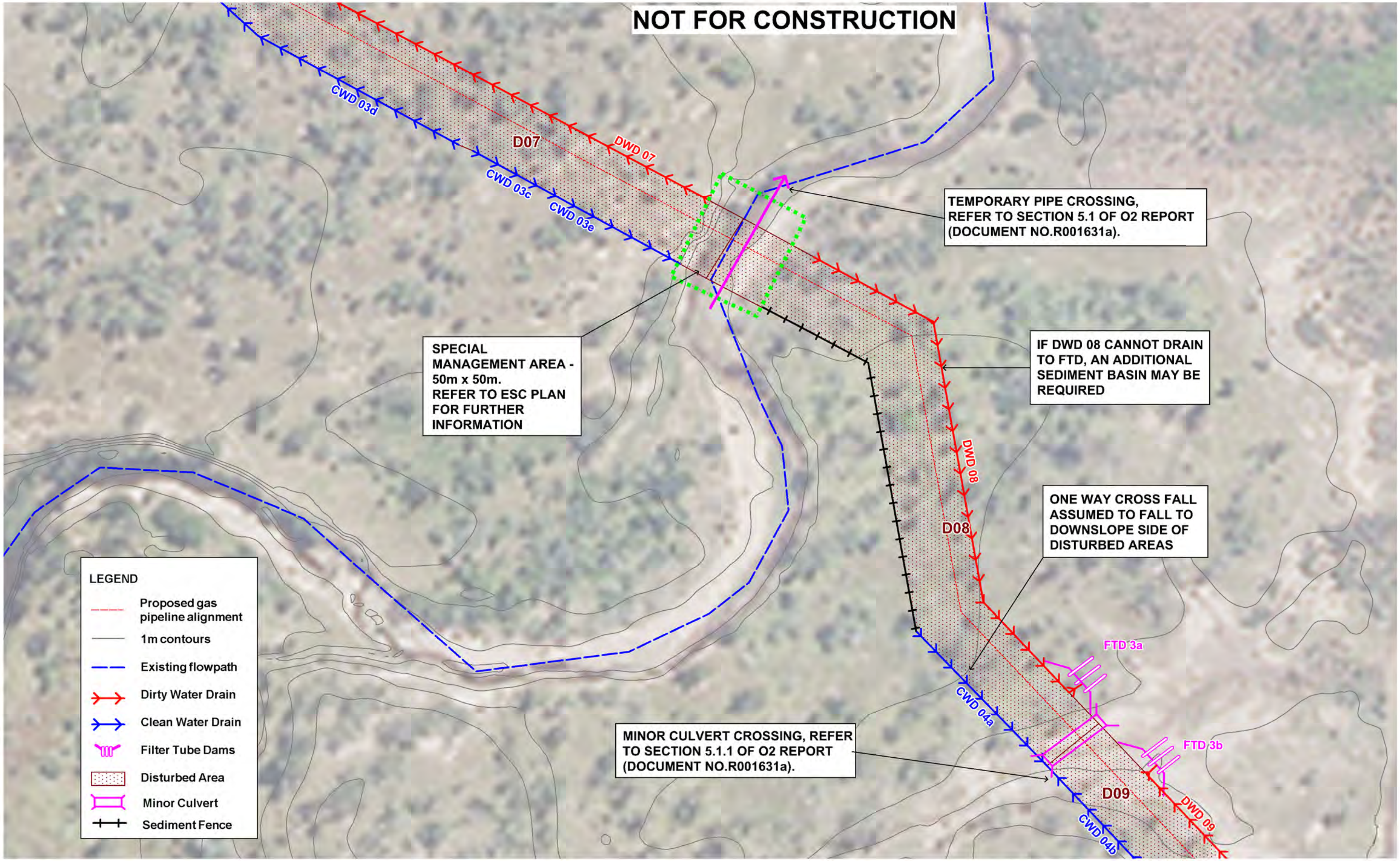

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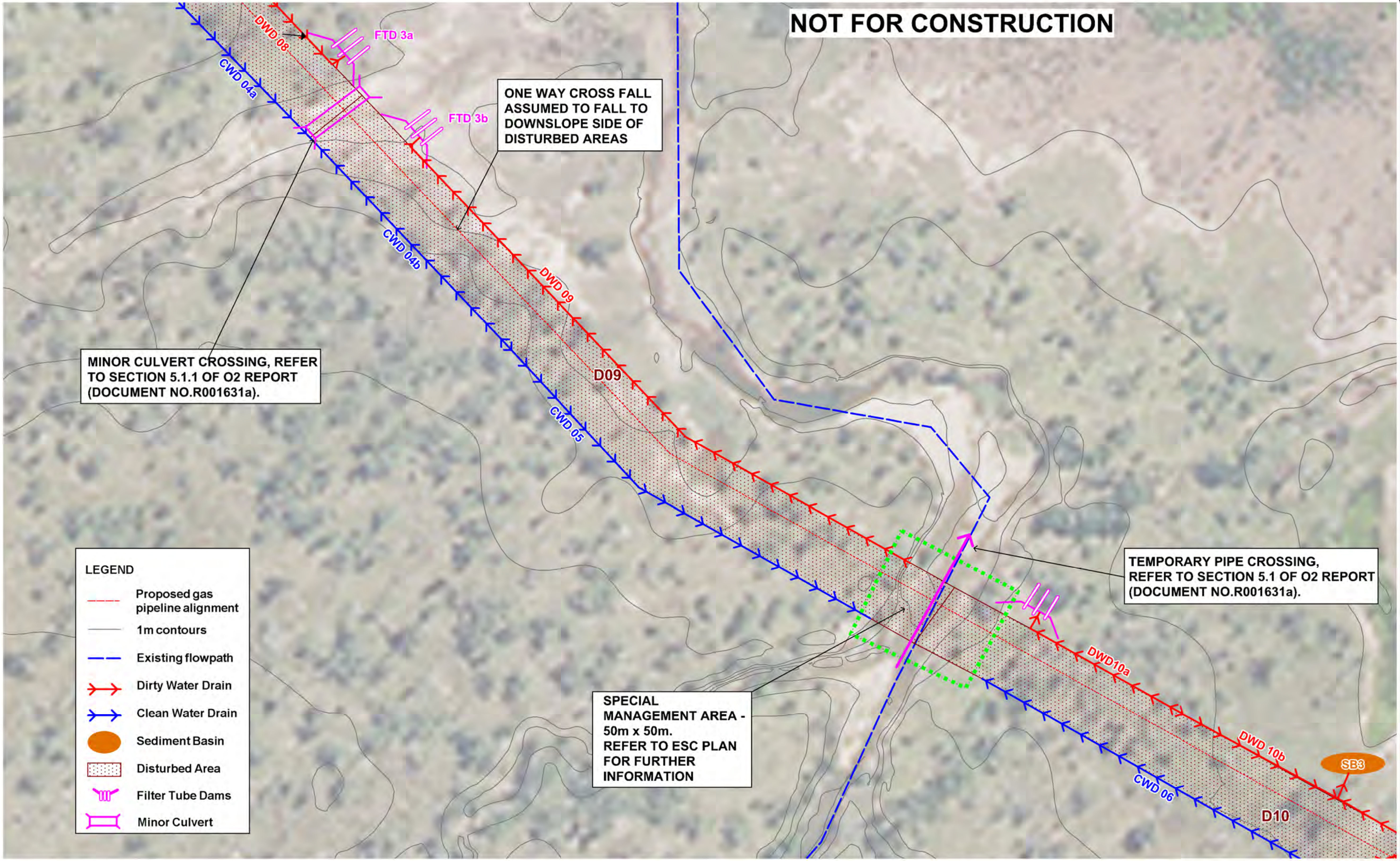

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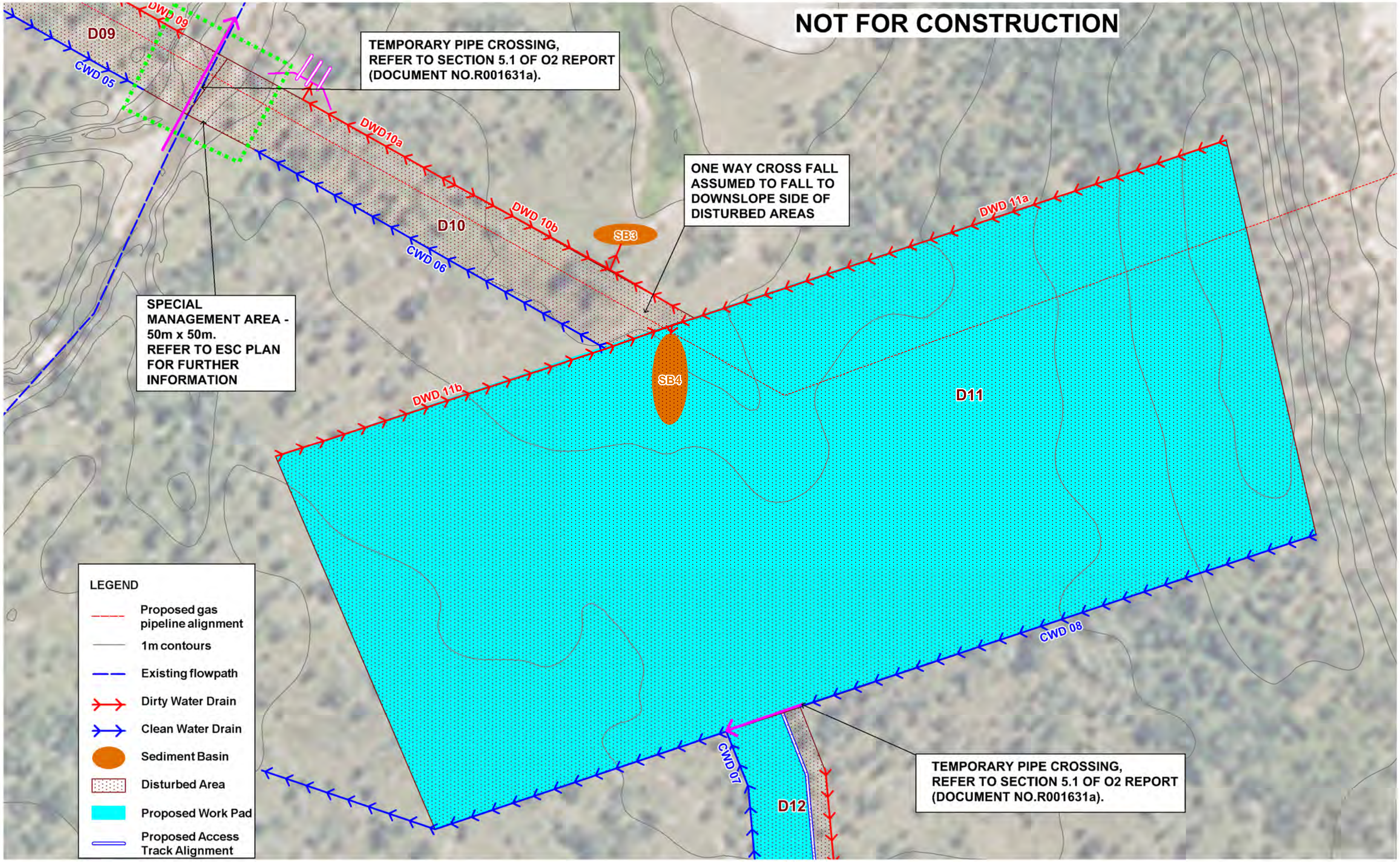

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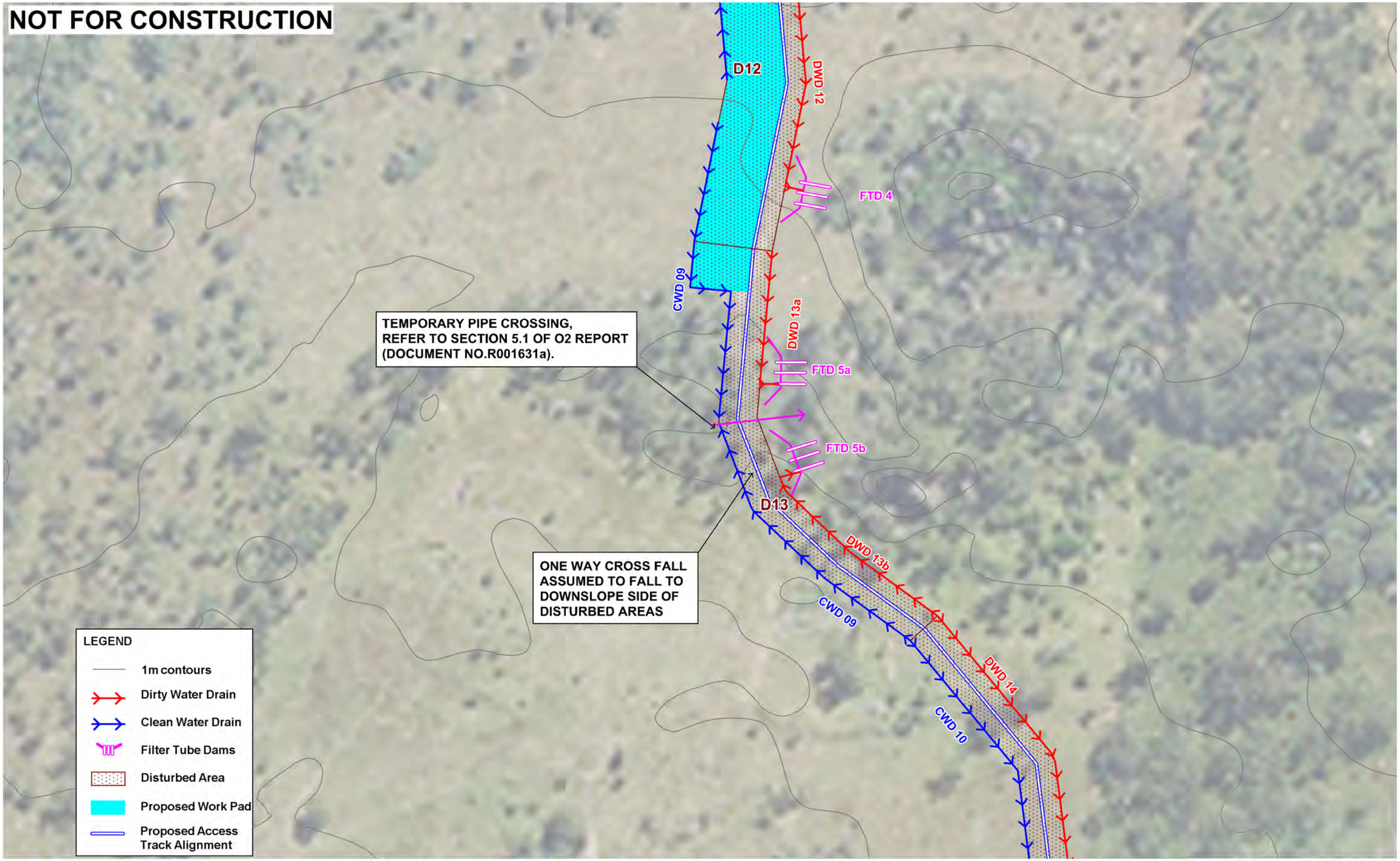

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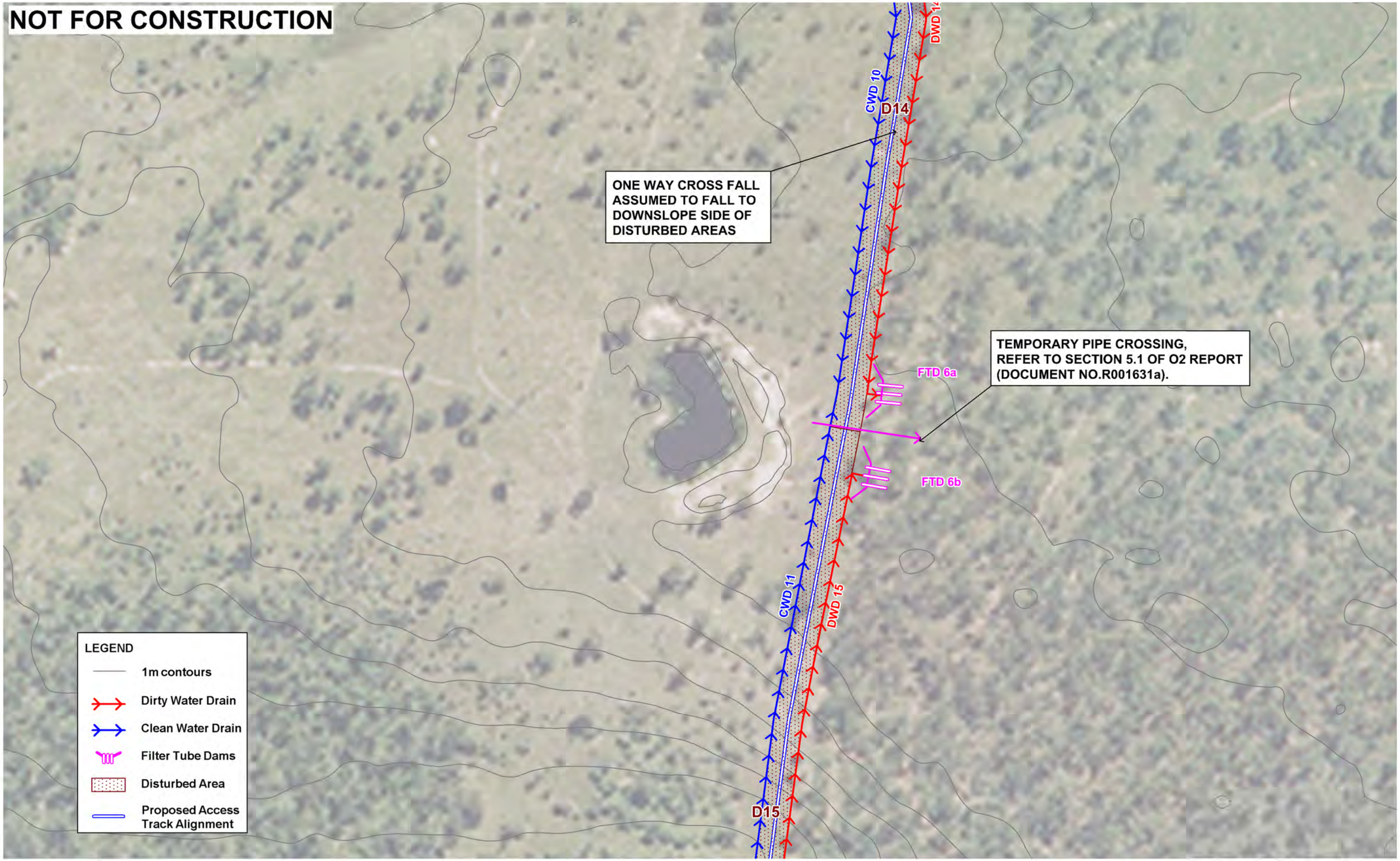

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CLEAR & GRUB ESC PLAN - SHEET 9

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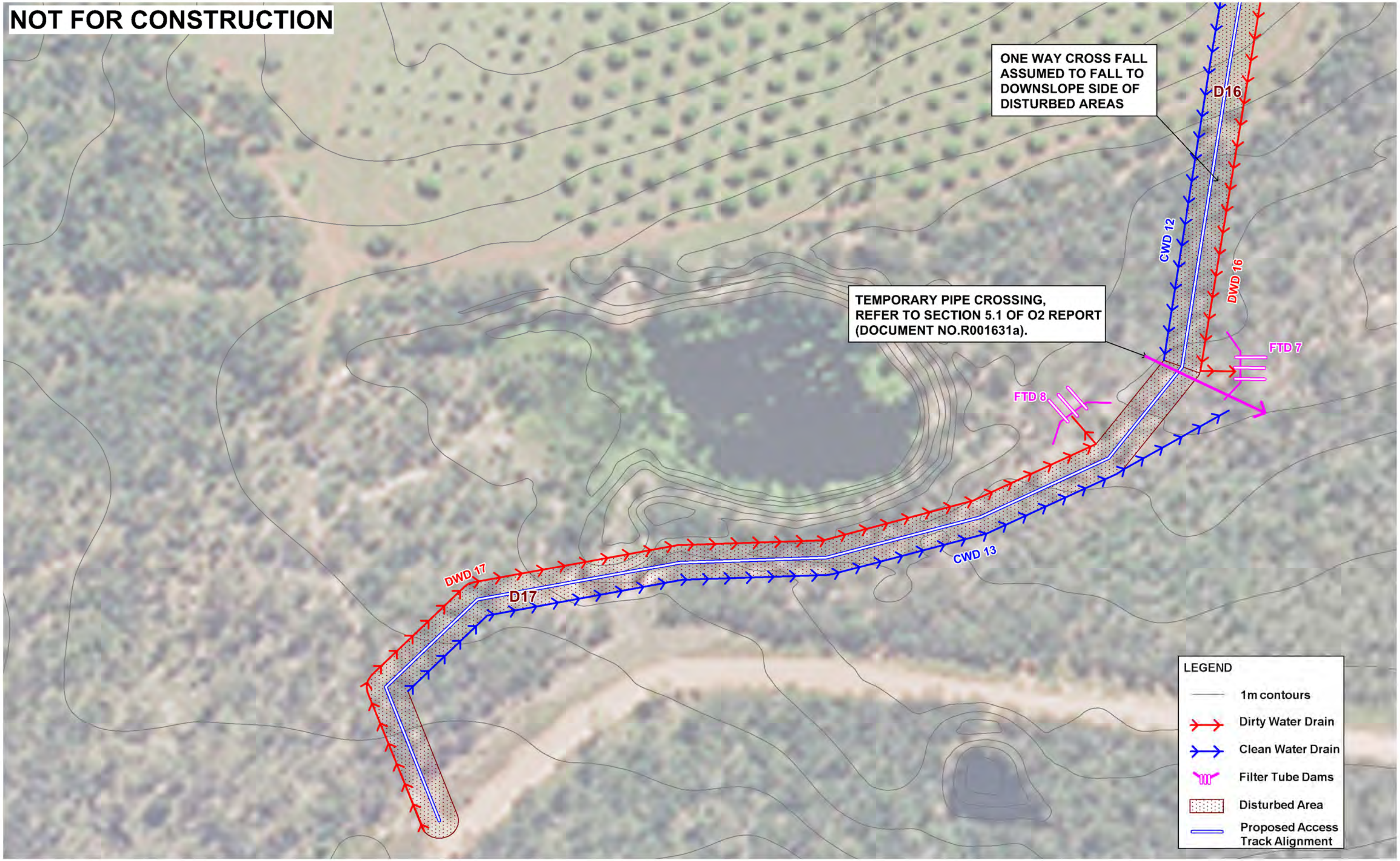

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GLNG Operations Gas Tranmission Pipeline Marine Crossing

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CLEAR & GRUB ESC PLAN - SHEET 10

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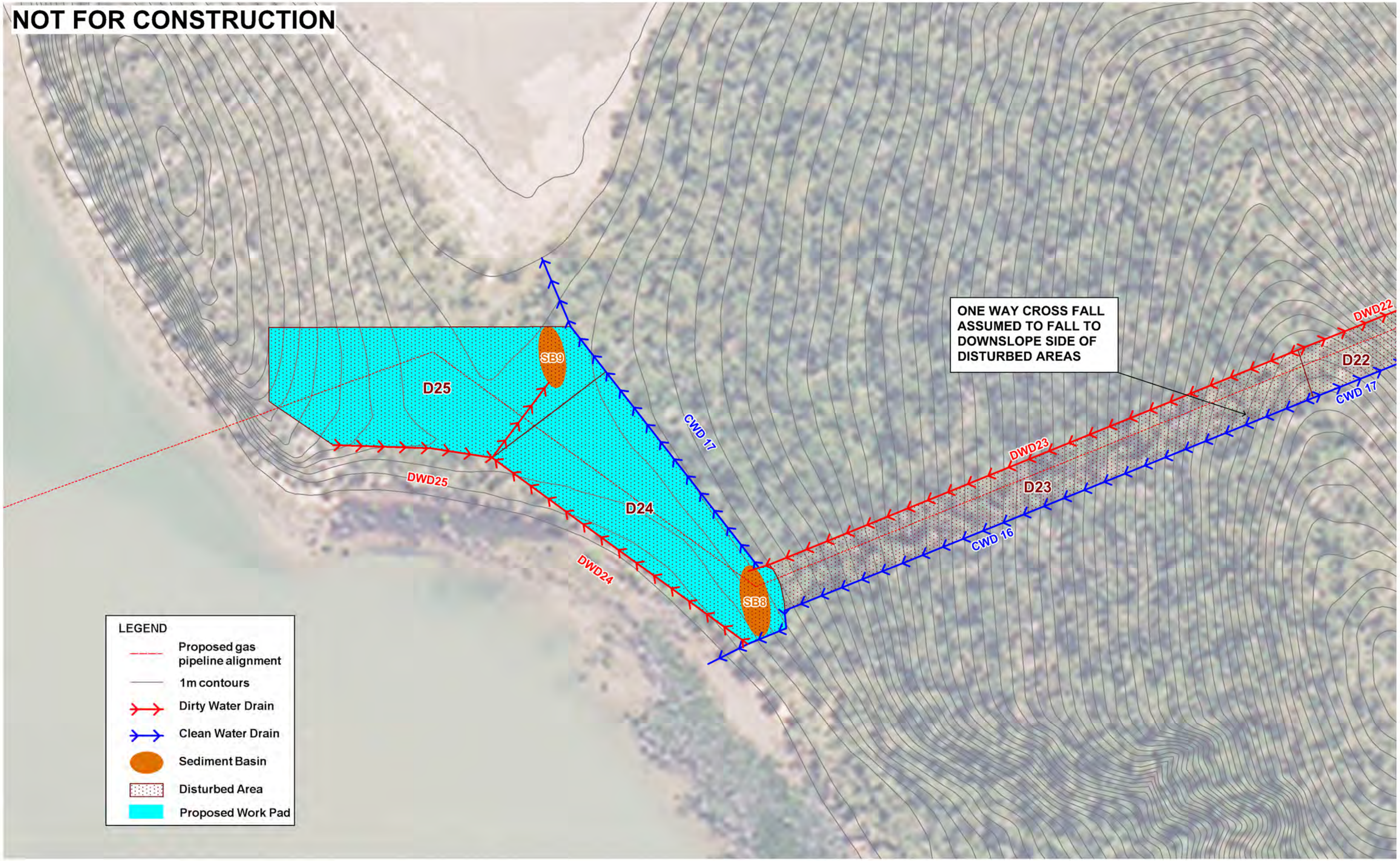

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GLNG Operations Gas Tranmission Pipeline Marine Crossing

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CLEAR & GRUB ESC PLAN - SHEET 11

date	MAY 2012
job #	SC12-0029
drawing	013

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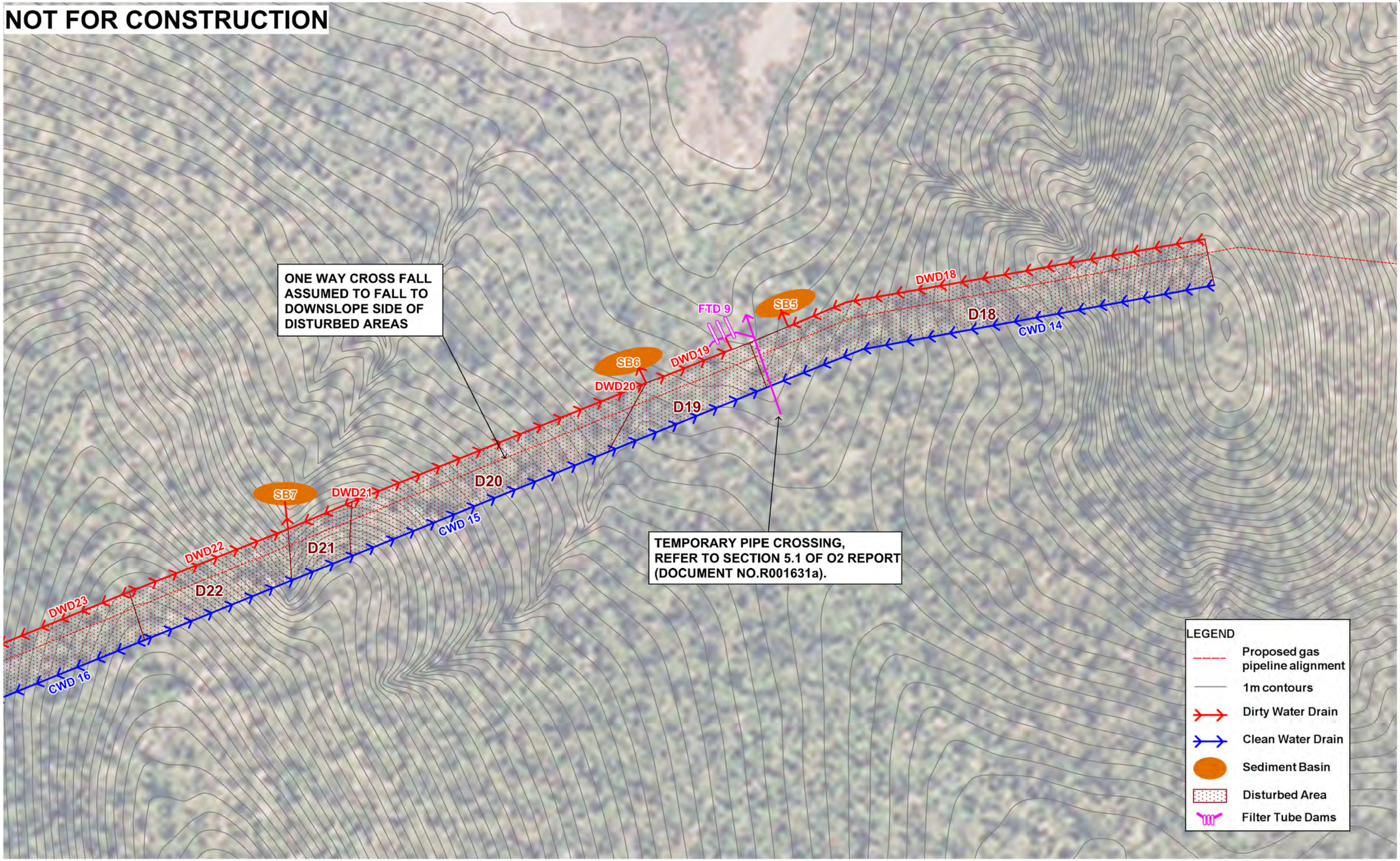

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GLNG Operations Gas Tranmission Pipeline Marine Crossing

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CLEAR & GRUB ESC PLAN - SHEET 12

date MAY 2012
job # SC12-0029
drawing 014

Appendix C Design Specification and Calculations

GLNG GAS TRANSMISSION ESCP

CLEAN WATER DRAIN DETAILS

Drain ID	Drain Type	Slope	Lining	Base Width (m)	Top Width (m)	Depth incl. freeboard (m)	Side Slope Length	Velocity (m/s)	Length (m)	Roll Size	Square Meters	Indicative No. of Rolls
CWD 01	Type C	1.4%	Coir TMC7	0.3	2.7	0.6	2	1.8	347	2m x 25m	1035	28
CWD 02	Type B	0.1%	Geofabric	1.2	4.0	0.7	2	0.8	361.4	4m x 150m	1565	6
CWD 3a	Type C	1.6%	Coir TMC7	0.3	2.7	0.6	2	2.0	85	2m x 25m	254	8
CWD 3b	Type C	1.6%	Coir TMC7	0.3	2.7	0.6	2	2.0	95	2m x 25m	283	8
CWD 3c	Type C	1.5%	Coir TMC7	0.3	2.7	0.6	2	1.8	135	2m x 25m	403	12
CWD 3d	Type C	1.0%	Coir TMC7	0.3	2.7	0.6	2	1.6	230	2m x 25m	686	20
CWD 3e	Type C	1.6%	Coir TMC7	0.3	2.7	0.6	2	1.9	100	2m x 25m	298	8
CWD 4a	Type C	1.2%	Coir TMC7	0.3	2.7	0.6	2	1.8	85	2m x 25m	254	8
CWD 4b	Type C	1.7%	Coir TMC7	0.3	2.7	0.6	2	2.0	125	2m x 25m	373	10
CWD 05	Type B	1.0%	Geofabric	0.3	2.3	0.5	2	1.5	361	4m x 150m	916	3
CWD 06	Type B	0.2%	Geofabric	0.3	2.3	0.5	2	0.7	584	4m x 150m	1481	4
CWD 07	Type B	0.3%	Geofabric	0.3	2.3	0.5	2	0.9	255	4m x 150m	647	2
CWD 08	Type B	0.6%	Geofabric	0.3	2.3	0.5	2	1.2	378	4m x 150m	959	3
CWD 09	Type C	1.0%	Coir TMC7	0.3	2.7	0.6	2	1.5	241	2m x 25m	719	20
CWD 10	Type B	0.1%	Geofabric	2.0	5.2	0.8	2	0.8	383	4m x 150m	2136	6
CWD 11	Type C	1.6%	Coir TMC7	0.3	3.5	0.8	2	2.5	372	2m x 25m	1443	30
CWD 12	Type C	2.5%	Coir TMC7	0.3	2.3	0.5	2	2.0	226	2m x 25m	573	20
CWD 13	Type C	1.4%	Coir TMC7	0.3	3.1	0.7	2	2.0	378	2m x 25m	1297	32
CWD 14	Type C	14.3%	Coir TMC7	1.0	2.2	0.3	2	3.3	258	2m x 25m	604	22
CWD 15	Type C	11.9%	Coir TMC7	3.0	4.2	0.3	2	3.3	380	2m x 25m	1650	48
CWD 16	Type C	14.9%	Coir TMC7	2.5	3.7	0.3	2	3.2	383	2m x 25m	1471	32
CWD 17	Type C	1.5%	Coir TMC7	0.3	2.7	0.6	2	1.9	226	2m x 25m	674	20

Construction Notes

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2. CLEAR AWAY TRASH AND LARGE STONES, AND GRADE THE SURFACE SMOOTHLY TO ELIMINATE FOOTPRINTS, TRACKS AND RUTS.

3. IF THE CHANNEL IS TO BE GRASSED, PREPARE A SMOOTH SEED BED OF APPROXIMATELY 75MM OF TOPSOIL, SEED, FERTILISE, WATER AND RAKE TO REMOVE ANY REMAINING SURFACE IRREGULARITIES.

4. EXCAVATED A 300mm DEEP BY 150mm WIDE ANCHOR TRENCH ALONG THE FULL WIDTH OF THE UPSTREAM END OF THE AREA TO BE TREATED.

5. STAPLE THE FABRIC WITHIN THE TRENCH AT 200 TO 250mm SPACING USING 100mm WIDE BY 150mm PENETRATION LENGTH U-SHAPED, 8 TO 11 GAUGE WIRE STAPLES. NARROWER U-SECTIONS MAY EASILY TEAR THE MATTING WHEN PLACED UNDER STRESS.

6. IN LARGE DRAINAGE CHANNEL WHERE THE WIDTH OF THE CHANNEL IS MORE THAN THE WIDTH OF ONE MATT, INSTALL EACH PARALLEL MAT SUCH THAT MAT HIGHER UP THE CHANNEL BANK ALWAYS OVERLAPS THE MAT LOWER DOWN THE BANK BY AT LEAST 300mm. THIS USUALLY REQUIRES THE MATS LOCATED ALONG THE CHANNEL BED TO BE UNROLLED FIRST, FOLLOWED BY EACH CONSECUTIVE PARALLEL MAT LOCATED HIGHER UP THE CHANNEL BANK.

7. WHEN ALL MATS HAVE BEEN ANCHORED WITHIN THE TRENCH ACROSS THE FULL WIDTH OF THE TREATED AREA, THEN THE TRENCH IS BACKFILLED AND COMPACTED. THE MATS ARE THE UNROLLED DOWN THE SLOPE SUCH THAT EACH MAT COVERS AND PROTECTS THE BACKFILLED TRENCH.

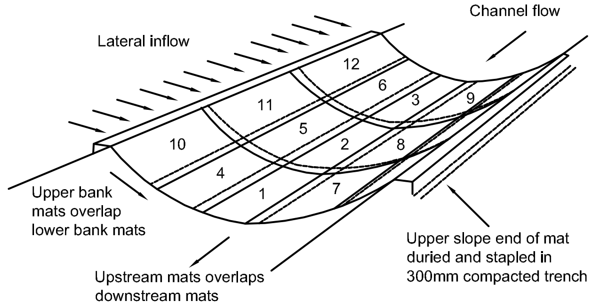
8. STAPLE THE SURFACE OF THE MATTING AT 1M CENTRES. ON IRREGULAR GROUND, ADDITIONAL STAPLES WILL BE REQUIRED WHEREVER THE MAT DOES NOT INITIALLY CONTACT THE GROUND SURFACE.

9. AT THE END OF EACH LENGTH OF MAT, A NEW TRENCH IS FORMED AT LEAST 300mm UP-SLOPE OF THE END OF THE MAT SUCH THAT THE END OF THE MAT WILL BE ABLE TO FULLY COVER THE TRENCH. A NEW ROLL OF MATTING IS THEN ANCHORED WITHIN THIS TRENCH AS PER THE FIRST MAT. AFTER THIS NEW MAT HAS BEEN UNROLLED DOWN THE SLOPE, THE UP-SLOPE MAT CAN BE PINNED IN PLACE FULLY COVERING THE NEW TRENCH AND AT LEAST 300mm OF THE DOWN-SLOPE MAT. THE PROCESS IS CONTINUED DOWN THE SLOPE UNTIL THE DESIRED AREA IS FULLY COVERED.

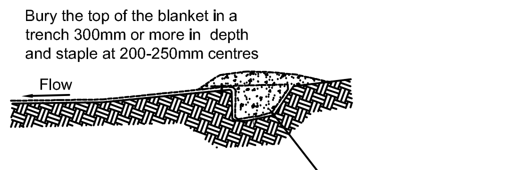
10. ANCHOR THE OUTER MOST EDGES (TOP AND UPPER MOST SIDES) OF THE TREATED AREA IN A 300mm DEEP TRENCH AND STAPLE AT 200 TO 250mm CENTRES.

11. THE INSTALLATION PROCEDURE MUST ENSURE THAT THE BLANKET ACHIEVES AND RETAINS GOOD CONTACT WITH THE SOIL.

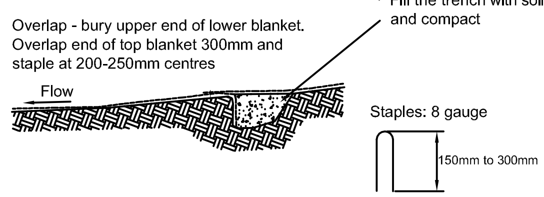
12. DAMAGED MATTING SHALL BE REPAIRED OR REPLACED.



Typical order of placement of mats



Centreline section at top of channel



Centreline section along the channel

DRAIN LINING QUANTITIES

Drain Type	Lining	Total m^2 Quantity	Indicative No. of Total Rolls Required
Type A	Earth - Firm loam soils	N/A	N/A
Type B	Geofabric	7,703	24
Type C	Coir TMC7	6,321	172
Type D	Coir TMC9	N/A	N/A
Type E	Turf	N/A	N/A
Type F	Jute Mesh	N/A	N/A
Type G	Plastic Sheeting	N/A	N/A
Type H	Loose Rock	N/A	N/A
Type J	Concrete	N/A	N/A

DRAIN LINING TYPE

Type A	Earth - Firm loam soils
Type B	Geofabric
Type C	Coir TMC7
Type D	Coir TMC9
Type E	Turf
Type F	Jute Mesh
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Type H	Loose Rock
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8 Grebe Street
Peregian Beach, QLD, 4566
t (07) 5448 3288 www.o-2.com.au

NORTH

0 20 40 60 80 100m

NTS

A3 THE SCALE SHOWN IS ORIGINAL DRAWING SCALE

MN&LD	CLIENT
MN	GLNG
ST	PROJECT
04/04/12	GLNG Operations Gas Transmission
N/A	Pipeline Marine Crossing
N/A	

TITLE
ESCP
CLEAN WATER DRAIN DETAILS

DRAWING NO. 015 REV. -

Wednesday, 6 June 2012 11:34:27 PM

GLNG GAS TRANSMISSION ESCP

DIRTY WATER DRAIN DETAILS

Drain ID	Drain Type	Slope	Lining	Base Width (m)	Top Width (m)	Depth incl. freeboard (m)	Side Slope Length	Velocity (m/s)	Length (m)	Roll Size	Square Meters	Indicative No. of Rolls
DWD 01	Type B	1.0%	Geofabric	0.3	1.9	0.4	2	1.3	415.0	4m x 150m	867	3
DWD 02	Type B	0.5%	Geofabric	0.3	1.9	0.4	2	0.7	104.0	4m x 150m	217	1
DWD 03	Type B	0.8%	Geofabric	0.3	1.5	0.3	2	0.9	210.0	4m x 150m	345	2
DWD 04	Type B	1.0%	Geofabric	0.3	1.5	0.3	2	1.0	161.0	4m x 150m	264	2
DWD 05	Type B	1.1%	Geofabric	0.3	1.5	0.3	2	0.9	97.0	4m x 150m	159	1
DWD 06	Type B	1.2%	Geofabric	0.3	1.5	0.3	2	1.0	124.0	4m x 150m	204	1
DWD 07	Type B	0.6%	Geofabric	0.3	1.9	0.4	2	1.0	322.0	4m x 150m	673	3
DWD 08	Type B	0.2%	Geofabric	0.3	2.3	0.5	2	0.6	294.0	4m x 150m	746	2
DWD 09	Type B	1.6%	Geofabric	0.3	1.5	0.3	2	1.3	283.0	4m x 150m	465	2
DWD 10a	Type B	0.5%	Geofabric	0.2	1.4	0.3	2	0.7	80.0	4m x 150m	123	1
DWD 10b	Type B	1.7%	Geofabric	0.2	1.4	0.3	2	1.2	78.0	4m x 150m	120	1
DWD 11a	Type B	0.6%	Geofabric	0.2	2.2	0.5	2	1.2	247.0	4m x 150m	602	2
DWD 11b	Type B	0.5%	Geofabric	0.2	3	0.7	2	1.4	177.0	4m x 150m	589	2
DWD 12	Type B	0.6%	Geofabric	0.2	1.8	0.4	2	0.9	400.0	4m x 150m	796	3
DWD 13	Type B	0.5%	Geofabric	0.2	1.4	0.3	2	0.7	580.0	4m x 150m	894	4
DWD 14	Type B	0.5%	Geofabric	0.2	1.8	0.4	2	0.7	310.0	4m x 150m	617	3
DWD 15	Type B	1.3%	Geofabric	0.2	1.8	0.4	2	1.2	330.0	4m x 150m	656	3
DWD 16	Type B	1.6%	Geofabric	0.2	1.4	0.3	2	1.2	276.0	4m x 150m	425	2
DWD 17	Type B	1.4%	Geofabric	0.2	1.4	0.3	2	1.2	70.0	4m x 150m	108	1
DWD 18	Type C	12.0%	Coir TMC7	0.3	1.5	0.3	2	2.9	196.0	2m x 25m	322	8
DWD 19	Type B	3.5%	Geofabric	0.2	1.4	0.3	2	1.4	40.0	4m x 150m	62	1
DWD 20	Type C	12.4%	Coir TMC7	0.2	1.4	0.3	2	2.5	113.0	2m x 25m	174	5
DWD 21	Type B	2.9%	Geofabric	0.2	1	0.2	2	1.1	336.0	4m x 150m	368	3
DWD 22	Type C	17.5%	Coir TMC7	0.2	1	0.2	2	2.6	183.0	2m x 25m	200	8
DWD 23	Type C	12.8%	Coir TMC7	0.3	1.5	0.3	2	3.1	145.0	2m x 25m	238	6

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4. EXCAVATED A 300mm DEEP BY 150mm WIDE ANCHOR TRENCH ALONG THE FULL WIDTH OF THE UPSTREAM END OF THE AREA TO BE TREATED.

5. STAPLE THE FABRIC WITHIN THE TRENCH AT 200 TO 250mm SPACING USING 100mm WIDE BY 150mm PENETRATION LENGHTH U-SHAPED, 8 TO 11 GAUGE WIRE STAPLES, NARROWER U-SECTIONS MAY EASILY TEAR THE MATTING WHEN PLACED UNDER STRESS.

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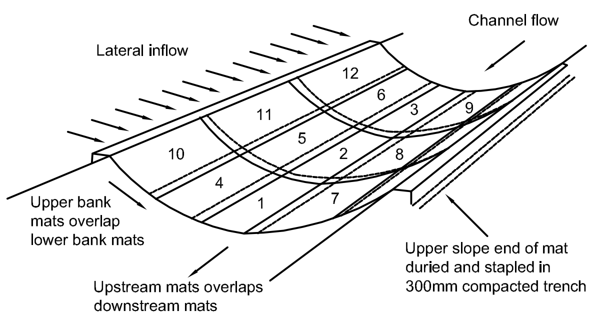
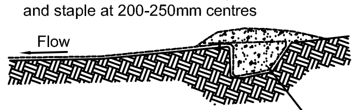


Typical order of placement of mats

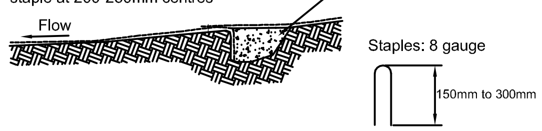
Bury the top of the blanket in a trench 300mm or more in depth and staple at 200-250mm centres



Centreline section at top of channel

Fill the trench with soil and compact

Overlap - bury upper end of lower blanket. Overlap end of top blanket 300mm and staple at 200-250mm centres



Centreline section along the channel

DRAIN LINING QUANTITIES

Drain Type	Lining	Total m^2 Quantity	Indicative No. of Total Rolls Required
Type A	Earth - Firm loam soils	N/A	N/A
Type B	Geofabric	9,299	43
Type C	Coir TMC7	934	27
Type D	Coir TMC9	N/A	N/A
Type E	Turf	N/A	N/A
Type F	Jute Mesh	N/A	N/A
Type G	Plastic Sheeting	N/A	N/A
Type H	Loose Rock	N/A	N/A
Type J	Concrete	N/A	N/A

DRAIN LINING TYPE

Type A	Earth - Firm loam soils
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Type D	Coir TMC9
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t (07) 5448 3288 www.o-2.com.au

NORTH

0 20 40 60 80 100m
NTS
A3 THE SCALE SHOWN IS ORIGINAL DRAWING SCALE

MN&LD	CLIENT GLNG	TITLE ESCP DIRTY WATER DRAIN DETAILS
MN		
ST	PROJECT	
04/04/12	GLNG Operations Gas Transmission	DRAWING NO. 016
N/A	Pipeline Marine Crossing	REV. -
N/A		

Wednesday, 6 June 2012 11:51:53 PM

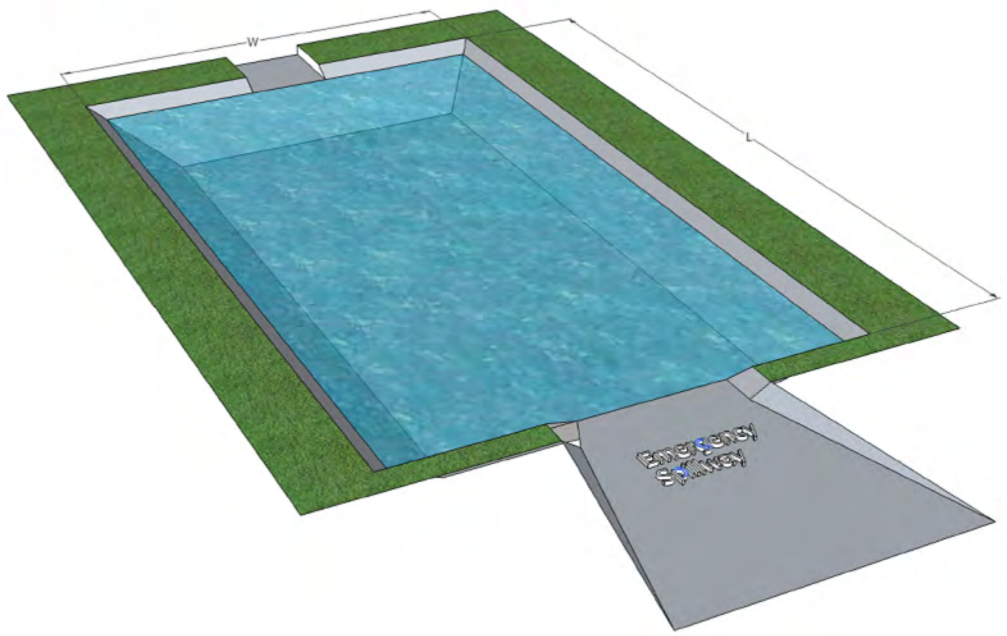
GLNG GAS TRANSMISSION ESCP

SEDIMENT BASIN DETAILS

Sediment Basin Label	Volumetric Runoff Coefficient	Catchment Area (ha)	Design Rainfall Event	Settling Zone Volume (m^3)	Sediment Storage Volume (m^3)	Total Volume at Spillway	Depth (incl. freeboard) (m)	Pond length width ratio (L/W)	Batter Slope	Freeboard (m)	Length (incl. freeboard) (m)	Width (incl. freeboard) (m)
	Cv	A	$R_{80\%ile, 5\text{-}day}$	$V_{settling}$	$V_{storage}$	V_{total}	d	L/W	a	f	L	w
SB1	0.56	1.38	32.8	253.5	23.3	276.8	1.5	3.0	3.0	0.3	35.3	13.0
SB2	0.56	1.13	32.8	207.6	11.6	219.1	1.5	3.0	3.0	0.3	32.4	12.0
SB3	0.56	0.67	32.8	123.1	6.0	129.0	1.5	3.0	3.0	0.3	27.0	10.2
SB4	0.56	7.46	32.8	1370.3	92.8	1463.1	1.5	3.0	3.0	0.3	69.5	24.4
SB5	0.56	1.01	32.8	185.5	158.9	344.4	1.5	3.0	3.0	0.3	38.4	14.0
SB6	0.56	0.51	32.8	93.7	100.0	193.6	1.5	3.0	3.0	0.3	31.0	11.5
SB7	0.56	0.39	32.8	71.6	145.1	216.7	1.5	3.0	3.0	0.3	32.3	12.0
SB8	0.56	0.96	32.8	176.3	197.6	373.9	1.5	3.0	3.0	0.3	39.6	14.4
SB9	0.56	2.23	32.8	409.6	154.6	564.2	1.5	3.0	3.0	0.3	46.6	16.7

SPILLWAY DETAILS

Sediment Basin Label	Peak Flow Entering Basin, Q (m^3/s)	Weir				Chute						Energy Dissipator			
		Base Width, b (m)	Horizontal Slope of Weir, m	Upsteam Water Level, Relative to Weir, H (m)	Min. Height with 0.30m Freeboard (m)	Base Width (m)	Side Slope	Chute Slope (m/m)	Lining	Flow Depth (m)	Required Chute Depth with 0.30m Freeboard (m)	Mean Rock Size, d50 (mm)	Width 1 (m)	Width 2 (m)	Length (m)
SB1	0.35	3.00	2	0.16	0.46	3.0	2	0.25	Concrete	0.04	0.34	100	3.7	4.0	2.1
SB2	0.38	3.00	2	0.16	0.46	3.0	2	0.25	Concrete	0.04	0.34	100	3.8	4.0	2.1
SB3	0.21	3.00	2	0.11	0.41	3.0	2	0.25	Concrete	0.03	0.33	100	3.7	3.7	1.5
SB4	2.19	9.00	2	0.26	0.56	9.0	2	0.25	Concrete	0.06	0.36	200	9.8	10.6	3.4
SB5	0.43	3.00	2	0.18	0.48	3.0	2	0.25	Concrete	0.04	0.34	100	3.8	4.0	2.1
SB6	0.23	3.00	2	0.12	0.42	3.0	2	0.25	Concrete	0.03	0.33	100	3.7	3.7	1.5
SB7	0.19	3.00	2	0.10	0.40	3.0	2	0.25	Concrete	0.03	0.33	100	3.7	0.0	0.0
SB8	0.39	3.00	2	0.16	0.46	3.0	2	0.25	Concrete	0.04	0.34	100	3.8	0.0	0.0
SB9	0.96	3.00	2	0.29	0.59	3.0	2	0.25	Concrete	0.07	0.37	200	3.9	0.0	0.0



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REV	DATE	REVISION DETAILS	APPROVED

NORTH

0 20 40 60 80 100m

NTS

A3 THE SCALE SHOWN IS ORIGINAL DRAWING SCALE

DRAWN	MN&LD
DESIGNED	MN
APPROVED	ST
DATE	04/04/12
RPEQ NO.	N/A
GRID REF.	N/A

CLIENT
GLNG

PROJECT
GLNG Operation Gas Transmission
Pipeline Marine Crossing

TITLE
ESCP
SEDIMENT BASIN DETAILS

DRAWING NO.
017

REV.
-

Appendix D Lab Results

SESL AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Soil Chemistry Profile

Mehlich 3 - Multi-nutrient Extractant

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 22163 **Sample N°: 1** **Date Received: 19/4/12** **Report Status:** ○ Draft ◉ Final

Client Name:	**O2 Environment & Engineering**	Project Name:	**Soil Sample Received 19/4/12**
Client Contact:	**Steven Chamberlain**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**Site 1 Subsoil**
Address:	**Unit 7a, 8 Grebe St Peregian Beach QLD 4573**	Description:	**Soil**
		Test Type:	**SSCP, EAT**

RECOMMENDATIONS

EAT - 3.2

This soil sample was analysed for properties related to healthy plant growth. It was found to be slightly acidic, not saline and not sodic. The cation balance is highly magnesic. The effective cation exchange capacity (eCEC) is low, indicating poor nutrient retention and holding capacity.

This sample is a light clay with low permeability. Combined with the magnicity, it may be prone to dispersion.

Magnesium is elevated and may lead to an induced potassium deficiency. To buffer against deficiencies, incorporate potassium chloride at 20 g/sqm and gypsum at 200 g/sqm. The gypsum will help to raise the low calcium levels. These additions will further help to improve permeability and negate any tendency to disperse.

SOIL SAMPLE DEPTH (mm): ○ 100 ◉ 150 ○ 200   FERTILITY RATING: ○ Low ◉ Moderate ○ High

pH and ELECTRICAL CONDUCTIVITY

Extreme Acidity	Very Strong Acidity	Strong Acidity	Medium Acidity	Slight Acidity	V. Slight Acidity	Neutral	Slight Alkalinity	Moderate Alkalinity	Strong Alkalinity	Very Strong Alkalinity

Scale: ≤4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, ≥10

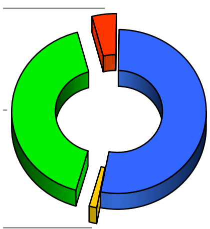
pH in H_2O †	(1:5)	6.6
pH in $CaCl_2$ †	(1:5)	5.7
Salinity†	(EC 1:5 dS/m)	0.04 Very low
Sodium (Na)†	(mg/kg)	Did not test.
Chloride (Cl)	(mg/kg)	Chloride only determined if EC (1:5) >0.25 dS/m

CATION BALANCE

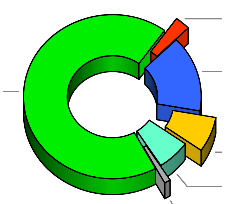
EXCHANGEABLE CATION PERCENTAGE

Note: Hydrogen only determined when pH in H_2O<6.0
Al only determined if pH in $CaCl_2$ is ≤ 5.2

Extractable Calcium (Ca) | Extractable Magnesium (Mg) | Extractable Hydrogen (H) | Exchangeable Sodium (Na) | Extractable Potassium (K) | Extractable Aluminium* (Al)



ACTUAL



IDEAL

EFFECTIVE CATION EXCHANGE CAPACITY (eCEC)

Scale: 0, 10, 20, 50, 100

8.7 Low

CATION RATIOS

Ratio	Result	Target Range
Ca:Mg	0.8	4.1 – 6.0
Comment: Potential Calcium deficiency		
Mg:K	38.3	2.6 – 5.0
Comment: Potential Potassium deficiency		
K/(Ca+Mg)	0.01	< 0.07
Comment: Acceptable		
K:Na	0.3	N/A

Sodium Absorption Ratio: 0.2 Low

Electrochemical Stability Index (ESI):
- Did not test.

SOLUBLE CATIONS (meq/100g)

Na: 0.19 K: Ca: 1.80 Mg: 2.30

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Soil Chemistry Profile

Mehlich 3 - Multi-nutrient Extractant

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
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Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 22163 | **Sample N°: 1** | **Date Received: 19/4/12** | **Report Status:** ○ Draft ◉ Final

PLANT AVAILABLE NUTRIENTS

Major Nutrients	Result (mg/kg)	Very Low / Low / Marginal / Adequate / High	Result (g/sqm)	Desirable (g/sqm)	Adjustment (g/sqm)
Nitrate-N (NO_3)	-		-	4.2	Did not test
Phosphate-P (PO_4)	0		-	12.6	Did not test
Potassium (K) †	46.9		9.4	43.9	34.5
Sulphate-S (SO_4)	-		-	13.6	13.6
Calcium (Ca) †	718		143.2	312.4	169.2
Magnesium (Mg) †	556		110.9	32.5	Drawdown
Iron (Fe)	-		-	110.1	Did not test
Manganese (Mn) †	-		-	8.8	Did not test
Zinc (Zn) †	-		-	1	Did not test
Copper (Cu)	-		-.	1.3	Did not test
Boron (B) †	-		-.	0.5	Did not test

Explanation of graph ranges:

Very Low — Growth is likely to be severely depressed and deficiency symptoms present. Large applications for soil building purposes are usually recommended. Potential response to nutrient addition is >90%.

Low — Potential "hidden hunger", or sub-clinical deficiency. Potential response to nutrient addition is 60 to 90%.

Marginal — Supply of this nutrient is barely adequate for the plant, and build-up is still recommended. Potential response to nutrient addition is 30 to 60%.

Adequate — Supply of this nutrient is adequate for the plant, and and only maintenance application rates are recommended. Potential response to nutrient addition is 5 to 30%.

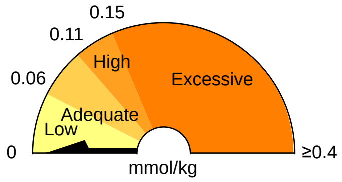
High — The level is excessive and may be detrimental to plant growth (i.e. phytotoxic) and may contribute to pollution of ground and surface waters. Drawdown is recommended. Potential response to nutrient addition is <2%.

NOTES: Adjustment recommendation calculates the elemental application to shift the soil test level to within the **Adequate** band, which maximises growth/yield, and economic efficiency, and minimises impact on the environment.

Drawdown: The objective nutrient management is to utilise residual soil nutrients. There is no agronomic reason to apply fertiliser when soil test levels exceed **Adequate**.

• g/sqm measurements are based on soil bulk density of 1.33 tonne/m^3 and selected soil depth.

Phosphorus Saturation Index



0

Low. Plant response to applied P is likely.

Exchangeable Acidity

Adams-Evans Buffer pH (BpH): **-**
Sum of Base Cations (meq/100g^{-1}): **8.7**
Eff. Cation Exch. Capacity (eCEC): **8.7**
Base Saturation (%): **100**
Exchangeable Acidity (meq/100g^{-1}): **-**
Exchangeable Acidity (%): **-**

Lime Application Rate
– to achieve pH 6.0 (g/sqm): **0**
– to neutralise Al (g/sqm): **-**

Gypsum Application Rate
– to achieve 67.5% exch. Ca (g/sqm): **392**
The CGAR is corrected for a soil depth of 150mm and any Lime addition to achieve pH 6.0.

Physical Description

Texture: **Light Clay**
Typical clay content: **35 - 40%**
Size: **Fine**
Gravel content: **Gravelly**
Aggregate strength: **Moderate**
Structural unit: **Granular**
Potential infiltration rate: **Slow**
Permeability (mm/hr): **2.5 - 5 mm/hr**
Calculated EC_{SE} (dS/m): **0.34**
– Non-saline. Salinity effects on plants are mostly negligible.
Organic Carbon (OC%)†: **Did not test**
Organic Matter (OM%): **-**
Additional comments:

Consultant: Bronwyn Woodward | **Authorised Signatory: Simon Leake** | **Date of Report: 30 Apr 2012**

B Woodward.

METHOD REFERENCES:
pH (1:5 H_2O) - Rayment & Higginson (1992) 4A1,
pH (1:5 $CaCl_2$) - Rayment & Higginson (1992) 4B1,
EC (1:5) - Rayment & Higginson (1992) 3A1,
Chloride - Rayment & Higginson (1992) 5A2,
Nitrate - Rayment & Higginson (1992) 7B1
Aluminium - SESL in-house,
PO_4, K, SO_4, Ca, Mg, Na, Fe, Mn, Zn, Cu, B - Mehlich 3 (1984),
Buffer pH and Hydrogen - Adams-Evans (1972)

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Soil Chemistry Profile

Mehlich 3 - Multi-nutrient Extractant

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Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
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Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 22163 **Sample N°: 2** **Date Received: 19/4/12** **Report Status:** ○ Draft ◉ **Final**

Client Name:	**O2 Environment & Engineering**	Project Name:	**Soil Sample Received 19/4/12**
Client Contact:	**Steven Chamberlain**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**Site 2 Subsoil**
Address:	**Unit 7a, 8 Grebe St Peregian Beach QLD 4573**	Description:	**Soil**
		Test Type:	**SSCP, EAT**

RECOMMENDATIONS

EAT - 3.2

This soil sample was analysed for properties related to healthy plant growth. It was found to be strongly acidic, not saline and not sodic. The cation balance is dominated by hydrogen, leading to the strong acidity. The high acidity has increased the availability of aluminium, which is at levels likely to result in plant toxicities. The effective cation exchange capacity (eCEC) is very low, indicating poor nutrient retention and holding capacity. This is normal for sandy soils.
This sample is a highly permeable loamy sand.
Calcium and magnesium are both deficient, and can be improved through additions of lime at 150 g/sqm. This will help to raise the pH and increase the availability of many nutrients. Raising the pH will reduce the risk of aluminium toxicity.

SOIL SAMPLE DEPTH (mm): ○ **100** ◉ **150** ○ **200** FERTILITY RATING: ○ Low ◉ Moderate ○ High

pH and ELECTRICAL CONDUCTIVITY

Extreme Acidity | Very Strong Acidity | Strong Acidity | Medium Acidity | Slight Acidity | V. Slight Acidity | Neutral | Slight Alkalinity | Moderate Alkalinity | Strong Alkalinity | Very Strong Alkalinity

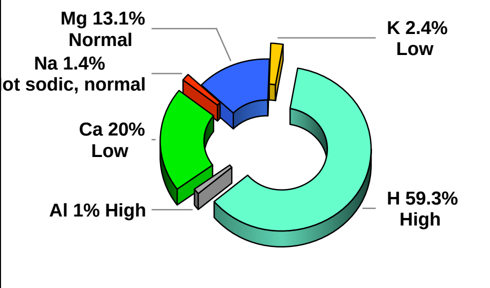
≤4.0 4.5 5.0 5.5 6.0 6.5 **7.0** 7.5 8.0 8.5 9.0 9.5 ≥10

pH in H_2O †	(1:5)	**5.7**
pH in $CaCl_2$ †	(1:5)	**4.7**
Salinity†	(EC 1:5 dS/m)	0.02 Very low
Sodium (Na)†	(mg/kg)	Did not test.
Chloride (Cl)	(mg/kg)	Chloride only determined if EC (1:5) >0.25 dS/m

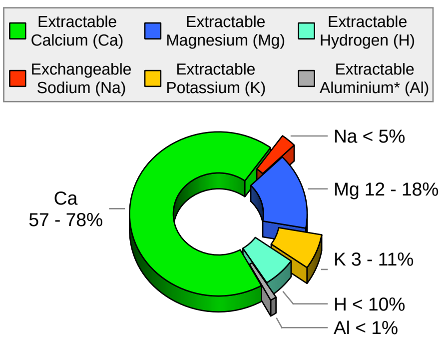
CATION BALANCE

EXCHANGEABLE CATION PERCENTAGE

Note: Hydrogen only determined when pH in H_2O<6.0
Al only determined if pH in $CaCl_2$ is ≤ 5.2



ACTUAL



IDEAL

EFFECTIVE CATION EXCHANGE CAPACITY (eCEC)

0 10 20 50 100

2.9 Very Low

CATION RATIOS

Ratio	Result	Target Range
Ca:Mg	**1.5**	4.1 – 6.0
Comment: Calcium low		
Mg:K	**5.4**	2.6 – 5.0
Comment: Potassium low		
K/(Ca+Mg)	**0.07**	< 0.07
Comment: High		
K:Na	**1.8**	N/A

Sodium Absorption Ratio: D.N.T.

Electrochemical Stability Index (ESI):
- Did not test.

SOLUBLE CATIONS (meq/100g)

Na: K: Ca: Mg:

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Soil Chemistry Profile

Mehlich 3 - Multi-nutrient Extractant

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Web: www.sesl.com.au

Quality ISO 9001

Batch N°: 22163 | **Sample N°: 2** | **Date Received: 19/4/12** | **Report Status:** ○ Draft ◉ Final

PLANT AVAILABLE NUTRIENTS

Major Nutrients	Result (mg/kg)	Very Low / Low / Marginal / Adequate / High	Result (g/sqm)	Desirable (g/sqm)	Adjustment (g/sqm)
Nitrate-N (NO_3)	-		-	4.2	Did not test
Phosphate-P (PO_4)	0		-	12.6	Did not test
Potassium (K) †	28.9		5.8	35.5	29.7
Sulphate-S (SO_4)	-		-	13.6	13.6
Calcium (Ca) †	116		23.1	252.8	229.7
Magnesium (Mg) †	45.4		9.1	26.7	17.6
Iron (Fe)	-		-	110.1	Did not test
Manganese (Mn) †	-		-	8.8	Did not test
Zinc (Zn) †	-		-	1	Did not test
Copper (Cu)	-		-.	1.3	Did not test
Boron (B) †	-		-.	0.5	Did not test

Explanation of graph ranges:

Very Low – Growth is likely to be severely depressed and deficiency symptoms present. Large applications for soil building purposes are usually recommended. Potential response to nutrient addition is >90%.

Low – Potential "hidden hunger", or sub-clinical deficiency. Potential response to nutrient addition is 60 to 90%.

Marginal – Supply of this nutrient is barely adequate for the plant, and build-up is still recommended. Potential response to nutrient addition is 30 to 60%.

Adequate – Supply of this nutrient is adequate for the plant, and and only maintenance application rates are recommended. Potential response to nutrient addition is 5 to 30%.

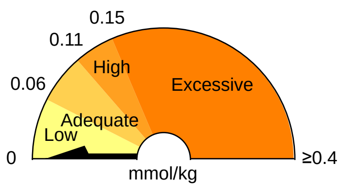
High – The level is excessive and may be detrimental to plant growth (i.e. phytotoxic) and may contribute to pollution of ground and surface waters. Drawdown is recommended. Potential response to nutrient addition is <2%.

NOTES: Adjustment recommendation calculates the elemental application to shift the soil test level to within the **Adequate** band, which maximises growth/yield, and economic efficiency, and minimises impact on the environment.

Drawdown: The objective nutrient management is to utilise residual soil nutrients. There is no agronomic reason to apply fertiliser when soil test levels exceed **Adequate**.

• g/sqm measurements are based on soil bulk density of 1.33 tonne/m³ and selected soil depth.

Phosphorus Saturation Index



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Low. Plant response to applied P is likely.

Exchangeable Acidity

Adams-Evans Buffer pH (BpH):	**7.7**
Sum of Base Cations (meq/100g^{-1}):	**1.1**
Eff. Cation Exch. Capacity (eCEC):	**2.9**
Base Saturation (%):	**37.93**
Exchangeable Acidity (meq/100g^{-1}):	**1.72**
Exchangeable Acidity (%):	**59.31**

Lime Application Rate

– to achieve pH 6.0 (g/sqm): **150**
– to neutralise Al (g/sqm): **4**

Gypsum Application Rate

– to achieve 67.5% exch. Ca (g/sqm): **0**
The CGAR is corrected for a soil depth of 150mm and any Lime addition to achieve pH 6.0.

Physical Description

Texture:	**Loamy Sand**
Typical clay content:	**5 - 10%**
Size:	**Fine**
Gravel content:	**Not gravelly**
Aggregate strength:	**Weak**
Structural unit:	**Crumb**
Potential infiltration rate:	**Very Rapid**
Permeability (mm/hr):	**>120 mm/hr**
Calculated EC_{SE} (dS/m):	**0.46**

– Non-saline. Salinity effects on plants are mostly negligible.

Organic Carbon (OC%)†: **Did not test**
Organic Matter (OM%): **-**
Additional comments:

Consultant: Bronwyn Woodward

BWoodward.

Authorised Signatory: Simon Leake

Date of Report: 30 Apr 2012

METHOD REFERENCES:
pH (1:5 H_2O) - Rayment & Higginson (1992) 4A1,
pH (1:5 $CaCl_2$) - Rayment & Higginson (1992) 4B1,
EC (1:5) - Rayment & Higginson (1992) 3A1,
Chloride - Rayment & Higginson (1992) 5A2,
Nitrate - Rayment & Higginson (1992) 7B1
Aluminium - SESL in-house,
PO_4, K, SO_4, Ca, Mg, Na, Fe, Mn, Zn, Cu, B - Mehlich 3 (1984),
Buffer pH and Hydrogen - Adams-Evans (1972)

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Soil Chemistry Profile

Mehlich 3 - Multi-nutrient Extractant

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
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Certified System Quality ISO 9001

Batch N°: 22163 **Sample N°: 3** **Date Received: 19/4/12** **Report Status:** ○ Draft ◉ Final

Client Name:	**O2 Environment & Engineering**	Project Name:	**Soil Sample Received 19/4/12**
Client Contact:	**Steven Chamberlain**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**Site 2 Topsoil**
Address:	**Unit 7a, 8 Grebe St Peregian Beach QLD 4573**	Description:	**Soil**
		Test Type:	**RSCP**

RECOMMENDATIONS

This soil sample was analysed for properties related to healthy plant growth. It was found to be moderately acidic, not saline and not sodic. The cation balance is dominated by hydrogen, leading to the strong acidity. The effective cation exchange capacity (eCEC) is very low, indicating poor nutrient retention and holding capacity (as expected of sandy soils).
This sample is a highly permeable loamy sand. Of the plant available nutrients analysed, all were deficient. N in particular will prove limiting at these low levels. Split applications of urea at 20 g/m2 (i.e. 2 x 20 g/sqm applications) will improve the nitrate levels.
To improve levels of other nutrients, apply a multipurpose low P NPK fertiliser such as "native plant food". This product should be applied at 15 - 25 g/sqm. Current phosphate levels will not be harmful to P-sensitive plantings. Incorporating lime at 200 g/sqm will help to raise the pH and increase nutrient availability. Incorporating composted organic matter at 20% by volume will assist in improving the water holding capacity and CEC of the soil.

SOIL SAMPLE DEPTH (mm): ○ **100** ◉ **150** ○ **200**   FERTILITY RATING: ○ Low ◉ Moderate ○ High

pH and ELECTRICAL CONDUCTIVITY

Extreme Acidity	Very Strong Acidity	Strong Acidity	Medium Acidity	Slight Acidity	V. Slight Acidity	Neutral	Slight Alkalinity	Moderate Alkalinity	Strong Alkalinity	Very Strong Alkalinity

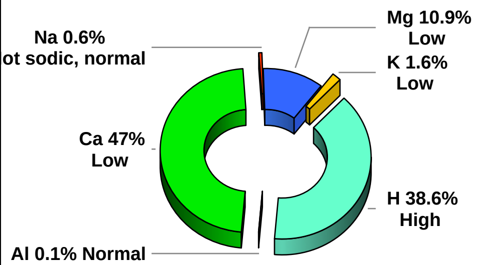
≤4.0 4.5 5.0 5.5 6.0 6.5 **7.0** 7.5 8.0 8.5 9.0 9.5 ≥10

Parameter		Result
pH in H_2O †	(1:5)	5.8
pH in $CaCl_2$ †	(1:5)	5
Salinity†	(EC 1:5 dS/m)	0.04 Very low
Sodium (Na)†	(mg/kg)	Did not test.
Chloride (Cl)	(mg/kg)	Chloride only determined if EC (1:5) >0.25 dS/m

CATION BALANCE

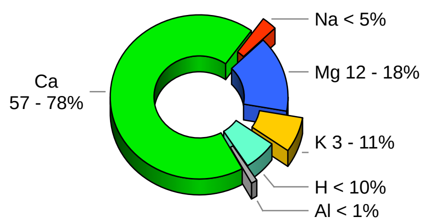
EXCHANGEABLE CATION PERCENTAGE

Note: Hydrogen only determined when pH in H_2O<6.0
Al only determined if pH in $CaCl_2$ is ≤ 5.2



ACTUAL

Extractable Calcium (Ca) · Extractable Magnesium (Mg) · Extractable Hydrogen (H) · Exchangeable Sodium (Na) · Extractable Potassium (K) · Extractable Aluminium* (Al)



IDEAL

EFFECTIVE CATION EXCHANGE CAPACITY (eCEC)

0 10 20 50 100

7.9 Very Low

CATION RATIOS

Ratio	Result	Target Range
Ca:Mg	**4.3**	4.1 – 6.0
Comment: Balanced		
Mg:K	**6.6**	2.6 – 5.0
Comment: Potassium low		
K/(Ca+Mg)	**0.03**	< 0.07
Comment: Acceptable		
K:Na	**2.6**	N/A

Sodium Absorption Ratio: D.N.T.

Electrochemical Stability Index (ESI):
- Did not test.

SOLUBLE CATIONS (meq/100g)

Na: K: Ca: Mg:

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Soil Chemistry Profile

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Certified System Quality ISO 9001

Batch N°: 22163 | **Sample N°: 3** | **Date Received: 19/4/12** | **Report Status:** ○ Draft ◉ Final

PLANT AVAILABLE NUTRIENTS

Major Nutrients	Result (mg/kg)	Very Low / Low / Marginal / Adequate / High	Result (g/sqm)	Desirable (g/sqm)	Adjustment (g/sqm)
Nitrate-N (NO_3)	9		1.8	4.2	2.4
Phosphate-P (PO_4)	6.3		1.3	12.6	11.3
Potassium (K) †	51.6		10.3	43.9	33.6
Sulphate-S (SO_4)	<3.20		0.6	13.6	13
Calcium (Ca) †	741		147.8	312.4	164.6
Magnesium (Mg) †	104		20.7	32.5	11.8
Iron (Fe)	-		-	110.1	Did not test
Manganese (Mn) †	-		-	8.8	Did not test
Zinc (Zn) †	-		-	1	Did not test
Copper (Cu)	-		-.	1.3	Did not test
Boron (B) †	-		-.	0.5	Did not test

Explanation of graph ranges:

Very Low
Growth is likely to be severely depressed and deficiency symptoms present. Large applications for soil building purposes are usually recommended. Potential response to nutrient addition is >90%.

Low
Potential "hidden hunger", or sub-clinical deficiency. Potential response to nutrient addition is 60 to 90%.

Marginal
Supply of this nutrient is barely adequate for the plant, and build-up is still recommended. Potential response to nutrient addition is 30 to 60%.

Adequate
Supply of this nutrient is adequate for the plant, and and only maintenance application rates are recommended. Potential response to nutrient addition is 5 to 30%.

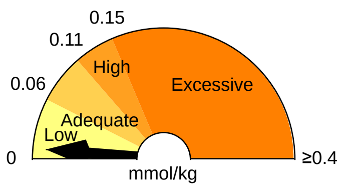
High
The level is excessive and may be detrimental to plant growth (i.e. phytotoxic) and may contribute to pollution of ground and surface waters. Drawdown is recommended. Potential response to nutrient addition is <2%.

NOTES: Adjustment recommendation calculates the elemental application to shift the soil test level to within the **Adequate** band, which maximises growth/yield, and economic efficiency, and minimises impact on the environment.

Drawdown: The objective nutrient management is to utilise residual soil nutrients. There is no agronomic reason to apply fertiliser when soil test levels exceed **Adequate**.

• g/sqm measurements are based on soil bulk density of 1.33 tonne/m³ and selected soil depth.

Phosphorus Saturation Index



0.01

Low. Plant response to applied P is likely.

Exchangeable Acidity

Adams-Evans Buffer pH (BpH):	**7.5**
Sum of Base Cations (meq/100g^{-1}):	**4.8**
Eff. Cation Exch. Capacity (eCEC):	**7.9**
Base Saturation (%):	**60.76**
Exchangeable Acidity (meq/100g^{-1}):	**3.05**
Exchangeable Acidity (%):	**38.61**

Lime Application Rate

– to achieve pH 6.0 (g/sqm): **230**
– to neutralise Al (g/sqm): **1**

Gypsum Application Rate

– to achieve 67.5% exch. Ca (g/sqm): **0**
The CGAR is corrected for a soil depth of 150mm and any Lime addition to achieve pH 6.0.

Physical Description

Texture:	**Sandy Loam**
Typical clay content:	**10 - 20%**
Size:	**Fine**
Gravel content:	**Not gravelly**
Aggregate strength:	**Weak**
Structural unit:	**Crumb**
Potential infiltration rate:	**Rapid**
Permeability (mm/hr):	**60 - 120 mm/hr**
Calculated EC_{SE} (dS/m):	**0.56**

– Non-saline. Salinity effects on plants are mostly negligible.

Organic Carbon (OC%)†: **Did not test**
Organic Matter (OM%): **-**
Additional comments:

Consultant: Bronwyn Woodward

BWoodward.

Authorised Signatory: Simon Leake

Date of Report: 30 Apr 2012

METHOD REFERENCES:
pH (1:5 H_2O) - Rayment & Higginson (1992) 4A1,
pH (1:5 $CaCl_2$) - Rayment & Higginson (1992) 4B1,
EC (1:5) - Rayment & Higginson (1992) 3A1,
Chloride - Rayment & Higginson (1992) 5A2,
Nitrate - Rayment & Higginson (1992) 7B1
Aluminium - SESL in-house,
PO_4, K, SO_4, Ca, Mg, Na, Fe, Mn, Zn, Cu, B - Mehlich 3 (1984),
Buffer pH and Hydrogen - Adams-Evans (1972)

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AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Soil Chemistry Profile

Mehlich 3 - Multi-nutrient Extractant

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 22163 | **Sample N°: 4** | **Date Received: 19/4/12** | **Report Status:** ○ Draft ◉ **Final**

Client Name:	**O2 Environment & Engineering**	Project Name:	**Soil Sample Received 19/4/12**
Client Contact:	**Steven Chamberlain**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**Site 3 Topsoil**
Address:	**Unit 7a, 8 Grebe St Peregian Beach QLD 4573**	Description:	**Soil**
		Test Type:	**RSCP**

RECOMMENDATIONS

This soil sample was analysed for properties related to healthy plant growth. It was found to be moderately acidic, not saline and not sodic. The cation balance is highly magnesic. The effective cation exchange capacity (eCEC) is moderate, indicating good nutrient retention and holding capacity.

This sample is a highly permeable loamy sand. Of the plant available nutrients analysed, all except magnesium were deficient. N in particular will prove limiting at these low levels. Use split applications of urea at 20 g/m2 (i.e. 2 x 20 g/sqm applications) to improve the nitrate levels.

Magnesium is elevated and may lead to an induced potassium deficiency. Incorporate composted organic matter at 20% by volume and gypsum at 200 g/sqm to raise the low calcium levels and improve the water holding capacity of the soil. These additions will further help to improve permeability and negate any tendency to disperse.

To improve nutrient levels, apply a multipurpose low P NPK fertiliser such as "native plant food". This product should be applied at 15 - 25 g/sqm. Current phosphate levels will not be harmful to P-sensitive plantings. Incorporating lime at 200 g/sqm will help to raise the pH and increase nutrient availability.

SOIL SAMPLE DEPTH (mm): ○ **100** ◉ **150** ○ **200**   FERTILITY RATING: ○ Low ◉ Moderate ○ High

pH and ELECTRICAL CONDUCTIVITY

Extreme Acidity	Very Strong Acidity	Strong Acidity	Medium Acidity	Slight Acidity	V. Slight Acidity	Neutral	Slight Alkalinity	Moderate Alkalinity	Strong Alkalinity	Very Strong Alkalinity

≤4.0 4.5 5.0 5.5 6.0 6.5 **7.0** 7.5 8.0 8.5 9.0 9.5 ≥10

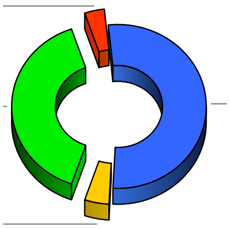
pH in H_2O †	(1:5)	**6.3**
pH in $CaCl_2$ †	(1:5)	**5.4**
Salinity†	(EC 1:5 dS/m)	0.05 Very low
Sodium (Na)†	(mg/kg)	Did not test.
Chloride (Cl)	(mg/kg)	Chloride only determined if EC (1:5) >0.25 dS/m

CATION BALANCE

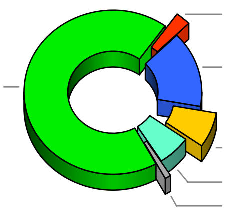
EXCHANGEABLE CATION PERCENTAGE

Note: Hydrogen only determined when pH in H_2O<6.0
Al only determined if pH in $CaCl_2$ is ≤ 5.2

Extractable Calcium (Ca) | Extractable Magnesium (Mg) | Extractable Hydrogen (H) | Exchangeable Sodium (Na) | Extractable Potassium (K) | Extractable Aluminium* (Al)



ACTUAL



IDEAL

EFFECTIVE CATION EXCHANGE CAPACITY (eCEC)

0 **10** **20** **50** **100**

15.8 Moderate

CATION RATIOS

Ratio	Result	Target Range
Ca:Mg	**0.8**	4.1 – 6.0
Comment: Potential Calcium deficiency		
Mg:K	**12.2**	2.6 – 5.0
Comment: Potential Potassium deficiency		
K/(Ca+Mg)	**0.05**	< 0.07
Comment: Acceptable		
K:Na	**1.2**	N/A

Sodium Absorption Ratio: D.N.T.

Electrochemical Stability Index (ESI):
- Did not test.

SOLUBLE CATIONS (meq/100g)

Na: K: Ca: Mg:

ASPAC

A member of the Australasian Soil and Plant Analysis Council
† This laboratory has been awarded a Certificate of Proficiency for specific soil and plant tissue analyses by the Australasian Soil and Plant Analysis Council (ASPAC). Tests for which proficiency has been demonstrated are highlighted in this report.

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Soil Chemistry Profile

Mehlich 3 - Multi-nutrient Extractant

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Certified System Quality ISO 9001

Batch N°: 22163 **Sample N°: 4** **Date Received: 19/4/12** **Report Status:** ○ Draft ◉ Final

PLANT AVAILABLE NUTRIENTS

Major Nutrients	Result (mg/kg)	Very Low / Low / Marginal / Adequate / High	Result (g/sqm)	Desirable (g/sqm)	Adjustment (g/sqm)
Nitrate-N (NO_3)	0.2		0	4.2	4.2
Phosphate-P (PO_4)	25.4		5.1	12.6	7.5
Potassium (K) †	267		53.3	60.6	7.3
Sulphate-S (SO_4)	<3.20		0.6	13.6	13
Calcium (Ca) †	1246		248.6	431.7	183.1
Magnesium (Mg) †	1002		199.9	44.9	Drawdown
Iron (Fe)	-		-	110.1	Did not test
Manganese (Mn) †	-		-	8.8	Did not test
Zinc (Zn) †	-		-	1	Did not test
Copper (Cu)	-		-.	1.3	Did not test
Boron (B) †	-		-.	0.5	Did not test

Explanation of graph ranges:

Very Low Growth is likely to be severely depressed and deficiency symptoms present. Large applications for soil building purposes are usually recommended. Potential response to nutrient addition is >90%.

Low Potential "hidden hunger", or sub-clinical deficiency. Potential response to nutrient addition is 60 to 90%.

Marginal Supply of this nutrient is barely adequate for the plant, and build-up is still recommended. Potential response to nutrient addition is 30 to 60%.

Adequate Supply of this nutrient is adequate for the plant, and and only maintenance application rates are recommended. Potential response to nutrient addition is 5 to 30%.

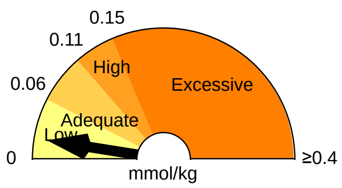
High The level is excessive and may be detrimental to plant growth (i.e. phytotoxic) and may contribute to pollution of ground and surface waters. Drawdown is recommended. Potential response to nutrient addition is <2%.

NOTES: Adjustment recommendation calculates the elemental application to shift the soil test level to within the **Adequate** band, which maximises growth/yield, and economic efficiency, and minimises impact on the environment.

Drawdown: The objective nutrient management is to utilise residual soil nutrients. There is no agronomic reason to apply fertiliser when soil test levels exceed **Adequate**.

• g/sqm measurements are based on soil bulk density of 1.33 tonne/m³ and selected soil depth.

Phosphorus Saturation Index



0.02

Low. Plant response to applied P is likely.

Exchangeable Acidity

Adams-Evans Buffer pH (BpH): **7.3**
Sum of Base Cations (meq/100g^{-1}): **15.8**
Eff. Cation Exch. Capacity (eCEC): **15.8**
Base Saturation (%): **100**
Exchangeable Acidity (meq/100g^{-1}): **-**
Exchangeable Acidity (%): **-**

Lime Application Rate

– to achieve pH 6.0 (g/sqm): **0**
– to neutralise Al (g/sqm): **-**

Gypsum Application Rate

– to achieve 67.5% exch. Ca (g/sqm): **761**
The CGAR is corrected for a soil depth of 150mm and any Lime addition to achieve pH 6.0.

Physical Description

Texture: **Loam**
Typical clay content: **10 - 25%**
Size: **Fine**
Gravel content: **Gravelly**
Aggregate strength: **Moderate**
Structural unit: **Granular**
Potential infiltration rate: **Rapid**
Permeability (mm/hr): **60 - 120 mm/hr**
Calculated EC_{SE} (dS/m): **0.48**
– Non-saline. Salinity effects on plants are mostly negligible.
Organic Carbon (OC%)†: **Did not test**
Organic Matter (OM%): **-**
Additional comments:

Consultant: Bronwyn Woodward

BWoodward.

Authorised Signatory: Simon Leake

Date of Report: 30 Apr 2012

METHOD REFERENCES:
pH (1:5 H_2O) - Rayment & Higginson (1992) 4A1,
pH (1:5 $CaCl_2$) - Rayment & Higginson (1992) 4B1,
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Chloride - Rayment & Higginson (1992) 5A2,
Nitrate - Rayment & Higginson (1992) 7B1
Aluminium - SESL in-house,
PO_4, K, SO_4, Ca, Mg, Na, Fe, Mn, Zn, Cu, B - Mehlich 3 (1984),
Buffer pH and Hydrogen - Adams-Evans (1972)

Appendix E Sediment Basin Construction and Operation Procedure

Standard Construction and Operation Procedure for Type F or Type D Sediment Basins

CLIENT:

STATUS:
Draft

REPORT NUMBER
Uncontrolled
Version d

ISSUE DATE:
June 2012

Important Note

Use of this document, including all attachments, requires professional interpretation and judgement. Appropriate operation and use of sediment basins may require variation to the methods described due to site specific circumstances.

No warranty or guarantee, express, implied, or statutory is made as to the accuracy, reliability, suitability, or results of the methods or recommendations provided herein. O2 waives all liability to any loss, damage, liability or claim arising out of or incidental to a third party publishing, using or relying on the facts, content, opinions or subject matter contained in this document.

Compliance with this procedure will not guarantee:

(i) Compliance with any statutory obligations
(ii) Compliance with specific water quality objectives
(iii) Avoidance of environmental harm or nuisance.

Version Register

Issue	Author	Reviewer	Change Notes	Authorised for Release	
				Signature	Date
a	Terry Clark	Ben Starr	Correct flowchart	Ben Starr	23 Mar 2010
b	Ben Starr	Ben Starr	Update Section 5	Ben Starr	11 Nov 2010
c	Ben Starr	Ben Starr	Added Construction and Maintenance Section and Annexures	Ben Starr	05 Dec 2010
D	Kyle Robson	Steve Dudgeon	pH value changed	Kyle Robson	23 Sep 2011
E	Steve Dudgeon	Steve Dudgeon	Add additional info flocculants	Steve Dudgeon	1 June 2012

Transmission Register

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Name	Email Address
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Table of Contents

1. Introduction

This guideline applies specifically to the construction and operation of a Wet Type F (fine grained soils) or Type D (dispersive soils) sediment basin/s in South East Queensland. The document provides default construction specifications and outlines requirements for monitoring, treatment and discharge of sediment laden water from the basin/s (refer **Figure 1**) on site sized to detain a 5 day, 80th percentile rainfall event.

This guideline does not provide any site specific design information for sediment basins, including sizing, batter slopes, spillway weir, chute dimensions and stabilization requirements or energy dissipater requirements. The location, sizing and design of the sediment basin if required must be specified in the contractor's erosion and sediment control plan prepared by a Certified Professional in Erosion and Sediment Control (CPESC). Where any other specification, local requirement, or detail design requirement conflicts with the specifications of this guideline, those other local requirements override any guidelines recommended here.

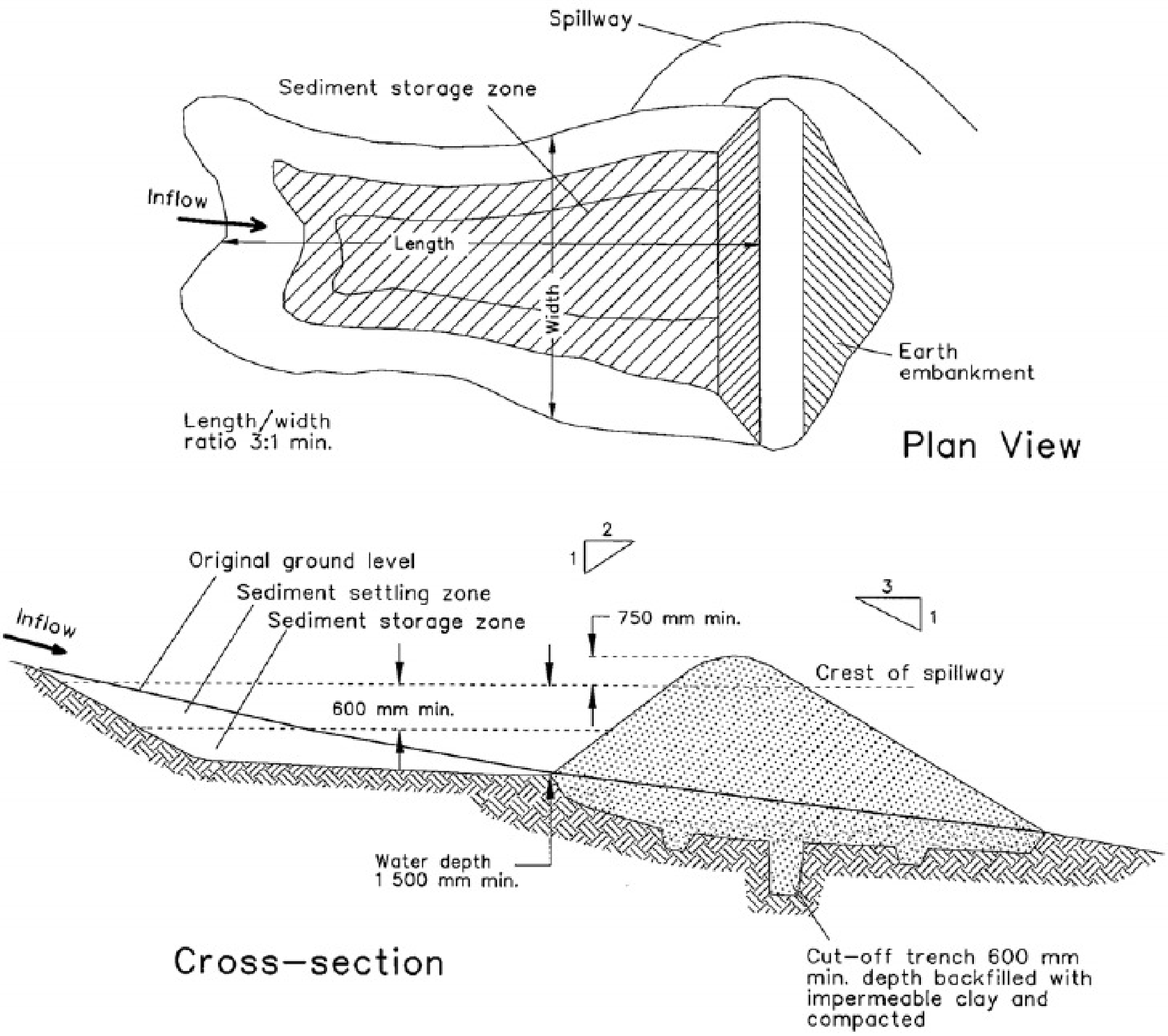

Figure 1 – Standard Drawing of Sediment Basin (Landcom 2004)

2. Sediment Basin Construction and Maintenance

The Basin Construction and Maintenance standard specifications provided in Section 2 of this report are reproduced from Section B3 of IECA 2008 “Best Practice Erosion and Sediment Control” document. This document should be referred to for additional supporting technical information relating to Basin monitoring and maintenance.

Appropriate construction, operation and maintenance of *Sediment Basins* is a critical component of construction site management and environmental protection.

Attached to the end of this section is an example "*Certification of Basin Construction*" form. This, or an equivalent form, should be submitted to the relevant regulatory authority for each Sediment Basin constructed. Regulatory authorities are encouraged to require the submission of such forms, as well as *As-constructed Plans*, as mandatory for all *sediment basins*.

2.1. Default specifications for Sediment Basin construction:

2.1.1. Materials

- Earth fill: clean soil with Emerson Class 2(1), 3, 4, or 5, and free of roots, woody vegetation, rocks and other unsuitable material. Soil with Emerson Class 4 and 5 may not be suitable depending on particle size distribution and degree of dispersion. Class 2(1) should only be used upon recommendation from geotechnical specialist. [*Alternatively, set a standard based on exchangeable sodium percentage - seek expert advice.*]

- Spillway rock: hard, angular, durable, weather resistant and evenly graded rock with 50% by weight larger than the specified nominal (d50) rock size. Large rock should dominate, with sufficient small rock to fill the voids between the larger rock. The diameter of the largest rock size should be no larger than 1.5 times the nominal rock size. The specific gravity should be at least 2.5.

- Geotextile fabric: heavy-duty, needle-punched, non-woven filter cloth, minimum bidim A24 or equivalent.

2.1.2. Construction

1. Notwithstanding any description contained within the approved plans or specifications, the Contractor shall be responsible for satisfying themselves as to the nature and extent of the specified works and the physical and legal conditions under which the works will be carried out. This shall include means of access, extent of clearing, nature of material to be excavated, type and size of mechanical plant required, location and suitability of water supply for construction and testing purposes, and any other like matters affecting the construction of the works.

2. Refer to approved plans for location, dimensions, and construction details. If there are questions or problems with the location, dimensions, or method of installation, contact the engineer or responsible on-site officer for assistance.

3. Before starting any clearing or construction, ensure all the necessary materials and components are on the site to avoid delays in completing the pond once works begin.

4. Install required short-term sediment control measures downstream of the proposed earthworks to control sediment runoff during construction of the basin.

5. The area to be covered by the embankment, borrow pits and incidental works, together with an area extending beyond the limits of each for a distance not exceeding five (5) metres all around must be cleared of all trees, scrub, stumps, roots, dead timber and rubbish and disposed of in a

suitable manner. Delay clearing the main pond area until the embankment is complete. [modify as necessary to limit total area of disturbance and any damage to protected vegetation]

6. Ensure all holes made by grubbing within the embankment footprint are filled with sound material, adequately compacted, and finished flush with the natural surface.

2.1.3. Cut-off trench:

7. Before construction of the cut-off trench or any ancillary works within the embankment footprint, all grass growth and topsoil must be removed from the area to be occupied by the embankment and must be deposited clear of this area and reserved for topdressing the completing the embankment.

8. Excavate a cut-off trench along the centre line of the earth fill embankment. Cut the trench to stable soil material, but in no case make it less than 600mm deep. The cut-off trench must extend into both abutments to at least the elevation of the riser pipe crest. Make the minimum bottom width wide enough to permit operation of excavation and compaction equipment, but in no case less than 600mm. Make the side slopes of the trench no steeper than 1:1 (H:V).

9. Ensure all water, loose soil, and rock are removed from the trench before backfilling commences. The cut-off trench must be backfilled with selected earth-fill of the type specified for the embankment, and this soil must have a moisture content and degree of compaction the same as that specified for the selected core zone.

10. Material excavated from the cut-off trench may be used in construction of the embankment provided it is suitable and it is placed in the correct zone according to its classification.

2.1.4. Embankment:

11. Scarify areas on which fill is to be placed before placing the fill.

12. Ensure all fill material used to form the embankment meets the specifications certified by a soil scientist or geotechnical specialist.

13. The fill material must contain sufficient moisture so it can be formed by hand into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compaction. Place fill material in 150 to 250mm continuous layers over the entire length of the fill area and then compact before placement of further fill.

14. Unless otherwise specified on the approved plans, compact the soil at about 1% to 2% wet of optimum and to 95% modified or 100% standard compaction.

15. Where both dispersive and non-dispersive classified earth-fill materials are available, non-dispersive earth-fill must be used in the core zone. The remaining classified earth-fill materials must only be used as directed by a geotechnical specialist.

16. Where specified, construct the embankment to an elevation 10% higher than the design height to allow for settling; otherwise finished dimensions of the embankment after spreading of topsoil must conform to the drawing with a tolerance of 75mm from the specified dimensions.

17. Ensure debris and other unsuitable building waste is not placed within the earth embankment.

18. After completion of the embankment all loose uncompacted earth-fill material on the upstream and downstream batter must be removed prior to spreading of topsoil.

19. Topsoil and revegetate/stabilised all exposed earth as directed within the approved plans.

2.1.5. Spillway construction:

20. The spillway must be excavated as shown on the plans, and the excavated material if classified as suitable, must be used in the embankment, and if not suitable it must be disposed of into spoil heaps.

21. Ensure excavated dimensions allow adequate boxing-out such that the specified elevations, grades, chute width, and entrance and exit slopes for the emergency spillway will be achieved after placement of the rock or other scour protection measures as specified in the plans.

22. Place specified scour protection measures on the emergency spillway. Ensure the finished grade blends with the surrounding area to allow a smooth flow transition from spillway to downstream channel.

23. If a synthetic filter fabric underlay is specified, place the filter fabric directly on the prepared foundation. If more than 1 sheet of filter fabric is required, overlap the edges by at least 300mm and place anchor pins at minimum 1m spacing along the overlap. Bury the upstream end of the fabric a minimum 300mm below ground and where necessary, bury the lower end of the fabric or overlap a minimum 300mm over the next downstream section as required. Ensure the filter fabric extends at least 1000mm upstream of the spillway crest.

24. Take care not to damage the fabric during or after placement. If damage occurs, remove the rock and repair the sheet by adding another layer of fabric with a minimum overlap of 300mm around the damaged area. If extensive damage is suspected, remove and replace the entire sheet.

25. Where large rock is used, or machine placement is difficult, a minimum 100m layer of fine gravel, aggregate, or sand may be needed to protect the fabric.

26. Placement of rock should follow immediately after placement of the filter fabric. Place rock so that it forms a dense, well-graded mass of rock with a minimum of voids. The desired distribution of rock throughout the mass may be obtained by selective loading at the quarry and controlled dumping during final placement.

27. The finished slope should be free of pockets of small rock or clusters of large rocks. Hand placing may be necessary to achieve the proper distribution of rock sizes to produce a relatively smooth, uniform surface. The finished grade of the rock should blend with the surrounding area. No overfall or protrusion of rock should be apparent.

28. Ensure that the final arrangement of the spillway crest will not promote excessive flow through the rock such that the water can be retained within the settling basin an elevation no less than 50mm above or below the nominated spillway crest elevation.

2.1.6. Establishment of settling pond:

29. The area to be covered by the stored water outside the limits of the borrow pits must be cleared of all scrub and rubbish. Trees must be cut down stump high and removed from the immediate vicinity of the work.

30. Establish all required inflow chutes and inlet baffles, if specified, to enable water to discharge into the basin in a manner that will not cause soil erosion or the re- suspension of settled sediment.

31. Install a sediment storage level marker post with a cross member set just below the top of the sediment storage zone (as specified on the approved plans). Use at least a 75mm wide post firmly set into the basin floor.

32. If specified, install internal settling pond baffles. Ensure the crest of these baffles is set level with, or just below, the elevation of the emergency spillway crest.

33. Install all appropriate measures to minimise safety risk to on-site personnel and the public caused by the presence of the settling pond. Avoid steep, smooth internal slopes. Appropriately fence the settling pond and post warning signs if unsupervised public access is likely or there is considered to be an unacceptable risk to the public.

2.1.7. Maintenance of Sediment Basin

1. Inspect the sediment basin during the following periods:

   (i) During construction to determine whether machinery, falling trees, or construction activity has damaged any components of the sediment basin. If damage has occurred, repair it.

   (ii) After each runoff event. Inspect the erosion damage at flow entry and exit points. If damage has occurred, make the necessary repairs.

   (iii) At least weekly during the nominated wet season (if any) otherwise at least fortnightly.

   (iv) Prior to, and immediately after, periods of "stop work" or site "shutdown".

2. Clean out accumulated sediment when it reaches the marker board/post, and restore the original storage volume. Place sediment in a disposal area or, if appropriate, mix with dry soil on the site.

3. Do not dispose of sediment in a manner that will create an erosion or pollution hazard.

4. Check all visible pipe connections for leaks, and repair as necessary.

5. Check fill material in the dam for excessive settlement, slumping of the slopes or piping between the conduit and the embankment; make all necessary repairs.

6. Remove all trash and other debris from the basin and riser.

7. Submerged inflow pipes must be inspected and de-silted (as required) after each inflow event.

2.1.8. Removal of Sediment Basin

1. When grading and construction in the drainage area above a temporary sediment basin is completed and the disturbed areas are adequately stabilised, the basin must be removed or otherwise incorporated into the permanent stormwater drainage system. In either case, sediment should be cleared and properly disposed of and the basin area stabilised.

2. Before starting any maintenance work on the basin or spillway, install all necessary short-term sediment control measures downstream of the sediment basin.

3. All water and sediment must be removed from the basin prior to the dam's removal. Dispose of sediment and water in a manner that will not create an erosion or pollution hazard.

4. Bring the disturbed area to a proper grade, then smooth, compact, and stabilise and/or revegetate as required to establish a stable land surface.

3. Sediment Basin Operation

Type F and Type D sediment basins operate as 'wet' basins, Wet basins are designed to retain sediment laden water, allowing adequate time for the settlement of fine particles, either by gravitational means or use of chemical flocculants. In operating a wet basin the settled/treated water must be decanted from the basin as soon as a suitable water quality is achieved.

Type F and Type D sediment basins are typically designed for a maximum 5 day cycle; that being the filling, treatment and discharge of the basin within a maximum 5 day period.

The sediment basin procedure described in **Figure 2** below should be carried out daily, prior to commencement of works on site. If water is above the sediment storage zone in the basin, treatment, sampling and discharge should be achieved in the following 48 hours.

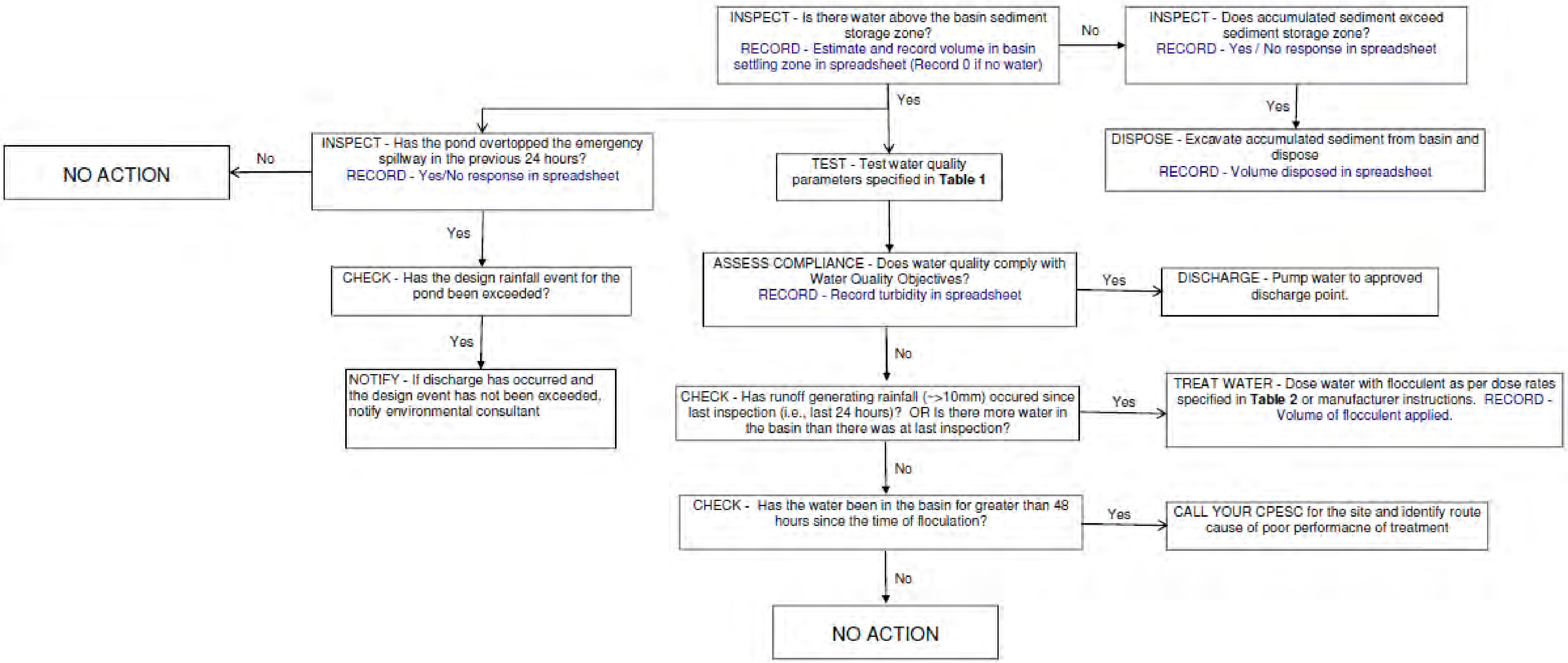

Figure 2 – Sediment Basin Procedure (Do Daily)

3.1. Monitoring

Monitoring of water quality in the sediment basin/s is to be conducted daily by the Contractors representative or other suitably qualified third party following runoff generating rainfall or when the water level is above the sediment storage zone. The site foreman is responsible for notifying the responsible party of such conditions. Recording and reporting of results is to be carried out as per **Section 4**.

Water quality is to be assessed against objectives outlined in **Table 1.**

Samples should be collected from the base of the settling zone and not at the surface; this may be achieved using a sample bottle fastened to the end of a pole. The bottle should be pushed with the opening facing down until it is submerged to the base of the settling zone. The sample can then be recovered and decentered into a sample bottle for submission to a laboratory or testing on site with a probe.

Until a site specific relationship is developed the Sunshine Coast Regional Council Maroon book (2007) notes that *'A turbidity reading of around 75 NTU roughly corresponds to 50 mg/L TSS in many of our catchments*'. Until a site specific calibration can be undertaken it is recommended that this figure is used as an interim water quality objective. Acceptability of the use of this correlation may vary from council to council.

Table 1 – Default Water Quality Objectives

Parameter	Target	Notes
TSS	50mg/L	Is achieved if turbidity target is met.
pH	6.5 – 8.5	Measure using calibrated pH probe
Turbidity	Initially 75 NTU	Measure using calibrated turbidity probe.

3.2. Records and Reporting

The following items are required to be recorded daily in a spreadsheet. This spreadsheet should be available in digital format upon request as part of any environmental audit or report/inspection by the regulating authority.

The spreadsheet should be arranged to readily allow the operator to identify if discharge has occurred

- Rainfall in previous 24 hours
- Running cumulative rainfall depth for the design size.
- Volume in settling zone (record 0 if water is below settling zone)
- Has spillway overtopped (yes/no)
- Volume of sediment disposed (record 0 if no sediment disposed of)
- Turbidity and pH of water daily
- Volume of flocculent applied (record 0 if no flocculent applied)

3.3. Treatment

Flocculation of captured water may be required to achieve water quality objectives. Bench testing is recommended to be carried out by a CPESC or other suitably qualified persons to identify the most suitable flocculants and appropriate dose rate for the site. Some example flocculants and rates are listed below.

3.3.1. Turbidity / Suspended Solids

If turbidity or suspended solids exceed the target water quality objective, treatment with a flocculent will be required. Some example flocculants and recommended rates are outlined in **Table 2**.

IMPORTANT Dose rates are required to be determined by on-site trials, carried out by a suitably qualified person. Over application of flocculent can result in environmental impacts.

Table 2 – Dose Rates

Compound	Indicative Dose Rate	Notes
Sedisolve™	5-8 L/100m^3	Aluminum based flocculent
Gypsum	32 kg/100m^3	Gypsum is not readily soluble in water.
PAC	5 to 8 mg/L (target aluminum concentration)	Aluminum based flocculent

3.3.1.1. Flocculants

Sedisolve

SedisolveTM2350 is a high quality, environmentally friendly, rapid acting flocculent for application to Sediment Basins. SedisolveTM2350 is an Aluminium Chlorohydrate-based product, manufactured to drinking water specifications with no cost penalty, i.e. very low impurities and it does not add heavy metals into treated water like some coagulants which are very low quality and contain heavy metals. Some key advantages are:

- Concentrated and 2 to 3 times more effective than PAC or Liquid alum.
- Easy to apply liquid - no dust like gypsum.
- Fast settling.(within hours)
- Excellent treated water clarity.
- Can be automatically dosed using Intelligent flocculant operation device (iFOD) reducing the risk of overdosing.
- Significantly lower aluminium residuals than PAC or alum in the treated water.
- Works over a wide pH range but optimal around 7-7.5, which is ideal for discharge.
- Reduced alkalinity consumption compared to PAC and alum, i.e.:less likely to need to correct the pH
- pH will not drop as much as when dosing PAC or alum
- Forms inert sludge unlike alum and PAC.
- Non Dangerous Good
- Contains no sulphates

Gypsum

Gypsum is often considered the least ecologically threatening flocculent; however it is also one of the least effective flocculants and can be difficult to apply in a manner that will allow the flocculent to work effectively. The application of gypsum will not generally impact pH levels, with only a slight increase in salinity resulting. Constraints and limitations of gypsum include a even application is required over the entire pond surface and a resulting scum deposit may form on equipment.

If high intensity storms are forecast it is recommended that gypsum dosage rates be increased to 70kg/100m^3. Depending on the clay mineralogy this can achieve flocculation within 24 hours, allowing discharge within 2 days from the conclusion of a storm. Spreading gypsum evenly over the pond surface is essential, hand spreading of solid gypsum will not result in flocculation. The following procedure should be applied for the manual dosing of gypsum (see **Figure 3**):

1. Place required gypsum quantity (say 32kg/100m^3 of water) in an approximately 50L drum perforated with 25mm holes at 150mm spacing;
2. Suspend the screened, re-circulating pump intake into the drum;
3. Lift the drum into the basin such that basin water can enter and circulate through the drum;
4. Using the pump, spray the gypsum-rich solution evenly over the surface of the basin until the gypsum is fully removed from the drum. The pump outlet must spray the mixture over a wide area rather that just discharging as a confined 'jet'.

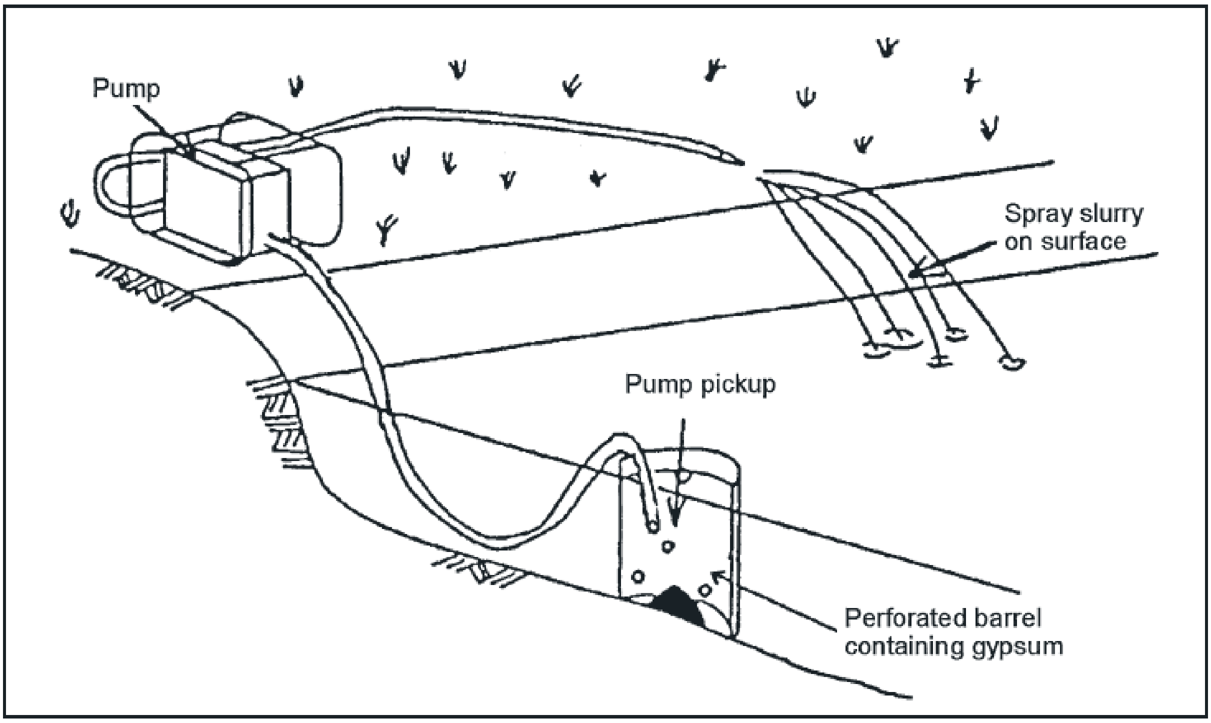

Figure 3 Application of Gypsum (taken from Landcom 2004 " Soils an dConstruction volume 1)

PAC (Poly Aluminium Chloride)

The use of PAC as a flocculant is only recommended under controlled circumstances and by users who are aware of the potential downstream risks to the environment. The advantage of PAC as a flocculent is the low dose rate required in comparison to gypsum, fast settling time and resulting stable sludge that binds pollutants.

As mentioned above in **Table 2** assessment of site specific dose rates must be undertaken by an environmental professional prior to use as overdosing will result in reduction of pH among other things. Residual alum concentrations remaining in the basin effluent should not exceed the ANZECC (2000) freshwater quality 'trigger value' of 0.055mg/L for aluminium at pH levels above 6.5. Continuous monitoring of water pH levels should be conducted when using PAC as a flocculent as pH levels lower than 5.5 will result in toxic concentrations of soluble aluminium, which can kill fish and other aquatic life.

3.3.2. pH Buffering

3.3.2.1. Increasing pH (treating acidic waters)

Liming rates for acidified water should be calculated with reference to **Table 3**.

Table 3 – Quantity of Pure Neutralisiing Agent Required to Raise From Existing Ph To Ph 7 for 1 Megalitre Of Low Salinity Acid Water. ***(From State Planning Policy 2/02 Guideline Acid Sulfate Soils)***

Current Water pH	$[H^+]$ (mol/L)	H^+ in 1 Megalitre (mol)	Aglime to neutralise 1 Megalitre (kg pure $CaCO_3$)	Hydrated lime to neutralise 1 Megalitre (kg pure $Ca(OH)_2$)	Sodium bicarbonate to neutralise 1 Megalitre (kg pure $NaHCO_3$)
0.5	.316	316 228	15 824	11 716	26 563
1.0	.1	100 000	5004	3705	8390
1.5	.032	32 000	1600	1185	2686
2.0	.01	10 000	500	370	839
2.5	.0032	3200	160	118	269
3.0	.001	1000	50	37	84
3.5	.00032	320	16	12	27
4.0	.0001	100	5	4	8.4
4.5	.000032	32	1.6	1.18	2.69
5.0	.00001	10	0.5	0.37	0.84
5.5	.0000032	3.2	0.16	0.12	0.27
6.0	.000001	1	0.05	0.037	0.08
6.5	.00000032	.32	0.016	0.012	0.027

Notes on Table 5:

1. 1 m^3 = 1000 litre = 1 kilolitre = 0.001 Megalitre
2. Correlations between current water pH and [H+] (mol/L) do not account for titratable acidity. The titratable acidity component should be included in any calculations of neutralising agent requirements.
3. Agricultural lime has a very low solubility and may take considerable time to even partially react. While aglime has a theoretical neutralising value of 2 mol of acidity (H+), this tends to be only fully available when there is excess acid. This, together with it's very low solubility, means that much more aglime beyond the theoretical calculation will generally be required.
4. Hydrated lime is more soluble than aglime and hence more suited to water treatment. However, as $Ca(OH)_2$ has a high water pH, incremental addition and thorough mixing is needed to prevent overshooting the desired pH. The water pH should be checked regularly after thorough mixing and allowing sufficient time for equilibration before further addition of neutralising product.
5. Weights of material given in the table above are based on theoretical pure material and hence use of such amounts of commercial product will generally result in under treatment.
6. To more accurately calculate the amount of commercial product required, the weight of neutralising agent from the table should be multiplied by a purity factor (100/ Neutralising Value for aglime) or (148/ Neutralising Value for hydrated lime).
7. If neutralising substantial quantities of ASS leachate, full laboratory analysis of the water will be necessary to adequately estimate the amount of neutralising material required.
8. Neutralising agents such as hydrated lime $Ca(OH)_2$, quick lime CaO, and magnesium oxide MgO neutralise 2 mol of acidity (H^+), while sodium bicarbonate $NaHCO_3$ and sodium hydroxide NaOH neutralise only 1 mol of acidity.

3.3.2.2. Reducing pH (treating basic waters)

Acid application rates for alkaline waters may be calculated with reference to **Table 4**.

Table 4 – Quantity of Acid Neutralisiing Agent (30-32% w/w mineral acid, as hydrochloric & sulphuric acids) Required to Reduce From Existing Ph To Ph 7 for 1 Megalitre Of Low Salinity Alkaline Water.

Current Water pH	Required Volume of Acid to Neutralise 1 Megalitre to pH 7.0 (Litres per 1,000 m^3)
7.4	8
7.6	12
7.8	16
8.0	20
8.2	24

Even distribution of neutralizing agent and suitable mixing is required to ensure effective neutralization occurs.

It should be noted that the volumes of acid listed within **Table 4** are for the specified concentration of acid. Prior to undertaking any pH buffering the manufacturer instructions of the neutralizing agent must be referred to, any dose rate information provided by the manufacturer must be followed in preference to the guideline dose rates provided in **Table 4**.

Validation testing of water pH must be carried out after a suitable mixing period (~2-4 hours depending on the size of the basin), to confirm that water is in the target pH range prior to discharge.

3.4. Discharge of Water

Prior to discharge of water from the sediment basin it is essential that the water quality complies with specified water quality objectives (see **Table 1**).

If possible, use water on site for dust suppression. Consumption of sediment basin water can be carried out without assessment of water quality. Care should be taken to ensure that this water does not runoff into waterways of drains.

After analytical results have been received and discharge of water authorized by the nominated suitably qualified person, water may be discharged to the receiving drainage line. When dewatering the sediment basin care should be taken so as to not re-suspend previously settled sediment. Intake pipes should be housed in an appropriate flow control chamber to prevent settled sediment being removed from the basin. Intake pipes must not rest on the bottom of the basin, or in any other location that will allow the entrainment of settled sediment.

An appropriate housing chamber for an inflow pipe may be formed from a section of PVC drainage pipe, sealed at one end and perforated along its length with inflow holes. An alternative is to suspend the inflow pipe from a floating raft that is designed to prevent the intake pipe from resting too close to the settled sediment. The intake pipe is normally placed inside a horizontal perforated PVC pipe attached to the underside of a floating raft. Perforations in the PVC pipe should only exist along the top of the pipe, thus minimizing the risk of settled sediment being entrained into the outlet.

Pump sizing should aim to discharge the basin's settling zone volume in less than 48 hours from the last runoff generating rainfall event.

Annexure A Certification of Basin Construction

Certification of Basin Construction

BASIN IDENTIFICATION CODE/NUMBER: …………………………………………………………………………..

LOCATION: ………..

Legend: ✓ OK ✗ Not OK N/A Not Applicable

Item	Consideration	Assessment
1	Sediment Basin Located in accordance with approved plans.	………………………
2	Embankment material compacted in accordance with specifications.	………………………
3	Critical basin and spillway dimensions and elevations confirmed by as-constructed survey.	………………………
4	Required freeboard adjacent embankments and spillway confirmed by as-constructed survey.	………………………
5	Placement of rock on chute and upstream face of spillway in accordance with design details and standards.	………………………
6	Placement of rock within energy dissipation zone downstream of spillway in accordance with design details and standard.	………………………
7	All other sediment basin requirements in accordance with design details and standards.	………………………
8	As-constructed plan prepared for basin and spillway.	………………………

INSPECTION OFFICER ………………………………………………….**DATE** ……………………………………………

SIGNATURE ………...

Geotechnical:

Item	Consideration	Assessment
9	Suitable material used to form all embankments.	………………………
10	Appropriate compaction achieved in embankment construction (if observed).	………………………
11	No foreseeable concerns regarding stability or construction of the basin and spillway.	………………………

INSPECTION OFFICER ………………………………………………….**DATE** ……………………………………………

SIGNATURE ………...

Annexure B Sediment Basin Discharge Authority

Sediment Basin Discharge Authority

Client:	**Date Authority Issued:**
Site:	**Date of Last Rainfall:**
Basin Reference:	**Maximum Volume of Basin (m^3):**
Inspecting Officer:	**Volume in Basin at Sample time (m^3):**

NB: *This authority is invalid if rainfall has occurred after last sample date and time*

TABLE 1 – INITIAL ANALYSIS

Sample Date:		**Sample Time:**	

	pH	**Turbidity (NTU)**	**SS (mg/L)**
Discharge Limit	*6.5-8.5*	*75*	*50*
Sample 1.			
Sample 2.			
Sample 3.			
Average			

TABLE 2 – TREATMENT APPLIED (if required)

Treatment Date:		**Treatment Time:**	

	HCL	**Lime**	**Gypsum/PAC (Cross out which)**
Dose Rate:			
Total Volume/Mass applied			

TABLE 3 – VALIDATION SAMPLING *(if any)*

Sample Date:		**Sample Time:**	

	pH	**Turbidity (NTU)**	**SS (mg/L)**
Discharge Limit	*6.5-8.5*	*75*	*50*
Sample 1.			
Sample 2.			
Sample 3.			
Average			

AUTHORITY TO DISCHARGE

Authority to discharge sediment basin water is given subject to conditions stipulated in the site sediment basin operation procedure or site erosion and sediment control plan.

Print Name: **Signature:**

Appendix F Technical Notes

The following technical notes apply to the implementation of erosion and sediment control measures on site.

General

1. Additional erosion and sediment control measures must be implemented as development progresses. Progressive staged Erosion and Sediment Control Plans (ESCPs) must be submitted for approval as site conditions change from those considered within the most current ESCP.

2. Where there is a high probability that serious or material environmental harm may occur as a result of sediment leaving the site, appropriate additional erosion and sediment control measures must be implemented such that all reasonable and practicable measures are being taken to prevent or minimise such harm. Only those works necessary to minimise or prevent environmental harm shall be conducted on-site prior to approval of the amended Erosion and Sediment Control Plan (ESCP).

Land Clearing

3. All reasonable and practicable efforts must be taken to delay the removal of, or disturbance to, existing ground cover (organic or inorganic) prior to land- disturbing activities.

4. Bulk tree clearing must occur in a manner that minimises disturbance to existing ground cover (organic or inorganic).

5. Vegetation removed during tree clearing should be mulched on site and reused for erosion control. Refer to IECA fact sheets

6. Disturbance to natural watercourses (including bed and banks) and their associated riparian zones must be limited to the minimum practicable. Management of ESC around watercourses should involve maintenance of a minimum 20 m buffer of vegetation adjacent to watercourse crossings until such time as the crossing is imminent and suitable erosion and sediment controls are established.

7. No land clearing shall be undertaken unless preceded by the installation of adequate drainage and sediment control measures, unless such clearing is required for the purpose of installing such measures, in which case, only the minimum clearing required to install such measures shall occur.

8. Prior to land clearing, areas of protected vegetation, and significant areas of retained vegetation must be clearly identified (e.g. with high-visibility tape, or light fencing) for the purposes of minimising the risk of unnecessary land clearing.

9. All reasonable and practicable measures must be taken to minimise the removal of, or disturbance to, those trees, shrubs and ground covers (organic or inorganic) that are intended to be retained.

10. All land clearing must be in accordance with the Federal, State and local government Vegetation Protection/Preservation requirements and/or policies.

11. Land clearing is limited to the minimum practicable during those periods when soil erosion due to wind, rain or surface water is possible.

Site Access

12. Site access must be restricted to the minimum practical number of locations

13. Site exit points must be appropriately managed to minimise the risk of sediment being tracked onto public roadways.

14. Stormwater runoff from access roads and stabilised entry/exit points must drain to an appropriate sediment control device.

Soil and Stockpile Management

15. All reasonable and practicable measures must be taken to obtain the maximum benefit from existing topsoil.

16. Stockpiles of erodible material that has the potential to cause environmental harm if displaced, must be:

    (i) Appropriately protected from wind, rain, concentrated surface flow and excessive up-slope stormwater surface flows.

    (ii) Located at least 2m from any hazardous area, retained vegetation, or concentrated drainage line.

    (iii) Located up-slope of an appropriate sediment control system.

17. A suitable flow diversion system must be established immediately up-slope of a stockpile of erodible material that has the potential to cause environmental harm if displaced.

Site Management

18. All office facilities and operational activities must be located such that any liquid effluent (e.g. process water, wash-down water, effluent from equipment cleaning, or plant watering), can be totally contained and treated within the site.

19. The construction schedule must aim to minimise the duration that any and all areas of soil are exposed to the erosive effects of wind, rain and surface water.

20. Land-disturbing activities must be undertaken in accordance with the Erosion and Sediment Control Plan and associated development conditions.

21. Land-disturbing activities must be undertaken in such a manner that allows all reasonable and practicable measures to be undertaken to:

    (i) Allow stormwater to pass through the site in a controlled manner and at non- erosive flow velocities up to the specified design storm discharge;

    (ii) Minimise soil erosion resulting from rain, water flow and/or wind;

    (iii) Minimise adverse effects of sediment runoff, including safety issues;

    (iv) Prevent, or at least minimise, environmental harm resulting from work-related soil erosion and sediment runoff;

    (v) Ensure that the value and use of land/properties adjacent to the development (including roads) are not diminished as a result of the adopted ESC measures.

22. All erosion and sediment control measures must conform to the standards and specifications contained in:

(i) The Environmental Management Plan; and

(ii) The approved ESCP and supporting documentation;

23. Any works that may cause significant soil disturbance and are ancillary to any activity for which regulatory body approval is required, must not commence before the issue of that approval.

24. Additional and/or alternative ESC measures must be implemented in the event that site inspections, the site's Monitoring and Maintenance Program, or the regulatory authority, identifies that unacceptable off-site sedimentation is occurring as a result of the work activities.

25. Land-disturbing activities must not cause unnecessary soil disturbance if an alternative construction process is available that achieves the same or equivalent outcomes at an equivalent cost.

26. Sediment (including clay, silt, sand, gravel, soil, mud, cement and ceramic waste) deposited off the site as a direct result of an on-site activity, must be collected and the area appropriately cleaned/rehabilitated as soon as reasonable and practicable, and in a manner that gives appropriate consideration to the safety and environmental risks associated with the sediment deposition.

27. Adequate waste collection bins must be provided on-site and maintained such that potential and actual environmental harm resulting from such material waste is minimised.

28. Concrete waste and chemical products, including petroleum and oil-based products, must be prevented from entering an internal water body, or an external drain, stormwater system, or water body.

29. All flammable and combustible liquids, including all liquid chemicals if such chemicals could potentially be washed or discharged from the site, are stored and handled on-site in accordance with relevant standards such as AS1940 The storage and handling of flammable and combustible liquids.

30. Site spoil must be lawfully disposed of in a manner that does not result in ongoing soil erosion or environmental harm.

31. All fill material placed on site must comprise only natural earth and rock, and is to be free of contaminants, be free draining, and be compacted in layers not exceeding 300mm to 90% modified maximum dry density in accordance with AS 1289.

Drainage Control

32. All drainage control measures must be applied and maintained in accordance with ESCP.

33. Wherever reasonable and practicable, stormwater runoff entering the site from external areas, and non-sediment laden (clean) stormwater runoff entering a work area or area of soil disturbance, must be diverted around or through that area in a manner that minimises soil erosion and the contamination of that water for all discharges up to the specified design storm discharge.

34. During the construction period, all reasonable and practicable measures must be implemented to control flow velocities in such a manner than prevents soil erosion along drainage paths and at the entrance and exit of all drains and drainage pipes during all storms up to the relevant design storm discharge.

35. Wherever reasonable and practicable, "clean" surface waters must be diverted away from sediment control devices and any untreated, sediment-laden waters.

Erosion Control

36. All erosion control measures must be applied and maintained in accordance with ESCP.

37. All temporary earth banks, flow diversion systems, and embankments associated with constructed sediment basins must be machine-compacted, seeded and mulched for the purpose of establishing a temporary vegetative cover within 10 days after grading.

Sediment Control

38. All sediment control measures must be applied and maintained in accordance with ESCP.

39. Optimum benefit must be made of every opportunity to trap sediment within the work site, and as close as practicable to its source.

40. Sediment traps must be installed and operated to both collect and retain sediment.

41. The potential safety risk of a proposed sediment trap to site workers and the public must be given appropriate consideration, especially those devices located within publicly accessible areas.

42. Suitable all-weather maintenance access must be provided to all sediment control devices.

43. Sediment control devices must be de-silted and made fully operational as soon as reasonable and practicable after a sediment-producing event, whether natural or artificial, if the device's sediment retention capacity falls below 75% of its design retention capacity.

44. Materials, whether liquid or solid, removed from sediment control devices during maintenance or decommissioning, must be disposed of in a manner that does not cause ongoing soil erosion or environmental harm.

45. As-Constructed plans must be prepared for all constructed sediment basins and associated emergency spillways. Such plans must appropriately verify the basin's dimensions, levels and volumes of each basin.

46. Constructed sediment basins must be maintained and fully operational throughout the construction period and until each basin's catchment area achieves the specified percentage of ground cover on all soil surfaces.

47. Settled sediment must be removed from sediment basins when the volume of the sediment exceeds the designated sediment storage volume, or the design maximum sediment storage elevation.

Site Rehabilitation

48. All disturbed areas must be suitably stabilised in accordance with the revegetation plan or final design drawings

Sediment Basin Rehabilitation

49. Required drainage, erosion and sediment control measures during the decommissioning and rehabilitation or a sediment basin must comply with same standards specified for the normal construction works.

50. Upon decommissioning of a sediment basin, all water and sediment must be removed from the basin prior to removal of the embankment (if any). Any such material, liquid or solid, must be dispose of in a manner that will not create an erosion or pollution hazard.

51. A basin's catchment conditions associated with the staged decommissioning of the basin from a Type 1 to a Type 2 sediment trap must comply with the specified sediment control standard.

52. If an alternative, permanent, outlet structure is to be constructed prior to stabilisation of the up-slope catchment area, then this outlet structure must not be made operational if it will adversely affect the required operation of the sediment basin.

53. The permanent stormwater treatment features (e.g. vegetation and filtration media) must be appropriately protected from the adverse effects of sediment runoff.

54. Sediment basin must not be decommissioned until all up-slope site stabilisation measures have been implemented and are appropriately working to control soil erosion and sediment runoff in accordance with the specified ESC standard.

55. Immediately prior to the construction of the permanent stormwater treatment device, appropriate flow bypass conditions must be established to prevent sediment-laden water entering the device.

Site Monitoring

56. All water quality data, including dates of rainfall, dates of testing, testing results and dates of water release, must be kept in an on-site register. The register is to be maintained up to date for the duration of the approved works and be available on-site for inspection.

57. Sediment basin water quality samples must be taken at a depth no greater than 200mm above the level of settled sediment.

58. All environmentally relevant incidents must be recorded in a field log that must remain accessible to all relevant regulatory authorities.

Site Maintenance

59. All erosion and sediment control measures, including drainage control measures, must be maintained in proper working order at all times during their operational lives.

60. All drainage, erosion and sediment control measures must be inspected:

    (i) At least daily (when work is occurring on-site);
    (ii) At least weekly (when work is not occurring on-site);
    (iii) Within 24 hours of expected rainfall; and
    (iv) Within 18 hours of a rainfall event of sufficient intensity and duration to cause runoff on-site).

Appendix G Temporary Crossing Factsheet

Temporary Watercourse Crossings: Culvert

DRAINAGE CONTROL TECHNIQUE

Low Gradient		Velocity Control		Short Term	✓
Steep Gradient		Channel Lining		Medium-Long Term	
Outlet Control		Soil Treatment		Permanent	

TCC

Symbol

Photo 1 – Temporary culvert formed from recycled steel pipes

Photo 2 – Temporary crossing of minor drainage channel

Key Principles

1. Significant bank damage can occur during the installation and removal of these temporary watercourse crossings; therefore, extreme care must to be taken to minimise such damage.
2. It is important to minimise the risk of sediment-laden runoff from the approach roads being allowed to discharge directly into the watercourse without passing through an appropriate sediment trap or vegetative filter.
3. Critical design parameters are the flood immunity of the road surface and the structural integrity of the culverts during flood flows.
4. Critical operational issue is the minimisation of harm to the watercourse, including any sediment releases.

Design Information

The material contained within this fact sheet has been supplied for use by persons experienced in hydraulic engineering.

Temporary culvert crossing require both structural and hydraulic design. Their design requires input from both structural and hydraulic specialists.

Design parameters include expected traffic loads, required flood immunity, and expected hydraulic and debris loadings. The following information is supplied for general reference purposes only.

Culvert Structure:

Consideration should be given to the potential damage caused to the watercourse if the culverts wash away during a flood event. In critical locations it may be necessary to tether the pipes to the watercourse banks using cables or chains to prevent individual components of the culvert being washed down the watercourse during severe floods.

Erosion and Sediment Control Model Code of Practice (Instream Works)

Compliance with a given Performance Criterion can only be achieved by:

(i) complying with the Acceptable Solution; or

(ii) formulating an alternative solution which complies with the Performance Criterion, or is shown to be at least equivalent to the acceptable solutions; or

(iii) a combination of (i) and (ii).

Unless otherwise indicated, all outcomes listed within the Acceptable Solution must be satisfied in order to comply with the Acceptable Solution.

Attachment A forms part of this Code. The Attachment provides essential information and requirements not otherwise provided within the Code.

In the event of a conflict over the desired outcome of a *Performance Criterion* or an *Acceptable Solution*, then the outcome shall be that which best achieves the *objective* of the Code, that being:

> *To protect the environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.*

To achieve this objective 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 prevent or minimise the harm.

In assessing all reasonable and practicable measures, appropriate consideration must be given to:

(i) the nature of the potential harm; and

(ii) the sensitivity of the receiving environment; and

(iii) the current state of technical knowledge for the activity; and

(iv) the likelihood of successful application of the various measures that might be undertaken; and

(v) the financial implications of the various measures relative to the type of activity.

The various recommendations presented in this guideline are an indication of what may be considered *reasonable and practicable* for the construction industry.

This model code of practice does not provide all the information necessary to adequately control soil erosion and sediment runoff in all situations. Users of the Code should always make their own site-specific evaluation, testing and design, and refer to their own advisers and consultants as appropriate.

Specifically, the adoption of this model code of practice will not necessarily guarantee:

(i) compliance with any statutory obligations or licence conditions;

(ii) avoidance of all environmental harm or nuisance.

SITE PLANNING AND DESIGN			
Performance Criteria		**Acceptable Solution**	
P1	Adequate data is obtained to allow appropriate site planning and design.	**A1**	(a) The extent and complexity of data collection is commensurate with the potential environmental risk, and the extent and complexity of the instream disturbance. (b) Adequate soil data is obtained for the site to: (i) identify dispersive soils; (ii) identify potential acid sulfate soils; (iii) assess site revegetation/stabilisation works; (iv) select and design ESC measures.
P2	The design and layout of instream works minimise the risk of environmental harm occurring during the construction phase.	**A2**	(a) Potential high-risk instream activities are identified during site planning. (b) Environmental risk, cost and safety are appropriately considered when determining the construction/maintenance process. (c) The design and layout of the instream works do not cause unnecessary soil disturbance if an alternative design or layout (which reduces the potential environmental harm) is available that achieves the same or equivalent project outcomes at a reasonable cost. (d) Site planning minimises the duration that any and all areas of soil will be exposed to the erosive effects of wind, rain and flowing water, in part through the progressive and prompt stabilisation of disturbed areas. (e) Instream sediment control measures are not employed if there is an appropriate off-stream sediment control process. (f) Development of the Erosion and Sediment Control Plan is an integral part of site planning. (g) Essential ESC control measures are appropriately integrated into the project's design and costing. (h) Adequate space is provided for the installation and maintenance of essential ESC measures. (i) The number of temporary watercourse crossings is minimised.
P3	The programming of instream works minimises the risk of environmental harm occurring during the construction phase.	**A3**	(a) Instream disturbances are programmed to occur during the least erosive and environmentally damaging period of the year. (b) Instream works that require the construction of a weir or cofferdam, or an alteration in stream flow conditions, including flow velocity, bed roughness or flow rate, are not programmed for those periods when essential fish migration is expected to occur.
P4	The design and layout of instream works minimise the risk of post-construction environmental harm.	**A4**	(a) Flow velocities at the inlet and outlet of permanent drainage systems (e.g. stormwater pipes) are controlled to minimise ongoing erosion. (b) To the maximum degree reasonable and practicable, instream works are designed to minimise potential environmental harm during operational works and ongoing maintenance.

EROSION AND SEDIMENT CONTROL PLAN (ESCP)			
Performance Criteria		**Acceptable Solution**	
P5	An Erosion and Sediment Control Plan (ESCP) is prepared prior to site disturbance that provides sufficient information to achieve the required environmental protection.	**A5**	(a) The design standard of drainage, erosion and sediment controls (whether instream or off-stream) comply with the requirements of the relevant regulatory authority, or where such a standard does not exist, are designed in accordance with current best practice. (b) As a minimum, the standard of drainage, erosion and sediment controls are commensurate with the site conditions, (e.g. soil type, flow rate and erosion hazard), type of watercourse, local environmental values, and the type, cost and scope of the works. (c) The level of information and detail supplied in the ESCP is commensurate with the potential environmental risk, and the complexity of the proposed works; and is of sufficient clarity to allow on-site personnel to appropriately implement the plan.
P6	The ESCP is prepared by, or under the supervision of, suitably qualified and experienced personnel.	**A6**	(a) The qualifications and experience of the personnel preparing and/or supervising the preparation of the ESCP is commensurate with the potential environmental risk, and the extent and complexity of the soil disturbance. (b) On sites with a soil disturbance greater than $50m^2$, the ESCP is signed-off by a suitably qualified and experienced professional. (c) On sites with a flow diversion barrier extending over one-third of the channel width, or a temporary structure extending over the full channel width (e.g. watercourse crossing or instream sediment trap) the ESCP is signed-off by an engineer experienced in waterway hydraulics.
P7	The ESCP remains relevant, at all times, to the current site conditions.	**A7**	(a) The ESCP remains both effective and flexible, and is based on anticipated soil, weather, stream flow, and construction conditions (as may vary from time to time). (b) The ESCP is appropriately amended if the implemented works fail to achieve the *objective* of the ESCP, the required performance standard, or the State's environmental protection requirements, or otherwise if there is the risk of serious or material environmental harm.

SITE ESTABLISHMENT			
Performance Criteria		**Acceptable Solution**	
P8	Site personnel are provided with all necessary information prior to site establishment.	**A8**	The Development Approval Conditions, Waterways Permit/Licence, Erosion and Sediment Control Plan, Monitoring and Maintenance Program, Site Rehabilitation Plan, and any other document required for the management of soil erosion and sediment control, are provided to the principal contractor prior to the commencement of land disturbing activities.

P9	Appropriate personnel are engaged to monitor the site prior to commencement of site disturbance.	**A9**	(a) Prior to the commencement of any instream disturbance, appropriately trained and experienced personnel are engaged to undertake regular ESC audits of the site. (b) Prior to commencement of site works, a "chain of command" in relation to the implementation, modification, and maintenance of ESC measures is established.
P10	Site establishment does not cause unnecessary soil disturbance or environmental harm.	**A10**	(a) No land-disturbing activities occur on the site until all appropriate ESC measures have been constructed in accordance with the ESCP and best practice erosion and sediment control. (b) All site office facilities and operational activities are located such that all effluent, including wash-down water, can be totally contained and treated within the site.
P11	Site access is appropriately managed to minimise the risk of environmental harm.	**A11**	(a) All reasonable and practicable measures are taken to ensure stormwater runoff from site access tracks and stabilised entry/exit systems, drains to an appropriate sediment control device. (b) Wherever reasonable and practicable, access tracks, whether temporary or permanent, are located a distance from the top of bank of at least 30m, or the width of the stream (measured at the top of the bank), whichever is the lesser.

SITE MANAGEMENT			
Performance Criteria		**Acceptable Solution**	
P12	The work site is managed such that environmental harm is minimised.	**A12**	(a) No land-disturbing activities (instream or off-stream) are undertaken prior to appropriate consideration being given to erosion and sediment control issues. (b) All works subject to an Erosion and Sediment Control Plan (ESCP) are carried out in accordance with the ESCP (as amended from time to time) unless circumstances arise where compliance with the ESCP would increase the potential for environmental harm as assessed by a recognised authority. (c) All ESC measures are installed, operated and maintained in accordance with current best management practice. (d) Land-disturbing activities are undertaken in such a manner that allows all reasonable and practicable measures to be undertaken to: (i) allow stormwater and stream flow to pass through the site in a controlled manner and at non-erosive flow velocities; and (ii) minimise soil erosion resulting from wind, rain and flowing water; and (iii) minimise the duration that disturbed soils are exposed to the erosive forces of wind, rain and flowing water; and (iv) prevent, or at least minimise, environmental harm (including public nuisance and safety issues) resulting from work-related soil

			erosion and sediment runoff. (e) Site spoil is lawfully disposed of in a manner that does not result in ongoing soil erosion or environmental harm.
P13	Those responsible for erosion and sediment control are appropriately trained and equipped.	**A13**	Site managers and/or the nominated responsible ESC personnel achieve and maintain a good working knowledge of the correct installation and operational procedures of all ESC measures used on the site.
P14	Disturbance to ESC measures by on-site personnel is minimised.	**A14**	(a) On-site personnel are appropriately instructed and educated as to the purpose and operation of adopted drainage, erosion and sediment control (ESC) measures, and the need to maintain such measures in proper working order at all times. (b) Unnecessary disturbance to ESC measures by on-site personnel, sub-contractors and construction traffic (including site management and material delivery vehicles) is minimised.
P15	The adopted ESC measures remain relevant at all times to the current site conditions.	**A15**	(a) Performance of the site's ESC measures is monitored in accordance with the site's Monitoring and Maintenance Program. (b) The adopted erosion and sediment control measures are appropriately amended if site conditions significantly change, or are expected to significantly change, from those conditions assumed during development of the ESCP. (c) The adopted erosion and sediment control measures are appropriately amended if the implemented works fail to achieve the "objective" of the ESCP, or the required performance standard, or the State's environmental protection requirements, or unacceptable environmental harm is occurring or is likely to occur.
P16	The work site is appropriately prepared for imminent construction activities and weather conditions.	**A16**	(a) Adequate supplies of drainage, erosion and sediment control, and relevant pollution clean-up materials, are retained on-site during the construction period. (b) Appropriate short-term drainage control measures (e.g. flow diversion around soil disturbances and recently opened trenches) are installed and operational prior to impending storms or increased stream flows.
P17	Land disturbing activities do not cause unnecessary soil disturbance.	**A17**	(a) Land disturbing activities do not cause unnecessary soil disturbance if an alternative construction process (that reduces potential environmental harm) is available that achieves the same or equivalent project outcomes at a reasonable cost. (b) The extent of unnecessary soil disturbance, including disturbances outside the designated work area, is minimised.
P18	Damage to retained or protected vegetation is minimised.	**A18**	(a) Prior to the commencement of land disturbing activities within any given area, all protected vegetation and significant areas of retained vegetation within that area, are appropriately identified to minimise the risk of disturbance to such areas.

			(b) No damage is allowed to occur to roots, trunk or branches of retained vegetation, unless under the direction of an appropriate Vegetation Management Plan.
P19	Adopted work practices minimise the release of pollutants into receiving waters.	**A19**	(a) Emergency and pollution control procedures are commensurate with the site conditions, local environmental values, and the type, cost, scope and complexity of the works. (b) All liquid chemicals, including petroleum products, that could potentially be washed or discharged from the site in association with sediment, are stored and handled on-site in accordance with relevant standards such as AS1940. (c) Adequate supplies of erosion control, sediment control, and pollution clean-up materials are retained on-site during the construction period. (d) Cement-laden runoff, concrete waste, and chemical products (including petroleum and oil-based products), are managed on-site in accordance with current best management practice. (e) All equipment is washed down (cleaned) well away from the water's edge, and in a manner that prevents sediment-laden water entering the waters. (f) All non water-soluble pollutants washed or blown onto waters are collected and secured as soon as practicable. (g) All waste receptors are sealed and/or covered outside working hours to prevent the entry of water and vermin, or wind disturbance of the contained material.
P20	Adopted work practices minimise the release of pollutants into tidal waters.	**A20**	(a) No erodible material is stockpiled within 40m from the high tide mark. (b) Sediment deposition within the voids between natural and introduced rock located within the tidal zone is minimised. (c) All materials being transported by boats or barges are adequately secured during transportation. (d) Drip pans are placed under all vehicles and motorised equipment placed on docks, barges, or other structures that extend over water bodies, if the vehicle or equipment is expected to be idle for more than 1 hour. (e) All barges are fitted with watertight curbs or toe boards to contain spills and prevent materials, tools, and debris from leaving the barge. (f) All appropriate measures are deployed to provide secondary containment for any spills while materials and/or equipment are being transferred on and off barges to (e.g. floating sediment curtains).

P21	Environmental harm, safety issues, and nuisance or damage to public and private property resulting from off-site sediment deposits, material spills, and/or the adopted ESC measures is minimised.	**A21**	(a) Sediment and other material originating from the work area, or as a result of the transportation of materials to or from the work area, that collect on sealed roads, or within gutters, drains or drainage channels outside the immediate work area, is removed: (i) immediately if rain is occurring or imminent; or (ii) immediately if considered a safety hazard; or (iii) if items (i) or (ii) do not apply, as soon as practicable, but before completion of the day's work. (b) The adopted ESC measures do not adversely affect drainage or flooding conditions within neighbouring properties.
P22	Potential safety risks to site workers and the public as a result of ESC measures are minimised.	**A22**	All stream flow diversion and ESC measures are installed and operated in a manner that does not cause a safety risk to the public or site personnel.
P23	Potential harm to wildlife as a result of ESC measures is minimised.	**A23**	(a) Disturbance to wildlife habitats is limited to the minimum necessary to complete the approved works. (b) Synthetic (plastic) reinforced fabrics are not placed within, or adjacent to, bushland areas, riparian zones and watercourses if such materials are likely to cause harm to wildlife or wildlife habitats. (c) The design of temporary instream structures does not adversely impact on terrestrial and aquatic passage along the waterway. (d) To the maximum degree reasonable and practicable, instream disturbances are programmed to occur during periods of least impact to fish migration. (e) Sediment traps, flow diversion systems and isolation barriers allow appropriate egress of wildlife where such wildlife could enter such areas. (f) Site rehabilitation procedures and outcomes are compatible with site conditions and local environmental values (including local wildlife).

SITE DISTURBANCE			
Performance Criteria		**Acceptable Solution**	
P24	Potential environmental harm resulting from land clearing is minimised.	**A24**	(a) All land clearing is conducted in accordance with State and local government Vegetation Protection and/or Preservation requirements and/or policies. (b) No instream disturbances are undertaken prior to development of a Vegetation Management Plan. (c) No instream soil disturbance occurs until the principal instream works are ready to commence. (d) Controls placed on the extent and duration of soil disturbance are commensurate with the potential erosion risk and/or erosion hazard.

			(e) To the maximum degree reasonable and practicable, disturbance to deep-rooted vegetation on slopes susceptible to mass movement is minimised, if not totally avoided. (f) Compliance with Performance Criterion P18.
P25	Disturbance to natural watercourses is minimised.	**A25**	(a) Disturbance to natural watercourses (including bed and bank vegetation) and their associated riparian zones is limited to the minimum necessary to complete the approved works. (b) The number, location, type and size of temporary watercourse crossing are such that the overall adverse impact on the environment is minimised. (c) All temporary watercourse crossings, including their approach roads, employ appropriate drainage, erosion and sediment controls to minimise sediment inflow into the watercourse.
P26	Disturbance to tidal and intertidal areas including any associated riparian zones is minimised.	**A26**	(a) Disturbance to aquatic vegetation, particularly seagrasses and mangroves, is minimised. (b) Vehicle/boat damage to seawalls (e.g. due to wave and wash conditions) is minimised.

SOIL AND STOCKPILE MANAGEMENT			
Performance Criteria		**Acceptable Solution**	
P27	Maximum benefit is obtained from existing topsoil.	**A27**	(a) The topsoil is managed (i.e. stripped, treated, stockpiled and reused) in accordance with the recommendations of an approved Vegetation Management Plan or similar. OR (b) Topsoil is stripped, stockpiled, placed, and where necessary treated, in accordance with current best practice.
P28	Environmental harm caused by the temporary stockpiling of erodible material is minimised.	**A28**	Stockpiles of erodible material are: (i) appropriately protected from wind, rain and surface flows in accordance with current best practice; and (ii) located at least 2m from hazardous areas, retained vegetation; and (iii) located up-slope of an appropriate sediment control system.
P29	Exposed dispersive soils are managed such that the risk of ongoing soil erosion is minimised.	**A29**	Construction details for drainage systems and bank stabilisation works within dispersive soil areas clearly demonstrate how these soils will be managed to prevent future erosion problems.
P30	Exposed potential acid sulfate soils are appropriately managed.	**A30**	(a) If acid sulfate soils conditions exist on site, then appropriate warnings are placed on the ESCP. (b) All exposed actual or potential acid sulfate soils are managed in accordance with current best practice. (c) On-site personnel involved in the disturbance of actual or potential acid sulfate soils are appropriately trained and/or supervised.

MANAGEMENT OF STREAM FLOW			
Performance Criteria		**Acceptable Solution**	
P31	Temporary drainage control measures are designed, constructed and maintained to an appropriate standard.	**A31**	(a) The standard of stream flow control complies with the requirements of the relevant regulatory authority, or where such a standard does not exist, flow controls are designed in accordance with current best practice. (b) The adopted stream flow control measures remain relevant, at all times, to the current and imminent site conditions. (c) Instream flow diversion structures are structurally sound during a 1 in 2 year ARI channel flow. (d) Wherever reasonable and practicable, isolation barriers do not isolate more than 30% of the channel width at any given time, otherwise not more than 50%, while channel flows are occurring.

DRAINAGE CONTROL			
Performance Criteria		**Acceptable Solution**	
P32	Temporary drainage control measures are designed, constructed and maintained to an appropriate standard.	**A32**	(a) The standard of drainage control complies with the requirements of the relevant regulatory authority, or where such a standard does not exist, drainage controls are designed in accordance with current best practice. (b) The adopted drainage control measures remain relevant, at all times, to the current and imminent site conditions.
P33	Stormwater movement through the site is appropriately managed to minimise soil erosion.	**A33**	(a) If the overbank drainage area up-slope of a soil disturbance exceeds 1500m^2, and the average monthly rainfall exceeds 45mm, all stormwater discharged from this area (up to the design storm) is diverted around or through the soil disturbance in a manner that minimises soil erosion. (b) Appropriate drainage controls are installed above an exposed stream bank to minimise soil erosion on the bank. (c) Flow velocities within flow diversion channels and at the entrance and exit of all drainage structures (including *Chutes*, and *Slope Drains*) are controlled in such a manner that prevents soil erosion during all discharges up to the relevant design discharge.
P34	Stormwater movement through the site is appropriately managed to minimise environmental harm.	**A34**	(a) Overbank stormwater runoff passing around or through the work site does not cause erosion to the banks of water bodies. (b) All reasonable and practicable measures are taken to ensure stormwater runoff entering an area of soil disturbance is diverted around or through that area in a manner that minimises soil erosion and contamination of that water for all discharges up to the specified design discharge.

			(c) Adequate drainage controls (e.g. cross drainage systems and/or longitudinal drainage) are applied to access tracks to minimise erosion on, and sediment runoff from, such areas.

EROSION CONTROL			
Performance Criteria		**Acceptable Solution**	
P35	Erosion control measures are designed, installed and maintained to an appropriate standard.	**A35**	(a) The standard of erosion control complies with the requirements of the relevant regulatory authority, or where such a standard does not exist, erosion controls are designed in accordance with current best practice. (b) As a minimum, the type and degree of erosion control are commensurate with the expected site conditions, soil type, stream flow, potential environmental risk, and the type, cost and scope of the works. (c) The adopted erosion control measures remain relevant, at all times, to the current and imminent site conditions.
P36	The control of soil erosion is given appropriate priority.	**A36**	(a) Wherever reasonable and practicable, priority is given to the prevention, or at least minimisation, of soil erosion, rather than allowing soil erosion to occur and trying to trap the resulting sediment. (b) The existence of best practice sediment control measures within a given sub-catchment does not diminish the need for the application of current best-practice erosion control measures.
P37	Soil erosion is minimised.	**A37**	(a) Existing ground covers are protected from damage and retained as long as practicable. (b) Site activities are carried out in a manner that minimises the duration that any and all disturbed soil surfaces are exposed to the erosive forces of wind, rain and flowing water. (c) All temporary erosion control measures are appropriately anchored to the soil as appropriate for the expected flow conditions. (d) Mechanical equipment does not enter the channel if alternative equipment or construction procedures are available that would allow the works to be conducted from an overbank location.
P38	Soil erosion resulting from stream flow is minimised.	**A38**	(a) All reasonable and practicable steps are taken to apply best practice erosion control measures to completed channel works, or otherwise stabilise such works, prior to an anticipated increase in stream flow. (b) Bed and bank stabilisation and revegetation methods are appropriate for the expected stream flow conditions such that ongoing soil erosion is minimised. (c) Dispersive soils are either treated, or covered with a layer of non-dispersible soil (200mm minimum) before being covered with vegetation, rock, mulch, or erosion control blankets.

SEDIMENT CONTROL			
Performance Criteria		**Acceptable Solution**	
P39	Sediment control measures are designed, installed, operated and maintained to an appropriate standard.	**A39**	(a) The standard of sediment control complies with the requirements of the relevant regulatory authority, or where such a standard does not exist, sediment controls are designed in accordance with current best practice. (b) As a minimum, the type and degree of sediment controls are commensurate with the expected site conditions, soil type, stream flow, potential environmental risk, and the type, cost and scope of the works. (c) Instream sediment control measures are designed for the expected base flow (i.e. stream flow not affected by flood flows or storm runoff). (d) The adopted sediment control measures remain relevant at all times to the current and imminent site conditions.
P40	Sediment contamination of instream waters is minimised.	**A40**	(a) All reasonable and practicable measures are taken to prevent, or at least minimise, the release of sediment from overbank areas into waters. (b) Wherever reasonable and practicable, instream disturbances are managed in accordance with the following hierarchy: (i) minimise, if not totally avoid, direct contamination of stream flows (e.g. through the use of flow diversion systems and the appropriate timing of instream works); (ii) treatment of sediment-laden water within off-stream sediment traps; (iii) treatment of sediment-laden water within instream sediment traps. (c) A suitable off-stream sediment trap is placed down-slope of any off-stream soil disturbance prior to the disturbance occurring. (d) Appropriate stream flow and/or sediment controls are installed and made operational before any instream soil disturbance occurs.
P41	Sediment displaced off site by vehicular traffic is minimised.	**A41**	(a) Number of site entry/exit points is limited to the minimum practical number. (b) Site entry/exit points are appropriately designed and stabilised to minimise sediment being washed off the site or into adjacent waters. (c) Sediment-laden stormwater runoff from access tracks and stabilised entry/exit systems drains to an appropriate sediment control device.
P42	Sediment-related environmental harm resulting from de-watering activities is minimised.	**A42**	(a) Flow diversion barriers, or other appropriate systems, are used to minimise the quantity of watering entering excavations and trenches. (b) As a minimum, sediment control measures implemented for the control of sediment-laden discharge from de-watering activities are designed to satisfy current best practice.

SITE STABILISATION AND REHABILITATION			
Performance Criteria		**Acceptable Solution**	
P43	Site rehabilitation, including site revegetation, is designed, installed and maintained to an appropriate standard.	**A43**	(a) A Site Stabilisation Plan or similar is prepared and approved by the relevant regulatory authority prior to site establishment. (b) The standard of site rehabilitation complies with the requirements of the relevant regulatory authority or, where such a standard does not exist, complies with current best practice. (c) As a minimum, the type and degree of site rehabilitation is commensurate with the expected site conditions, soil type, stream flow, potential environmental risk, and the type, cost and scope of the works.
P44	Site rehabilitation methods and procedures minimise the risk of environmental harm.	**A44**	(a) Site revegetation (excluding temporary revegetation conducted for purposes of erosion control) is conducted in accordance with a Site Stabilisation Plan or similar, where such a plan exists. (b) Disturbed soil surfaces are appropriately stabilised to minimise the risk of short-term soil erosion. (c) All temporary ESC measures are removed and the land rehabilitated as soon as practicable after their use is no longer needed.
P45	Site rehabilitation methods, procedures and outcomes are compatible with site conditions and local environmental values.	**A45**	(a) The qualifications and experience of the personnel preparing and/or supervising the preparation of any Site Stabilisation Plan, Vegetation Management Plan, or similar, is commensurate with the potential environmental risk, and the extent and complexity of the works. (b) Plant selection and landscape design are compatible with identified environmental values.

SITE INSPECTION AND MONITORING			
Performance Criteria		**Acceptable Solution**	
P46	A Monitoring Program is prepared by, or under the supervision of, suitably qualified and experienced personnel.	**A46**	(a) A Water Quality Monitoring Program is prepared and approved by the relevant regulatory authority prior to site establishment. (b) The qualifications and experience of the personnel preparing and/or supervising the preparation of the Monitoring and Maintenance Program is commensurate with the potential environmental risk, and the extent and complexity of the works.
P47	The performance of the site's drainage, erosion and sediment control measures is regularly monitored.	**A47**	(a) The extent and complexity of site monitoring (including water quality monitoring) is commensurate with the potential environmental risk, and the extent and complexity of the works. (b) A record is maintained of the site's compliance and non-compliance with erosion and sediment control approval requirements. (c) All site monitoring data including environmental incidents, rainfall records, dates of water quality testing, testing results, and records of controlled water releases for the site, are kept in a register.
P48	The site's stream flow, drainage, erosion and sediment control measures remain relevant at all times to the current site conditions.	**A48**	All stream flow and ESC measures are inspected by site personnel: (i) at least daily (when work is occurring on-site); (ii) at least weekly (when work is not occurring on-site); (iii) within 24-hours of expected rainfall; and (iv) within 18-hours of a rainfall event of sufficient intensity and duration to cause runoff on the site.

SITE MAINTENANCE			
Performance Criteria		**Acceptable Solution**	
P49	All ESC measures are maintained in proper working order at all times during their required operational life.	**A49**	(a) All ESC measures are maintained in proper working order for the duration of the period in which their operation is required in order to satisfy the required treatment standard, and/or the objective of the ESCP. (b) All sediment control measures are maintained in accordance with the requirements of the relevant regulatory authority, or where such a standard does not exist, in accordance with current best practice. (c) As a minimum, the maintenance of all ESC measures is commensurate with the expected site conditions, and potential environmental risk.
P50	The maintenance of ESC measures does not cause environmental harm.	**A50**	All materials removed from ESC devices during maintenance or decommissioning, whether solid or liquid, is lawfully disposed of in a manner that does not cause ongoing soil erosion or environmental harm.

Attachment A

SITE PLANNING AND DESIGN

The *intent* of the Site Planning and Design section is to:

- Enable erosion and sediment control issues to appropriately influence the planning and design of instream works for the purpose of minimising their overall adverse environmental impact.
- Enable planners and designers to recognise that along with consideration of the operational phase of a development, appropriate consideration must be given to how something is to be constructed and maintained, and the potential adverse impacts of the construction and maintenance phases.
- Take all reasonable and practicable measures to actively avoid foreseeable soil erosion problems and associated environmental hazards during the construction phase.

The term "maintenance phase" refers to such activities as the de-silting of instream structures such culverts, stormwater pipes, and permanent instream sediment traps.

Acceptable Solution A1(a)
Data collection may include: soil testing, identification of potential site constraints, and development of a Conceptual Erosion and Sediment Control Plan (where such data and/or plans are considered reasonably necessary to enable appropriate site planning and design). Appropriate site planning and design refers to the aim of minimising the potential environmental harm (both during the construction and operational phases) of the instream works.

The "potential environmental risk" relates to the potential of a land-disturbing activity to cause harm, whether material, serious, reversible or irreversible, to an environmental value, including nuisance to a neighbouring property or person. The potential environmental risk is related, in part, to the assessed Erosion Hazard.

Acceptable Solution A1(b)
Data collection necessary to assist the design of site revegetation is outlined in Sections C3 and C9 of IECA (2008).

Acceptable Solution A2(a)
Construction activities that are deemed to represent a high to extreme erosion hazard include:

- Any disturbance of high to extreme hazard areas, or a problematic soil that could result in unmanageable soil erosion and/or environmental harm.
- Any construction or building activity, or procedure, that could potentially cause "serious" environmental harm.
- Any soil disturbance that could cause the transformation of significant quantities of potential acid sulfate soils (PASS) into actual acid sulfate soils (AASS), such as to cause "material" or "serious" environmental harm.

Acceptable Solution A2(f)
Ideally, Erosion and Sediment Control Plans (ESCPs) should be developed in close association with construction planning because the needs and limitations of the construction process represent an important component of the ESCP. In theory, a construction process cannot be finalised without reference to an ESCP, and an ESCP cannot be finalised without knowledge of the construction process.

Acceptable Solution A2(g)
Essential ESC control measures includes any instream sediment control and flow diversion systems, and bank and overbank drainage, erosion or sediment control measures.

Acceptable Solution A2(h)
The most critical issue is ensuring sufficient space is available to construct and maintain all *Sediment Basins* and flow diversion systems.

Acceptable Solution A2(i)
"Temporary" watercourse crossings refer to those crossings constructed for use only during the construction phase.

Acceptable Solution A3(a)
Minimising the potential environmental harm can be achieved, in part, by scheduling major land disturbances, and disturbances to high and extreme erosion risk areas, for the least erosive periods of the year.

The least erosive period of the year is usually the period of lowest stream flow. The least environmentally damaging period of the year usually relates to periods of no, or minimum, fish migration. Refer to State fisheries authorities for advice.

Acceptable Solution A4(a)
Ongoing erosion problems can result from any of the following:
- changes to the volume, duration, frequency or rate of stormwater runoff;
- excessive (i.e. erosive) flow velocities;
- inappropriate distribution of flow velocities throughout the depth and width of flow discharged from a stormwater drain into a receiving water;
- inappropriate direction of flow discharged from a stormwater drain into a receiving water.

Acceptable Solution A4(b)
"Ongoing maintenance" refers to such activities as the de-silting of instream structures such culverts, stormwater pipes, and permanent instream sediment traps.

EROSION AND SEDIMENT CONTROL PLAN (ESCP)

The *intent* of this section is to ensure Erosion and Sediment Control Plans (ESCPs):
- are appropriate for the site conditions, which may vary from time to time;
- are prepared by, or under the supervision of, suitable personnel;
- are able to achieve the required design standard and environmental protection.

Acceptable Solution A5(a)
Such a clause shall not reduce the responsibility of applying and maintaining, at all times, all necessary sediment control measures in accordance with the sediment control standard.

Acceptable Solution A5(b)
Refer to A1(a) for discussion on "environmental risk".
It is recognised that the degree of erosion and sediment control is related to the type, cost and scope of works in addition to the environmental risk. This association is acknowledged within the terms of current best practice erosion and sediment control as defined within this document (2008 conditions).

Acceptable Solution A5(c)
On very minor works, such as regular council maintenance activities, or the installation of minor services, the ESCP may be represented by standard drawings prepared by the principle company/organisation as part of an in-house Code of Practice. The key *intent* is to ensure that appropriate consideration is given to erosion and sediment control requirements <u>before</u> works commence.

For instream works with a soil disturbance greater than $50m^2$, the Erosion and Sediment Control Plan (including supporting documentation and construction specifications) must include:
(i) North point and plan scale.
(ii) Site and easement boundaries and adjoining roadways.
(iii) Construction access points.
(iv) Site office, car park and location of stockpiles.
(v) Proposed construction activities and limits of disturbance.
(vi) Retained vegetation including protected trees.
(vii) General soil information and location of problem soils.
(viii) Location of critical environmental values (where appropriate).
(ix) Existing site contours (unless the provision of these contours adversely impacts the clarity of the ESCP).
(x) Final site contours including locations of cut and fill.
(xi) General layout and staging of proposed works.
(xii) Location of all drainage, erosion and sediment control measures.

(xiii) Full design and construction details (e.g. cross-sections, minimum channel grades, channel linings,) for all drainage and sediment control devices, including *Flow Diversion Barriers* and instream sediment traps.
(xiv) Construction specifications for adopted ESC measures (as appropriate).
(xv) Site revegetation requirements (if not contained within separate plans).
(xvi) Site Monitoring and Maintenance Program, including the location of proposed water quality monitoring stations.
(xvii) Technical notes relating to:
- site preparation and land clearing;
- extent, timing and application of erosion control measures;
- temporary ESC measures installed at end of working day;
- temporary ESC measure in case of impending storms or elevated stream flows, or emergency situations;
- installation sequence for ESC measures;
- application rates (or at least the minimum application rates) for mulching and revegetation measures;
- legend of standard symbols used within the plans.

(xviii) Calculation sheets for the sizing of ESC measures.
(xix) A completed Erosion and Sediment Control Plan checklist such as presented in *(insert publication).*
(xx) Any other relevant information the regulatory authority may require to properly assess the ESCP.

The ESCP must clearly state that no land-disturbing activities shall occur on the site until all associated perimeter ESC measures, including flow diversion barriers, sediment traps and temporary drainage controls, have been constructed in accordance with the ESCP and current best practice erosion and sediment control procedures.

Acceptable Solution A6(a) & (b)
A suitably qualified and experienced professional is defined as a person with:
(i) training and/or qualifications in erosion and sediment control that are recognised by the regulatory authority; and
(ii) professional affiliations with an engineering, environmental engineering, soil science, and/or scientific organisation (e.g. the International Erosion Control Association; Engineers Australia; Environment Institute of Australia and New Zealand; or the Australian Society of Soil Science Inc.) and
(iii) at least 2 years experience in the management of erosion and sediment control that can be verified by an independent third party.

ESCPs for high-risk sites should be reviewed by a suitably qualified and experienced third party reviewer prior to its implementation.

The assessment and categorisation of high-risk sites may be defined by the relevant regulatory authority; otherwise, refer to the discussion in Chapter 3 and Appendix F of IECA (2008).

Acceptable Solution A6(c)
The *intent* is to ensure the adoption of appropriate design procedures for temporary instream structures, and to minimise the risk of avoidable harm to the waterway.

Acceptable Solution A7(a)
The timing and degree of ESC specified in the Erosion and Sediment Control Plan(s) needs to be appropriate for the given soil properties, expected weather conditions, and susceptibility of the receiving waters to environmental harm resulting from sediment-laden runoff. Current (2008) best practice design standard of the drainage, erosion and sediment control measures are outlined in Chapter 4 of IECA (2008).

Acceptable Solution A7(b)
Additional and/or alternative erosion and sediment control measures must be implemented, and a revised Erosion and Sediment Control Plan (ESCP) must be prepared and submitted to relevant regulatory authority for approval (where required) in the event that:
(i) site conditions significantly change from those previously anticipated; or

(ii) there is a high probability that serious or material environmental harm might occur as a result of sediment leaving the site; or
(iii) the implemented works fail to achieve the adopted ESC standard, or the State's environmental protection requirements; or
(iv) site inspections indicate that the implemented works are failing to achieve the "objective" of this ESCP.

SITE ESTABLISHMENT

The *intent* of this section is to ensure that during site establishment:

- on-site personnel are provided with all necessary information to fully comply with all legal requirements, minimise environmental harm, and achieve the objective of the ESCP; and
- land disturbing activities proceed in a manner consistent with the objective of the ESCP.

Acceptable Solution A8
Supply of such material is relevant only to that material that exists, or is required to exist.

Acceptable Solution A9(a)
On low-risk site, ESC audits (including site inspections and water quality monitoring) may be performed by site personnel; however, as the risk of environmental harm increases, the need for third-party site inspections and water quality monitoring increases.

In reference to instream works, "low-risk sites" would include works conducted within dry-bed channels during periods when stream flow is highly unlikely.

Personnel undertaking ESC audits of a site must, collectively, have the following capabilities:
(i) an understanding of the local environmental values that could potentially be affected by the proposed works; and
(ii) a good working knowledge of the site's Erosion and Sediment Control (ESC) issues, and potential environmental impacts, that is commensurate with the complexity of the site and the degree of environmental risk; and
(iii) a good working knowledge of current best practice ESC measures for the given site conditions and type of works; and
(iv) ability to appropriately monitor, interpret, and report on the site's ESC performance, including the ability to recognise poor performance and potential ESC problems; and
(v) ability to provide advice and guidance on appropriate measures and procedures to maintain the site at all times in a condition representative of current best practice, and that is reasonably likely to achieve the required ESC standard; and
(vi) a good working knowledge of the correct installation, operational and maintenance procedures for the full range of ESC measures used on the site.

Acceptable Solution A9(b)
The construction industry's method of dealing with workplace safety issues is a good model for the development of an appropriate "chain of command" for the protection of environmental values. The aim is to produce a fair, reasonable and practicable approach based on environmental risk.

As in workplace safety, the responsibility of environmental protection, and therefore erosion and sediment control, rests with **all** site personnel, whether or not the work site is the normal place of work of any and all personnel. Establishing a "chain of command" does **not** diminish the responsibility of each and every person to take all reasonable and practicable measures to minimise environmental harm resulting from their actions as per their "environmental duty of care".

Acceptable Solution A10(a)
The exception to this clause is land disturbance necessary to provide access and allow the installation the initial ESC measures.

In general, initial land-disturbing activities should be limited to the establishment of the site compound, site entry/exit points, temporary drainage controls (including drain stabilisation measures), haul road(s), perimeter sediment controls, installation of flow diversion barriers, and any sediment basins/traps required for the first stage of works.

Acceptable Solution A10(b)
“Operational activities” include such things as material stockpiles, storage areas, or concrete waste receptors.

Acceptable Solution A11(a)
It is recognised that it may not be practicable for **all** stormwater runoff from **all** areas of site entry/exit paths to be directed to a sediment trap; however, such areas must be limited to the minimum practicable.

SITE MANAGEMENT

Acceptable Solution A12(a)
Where appropriate, an Erosion and Sediment Control Plan is prepared (in accordance with Section G3.3), and where necessary approved by a relevant regulatory authority, prior to commencing any land-disturbing activities.

Acceptable Solution A12(b)
The potential for environmental harm must be assessed by a recognised expert or authority.

Acceptable Solution A12(c)
Refer to A1(a) for a discussion on “potential environmental risk”.

Acceptable Solution A12(d)
Applies to all land-disturbing activities, whether planned or unplanned, and especially to any works that are required to be conducted without an associated Erosion and Sediment Control Plan.

Acceptable Solution A12(d)(iv)
Includes ensuring that the value and use of land/properties adjacent to the development (including roads) are not diminished as a result of work-related soil erosion and sediment runoff.

Acceptable Solution A13
“Responsible ESC personnel” are those persons employed or contracted by the landowner and/or developer as the principal officer(s) responsible for ensuring appropriate application of the planned ESC measures and for the provision of advice in response to unplanned ESC issues.

Acceptable Solution A14(a)
Recommended training requirements are discussed in Section 6.19 of IECA (2008).

Acceptable Solution A14(b)
Necessary disturbance to ESC measures would include the short-term removal of an ESC measure to allow the installation of services under the ESC measure, or to allow vehicular or material access.

Performance Criterion P15
Performance Criteria P15 and P16 require work sites to be appropriately prepared for both current and imminent site conditions. Compliance with these criteria requires ESCPs to be living documents that remain both effective and flexible, and thus are able to appropriately adapt to changing site conditions.

Acceptable Solution A15(b)
A significant change in site conditions includes:
- unseasonable weather conditions;
- unseasonable stream flow;
- exposure of problematic soil conditions not previously anticipated;
- significant change in construction methodology, staging or programming of earthworks and/or site stabilisation activities;
- significant change in the development design or layout;
- an unprogrammed site shutdown.

Performance Criterion P16
Performance Criteria P15 and P16 require work sites to be appropriately prepared for both current and imminent site conditions. Compliance with these criteria requires ESCPs to be living documents that remain both effective and flexible, and thus are able to appropriately adapt to changing site conditions.

Acceptable Solution A18(a)
Appropriate identification depends on the level of risk of damage to protected or retained vegetation. Appropriate identification does not necessarily mean markers, signs or fencing; however, such measures may be appropriate in some areas.

Acceptable Solution A19(b)
AS1940 *The storage and handling of flammable and combustible liquids* (as amended from time to time).

In addition to the above:

- Impervious bunds must be constructed around all storage areas containing more than $1m^3$ of petroleum and oil-based products such that the enclosed volume is large enough to contain 110% of the volume held in the largest, individual storage tank.
- On-site personnel involved in the handling and storage of flammable and combustible liquids, including all liquid chemicals, must be appropriately trained and/or supervised, as required in order to allow such personnel to appropriately preform such activities.

Acceptable Solution A19(d)
Current (2008) best practice requires that all reasonable and practicable measures are taken to:

(i) prevent the release of cement-laden runoff, concrete waste, and chemical products (including petroleum and oil-based products), into an internal or external water body, completed internal drainage systems, or any external drainage system, excluding those on-site drains and water bodies specifically designed to contain and/or treat such material;
(ii) ensure all solid and liquid waste from concrete production, concreting equipment (including delivery and placement vehicles), is fully contained within the property;
(iii) ensure cement residue from work activities is:
   - retained on a pervious surface (e.g. a grassed or open soil area, or excavated trench); or
   - filtered through a fine-grained, porous, earth embankment; or
   - collected and disposed of in a manner that minimise ongoing environmental harm.

Acceptable Solution A19(e)
Current (2008) best practice requires that wherever practicable, the washing of tools and painting equipment is carried out in a manner that:

(i) complies with current State guidelines, policies and legislation; and
(ii) fully contains any contaminated waste water for later treatment and/or lawful disposal; or
(iii) appropriately filters (e.g. through a fine-grained, porous earth embankment) any contaminated liquid prior to its release from the immediate work area; or
(iv) appropriately infiltrates all contaminated liquid matter into an area of porous grass or open soil.

Acceptable Solution A21(a)
“Sediment and other material” includes clay, silt, sand, gravel, soil, mud, cement and fine-ceramic waste.

Acceptable Solution A21(b)
Sealed surfaces include sealed roads and car parks.

In circumstances where the washing/flushing of sealed surfaces is required, all reasonable and practicable sediment control measures must be employed to prevent, or at least minimise, the release of sediment into receiving waters. Only those measures that will not cause safety issues or adverse property flooding to third parties shall be employed.

Acceptable Solution A22

"Appropriate consideration" includes taking all reasonable and practicable measures to minimise safety risks. As a general rule, safety issues take a higher priority than ESC issues; however, this does **not** mean that the existence of potential safety issues diminishes the ESC standard required of a work site.

Public safety risks include potential damage to public vehicles resulting from the use of inappropriate kerb-inlet sediment traps on public roads. The potential safety risk of a proposed sediment trap to site workers and the public must be given appropriate consideration **before** its installation, especially those sediment traps located within publicly accessible areas.

Sediment and sediment-laden runoff must not settle or collect on public roadways where such material could result in a traffic or safety hazard.

Performance Criterion P23
The protection of wildlife does not diminish the required ESC standard, or the need to take all reasonable and practicable measures to minimise environmental harm resulting from soil erosion and displaced sediment.

Acceptable Solution A23(c)
Refer to Witheridge (2002) for guidelines on the design of fish-friendly watercourse crossings.

Acceptable Solution A23(b)
Synthetic reinforced fabrics include "plastic" reinforced *Erosion Control Blankets*, *Mats* and *Meshes*.

SITE DISTURBANCE

Acceptable Solution A24(d)
Operational restrictions on the extent and duration of land disturbance, including land clearing only apply when such land disturbance is at risk, or potentially at risk, of erosion by wind, rain or flowing water.

The potential erosion risk is related (in part) to the potential rainfall erosivity as defined in Section 4.4 of IECA (2008). The potential erosion hazard may be identified through the application of an appropriate Erosion Hazard Assessment scheme such as those discussed in Chapter 3 and Appendix F of IECA (2008).

Acceptable Solution A24(e)
The full impact of the removal of deep-rooted vegetation from steep slopes may not be evident for 5 to 10 years, or until such time as the plant root system begins to fail (assuming that the root system remains within the soil profile after removal of the upper portion of the plant). Planners and designers must appreciate that plants provide many essential roles besides the provision of "scenery".

Periods of high and extreme erosion potential refers to the variation in the erosion hazard throughout a calender year based on variations in the rainfall erosivity as described in Appendix E of IECA (2008). Periods of high to extreme erosion potential include:

- periods of high to extreme erosion risk as defined in Section 4.4 of IECA (2008); and
- periods of strong winds sufficient to cause significant dust problems.

Acceptable Solution A25(a)
The extent of unnecessary soil disturbance, including disturbances outside the designated work area, must be minimised at all times.

Wherever reasonable and practicable, land clearing must be limited to the current stage of works. Current (2008) best practice recommends that land clearing not extend beyond the parameters indicated in Table I11 of IECA (2008).

Table I11 of IECA (2008) does not imply that land clearing should occur to the full extent of these limits, rather than all reasonable and practicable measures are taken to limit land clearing to no more than these limits. In all cases, land clearing must be limited to the minimum necessary to complete the approved works.

SOIL AND STOCKPILE MANAGEMENT

Performance Criterion A27
Applies to all areas of proposed soil disturbance, including footprint of proposed stockpiles prior to placement of soil within such areas. Does not include any material best described as subsoil.

Acceptable Solution A27(b)
Current (2008) best practice recommendations for the management of topsoil are presented in Table 6.2 of IECA (2008).

Acceptable Solution A28(ii)
The diversion of overbank, stormwater is recommended during those periods when rainfall is possible and the overbank catchment area exceeds 1500m^2.

Current (2008) best practice recommendations for the protection of sand and soil stockpiles from the erosive effects of wind and rainfall are presented in Table 4.6.1 of IECA (2008).

Acceptable Solution A28(iv)
Current (2008) best practice recommendations for the selection of an appropriate sediment control system is presented in Table 4.6.2 of IECA (2008).

Short-term stockpiles of erodible material located outside of an appropriate sediment control zone must be covered if it is raining, or if rain is imminent or possible.

Acceptable Solution A29
Dispersive soils normally need to be stabilised (i.e. treated with gypsum or lime depending on desired pH adjustment) and/or buried under a layer of non-dispersive soil prior to placement of channel lining (whether rock, gabion, synthetic material, or concrete), or initiation of revegetation.

Acceptable Solution A30
Within Queensland, guidelines on the management of acid sulfate soils is provided in State Planning Policy 2/02 *Guideline: Planning and Managing Development involving Acid Sulfate Soils*, and Dear, et al. 2002, *Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines.* Department of Natural Resources and Mines, Indooroopilly, Queensland.

DRAINAGE CONTROL

The *intent* of this section is to take all reasonable and practicable measures to prevent, or at least minimise, environmental harm and public nuisance resulting from the exposure of soil to the erosive forces of flowing water. It is not the intent to unfairly burden those performing land-disturbing activities with the cost and inconvenience of installing and maintaining drainage control measures if there is no risk of such environmental harm and public nuisance.

Acceptable Solution A32(a)
Current (2008) best practice construction phase drainage standards are presented in Table 4.3.1 of IECA (2008). Drainage systems must be designed to have a minimum non-erosive hydraulic capacity (excluding 150mm freeboard) in accordance with this table.

Acceptable Solution A32(b)
Construction Drainage Plans are normally prepared for sites with a soil disturbance exceeding 50m^2. Further discussion on the requirements of *Construction Drainage Plans* is presented in Acceptable Solution A11(d).

Acceptable Solution A33(b)
Sandbag flow diversion banks, catch drains, and flow diversion banks are examples of appropriate drainage systems that can be used to divert stormwater around excavations and other soil disturbances.

EROSION CONTROL

The *intent* of this section is to take all reasonable and practicable measures to prevent, or at least minimise, environmental harm and public nuisance resulting from the exposure of soil, sand, silt, mud or cement to the erosive forces of wind, rain and flowing water. It is not the intent to unfairly burden those performing land-disturbing activities with the cost and inconvenience of installing and maintaining erosion control measures if there is no risk of such environmental harm and public nuisance.

Acceptable Solution A35(a)
Current (2008) best practice (construction phase) land clearing and site rehabilitation standards are presented in Table I11 of IECA (2008). Unless otherwise stated by the relevant regulatory authority, the potential erosion risk is based on the rating outlined in Tables I9 and I10 of IECA (2008).

In addition, all temporary earth banks, flow diversion systems, and off-stream *Sediment Basin* embankments should be machine-compacted, seeded and mulched within ten (10) days of formation for the purpose of establishing a vegetative cover, unless otherwise stated within an approved Site Stabilisation Plan, Revegetation Plan, or Vegetation Management Plan.

Acceptable Solution A35(b)
Erosion control measures primarily focus on the control of fine sediments such as clay and silt-sized particles. Thus, with respect to the value of “erosion control measures”, potential environmental harm is strongly related to the susceptibility of the receiving waters to environmental harm resulting from turbid runoff (i.e. suspended fine sediments).

Erosion control measures need to be appropriate for the land slope and the expected wind, rain and hydraulic conditions. Application of effective drainage control measures should help to control hydraulic conditions such that damage to adopted erosion control measures during regular rainfall events is minimised.

Acceptable Solution A35(c)
This clause requires compliance with Performance Criteria P15 and P16.

Acceptable Solution A36(a)
Such a clause shall not reduce the responsibility to apply and maintain, at all times, all necessary sediment control measures.

The minimisation of soil erosion requires the application of effective drainage and erosion control throughout each and all sub-catchments.

Acceptable Solution A37(b)
Compliance with this clause requires:
- soil disturbance within any sub-catchment to be delayed as long as possible, and ideally, not until the principal on-site activities within that area are ready to commence;
- soil disturbance at any given time to be limited to the minimum necessary to perform the required works;
- the extent of unnecessary soil disturbance, including disturbances outside the designated work area, to be minimised.

The stabilisation of non-completed earthworks that are likely to be exposed to rainfall is discussed in Table I11 of IECA (2008).

Compliance with the requirements outlined within Table I11 of IECA (2008) does not diminish the need to apply all reasonable erosion control measures as soon as practicable.

Acceptable Solution A38(c)
Dispersive soils normally need to be stabilised (i.e. treated with gypsum or lime depending on desired pH adjustment) and/or buried under a layer of non-dispersive soil prior to placement of channel lining (whether rock, gabion, synthetic material, or concrete), or initiation of revegetation.

SEDIMENT CONTROL

The *intent* of this section is to take all reasonable and practicable measures to prevent, or at least minimise, environmental harm and public nuisance resulting from the exposure, placement, or displacement of sediment (including soil, sand, silt, mud and cement). It is not the intent to unfairly burden those performing land-disturbing activities with the cost and inconvenience of installing and maintaining sediment control measures if there is no risk of such environmental harm and public nuisance.

Acceptable Solution A39(a)
Current (2008) best practice (construction phase) sediment control standards are presented in Table 4.5.1 of IECA (2008).

Acceptable Solution A39(b)
Relevant site conditions include the soil type, design flow rate, flow condition (i.e. sheet flow or concentrated flow) and erosion hazard.

Unless otherwise noted within this document, or specified by the regulatory authority, the design storm for off-stream sediment traps (excluding de-watering and instream sediment control measures) must be taken as 0.5 times the 1 in 1 year ARI peak discharge.

The “potential environmental risk” is discussed in Acceptable Solution A1(a), and is summarised in Table 5.1 of IECA (2008).

Acceptable Solution A42(a)
The *intent* of this clause is to minimise the quantity of water that needs to be de-watered from excavations and trenches. Thus, if water does not need to be de-watered from such areas, then the clause does not apply.

Acceptable Solution A42(b)
Current (2008) best practice sediment control standards for de-watering activities are outlined in Table 4.5.13 of IECA (2008).

Alternatively, Table 4.5.14 of IECA (2008) presents a water quality standard for de-watering operations based on Nephelometric Turbidity Units (NTU).

Appropriate sediment controls placed down-slope of material stockpiles during the de-watering of such stockpiles are summarised in Table 4.5.14 of IECA (2008).

SITE STABILISATION AND REHABILITATION

Acceptable Solution A43(a)
Site Stabilisation Plans, Landscape Plans, and/or Vegetation Management Plans must show progressive stabilisation of exposed soil for the purposes of erosion control, including but not limited to, all of the following:

(i) schedule for stabilisation of exposed soil areas; and
(ii) specifications for subsoil and topsoil preparation and application; and
(iii) specification of stabilisation by mulching or other appropriate surface treatment (note, grass seeding without adequate mulching is generally not considered best practice); and
(iv) details on the type and application rate of any tackifiers to be used in the application of mulches (including *hydromulch*, *Bonded Fibre Matrix*, and *Compost Blankets*).

Water Quality Monitoring Programs must document proposed water quality monitoring, and include:

(i) location of all instream water quality monitoring stations;
(ii) water quality monitoring, sampling, and analysis procedures and standards.

Acceptable Solution A43(b)
Current (2008) best practice site rehabilitation standards are presented in Table I11 of IECA (2008). Unless otherwise stated by the relevant regulatory authority, the potential erosion risk is based on the rating outlined in Tables I9 and I10 of IECA (2008).

Acceptable Solution A44(a)
Temporary revegetation conducted for the purpose of erosion control must be conducted in accordance with a Site Stabilisation Plan, Landscape Plan, Revegetation Plan, or Vegetation Management Plan, where such a plan specifically refers to such activities.

Acceptable Solution A44(b)
The type of permanent vegetation applied to completed earthworks must be compatible with the anticipated long-term land use, current and ongoing erosion risk, environmental requirements (including weed control), and associated components of the site rehabilitation.

Performance Criterion P45
Local environment includes local wildlife.

SITE INSPECTION AND MONITORING

Acceptable Solution A46(b)
Personnel preparing and/or supervising the preparation of the Monitoring and Maintenance Program must, collectively, have the following capabilities:
(i) an understanding of the local environmental values that could potentially be affected by the proposed works; and
(ii) a good working knowledge of the site's Erosion and Sediment Control (ESC) issues, and potential environmental impacts, that is commensurate with the complexity of the site and the degree of environmental risk; and
(iii) a good working knowledge of current best practice Erosion and Sediment Control measures appropriate for the given site conditions and type of works; and
(iv) a good working knowledge of the correct installation, operational and maintenance procedures for the full range of ESC measures used on the site.

Refer to A1(a) for discussion on "potential environmental risk ".

Acceptable Solution A47(a)
Discussion on scheduling and conducting site inspections by internal and external parties is provided in Chapter 7 of IECA (2008).

In those instances where specific site monitoring stations are identified within the Monitoring and Maintenance Program, then:
- during periods of water discharge from the site, water quality samples are collected at each monitoring station at least once on each calendar day until such discharge stops; and
- a minimum of 3 water samples are taken and analysed, and the average result used to determine quality.

Current (2008) best-practice procedures for "high-risk" sites, requires regular ESC audits to be:
(i) undertaken by a person suitably qualified and experienced in erosion and sediment control that can be verified by an independent third-party (this person must not be an employee or agent of the principal contractor); and
(ii) conducted on the next business day following a rainfall event in which greater than 10 mm of rainfall has been recorded by the Bureau of Meteorology rain gauge nearest to the site; and
(iii) conducted at intervals of not more than one (1) calendar month commencing from the day of site disturbance until all disturbed areas have been adequately stabilised against erosion to the acceptance of the relevant regulatory authority; and
(iv) conducted using an appropriate Site Inspection Checklist.

"High-risk sites" are work sites that:
- satisfy the requirements of a high-risk site as defined by either the State or local government; or
- satisfy the requirements of those risk categories greater than high-risk (such as extreme-risk) where such categories have been defined (i.e. score a hazard rating equal to or greater than the "critical hazard value").

Discussion on the assessment of *erosion hazard* and *site risk assessment* is presented in Chapter 3 and Appendix F of IECA (2008).

ESC audits must include, as a minimum:

- copies of all original Site Inspection Checklists; and
- non-conformance and corrective action reports;
- sediment basin water quality and site discharge water quality monitoring results;
- a plan showing the areas of completed soil stabilisation; and
- rainfall records including date and rainfall depth.

Acceptable Solution A48
Discussion on scheduling and conducting of site inspections is provided in Chapter 7 of IECA (2008).

SITE MAINTENANCE

Performance Criterion P49
Proper working order includes maintaining the required hydraulic capacity and operational effectiveness.

Acceptable Solution A49(b)
Current (2008) best practice requirements for the maintenance of sediment control devices requires these devices to be maintained and made fully operational as soon as reasonable and practicable in accordance with Table 6.1 of IECA (2008).

Reference

IECA 2008, *Best Practice Erosion and Sediment Control*. International Erosion Control Association (Australasia), Picton NSW.

Santos
GLNG Project

Appendix D
Concept Dewatering, Hydrotest Water and Land Release Management Plan (DHWLRMP)

Santos | PETRONAS | TOTAL | KOGAS

Concept Dewatering, Hydrotest, Water and Land Release Management Plan

Marine Crossing – Gas Transmission Pipeline

CLIENT:
GLNG Operations P/L

STATUS:
FINAL

REPORT NUMBER:
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Transmission Register

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Figures

Tables

1. Introduction

O2 was commissioned by Downes Group on behalf of GLNG Operations P/L (herein the Client) to prepare a Dewatering, Hydrotest Water and Land Release Management Plan for the proposed works associated with the Gas Transmission Pipeline Narrows Marine Crossing construction.

The area of interest is located approximately 16km north of Gladstone. The location is commonly called the 'Narrows'.

This plan describes physical controls and processes that are expected to result in general compliance with the objectives in Section 1.2. Should the controls indicated in this document not achieve the identified performance criteria for any reason, it is the responsibility of the operator to notify the nominated specialist so that a revision of the plan can be undertaken.

This plan should be read in conjunction with the O2 Marine Crossing – Gas Transmission Pipeline: Stormwater Management and Erosion and Sediment Control Plan (Document Number R001631).

1.1. Environmental Approvals and Legislative Requirements

This plan is provided to meet the following requirements:

Dewatering – Relating to dewatering tunnelling operations to meet requirements as set out in **5.2 (a)** & **5.3** of the DERM additional information request (375042/BNE45992) and Condition 32 (e), (m) & (n) of the EPBC Approval (22/10/2010).

Hydrotest water – To meet requirements as set out in **5.1** of the DERM additional information request (375042/BNE45992), Appendix 3 Part 3 Condition 3 e) of the CG (May 2010) Report and Condition 37 (d) of the EPBC Approval (22/10/2010).

Land Release – In accordance with **5.1** (Hydrotest Water) of the DERM additional information request (375042/BNE45992) and **5.3** (Dewatering) in accordance with **5.1** (Hydrotest Water) of the DERM additional information request (375042/BNE45992)

1.2. Objectives and Targets

This Dewatering, Hydrotest Water and Land Release plan has been developed in accordance with the following guidelines:

- Queensland Water Quality Guidelines (Department of Environment and Resource Management, 2009)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)

The objective of this plan is to minimise harmful impacts on receiving land and waters during the operational period.

1.3. Proposed Works

The summary of relevant works below is based on information provided by GLNG Operations Pty Ltd in a File Note titled 'Preliminary Narrows Crossing Information for Environmental Studies (Ref: 3301-GLNG-3-4-3.3-0004).

The Marine Crossing Project is the construction of a 4.3km long, 3.4m internal diameter tunnel from the mainland to Curtis Island across a channel of tidal sea water to provide access for an LNG pipe to connect to the processing facility on Curtis Island near Gladstone, QLD.

The Areas of Interest associated with the project include the following:

- Launch pad and receptor pad for tunnel boring activities located on the mainland and Curtis Island respectively
- Tunnel between the mainland and Curtis Island
- Pipeline laid within the tunnel

The draft site layout plan provided by client is shown below in Figure 1, with layout details of the launch and receptor pads provided in Figure 2 and Figure 3 respectively.

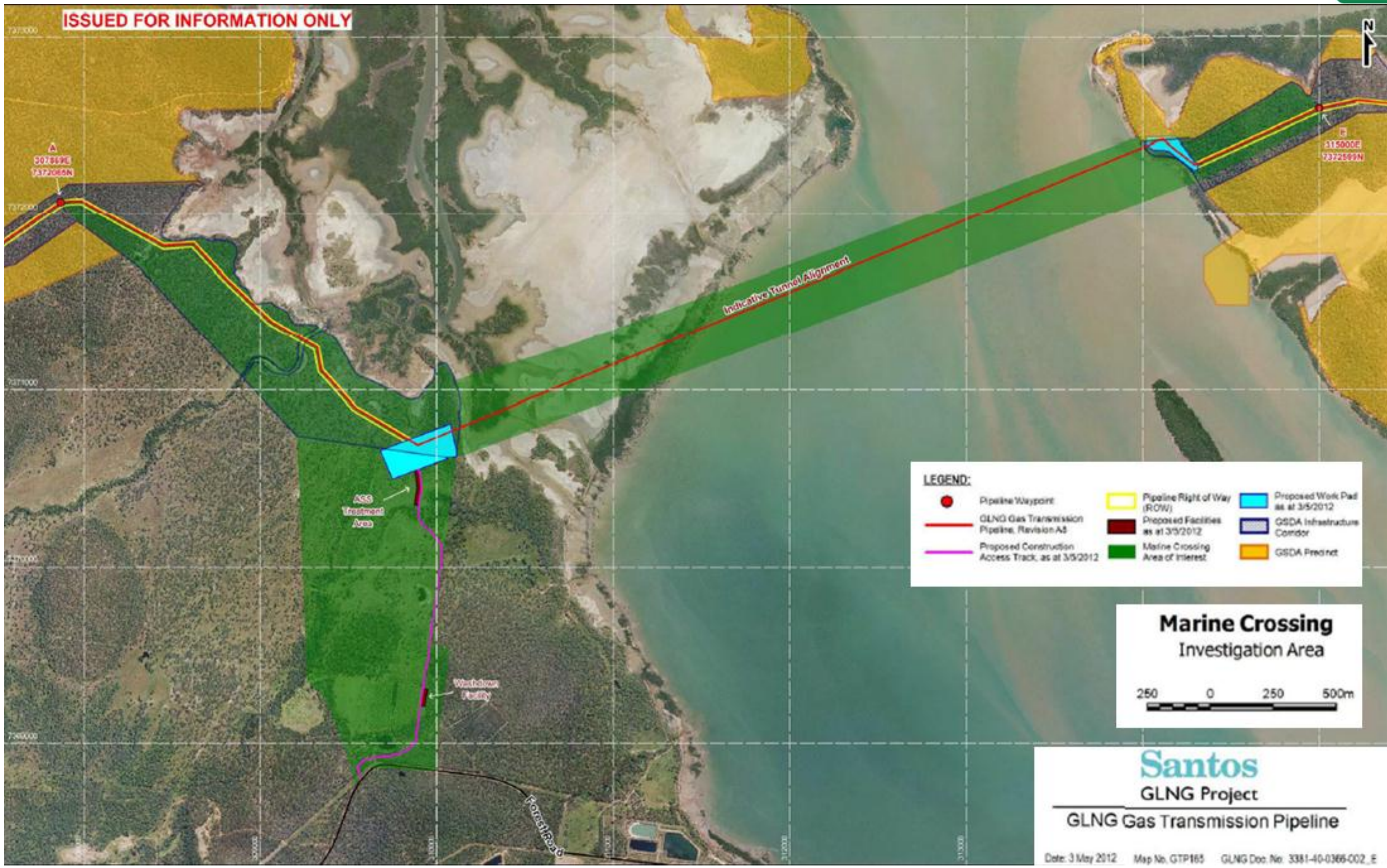

Figure 1: Site Layout Plan

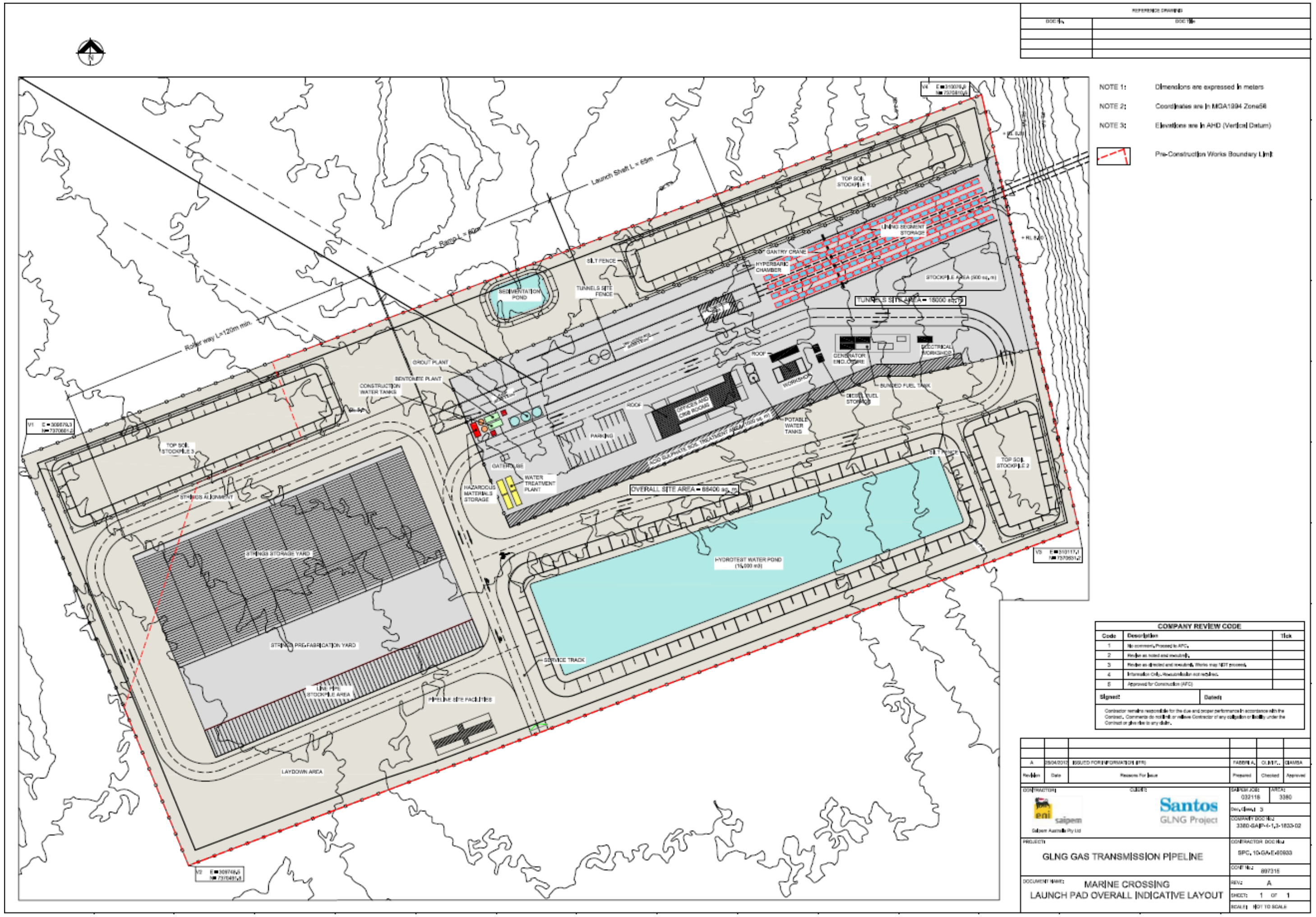

Figure 2: Launch pad infrastructure draft drawing

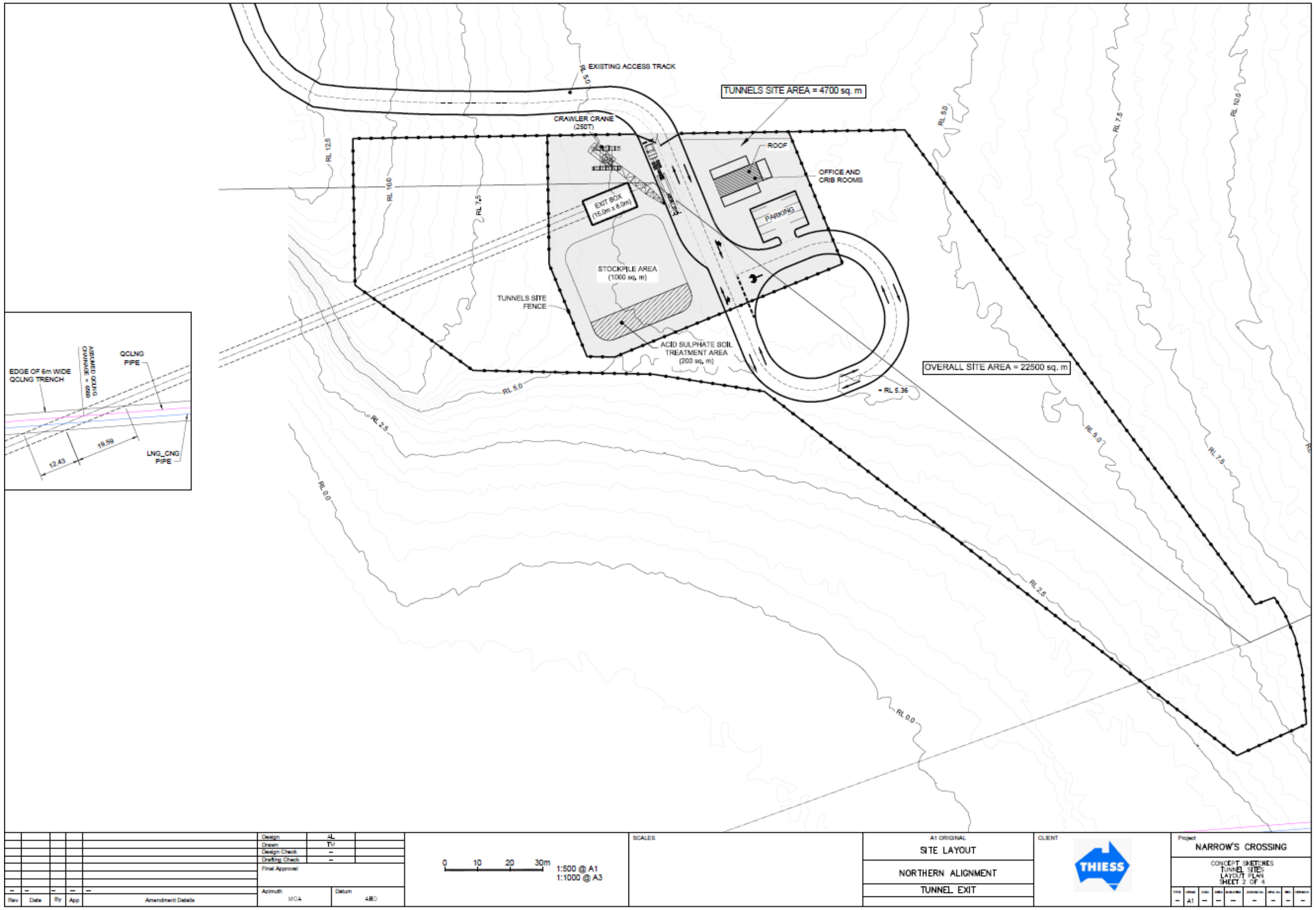

Figure 3: Receptor pad infrastructure draft drawing

2. Site Description

The site was inspected on the 4th and 13th of April 2012. Most areas were able to be accessed with the exception of the pipeline from the launch pad to Humpy Creek (marked in yellow dotted line). Figure 4 displays all photo points and sites inspected (red dots).

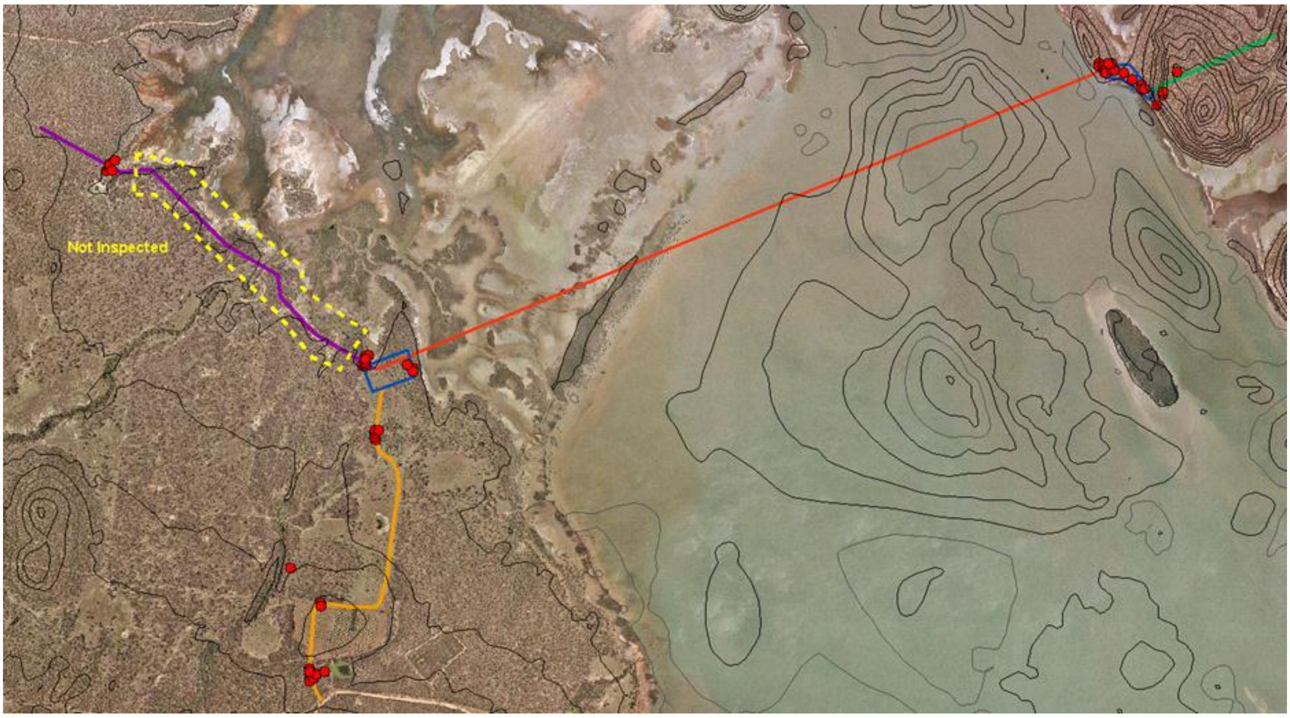

Figure 4: Photo and inspection points

2.1. Site Drainage

Downes Group provided a report 'Site Value Assessment and Water Mouse Habitat Assessment Report (2012)'. The following information is an extract from their findings in regard to aquatic values.

The site has four constructed waterholes / dams which are all very stable and mostly well vegetated with a range of macrophytes and aquatic plants (native and exotic).

Areas from the access gate and southern parts of the "orchard" appear to drain towards a drainage line. This drainage line was flowing at the time of inspection following significant rainfall in the week prior to the site visit. This drainage line flows into the southern dam.

The second dam will be bypassed (in fairly close proximity) by the proposed access track with no impacts anticipated. This area is open and relatively flat with good opportunities to manage surface erosion and stormwater impacts.

The third larger central dam capture runoff from areas from within and to the south of the proposed pad and is a large and well established landscape feature. Drainage patterns for the pad area appear to flow mostly from the east either north to the small *Baumea articulata* and *Eleaocharis* packed waterhole, or south to the large third central dam. Areas draining to the southern dam are presently wet on the site with numerous sedges and wetland plants interspersed with grazing grasses.

Water birds and ducks were observed in all dams and an active and inquisitive population of Double Barred Finches (*Taeniopygia bichenovi*) observed in the northern *Baumea* dam. The northern dam is unique in that it remains freshwater despite the estuarine influence observable in lower lying areas around the landscape feature to the east and north.

The existing proposed location of the pad is well positioned avoiding both drainage features (dams) to the north and south, and positioned such that the seaward edge of the clearing is perched on the top of the existing natural ridgeline. Due to the topography and possibly soil type there is minimal intertidal zone with the open forest dropping immediately into tidal mudflats. A mangrove community is located approximately 50m from the edge of the mudflats

2.2. Acid Sulphate Soils

An investigation of acid sulphate soils (ASS) carried out for the Environmental Impact Statement for the project indicates that both Actual ASS (AASS) and Potential ASS (PASS) occur within the upper levels of the estuarine sediments in the area. Further details can be found in the Acid Sulfate Soil Management Plan (ASSMP) prepared by Golder as part of the Environmental Management Plan.

3. Methodology

The summarised methodology in relation to dewatering and hydrotesting below is based on information provided by Downes Group in the following reports:

- Preliminary Narrows Crossing Information For Environmental Studies (Document Number: 3301-GLNG-4-3.3-0004)
- Hydrotest Conceptual Plan – Marine Crossing (Company Doc. No. 3380-SAIP-4-1.3-XXXX)
- Hydrotest Water Management Plan (Company Doc. No. 3380-SAIP-4-1.3-1840)

The tunnel construction will be carried out by a Tunnel Boring Machine (TBM) beginning at the launching pad on the mainland and concluding at the receptor pad on Curtis Island.

Once the tunnel construction is complete, the pipe will be installed with welding taking place immediately before the tunnel entrance.

Hydrotesting will then be carried out on the pipe section.

The water for the tunnel construction will be sourced, treated and discharged separately from the water for the hydrotesting.

Each of these activities is described in more detail in the following sections.

3.1. Tunnel Boring

The tunnel will be constructed by a Tunnel Boring Machine (TBM) that will place waterproof concrete segments as it progresses through to the receptor pad on Curtis Island.

The concrete segmental rings and the grout placed between them is substantially watertight, however a small quantity of water is expected to infiltrate the tunnel. Over the period of 13 months the estimated total infiltration of water is expected to be between 2,500m^3 to 5,000m^3. Infiltration of water into the tunnel will cease when the tunnel is flooded.

The client advises that, based on past experience with similar tunnels, water imported by tankers from approved Gladstone Area Water Board sources will be used at the commencement of tunnelling and periodically during operations.

Water is considered a valuable resource and will be recycled to the greatest practical extent for use in tunnel construction. Water for this purpose will be processed through a dedicated site water treatment plant located at the launch pad and stored in tanks for reuse.

The majority of this water will ultimately be returned to the tunnel either as a component of the 6000 m^3 of grout required or when the tunnel is flooded.

Water will also be used during construction for dust suppression and housekeeping on the pad.

On completion the tunnel will be flooded with any water remaining in the tanks holding (treated) tunnel water, and the balance made up with seawater sourced from the Narrows.

If it is considered inappropriate to use this water to flood the tunnel once it has been completed, the water will be treated to a standard suitable for discharge.

A small amount of Bentonite may be stored and used on site as a contingency measure to lubricate parts of the tunnelling operation and will be used as a component of the grout which will be fixed between the segments.

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) regulates international cooperation on environmental protection in the North-East Atlantic region. The OSPAR Commission is the mechanism by which the European Community and fifteen Governments of the western coasts and catchments of Europe co-operate to protect the marine environment of the North-East Atlantic. Bentonite is listed in the OSPAR Commission's List of Substances/Preparations Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment (PLONOR). (OSPAR Commission, 2012)

3.2. Hydrotesting

The tunnel section will be constructed from the mainland end in the direction of Curtis Island. During the tunnel construction, pipe will be welded and pretested in readiness for installation. Installation of the pipe will not take place until the tunnel is completed and the tunnelling infrastructure that is not required for the pipe installation has been removed.

Hydrotesting, or hydrostatic pressure testing, is the testing of a section of pipeline with water to establish the strength and leak tightness of the test section and to confirm the maximum allowable operating pressure.

All sections of pipe to be tested are cleaned with a pig and compressed air to remove any construction debris prior to filling with water for hydrotesting.

The hydrotest water will be water that has been used for testing inland sections of pipe. Once testing of the upstream sections is complete, the water will be transferred to the pond at the pad and testing of the mainland sections of pipe will be carried out. When the tunnel is complete and the pipe has been installed, hydrotesting of the pipe in the tunnel and on Curtis Island will be carried out. Water will then be returned to the pond at the pad for land release.

3.2.1. Water Supply for Hydrotests

Water for hydrotesting the mainland section of the pipeline will be transferred from the adjoining mainland pipeline sections. This water will be reused water from hydrotesting of inland sections of pipe and will originally have been raw water sourced from bores to the west in the Arcadia Valley or near Bauhinia Downs.

On completion of the adjoining mainline test section, water will be transferred into a pond constructed at the launch pad. The pond will be approximately 15,000 m^3 in capacity with a maximum water depth of approximately 5 to 6 metres and freeboard of approximately 1m to manage the risk of uncontrolled release, based on a Q10 event. The pond will be lined to prevent losses due to infiltration and avoid contamination from groundwater infiltration or interception of any acid sulphate soils at the location. A sump will allow most of the water to be removed.

Water cannot be passed through the mainline test section once it has been dewatered and dried. Any additional water (if required) must be obtained via road tankers from the Gladstone Area Water Board or other available water sources of suitable quality.

3.2.2. Water Quality

The desired water quality for hydrotest water is essentially fresh water with dissolved solids of less than 2,000 ppm. There is no intention of using biocide or corrosion inhibitors and the pipe will be cleaned by a pig and compressed air prior to hydrotesting.

A study conducted by the CSIRO (G. Tjandraatmadja, 2005) found that the quality of the used hydrotest water did not represent a hazard to the environment, provided that the source water was of adequate quality. The source water quality was identified as the primary driver of the quality of used hydrotest water.

The water will need to be assessed for Sulphate Reducing Bacteria (SRB) and turbidity prior to use for hydrotesting.

If both SRB and sufficient sulphate availability is detected in the water, measures will be taken to prevent the growth of SRB. The preferred method is to increase the pH to a minimum of pH10 by the addition of sodium bicarbonate, sodium carbonate and sodium hydroxide.

The presence of suspended solids encourages the growth of SRB. Removal of suspended solids by settlement will assist in controlling SRB. Aeration of the water also reduces SRB activity.

3.2.3. Water Treatment

If any pH adjustment has been carried out prior to hydrotesting, pH correction to pH6.5 – pH8.5 will be carried out in the pond by acid dosing prior to disposal.

3.3. Water Disposal

The water associated with tunnelling activities will be treated by the site treatment plant and ultimately either used to flood the tunnel or be discharged appropriately according to the ASSMP.

The hydrotest water will essentially be raw fresh water and should require minimal treatment before discharge. Any treatment that is required, such as pH correction in the case that SRB are found in the source water, will occur within the pond. The hydrotest water is anticipated to be ultimately discharged to land.

3.3.1. Water Balance

The following information was provided by the Client on 30 May 2012 in Santos GLNG Project – Marine Crossing Comment Sheet – Water packages: Hydrotest, Dewatering, Land Release.

The volume of pipeline to be hydrotested is approximately 10,000m^3. An extra 5,000m^3 of water will account for evaporation and pre-testing. 15,000m^3 of water will be collected and stored over a period of 6 months in the pond lined with impervious lining. The hydrotesting will be carried out over a 6 month period and final disposal of hydrotesting water will be via controlled discharge to land at the end of the 12 months.

The design groundwater infiltration into the tunnel is 1L/hr/100m, resulting in approximately 2,500m^3 to 5,000m^3 over 13 months being passed through the treatment plant. Some of this water may be lost in the spoil that is being exported from the site.

The volume of water required for the drilling operations is unknown. This water will also be passed through the treatment plant.

5,000m^3 of water from the treatment plant will be used to create 6,000m^3 of grout for the tunnel. Some water from the treatment plant will be used to wash down the surrounds and for dust suppression. Any remaining treated water will either be used to flood the tunnel or will be realeased via control release, as appropriate.

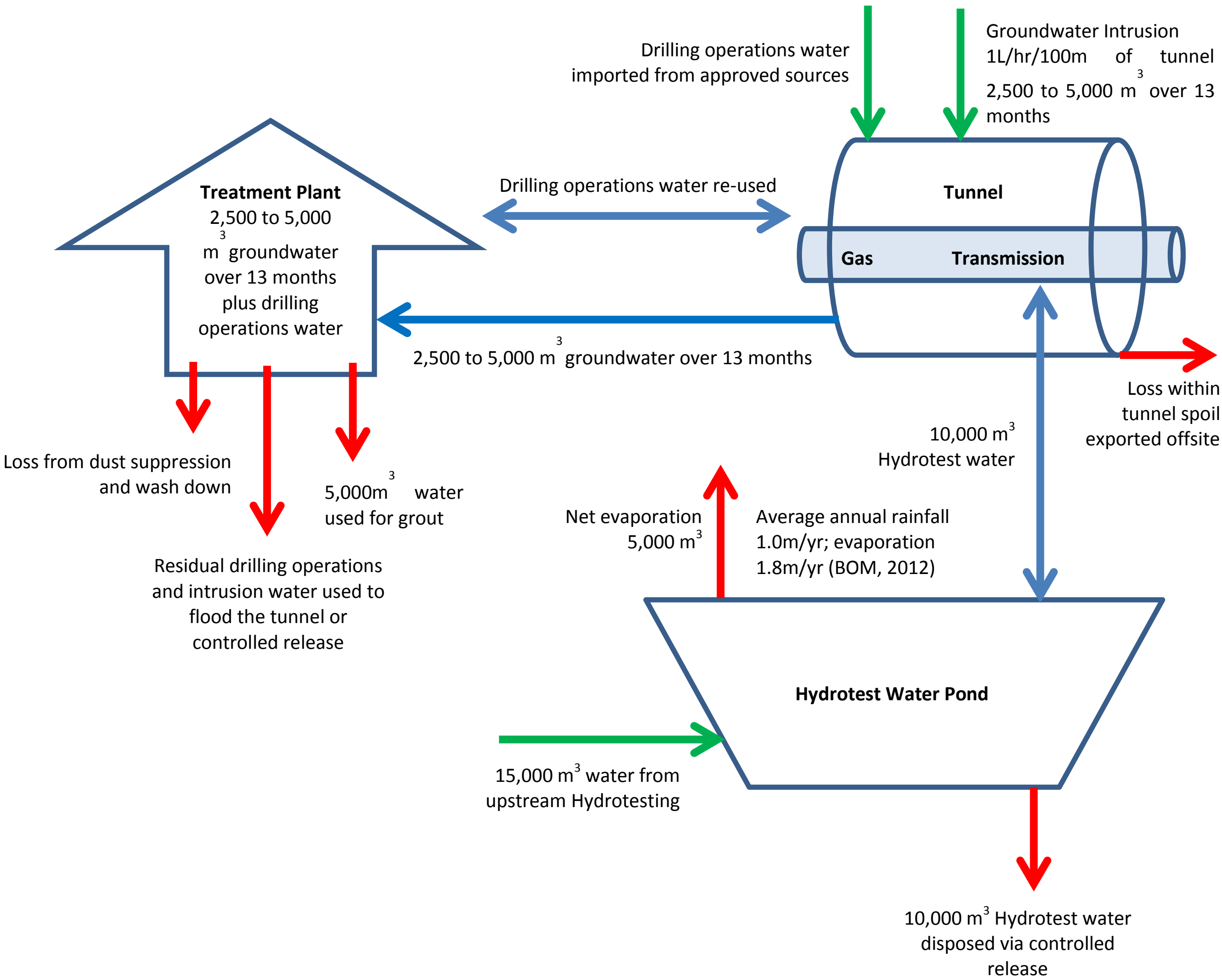

Figure 5: A schematic for water around the site

At this stage, it is understood that at least 10,000m^3 of water will require controlled release to land.

3.3.2. Controlled Land Release

Possible locations for land release are shown in

Figure and include areas that are at least 100m from water courses, 100m landward of Highest Astronomical Tide (HAT) and avoid areas of significant vegetation.

The most appropriate site for discharge will be selected prior to discharge. Key considerations for site selection include:

- Locations must be a minimum 100m from watercourses and 100m landward of (HAT)
- Areas of saturated soil or high ground water table will be avoided - simple permeability tests will be carried out to confirm the existing groundwater level and the permeability of the soil

- Soil erosivity – sites will be chosen to minimise erosion and erosion and sediment control techniques will be employed where necessary
- Discharge or infiltration into disturbed grassland is preferred and areas of significant vegetation will be avoided
- Minimisation of flows into existing dams

The method, rate, surface area and timing of discharge will be determined based on the volume of water to be released, soil properties of the chosen location and the weather conditions. Discharge events will be planned for appropriate weather conditions and forecasts. If applicable, release areas may be rotated to minimise impacts.

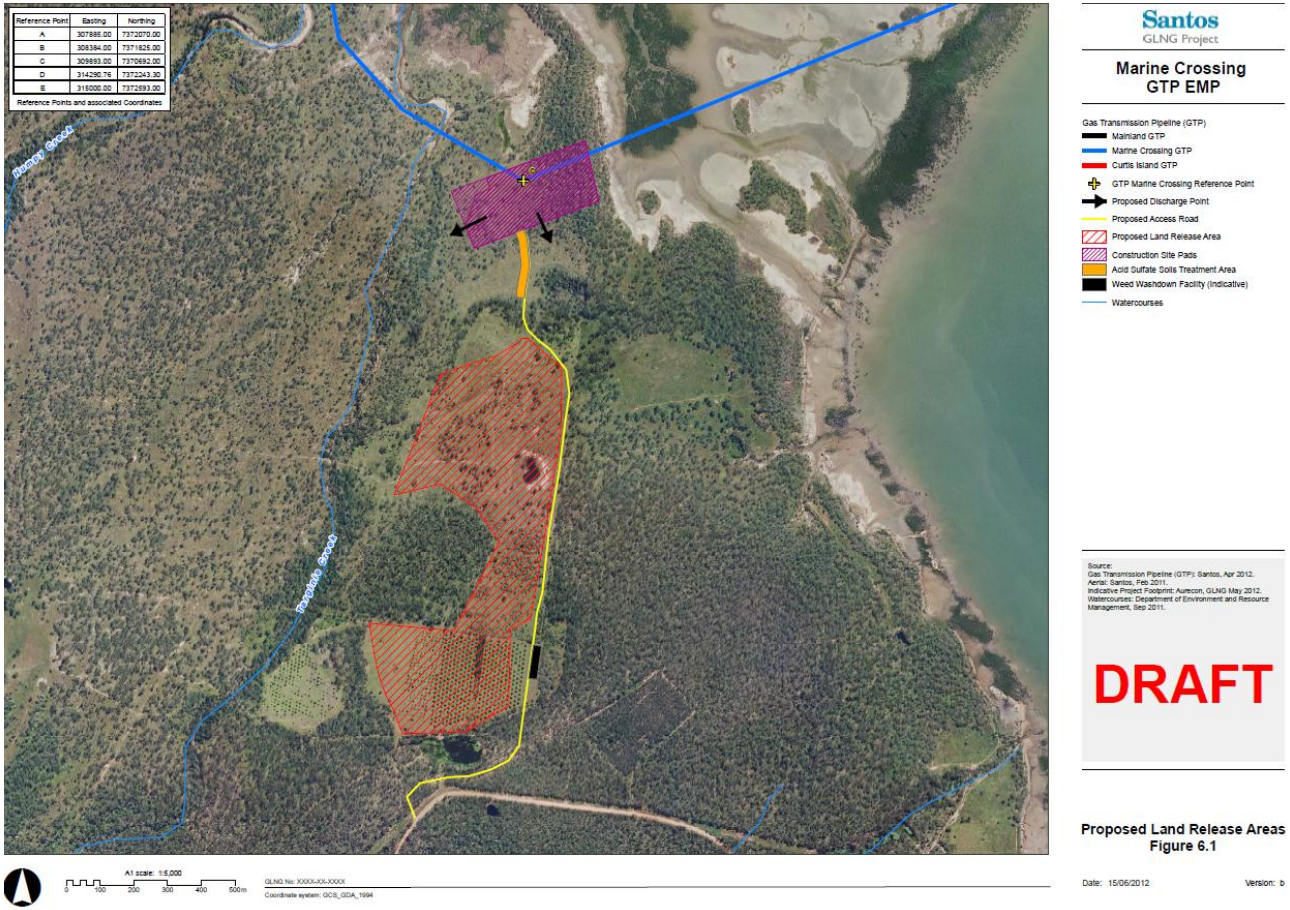

Figure 6: Suggested locations for controlled land release

4. Dewatering, Hydrotesting and Land Disposal Management

The following sections contain recommendations for monitoring, performance criteria and contingency planning for tunnelling water, hydrotest water and controlled land release.

4.1. Dewatering

Any dewatering activity should strive to minimise the radius of influence of the cone of depression and any impacts on sensitive surface water receptors near the operation. It is anticipated that there will be minimal dewatering relating to the project's tunnelling operations.

Given the likelihood that groundwater will be acidic or otherwise need treatment, the Acid Sulphate Soil Management Plan produced by Golder Associates will describe the management and treatment of all groundwater. Refer to the following for the dewatering details:

- Draft Acid Sulphate Soil Management Plan, GLNG Pipeline Route
- Phase 1 Acid Sulphate Soil Investigation

Prior to discharge, the groundwater would be field tested and treated in accordance with the Golder ASSMP. In the event the volume of tunnelling water generated is higher than anticipated, the number of temporary holding and treatment tanks may be increased or other contingencies will need to be considered.

According to the Golder ASSMP, groundwater levels will be monitored prior to and during tunnel construction via installed groundwater wells adjacent to the launch pad. If drawdown is found to be excessive, a contingency strategy can be implemented to recharge the aquifer by circulating groundwater from dewatering operations back behind the sheet piles. This would negate the possible impacts of lowered groundwater levels and the potential oxidation of surrounding sediments.

4.2. Hydrotesting

Any hydrotesting activity should strive to minimise any impacts on the environment.

The cleanest and most practical water source for hydrotesting water will be chosen to minimise treatment requirements prior to disposal via controlled land release.

Hydrotesting water will essentially be raw water from bores to the west of the site.

There is no intention of chemically treating the water prior to hydrotesting. However, if sulphate, SRB and turbidity levels are found to be high enough to encourage SRB growth, the water will require pH correction prior to hydrotesting to minimise the risk of corrosion. The pH will then be corrected post-hydrotesting to the range of pH6.5 – pH8.5.

4.2.1. Monitoring and Performance Criteria

Water quality analysis will be carried out upon completion of the hydrotesting.

If necessary, the water will be treated to conform with the limits set out in Table 1 for disposal of water to land. The water will be monitored on the release line to ensure that these criteria are met. Water will be returned for treatment if the criteria are not met.

Table 1: Water quality limits for disposal of hydrostatic water to land

Parameter	Parameter Maximum Value
pH	pH 6.5 - 8.5 (Range)
Arsenic (mg/L)	2
Cadmium (mg/L)	0.05
Chromium (mg/L)	1
Copper (mg/L)	5
Iron (mg/L)	10
Lead (mg/L)	5
Manganese (mg/L)	10
Zinc (mg/L)	5
Nitrogen (mg/L)	5
Phosphorus (mg/L)	1
Electrical Conductivity (µS/cm)	2000

4.2.2. Contingency Plans

Contingency plans will be developed once more is known about the site to address actions required if performance criteria are not met. Contingency plans will include but are not limited to implementation of the following:

- Additional treatment methods in the event that performance criteria are not met

4.3. Controlled Land Release

Controlled land release relates primarily to the hydrotest water but may also apply to residual water from tunnelling operations if this water is not fully used to produce the grout or to flood the tunnel.

Land discharge of appropriate water could be undertaken either via infiltration or irrigation of a nearby orchard. The controlled discharge will be to appropriate discharge structures 100m from water course and 100m landward of Highest Astronomical Tide (HAT) to dissipate energy to reduce erosion, protect the water quality of nearby water bodies and reduce the potential for the introduction of new species.

There is no intention of chemically treating the water prior to hydrotesting. However, if pH correction or flocculation is required to minimise the risk of corrosion, the requirements for discharge water quality will be taken into consideration when determining dosing procedures.

Disposal to land will require erosion protection, runoff controls and sediment interception to minimise impacts on the receiving environment. Refer to Marine Crossing – Gas Transmission Pipeline: Stormwater Management and Erosion and Sediment Control Plan for more details.

Control measures will be used to maintain stable landforms. The energy dissipation technique can be selected with reference to section 8.06 of Queensland Urban Drainage Manual (Natural Resources and Water, 2007). Suggested energy dissipation techniques could include a Rock Pad, Rock Mattress or Riprap Basin (See Figure 7).

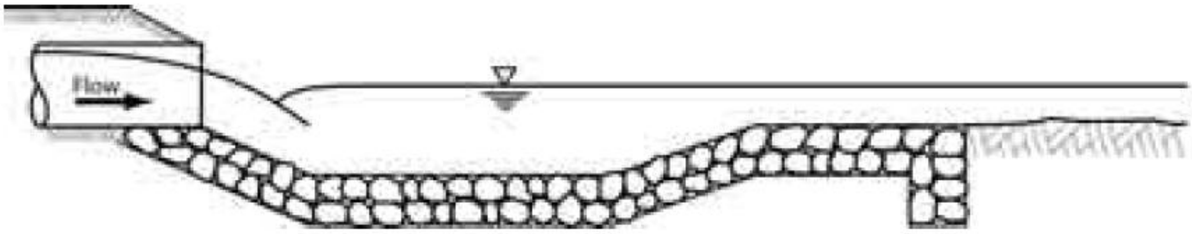

Figure 7: Riprap basin (QUDM pg 8-28) (Natural Resources and Water, 2007)

4.3.1. Monitoring and Performance Criteria

Sampling will be carried out on all outgoing streams prior to discharge in order to verify compliance with the water quality criteria in Table 1 (above) and any specific conditions of relevant environmental permits.

Discharge locations and downstream land and water bodies will be visually inspected for signs of erosion or increased turbidity on a daily basis. Groundwater and surface water quality sampling will be carried out during discharge activities to monitor for adverse changes to the environment. Refer to section 4.1.

4.3.2. Contingency Plans

Contingency plans will be developed once more is known about the site to address actions required if performance criteria are not met. Contingency plans will include but are not limited to implementation of the following:

- Additional treatment methods in the event that performance criteria are not met
- Alternative disposal options if the preferred method is considered to be causing environmental harm
- A reduction of discharge rates if the discharge is considered to be causing environmental harm
- Addition of further erosion protection, runoff controls and sediment interception measures if adverse changes are observed at or downstream of the controlled discharge location
- Reviewing and updating the surface water quality sampling requirements upon the advice of the Site Environmental Officer, such as in the case where the initial round of sampling indicates that there may be an issue with the hydrotest discharge water quality
- Addition of a comprehensive suite of monitoring at an appropriate frequency if discharge, groundwater or surface water quality adversely varies significantly compared to pre-dishcharge conditions
- Additional assessment of the causes of water quality deterioration if long term water quality is considered to have degraded for reasons directly attributable to discharge activities. This may include assessment of soil and groundwater quality, and development of a suitable management strategy

5. Reporting and Notification

Operators shall record and report the results of all monitoring sampling and surveys monthly.

If any non-compliance or adverse environmental effects are observed, the operator will notify the Client immediately and include suggestions for additional mitigation and management measures.

6. References

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Appendix F
Waste Management Plan (WMP)

Waste Management Plan – Santos GLNG Gas Transmission Pipeline (Mainland, Marine Crossing (The Narrows) and Curtis Island Sections)

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Document control

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Rev No	Date	Revision details	Typist	Author	Verifier	Approver
0	15 February 2011	Draft Waste MP Waste Quantity Estimates (Section 6) Issued to GLNG	KKF	KKF/OF	-	-
1	4 March 2011	Draft Waste MP	KKF	KKF/OF	GNC	-
2	1 April 2011	Revised Draft Waste MP submitted to GLNG for review	KKF	KKF	-	-
3	5 April 2011	Revised Draft Waste MP submitted to GLNG for legal review	KKF	KKF	-	-
4	8 April 2011	Review by SJM	KKF	KKF	-	-
5	15 April 2011	Final for legal review	KKF	KKF	-	-
6	30 June 2011	Legal comments addressed	CC	-	-	-
7	15 July 2011	FOR AGENCY REVIEW	KH	KKF	GNC	CC
8	6 February 2012	For SEWPaC Review	KH	KKF	GNC	AW
9	28 June 2012	Revised draft for Marine Crossing GTP EMP and change in construction methodology	KKF	KKF	BDP	

Contents

1. Introduction

1.1 Project overview

The Santos Gladstone Liquid Natural Gas (GLNG) Project has the following major components:

- Coal seam gas fields
- Gas transmission pipeline (GTP)
- LNG liquefaction and export facility (LNG facility)

1.2 Scope

This Waste Management Plan (WMP) addresses the waste management issues relating to construction, operation and decommissioning of the Santos GLNG GTP (the Project). It has been developed in accordance with the *Environmental Protection Act 1994* (EP Act) *Waste Reduction and Recycling Act 2011*(WRR Act) and other relevant State and Commonwealth legislative, guidelines, standards and covers the following key areas:

- The types and amounts of waste expected to be generated during construction and operation including chemical and hazardous materials, liquid wastes and hydrotest water. It also stipulates how wastes will be dealt with in accordance with the principles of the waste and resource management hierarchy (formerly the waste management hierarchy) as described in the Queensland Waste Reduction and Recycling Strategy (2010)
- Mitigation measures for dealing with accidents, spills and other incidents that may impact on the environment as a result of waste generation, handling and storage during construction and operational activities

This WMP also seeks to support the Project Environmental Management Plans (EMPs) and address the specific project approval conditions and items that have been raised as a result of the Coordinator General's (former Department of Infrastructure and Planning) comments in relation to the GLNG Environmental Impact Statement (EIS) (URS, 2009a) and Supplementary EIS (URS, 2009b), the *Report for Crossing of the Narrows – Review of the GLNG EMP* (DIP, 2011) and the former Department of Environment and Resource Management (DERM) request for additional information, dated 01/12/2011.

1.3 Objectives

The objectives of this WMP are:

- No contaminants or wastes discharged to land or water on the project site
- No unauthorised discharges of contaminants or waste to land or water offsite
- Minimise the quantity of wastes generated and disposed to a landfill during construction and operation
- Maximise the amount of material recovered for reuse or recycling during construction and operation
- All waste disposed of in accordance with State and Commonwealth legislation and guidelines
- No complaints relating to the management of waste during construction and operation

1.4 Project description

The Project includes the construction, operation and decommissioning of a 420 km GTP network to link the coal seam gas fields near Roma, Emerald, Injune and Taroom in Queensland to the proposed LNG Facility located on Curtis Island.

This WMP has been prepared to address all three sections of the Project, including the:

- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP

It is anticipated that the Project will have an operational lifespan of 42 years followed by a period associated with the decommissioning of the GTP and associated infrastructure.

1.4.1 Mainland GTP section

The Mainland GTP runs from the gas fields at Fairview to Port Curtis, traversing a distance of approximately 406 km.

1.4.2 Marine Crossing GTP section

The Marine Crossing GTP will connect the Mainland GTP to Curtis Island GTP (8.04 km) through a bored tunnel extending under The Narrows, between reference points C and D, utilising Earth Pressure Balance (EPB) Tunnel Boring Machine (TBM)construction methods. The Marine Crossing GTP Project will also encompass a section of open trenching on the Mainland, above the intertidal zone (reference points A to C), and on Curtis Island between the reference points D and E.

1.4.3 Curtis Island GTP section

The GTP on Curtis Island is 5 km long commencing at Point E at Laird Point and running through to the proposed LNG Facility. This section is a terrestrial section and will be constructed using open trench construction.

Further information on the project description has been provided in Section 4 and in the relevant EMP for each section of the Project.

1.5 Roles and responsibilities

GLNG Operation's personnel and contractors will be responsible for implementing this WMP in a manner that complies with relevant environmental standards, adheres to legislative requirements and ensures that environmental objectives associated with construction and operation for the Project are achieved.

Contract documents will include the necessary environmental specifications and commitments, and require compliance with the Environmental Authority (which this WMP supports), construction specifications, technical drawings and the general environmental duty.

All personnel are responsible for the environmental performance of their activities and for complying with the General Environmental Duty as outlined in the *Environmental Protection Act 1994 (EP Act)*. Section 319(1) of the *EP Act* 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 1.1.

Table 1.1 Specific environmental responsibilities

Position	Overview
GLNG Operations Pipeline Project Manager	The GLNG Operations Pipeline Project Manager is ultimately responsible for the standard of management, including environmental management. To assist in fulfilling this responsibility, the GLNG Operations Pipeline Project Manager is supported by a series of specialised personnel
Construction Manager	The Construction Manager is responsible for all construction activities including planning, procedure approvals and execution of works. The Construction Manager is also responsible for ensuring that adequate provision is made for compliance activities
Engineering Manager	The Engineering Manager is responsible for generating the design drawings and specifications consistent with the EMP and AS2885
Pipeline Construction Superintendent	The Pipeline Construction Superintendent will direct work in a manner that complies with all relevant environmental procedures; adheres to all legislative requirements and ensures that all environmental objectives associated with the Project are achieved. The Construction Superintendent has "stop task" and "stop work" authority
Environmental Manager	The Environmental Manager will direct work in a manner that complies with all relevant environmental procedures, adheres to all legislative requirements and ensures that all environmental objectives associated with the Project are achieved. The Environmental Manager has "stop task" and "stop work" authority
Construction Contractor	The Construction Contractor is responsible for ensuring compliance with the EMP and the development and implementation of a specific Construction EMP (CEMP). This will include training of personnel (refer Section 7.9), provision and maintenance of equipment, facilities and associated services and consumables, and the monitoring of compliance with the EMP

Source GLNG Operations, 2011 EMP (Mainland)

1.6 Limitations of this WMP

This document provides guidance related to chemical and hazardous materials storage, spill management and clean up (containment and remediation), however it does not address health and safety aspects. Health and Safety aspects will be addressed in relevant GLNG Operations guidelines including the Environment, Health and Safety Management System (EHSMS) and inductions process.

This WMP should be viewed as a living document that will be progressively updated with additional information throughout the construction and operation phases.

2. Waste Management Legislation

2.1 General legislative structure

There are a number of Queensland and Commonwealth statutory environmental requirements, policies and guidelines that apply to the Project and have been taken into consideration during the preparation of this WMP. These statutory requirements are summarised in Table 2.1.

Table 2.1 Key legislation

Waste management legislation	Key requirement of legislation
Environmental Protection Act 1994	Includes licensing and approval of all Environmentally Relevant Activities (ERAs) Establishes a general environmental duty Process to prepare EMPs Provides for the making of environmental protection policies
Environmental Protection Regulation 2008	Defines regulated waste and waste disposal management Establishes regulated waste transport requirements
Environmental Protection (Waste Management) Regulation 2000	Establishes waste tracking requirements
National Environmental Protection (Movement of Controlled Waste between States and Territories) Measure as Varied (2010)	Controls the movement of Controlled Waste between States and Territories
Queensland's Waste Reduction and Recycling Strategy 2010-2020	Establishes waste and resource management hierarchy; sets targets to halve landfill volumes, double the recycling rate of municipal solid waste (MSW), and increase the recycling rates for commercial and industrial waste. Introduction of a levy on waste to landfill excluding MSW
Waste Reduction and Recycling Act 2011	Establishes waste disposal levy on industry waste sent to landfill (price signal); requirement for local government and Queensland Government agencies to prepare Waste Management Plans; introduction of product stewardship arrangements; litter and illegal dumping offences
Waste Reduction and Recycling Regulation 2011	Details provisions regarding the waste levy
Dangerous Goods Safety Management Act 2001	Controls storage and handling of dangerous goods and combustible liquids as well as the operation of major hazard facilities
Dangerous Goods Safety Management Regulation 2001	Prescription of dangerous goods location; major hazard facility or possible major hazard facility Safety obligations Flammable and combustible liquids licensing

Waste management legislation	Key requirement of legislation
Transport Operations (Road Use Management – Dangerous Goods) Regulation 2008	Prescribes the obligations of persons involved in the transport of dangerous goods by road Aims to reduce as far as practicable the risks arising from the transport of dangerous goods by road Gives effect to the standards, requirements and procedures of the Australian Dangerous Goods (ADG) Code as far as they apply to the transport of dangerous goods by road Aim to promote consistency between the standards, requirements and procedures applying to the transport of dangerous goods by road and those applying to other modes of transport

2.1.1 Queensland legislation

The relevant legislation which will impact on waste management related to the Project includes, but is not limited to:

Environmental Protection Act 1994

The (EP Act and its regulations and policies were developed to protect Queensland's environment, while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. The EP Act is administered by the Department of Environment and Heritage Protection (DEHP) (formerly DERM).

The EP Act utilises a number of mechanisms to achieve its objective including:

- Environmental Protection Regulation, which includes licensing and approval of all ERAs
- Establishing a general environmental duty
- Process to prepare EMPs
- Issuing environmental protection policies

The EP Act establishes a duty of care for all persons to take reasonable and practicable measures to prevent and minimise environmental harm.

The EP Act allows for the establishment of Environmental Protection Policies (EPPs) which allow for the Queensland Government to declare and implement its aims and objectives for environmental protection. In regards to waste management; waste generators, transporters and receivers must comply with the following regulations:

- *Environmental Protection Regulation 2008* (EP Reg)

Environmental Protection (Waste Management) Regulation 2000 (EP(WM) Reg)
The EP Reg combined with the EP (WM) Reg aim to coordinate and clarify waste management practices in Queensland and provide a framework for improved environmental safeguards.

Environmental Protection Regulation 2008

The EP Reg replaces the Environmental Protection Regulation 1998, and supports the EIS process. It also identifies ERAs prescribed under the EP Act.

The EP Reg defines regulated waste and regulated waste disposal management. It also provides the statutory basis for implementing the National Environment Protection Measure for the National Pollutant Inventory.

Environmental Protection (Waste Management) Regulation 2000

The EP(WM) Reg sets specific requirements for the management of regulated waste, waste disposal facilities, waste management by local government, and litter control such as:

- Offences for littering, waste dumping and unlawful activities at waste facilities
- A waste tracking system within Queensland and interstate (National Environment Protection Measure (NEPM) for the Movement of Controlled Waste between States and Territories)
- Requirements for premises generating clinical and related waste
- A procedure for approval of wastes for beneficial reuse
- Approval processes for beneficial use of wastes
- Design rules for waste equipment

Waste Reduction and Recycling Act 2011

The WRR Act coordinates and clarifies waste and resource management practices in Queensland and promotes waste avoidance and reduction to encourage resource recovery and efficiency.

The WRR Act provides a tailored framework for waste management and resource recovery by the adoption of the waste and resource management hierarchy along with several management principles which include:

- “Polluter pays principle” – All costs associated with waste management should, where possible, be borne by the waste generator
- “User pay principle” – All costs associated with the use of a resource should, where possible, be included in the price of goods and services that result from the use
- “Proximity principle” – waste and recovered resources should be managed as close to the source of generation as possible
- “Product stewardship principle” – shared responsibility between all persons involved in the life cycle of a product and for managing the environmental, social and economic impact of the product

The above four principles form a hierarchy and provide a basis for waste management programs under ERAs. The waste and resource management hierarchy includes the following management principles (in order of priority) (DERM, 2010).

- Avoid
- Reduce
- Re-use
- Recycle
- Recover
- Treat
- Dispose

The WRR Act also lists matters that may be included in a waste reduction and recycling plan and introduces a levy on waste disposal.

Waste Reduction and Recycling Regulation 2011

This Regulation defines types of waste including commercial and industrial waste, construction and demolition waste and regulated waste, It describes the application of the waste levy including rates, zones and fees.

2.1.2 Commonwealth legislation

National Environmental Protection (Movement of Controlled Waste between States and Territories) Measure

The NEPM Movement of Controlled Waste between States and Territories aims to ensure that controlled wastes that are moved between States and Territories are properly identified, transported and handled in an environmentally sound manner, and that they reach licensed or approved facilities for treatment, recycling, storage and/or disposal. The NEPM provides a framework for developing and integrating systems for the movement of controlled waste between States and Territories which includes:

- Tracking systems, which provide information to assist agencies and emergency services and ensure that controlled wastes are directed to appropriate facilities
- Prior notification systems, which provide participating States and Territories with access to information to assess the appropriateness of proposed movements of controlled wastes in terms of transportation and facility selection
- Systems for licensing transporters and the regulating of generators and facilities so that tracking and notification functions are compatible between States and Territories
- Provision for mutual recognition by States and Territories of each other's transport licences (EP Reg)

2.1.3 Waste definitions

Under the EP Act "waste" is defined as anything that is:

- Left over, or an unwanted by-product, from an industrial, commercial, domestic or other activity
- Surplus to the industrial, commercial, domestic or other activity generating wastes

The EP Reg defines "general waste" as waste other than regulated waste. Regulated wastes are defined in the EP Reg as commercial or industrial waste that contains a constituent of a type mentioned in schedule 7 (Refer section 65 of the EP Reg). A list of all defined regulated wastes is outlined in Schedule 7 of the EP Reg. Appendix A provides a glossary of additional definitions relevant to this WMP.

2.1.4 Environmentally Relevant Activities – *Environmental Protection Act 1994*

The Project has the potential to trigger a number of ERA's during the construction and operation of the GTP.

The ERAs are prescribed under Schedule 2 of the EP Reg and the GTP construction work may include the following ERAs:

- ERA 8: Chemical storage

- ERA 17: Abrasive blasting
- ERA 21: Motor vehicle workshop operation
- ERA 38: Surface coating
- ERA 56: Regulated waste storage
- ERA 57: Regulated waste transport
- ERA 63: Sewage treatment
- ERA 64: Water treatment

If any GTP construction activity triggers an ERA then approval under the EP Act shall be sought by the Construction Contractor prior to construction and the activity commencing. Likewise for the Operational phase, GLNG Operations shall seek approval to conduct an ERA prior to the activity commencing.

2.1.5 Environmental Authority requirements

GTP Environmental Authority requirements regarding waste management are described within this WMP. All regulated wastes are to be disposed of to licensed waste disposal facilities or recycling facilities and transported by authorised companies or personnel. Designated personnel who will be required to collected, treat, transport or dispose of waste or recyclable materials will need to document their operational capacity in accordance with relevant State and Commonwealth legislation.

2.1.6 Records and data management

It is a legal requirement that records are be kept in regards to regulated waste (defined under the EP Reg). The EP Reg requires all persons or business involved with the production or transportation of trackable wastes to record detailed information about the waste as defined in the EP (WM) Reg. These include the requirement to complete a Waste Transport Certificate for all deemed trackable waste. The EP(WM) Reg details the regulatory procedures.

2.2 Summary of standards, guidelines and codes of environmental compliance

Table 2.2 is a summary of Australian Standards, guidelines and codes which provide guidance on waste management and dangerous/hazardous goods storage and handling in relation to construction and operation of the GTP.

Table 2.2 Summary of standards, guidelines and codes of environmental compliance

Standard/guideline/code	Key requirements
AS1940	The storage and handling of flammable and combustible liquids
DNRMW On-Site Sewerage Code	Technical requirements for the management, site and soil evaluation, design, installation and operation of on-site sewerage facilities
DNRMW Guidelines for Vertical and Horizontal Separation Distance	Details acceptable vertical and horizontal separation distances from buildings, watercourses, bores etc
Standards Australia AS/NZS 1547 On-Site Domestic Wastewater Management	Australian Standard for on-site wastewater management
AS3833	Australian Standard for storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers
AS3780	Australian Standard for storage and handling of corrosive substances

Standard/guideline/code	Key requirements
AS2187 Explosives	Australian Standard for the storage and prescribed licenses and permits. (Specialist Contractor)
AS2885.3 & APIA Code of Environmental Practice – Onshore pipeline	Code of practice for onshore pipelines - gas and liquid petroleum - operation and maintenance
AS4452	Australian Standard for the storage and handling of toxic substances
Material Safety Data Sheets	Compliance with OH&S and legislative obligations related to the storage and handling of chemicals chemical registers (inventories)
Guide to the *Dangerous Goods Safety Management Act 2001*	This Queensland Department of Emergency Services document outlines the obligations, and provides definitions and information to help explain requirements under the *Dangerous Goods Safety Management Act 2001*
Code of environmental compliance ERA 17 – Abrasive blasting (mobile and temporary activity)	Sets out standard environmental conditions for abrasive blasting activity. Failure to comply with the code conditions is an offence under the EP Act and penalties apply
Code of environmental compliance ERA 57 – Regulated waste transport	Sets out standard environmental conditions for regulated waste transport by road. Failure to comply with the code conditions is an offence under the EP Act and penalties apply

2.3 Other regulatory conditions

In addition to the legislative requirements detailed in Section 2.1, this WMP has sought to address the relevant project approval conditions that have been raised as a result of the regulators' comments in relation to the GLNG EIS (URS, 2009a). These include:

- The conditions within the Coordinator General's Report (CG Report) related to waste management and the storage and handling of chemicals, flammable and combustible liquids. In particular the Part 4 Environmental Authority Conditions – Gas Pipeline, Schedule D – Waste Management and Condition D8 and D9
- The Department of Infrastructure and Planning comments related to waste management as documented in *Report for Crossing of the Narrows – Review of the GLNG EMP*
- The former DERM's (now DEHP) Guideline *Preparing an environmental management plan for coal seam gas activities* related to waste generated by the proposed petroleum activities

3. Waste Management Principles

3.1 Overview

The management of waste material generated as a result of GTP construction, operation and decommissioning will be dealt with in accordance with the principles of the waste and resource management hierarchy[1] (refer Figure 3.1) as described in the Queensland Waste Reduction and Recycling Strategy 2010 - 2020 (DERM 2010).

Source Queensland's Waste Reduction and Recycling Strategy 2010–2020 (DERM, 2010)

Figure 3.1 Waste and resource management hierarchy

The GTP waste and resource recovery hierarchy principles are outlined in Section 3.2.

3.2 Waste and resource management hierarchy principles

3.2.1 Waste avoidance

Waste avoidance will be targeted through adoption of alternative products and implementation of procurement processes which include the provision of contracts with companies which have documented sustainable waste management practices.

During delivery and transportation, the pipe sections will be protected with a coating applied during manufacture off-shore that reduces damage and subsequent wastage during the GTP construction process. All pipeline sections will be ordered and delivered to meet the detailed design requirements. This will reduce the quantities of some waste streams associated with the construction phase, including scrap steel.

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[1] Prior to publishing of the Queensland Waste Reduction and Recycling Strategy 2010 – 2020, the Waste and resource management hierarchy was referred to in Queensland Legislation and other government documents as the Waste Management Hierarchy comprising waste avoidance, waste reuse, waste recycling, energy recovery and waste disposal

3.2.2 Waste reduction

Where possible, contracts will be established with companies that minimise waste through their production process, maximise recycling of waste produced and maximise recycling opportunities for the used end product and associated packaging waste. Procurement of pre-fabricated materials will be encouraged to reduce the quantity of waste generated onsite.

3.2.3 Waste re-use

The re-use of waste will be achieved through identifying at the earliest opportunity materials which can be re-used during the construction period. Items such as timber skids, sand bags, timber pallets and hydrotest water are examples of materials that will be targeted for reuse.

To maximise re-use opportunities, materials will be segregated within the designated waste storage areas along the GTP ROW. The environmental protection commitments, objectives and control strategies described in Section 8 provide recommendations on how re-use could be implemented for the Project.

3.2.4 Waste recycling

The collection of waste materials for recycling will be integral to the management of waste during construction of the GTP. A proportion of the materials created as a result of construction will be recycled. An example of some of the materials are:

- Dry recyclables like paper, cardboard, plastic and glass
- Ferrous and non-ferrous metals generated from the pipe welding and cutting process
- Oils generated from plant and equipment maintenance
- Timber generated from pallets, skids and off cuts (once reused)

Other potentially recyclable materials will be treated in accordance with the principles of the waste and resource management hierarchy where opportunities exist.

3.2.5 Other recovery and treatment of waste

This includes capturing the energy available in discarded products and treating the waste prior to disposal to reduce the hazardous characteristics of the waste.

Energy recovery facilities are generally not available in Central Queensland and are not likely to be an option for project waste. As such, some regulated waste from the Project may need to be sent to licensed treatment facilities to reduce the hazardous characteristics of the waste prior to disposal.

Opportunities for energy/resource recovery will be periodically reviewed through the auditing process and the Project waste and resource management hierarchy initiatives (refer Section3.3). Potential opportunities will be assessed for suitability when they are identified.

3.2.6 Waste disposal

The construction and operation of the GTP will employ suitably licensed waste management and recycling contractors that will provide bins and collection/transportation services for specified waste/recyclables to be hauled to licensed waste management and resource recovery facilities.

Disposal options for wastes generated by the construction and operation of the GTP depends on the characteristics of the waste. The following section presents the waste disposal options that have been considered for the construction and operation of the GTP.

Landfill

Although most towns in Maranoa Regional Council, Central Highlands Regional Council and Banana Shire Council have a local waste disposal facility, many facilities only accept domestic waste (ie from residential premises) for disposal. The waste facilities that accept waste for disposal from commercial operators are listed in Table 3.1. No other waste disposal facilities may be used for disposal of Project waste without prior approval of GLNG Operations.

Table 3.1 Waste disposal facilities closest to GLNG GTP ROW

Licensed waste facility	Allowable annual capacity as per site environmental authority	Comments
Gracemere Landfill, Allen Road, Gracemere	20,000 t per annum for disposing of general waste or limited regulated waste	Construction and Operations Contractor/s to investigate if Rockhampton Regional Council will accept Project waste at the Gracemere Landfill from the Port Alma temporary pipe receiving area
Benaraby Landfill, Bruce Highway Benaraby (south of Gladstone)	50,000 t per annum	This will be the primary facility for disposal of Project waste. Construction and Operations Contractor/s to confirm waste acceptance criteria (ie types of waste permitted for disposal)
Trap Gully Landfill, Forestry Road, near Biloela	Less than 2,000 t per annum for disposing of general waste or limited regulated waste	Limited capacity to accept waste materials for disposal. Construction Contractor to investigate if Banana Shire Council will accept GTP construction waste at the Trap Gully Landfill from the Project
Rolleston Landfill, Rolleston	Unconfirmed	Construction Contractor to investigate if Council will accept GTP construction waste at the Rolleston Landfill from the Project
Roma Landfill, Short Street, Roma	Unconfirmed	Construction Contractor to investigate if Council will accept GTP construction waste at the Roma Landfill from the Project
Injune Landfill, Injune	Unconfirmed	Construction Contractor to investigate if Council will accept GTP construction waste at the Injune Rolleston Landfill from the Project

Sewage treatment plants

The Waste Management and Recycling Contractor (WMRC) is to contact the relevant local authority to determine the location of suitable Sewage Treatment Plants (STPs) for disposal of sewage from construction ablution facilities and to make arrangements to receive wastewater, effluent or sewage sludge from the construction camps.

3.3 Waste and resource management hierarchy initiatives

The Project will aim to achieve positive outcomes by targeting the source of the waste and adopting the waste and resource management hierarchy.

Table 3.2 outlines the potential Project opportunities for implementing the waste and resource management hierarchy within the Project.

Table 3.2 Waste and resource management hierarchy opportunities

Waste hierarchy	Opportunity	GTP initiative
Waste avoidance/ Waste reduction	Excavated material and topsoil	All excavated material and topsoil is to be used for backfill and respread along the ROW during restoration
	Hardstand material and rock	Clean hardstand material from areas to be restored to their original condition will be provided to local landowners for use on their properties (ie for roadways)
	Spoil from marine crossing tunnel construction	Beneficial reuse as fill for rehabilitation works for other sites in the Gladstone region
	Temporary fencing and gates	Temporary fencing and gates constructed along the boundary of the ROW are likely to remain after completion of restoration as many of the landowners have indicated that they would like to keep this fencing
	Pipe	Minimum length of pipe cut permitted is 2 m. These cut lengths are to be used within the pipeline
	Packaging materials in pipe and materials delivery	Where possible, packaging materials used to deliver pipe and materials will be reusable or recyclable
Waste re-use	Green waste (felled vegetation and plant matter)	Where possible, green waste will be reapplied during ROW restoration. Whole felled and mulched vegetation will be used in rehabilitation and soil stabilisation of ROW (refer Landscape Rehabilitation Management Plan (LRMP), document number 3380-GLNG-3-1.3-0037)
	Timber skids	Timber skids used during pipe stringing will be collected and transferred along the ROW for reuse in pipe stringing further along the corridor
	Wastewater effluent (treated wastewater) re-use	Explore whether treated wastewater from construction camps is suitable for use for dust suppression or use in vehicle washdown facilities
	Hydrotest water re-use	Where possible hydrotest water will be reused for other pipeline segment hydrotesting
Waste recycling	Waste oil and hydrocarbons	A waste oil contractor would be engaged for recycling waste oil
	Steel and metal, cabling	Waste steel and other metals will be recycled by a steel and metal merchant
	Batteries	Batteries will be recycled with a battery recycler
	Tyres	A licensed contractor will be engaged to transport tyres to a tyre recycler
	Commingled recyclables (plastic, liquid paper board, aluminium and ferrous food/drink containers)	Investigate if recyclable materials can be sent to the CQ's Rockhampton Materials Recovery Facility (MRF) for recycling

Waste hierarchy	Opportunity	GTP initiative
	Waste paper and cardboard	Banana Shire Council operates a small waste paper and cardboard bailing plant in Biloela. Construction Contactor to investigate the opportunity to recycle source separated waste paper and cardboard at Banana Shire Council's Calvale Road facility in Biloela
	Concrete	Construction Contractor to investigate if opportunities for waste concrete recycling are available in the Gladstone/Banana region
Energy recovery	There are no energy recovery facilities in Central Queensland. There is a potential opportunity for some waste material to be used as a fuel for the cement kiln at Fisherman's Landing, Gladstone (eg tyres)	Construction Contractor to investigate if any waste materials have value and are suitable for use (ie meet the kiln's acceptance criteria) as a fuel/feed stock in the cement kiln at Fisherman's Landing, Gladstone

4. Project Description

4.1 Project overview

An underground 420 km GTP will feed CSG from the CSG fields at Fairview through to the proposed LNG Facility on Curtis Island. The GTP route is shown on Figure 1 – GTP Waste and Recovered Material Haulage Route (refer Appendix B). The Project activities occur in 3 phases - construction, operation and decommissioning phases. Sections 4.2 to 4.4 provides an overview of the various activities that will be undertaken during each phase and a description of the Project components.

4.2 Construction

During the construction phase three distinct work areas are proposed, referred to as the Mainland GTP section, which is approximately 406 km in length, the Marine Crossing GTP section which is 8.04 km long and the Curtis Island GTP section which is 5 km in length. The construction activities provided in Section 4.2 summarise the details that are provided for each section in the relevant EMP for each Project section.

Pipeline materials will be imported via ship to the Port of Gladstone or Port Alma, transported via road and stored in temporary locations called 'temporary pipe storage sites' along the GTP ROW. A peak workforce of approximately 900 construction personnel are required for the pipeline construction, working 12 hours each day on a 28 days on, 9 days off roster.

4.2.1 Mainland GTP construction activities

Construction workforce and camps

Construction personnel will be accommodated in construction camps. Four construction camp locations have been identified (Arcadia Valley, Bauhinia, Banana and Calliope (refer Figure 1 – GTP Waste and Recovered Material Haulage Route). Temporary work site facilities such as vehicle refuelling facilities, waste storage areas, site offices, warehouse and laydown areas, maintenance workshop, prefabrication workshop, vehicle parking areas, vehicle washdown facilities and associated infrastructure such as water storage tanks, diesel generators and portable sewage treatment facilities will be located within the construction camps. These construction camps will use sectional trailers and modular structures joined together to provide the required buildings. The workshops and other facilities will be relocatable and will be moved to follow the Mainland GTP construction as it progresses along the ROW.

The construction camps will require potable and non-potable water for domestic use during construction. It is estimated that the overall usage of potable water during construction will be approximately 200 L/person/day.

A temporary equipment maintenance workshop, which is mostly containerised, will be mobilised at each construction camp for the purpose of undertaking maintenance and repairs of construction plant and equipment.

It is proposed that fuel trucks, lubrication trucks and small maintenance vehicles with roving mechanics will be on site daily to service and perform maintenance on plant and equipment. Plant and equipment requiring major repair will be brought to the construction camp's equipment workshop.

It is proposed that emergency vehicle maintenance will be provided for the following services:

- Towing of stalled vehicles to the workshop
- Tyre repair
- Changing fan belts, replacing hoses and other repairs requiring 3 hours or less

The prefabrication workshop will be provided for fabrication of mainline valves and end of loops piping.

General GTP construction activities

Pipe will be imported via ships, which will be unloaded to pipe receiving areas within each port area. Approximately 11 pipe shipments will be received at Port Alma and 5 pipe shipments at Gladstone Port Central. Prior to transport from the port to the temporary pipe receiving areas, the pipe will be inspected for compliance with the specification. Many of the construction vehicles, equipment and materials which are required for the pipeline construction will be sourced from the Construction Contractor's fleet and stores located outside Australia. The Construction Contractor's fleet, equipment and materials, which are imported into Australia, will arrive and be unloaded either at Gladstone Port Central or the Port of Brisbane and transported via road to the construction camp or ROW work area.

Pipe arriving at Port Alma will be transferred to the temporary pipe receiving area located at Lot 96 on DS186 on the Toonda Port Alma Road, Bajool. The pipe will be stored on at this location until scheduled for dispatch to the temporary pipe storage sites adjacent to the GTP ROW.

Similarly, pipe arriving at Gladstone Port Central will be transferred to the temporary pipe receiving area at the Gladstone Port Lot 300 or direct to the temporary pipe storage sites along the ROW. The pipe will be stored at Gladstone Port Lot 300 until scheduled for dispatch to the temporary pipe storage sites adjacent to the Mainland ROW or transported via barge to Curtis Island ROW. The Gladstone Port Lot 300 is to be established to support the pipeline construction activities near Gladstone and will be operational for the duration of the Project. Site offices, warehouse, small waste storage area laydown area and prefabrication workshop will also be located at Gladstone Port Lot 300.

Up to 11 temporary pipe storage sites (pipe laydown areas) are to be constructed at various locations adjacent to the Mainland ROW for temporary storage of pipe prior to transferring the pipe to the ROW during stringing works (Refer Figure 1 – GTP Waste and Recovered Material Haulage Route). Each temporary pipe storage site will typically be 8 ha in area to accommodate temporary storage of up to 60,000 pipes.

To prevent spread of weeds by construction vehicles, ROW access will be strictly controlled so that vehicles cannot travel from a weed infested area into a weed free area without passing through a vehicle washdown facility. It is proposed to install 12 ROW access points with vehicle washdown facilities along the Mainland ROW. Weed management and control associated with vehicle washdown and weed zones is addressed in the Pest and Weed Management Plan (PWMP) (document number 3380-GLNG-3-1.3-0006), which states that access routes shall be planned to achieve the following objectives:

- Vehicles operate in such a manner as to limit crossing of weed zone boundaries
- Vehicles start in clean areas and then move into the dirty areas
- Vehicles do not drive through or contact any seeding or flowering weeds

- Vehicles are subject to washdown and certification to move between zones

It is understood that the following pipeline construction activities are likely to generate waste:

- Early works
  - Weed control along the ROW
  - Construction of platforms for pipe storage at the temporary pipe storage sites
- Construction Contractor plant and equipment receival in Gladstone and Brisbane ports
- Construction of port pipe laydown areas at Gladstone Port Lot 300 and Lot 96 on DS186 on the Toonda Port Alma Road, Bajool
- Pipe receival at temporary pipe receiving areas at Port Alma and Gladstone Port Central
- Mobilisation
  - Construction of temporary facilities – Temporary receiving pipe areas (11) adjacent to the ROW
  - Transport and delivery of plant and equipment
  - Transport and delivery of pipe to temporary pipe storage sites
  - Progressive installation of construction camps - 4 mobile construction camps for worker accommodation, relevant to the work area of the construction workers
- Clearing and grading pipeline corridor and access tracks
- Erosion and sediment control maintenance
- Restoration and maintenance of existing roads, ROW access tracks and haul roads
- Trenching
- Drilling and blasting
- Pipe installation – welding and weld checking called holiday testing
- Pipe cleaning (pigging) and testing (hydrotesting and leak detection testing)
- Infield servicing of equipment and mobile plant
- Mobile refuelling of construction equipment
- Construction of inlet station and mainline valve stations
- ROW rehabilitation – backfilling and pipeline corridor restoration
- Decommissioning and relocation of construction camps

4.2.2 Marine Crossing section construction activities

The Marine Crossing GTP is an 8.04 km section of pipeline that includes a 4.3 km tunnel under the intertidal areas and The Narrows to reach Curtis Island. An EPB TBM will be use to excavated the tunnel, which entails boring a tunnel beneath The Narrows, between reference points C and D, and then constructing and installing the GTP and other utility components including a fibre optic cable through the tunnel. The intent of adopting this tunnelling technique is to leave the surface of the intertidal areas and The Narrows channel undisturbed. The other sections of the Marine Crossing GTP will be constructed by open trench. Details relating to the TBM construction process are included in the Marine Crossing EMP (document number 3380-GLNG-4-8.2-0021).

The TBM activity will generate 83,000 m^3 of spoil..

The tunnel spoil will be beneficially used as soil for rehabilitation of other industrial residue sites in the Gladstone region. Tunnel spoil that potentially contains Acid Sulfate Soil (ASS) will be transported to an ASS treatment area for treatment in accordance with the Acid Sulfate Soil Management Plan (ASSMP). Treated material will then be transferred to the proposed reuse destination. Material that doesn't comply with the reuse destination's rehabilitation soil acceptance criteria will be disposed to landfill.

Upon completion of the Marine Crossing GTP section, the construction site pads, Access Road and associated pipe stringing and welding platforms will be removed and the area will be rehabilitated in accordance with the LRMP (document number 3380-GLNG-3-1.3-0037).

Waste and recyclable material from the construction site pad (Curtis Island) will be transported via barge to the Port of Gladstone and then via road transport to the WMRC's depot at Landing Road, Yarwun for aggregation and sorting prior to transport of the waste and recyclable material to a disposal or recycling facility. Figure 2 and 3 (refer Appendix B) show the waste and recovered material haulage routes and location of construction areas.

4.2.3 Curtis Island section construction activities

The Curtis Island GTP section that joins the Marine Crossing GTP section to the proposed LNG Facility will be constructed using open cut trenching (as described for the Mainland GTP section).

Waste and recyclable materials generated from the Curtis Island GTP will be transported via barge to the Port of Gladstone and then via road transport to the WMRC's depot at Landing Road, Yarwun for aggregation and sorting prior to transport of the waste and recyclable material to a disposal or recycling facility.

4.3 Operation

The operational phase involves activities associated with:

- Structural integrity monitoring
- Maintaining and repairing the GTP, valves and metering stations
- Cleaning the GTP
- Maintenance to operational access tracks such as weed control and vegetation management
- Monitoring the performance of the cathodic protection system and anti-corrosion initiatives
- Monitoring the gas transmission

Waste and recyclable materials likely to be generated from the operational phase are detailed in Section 5.2.

4.4 Decommissioning

Decommissioning will occur in accordance with regulatory requirements as set out in the EMPs for each GTP section.

Waste and recyclable materials likely to be generated from the decommissioning phase are detailed in Section 5.3.

5. Waste generation

Waste will be generated as a result of the Project construction activities. Three distinct construction work areas identified and outlined in Section 4 will generate waste; these are the Mainland GTP section, the Marine Crossing GTP section and the Curtis Island GTP section.

The estimated waste streams from the construction and operation of the GTP fall into one of the following broad categories:

- General waste
  - Recyclable waste such as paper, cardboard, plastics, glass, aluminium and timber
  - Putrescible waste
  - Medical and first aid waste
  - Scrap metals
- Liquid waste
  - Sanitary waste
  - Hydrotest water
  - Washdown facility wastewater and residue
  - Water treatment plant residue
- Construction and demolition waste
- Tunnelling and shaft spoil, excess or out of specification grout
- Fill material from roadway and construction site pads
- Workshop and electrical workshop waste
- Hazardous and regulated waste

The waste materials likely to be generated from construction, operation decommissioning phases of the Project have been described in Section 5.1 to Section 5.3. The quantities of waste are estimates only.

5.1 Construction waste

5.1.1 Mainland section

Table 5.1 to Table 5.3 list the expected wastes to be generated from the construction activities from the Mainland GTP section. The waste generation lists have been compiled relative to the key activity areas:

- Temporary pipe receiving area at the Port of Gladstone (ie Gladstone Port Lot 300) and Port Alma (Lot 96 on DS186 on the Toonda Port Alma Road, Bajool)
- Mainland ROW including temporary pipe storage sites and ROW access points
- Construction camps including plant and equipment workshops

Temporary pipe receiving areas

Table 5.1 Waste generated at temporary pipe receiving area at the Gladstone Port Lot 300 and Bajool (Lot 96 on DS186)

GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Delivery of plant and equipment to site (ie light vehicles and construction vehicles, dongas, portable toilets)	Packaging (ropes and strapping, cardboard), timber skids, fibre/nylon rope spacers, pallets, drums and scrap metals	Materials treated as per waste and resource management hierarchy with general waste disposed to local licensed landfill	Negligible
Delivery of pipe at port to temporary pipe receiving area	Pipes with irreparable defects or specification non-conformity or damage Pipe will arrive with PVC or polyethylene end caps and 3 pieces of nylon rope tied around each end and in the centre. These will remain on the pipe until stringing and welding is undertaken within the ROW	All dunnage and damaged pipe sections will remain on ship	Negligible
Site office	General waste, waste paper	General waste to local licensed landfill Recyclable material to recycling facility (where available)	General waste 240 L per week
Prefabrication workshop valve assemblies, pipe supports and light structures (not applicable to Port Alma)	Waste materials such as pipe spools, various off cuts and grindings, paint containers, welding waste	Recycle metals General waste to local licensed landfill	Pipe off cuts and waste steel 0.5 t per week (approximately one 12 m length of pipe per week) General industrial waste 0.5 t per week

Temporary pipe storage sites and ROW access points

Table 5.2 Waste generated from the Mainland ROW construction area and temporary pipe storage sites

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Mobilisation activities			
Translocation of plants	Plastic pots Wooden stakes Packaging material	All existing fencing removed from the ROW during the construction phase will be offered to local landowners for reuse. Any remaining items will be removed in accordance with the principles of the waste and resource management hierarchy Recyclable material to recycling facility (where available)	10 m^3 per week of general construction and recyclable waste during site establishment
Weed control	Surplus herbicides and empty chemical containers and other consumables		
Delivery of plant, equipment and portable structures to site (ie vehicles, dongas, portable toilets, vehicle weed washdown facilities at ROW access points)	Packaging (ropes and strapping, cardboard), timber skids, wooden crates, fibre/nylon rope spacers, pallets, drums and scrap metals		

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Installation of fencing and gates (temporary and permanent) and removal of existing fencing as per Landholder agreements	Damaged fencing, fencing wire off cuts, timber post off cuts Temporary fencing that can not be reused	General waste to local licensed landfill Unused herbicides will be retained by Weed Control subcontractor for use on other projects Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	
Construction			
Hardstand - import of hard standing materials for roadway or hardstand construction	Hardstand materials – gravel fill	Surplus clean material will be offered to local landowners for re-use, stored temporarily for use during the construction period, returned to the supplier or removed in accordance with the principles of the waste and resource management hierarchy	No waste materials are expected to be generated
Weed washdown facilities	Wastewater Sludge	Water is filtered and reused in washdown facility. Sludge disposed at local licensed landfill or Wastewater Treatment Plant (WWTP)	1 m^3 sludge per week per washdown facility
Clearing and grading of the ROW, temporary pipe laydown areas (temporary pipe storage sites) and access roads/tracks (clear and grade)	Green waste (felled vegetation and plant matter) Topsoil and excavated material (stockpiled for backfilling and application to ROW) Installation of temporary fencing and gates Construction of access tracks as required Steel post off cuts (from signage installation)	Stockpiled/windrowed vegetation will be reapplied during restoration/rehabilitation of ROW All topsoil and excavated material reused for backfilling in ROW Any surplus fencing material will be either removed for reuse by the fencing contractor or offered to local landowners for re-use or removed in accordance with the principles of the waste and resource management hierarchy	Included in general waste in mobilisation activities

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Construction of temporary pipe storage sites – grading and levelling, hardstand, berm construction, and fencing where required	Hardstand materials	Surplus clean material will be offered to local landowners for reuse or removed in accordance with the principles of the waste and resource management hierarchy	Included in general waste in pipe construction works
Erosion and sediment control installation and maintenance	Packaging material – cardboard, plastic wrapping, wooden pickets and geofabric sediment fencing Geofabrics "Bidim" A34 grade polyester filter off cuts	Sediment collected in devices stored in the ROW for respreading during rehabilitation works General waste to local licensed landfill	Quantities of waste dependent on climatic, site and topography conditions Included in general waste in mobilisation activities
Drilling and blasting	Packaging – cardboard, plastic wrapping	Specialist contractors will manage all waste associated with the handling and storage of explosives in accordance with relevant legislation and standards AS2187	No waste materials are expected be generated
Delivery of pipe construction materials and consumables to temporary pipe storage sites	Neoprene plastic wrapping Nylon rope Rubber matting Packaging – timber dunnage, pallets and crates, plastic wrapping, metal and plastic strapping around consumables Ropes and strapping, cardboard, timber skids, fibre/nylon rope spacers, pallets, drums and scrap metals	Materials will be recycled where possible General waste to local licensed landfill	Included in general waste in pipe construction works
Pipeline construction works • Pipe stringing and bending • Pipe cutting and trimming • Pipe welding (up to 1000 m pipe strings) • Weld sandblasting	PVC or polyethylene pipe end caps (68,000 pipe end caps for pipeline) 42” mild steel pipe off cuts and defective pipe; metal filings (less than 100 m of pipe for pipeline) Timber skids and sand bags (reuse on each 30 km section)	PVC or polyethylene pipe end caps recycled Metal recycled Timber skids and sand bags reused General waste to local licensed landfill Licensed contractor to transport regulated waste to an	17.5 t per week of pipe end caps (10 kg per pipe end) 0.6 t per week of steel pipe off cuts and defective pipe 1.7 t per week of metal filings 8 t per week of general waste 100 L per week of regulated waste (spent chemicals and chemical container)

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
• Tie-ins (above ground or in-the-trench) • Coating of field joints - application of rust proofing agent required to be applied when pipe is cut and a coating of epoxy-urethane over weld • Holiday detection survey and weld testing • Ducting for fibre optic cable • River/waterway crossings	Off cuts – duct for future installation of fibre optic cable Marker tape Chemical containers (ie paint/epoxy coating cans, empty containers of rust proofing agents) Sandblasting grit (GMA Garnet) – spent grit will contain some metal fragments and paint/surface coatings (refer Appendix D) Welding residue – welding rod scraps and electrode butts Polypropylene bags Waste cement and concrete Nylon rope	appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill "Spent" Sandblasting grit disposed in accordance with Code of Environment Compliance (DERM, 2009) Spent abrasive (ie spent sandblasting grit) will be tested (eg Toxicity Characteristics Leaching Procedures test) to check whether it requires treatment in an approved hazardous waste treatment facility	
Trenching Foam trench breakers and foam pillows installation	Excavated material Excess rigid polyurethane foam (Aptane P220 / Isocyanate B900) and hose washings Spent absorbent material Drums/plastic bags (polypropylene) PPE - Protective gloves and disposable overalls PVC conduit offcuts	All excavated material reused for backfilling in ROW or offered to local landowners for reuse All materials will be managed as per the waste and resource management hierarchy with general waste disposed to the local licensed landfill	Included in general waste in pipe construction works
Pipe cleaning and gauging Pipe testing – Hydrotesting 48 hour leak test	Pipe cleaning waste (pigging grit - scale, rust, or other foreign material) Hydrotest water not treated with biocides, corrosion inhibitor and oxygen scavengers (estimated 25 km tested at a time (approximately 90 m^3 water required), used 4 times before discharge)	Pigging grit - licensed contractor to transport regulated waste to a licensed regulated waste landfill Hydrotest water released to land (refer Mainland EMP – document number 3380-GLNG-3-8.2-0024) No chemical treatment of water is required as source is potable water (refer Dewatering, Hydrotest Water and Land Release Management Plan (DHWLRMP))	200 m^3 pigging grit total (assume 0.5 m^3 per km) 360 m^3 water

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Infield servicing and maintenance of construction plant and equipment Fuel trucks, lubrication trucks and minor maintenance pick-ups provide onsite daily service and perform regular checks on equipment Daily field servicing, safety checks and refuelling in the field to be undertaken in the ROW	Oily rags, spent absorbent material infield servicing and maintenance (minor servicing only) Waste oil and greases (eg lube oil, hydraulic oil and engine oil) Spent spill kit materials Packaging from replacement parts End of life vehicle parts (eg fan belts, hoses, other machinery parts) Tyres Batteries Used chemicals – chemicals, used tins from solvents, degreasing agents, lubricants Waste associated with diesel generator operation and maintenance	Licensed contractor to transport regulated waste to a licensed recycling facility Residual material dealt with in accordance with the principles of the waste and resource management hierarchy	All waste generated from infield servicing will be returned to the waste storage area at the construction camps 250 kg regulated waste per week 1 m^3 of waste oil per month
Site offices, crib room/s, site amenities (servicing of construction site amenities)	Office waste – paper, cardboard packaging Kitchen waste Rubbish bin waste in facilities (ie paper towels) First aid waste Wastewater	Recyclable material to recycling facility (where available) General waste to local licensed landfill Wastewater hauled via vacuum truck and disposed at construction camp's WWTP	Recycling and general waste quantities included in the construction camp quantities per person per week Wastewater volumes included in construction camp quantities per person per day
Spill clean up	Hydrocarbon contaminated soil (small quantities) Contaminated absorbent material from ROW	Licensed contractor to transport regulated waste to a licensed recycling facility and residual material disposal at a licensed regulated waste landfill	Up to 160 L per week of regulated waste across Mainland GTP activities
ROW rehabilitation			
Clean up and restoration: reinstatement of the ROW, removal of foreign material (construction material and waste), surface contouring, compaction, respreading topsoil, respreading felled vegetation (whole or mulched) and reseeding	Any recyclable or general waste items listed above Useable surplus pipe will be delivered to a location designated by GLNG Operations	Clean hardstand material will be offered to local landowners or local council for reuse or removed for treatment or disposal in accordance with the principles of the waste and resource management hierarchy	100 t timber skids 50 t sand bags (assume timber skids and sand bags are reused approximately 15 times over the length of the pipeline (ie assume reuse on each 30 km section)

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Removing any surplus materials, restoring services to their original condition, disposing of refuse, smoothing disturbed earth, removing temporary fills, culverts and bridges, and performing such work as may be necessary to restore ROW to original condition		Useable surplus pipe and other reusable materials stored at location designated by GLNG Operations General waste to local licensed landfill	
Reinstatement of temporary pipe storage sites/pipe storage yards and other non ROW areas such as haul roads, spoil storage and other such areas requiring restoration	Polyethylene sheeting from pipe storage area	Reused or recycled where possible. Will be offered to local landowners for re-use General waste to local licensed landfill	80 t of polyethylene sheeting from temporary pipe storage sites
Establishment of vegetation	Plastic pots Wooden stakes Packaging material Surplus herbicides and empty containers	Residual material dealt with in accordance with the principles of the waste and resource management hierarchy Items will be recycled where possible if no option available then waste will be disposed of to a local licensed landfill General waste to local licensed landfill Unused herbicides will be retained by Weed Control subcontractor for use on other projects Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	50 kg per week during vegetation establishment activities in the ROW Quantity dependent upon whether herbicides for weed control are required during establishment of vegetation

Construction camps

Table 5.3 Waste generated from construction camps

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Mobilisation, construction and commissioning of construction camps	Site clearance green waste, topsoil and excavated material (stockpiled for backfilling and application to construction camps)	Stockpiled/windrowed vegetation will be reapplied during restoration/rehabilitation of ROW All topsoil and excavated material stockpiled along ROW for backfilling and spreading during site restoration	Nil
	Construction materials, concrete, scrap metal, timber, plastics, plumbing, electrical wiring	The construction methodology will aim to limit the amount of waste produced on the construction site and ensure that wherever possible, waste materials are re-used or recycled General waste to local licensed landfill	20 m^3 per week general and recyclable waste per construction camp during construction camp set up activities
Operation of construction camps – cleaning, catering, site offices, accommodation areas, ROW, temporary pipe storage sites, construction areas, temporary storage, and residential blocks within construction camps	General waste (including putrescible and non-hazardous waste) Recyclables (dry recyclables, cardboard, packaging materials and offices wastes)	Recyclable material to recycling facility (where available) General waste to local licensed landfill	6 kg per person per week recyclable material 13 kg per person per week general waste
	Metals - aerosol, aluminium cans, steel chemical containers, copper and aluminium (other than cans), steel drums (damaged), steel drums (good condition), scrap steel, steel chemical containers, bulk food containers		
	Food waste - Putrescible waste, metal, plastic, plastic and other associated food packaging		
	Chemicals - Cleaning and maintenance of camp buildings chemicals		
	Cardboard – Bulk food packaging and plant and equipment maintenance storage		

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
	Cooking oils – Food production activities	Waste cooking oil will be securely stored by the catering contractor and removed by the supplier for recycling where practicable	Recycling and general waste quantities included in the per person quantities per week
	Wood (pallets) bulk deliveries of food	All pallets will be collected by suppliers and returned for reuse	
	Clinical, medical, sanitary waste, first aid station waste, medical waste	Waste material dealt with in accordance with the principles of the waste and resource management hierarchy	Minimal quantities expected to be produced and have been included in the per person general waste quantities
	Wastewater treatment plant effluent	Discharge to mobile sewage treatment plants – irrigation beds/absorption beds	200 L per person per day - effluent
	Sludge from wastewater treatment plant	Licensed landfill or wastewater treatment plant	5 L sludge per person per week at 2% solids
Site mowing and vegetation maintenance	Green organic waste (woody garden waste, grass)	Stockpiled/windrowed vegetation will be reapplied during restoration / rehabilitation of construction camp	No waste expected to be generated
Office waste, construction materials and equipment store	Spent toner and printer cartridges, electronic and electrical equipment, white goods, computers, office equipment, mobile phones, batteries (dry cell)	Equipment will be reused by returning items to Brisbane	Minimal – each office will only be operational 6 to 9 months Recycling and general waste quantities included in the kg per person per week
	Spent lamps and fluorescent tubes	Recyclable material to recycling facility (where available) General waste to local licensed landfill	Recycling and general waste quantities included in the kg per person per week
	Paper – Office paper, other sources of packaging		
	General non-recyclable - synthetic material waste Fibre insulation filters (activated carbon) filters (air, dust, paper)		
	Wood (pallets) construction materials and other equipment	Pallets will be collected by suppliers during subsequent deliveries	

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Plant and equipment maintenance service areas / workshops			
Vehicle wash down	Wastewater and sludge	Water will be reused at the vehicle wash facilities Sludge disposed at local licensed landfill or WWTP	0.5 m^3 sludge per week per construction camp wash down facility
Delivery of bulk equipment and supplies	Packaging (ropes and strapping, cardboard), timber pallets, fibre/nylon rope, drums and scrap metals	All packaging materials such as pallets will be collected by suppliers and returned for reuse or dealt with on site as per the principles of the waste and resource management hierarchy General waste to local licensed landfill	0.5 t per week of packaging material
	Explosives	Specialist contractors will manage all waste associated with the handling and storage of explosives in accordance with relevant legislation and standards AS2187	No waste materials are expected to be generated Included in Mainland – ROW (Table 5.2)
Refuelling – diesel generators	Absorbent material	All waste will be stored in accordance with Australian Standard AS 1940 in bunded areas	No waste expected to be generated (absorbent material listed below)
Diesel refuelling area for construction vehicles - fuel storage up to three 30 kL tanks at construction camps for refuelling construction vehicles	Absorbent material	All waste will be stored in accordance with Australian Standard AS 1940 in bunded areas	
Plant and equipment maintenance workshop	Filters (oil) filters (air, dust, paper)	Collected and transported by a licensed contractor for recycling where possible	100 kg per week oil and air filters
	Batteries (wet lead acid)	Collected and transported by a licensed contractor for recycling where possible	Up to 50 batteries are expected for the duration of the Project
	Oils and oil contaminated waters - waste oil, oily absorbents, oily rags, oily sludges, sump oils, grease traps	Collected and transported by a licensed contractor for recycling or disposal to regulated waste landfill	Up to 3,000 L per week of waste oil 160 L per week of oily rags and absorbent material
	Rubber – tyres	Collected and transported by a licensed contractor for recycling	Up to 20 tyres per week

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Prefabrication workshop valve assemblies, pipe supports and light structures	Waste materials such as pipe spools, various off cuts and grindings, paint containers, welding waste	Recyclable material to recycling facility (where available) General waste to local licensed landfill	Pipe off cuts and waste steel 0.5 t per week General industrial waste 0.5 t per week
Restoration and rehabilitation (decommissioning of construction camps)	Construction materials, concrete, scrap metal, timber, plastics, plumbing, electrical wiring	On decommissioning any remaining material will be offered to local landowners for reuse or removed for treatment or disposal in accordance with the principles of the waste and resource management hierarchy	Reusable accommodation facilities and relocatable buildings will be retained by Construction Camp subcontractor for use on other projects Waste produced during decommissioning of the construction camps will be re-used or recycled wherever possible

5.1.2 Marine Crossing section

Table 5.4 lists the expected waste types and estimated quantities for the Marine Crossing GTP Project. Each construction worker will be responsible for transporting their recyclable materials and waste to the designated waste storage area located within the construction site pads. The workers will be required to separate their waste into the correct bin as per the bin label.

All waste and recyclable material from the Marine Crossing GTP Project waste storage area located within the construction site pad (mainland) will be collected and transferred by road to the WMRC's depot for further sorting or consolidation with other recyclable material and dispatch to markets or transported direct to the recycling or disposal destination.

All waste and recyclable material from the construction site pad (Curtis Island) will be collected and transferred by barge and then road to the WMRC's depot for further sorting or consolidation with other recyclable material and dispatch to markets or transported direct to the recycling or disposal destination (refer Table 3.1).

All waste and recyclable material from the construction site pad (Curtis Island) will be collected and transferred by barge to Gladstone Port Central and then by road to the WMRC's depot for further sorting or consolidation with other recyclable material and dispatch to markets or transported direct to the licensed recycling or disposal destination. Where logistically more efficient (ie when waste quantities equate to a full hook lift or front lift collection vehicle), general waste may be hauled directly from the Marine Crossing Project waste storage area at construction site pad (mainland) via road to Benaraby Landfill for sorting and appropriate disposal. Recyclable material may be collected and hauled from the Marine Crossing GTP Project waste storage area directly to the recycling service provider's yard for aggregation and dispatch to recycling markets.

Figures 2 and 3 (refer Appendix B) show the location of the Project, the WMRC's depot, construction site pads, proposed waste haulage routes and local waste and sewage disposal facilities. Post construction, the construction site pads and Access Road will be removed and managed as per the control measures listed Table 8.4.

Table 5.4 Waste generated from construction activity – Marine Crossing GTP ROW

Marine crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Mobilisation activities			
Delivery of plant and equipment	Packaging (ropes and strapping, cardboard), timber skids, fibre/nylon rope spacers, pallets, metal and plastic drums	General waste to local licensed landfill	Negligible
Weed control	Surplus herbicides and empty chemical containers and other consumables	Recyclable material to recycling facility (where available) General waste to local licensed landfill Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	20 m^3 per month of general construction waste during site establishment 4.5 m^3 per month of metal (recycled)
Site establishment - Delivery of plant, equipment and portable structures to site (ie vehicles, dongas, portable toilets, vehicle weed washdown facilities at ROW access points, sheet piling retaining walls)	Packaging (ropes and strapping, cardboard), timber skids, wooden crates, fibre/nylon rope spacers, pallets, drums and scrap metals		
Construction			
Construction site pads – import of hard standing materials for roadway and hardstand construction	Hard standing materials – gravel fill	Surplus imported clean material will be offered to local landowner for reuse, stored temporarily for use during the construction period, returned to the supplier or removed in accordance with the principles of the waste and resource management hierarchy	No waste materials are expected to be generated
Vehicle weed and mud washdown facilities	Wastewater Sludge	Water is filtered and reused in washdown facility Sludge disposed at local licensed landfill or WWTP	1 m^3 sludge per week per washdown facility

Marine crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Clearing and grubbing of the ROW, construction site pads, pipe laydown areas (temporary pipe storage sites) and Access Road (clear and grade)	Green waste (felled vegetation and plant matter) Topsoil and excavated material (stockpiled for backfilling and application to ROW) Installation of temporary fencing and gates (around Site Pads) Construction of access tracks as required Steel post offcuts (from signage installation)	Stockpiled/windrowed vegetation will be reapplied during restoration/rehabilitation of ROW (refer LRMP – document number 3380-GLNG-3-1.3-0037) All topsoil and excavated material reused for backfilling in ROW Any surplus fencing material will be either removed for reuse by the fencing contractor, offered to local landowners for reuse or removed in accordance with the principles of the waste and resource management hierarchy	Included in general waste in mobilisation activities
ROW, access / service roads and string area preparation	Hardstand materials	Surplus materials will be returned to supplier or offered to local landowners for reuse or removed in accordance with the principles of the waste and resource management hierarchy	Nil
TBM shaft construction	Surplus concrete Formwork (for concrete slabs) Damaged sheet piles Excavated material	Surplus concrete, damaged formwork and sheet piles to be treated as per the waste and resource management hierarchy with general waste to local licensed landfill Formwork and sheet piles to be removed from site by the contractor for reuse on other projects Excavated material from the shaft will be stored in the site pad stockpile area for backfilling shaft at completion	No waste materials are expected to be generated
Tunnel boring by TBM	Tunnel and TBM shaft spoil	Tunnel spoil transported by road transport for disposal at proposed location as described in Chapter 2 Project Description of the Marine Crossing EMP. Spoil will need to meet the specific acceptance criteria	83,000 m^3

Marine crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
	Oily rags, spent absorbent material from TBM	Licensed contractor to transport regulated waste to a licensed recycling facility and residual material for disposal at a licensed regulated waste landfill	240 L per week
Lining tunnel with concrete segments, grouting and backfilling annulus	Damaged concrete segments Timber strips (packaging between concrete tunnel lining segments for transport) Out of specification grout or stabilised sand Glue/adhesive and empty containers	Concrete to be treated as per the waste and resource management hierarchy with general waste to local licensed landfill Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	12 m^3 per month of general construction waste 4.5 m^3 per month of metal (recycled) 100 m^3 in total of out of specification grout and stabilised sand
Dewatering	Shaft dewatering and tunnel water ingress	Refer to Chapter 15 of the Marine Crossing EMP	Refer to Marine Crossing GTP EMP – document number 3380-GLNG-4-8.2-0021)
Construct pipe laydown areas (temporary pipe storage sites) – grading and levelled, hardstand, berm construction, and fencing where required	Polyethylene sheeting offcuts Cardboard or plastic tubes Plastic wrapping	Surplus clean material will be offered to local landowners for reuse or removed in accordance with the principles of the waste and resource management hierarchy	Included in general waste in pipe construction works
Erosion and sediment control installation and maintenance	Packaging material – cardboard, plastic wrapping, wooden pickets and geofabric sediment fencing Geofabrics "Bidim" A34 grade polyester filter off cuts	Sediment collected in devices stored in the ROW for respreading during rehabilitation works General waste to local licensed landfill	Quantities of waste dependent on climatic, site and topography conditions Included in general waste in mobilisation activities
Trenching and bulk earthworks Foam trench breakers and foam pillows installation	Excavated material Excess Rigid Polyurethane foam (Aptane P220/Isocyanate B900) Spent absorbent material Drums/plastic bags Polypropylene PPE - Protective gloves and disposable overalls PVC conduit off cuts	All non ASS excavated material reused for backfilling in ROW or offered to local landowners for reuse ASS material will be treated and disposed of as per the ASSMP All materials will be treated as per the waste and resource management hierarchy with general waste to local licensed landfill	Included in general waste in pipe construction works

Marine crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Delivery of pipe construction materials and consumables to Marine Crossing GTP Project	Neoprene plastic wrapping Nylon rope Rubber matting Packaging – timber dunnage, pallets and crates, plastic wrapping, metal and plastic strapping around consumables Ropes and strapping, cardboard, timber skids, fibre/nylon rope spacers, pallets, drums and scrap metals	Materials to be treated as per the waste and resource management hierarchy with general waste to local licensed landfill	Included in general waste in pipe construction works
Pipeline construction works • Pipe stringing and bending • Pipe cutting and trimming • Pipe welding (up to 800 pipes) • Weld sandblasting • Tie-ins (above ground or in-the-trench) • Coating of field joints - application of rust proofing agent required to be applied when pipe is cut and a coating of epoxy-urethane over weld • Holiday detection survey and weld testing • Ducting for fibre optic cable • River/waterway crossings	PVC or polyethylene pipe end caps (1,500 pipe end caps for pipeline) 42” mild steel pipe off cuts and defective pipe; metal filings (less than 5 metres of pipe for pipeline) Timber skids and sand bags Offcuts – duct for future installation of fibre optic cable Marker tape Chemical containers (ie paint/epoxy coating cans, empty containers of rust proofing agents) Sandblasting grit (GMA Garnet) - Spent grit will contain some metal fragments and paint/ surface coatings (refer Appendix D) Welding residue – welding rod scraps and electrode butts Polypropylene bags Waste cement and concrete Nylon rope	PVC or polyethylene pipe end caps recycled Metal recycled Timber skids and sand bags reused General waste to local licensed landfill Licensed contractor to transport regulated waste to a licensed recycling facility and residual material disposal at a licensed regulated waste landfill “Spent” Sandblasting grit disposed in accordance with Code of environmental compliance (DERM 2009) Spent abrasive (ie spent sandblasting grit) will be tested (eg Toxicity Characteristics Leaching Procedures test) to check whether it requires treatment in an approved hazardous waste treatment facility	15 t in total of pipe end caps 1 t in total steel pipe off cuts and defective pipe 1.5 t in total of metal filings 0.5 t per week of general waste 10 L per week of regulated waste (spent chemicals and chemical container)
Pipe cleaning and gauging Pipe testing – Hydrotesting 48 hour leak test	Pipe cleaning waste (pigging grit - scale, rust, or other foreign material) Hydrostatic test water not treated with biocides, corrosion inhibitor and oxygen scavengers (assuming whole 8.04 km tested - approximately 15,000 m^3 of water required)	Pigging grit - Licensed contractor to transport regulated waste to an licensed regulated waste landfill Hydrotest water released to land (refer Marine Crossing GTP EMP – document number 3380-GLNG-4-8.2-0021)	Up to 4 m^3 pigging grit in total over construction period (assume 0.5 m^3 / km) 15,000 m^3 hydrotest water

Marine crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Infield servicing and maintenance of construction vehicles and equipment Fuel trucks, lubrication trucks and minor maintenance pick-ups provide on-site daily service and perform regular maintenance on plant and equipment Daily field servicing, safety checks and refuelling in the field to be undertaken in the ROW	Oily rags, spent absorbent material infield servicing and maintenance (minor servicing only, no service workshop) Waste oil and greases (eg lube oil, hydraulic oil and engine oil) Spent spill kit materials Packaging from replacement parts End of life vehicle parts (eg fan belts, hoses, other machinery parts) Tyres Batteries Used chemicals – chemicals, used tins from solvents, degreasing agents, lubricants Waste associated with diesel generator operation and maintenance	Licensed contractor to transport regulated waste to a licensed recycling facility Residual material for disposal at a licensed landfill	All wastes generated from infield servicing will be returned to the waste storage area 250 kg regulated waste per week 1 m^3 of waste oil per month
Site offices, crib room/s, site amenities (servicing of construction site amenities)	Office waste – paper, cardboard packaging etc Kitchen waste Rubbish bin waste in facilities (ie paper towels) First aid waste Kitchen and amenity wastewater	Recyclable material to recycling facility (where available) General waste to local licensed landfill Wastewater from crib rooms and amenities will be hauled via vacuum truck and disposed at a local WWTP in Gladstone	Recyclable material 50 kg per week 200 kg per week of general waste (approximately one 6 m^3 skip bin per week) 0.25 m^3 of waste paper and cardboard per month 20 L wastewater per person per day
Spill clean up	Contaminated soil and absorbent material	Licensed contractor to transport regulated waste to an a licensed recycling facility and residual material for disposal at a licensed regulated waste landfill	10 L per week of regulated waste across Marine Crossing GTP activities
WTP residue	Alum based sludges/filter cake	Residue to local licensed landfill Treated water from WTP is used in grout batching and for other construction activities such as dust suppression (further information will be provided in the WTP Operation Manual)	1 m^3 per week

Marine crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
ROW rehabilitation			
Construction site pad removal	Gravel, hardstand, concrete foundations, clay material for pond lining	Clean hardstand, gravel and clay material will be offered to local landowners or GRC for reuse or removed for treatment or disposal in accordance with the principles of the waste and resource management hierarchy Surplus concrete to be treated as per the waste and resource management hierarchy if no reuse can be found then will be disposed to local licensed landfill	Approximate 10,000 m^3 from construction site pad (mainland) and 5,000 m^3 from construction site pad (Curtis Island)
Clean up and restoration: reinstatement of the ROW, removal of foreign material (construction material and waste), surface contouring, compaction, respreading topsoil, respreading felled vegetation (whole or mulched) and reseeding Removing any surplus materials, restoring services to their original condition, disposing of refuse, smoothing disturbed earth, removing temporary fills, culverts and bridges, and performing such work as may be necessary to restore ROW to original condition Reinstatement of storage areas and other off ROW areas such as haul roads, spoil storage and other such areas requiring restoration	Recyclable or general waste items listed above Useable surplus pipe will be delivered to a location designated by GLNG Operations	Clean hardstand material will be offered to local landowners or GRC for reuse or removed for treatment or disposal in accordance with the principles of the waste and resource management hierarchy Useable surplus pipe and other reusable materials stored at location designated by GLNG Operations Fencing may be removed from site by the contractor for reuse on other projects Residual material dealt with in accordance with the principles of the waste and resource management hierarchy	20 t timber skids 10 t sand bags

Marine crossing GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Demobilisation	General construction waste - timber, construction fines (incidental soil), plastic, cardboard, chemical drums, metal	Residual material dealt with in accordance with the principles of the waste and resource management hierarchy General waste to local licensed landfill Licensed contractor to transport regulated waste to an appropriately licensed recycling facility (if available locally) and residual material disposal at appropriately licensed regulated waste landfill	55 m^3 per month of general construction waste 25 m^3 per month of metal (recycled)
Shaft removal	Concrete slabs Sheet piles	Concrete to be treated as per the waste and resource management hierarchy with general waste to local licensed landfill Sheet piles will be removed for reuse by the contractor on other projects	5,000 m^3 concrete
Establishment of vegetation	Plastic pots, wooden stakes. packaging material, surplus herbicides and empty containers	Residual material dealt with in accordance with the principles of the waste and resource management hierarchy General waste to local licensed landfill Unused herbicides will be retained by Weed Control subcontractor for use on other projects Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	10 kg per week during vegetation establishment activities in the ROW Quantity dependent upon whether herbicides for weed control are required during establishment of vegetation

5.1.3 Curtis Island section

Table 5.5 Waste generated from the Curtis Island section

Curtis Island GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Mobilisation activities			
Translocation of plants	Plastic pots Wooden stakes Packaging material	Recyclable material to recycling facility (where available) General waste to local licensed landfill Unused herbicides will be retained by Weed Control subcontractor for use on other projects Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	Less than 1 m^3 per week of general and recyclable waste during mobilisation activities
Weed control	Surplus herbicides and empty chemical containers and other consumables		
Delivery of plant, equipment and portable structures to site (ie vehicles, dongas, portable toilets, vehicle weed washdown facilities at ROW access points	Packaging (ropes and strapping, cardboard), timber skids, wooden crates, fibre/nylon rope spacers, pallets, drums and scrap metals		
Installation of fencing and gates and removal of existing fencing	Damaged fencing, fencing wire off cuts, timber post off cuts Temporary fencing that cannot be reused	Recyclable material to recycling facility (where available) General waste to local licensed landfill	No fences or gates to be installed or removed from the Curtis Island ROW
Construction			
Hard standing - import of hard standing materials for roadway or hardstand construction	Hardstand materials	Surplus clean material will be offered to local landowners for reuse or removed in accordance with the principles of the waste and resource management hierarchy	No waste materials are expected to be generated
Vehicle weed and mud washdown facility	Wastewater Sludge	Water is filtered and reused in washdown facility Sludge disposed at local licensed landfill or WWTP	1 m^3 sludge per week per washdown facility
Clearing and grubbing of ROW, temporary pipe storage sites and access tracks (clear and grade)	Green waste (felled vegetation and plant matter) Topsoil and excavated material (stockpiled for backfilling and application to ROW) Installation of temporary fencing and gates	Stockpiled/windrowed vegetation will be reapplied during restoration/rehabilitation of ROW All topsoil and excavated material reused for backfilling in ROW	Included in general waste in mobilisation activities

Curtis Island GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
	Construction of access tracks as required Steel post off cuts (from signage installation)	Any surplus fencing material will be either removed for reuse by the fencing contractor, offered to local landowners for reuse or removed in accordance with the principles of the waste and resource management hierarchy	
Construct of temporary pipe storage sites – grading and levelling, hardstand, berm construction, and fencing where required	Polyethylene sheeting off cuts Cardboard or plastic tubes Plastic wrapping	Minimise surplus clean material in accordance with the principles of the waste and resource management hierarchy	Included in general waste in pipe construction works
Erosion and sediment control installation and maintenance	Packaging material – cardboard, plastic wrapping, wooden pickets and geofabric sediment fencing Geofabrics "Bidim" A34 grade polyester filter off cuts	Sediment collected in devices stored in the ROW for respreading during rehabilitation works General waste to local licensed landfill	Quantities of waste dependent on climatic, site and topography conditions Included in general waste in mobilisation activities
Delivery of pipe construction materials and consumables to the Curtis Island GTP Project	Neoprene plastic wrapping Nylon rope Rubber matting Packaging – timber dunnage, pallets and crates, plastic wrapping, metal and plastic strapping around consumables Ropes and strapping, cardboard, timber skids, fibre /nylon rope spacers, pallets, drums and scrap metals	Materials to be treated as per the waste and resource management hierarchy with general waste to local licensed landfill	Included in general waste in pipe construction works
Pipe construction works • Pipe stringing and bending • Pipe cutting and trimming • Pipe welding (up to 1000 m pipe strings) • Weld sandblasting • Tie-ins (above ground or in-the-trench) • Coating of field joints - application of rust proofing agent required to be applied when	PVC or polyethylene pipe end caps (1,000 pipe end caps for Curtis Island GTP) 42" mild steel pipe off cuts and defective pipe; metal filings(less than 5 m of pipe for Curtis Island GTP) Timber skids and sand bags Off cuts – duct for future installation of fibre optic cable Marker tape Chemical containers (ie paint/epoxy coating cans, empty containers of rust	PVC or polyethylene pipe end caps recycled Metal recycled Timber skids and sand bags reused General waste to local licensed landfill Licensed contractor to transport regulated waste to a licensed recycling facility and residual material disposal at a licensed regulated waste landfill	9.2 t in total of pipe end caps (10 kg per pipe end) 1 t in total of steel pipe off cuts and defective pipe 1 t in total of metal filings General waste 0.5 t per week 10 L per week of regulated waste (spent chemicals and chemical container)

Curtis Island GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
• pipe is cut and a coating of epoxy-urethane over weld • Holiday detection survey and weld testing • Ducting for fibre optic cable • River/waterway crossings	proofing agents) Sandblasting grit (GMA Garnet) - Spent grit may contain some metal fragments and paint/surface coatings (refer Appendix D) Welding residue – welding rod scraps and electrode butts Polypropylene bags Waste cement and concrete Nylon rope	"Spent" Sandblasting grit disposed in accordance with Code of Environment Compliance (DERM, 2009) Spent abrasive (ie spent sandblasting grit) will be tested (eg Toxicity Characteristics Leaching Procedures test) to check whether it requires treatment in an approved hazardous waste treatment facility	
Trenching and bulk earthworks Foam trench breakers and foam pillows installation	Excavated material Excess Rigid Polyurethane foam (Aptane P220/ Isocyanate B900) and hose washings Spent absorbent material Drums/plastic bags (polypropylene) PPE - protective gloves and disposable overalls PVC conduit off cuts	All excavated material reused for backfilling in ROW to be spread across ROW All materials will be treated as per the waste and resource management hierarchy with general waste disposed to local licensed landfill	Included in general waste in pipe construction works
Pipe cleaning and gauging Pipe testing – hydrotesting 48 hour leak test	Pipe cleaning waste (pigging grit - scale, rust, or other foreign material) Hydrostatic test water not treated with biocides, corrosion inhibitor and oxygen scavengers (assuming 5 km tested at a time (20 kL water required)	Pigging grit - licensed contractor to transport regulated waste to a licensed regulated waste landfill Hydrotest water released to land (refer to Curtis Island GTP EMP – document number 3380-GLNG-3-8.2-0026) (assume no chemical treatment of water is required as source is potable water) (refer DHWLRMP)	2 m^3 pigging grit in total (assume 0.5 m^3 per km) 20 kL water
Infield servicing and maintenance of construction vehicles and equipment Fuel trucks, lubrication trucks and minor maintenance pick-ups provide on-site daily service and perform regular checks on	Oily rags, spent absorbent material infield servicing and maintenance Waste oil and greases eg lube oil, hydraulic oil and engine oil Spent spill kit materials Packaging from replacement parts	Licensed contractor to transport regulated waste to an a licensed recycling facility. Residual material dealt with in accordance with the principles of the waste and resource management hierarchy	All waste generated from infield servicing will be returned to the waste storage area 250 kg regulated waste per week 1 m^3 of waste oil per month

Curtis Island GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
equipment Daily field servicing, safety checks and refuelling in the field to be undertaken in the Curtis Island GTP ROW	End of life vehicle parts (eg fan belts, hoses, other machinery parts) Tyres Batteries Used chemicals – chemicals, used tins from solvents, degreasing agents, lubricants Waste associated with diesel generator operation and maintenance		
Site offices, crib room/s, site amenities (servicing of construction site amenities)	Office waste – paper, cardboard packaging Kitchen waste Rubbish bin waste in facilities (ie paper towels) First aid waste Kitchen and amenity wastewater	Recyclable material to recycling facility (where available) General waste to local licensed landfill Wastewater hauled via vacuum truck and disposed at a local WWTP in Gladstone (Calliope River STP)	Recyclable material 50 kg per week 200 kg per week of general waste 20 L wastewater per person per day
Spill clean up	Hydrocarbon contaminated soil (small quantities) Contaminated absorbent material from ROW	Licensed contractor to transport regulated waste to a licensed recycling facility and residual material disposal at a licensed regulated waste landfill	10 L per week of regulated waste across the Curtis Island GTP activities
ROW rehabilitation			
Clean up and restoration: reinstatement of the ROW, removal of foreign material (construction material and waste), surface contouring, compaction, respreading topsoil, respreading felled vegetation (whole or mulched) and reseeding Removing any surplus materials, restoring services to their original condition, disposing of refuse, smoothing disturbed earth, removing temporary fills, culverts and bridges, and performing such work as may be necessary to restore ROW to original condition	Useable surplus pipe will be delivered to a location designated by GLNG Operations	Clean hardstand material will be offered to Gladstone Regional Council for reuse or removed for treatment or disposal in accordance with the principles of the waste and resource management hierarchy Useable surplus line pipe and other reusable materials stored at location designated by GLNG Operations Residual material dealt with in accordance with the principles of the waste and resource management hierarchy	20 t timber skids 10 t sand bags

Curtis Island GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate
Demobilisation	General construction waste - timber, construction fines (incidental soil), plastic, cardboard, chemical drums, metal	Residual material dealt with in accordance with the principles of the waste and resource management hierarchy General waste to local licensed landfill Licensed contractor to transport regulated waste to an appropriately licensed recycling facility (if available locally) and residual material disposal at appropriately licensed regulated waste landfill	55 m^3 per month of general construction waste during demobilisation 25 m^3 per month of metal (recycled)
Establishment of vegetation	Plastic pots Wooden stakes Packaging material Herbicides	Residual material dealt with in accordance with the principles of the waste and resource management hierarchy General waste to local licensed landfill Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	10 kg per week during vegetation establishment activities in the ROW Quantity dependent upon whether herbicides for weed control are required during establishment of vegetation

5.2 Operational waste

A list of the waste types and an estimate of the waste quantities generated from operational activities is detailed in Table 5.6, Table 5.7 and Table 5.8.

Table 5.6 Waste generated from Mainland GTP operations

Mainland GTP operation activity	Waste generated	General management principle	Estimate of waste quantity/rate
Vegetation maintenance of the ROW	Green waste – felled/ trimmed vegetation and plant matter to maintain designated maximum vegetation heights	Green waste is to be chipped/mulched and reapplied to ROW for weed suppression	Nil as reapplied to ROW (quantity dependent upon soil type and weather conditions)
Maintenance of Mainland GTP ROW pipeline valves, delivery and metering stations	Filters (non-oily, oily and gas)	Collected and transported by a licensed contractor for recycling or disposal to regulated waste landfill	Less than 350 kg per year (approximately 0.8 kg/km/year based upon 30 kg per month for entire pipeline)
	Waste oils and greases	Collected and transported by a licensed contractor for recycling where possible	5 m^3 per year (estimate 10 L per km)
	Packaging	General waste for disposal at a licensed landfill	1,500 kg per year (approximately 3.6 kg/km/year based upon 30 kg per week for entire pipeline)
Cleaning of pipeline - pigging (if undertaken in the future)	Pipe cleaning waste (pigging grit - scale, rust, or other foreign material)	Pigging grit - licensed contractor to transport regulated waste to a licensed regulated waste landfill	8 m^3 pigging grit per year (approximately 20 L per km)
Spills of hydrocarbon based material	Potential hydrocarbon contaminated soil from spills oils and greases	Remediation in situ for small quantities. Advice sought from DEHP regarding treatment options for larger spills (eg >200 L). Removal of soil under disposal permit for remediation or disposal at suitably licensed facility	No waste materials are expected be generated
Offices, crib room/s, site amenities along pipeline	Office waste – paper, cardboard packaging Kitchen waste Rubbish bin waste in facilities (ie paper towels) First aid waste Kitchen and amenity wastewater	Recyclable material to recycling facility (where available) Residual material local licensed landfill Wastewater from crib rooms and amenities will be hauled via vacuum truck and disposed at a local WWTP	Recyclable material and general waste very small quantities – less than 30 kg per week Very small quantities of wastewater are expected. Amenities to be serviced weekly when in use

Table 5.7 Waste generated from Marine Crossing GTP operations

Marine Crossing GTP operation activity	Waste generated	General management principle	Estimate of waste quantity/rate[2]
Vegetation maintenance of the ROW	Green waste – felled/ trimmed vegetation and plant matter to maintain designated maximum vegetation heights	Green waste is to be chipped/mulched and reapplied to ROW for weed suppression	Nil as reapplied to ROW (quantity dependent upon soil type and weather conditions)
Maintenance of Marine Crossing GTP ROW pipeline valves, delivery and metering stations	Filters (non-oily, oily and gas)	Collected and transported by a licensed contractor for recycling or disposal to regulated waste landfill	Less than 10 kg per year (approximately 0.8 kg/km/year based upon 30 kg per month for the GTP)
	Waste oils and greases	Collected and transported by a licensed contractor for recycling where possible	100 L per year (estimate 10 L per km)
	Packaging	General waste for disposal at a licensed landfill	30 kg per year (approximately 3.6 kg/km/year based upon 30 kg per week for entire pipeline)
Cleaning of pipeline - pigging (if undertaken in the future)	Pipe cleaning waste (pigging grit - scale, rust, or other foreign material)	Pigging grit - licensed contractor to transport regulated waste to a licensed regulated waste landfill	200 L of pigging grit per year (approximately 20 L / km)
Spills of hydrocarbon based material	Potential hydrocarbon contaminated soil from spills oils and greases	Remediation in situ for small quantities. Advice sought from DEHP regarding treatment options for larger spills (eg >200 L) Removal of soil under disposal permit for remediation or disposal at suitably licensed facility	No waste materials are expected be generated
Offices, crib room/s, site amenities along pipeline	Office waste – paper, cardboard packaging Kitchen waste Rubbish bin waste in facilities (ie paper towels) First aid waste Kitchen and amenity wastewater	Recyclable material to recycling facility (where available) Residual material local licensed landfill Wastewater from crib rooms and amenities will be hauled via vacuum truck and disposed at a local WWTP	30 kg per year recyclable material and general waste (approximately 3.6 kg/km/year based upon 30 kg per week for entire pipeline) Small quantities of wastewater are expected. Portable amenities to be serviced weekly when in use

[2] Estimated operational waste quantities are based on proportions

Table 5.8 Waste generated from Curtis Island GTP operations

Curtis Island GTP operation activity	Waste generated	General management principle	Estimate of waste quantity/rate
Vegetation maintenance of the ROW	Green waste – felled/ trimmed vegetation and plant matter to maintain designated maximum vegetation heights	Green waste is to be chipped/mulched and reapplied to ROW for weed suppression	Nil as reapplied to ROW (quantity dependent upon soil type and weather conditions)
Maintenance of Curtis Island GTP ROW pipeline valves, delivery and metering stations	Filters (non-oily, oily and gas)	Collected and transported by a licensed contractor for recycling or disposal to regulated waste landfill	Less than 5 kg per year (approximately 0.8 kg/km/year based upon 30 kg per month for the GTP)
	Waste oils and greases	Collected and transported by a licensed contractor for recycling where possible	50 L per year (estimate 10 L per km)
	Packaging	General waste for disposal at a licensed landfill	20 kg per year (approximately 3.6 kg/km/year based upon 30 kg per week for entire pipeline)
Cleaning of pipeline - pigging (if undertaken in the future)	Pipe cleaning waste (pigging grit - scale, rust, or other foreign material)	Pigging grit - licensed contractor to transport regulated waste to a licensed regulated waste landfill	100 L of pigging grit per year (approximately 20 L / km)
Spills of hydrocarbon based material	Potential hydrocarbon contaminated soil from spills oils and greases	Remediation in situ for small quantities. Advice sought from DEHP regarding treatment options for larger spills (eg >200 L) Removal of soil under disposal permit for remediation or disposal at suitably licensed facility	No waste materials are expected be generated
Offices, crib room/s, site amenities along pipeline	Office waste – paper, cardboard packaging etc Kitchen waste Rubbish bin waste in facilities (ie paper towels etc) First aid waste Kitchen and amenity wastewater	Recyclable material to recycling facility (where available) Residual material local licensed landfill Wastewater from crib rooms and amenities will be hauled via vacuum truck and disposed at a local WWTP	20 kg per year recyclable material and general waste (approximately 3.6 kg/km/year based upon 30 kg per week for entire pipeline) Small quantities of wastewater are expected. Portable amenities to be serviced weekly when in use

5.3 Decommissioning waste

The rehabilitation of the Project disturbance footprint is not expected to generate large volumes of waste. The GTP is expected to be operational for a period of 42 years.

Prior to final decommissioning or abandonment of any facilities associated with the GTP, GLNG Operations will investigate potential environmental issues and impacts associated with decommissioning or abandonment. Infrastructure that is no longer required for the operation of the GTP will be decommissioned or abandoned in accordance with the regulatory requirements and accepted management environmental practice of the day.

Prior to the decommissioning of the GTP, a detailed assessment of the types and quantities of waste materials that could be expected will be conducted.

It is likely that above ground materials such as signs and some fencing would be disposed of in accordance with the principles of the waste and resource management hierarchy.

6. Environmental Values and Potential Impacts

6.1 Environmental values

Existing environmental values that may be impacted by the generation of waste as a result of the Project include:

- Life, health and wellbeing of people and the community
- Diversity of ecology and associated ecosystems
- Land use capability, having regard to economic considerations
- Management of finite resources

The Project will create liquid, solid and gaseous wastes as a result of the construction, operation and decommissioning phases of the GTP ROW. Typical wastes that will be generated include regulated, general, recyclable and inert waste.

The management of waste in accordance with the waste and resource management hierarchy and the relevant State and Commonwealth legislation and standards, will reduce the risk of harm to staff, community and the environment. The potential impacts include the following:

- Water (surface water, marine environment and groundwater) contamination from unsuitable storage, handling, spills and disposal of solid and liquid wastes
- Land contamination from spills during handling and transportation of liquids and solid waste
- Increased occurrences of vermin due to unsuitable storage and handling of putrescible wastes
- Wasteful use of finite resources
- Adverse effects to flora and fauna

6.2 Potential adverse or beneficial impacts associated with waste management

Table 6.1 details the potential impacts of the waste management activities associated with the Mainland GTP, the Marine Crossing GTP and the Curtis Island GTP ROW and associated construction activities. Further details of the existing environmental values of the Project that have the potential to be affected by waste are provided in this WMP (refer Table 6.1).

Table 6.1 Summary of impacts on the environmental values associated with the Project

Aspect/source/activity	Potential impacts
Inappropriate waste management and disposal	Soil, groundwater, surface water contamination, ambient air quality impact, marine environment degradation
Construction camp wastewater disposal	Habitat degradation to wetlands or waterways. Soil, groundwater and surface water contamination; health and safety risks
Disposal of treated wastewater effluent, wastewater and other liquid wastes from project-related sources (eg construction camps, equipment washdown stations)	Reduced water quality (particularly suspended solids/ turbidity, nutrients and microbiological contaminants) with potential reduction in: • Suitability of water for drinking • Potential contamination of surface water and/or groundwater
Spillage of oil/fuel/chemical during transport, storage, handling or refuelling	Loss of oil/fuel/other hazardous material to air, surface water, marine environment, groundwater, soil and/or sediment with consequent adverse impacts on associated quality and beneficial values

Aspect/source/activity	Potential impacts
Spillage of hazardous materials during transport, storage, handling and use	Loss of hazardous material to air, surface water, marine environment, groundwater, soil and/or sediment with consequent adverse impacts on associated quality and beneficial values
Tunnel spoil and grout from TBM	Soil, groundwater, marine environment and surface water contamination; health and safety risks
Spill during transfer of liquid and solid waste on/off barge	Release of hazardous material to terrestrial and marine environment resulting in adverse environmental and health effects
Hydrotest water discharge	Accidental release of hydrotest water may impact on, surface water, drinking water, terrestrial and marine aquatic habitat quality, temporary loss of land use for economic use, due to excessive erosion

7. Activity Specific Waste Management Requirements

7.1 Temporary pipe receiving areas

A waste management area will be allocated at the Port Alma temporary pipe receiving area for storage of waste and recyclable material. On an as needs basis, recyclable material and waste will be collected by the WMRC for dispatch to Rockhampton's MRF for recycling and landfill disposal in Rockhampton, respectively.

A waste management area will be allocated at the Gladstone Port Lot 300 temporary pipe receiving area for storage of waste and recyclable material. On an as needs basis, recyclable material and waste will be collected by the WMRC for dispatch to recycling markets and landfill disposal respectively.

7.2 Temporary pipe storage sites

The temporary pipe storage sites will be primarily used for pipe and some equipment storage. Waste materials generated at these locations will be collected and transported daily by the Construction Contractor's personnel for sorting and segregation into the appropriate storage containers or bins at the construction camp waste storage area.

Portable site amenities at these sites will be provided and these will be serviced on a regular basis. Wastewater from the portable amenities will either be hauled to the nearest construction camp wastewater treatment plant for treatment or to a local Council operated WWTP if accepted for disposal by the relevant local authority.

7.3 ROW

All personnel will be responsible for collecting and transporting all solid waste from the ROW daily to the waste and recyclables storage area at the construction camps. A WMRC will be responsible for collecting solid waste and recycling materials from waste and recyclables storage area at the construction camps on a regular basis and transporting the waste materials to the recycling or disposal destination.

Green waste and excavated material will be reused within the ROW during rehabilitation. Steel pipe off cuts, packaging and general waste will be collected by the Construction Contractor's personnel and transported to the construction camp waste storage area at the end of the working day. The Construction Contractor's personnel will sort the ROW waste materials into bins (or containers) for recyclable materials such as metals, cardboard and plastics, regulated waste or general waste. On a regular basis the waste and recyclables from the waste management areas will be transported offsite by the WMRC either for transfer to the WMRC's depot for aggregation with other waste or recyclable materials, or transported to a disposal facility in accordance with the principles of the waste and resource management hierarchy.

7.4 Vehicle wash down facilities

It is anticipated that there will be 11 access points from public roads provided to the GTP ROW. The ROW access points will be located to optimise vehicle movements and to meet the requirements of the PWMP (document number 3380-GLNG-3-1.3-0006).

A vehicle washdown facility will be located at each of these access points for the purpose of removing mud and weed seeds as part of weed management control measures. It is anticipated that on average 1 m^3 of mud and silt material will accumulated in each sump per week.

A licensed WMRC will remove the washdown facility sludge and dispose to an appropriately licensed facility.

7.5 Hydrotesting

The water from hydrotesting will be reused along the length of the GTP to reduce the amount of water to be managed. Given that raw water will be used, it is considered unlikely that any additional chemicals (eg oxygen scavengers or biocides) will be added. If chemicals are used, they will be biodegradable. Chemicals that are unsuitable for release to land will not be used. Hydrotest water will be transferred from one test section to another via a break tank.

The preferred method to dispose of the hydrotest water is to release it directly to land, away from watercourses. All hydrotest water released to land will be tested and will comply with discharge limits as per the Environmental Authority Conditions for the Gas Pipeline – Schedule C, Table 1. Hydrotest water will be tested and managed as described in Section 8 and as per the DHWLRMP. The hydrotest water management procedures will aim to maximise the efficiency of testing, taking into consideration the timing of construction and commissioning, and will follow good environmental practice. Release of hydrotest water to land will only occur where an assessment of water quality meets relevant criteria and relevant approvals have been obtained.

Hydrotest water will be released to land at locations in accordance with the relevant environmental authority conditions. Written consent of the administering authority must be obtained if hydrotest water containing chemical additives is proposed to be released to land.

7.6 Construction camps

The construction camps will generate general putrescible wastes along with recyclables, sewage, grey water and other wastes.

An area at each of the construction camps will be set aside for storage of waste materials which are to be recycled or reused. The waste storage area will receive waste and recyclable material from the:

- Accommodation and kitchen facilities
- Offices
- Vehicle workshop
- Prefabrication workshop
- Warehouse
- ROW and temporary pipe storage sites

All bins will be serviced by the WMRC . Separate bins will be provided for general waste, waste metal, oily waste (rags and absorbent material), batteries, tyres, regulated waste and items for recycling. Likewise an area will be set aside for a bunded waste oil tank.

7.6.1 Wastewater treatment plants in construction camps

Each construction camp will have a wastewater treatment system installed capable of treating the maximum amount of effluent generated from the construction camp and associated workshops and offices.

Emphasis will be placed on the reduction and re-use of effluent onsite. Each construction camp will adopt the principles of the waste and resource management hierarchy to minimise the wastewater quantities generated (where possible) through education and adoption of water efficient equipment and machinery.

Wastewater collection systems will segregate the wastes. Sanitary waste from various sources will be directed to a wastewater treatment plant. Once the wastewater has been treated to the relevant effluent standard, it will be used for irrigation or disposed of to a licensed facility. If the effluent is to be irrigated to land a disposal system will consist of a fenced (sediment fencing and bund), vegetated area, where treated effluent will be irrigated above-ground. Sludge from wastewater treatment facilities will be removed as required to a licensed facility.

7.7 Tunnel boring

Tunnel boring waste includes tunnel spoil and out of specification grout and TBM waste includes oily wastes. A waste storage area at the construction site pad (mainland) and construction site pad (Curtis Island) will be provided for storage of general waste and any regulated waste.

Tunnel spoil will be temporarily stored in an area located in the construction site pad and periodically transported by road for re-use on another site as rehabilitation material in accordance with the relevant site's acceptance criteria as per their environmental approval. Prior to transfer to the reuse site, samples of tunnel spoil will be collected and submitted for laboratory analysis to confirm whether the tunnel spoil complies with the site's approval conditions.

7.8 Transport of project related waste

Traffic movements associated with the WMRC's vehicles have been addressed in the Road Use Management Plan (RUMP).

Waste and recyclable materials will be moved on a daily basis from all construction accommodation camps during the construction phase.. Waste materials will be transported by Saipem personnel from the point of generation on the ROW and transported to the closest waste storage areas located within the construction camps.

During operation waste and recyclable materials will be removed on a daily basis by GLNG Operations personnel and transported to the relevant waste storage area within GLNG's depot and holding yard.

From there the waste material will be consolidated prior to collection for recycling or disposal. The existing network of state and regional council controlled roads, as well as the ROW will be used by waste collection vehicles to collect and transport the waste and recyclables.

The WMRC will identify and confirm the proposed haulage routes (refer Figures 1, 2 and 3) and potential issues associated the collection and haulage of waste and recyclable materials. Haulage route and site access procedures will be prepared and implemented by the

Construction Contractor in order to minimise impacts, the procedures will be developed with regard to the Project's RUMP. This plan will also detail the proposed destinations for the waste and recyclable materials. All waste vehicles travelling to and from the Project sites will follow dedicated heavy vehicle routes to avoid built-up areas. The WMRC, where practicable, will limit vehicle movements to daytime working hours.

Waste deemed as regulated or dangerous will be transported along preferred routes in accordance with the *Australian Code for the Transport of Dangerous Goods by Road and Rail*, and in accordance with the *Queensland Transport Operations (Road Use Management – Dangerous Goods) Regulation 1998* and the *Transport Infrastructure Act 1994* and the EP Reg.

7.8.1 Waste tracking

Regulated waste which is transported by road and barge is required to be accompanied by a Waste Transport Certificate stating the nature of the waste and any associated hazard in accordance with the EP (WM) Reg. A licensed WMRC will collect and transport the Project waste. The following requirements will be implemented for the Project waste-tracking system:

- Provide tracking of wastes of environmental concern from production to disposal, with the aim of ensuring that Project waste is disposed in an environmentally appropriate manner
- Ensure that only those licensed facilities that have adequate treatment and disposal methods receive wastes
- Promote responsibility to reduce the risk of illegal dumping and establish a system of accountability

The types of trackable wastes and instructions for completing the Waste Transport Certificate are outlined in the EP (WM) Reg.

7.8.2 Non-trackable waste

Non-trackable waste associated with GTP Project will be identified and basic waste shipment information will be recorded for the purpose of recording project waste quantities and monitoring compliance with this WMP.

This information will be stored by the WMRC for the purposes of recording Project waste quantities and monitoring compliance with this WMP. Table 7.1 provides an example of a waste shipment record for non-regulated/non-trackable waste shipments.

Table 7.1 Example of waste shipment record

Information to be recorded on each waste shipment	
Type of waste	
Date waste collected	
Quantity of waste (L, kg, number of bags, size of container)	
Waste transportation certificate number (only if trackable waste)	
Waste collection contractor name	
Vehicle driver name	
Vehicle transporting waste from project site	
Destination of waste	

Information to be recorded on each waste shipment	
Recipient names (company or site)	
Other details or comments	
Transporters signature	

7.9 Waste inductions and training

All construction personnel associated with the Project will be required to complete an induction. The induction training should incorporate relevant aspects of this WMP and cover an individual's personal obligations with regard to the management procedures for all waste items and materials. This training will outline the importance of managing waste materials in accordance the principles of the waste and resource management hierarchy. A list of employees and dates that training was provided will be recorded for the purpose of demonstrating Project training compliance with this WMP.

7.10 Waste chemical and hazardous materials management

The Project will require the use of chemicals and hazardous materials and will therefore generate waste chemicals and hazardous waste.

Chemical and hazardous wastes associated with the Project will be handled and stored in accordance with the State and Commonwealth legislation (refer Table 2.1) and Australian standards and guidelines (refer Table 2.2). This will include the separate storage of waste chemicals in containers at designated storage areas within construction camps, construction site pads and GLNG Operation's depot . Table 7.2 provides a list of likely chemicals and hazardous materials to be used during the Project construction phase including relevant activity and likely storage location.

Table 7.2 Likely chemical and hazardous materials during construction

Chemical/hazardous material	Activity	Likely storage location
Diesel	Fuel for construction vehicles and machinery and diesel generators at construction camps and offices	Storage tanks located at construction camps Up to a total storage capacity 90,000 L at each construction camp (3 x T30 fuel tanks (30,000 L each))
	Fuel for tunnel boring machine generator and associated equipment	Construction site pad (mainland) and construction site pad (Curtis Island)
Fuel dispenser pump and storage (gasoline) Fuel dispenser pump and storage (diesel)	Fuelling facilities for vehicles at the Marine Crossing GTP section and the Curtis Island GTP section	Diesel and petrol fuel storage on the construction site pad (mainland) and construction site pad (Curtis Island)
Fertiliser	Translocation of plants and restoration of the ROW	Construction camps storage area and Gladstone
Herbicides (chemicals registered for the specific weed to be controlled)	Chemical spraying of weeds	Brought to site by Weed Control Contractor only during weed control activities
Rigid Polyurethane foam (Aptane P220/Isocyanate B900)	Foam trench breakers and foam pillow installation – to hold the pipe off the trench invert (alternative material - sand bags)	Specialist subcontractors will be engaged to mobilise foam components to site in storage

Chemical/hazardous material	Activity	Likely storage location
		containers on vehicles. Subcontractors will provide the Construction Contractor and the WMRC with documentation regarding storage, handling and disposal arrangements prior to bringing to site
Oils and greases	In field vehicle servicing and maintenance of construction vehicles and equipment Major Note: major repair and maintenance of construction equipment will occur at the Preventative Vehicle Maintenance workshopat the temporary maintenance workshop at each of the construction camps. HDD	Construction camp and Gladstone Logistic Base Designated storage area in suitably sized tanks within appropriately bunded compounds as per AS1940 at the construction camps and Marine Crossing GTP Project construction site pads (mainland and Curtis Island) HDD drilling pad
Waste oil	Minor repairs and maintenance of construction equipment during infield servicing and maintenance – minor servicing only at the ROW. Other servicing at the Preventative Vehicle Mmaintenance workshop within the construction camps and Gladstone Logistic Base	All waste oils will be collected and stored within appropriately sized bunded storage containers within construction camps, construction site pad (mainland) and construction site pad (Curtis Island)
Emulite (bottom charge)	Blasting	Specialist subcontractors will be engaged to mobilise blasting materials to site. Handling, storage requirements and disposal methods to be documented by the blasting contractor ie AS 2187
Prillite (column charge) Nonel U175 or U500 detonators, Nonel UB,42 UB17, UB25 Paint	Blasting Painting welds and pipe coating defects	Specialist subcontractors will be engaged to mobilise blasting materials to site. Handling, storage requirements and disposal methods to be documented by the blasting contractor ie AS 2187 Hazardous materials storage area at the construction camps, construction site pad (mainland) and construction site pad (Curtis Island)/Gladstone Logistic Base Storage area at construction camps/Gladstone Logistic Base Storage area at construction camps/Gladstone Logistic Base

Chemical/hazardous material	Activity	Likely storage location
		Storage area at construction camps/Gladstone Logistic Base Storage area at construction camps/Gladstone Logistic Base Contained in pipe crawler machine. Pipe crawler located (ROW) or parked in equipment storage area at the construction camp/Gladstone Logistic Base Specialist subcontractor will maintain documentation and certificates to transport these materials to site and be responsible for handling, storage requirements and identification of disposal methods Darkroom, containing the necessary film processing equipment, will be located at the construction camps/Gladstone Logistic Base Specialist subcontractor will maintain documentation and certificates to transport these materials to site and be responsible for handling, storage requirements and identification of disposal methods
Fusion bond epoxy powder	Coating for welded field joints	Hazardous materials storage area at the construction camps, construction site pad (mainland) and construction site pad (Curtis Island)
Polyurethane-tar coating compound	Field joint coating	
Oxygen scavenger	Chemical dosing during Hydrotesting	Construction site pads in secure containers as per Australian Standards
Biocide Radioactive isotope/ material/ element within weld inspection device (pipe crawler)	Hydrotesting Weld inspection activities Non-destructive testing (NDT) X-ray films development for weld quality assurance	
Drilling additives - polymers	Tunnel spoil	
Water treatment chemicals – aluminium sulphate, sulphuric acid	WTP	Hazardous materials storage at the construction site pad (mainland)
Lime	ASS treatment	Hazardous materials storage at the construction site pad (mainland)

Table 7.3 provides a list of likely chemicals and hazardous materials to be stored and used during the operation of the GTP, along with the relevant activity and proposed storage location.

Table 7.3 Likely chemical and hazardous materials during operation

Chemical/hazardous material	Activity	Likely storage location
Lubricants	Maintenance of mainline valve stations	GLNG Operations headquarters in Gladstone
Solvents	Cleaning pigging equipment and sumps	
Oils and greases	Maintenance of equipment for pipeline maintenance	

8. Proposed environmental protection commitments, objectives and control strategies

Waste material generated as a result of the Project construction and operation activities will be managed in accordance with the principles of the waste and resource management hierarchy as described in Section 3.2 and in accordance with the Queensland Waste Reduction and Recycling Strategy 2010 – 2020 (DERM, 2010).

The following environmental protection commitments, objectives and control measures for each aspect of the Project have been described for the following areas:

- Waste management
- Hydrotest water
- Chemicals and hazardous materials

8.1 Waste management – Mainland GTP and Curtis Island GTP

Table 8.1 details the environmental protection objectives, control strategies and performance indicators for the waste management objectives detailed in Section 6 above.

8.1.1 Waste management

Table 8.1 Environmental protection commitments, objectives and control strategies for general waste

Item	Detail
Environmental protection objective	• The GTP construction adheres to the waste management hierarchy of avoid, reuse, re-use and recycle. Where this is not possible, waste is disposed of in the most appropriate manner
Specific objectives	• No inappropriate disposal or management of waste • No contamination of soil, air or water as a result of waste handling • Petroleum activities do not result in the release or likely release of contaminants to the environment from the storage, conditioning, treatment and disposal of regulated waste materials
Control strategies	**General** • Prior to commencement of works, the appropriate methods for disposal of waste will be determined by consultation with the relevant administrating authorities and DEHP • A waste management plan in accordance with the WRR Act will be implemented including: – The types and amounts of waste generated – How the waste will be dealt with, including a description of the types and amounts of waste that will be dealt with under each of the waste management practices mentioned in the waste management hierarchy (Section 9 of the WRR Act) – Procedures for dealing with accidents, spills and other incidents that may impact on waste management – How often the performance of the waste management practices will be assessed (ie at least annually) – The indicators or other criteria on which the performance of the waste management practices will be assessed • On completion of each section of pipeline, all waste material will be removed from the workplace. No wastes will be buried or disposed of on-site without local government and/or DEHP approval • The Construction Contractor will advise designated disposal areas for each section of the ROW

Item	Detail

- All welding waste will be managed appropriately and removed from the GTP Project area on a daily basis
- General waste will be collected and transported generally to local council approved disposal sites
- Food wastes will be collected, where practicable, considering health and hygiene issues, for disposal off-site
- All waste/rubbish will be correctly disposed of and will not pose a risk to marine fauna. Plastic bags will be banned from all site offices and project areas within the coastal zone (intertidal and marine zones)
- Refuse containers will be located at each worksite
- Where practical, wastes will be segregated and reused / recycled (eg scrap metal)
- All personnel will be instructed in project waste management practices and procedures as a component of the environmental induction process
- Suppliers will be requested to minimise packaging where practicable
- Emphasis will be placed on housekeeping and all work areas will be maintained in a neat and orderly manner
- All equipment and facilities will be maintained in a clean and safe condition

Liquid waste

- Wastewater from construction, cleaning and testing operations will be treated and managed in accordance with the relevant environmental authorities
- Sewage or grey water will either be collected for treatment and disposal off-site or treated via an on-site treatment system and disposed of to effluent absorption beds or irrigation fields, with treated sewage effluent generally to be disposed of by irrigation
- The treatment method will be selected in consultation with a relevant local authority and DEHP and the relevant environmental authority obtained
- Prior to commencement of works, the Construction Contractor must determine from all relevant local governments, any additional upgrades of sewerage or waste disposal facilities required as a result of this project's requirements for workers' accommodation and meet any costs associated with these upgrades
- Prior to discharge of wastewater to land, the Contractor must submit a copy of the Wastewater Irrigation Management Plan (WIMP) to GLNG Operations within a sufficient timeframe to obtain approval from the administering authority allowing for review and comment and having due regard to that comment in the finalisation of the plan
- The release of contaminants from the sewage treatment plant to land must comply, at the sampling and in situ monitoring point(s) with each of the limits specified in Table 1 for each quality characteristic

Table 1 Release quality characteristics for discharge to land

Quality characteristics	Release limit	Limit type	Monitoring frequency
Total-N	3 mg/l	50 percentile Compliance	Weekly
Total-N	10 mg/l	Maximum	Weekly
Total-P	0.1 mg/l	50 percentile Compliance	Weekly
Total-P	1 mg/l	Maximum	Weekly
Ammonia-N	1 mg/l	50 percentile Compliance	Weekly
5-day Biochemical Oxygen Demand	<5 mg/l	80 percentile Compliance	Weekly
Suspended Solids	<5 mg/l	80 percentile Compliance	Weekly
pH	6.5 – 8.0	Range	Daily
Faecal Coliforms	5 colonies per 100 ml sample	Geometric Mean	Weekly

Item	Detail
	• The effluent released must not have any properties nor contain any organisms or contaminants in concentrations which are capable of causing environmental harm or an environmental nuisance • Signage must be placed around the land irrigation area and irrigation equipment warning the public that the area and equipment has been set aside for irrigation by treated effluent, which is not to be used for drinking purposes. The signs must be maintained in a visible and legible condition • Any treated effluent irrigation area must not be used for: – Recreational activities or as a traffic thoroughfare during irrigation – Any activity which may involve members of the public or employees without appropriate personal protective equipment coming in contact with treated wastewater during irrigation periods and for at least four hours after irrigation has ceased or until irrigated vegetation has dried • Sufficient wet weather storage should be provided for a 3 month period • When weather conditions or soil conditions preclude the irrigation of treated effluent, the treated effluent must only be discharged at nomination locations as per environmental authority • Treated sewage effluent must not be irrigated when weather or soil conditions would cause run-off or ponding of any irrigated wastewater • The amount of treated sewage effluent irrigated must be matched to the water requirements of the vegetation irrigated, without exceeding a reasonable estimation of the field capacity of the soil, in the root zone, in the irrigation area • The rate of application of treated sewage effluent to the release area must not exceed the capacity of the soil in the contaminant release area to absorb it • The irrigation of treated effluent must be carried out with a sufficient buffer distance to comply with all environmental conditions and requirements (eg contaminants release, Air quality) • Treated effluent will not be released to other parties for irrigation without written permission from GLNG Operations. The quality of the treated effluent released to other parties for the purpose of irrigation must comply, at the sampling point specified, with each of the release limits specified in Table 2 • Copies of agreements to supply treated sewage effluent from the Sewage Treatment Plant for the purpose of irrigation must be forwarded to GLNG Operations in a sufficient timeframe to be approved by administering authority • The Contractor must prepare a Wastewater Irrigation Management Plan (WIMP) as part of the EMP. The WIMP is to be developed in accordance with the "Interim Guidelines for the Reuse of Reclaimed Wastewater in Queensland, 1996" produced by the Department of Natural Resources or the "Draft National Guidelines for Sewerage Systems: Reclaimed Water" endorsed by National Health and Medical Research Council (NHMRC) in 2000. The WIMP should address at least, but not be limited to, the following matters: – The measurement of the quantity and quality of treated effluent produced by the activity – An assessment of the suitability of the area of land available for wastewater irrigation – The definition and clear identification of areas to be used for wastewater irrigation – Carrying out daily time step modelling (using MEDLI or similar) to estimate at least wastewater irrigation application rates, the wastewater irrigation area required and the volume of wet weather storage required, taking into account at local tropical climatic conditions, soils in the wastewater irrigation area and the vegetation grown in the wastewater irrigation area – An assessment of surface waters, including stormwater, that may be affected – An assessment of the characteristics of the soils in the wastewater irrigation area including assessment of nutrient and salt levels of the soils in the disposal area and how soils will be managed – An assessment of the potential impacts of odour resulting from wastewater irrigation – Management of human and fauna health issues associated with the irrigation of

Item	Detail
	wastewater • Sewage treatment plants associated with temporary workers' accommodation must be located above Q50 flood levels • The plant and equipment used for sewage treatment or disposal will be installed, maintained and operated in a proper and efficient manner by a suitably qualified and experienced person • Sewage effluent absorption beds and/or irrigation fields will be selected and designed to ensure that: – Sensitive areas are avoided – Soil erosion and soil structure damage is avoided to the extent possible – There is no ponding or runoff of effluent – The receiving environment has the capacity to assimilate the contaminants – There will be no discharge of treated effluent from wet weather storage to any waters • Flammable and combustible liquids (including petroleum products and associated piping and infrastructure), must be stored, handled and maintained in accordance with the latest edition of Australian Standard 1940 - the Storage and Handling of Flammable and Combustible Liquids • Any liquids stored on site that have the potential to cause environmental harm must be stored in or serviced by an effective containment system that is impervious to the materials stored and managed to prevent the release of liquids to waters or land. Where no relevant Australian Standard is available, the following must be applied: – Storage tanks must be bunded so that the capacity and construction of the bund is sufficient to contain at least 110 % of a single storage tank or 100 % of the largest storage tank plus 10 % of the second largest storage tank in multiple storage areas – Drum storages must be bunded so that the capacity and construction of the bund is sufficient to contain at least 25 % of the maximum design storage volume within the bund **Hazardous waste** • Chemical wastes will be collected in 200 L drums (or similar sealed container) and appropriately labelled for safe transport to an approved chemical waste depot or collection by a liquid waste treatment service • Storage, transport and handling of all chemicals will be conducted in accordance with all legislative requirements • Containment bunds and/or sumps will be drained periodically to prevent overflow and subsequent pollution of the surrounding land and/or water body • All hazardous wastes will be appropriately stored in bunded areas away from watercourses and in accordance with legislative requirements • Where no Australian Standard is available, any liquid with potential to harm the environment will be: – Stored in impervious bunded tanks with bunded capacity at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas – Impervious drum storage must have a bunded capacity to contain at least 25% of the maximum design storage volume within the bund • Hazardous wastes, such as solvents, rust proofing agents and primers will be managed in accordance with the requirements of relevant legislation and industry standards • A hazardous materials inventory will be prepared • Material Safety Data Sheets (MSDS) for hazardous materials will be available at all work sites • Hydrocarbon wastes, including lube oils, will be collected for safe transport off-site for reuse, recycling, treatment or disposal at approved locations

Item	Detail
	• As soon as practicable remove and dispose of all regulated waste to a licensed waste disposal facility or recycling facility • All regulated waste removed from the site must be removed by a person who holds a current authority to transport such waste under the provisions of the EP Act and sent to a facility licensed to accept such waste • When regulated waste is removed from within the boundary of the petroleum tenure and transported by the holder of this authority, a record must be kept of the following: – Date of waste transport – Quantity of waste removed and transported – Type of waste removed and transported – Route selected for transport of waste – Quantity of waste delivered – Any incidents (eg spillage) that may have occurred on route • If a person removes regulated waste associated with activities within the operational land and disposes of such waste in a manner which is not authorised or is improper or unlawful then, as soon as practicable, the administering authority will be notified of all relevant facts, matters and circumstances known concerning the disposal • If a hazardous contaminant is released to waters or land the following steps must be taken: – Take immediate action to stop any further release and make sure that the area is safe – 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 – Ensure that all health risks associated with the disposal and reuse of treated sewerage is mitigated through appropriate primary and secondary treatment
Performance indicators	• No inappropriate disposal or management of waste • No contamination of soil, air or water as a result of waste handling

8.1.2 Hydrotest water

Table 8.2 details the environmental protection objectives, control strategies, monitoring and reporting requirements for the management of hydrotest water.

Table 8.2 Environmental protection commitments, objectives and control strategies for hydrotesting

Item	Detail
Environmental protection objective	• The quality of local land and water resources during pipeline hydrotesting is protected
Specific objectives	• Appropriate permits obtained prior to drawing water • No existing water sources unsustainably depleted to provide hydrotesting water • No adverse impacts on soil or surface water as the result of discharging hydrotesting water
Control strategies	• Relevant permits to draw water obtained • Hydrotest water will be re-used on multiple and adjacent pipeline sections as much as possible to reduce actual volumes used • Pipe sections crossing water bodies will be tested prior to installation • Inspection of all pipeline section welds, or hydrotesting of pipeline sections before installation under water bodies, will be performed in accordance with construction specifications/procedures • Biocides, where required, will be biodegradable • Where biocides are added, discharge water will be aerated • The Contractor will prepare a (DHWLRMP prior to commencement of construction works for the Project. The HWMP will include: – A detailed assessment of impacts from hydrostatic test water along the pipeline route including source water quality data and characteristics of additives, particularly biocides – Proposed storage, treatment and disposal methods of hydrotest water – Site specific mitigation measures for management of hydrotest water including monitoring and reporting – Determination of whether testing of the hydrotest water is necessary and submit a plan for review to GLNG Operations. Where the water source and water quality is known, and no chemicals have been added, water quality testing may not be required • Hydrostatic test water, including a detailed assessment of impacts from hydrostatic test water along the pipeline route, will be provided. Source water quality data and characteristics of additives, (particularly biocides) will be provided along with the proposed storage, treatment and disposal methods. The information will be used to determine the site specific mitigation measures including monitoring and reporting • Hydrotest water will be treated as necessary and then disposed of such that it does not enter into any watercourses or run in an uncontrolled manner onto open land. Where water cannot be discharged to ground, other options will be considered to ensure compliance with all regulations • Hydrotest water will be released at least 100 m from any watercourse such that vegetation and soil structure are not damaged or eroded and the quality of groundwater is not adversely impacted • Discharge of hydrotesting water will comply with all regulatory and landholder requirements • Where hydrostatic test water is proposed to be released to land, it will not exceed the water quality limits specified in Table 1: Water Quality Limits. Hydrostatic test water containing chemical additives must not be released to land without written consent from GLNG Operations and the administering authority

Item	Detail
	Table 1 Water quality limits

Parameter	Maximum value
pH	6.5-8.5 (Range)
Arsenic (mg/L)	2.0
Cadmium (mg/L)	0.05
Chromium (mg/L)	1
Copper (mg/L)	5
Iron (mg/L)	10
Lead (mg/L)	5
Manganese	10
Zinc (mg/L)	5
Nitrogen (mg/L)	35
Phosphorus (mg/L)	10
Electrical Conductivity (uS/cm)	2000

Item	Detail
Performance indicators	• Appropriate permits are obtained prior to drawing water • No existing water sources unsustainably depleted to provide hydrotesting water • No adverse impacts on soil or surface water as the result of discharging hydrotesting water

8.1.3 Chemical and hazardous materials

Table 8.3 Environmental protection commitments, objectives and control strategies for chemical and hazardous materials management

Item	Detail
Operational policy or management objective	• Storage and handling of chemicals and dangerous goods does not cause environmental harm or harm to persons
Performance criteria	• Petroleum activities do not result in the release or likely release of a hazardous contaminant to the environment • Storage and handling procedures correct and appropriate • Chemicals stored in secure areas • All containment systems must be designed to minimise rainfall collection within the system
Control strategies	• Spill control procedures will be prepared and personnel trained • Dangerous goods will be stored and handled as per the requirements of relevant Australian Standards • Areas where contaminants or wastes are stored or handled will be minimised or roofed • Dangerous goods will, where appropriate (eg outside locations), be stored in bunded areas away from watercourses • Stormwater will be diverted around disturbed areas and areas where contaminants or wastes are stored or handled • All explosives, hazardous chemicals, corrosive substances, toxic substances, gases and dangerous goods must be stored and handled in accordance with the relevant Australian Standard • Explosives will be stored in magazines constructed and located as prescribed in AS 2187

Item	Detail
	• Where no Australian Standard is available, any liquid with potential to harm the environment will be – Stored in impervious bunded tanks with bunded capacity at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas – Impervious drum storage must have a bunded capacity to contain at least 25% of the maximum design storage volume within the bund • Stormwater runoff and rainfall events will be collected, treated, reused or released in accordance with environmental and legal requirements • Material safety data sheets for chemicals and dangerous goods will be available on-site • Waste dangerous goods, which cannot be recycled, will be transported to a designated disposal site as approved by the local authority • Any spillage of hazardous waste or other contaminants that may cause environmental harm, will be effectively contained and cleaned up as quickly as practicable. Such spillage must not be cleaned up by hosing, or otherwise thereby releasing such waste or contaminants to any land or waters • Spillages must be cleaned up using dry methods that minimise the release of wastes, contaminants or materials to any stormwater drainage system, roadside gutter or waters • Spills of dangerous goods will be rendered harmless and collected for treatment and disposal at a designated site, including cleaning materials, absorbents and contaminated soils • Hydrocarbon spillage from storage areas, diesel and chemical spills from construction equipment, and industrial waste spill will be contained, reported, and treated/remediated in accordance with appropriate legislative and regulatory agency requirements. Drainage will be reinstated • Absorbent and containment material (eg absorbent matting) will be available where hazardous materials are used and stored and personnel trained in their correct use • Protective clothing, appropriate to the materials in use, will be provided • Relevant permits will be held and conditions of permits met • Servicing of equipment/machinery will not be permitted on the ROW without prior authorisation from GLNG Operations. All planned services for all equipment is to occur in an approved workshop
Performance indicators	• No hazardous goods contamination of the environment • Storage and handling procedures are correct and appropriate • Chemicals are stored in secure areas • All containment systems are designed to minimise rainfall collection within the system

8.2 Waste management control strategies – Marine Crossing GTP

Table 8.4 details the environmental protection objectives, strategies, monitoring and reporting requirements for the management of construction waste.

8.2.1 Waste management

Table 8.4 Environmental protection commitments, objectives and control strategies for general waste

Item	Outcomes
Environmental protection objective	• The Marine Crossing GTP construction adheres to the waste management hierarchy of avoid, reuse, re-use and recycle. Where this is not possible, waste is disposed of in the most appropriate manner
Specific objectives	• No inappropriate disposal or management of waste • No contamination of soil, air or water as a result of waste handling • Petroleum activities do not result in the release or likely release of contaminants to the environment from the storage, conditioning, treatment and disposal of regulated waste materials

Control strategies	**General**
	• Prior to commencement of works, the appropriate methods for disposal of waste will be determined by consultation with the relevant administering authorities and DEHP
	• A WMP (this plan) has been developed in accordance with the WRR Act and will be implemented. The WMP includes:
	  o The types and amounts of waste generated
	  o How the waste will be dealt with, including a description of the types and amounts of waste that will be dealt with under each of the waste management practices mentioned in the waste and resource management hierarchy (Section 9 of the WRR Act)
	  o Procedures for dealing with accidents, spills and other incidents that may impact on waste management
	  o How often the performance of the waste management practices will be assessed (ie at least annually)
	  o The indicators or other criteria on which the performance of the waste management practices will be assessed
	• On completion of each section of pipeline, all waste material will be removed from the workplace. No wastes will be buried or disposed of onsite
	• The Construction Contractor will advise designated disposal areas for each section of the ROW
	• All welding waste will be managed appropriately and removed from the Marine Crossing GTP Project area on an as required basis
	• General waste will be collected and transported to local council approved disposal sites
	• Food wastes will be collected, where practicable, considering health and hygiene issues, for disposal off-site
	• Refuse containers will be located at each worksite
	• Where practical, wastes will be segregated and reused / recycled (eg scrap metal)
	• All personnel will be instructed in project waste management practices and procedures

Item	Outcomes
	as a component of the environmental induction process • Suppliers will be requested to minimise packaging where practicable • Emphasis will be placed on housekeeping and all work areas will be maintained in a neat and orderly manner • All equipment and facilities will be maintained in a clean and safe condition • All waste/rubbish will be correctly disposed of and will not pose a risk to marine fauna • Plastic bags will be banned from all site offices and project areas within the coastal zone (intertidal and marine zones) **Liquid Waste** • Wastewater from construction, cleaning and testing operations will be treated and managed in accordance with the relevant environmental authorities • The treatment method will be selected in consultation with a relevant local authority and DEHP and the relevant environmental authority obtained • Flammable and combustible liquids (including petroleum products and associated piping and infrastructure), must be stored, handled and maintained in accordance with AS1940 • Any liquids stored on site that have the potential to cause environmental harm will be stored in or serviced by an effective containment system that is impervious to the materials stored and managed to prevent the release of liquids to waters or land. Where no relevant Australian Standard is available, the following will be applied:

	• Storage tanks will be bunded so that the capacity and construction of the bund is sufficient to contain at least 110 % of a single storage tank or 100 % of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas; and
	• Drum storages will be bunded so that the capacity and construction of the bund is sufficient to contain at least 25 % of the maximum design storage volume within the bund
	• Hazardous Waste
	• Chemical wastes will be collected in 200 L drums (or similar sealed container) and appropriately labelled for safe transport to an approved chemical waste depot or collection by a liquid waste treatment service
	• Storage, transport and handling of all chemicals will be conducted in accordance with all legislative requirements
	• Containment bunds and/or sumps will be drained periodically to prevent overflow and subsequent pollution of the surrounding land and/or water body
	• All hazardous wastes will be appropriately stored in bunded areas away from watercourses and in accordance with legislative requirements
	• Where no Australian Standard is available, any liquid with potential to harm the environment will be:
	  o Stored in impervious bunded tanks with bunded capacity at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas
	  o Impervious drum storage will have a bunded capacity to contain at least 25% of the maximum design storage volume within the bund
	• Hazardous wastes, such as solvents, rust proofing agents and primers will be managed in accordance with the requirements of relevant legislation and industry standards
	• A hazardous materials inventory will be prepared

Item	Outcomes
	• Material Safety Data Sheets (MSDS) for hazardous materials will be available at all work sites • Hydrocarbon wastes, including lube oils, will be collected for safe transport off-site for reuse, recycling, treatment or disposal at approved locations • As soon as practicable, all regulated waste will be removed and disposed of to a licensed waste disposal facility or recycling facility • All regulated waste removed from the site will be removed by a person who holds a current authority to transport such waste under the provisions of the EP Act and sent to a facility licensed to accept such waste • When regulated waste is removed from within the boundary of the petroleum tenure and transported by the holder of this authority, a record will be kept of the following: - Date of waste transport - Quantity of waste removed and transported - Type of waste removed and transported - Route selected for transport of waste - Quantity of waste delivered - Any incidents (eg spillage) that may have occurred on route • If a person removes regulated waste associated with activities within the operational land and disposes of such waste in a manner which is not authorised or is improper or unlawful then, as soon as practicable, the administering authority will be notified of all relevant facts, matters and circumstances known concerning the disposal • Hydrotest water will be disposed of in accordance with the DHWLRMP (refer Appendix D) • If a hazardous contaminant is released to waters or land the following steps will be taken: - Immediate action to stop any further release and make sure that the area is safe - 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
Performance indicators	• Waste handling is conducted in a way that minimises contamination of soil, air or water

8.3 Chemical and hazardous materials

Table 8.5 details the environmental protection objectives, relevant control strategies, monitoring and reporting requirements for the management of chemical and hazardous materials.

Table 8.5 Environmental protection commitments, objectives and control strategies for chemical and hazardous materials management

Item	Detail
Environmental protection objective	• Storage and handling of chemicals and dangerous goods does not cause environmental harm or harm to persons
Specific objectives	• Petroleum activities do not result in the release or likely release of a hazardous contaminant to the environment • Storage and handling procedures as per the WMP • Chemicals stored as per the WMP • All containment systems must be designed to minimise rainfall collection within the system

Item	Detail
Control strategies	• Spill control procedures (refer Marine Crossing GTP EMP – document number 3380-GLNG-4-8.2-0021 will be prepared and personnel trained • Dangerous goods will be stored and handled as per the requirements of relevant Australian Standards • Areas where contaminants or wastes are stored or handled will be minimised or roofed • Dangerous goods will, where appropriate (eg outside locations), be stored in bunded areas away from watercourses • Stormwater will be diverted around disturbed areas and areas where contaminants or wastes are stored or handled • All explosives, hazardous chemicals, corrosive substances, toxic substances, gases and dangerous goods will be stored and handled in accordance with the relevant Australian Standard • Where no Australian Standard is available, any liquid with potential to harm the environment will be: – Stored in impervious bunded tanks with bunded capacity at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas – Impervious drum storage will have a bunded capacity to contain at least 25% of the maximum design storage volume within the bund – If the bunded area is not covered, stormwater runoff from rainfall events will collect within bunded areas, and will be treated, reused or released in accordance with environmental and legal requirements, DHWLRMP and SMESCP • MSDS for chemicals and dangerous goods will be available on-site • Waste dangerous goods, which cannot be recycled, will be transported to a designated disposal site as approved by the local authority • Any spillage of hazardous waste or other contaminants that may cause environmental harm, will be effectively contained and cleaned up as quickly as practicable (refer Marine Crossing GTP EMP – document number 3380-GLNG-4-8.2-0021. Such spillage must not be cleaned up by hosing, or otherwise thereby releasing such waste or contaminants to any land or waters • Spillages will be cleaned up using dry methods that minimise the release of wastes, contaminants or materials to any stormwater drainage system, roadside gutter or waters • Spills of dangerous goods will be rendered harmless and collected for treatment and disposal at a designated site, including cleaning materials, absorbents and contaminated soils • Hydrocarbon spillage from storage areas, diesel and chemical spills from construction equipment, and industrial waste spill will be contained, reported, and treated/remediated in accordance with appropriate legislative and regulatory agency requirements. Drainage will be reinstated • Absorbent and containment material (eg absorbent matting) will be available where hazardous materials are used and stored and personnel trained in their correct use • Protective clothing, appropriate to the materials in use, will be provided • Relevant permits will be held and conditions of permits met • Servicing of equipment/machinery will not be permitted on the Marine Crossing GTP ROW. All planned services for all equipment is to occur in an approved workshop
Performance indicators	• The environment is not being contaminated by hazardous materials • Storage and handling procedures as per the WMP and relevant Australian Standards • Chemicals are stored in secure areas

8.4 Waste management record keeping, auditing and monitoring

This section addresses the recording and monitoring requirements which will be undertaken as part of this WMP. Waste streams, quantities and management practices (including chemical and hazardous materials) will be monitored during the construction and operational phases to ensure compliance with State and Commonwealth legislation, approval conditions and Australian Standards.

The key objectives of auditing the waste management and chemical management activities are to:

- Monitor and review wastes and chemical handling, usage, storage and disposal
- Monitor and review transportation records
- Monitor and review compliance with legislation, approval conditions and standards
- Assess the wastes quantities and streams compared to the predicted levels
- Recommend and implement actions to improve waste management practices
- Monitoring performance against the key performance indicators

8.4.1 Record keeping

Information generated from auditing and monitoring will be stored by the WMRC to enable corrective actions identified during the inspection / auditing process to be recorded, tracked and finalised. The information will be made available to the relevant regulatory authorities as required. The WMRC will keep the following key records:

- Regulated waste records
- Waste register including hazardous and dangerous materials
- Other records prescribed by DEHP or government agencies through the licensing and permitting of these activities
- Copies of relevant waste management licences
- Environmental training and induction
- Complaints and incidents
- Inspection and audit details including findings
- Corrective actions

8.4.2 Auditing

The WMRC will be required to comply with the following auditing requirements:

- During construction the WMRC will be required to report on environmental compliance on a weekly and monthly basis
- During construction undertake internal audits to verify that all work is proceeding in accordance with this WMP
- GLNG Operations will conduct a post-construction audit of the ROW and other related infrastructure annually for two years following construction to ensure all waste materials have been removed from the ROW
- The audit report will identify the segment of the Project being audited, the conditions that were activated during the period, and a compliance/non-compliance table. A description of the evidence to support the compliance table will be provided. The audit report shall also contain recommendations on any non-compliance or other matter to improve compliance. The third party auditor must certify the findings of the audit report

- The WMRC will immediately act upon any recommendations arising from the audit report and investigate any non-compliance issues identified
- As soon as practicable, implement measures or take necessary action to ensure compliance
- When first becoming aware of a non-compliance, the WMRC will:
  - Undertake action to bring the matter into compliance within an effective time frame
  - Report the non-compliance and remedial action to GLNG Operations within the specified timeframe

8.4.3 Monitoring

Table 8.5 to Table 8.9 outline the recommended auditing requirements along with the monitoring activities and inspection frequencies.

Table 8.5 WMP auditing and monitoring activities – general waste

Inspection and monitoring activity*	Frequency
Inspect waste handling activities and storage areas to check processes effectively handle, store and securely contain wastes as per the project WM Plan ie lids are closed, no spillages or leaks from liquid or solid waste tanks or containers that could cause nuisance or harm to water or the environment	Weekly
Review waste disposal records/transport receipts to confirm use of licensed waste management facilities and transport contractors to ensure wastes are appropriately collected, transported and disposed of	Weekly
Check all WMRC vehicles brought to the GTP construction sites have correct and up to date licenses and permits as required to conduct the waste transport and disposal activity	Weekly / monthly/ annually
Check MSDS and a dangerous goods register is available and easily accessible and contains MSDS for each stored chemical	Weekly
Check that spill containment and remediation process equipment is in place and unused Check construction personnel effectively implement the required procedures for spill response and the storage, handling and disposal of hazardous waste	Weekly
Check the training and induction/awareness program records to check all personnel have undertaken awareness training in their responsibilities with regard to waste management	Weekly
Any findings where a breach of license conditions has been identified, are to be reported to GLNG Operations or relevant external stakeholders (ie DEHP)	Monthly / annually
Review waste handling, storage and sorting practices to ensure all materials are being dealt with in accordance with the Waste and Resource Management Hierarchy	Weekly / monthly/ annually
Conduct a post-construction audit of the construction camp and ROW and other related infrastructure to check all waste materials have been removed from the ROW	Annually for two years following construction

*Note These suggested monitoring actions and frequencies are not comprehensive, detailed monitoring and auditing schedules should be developed by the WMRC

Table 8.6 WMP auditing and monitoring activities – liquid waste

Inspection and monitoring activity*	Frequency
Record the quantity of effluent treated on a daily basis as required in the approval conditions	Daily
Conduct treated effluent quality monitoring as required in the approval conditions	Weekly
Check that any environmental incidents or accidents that have occurred are reported in accordance with EHSMS	As required
Inspect the construction camp wastewater storage/s and irrigation area in accordance with Wastewater Irrigation Management Plan (WIMP)	Weekly
Inspect the hydrotest water discharge areas in accordance with DHWLRMP	Weekly / monthly/ annually
Inspect waste handling activities and storage areas to check processes effectively handle, store and securely contain wastes as per the project Waste MP and relevant Australian Standards ie lids are closed, no spillages or leaks from liquid or solid waste tanks or containers that could cause nuisance or harm to water or the environment	As required
Check MSDS and a dangerous goods register is available and easily accessible and contains MSDS for each stored chemical	As required
Review liquid waste disposal records/transport receipts to confirm use of licensed waste management facilities and transport contractors to ensure liquid wastes are correctly collected, transported and disposed of	Weekly
Review the waste auditing and monitoring process to ensure the process is effectively achieving objectives	As required
Check that spill containment and remediation process equipment is in place and unused Check project workers effectively implement the required procedures for spill response and associated storage, handling and disposal of hazardous waste	As required
Check the training and induction/awareness program records to check all personnel have undertaken awareness training in their responsibilities with regard to waste management	As required
Check copies of agreements (if any) to supply treated sewage effluent from the wastewater treatment plant for the purpose of irrigation have been forwarded to administering authority	Monthly/ annually
Review waste handling, storage and sorting practices to ensure all materials are being dealt with in accordance with the Waste and Resource Management Hierarchy	Weekly / monthly/ annually
Check WIMP against its objectives such as discharge quality, rates or application area and erosion	Monthly
Conduct a post-construction audit of the construction camp and ROW and other related infrastructure to check all waste materials have been removed from the ROW	Annually for two years following construction

*Note These suggested monitoring actions and frequencies are not comprehensive, detailed monitoring and auditing schedules should be developed by the Construction Contractor

Table 8.7 WMP auditing and monitoring activities – vehicles and machinery

Inspection and monitoring activity*	Frequency
Check vehicles, plant and equipment are maintained as per maintenance schedules to ensure no leaks or damage which could result in spills or leaks	Daily
Inspect waste handling and storage processes to check waste is effectively handled, stored and securely contained as per this WMP and Australian Standards (ie no spillages, leaks from liquid or solid waste tanks or containers that could cause damage to water or the environment)	As required
Check the training and induction/awareness program records to check all personnel have undertaken awareness training in their responsibilities with regard to waste management	As required
Check all WMRC vehicles brought to the Project construction sites have appropriate and up to date licenses and permits as required to conduct the waste transport and disposal activity	Weekly / monthly/ annually
Review waste handling, storage and sorting practices to check all materials are being dealt with in accordance with the Waste and Resource Management Hierarchy	Weekly / monthly/ annually

*Note These suggested monitoring actions and frequencies are not comprehensive, detailed monitoring and auditing schedules should be developed by the Construction Contractor

Table 8.8 WMP auditing and monitoring activities – hazardous waste and chemical storages monitoring

Inspection and monitoring activity*	Frequency
Inspect hazardous wastes handling activities and storage areas to check hazardous waste is stored in sealed containers, bunded areas, correctly labelled as per the WMP and Australian Standards and Legislation	As required
Inspect containment bunds and/or sumps to check integrity of bund and to maintain storage capacity to reduce risk of overflow and subsequent pollution of the surrounding land and/or water body (ie captured sump liquid to extracted periodically when required – noting that extracted liquid will need to be handled and disposed correctly)	As required
Review waste disposal records/transport receipts to confirm use of licensed waste management facilities and transport contractors to ensure wastes are correctly collected, transported and disposed of	Weekly
Check regulated waste tracking paperwork to ensure the process accurately records all necessary details with regard to waste	Weekly / monthly/ annually
Check all WMRC vehicles brought to the GTP construction sites have correct and up to date licenses and permits as required to conduct the waste transport and disposal activity	Weekly / monthly/ annually
Review hazardous materials inventory with stored items to check all items are recorded, stored and treated correctly	Weekly / monthly/ annually
Check MSDS and a dangerous goods register is available and easily accessible and contains MSDS for each stored chemical	Weekly
Check that spill containment and remediation process equipment is in place and unused Check project workers effectively implement the required procedures for spill response and associated storage, handling and disposal of hazardous waste	Weekly
Check the training and induction/awareness program records to check all personnel have undertaken awareness training in their responsibilities with regard to waste management	As required
Review waste handling, storage and sorting practices to ensure all materials are being dealt with in accordance with the Waste and Resource Management Hierarchy (Review waste and recyclable quantities and check dispatched to correct destination)	Weekly / monthly/ annually
Any findings of auditing and monitoring where a breach of license conditions has been identified, are to be reported to GLNG Operations or relevant external stakeholders (ie DEHP)	As required

*Note These suggested monitoring actions and frequencies are not comprehensive, detailed monitoring and auditing schedules should be developed by the Construction Contractor

Table 8.9 WMP auditing and monitoring activities – TBM

Inspection and monitoring activity*	Frequency
Review spoil material laboratory results to check that the tunnel spoil complies with the proposed beneficial reuse area's acceptance criteria	
Review waste disposal records/transport receipts to confirm use of licensed waste management facilities and licensed waste transport contractors to check wastes are correctly collected, transported and disposed of	As required
Check TBM equipment is maintained as per maintenance schedules to check for leaks or damage which could result in spills or leaks	Daily
Inspect waste handling and storage processes to check appropriate and effective handling, storage and secure containment of tunnel spoil and associated TBM wastes as per project WMP and Australian Standards ie no spillages, leaks from liquid or solid waste tanks or containments (ie spoil storage areas) that could cause nuisance or harm to water or the environment	Daily
Check MSDS and a dangerous goods register is available and easily accessible and contains MSDS for each stored chemical	As required
Check the training and induction/awareness program records to check all personnel have undertaken awareness training in their responsibilities with regard to waste management	As required
Check all WMRC vehicles brought to the Marine Crossing construction site pads have appropriate and up to date licenses and permits as required to conduct the waste transport and disposal activity	As required
Review waste handling, storage and sorting practices to check all materials are being dealt with in accordance with the Waste and Resource Management Hierarchy	As required
Conduct a post-construction audit of the Marine Crossing ROW and other related infrastructure to ensure all waste materials have been removed from the ROW	Annually for two years following construction

*Note These suggested monitoring actions and frequencies are not comprehensive, detailed monitoring and auditing schedules should be developed by the Construction Contractor

8.4.4 Continuous improvement

GLNG Operations will work closely with the Construction Contractor to rectify any issues identified as a result of WMP monitoring and auditing activities.

GLNG Operations will continue to investigate and implement actions to reduce impacts and deliver positive outcomes through the operation of the GTP ROW in relation to waste management.

The results of inspections, audits and incident reports will be used to drive continuous improvement along with other associated internal environmental performance reviews conducted by the Mainland, Marine Crossing and Curtis Island sections of GLNG Operations.

Following any significant changes to the GTP design or operational processes the WMP will be reviewed and mitigation measures updated to reflect the changes.

Following any environmental incidents resulting in environmental harm, this WMP will be reviewed and mitigation measures updated and improved to reduce the risk of incidents.

This WMP will be subject to annual review by GLNG Operations and its effectiveness in managing the waste streams associated with the Mainland, Marine Crossing and Curtis Island sections of GLNG Operations reported internally and to any relevant stakeholder.

8.4.5 Complaints response

Complaints which are received from internal or external stakeholders should be recorded and investigated in accordance with the Complaints Response Procedures.

Refer to the proposed management objectives and strategies as detailed in Section 8 for more details on the complaints procedure.

9. Emergency Response Management

Emergency response management for spills and incident involving waste and hazardous materials will be undertaken in accordance with the requirements stipulated in the Project EMPs.

10. References

Australian Standard 2885.3-2001: Pipelines – Gas and liquid petroleum Part 3: Operation and Maintenance

GLNG Operations (2011) GLNG Gas Transmission Pipeline Environmental Management Plan in Support of an Environmental Authority for Mainland

GLNG Operations (2012) GLNG Gas Transmission Pipeline Environmental Management Plan in Support of an Environmental Authority for Marine Crossing

GLNG Operation (2011)a GLNG Gas Transmission Pipeline Environmental Management Plan in Support of an Environmental Authority for Curtis Island

Department of Infrastructure and Planning (2010) Report for Crossing of The Narrows, Review of GLNG Environmental Management Plan

Ecologica Consulting (2010) Landscape Rehabilitation Management Plan for the GLNG Gas Transportation Pipeline Corridor, Brisbane.

Department of Environment and Resource Management (2009) Code of environmental compliance ERA 17 – Abrasive blasting (mobile and temporary activity).

Department of Environment and Resource Management (2010) Queensland's Waste Reduction and Recycling Strategy 2010-2020Department of Environment and Resource Management (2011) Request for additional information, dated 01/12/2011

GLNG (no date) O&M Procedures – Pipeline Abandoning Document

GLNG (no date a) Pipeline – GLNG Project Environmental Management Plan (3380-GLNG-3-1.3-0007)

GLNG (no date b) Gas Transmission Pipeline Operations and Maintenance Procedures

International Erosion Control Association (IECA) (2008) Best Practice Erosion and Sediment Control

O2 (2012) Concept Dewatering, Hydrotest Water and Land Release Management Plan, Marine Crossing – Gas Transmission Pipeline

Queensland Government (May 2010) Coordinator-General's evaluation report for an environmental impact statement, Gladstone Liquefied Natural Gas-GLNG project

Queensland Government, Environmental Protection Agency (December 2005) Queensland Water Recycling Guidelines

Santos (2007) Environment, Health and Safety Management Guide Accessed [online] February 2011, Available at. http://www.glng.com.au/library/EIS/Appendices/BB3_Health%20and%20Safety%20FINAL%20PUBLIC.pdf

Santos Petronas (2010) GLNG Gas Transmission Pipeline Weed Management Plan (Document Number: 3380-GLNG-3-1.3-0006-DOC)

URS (2009) Final Report GLNG Environmental Impact Statement – Waste Management Plan (Ref 42626220)

URS (2009a) GLNG Project – Environmental Impact Statement

URS, (2009b) Supplementary EIS

The Australian Pipeline Industry Association (APIA): Code of Environmental Practice – Onshore Pipelines, March 2009

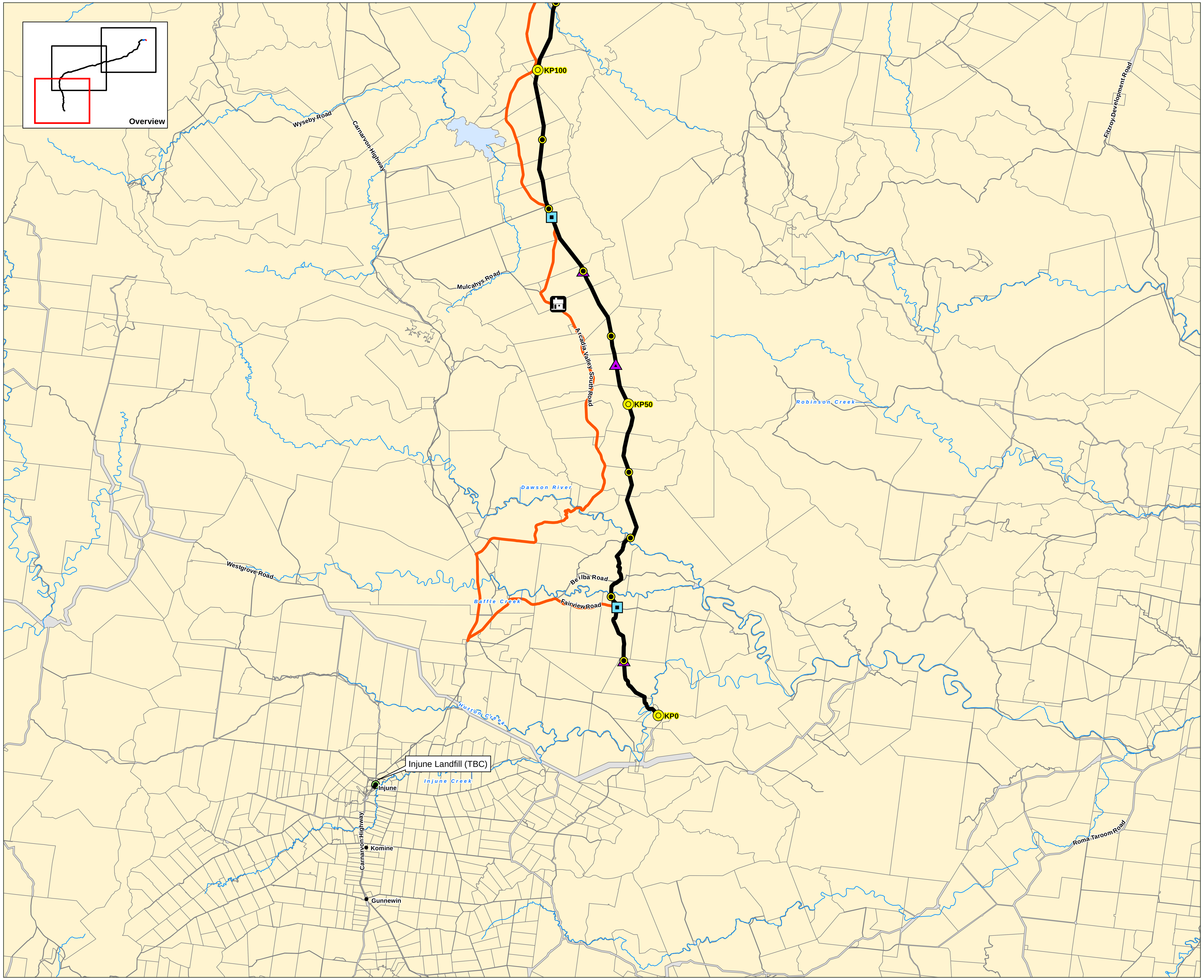
Appendix A
Abbreviations

Appendix A

Abbreviation	Description
AIM	Audit and Inspection Manager
APIA Code	Australian Pipeline Industry Association Code of Environmental Practice for Onshore Pipelines
APLNG	Australia Pacific Liquefied Natural Gas
AS	Australian Standard
AS/NZS	Australian Standard/New Zealand Standard
ASS	Acid Sulfate Soil
ASSMP	Acid Sulfate Soils Management Plan
CEMP	Construction Environmental Management Plan
CG	Coordinator General
CMP	Construction Management Plan
Contractor	Construction Contractor (to be advised)
CSG	Coal Seam Gas
C&I	Construction and Industrial
DERM	Department of Environment and Resource Management
DMP	Dredge Management Plan
DNRMW	Department of Natural Resources, Mines and Water
EA	Environmental Authority
EHSMS	Environment Health and Safety Management System
EHS&S	Environmental, Health, Safety & Security
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EP Act	*Environmental Protection Act 1994*
EP Reg	*Environmental Protection Regulation 2008*
EP (WM) Reg	Environmental Protection (Waste Management) 2000
EP Waste Reg	Environmental Protection Regulations 2008
ERA	Environmentally Relevant Activity
ERP	Emergency Response Plan
FEED	Front End Engineering Design
GPL 300	Gladstone Port Lot 300
GLNG	Gladstone Liquefied Natural Gas
GPC	Gladstone Port Corporation
GTP	Gas Transmission Pipeline
HDPE	High Density Polyethylene
DHWLRMP	Dewatering, Hydrotest Water and Land Release Management Plan
IECA	International Erosion Control Australasia
IMS	Incident Monitoring System

Abbreviation	Description
LNG Facility	Liquefied Natural Gas Facility
MEDLI	Model for effluent disposal using land irrigation
MRF	Material Recovery Facility
MSDS	Material Safety Data Sheet
MSW	Municipal Solid Waste
Mtpa	Million Tonnes per Annum
NEPM	National Environment Protection Measures
NHMRC	National Health and Medical Research Council
NPI	National Pollution Inventory
N/A	Not Applicable
Pigging	Pipe Cleaning Activities
PPE	Personal Protective Equipment
PVM	Preventative Vehicle Maintenance
PVMW	Preventative Vehicle Maintenance Workshops
PWMP	Pest and Weed Management Plan
QCLNG	Queensland Curtis Liquefied Natural Gas
Qld	Queensland
RMP	Road use Management Plan
ROW	Right-of-Way
SSMP	Significant Species Management Plan
SMESCP	Stormwater Management, Erosion and Sediment Control Plan
STP	Sewage Treatment Plant
t	Tonnes
TBM	Tunnel Boring Machine
TPRA	Temporary Pipe Receival Area
TPSA	Temporary Pipe Storage Area
WMP	Waste Management Plan
WIMP	Wastewater Irrigation Management Plan
WMRC	Waste Management and Recycling Contractor
WWTP	Wastewater Treatment Plant
WONS	Weeds of National Significance
WRR Act	*Waste Reduction and Recycling Act 2011*

Appendix B
Figures



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Map by: BS

Santos
GLNG Project

Waste Management Plan

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP

Kilometre Post Distance Marker
- 50km
- 10km

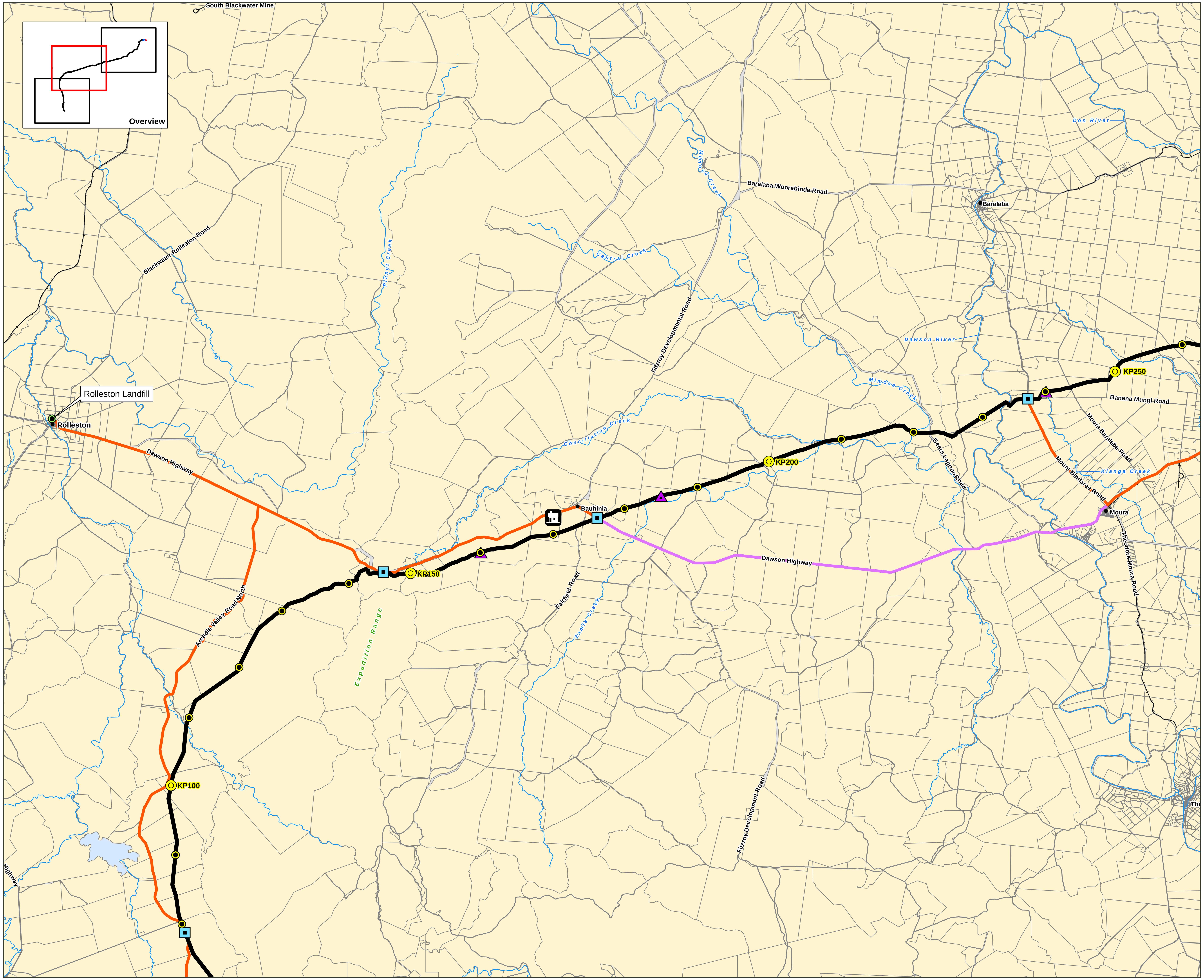
Road Haulage Route
- Waste to Benaraby Landfill; regulated waste and recyclables to SE Qld
- Other GLNG haulage route
- Access Road
- Port Alma Temporary Pipe Receiving Area
- Landfill
- Sewage Treatment Plant
- Temporary Pipe Storage Site
- Construction Camp
- Vehicle Washdown and RoW Access Point (Indicative Location Only)
- Saipem Waste Contractor Depot
- Barge Haulage Route
- Cadastre
- Rail
- Watercourse
- Major Road

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Fishermans Landing and Western Basin Reclamation Area, Aurecon, Feb 2011.
Protected Areas: Department of Environment and Resource Management, Feb 2011.
Cadastre: Department of Environment and Resource Management, Jun 2011.
Temporary Pipe Storage Site: GLNG Pipeline Logistics Study, GHD, Nov 2009.
Vehicle Washdown Points: Aurecon, Feb 2011.
Construction Camps: GLNG Pipeline Logistics Study, GHD, Nov 2009.

Waste and Recovered Material Haulage Route
Appendix B Figure 1 (Page 1 of 3)

GLNG No: XXXX-XX-XXXX
Coordinate system: GCS GDA 1994

Date: 21/06/2012 Version: d



Santos
GLNG Project

Waste Management Plan

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP

Kilometre Post Distance Marker
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- 10km

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- Waste to Benaraby Landfill; regulated waste and recyclables to SE Qld
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- Saipem Waste Contractor Depot
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- Rail
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Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
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Protected Areas: Department of Environment and Resource Management, Feb 2011.
Cadastre: Department of Environment and Resource Management, Jun 2011.
Temporary Pipe Storage Site: GLNG Pipeline Logistics Study, GHD, Nov 2009.
Vehicle Washdown Points: Aurecon, Feb 2011.
Construction Camps: GLNG Pipeline Logistics Study, GHD, Nov 2009.

Waste and Recovered Material Haulage Route
Appendix B Figure 1 (Page 2 of 3)

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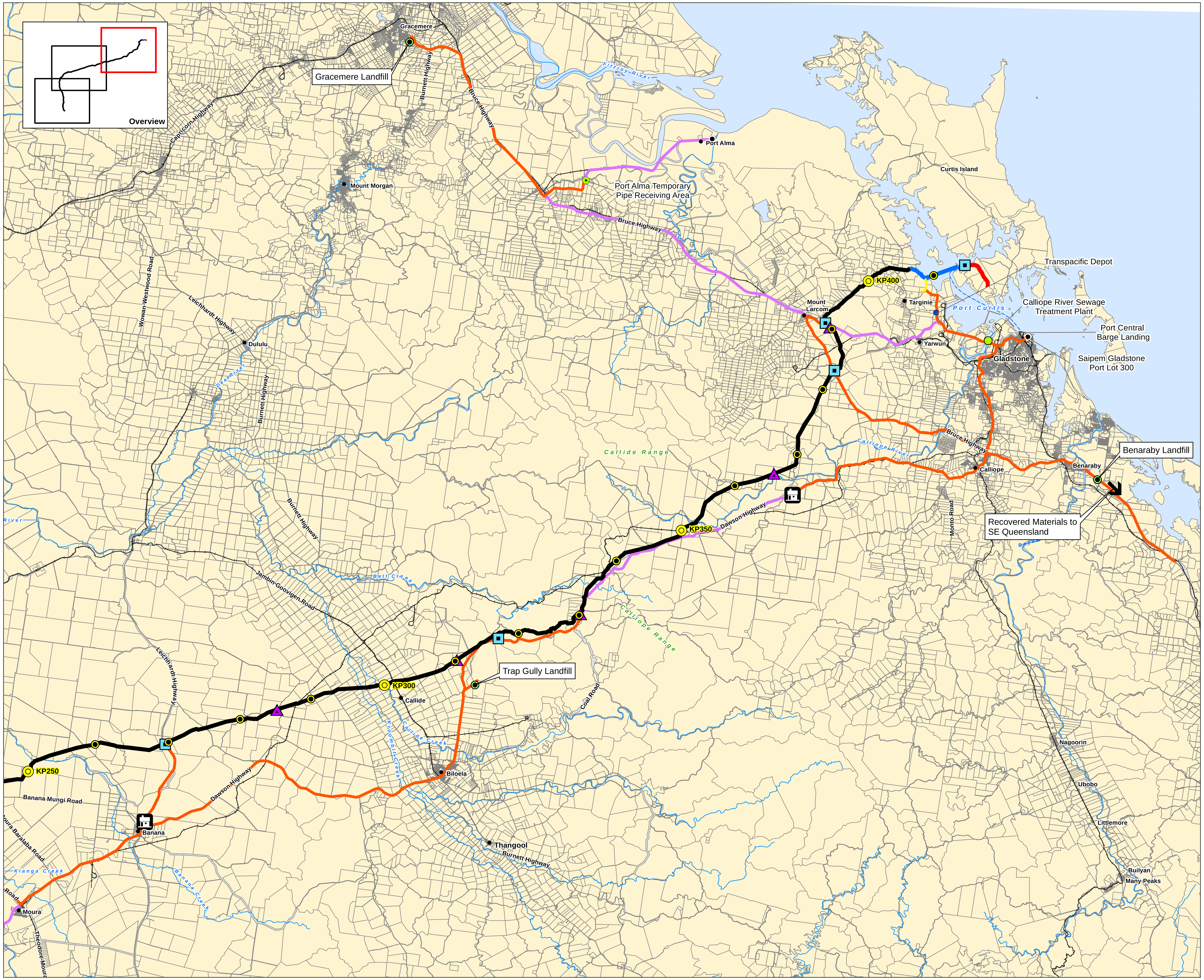
GLNG No: XXXX-XX-XXXX

Coordinate system: GCS GDA 1994



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Map by: BS

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GLNG No: XXXX-XX-XXXX

Coordinate system: GCS GDA 1994

Santos
GLNG Project

Waste Management Plan

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP

Kilometre Post Distance Marker
- 50km
- 10km

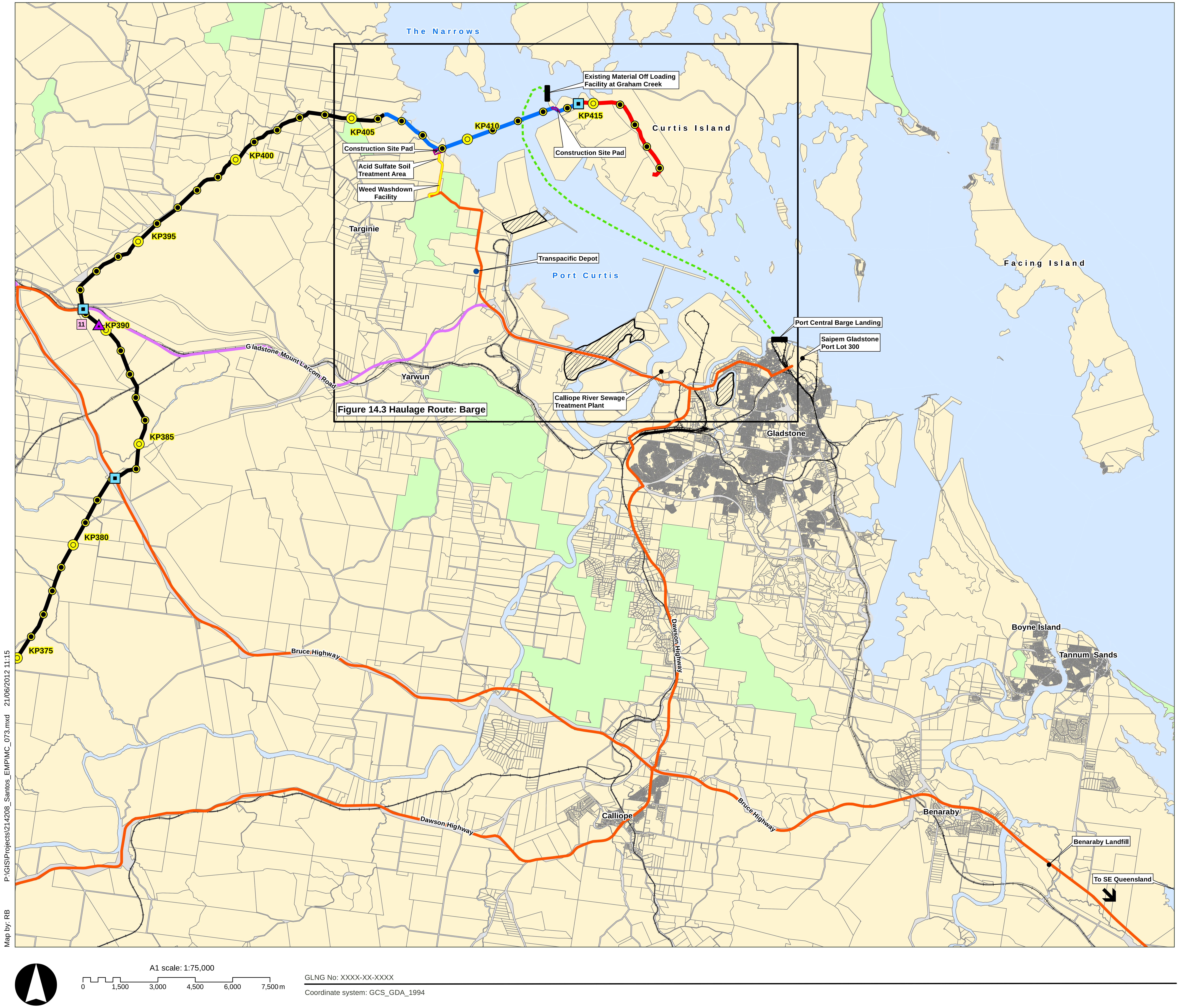
Road Haulage Route
- Waste to Benaraby Landfill; regulated waste and recyclables to SE Qld
- Other GLNG haulage route
- Access Road
- Port Alma Temporary Pipe Receiving Area
- Landfill
- Sewage Treatment Plant
- Temporary Pipe Storage Site
- Construction Camp
- Vehicle Washdown and RoW Access Point (Indicative Location Only)
- Saipem Waste Contractor Depot
- Barge Haulage Route
- Cadastre
- Rail
- Watercourse
- Major Road

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Fishermans Landing and Western Basin Reclamation Area, Aurecon, Feb 2011.
Protected Areas: Department of Environment and Resource Management, Feb 2011.
Cadastre: Department of Environment and Resource Management, Jun 2011.
Temporary Pipe Storage Site: GLNG Pipeline Logistics Study, GHD, Nov 2009.
Vehicle Washdown Points: Aurecon, Feb 2011.
Construction Camps: GLNG Pipeline Logistics Study, GHD, Nov 2009.

Waste and Recovered Material Haulage Route
Appendix B Figure 1 (Page 3 of 3)

Date: 21/06/2012

Version: d



GLNG No: XXXX-XX-XXXX

Coordinate system: GCS_GDA_1994

Santos GLNG Project

Waste Management Plan

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP

Kilometre Post Distance Marker
- 5km
- 1km
- Construction Site Pads
- Access Road

Road Haulage Route
- Waste to Benaraby Landfill; regulated waste and recyclables to SE Qld
- Other GLNG haulage route
- All waste and materials from Curtis Island
- Barge Landing (Indicative Location Only)
- Vehicle Washdown and RoW Access Point (Indicative Location Only)
- Temporary Pipe Storage Site
- Saipem Waste Contractor Depot
- Potential Beneficial Tunnel Spoil Reuse Options
- Protected Area
- Cadastre
- Rail

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, 2011.
Protected Areas: Department of Environment and Resource Management, Feb 2011.
Cadastre: Department of Environment and Resource Management, Oct 2011.
Temporary Pipe Storage Site: GLNG Pipeline Logistics Study, GHD, Nov 2009.
Vehicle Washdown Point: Aurecon, Feb 2011.

Note:
Barge landing and routes are approximate only.

Waste and Recovered Material Haulage Route: Overview Appendix B Figure 2

Date: 21/06/2012 Version: b

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos GLNG Project

Waste Management Plan

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Weed Washdown Facility (Indicative)
- Access Road

Road Haulage Route
- Waste to Benaraby Landfill; regulated waste and recyclables to SE Qld
- Other GLNG haulage route

Barge Haulage Route
- All waste and materials from Curtis Island
- Drill cuttings
- Barge Landing (Indicative Location Only)
- Vehicle Washdown and RoW Access Point (Indicative Location Only)
- Potential Beneficial Tunnel Spoil Reuse Options
- Rail

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, 2011.
Fishermans Landing and Western Basin Reclamation Area, Aurecon, Feb 2011.
Vehicle Washdown Point: Aurecon, Feb 2011.

Note:
Barge landing and routes are approximate only.

Waste and Recovered Material Haulage Route:Barge Appendix B Figure 3

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GLNG No: XXXX-XX-XXXX

Coordinate system: GCS_GDA_1994

Date: 21/06/2012

Version: b

Appendix C
Chemical inventory – Marine Crossing

Chemical register

Key:

1. Hardware, Glues & Sealants		2. Paints & Solvents	3. Fuels
4. WTP	5. Concrete Products	6. Oils & Lubricants	7. Hygiene/Office

Workplace: GLNG Marine Crossing

Product name	Supplier (if applicable)	U.N. No.	Physical description	Class dangerous good and/or Hazardous substance	Maximum quantity on site	Location in workplace	MSDS Issue Date	MSDS Available Yes/No
1								
Bentocryl 86	Sud-Chemie	N/A		N/A			14/09/2010	Yes
CRC Brakleen Aerosol	CRC	1950		HS, DG Class 2			14/07/2008	Yes
Flexovit Reinforced Cutting Off Wheels	Saint-Gobain	N/A		HS			15/04/2011	Yes
Hempel Hempatex Hi-Bluid 46410	Hempel's Marine Paints	1263		HS, DG Class 3			19/02/2008	Yes
Hilti Hit Max	Hilti	N/A	Grey Paste	HS			1/09/2009	Yes
Loctite 747 Primer T (Non-aerosol)	Henkel	2831		HS, DG Class 6.1			19/02/2008	Yes
Loctite 747 1 Primer	PPG Industries Aerospace	1993		HS, DG Class 3			23/10/2008	Yes
Parchem Fosroc Nitobond Har	Parchem	N/A		N/A			16/02/2010	Yes
Selleys Liquid Nails (solvent based)	Selleys	1133		HS, DG Class 3			10/03/2010	Yes
Selleys Polyfilla Expanding Foam (aerosol)	Selleys	1950		HS, DG Class 2			17/06/2008	Yes
Selleys Roof & Gutter Silicone Sealant	Selleys	N/A		N/A			13/03/2009	Yes
Septone Parts Wash	Septone	N/A		HS			7/10/2011	Yes
Sikadur 33 Part A	Sika	N/A		HS			14/06/2007	Yes
Sikadur 33 Part B Normal	Sika	N/A		HS			14/06/2007	Yes
Sika Rugasol 90	Sika	N/A		N/A			23/01/2012	Yes
Sika Rugasol C	Sika	N/A		N/A			1/08/2011	Yes
Sika Sikasil C	Sika	N/A		N/A			8/07/2010	Yes
Sika Sikaflex 11FC	Sika	N/A		N/A			27/10/2019	Yes
Sika Sikaflex PRO	Sika	N/A		HS			6/05/2011	Yes
Silicone Sealant (White) #512-799	RS Components	N/A		N/A			15/04/2011	Yes
Silver Brazing Flux F100	Toshiba	1811		HS, DG Class 8			28/03/2008	Yes
Solvent_Cement_Type_N	Vinidex	1133	blue glue for PVC pipe	DG Class 3		Container	1/11/2008	Yes
2								
Dulux 066-Line Accent Gloss Enamel	Dulux	1263		HS, DG Class 3			15/04/2011	Yes
Dy Mark Mine Marking Aersosol	Dy-Mark	1950		HS, DG Class 2.1			1/10/2010	Yes
Hempels thinner 08080	Hempel's Marine Paints	1307		HS, DG Class 3			30/05/2008	Yes
Line Marking Paint	RS Components	1950		HS, DG Class 2.1			23/07/2010	Yes
Wattyl Killrust Cold Galvit (for aerosols)	Wattyl	1263		HS, DG Class 3			16/09/2008	Yes
Wattyl Killrust Fishoilene Aerosol	Wattyl	1950		HS, DG Class 2			15/07/2008	Yes
3								
Diesel (automotive)	Caltex	N/A	Liquid, dark	HS		Multiple	21/02/2012	Yes
Kerosene - Recochem Home Kerosene	Rechochem	1223		HS, DG Class 3			16/04/2010	Yes
Petrol - Shell Unleaded Petrol	Shell	1203		HS, DG Class 3			31/12/2008	Yes
4								
Aluminium Sulfate	Baker's	N/A	White powder	HS	1 tonne	WTP - container	13/11/2009	Yes
Formazine Turbidity solution	Yeokal	N/A	Milky liquid suspension	N/A	1 litre	Env office	19/12/2011	Yes
pH 4 buffer	Yeokal	N/A	Colourless liquid	N/A	1 litre	Env Office	19/12/2011	Yes
pH 10 buffer	Yeokal	N/A	Colourless liquid	N/A	1 Litre	Env Office	19/12/2011	Yes
Poly aluminium chloride - HyBind 2001	Eimco Water	N/A	Colourless liquid	N/A		WTP	2/02/2010	Yes
Sodium Hydroxide - Optireg 1001	Ovivo	1824		HS, DG Class 8		WTP	1/02/2010	Yes
Sodium Bisulphate - Dry Acid	Pool Resources	N/A		HS		WTP	15/05/2011	Yes
Sulphuric Acid - Optireg 1003	Ovivo	2796		HS, DG Class 8	1000L	WTP	17/02/2012	Yes
5								
AMC AUS-BEN (Bentonite)	Australian Mud Company	N/A		HS			6/05/2009	Yes

BASF Masterkure 404	BASF	N/A		HS			28/01/2010	Yes
BASF Masterkure 100WB Clear	BASF	N/A		N/A			10/07/2009	Yes
BASF Masterkure 100WB White	BASF	N/A		HS			3/03/2010	Yes
BASF Meyco SA160 T	BASF	N/A		HS			11/05/2011	Yes
Concrete - Blue Circle Premium Blended Concrete Mix	Blue Circle	N/A		HS			15/04/2011	Yes
Concrete - Cement Australia Portland Cement	Cement Australia	N/A		HS			20/11/2009	Yes
Concrete - Readymix Sprayed Concrete	Readymix	N/A		HS			15/10/2010	Yes
Concrete - Vandex Grey	Vandex	N/A	Light grey powder	HS			1/03/2012	Yes
Grout - BluCem GP60 Construction Grout	Bluey	N/A	Light grey powder	HS			27/02/2008	Yes
Grout - GroutAid	Elkem AS	N/A		N/A			8/07/2010	Yes
Hilti Hit Hy 150	Hilti	N/A	Grey Paste	HS			11/05/2010	Yes
Hilti Hit - RE 500	Hilti	3259		HS, DG Class 8			9/04/2010	Yes
Hydrated Lime	Adelaide Brighton	3262	Powder	HS, DG Class 8			28/08/2009	Yes
Interstate Form Release Agent	Interstate Energy	N/A		HS			7/10/2011	Yes
Sika Formol	Sika	N/A		HS			15/04/2011	Yes
Sodium Silicate Solution	PQ Australia	N/A		HS			24/06/2008	Yes
Stabilizer (admixture for concrete & mortar)	Tachibana Material	N/A		N/A			30/09/2009	Yes
6								
Air Tool Lubricant	RS Components	N/A	Metal Processing Oil	N/A			13/01/2012	Yes
Drill Lubricant - BP Rock Drill Compound	Castrol	N/A		N/A			6/12/2007	Yes
Drill Lubricant - Shell Torcula Oil 32	Shell	N/A		N/A			29/01/2010	Yes
Drill Lubricant - Sud-Chemie Bentonil HR	Sud-Chemie	N/A		N/A			30/10/2009	Yes
Engine Oil - BP Vanellus M30	Castrol	N/A		N/A			12/01/2012	Yes
Engine Oil - Super 2 Stroke Oil	Peak Lubricants	N/A		N/A			1/08/2008	Yes
Gear Lubricant - Ampol Gearlube TA 80W	Caltex	N/A	Oil, Dark	HS			29/01/2010	Yes
Gear Lubricant - Mobil (USA) SHC 630	ExxonMobil	N/A		HS			19/06/2009	Yes
Gear Lubricant - Shell Omala Oil F 320	Shell	N/A		N/A			3/01/2012	Yes
General Lubricant - Lanotec Heavy Duty Liquid Lanolin Aerosol	Lanotec	1950		DG Class 2			29/01/2010	Yes
General Lubricant - TG&S Standard Pipe Jointing Lube	Thomas Grozier & Son	N/A		N/A			8/02/2010	Yes
General Lubricant - WD-40 3-In-One Multi-Purpose Oil	WD-40 Company	N/A		N/A			29/04/2011	Yes
Grease - BP Energrease MG-EP 2	Castrol	N/A		N/A			13/01/2012	Yes
Grease - Equilon Alvania EP Grease 2	Equilon Alvania	N/A		N/A			6/08/2010	Yes
Hydraulic Oil - Condat D 46	Condat	N/A		HS			22/04/2009	Yes
Hydraulic Oil - Oilman Masterlube 68 Hydraulic Oil	Oilman Group	N/A		N/A			16/08/2011	Yes
Hydraulic Oil - Shell Tellus Oil T68	Shell	N/A		N/A			29/01/2010	Yes
TBM - Condat WR 89 S	Condat	N/A	N/A	N/A			6/02/2009	Yes
TBM - Condat WR 89	Condat	N/A	N/A	N/A			6/02/2009	Yes
TBM - Condat HBW	Condat	N/A	N/A	N/A			12/05/2009	Yes
TBM - Condat GR 217 EP2	Condat	N/A	N/A	N/A			26/03/2009	Yes
7								
Bleach Concentrate	Septone	1791		HS, DG Class 8			30/05/2008	
Blockettes Deoderant tablets	Septone	3077	Blocks for urinals	HS, DG Class 9		Amenities	15/10/2010	Yes
Disinfectant Liquid	Septone	N/A	Liquid	N/A			2/06/2008	Yes
Glen 20 Surface Spray	Reckitt Benckiser	1950	Aerosol / mist	HS, DG Class2.1		Amenities	26/02/2010	Yes
Hand Wash - Lightning Fresh Hand cleaner	Lightning Products	N/A		HS		Amenities	8/12/2009	Yes
Insect Repellent - Aeroguard Tropical Strength (aerosol)	Reckitt Benckiser	1950	clear spray/mist	HS, DG Class 2.1			7/05/2009	Yes
Sun Cream - Piz Buin Mountain Sun Cream	Johnson & Johnson	N/A	White viscous liquid	N/A			2/02/2009	Yes

Appendix D
Sandblasting Grit information

GMA Garnet

The Natural Abrasive

Blasting Grade Product Data Sheet

Average Chemical Composition (Typical)

SiO_2 *	36%
Al_2O_3	20%
FeO	30%
Fe_2O_3	2%
TiO_2	1%
MnO	1%
CaO	2%
MgO	6%

* Refers to SiO_2 bound within the lattice of the homogeneous garnet crystal (no free silica)

Physical Characteristics (Typical)

Bulk Density	2.3T/m³
Specific Gravity	4.1
Hardness (moh)	7.50-8.0
Melting Point	1250°C
Shape of natural grains	sub-angular

Other Characteristics (Typical)

Conductivity	10-15ms/m (max 25ms/m)
Radioactivity	Not detectable above background
Moisture Absorption	Non-hydroscopic, Inert
Total Chlorides	10-15ppm (max 25ppm)
Ferrite (free iron)	less than 0.01%*
Lead	less than 0.002%*
Copper	less than 0.005%*
Other Heavy Metals	less than 0.01%*
Sulphur	less than 0.01%*

* Generally below detectable levels.

Mineral Composition (Typical)

Garnet (Almandite)	97-98%
Ilmenite	1-2%
Zircon	0.20%
Quartz (free silica)	<0.5%
Others	0.25%

Blast Grade Product Range

Typical Results	New-Steel	Speed-Blast	Premium-Blast
Profile (microns)	45-55	50-70	50-85
Consumption (kg/m2)	7-10	8-10	10-12
Cleaning Rate (m2/hour)	20-25	15-25	15-20

Standard Packing

* 80 x 25kg multilayer paper bags shrinkwrapped to 2 MT pallets, or
* 80 x 25kg multilayer paper bags packed into 2 T bulk bags or
* 2,000kg top and bottom spouted bulk bags with internal PVC liner, or
* Loose bulk.

GMA Garnet is certified by the California Air Resources Board for dry unconfined blasting. GMA Garnet meets all known current chemical limits for free silica and heavy toxic metals including ISO 11126-10: E2000 and US Navy specification MIL-A-22262 B(SH).

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GMA GARNET GROUP

when your abrasive matters!

MATERIAL SAFETY DATA SHEET

SECTION 1 – IDENTIFICATION

Product Name	:	**GMA Garnet**
Other Names	:	garnet sand, almandine garnet, PremiumBlast, SpeedBlast, NewSteel, 30/60 mesh, 50 mesh, 60 mesh, 80 mesh, 120 mesh, 600/250
Recommended Use	:	blast cleaning abrasive, water jet cutting abrasive, water filtration media
Supplier	:	GMA Garnet Pty Ltd
Address	:	122 Goulds Rd, Geraldton, Western Australia 6532
Telephone Number	:	+61 8 9923 6000 (Australia)
	:	+1 8 32243 9300 (United States)
Fax Number	:	+61 8 9923 3747
E-mail	:	sales@gmagarnet.com.au
Emergency Number	:	+61 8 9923 6000; 24 hours: +61 402 293 603 (Australia)
	:	+1 8 32243 9300; 24 hours: +1 713 301 0354 (United States)

SECTION 2 - HAZARDS IDENTIFICATION

Non Dangerous but **Hazardous** according to NOHSC: 1008(2004)
The product as supplied contains traces of quartz (crystalline silica) which when used as an abrasive can break down to respirable dust size (particles small enough to go into deep parts of the lung when breathed in). Respirable crystalline silica is a listed carcinogenic substance which may cause silicosis and cancer.

The product is dominantly garnet (almandine variety) which is a Non-Hazardous substance. Traces of dust in the unused product are from calcium carbonate which is also Non-Dangerous and Non-Hazardous.

Risk Phrase: T R49 - contains crystalline silica which may cause cancer by inhalation.
Safety Phrase: S22 - do not breathe dust liberated from used product.

SECTION 3 – COMPOSITION / INFORMATION ON INGREDIENTS

This material is a natural mixture of almandine garnet and other trace minerals.

Chemical Name	CAS Number	Proportion (weight %)
Almandine Garnet $Fe_3Al_2(SiO_4)_3$	1302-62-1	Greater than 97%
Ilmenite $FeTiO_3$	103170-28-1	Less than 2.0%
Calcium Carbonate $CaCO_3$	471-34-1	Less than 1.5%
Zircon $ZrSiO_4$	149040-68-2	Less than 0.2%
Quartz SiO_2 (Crystalline Silica)	14808-60-7	Less than 0.2%

SECTION 4 – FIRST AID MEASURES

No acute or chronic health effects known in workers arising from short or long term exposure to this product. Note that crystalline silica is present at low levels and chronic exposure, by way of dust inhalation, may cause silicosis and cancer.

- Swallowed — Non toxic. There are no known health effects resulting from accidental ingestion of small amounts that may occur during normal handling. Ingestion of larger amounts may cause irritation due to abrasiveness. Seek medical attention if symptoms develop.
- Eye — Particle and dust exposure may cause eye irritation due to abrasiveness. Flush with plenty of clean water for at least 15 minutes or until particles are removed. Seek medical attention if irritation or soreness persists.
- Skin — There are no known health effects from skin contact that may occur during normal handling. Seek medical attention if symptoms develop. Contact with material under pressure will damage skin by abrasion. Clean and dress any open wounds and seek medical attention. Inhaled: Exposure to dust created by use as a blast cleaning media may cause throat and lung irritation, coughing or shortness of breath. Move to fresh air and blow nose to remove particulates from nasal passages. Seek medical attention if symptoms persist.

It is recommended that eyewash facilities are available in the workplace.

SECTION 5 – FIRE FIGHTING MEASURES

Flammability	: Non-flammable.
Flashpoint	: Non-explosive.
General Hazard	: This product is non-flammable and does not support combustion.
Extinguishing Media	: Use media suitable for the material that is burning.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

No special precautions necessary. Wear safety equipment as for normal handling. If possible, vacuum the material to avoid generating unnecessary dust, otherwise, sweep any spillages.

SECTION 7 – HANDLING AND STORAGE

No special precautions necessary. Storage areas should be ventilated and dust generation minimised when handling loose bulk product. Use good housekeeping practices to keep dust to a minimum.

SECTION 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Standards	**Crystalline silica (quartz)** respirable dust: 0.1 mg/m³ TWA (time weighted average) may be exceeded when the product is used for dry blast cleaning (respirable dust is ≤ 7 microns particle equivalent aerodynamic diameter) **Total dust (inspirable)**: 10 mg/m³ TWA
Engineering Controls	Maintain ventilation and/or dust collection to reduce exposure to dust generated during handling, use and clean-up. Maintain a clean and safe work environment and monitor effectiveness.
Personal Protection	Follow local, state or federal guidelines for the use of personal protection equipment. Blast cleaning operations should use an air fed abrasive blast hood conforming with Australian Standards 1715 and 1716, such as a Nova 2000, as well as leather (or equivalent) gloves and apron when in use. Hearing protection should also be worn when blast cleaning.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Appearance	: Pink to red coloured free flowing sand.
Odour	: Odourless.
pH	: 7.0 to 8.5
Vapour Pressure	: Not applicable.
Boiling Point	: Not applicable.
Melting Point	: Approximately 1250˚C
Radioactivity	: Not detectable above background levels.
Solubility in Water	: Insoluble.
Specific Gravity	: 4.1
Flammability	: Non-flammable.
Hardness	: 7.5 – 8.0 Mohs
Bulk Density	: Approximately 2.3 t/m³
Particle Size	: Average range between 0.1 – 0.6mm, depending on grade.

SECTION 10 – STABILITY AND REACTIVITY

Chemical Stability	: Stable and inert material under normal and anticipated storage, handling and use conditions.
Conditions to Avoid	: None known.
Incompatible Materials	: None known.
Decomposition	: Not applicable.
Hazardous Reactions	: None known.

SECTION 11 – TOXICOLOGICAL INFORMATION

Note that crystalline silica is present at low levels, typically less than 0.1%, and chronic exposure to crystalline silica dust through inhalation may cause silicosis and cancer.

SECTION 12 – ECOLOGICAL INFORMATION

This material is a naturally occurring mineral with no known ecotoxicity. It is insoluble in water and unlikely to contaminate waterways or food chains.

SECTION 13 – DISPOSAL CONSIDERATIONS

Follow local, state or federal guidelines for disposal of inert solid waste, e.g. for landfill.

MATERIAL CONTAMINATED OR REDUCED TO DUST IN USE MAY NEED SPECIAL HANDLING AND DISPOSAL. IT IS THE RESPONSIBILITY OF THE USER TO UNDERTAKE ANY EVALUATION CLASSIFICATION AND DISPOSAL OF MATERIAL AFTER USE.

SECTION 14 – TRANSPORT INFORMATION

No special precautions necessary. It is recommended to keep bags closed and dry bulk loads covered to prevent dust generation and moisture incursion.

SECTION 15 – REGULATORY INFORMATION

No known additional regulations for this product.

SECTION 16 – OTHER INFORMATION

This MSDS has been prepared by GMA Garnet Pty Ltd in accordance with the National Code of Practice for the Preparation of Material Safety Data Sheets 2nd Edition [NOHSC:2011(2003)].

Date of Issue: April 2012
Revision 6

As per Worksafe Guidance Note NOHSC 3017, each user should review the information in the specific context of the intended application.

End of MSDS.

Appendix G
Mosquito and Midge Management Plan (MMMP)

GLNG
Gas Transmission Pipeline

Mosquito and Midge Management Plan

Document Number: 3380-GLNG-4-1.3-0009

PREPARED BY:

Title	Name	Signature	Date
Senior Civil Engineer	Georgina Squire		28.06.12

ENDORSED BY:

Title	Name	Signature	Date

APPROVED BY:

Title	Name	Signature	Date

DATE	REV	REASON FOR ISSUE	AUTHOR	ENDORSED	APPROVED
23.03.11	1	DRAFT for review and verification	CS		
30.03.11	2	Final	CS	SJM	
08.04.11	3	Amended Final	CS	CC	
15.04.11	4	Final for Legal review	CS		
30.05.11	5	LEGAL COMMENTS ADDRESSED	CC		
15.07.11	6	FOR AGENCY REVIEW	CC		
09.05.12	7	Construction methodology updated	GS		
22.06.12	8	GLNG comments addressed	MH		
28.06.12	9	For Santos Sustainability Review	MH		

Table of contents

1. Introduction

This Mosquito and Midge Management Plan (MMMP) has been developed to manage mosquitoes and biting midges for the purposes of public health, community wellbeing and for the health of onsite workers associated with the Marine Crossing Gas Transmission Pipeline (GTP) Project.

Mosquitoes pose a risk to human health as a number of species are vectors for many serious diseases, such as Ross River Virus and Barmah Forest Virus. Midges, although a nuisance, do not pose any serious risk to human health. For this reason and the fact that there are limited control measures specifically for biting midge species, this MMMP largely focuses on mosquito management.

1.1 Aim

This MMMP aims to meet the goal of Integrated Pest Management (IPM) by combining a variety of reasonable, practical, effective and economical pest control measures to reduce the risk of increase in population numbers and disease from mosquitoes resulting from the development of the Marine Crossing GTP Project, while having minimal impact on the environment. This MMMP provides a framework for identifying and monitoring potential mosquito breeding sites as well as outlining procedures for implementing risk management strategies during the construction and operation phases of the Project.

2. Legislative and policy framework

2.1 Relevant legislation

Relevant legislation associated with the management and control of mosquito and biting midge populations within the Marine Crossing GTP Project include:

- *Public Health Act 2005 / Public Health Regulation 2005*
- *Work Health and Safety Act 2011*
- *Environmental Protection Act 1994* (EP Act)
- *Coastal Protection and Management Act 1995*
- *Fisheries Act 1994*
- *Sustainable Planning Act 2009* (SPA)
- *Agricultural Chemicals Distribution Control Act 1966* (ACDC Act)
- *Chemical Usage (Agricultural and Veterinary) Control Act 1998*
- *Nature Conservation Act 1992* (NC Act)
- *Marine Parks Act 2004*
- *Transport Infrastructure Act 1994*

2.2 Relevant standards and guidelines

Relevant policies and codes associated with the management and control of mosquito and biting midge populations within the Marine Crossing GTP Project include:

- Gladstone Regional Council Mosquito Management Plan (GRCMMP) (Gladstone Regional Council (GRC), 2010)
- Operational Policy Pest Management – Mosquito and biting midge control (Department of Environment and Resource Management (DERM), 2011)
- Guidelines to minimise mosquito and biting midge problems in new development areas (Queensland Health (QH), 2002)

- Mosquito Management Code of Practice for Queensland (Local Government Association of Queensland (LGAQ), 2002)
- AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines

3. Aspects and potential impacts

3.1 Potential for species and prevalence

3.1.1 Breeding areas

Likely mosquito species and breeding areas

This MMMP outlines the mosquito species likely to be significant within the Marine Crossing GTP Project based on vector capability, nuisance value and seasonal variation. While there are likely to be many mosquito species present within the greater Gladstone area, there are some species that are of greater importance because of their ability to transmit disease or to be significant pests. A number of mosquito species are associated with breeding in freshwater pools and/or intertidal wetlands and may be broadly divided into freshwater and intertidal species. Mosquitoes within both of these categories have the potential to become disease vectors and are therefore outlined within this MMMP.

Potential onsite freshwater habitats for mosquitoes include:

- Stormwater drainage systems
- Pooled water in bunded areas, containers or other vessels
- Low lying areas temporarily flooded by high rainfall
- Areas created during construction works (trenches)
- Construction water and sedimentation ponds

Intertidal species are likely to utilise mangrove habitats as well as saltwater marshland as breeding sites. In particular, mangrove areas are likely to provide ideal habitat conditions for breeding. Intertidal wetlands (including mangrove areas) are adjacent to the Marine Crossing GTP Right of Way (RoW) and associated construction areas.

Existing potential breeding areas and suitable habitat locations for mosquitoes and biting midges are shown in Figure 3.1.

The mosquito species likely to be significant pests within the Marine Crossing GTP Project are briefly described in Table 3.1.

Table 3.1 Potentially favourable habitat conditions for mosquito species

Species	Favourable breeding site conditions	Preferred habitat
Aedes aegypti	• A container breeding species • A major vector for Dengue fever, Yellow fever and a potential vector of Murray Valley encephalitis and Ross river virus	Freshwater
Culex annulirostris	• Preferred breeding habitats include freshwater wetlands and low lying grassy areas that are commonly inundated following rain, as well as irrigation areas having heavy organic effluent component • A vector of Ross River virus, Barmah Forest virus, Japanese encephalitis and Kunjin virus	Freshwater
Culex quinquefasciatus	• Utilises containers, troughs and drainage channels as breeding sites	Freshwater

Species	Favourable breeding site conditions	Preferred habitat
Ochlerotatus vittiger	• Preferred breeding sites consist of depressions filled by summer rain	Freshwater
Ochlerotatus notoscriptus	• Breeds in artificial containers • A suitable vector for Barmah Forest virus and Ross River virus	Freshwater
Ochlerotatus alternans	• Breeding can occur in temporary brackish pools and marshes on the coast • Can reach relatively high pest levels following extended periods of rain • An aggressive biter, especially in and around mangroves and will attack throughout the day and night • Can travel 5 km to 8 km from breeding sites in search of food • May continue to be a pest from one to three weeks after breeding areas are inundated	Intertidal wetlands
Ochlerotatus vigilax	• Utilises a variety of saline habitats including salt marshes filled as a result of tidal inundation • A primary coastal vector of Ross River virus, Barmah Forest virus and other arboviruses in Queensland • Feeds on humans and animals during the day or night • Can travel up to 40 km from breeding sites	Intertidal wetlands
Culex sitiens	• Utilises temporary brackish pools and salt marshes filled as a result of tidal inundation as breeding sites • A vector of Ross River virus • Has the ability to travel long distances from breeding habitat	Intertidal wetlands
Verrallina funerea	• Can breed in both fresh and slightly brackish water • A major pest where residential housing is in close proximity to breeding sites • Does not readily disperse from its breeding habitat	Intertidal wetlands

Likely midge breeding areas

Areas of mangroves and estuarine areas with sandy beaches are potential breeding grounds for midges. Midge population numbers peak monthly and are associated with tidal patterns and also peak seasonally during the summer months. There is no suitable habitat located within the Marine Crossing GTP Project, and as such no specific management measures for the biting midge will be included in this MMMP. However, GRC will be notified of any management measures developed and implemented for the reduction of mosquito breeding sites within the Marine Crossing GTP Project or any potential breeding sites identified during visual monitoring activities. Indirect control measures will be implemented in accordance with this MMMP and the GRCMMP. This information may also be used by GRC to tailor management programmes for these species.

3.1.2 Species prevalence

No field investigations were completed to quantify or monitor mosquito or biting midge numbers or species distribution within the Marine Crossing GTP Project during the EIS. However, under the GRCMMP, the GRC has committed to mapping all mosquito breeding areas within their jurisdiction, including regional areas of significance. The strategy developed for mapping all mosquito breeding areas includes the inspection and documentation of each mosquito breeding site and identifying any specific environmental issues with each site (GRC, 2010). It is envisaged that the information and data compiled through GRC's strategy commitments will be used to inform proposed treatment and control methodologies adopted/approved for each location.

Reference Point	Easting	Northing
A	307885.00	7372070.00
B	308384.00	7371825.00
C	309893.00	7370692.00
D	314290.76	7372243.30
E	315000.00	7372593.00

Reference Points and associated Coordinates

Santos
GLNG Project

Marine Crossing GTP Mosquito and Midge Management Plan

Gas Transmission Pipeline (GTP)
- Mainland GTP
- Marine Crossing GTP
- Curtis Island GTP
- GTP Marine Crossing Reference Point
- Construction Site Pads
- Acid Sulfate Soils Treatment Area
- Weed Washdown Facility (Indicative)
- Proposed Access Road
- Water Points
- Highest Astronomical Tide
- Watercourses

Note: High Astronomical Tide (HAT) is approximate and indicative only.

Source:
Gas Transmission Pipeline (GTP): Santos, Apr 2012.
Aerial: Santos, Feb 2011.
Indicative Project Footprint: Aurecon, GLNG May 2012.
Watercourses: Department of Environment and Resource Management, Sep 2011.

MMMP - Potential Habitat
Figure 3.1

Map by: RB   P:\GIS\Projects\214208_Santos_EMPMC_068.mxd   14/06/2012 08:53

A1 scale: 1:15,000
0 250 500 750 1,000 1,250 m

GLNG No: XXXX-XX-XXXX
Coordinate system: GCS_GDA_1994

Date: 14/06/2012   Version: a

3.2 Summary of aspects and potential impacts

The key environmental aspects and their associated potential impacts relevant to the construction activities, locations and work areas are outlined in Table 3.2.

Table 3.2 Environmental aspects and impacts for mosquito and biting midge

Item	Outcome
Environmental aspect	• Pooling of water • Changed surface water hydrology • Habitat modification
Construction activity that have potential to create breeding areas	• Bulk earthworks, including clearing and grading, cut and fill, compacting, levelling, shaping, gravel covering, backfilling, trenching and blasting • Stockpiling of bulk topsoil and cleared vegetation • Soil and sediment movement • Water management, including water diversion, storage and release/discharge • Facilities and structures management, including operation, maintenance and housekeeping • Systems management, including Erosion and Sediment Controls (ESC) and waste containment, storage, treatment, transport and disposal • Rehabilitation and site reinstatement, including backfilling, compaction and ripping, replacement of topsoil, revegetation and re-sowing pastures, and removal of the Access Road and access tracks
Construction location/work areas associated with potential breeding areas	• Upgrading and construction of the Access Road and access tracks within the Marine Crossing GTP ROW • Site preparation for camp, stockpiling and laydown area construction • Installation and maintenance for ESC, stormwater and wastewater measures/facilities (temporary and permanent structures), including drainage trenches, embankments, sediment traps, ponds, storage treatment and discharge points • Low hazard dam design, construction, operation and maintenance • Installation and relocation of services/site facilities • Operation and maintenance of facilities, including washdown facilities, sewage treatment facilities, refuelling stations and workshops • Installation of the GTP • Rehabilitation and reinstatement of embankments, landforms, vegetation and cultivation areas, trenches, drains, ponds and dams
Environmental impact	• Increase mosquito and biting midge breeding sites • Impacts on human health, including site workers and personnel • Impacts on human (and animal) health of nearest sensitive receptors, including residents and site personnel at neighbouring commercial/industrial sites and members of the community • Increased risk of exposure of site personnel to existing breeding sites and dispersal locations • Nuisance complaints

4. Objectives, performance criteria and targets

The specific details on objectives, performance criteria and targets of the MMMP are outlined in Table 4.1.

Table 4.1 Objectives, performance criteria and targets

Item	Outcome
Objectives	• Comply with GRC requirements • Treatment strategies implemented comply with the Mosquito Management Code of Practice for Queensland (LGAQ, 2002) • Achieve continual improvement in risk assessment and impact management performance through periodic review of surveillance and treatment activities and procedures
Performance criteria	• Comply with legislative requirements and permit/development approval conditions • Communicate findings, performance and corrective actions implemented to GRC and the Regional Mosquito Management Forum annually or on request from GRC • No environmental harm resulting from the implementation of mosquito management or treatment strategies • No outbreaks of mosquito-borne disease within the Marine Crossing GTP Project area • All staff to be adequately trained in mosquito and biting midge exposure prevention and awareness prior to work commencing
Targets	• Identify triggers for initiating treatment strategies (refer Section 5.2) • Develop treatment strategies that environmentally sound, effective and cost efficient • Identify suitable surveillance procedures and treatment efficacy targets • Staff training details correctly recorded in training register and available for auditing purposes • Implementation of all mitigation measures outlined in this MMMP

5. Implementation strategy

5.1 Risk assessment and management approach

Under this MMMP it is proposed to adopt a risk management approach to managing the risks associated with the Marine Crossing GTP Project relating to the potential impacts of biting midge and mosquito species. The risk management process is based on AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines. Adopting this approach provides a structured method for the identification, assessment, management, monitoring and reporting of risks potentially affecting or affected by the Marine Crossing GTP Project.

In order for a risk to exist there must be the potential for an event to occur, a pathway of exposure and a receptor. These are described in the following sections.

5.1.1 Event

The potential events associated with biting midge and mosquito species have been identified as impacts in Table 3.2, which include:

- Increased mosquito breeding sites affecting human health (site personnel, nearest sensitive receptors and community)
- Exposure of site personnel to existing biting midge and mosquito breeding sites and dispersal locations resulting in nuisance complaints and affecting human health

5.1.2 Receptors

The potential receptors include:

- Site personnel
- Neighbouring residents
- Members of the community utilising areas surrounding the Marine Crossing GTP Project

5.1.3 Pathways for exposure

The potential pathways for exposure include:

- Construction activities associated with the Marine Crossing GTP Project, which bring humans into contact with breeding sites or dispersal locations due to:
  - Location of the activity
  - Timing of the activity (daily shift and/or seasonal)
  - Nature of the activity resulting in the creation of pooled water (permanent or temporary) due to design of water storage structures, earthmoving for drainage and placement of material stockpiles, placement of equipment items creating opportunities for containing runoff or rainfall and release/discharge of water and wastewater from storage/treatment facilities/locations
- Operational activities associated with the Marine Crossing GTP ROW, which create opportunities for increased human contact with breeding sites or dispersal locations due to differential settlement or subsidence of GTP ROW or other backfilled areas creating habitat suitable for additional breeding sites

5.1.4 Risk assessment and management process

The risk assessment and management process will follow the fundamental process of:

- Identify risks

- Manage risks and potential for exposure
- Monitor, record and report risk, exposure and potential impacts identified
- Review, audit and update treatment strategies, procedures and mitigation measures to achieve continual improvement in performance and compliance with performance criteria for this MMMP

5.1.5 Treatment triggers

Triggers for treatment will largely depend upon the target environment, the terrain, accessibility and location of breeding sites, the mosquito species involved, tidal flows and the weather conditions. Considerations may include:

- Tides
- Rainfall events
- Season
- Potential for exposure of site personnel
- Complaints received
- Scheduled work
- Visual inspection results

It is difficult to predict a definitive level of rainfall that will necessitate treatment. A number of variables such as duration and amount of rainfall received, the period since the last rainfall event, barometric air pressure, wind velocity and temperature may all combine in different combinations, with different outcomes. The variability of these elements precludes the ability to consistently place definitive measurement on such elements.

This MMMP will be updated following the completion of the initial identification of risks, within one month of the six-monthly review and update of the risk assessment and/or within one month of reporting/consultation with GRC or the Regional Mosquito Management Group Forum or when requested by the administering authority outlined in Table 5.1 and will aim to specify treatment thresholds. Guidance will also be sought from GRC for evaluation of trigger conditions and when it is considered that a major mosquito event is imminent.

Risk assessment and management actions are outlined in Table 5.1

Table 5.1 Risk assessment and management actions

Action	Task	Timing	Responsibility	Trigger/s
Identify risks	• Review GRC mosquito breeding area mapping	Pre-disturbance	Construction Contractor	• Pre-disturbance action requirement
	• Document potential breeding sites, high risk locations for exposure of site workers and personnel through construction activities and high risk times for exposure to breeding sites or dispersal locations	Pre-disturbance	Construction Contractor	• Pre-disturbance action requirement
	• Establish communication pathways and systems for consultation/participation with GRC and the Regional Mosquito Management Group Forum	Pre-disturbance	Construction Contractor	• Annual reporting schedule • On request from GRC, QH or Department of Environment and Heritage Protection (DEHP) (formerly DERM)
	• Establish treatment triggers and thresholds for implementing corrective actions for treatment strategies	Pre-disturbance	Construction Contractor	• Health, Safety and Security Management Plan (HSSMP) requirements • On request from Health, Safety and Security Manager • Complaint/s received
	• Establish communication pathways and systems for promoting mosquito management awareness, monitoring and reporting mosquito-related health issues/statistics affecting site personnel and managing complaints	Pre-construction	Construction Contractor	• Induction training schedule • Health, Safety and Security Management Plan (HSSMP) requirements • On request from Health, Safety and Security Manager
	• Review construction program and work schedule	Pre-construction and construction	Construction Contractor	• Monthly programming and scheduling updates
	• Schedule visual inspections of construction activities within the Marine Crossing GTP Project	Construction	Construction Contractor	• Daily inspection schedule
Manage risks and potential exposure	• Implement design constraints for water storage facilities	Pre-construction and construction	GLNG Operations and Construction Contractor	• Design/construction specifications

Action	Task	Timing	Responsibility	Trigger/s
	• Develop site procedures and specifications for water management onsite, maintenance of water storage and housekeeping for construction work areas and disturbance areas	Pre-construction	Construction Contractor	• Identification of potential breeding site/s • Identification of potential exposure opportunities
	• Implement treatment strategies and corrective actions when trigger levels/threshold criteria exceedances are identified during monitoring	Construction	Construction Contractor	• Visual inspection results
	• Implement changes to construction program and work schedule to minimise exposure opportunities at high risk locations or during high risk periods	Construction	Construction Contractor	• Daily triggers – dawn/dusk and outgoing tides • Seasonal triggers – summer months and high rainfall periods • Meteorological event triggers, including significant rainfall events (2 year ARI event or greater)
Monitor, record and report risk/s, exposure and potential impacts identified	• Conduct visual inspections of site conditions, housekeeping performance and maintenance requirements for drainage measures, water storage	Construction	Construction Contractor	• Daily visual inspection schedule
	• Complete monitoring checklist for visual inspections and report new locations for potential breeding sites or exposure opportunities	Construction	Construction Contractor	• Weekly monitoring report schedule
	• Record on ongoing basis, health data and statistics for site workers and personnel affected by mosquito-related health impacts	Construction	Construction Contractor	• Complaints received • First aid/medical treatment records • Absenteeism data (eg medical certificates)
	• Record on ongoing basis, complaints received relating to mosquito nuisance	Construction	Construction Contractor	• Complaints received
	• Report health data and statistics for site works and personnel affected by mosquito-related health impacts	Construction	Construction Contractor	• Annual reporting schedule • On request by GRC or QH • HSSMP requirements
	• Report the number of complaints received relating to mosquito nuisance	Construction	Construction Contractor	• Monthly reporting schedule • On request by GRC, QH or DEHP
	• Review and update risk assessment	Construction	Construction Contractor	• Marine Crossing GTP Project auditing schedule • GRCMMP (GRC, 2010) • Guidelines to minimise mosquito and biting midge problems in new development areas (QH, 2002)

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Action	Task	Timing	Responsibility	Trigger/s
	• Report on risk assessment findings and performance of treatment strategies implemented to GRC and the Regional Mosquito Management Group Forum	Construction	Construction Contractor	• Annual reporting schedule • On request by GRC • GRCMMP (GRC, 2010) • Mosquito Management Code of Practice for Queensland (LGAQ, 2002)
	• Report awareness training data (number of inductions completed), visual inspection performance, site personnel health monitoring and risk assessment review findings and corrective actions implemented to GRC and the Regional Mosquito Management Group Forum	Construction	Construction Contractor	• Annual reporting schedule
	• Review and evaluate the performance of treatment strategies implemented	Construction and operation	Construction Contractor and GLNG Operations	• Marine Crossing GTP Project auditing schedule • GRCMMP (GRC, 2010) • Mosquito Management Code of Practice for Queensland (LGAQ, 2002) • Guidelines to minimise mosquito and biting midge problems in new development areas (QH, 2002)

5.2 Treatment strategies

To achieve environmentally sustainable outcomes, this MMMP focuses on indirect management controls, such as site management and inspection, promoting awareness, personal protection and design controls. The use of direct management controls, such as chemicals and habitat modification are regarded as the least preferred methods and shall be implemented under the direction of GRC and/or DNRM (formerly DERM).

In the event that direct control measures are required, permits and development approvals will be required for work undertaken by GLNG Operations, unless the work/activities comply with a relevant exemption or a self-assessable code. Work that is likely to require a permit or development approval from the administering authority/authorities or that may be prohibited development within specified areas of the Marine Crossing GTP Project includes:

- Operational work for habitat modification (eg runnelling)
- Use of chemical control measures/agents

The relevant legislation will include (but not be limited to):

- *Fisheries Act 1994*
- *Marine Parks Act 2004*
- *Nature Conservation Act 1992*
- *Sustainable Planning Act 2009*
- *Transport Infrastructure Act 1994*

The potential triggers for environmental permits, development approvals or prohibited development are summarised in Table 5.2.

Table 5.2 Summary of permit, approval and prohibited development triggers for approved direct control measures for mosquito and biting midge

Legislation	Permit/ approval	Trigger description/s	Direct control activity
Sustainable Planning Act 2009 (SPA)	Development approval for operational work	• Assessable development (under Schedule 3 of SPA) • Disturbance of marine plants / habitat (*Fisheries Act 1994*) • Fish stocking in ponds (*Fisheries Act 1994*) • Operational work within a waterway (*Fisheries Act 1994*) • Operational work below occurring below Mean High Water Springs (MHWS) or between MHWS and Highest Astronomical Tide (tidal work) (*Coastal Protection and Management Act 1995* and *Transport Infrastructure Act 1994*) • Resource Entitlement for operational work on State land (under Schedule 14 of SPA) • Resource Allocation for use of State resources under the *Fisheries Act 1994* or the *Coastal Protection and Management Act 1995*	• Habitat modification involving runnelling • Operational work to modify drainage structures, overland flow paths or waterways • Operational work (tidal work)
Fisheries Act 1994	Resource allocation	• Use of State resource/s administered under the *Fisheries Act 1994*	• Removal or excavation of material from a waterway

Legislation	Permit/ approval	Trigger description/s	Direct control activity
Coastal Protection and Management Act 1995	Resource allocation	• Use of State resource/s administered under the *Coastal Protection and Management Act 1995*	• Removal or excavation of material from below High Water Mark (MHWS) or within a Coastal Management District
Marine Park Act 2004	Marine park permit or prohibited development	• Operational work within a Marine Park or Protection Zone	• Operational work within tidal areas of Curtis Island that are subject to the Dugong Protection Zone and other QPWS managed areas
Nature Conservation Act 1992	Clearing permit	• Clearing protected plants	• Clearing for operational work associated with habitat modification activities

The following is a list of management strategies to be adopted for the Marine Crossing GTP Project during construction activities.

5.2.1 Personal protection

- Personnel will wear hats, socks, and loose fitting, light coloured clothing with long pants and long sleeves when outdoors. Head nets and gloves will also be worn, if required. Head nets with meshes are recommended. Sleeves and collars will be kept buttoned and trousers tucked into boots. In severe cases clothing may be impregnated with pyrethrum
- Where practicable, personnel will avoid peak biting times; specifically at dusk
- Personnel will be educated on the mosquito and midge problem onsite and educated in management strategies and responsibilities for their own health (through induction, regular communication and posters throughout the construction site)
- The workforce will be notified if there is a mosquito or biting midge problem and individuals will implement appropriate personal protection measures
- When required, personnel will use tropical strength mosquito repellents

5.2.2 Design

- All onsite work offices and day accommodation for the Marine Crossing GTP Project will be air conditioned and screened. Screens will be the correct mesh size, fit tightly and be in good repair. All screen doors on buildings will open outward and have automatic closing devices. Where required, Bifenthrin barrier treatments around personnel areas will be implemented to reduce adult biting midge numbers

5.2.3 Source reduction

Container breeding

Management actions for container and vessel breeding include:

- The creation of areas and structures in which water could be retained for more than five days will be avoided (eg vigilance relating to potential mosquito breeding habitat)
- The Project area will be inspected daily for the presence of any containers and vessels capable of holding water (including bunded areas) to prevent water pooling. These areas will be drained and treated as required

Drainage systems

Drains will be constructed in a manner that does not lead to the creation of new mosquito breeding sites. The design of drainage systems will consider the following design features:

- Erosion control measures will be installed on drain batters to prevent silting
- Erosion control measures will be visually inspected daily and silt removal will be conducted as required, in accordance with the Stormwater Management and Erosion and Sediment Control Plan (SMESCP) to prevent creation of favourable breeding conditions
- Any plant species selected to stabilise slopes will be terrestrial and not be likely to invade water bodies and create breeding grounds for mosquitoes
- Drainage design will prevent the accumulation of silt and debris that may create pooling of water or favourable breeding conditions
- All maintenance of drains will be carried out in accordance with procedures which ensure that further habitats for mosquitoes or midges are not created by wheel ruts
- Drains will be maintained free of siltation and debris
- Drains will be inspected as per the monitoring programme in Table 5.1

Construction

Construction activities may create mosquito/biting midge breeding sites. In order to minimise the potential for this to occur, the following actions will be implemented:

- Access roads will be fitted with culverts where necessary, in order to prevent water ponding upstream, and thus prevent mosquito breeding
- Regular dewatering of trenches will minimise the potential for any standing water during trenching activities
- Regular reuse and/or removal of water from all water storage systems, such as the sedimentation pond, water treatment plant, hydrotest water dam and freshwater storage tanks will minimise sources of standing water and thereby minimising the potential for mosquito breeding and larvae forming on the edges of the water storage tanks or ponds
- Construction site pads will be constructed of compacted gravel and concrete hardstand surfaces, which will direct water to drain to the stormwater storage and prevent mosquito access to excess water
- Reinstated sites will be recontoured to the original surface profiles to prevent ponding

5.2.4 Controls

Chemical controls

If necessary and under the direction of GRC, Department of Natural Resource Management (DNRM) (formerly DERM), DEHP or QH, areas that cannot be managed with other controls (eg planning and risk management methods) will be treated as required with a control agent. Relatively few chemicals can be recommended for use in wetlands, whether natural or constructed (usually flow into natural water systems), because of environmental concerns. The importance of pre-inspection activities is further reinforced when considering the selection of the most suitable treatment chemical, as the effectiveness of the approved control agent is dependent on local conditions and the mosquito species that is being targeted.

Consultation will be undertaken with GRC and QH prior to the planning of and implementation of this management option.

If chemical controls are to be used, in addition to controls specified by GRC or other administering authorities, the following management actions will be adhered to:

- A suitably qualified consultant will be engaged to develop a treatment programme that meets the Mosquito Management Code of Practice (LGAQ, 2002)
- A licensed and experienced operator will be engaged to undertake the chemical treatment
- Only environmentally safe bio-rational agents would be used for larval control and adulticiding. Chemicals used will be registered and used in accordance with manufacturer's instruction
- Treatments will not be undertaken prior to a breeding event
- Areas identified for treatment will consider proximity to environmentally sensitive areas and appropriate buffer zones will be designated
- A treatment register will be maintained and will include:
  - Areas treated
  - Date and time of treatment
  - Equipment
  - Pilot/operator
  - Insecticide dose
  - Insecticide batch measure
  - Result

Larviciding

Larviciding is the control of mosquito larvae prior to their metamorphosis into adult flying mosquitos. Several products are available for use in larvacidal applications and selection of these products will be confirmed prior to construction.

It should be noted chemicals should only be used after full assessment of potential adverse effects, consideration of the receiving environment and onsite risk/benefit analysis.

Adulticiding

Adulticiding is the control of adult, mature mosquitoes following their metamorphosis from the larval form. This stage of the lifecycle constitutes the pest stage. Several products are available for use in adulticidal applications and selection of these products will be confirmed prior to construction.

5.3 Management and mitigation measures

The mitigation and management measures to be implemented are outlined in Table 5.3. The person(s) responsible for compliance with this MMMP during the construction period and operational phase and their responsibilities are also summarised in Table 5.3.

Table 5.3 Mitigation measures for mosquitoes and biting midges

Actions	Action timing	Responsibility
Review aerial photography and ecological survey data and identify potential mosquito and biting midge breeding locations that exist within the Marine Crossing GTP Project area and surrounding areas up to 1 km from the boundary	Pre-disturbance	Construction Contractor
Develop a site register and record all potential mosquito and biting midge breeding sites identified within the Marine Crossing GTP ROW and associated construction areas	Pre-disturbance	Construction Contractor

Actions	Action timing	Responsibility
Identify all potential mosquito and biting midge breeding sites recorded in the site register that occur within the Marine Crossing GTP Project area and 1 km buffer, on detailed design drawings	Pre-disturbance	Construction Contractor
Physically locate and flag all potential mosquito and biting midge breeding sites, recorded in the site register and marked on detailed design drawings, that occur within the Marine Crossing GTP Project area, in the field using cadastral survey	Pre-disturbance	Construction Contractor
Identify treatment triggers and adopt threshold criteria that result in the initiation/implementation of specified control strategies, monitoring, reporting or corrective actions and external notification procedures	Pre-disturbance	Construction Contractor
Develop procedures that provide guidance for the approved response to triggering of threshold criteria	Pre-disturbance	Construction Contractor
Identify proposed construction activities that will potentially exacerbate mosquito and biting midge impacts	Pre-construction	Construction Contractor
Develop specific avoidance measures and incorporate the implementation of these measures in the relevant Work Method Statements (WMS) and Job Safety and Environmental Assessments (JSEAs)	Pre-construction and construction	Construction Contractor
Review site layout plans and identify (and relocate) activities that can be relocated within the Marine Crossing GTP Project area, away from identified potential mosquito breeding sites	Pre-construction and construction	Construction Contractor
Review site layout plans and detailed design drawings and identify and communicate locations within the Marine Crossing GTP Project that are no-go zones or restricted activity areas during specified times of the day (eg dawn and dusk within 500 m of intertidal areas or creeks), during particular seasons or for a specified time after a threshold meteorological event	Pre-construction and construction	Construction contractor
Review the construction work schedule and identify (an reschedule) activities that can be rescheduled to occur during the cooler and drier periods of the year during daytime hours (not dawn or dusk hours)	Pre-construction and construction	Construction Contractor
Review detailed design drawings and site layout plans and identify structures (temporary and permanent) that will potentially exacerbate mosquito and biting midge impacts	Pre-construction and construction	Construction Contractor
Develop and implement specific indirect control measures for managing mosquito and biting midge impacts throughout construction that will be documented and implemented through design specifications and construction site maintenance procedures	Pre-construction and construction	Construction Contractor
Develop and implement a daily visual monitoring procedure for detecting the presence of mosquito and biting midge and favourable habitat conditions (naturally occurring and construction-related)	Pre-construction	Construction Contractor
Conduct daily visual inspections, identify, record and report favourable habitat conditions (naturally occurring and construction-related), ineffectiveness and/or non-conformance with avoidance and control measures, activity specifications, design specifications, WMS, JSEAs and triggers for corrective actions	Construction (daily)	Construction Contractor

Actions	Action timing	Responsibility
Identify and communicate visual monitoring parameters and performance criteria that will be adopted during operation and maintenance of the Marine Crossing GTP to measure, monitor and report ineffectiveness or non-conformance due to changed conditions and trigger corrective action and maintenance activities to manage and control mosquito and biting midge impacts	Post-construction	GLNG Operations
Develop and implement a visual monitoring procedure that will be implemented during operation and maintenance inspections to measure, monitor and report ineffectiveness or non-conformance due to changed conditions	Operation and maintenance	GLNG Operations

5.4 Reporting and record keeping

5.4.1 Construction phase

During the construction period, the Construction Contractor will be responsible and will undertake the following:

- Retain a copy of the MMMP onsite for reference by appropriate personnel and provide a copy to contractors and subcontractors
- Ensure compliance with the MMMP
- Ensure that contractors and subcontractors engaged in the construction are advised of their responsibilities to undertake their activities in accordance with the MMMP
- Ensure that contractors and subcontractors engaged in the construction activities within the Project area are advised of their responsibilities regarding mosquito management
- Ensure that an auditing/monitoring programme is implemented
- Ensure appropriate records are kept and maintained
- Ensure performance and compliance with the MMMP is reported in the monthly performance report to GLNG
- Prepare incident reports and implement corrective actions
- Recommend additions or changes to the MMMP based on experience gained from implementation of the MMMP

5.4.2 Operational phase

During the operational phase and subsequent de-commissioning period, GLNG Operations will be responsible and will undertake the following:

- Retain a copy of the MMMP
- Ensure compliance with the MMMP
- Ensure appropriate records are kept and maintained on-site
- Ensure that the monitoring programme is implemented on an as needed basis
- Prepare incident reports and implement corrective actions as required

5.4.3 Continual improvement

This MMMP will be reviewed annually to ensure GRC, DNRM and QH requirements and standards are met and make any necessary changes to improve the MMMP

5.5 Training and awareness

All construction personnel will be made aware of the MMMP during the Project Environmental Induction Programme. A register of induction training will be maintained.

6. Compliance evaluation

6.1 Mosquito and midge population monitoring

To determine the ongoing prevalence and distribution of mosquito and larvae and to enable timely control activities the following monitoring will be undertaken during the peak mosquito breeding season (December to March), as outlined in Table 6.1

Table 6.1 Ongoing monitoring programme during peak breeding season

Monitoring sites	Frequency
Visual inspection for site condition and housekeeping (all active areas)	Daily
Pooled water and containers around the site	
Pooled water Visual inspection	Weekly
Sampling of mosquito larvae	Upon request by administering authority
Stormwater drainage systems	
Visual inspection	Daily
Sampling of mosquito larvae	Upon request by administering authority
Areas with pooled water Visual inspection	Weekly
Construction site pads, including ponds and water storage facilities	
Visual inspection	Daily
Sampling of mosquito larvae	Upon request by administering authority
Areas with pooled water Visual inspection	Weekly
Sampling of mosquito larvae	Upon request by administering authority
Low lying areas	
Visual inspection	Weekly following heavy rain events
Sampling of mosquito larvae	Upon request by administering authority

In addition to this monitoring, close liaison with GRC and QH will occur to obtain results of any previous surveys undertaken within the area, and to be notified of major mosquito events within the Marine Crossing GTP Project area.

7. Non-conformance

Non-conformance, preventative and corrective action procedures are detailed in Section 5.6 of the CEMP.

7.1 Corrective Action

The GLNG Project community relations grievance management process and complaints register will be developed and implemented under the Construction Environmental Management Plan (CEMP) to capture complaints from individuals or communities with respect to any issues including mosquito and midge prevalence.

7.2 Notification of vector borne disease

A register will be maintained of any construction personnel member infected by the following vector borne diseases:

- Ross River virus
- Japanese encephalitis
- Malaria (unspecified and other)
- Malaria Falciparum
- Malaria Malariae
- Malaria Ovale
- Malaria Vivax
- Barmah Forest virus
- Dengue fever

Data on vector borne disease numbers for the region can be requested from QH if deemed necessary. However, these records are not always indicative of the mosquito problem as records only show those who have been diagnosed by a doctor and do not link the result to the area of transmission.

8. References

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