F3 Water Quality

Santos | PETRONAS

Report

GLNG LNG Facility

Wastewater Discharge Assessment

NOVEMBER 2009

Prepared for

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Abbreviations

Abbreviation	Description
ALS	Australian Laboratory Services
ANZECC	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
AS	Australian Standards
AWQG	Australian Water Quality Guidelines
ºC	Degrees Celsius
DO	Dissolved Oxygen
L	Litre
LD	Less than Detection Limit
mg	Milligram
Mn	Manganese
N	Nitrogen
NEPM	National Environment Protection Measures
NO_2	Nitrite
NO_3	Nitrate
N_{org}	Organic Nitrogen
NTU	Nephelometric Turbidity Units
P	Phosphorus
Pb	Lead
PCIMP	Port Curtis Integrated Monitoring Program
QWQG	Queensland Water Quality Guidelines
ROC	Reverse osmosis concentration
TKN	Total Kjeldahl nitrogen
TN	Total Nitrogen
TON	Total Organic Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
WQO	Water Quality Objectives
WWTP	Wastewater Treatment Plant
µg	Microgram

1 Introduction

This report has been prepared as part of the Supplementary EIS to provide additional information on the potential impacts of wastewater and brine discharges into Port Curtis in response to project description changes. This report builds on information provided in the coastal environment assessment of the proposed impacts of the brine discharge presented in EIS Section 8.7 and EIS Appendix R2 and its purpose is to:

- Describe changes to the proposed wastewater management approach;
- Assess the coastal environment impacts assessment to the proposed discharge; and
- Address comments that were raised in government agency and public submissions on the EIS.

1.1 Background

The LNG facility for the GLNG Project will be located at the Hamilton Point West site adjacent to China Bay on Curtis Island. A desalination plant will be constructed to provide the water supply for the LNG facility. This will generate a brine stream which will be discharged into Port Curtis. The impacts of this discharge were assessed in EIS Appendix R2.

Construction of the LNG facility will take approximately four years. The construction workforce will peak at approximately 3,000 people for the stick-built option. If pre-assembled modules are used this may reduce to 2,000. Sixty five percent (65 %) of the construction workforce will be accommodated in an accommodation facility to be established on Curtis Island. The accommodation facility will be completely self-contained and will provide the housing, dining, logistics and recreation facilities for the residents.

A package sewage treatment facility will be constructed to treat wastewater generated from the accommodation facility and from the LNG facility. The sewage treatment facility for the accommodation facility was discussed in EIS Section 3.8.2.8. At the time of preparing the EIS it was proposed that treated effluent from the accommodation facility would be barged onto the mainland for disposal at an existing wastewater treatment plant. The sewage treatment for the LNG facility was discussed in EIS Section 3.8.3.12; at that time it was proposed that treated effluent from the LNG facility would be disposed through irrigation.

It is now proposed that treated effluent from the accommodation facility and from the LNG facility will be discharged directly into Port Curtis. The treated effluent will be discharged either as a single stream (Scenario 1) or in combination with the brine discharge from the desalination plant (Scenario 2). Both Scenarios have been assessed. The impacts of brine discharge directly into Port Curtis were considered in EIS Appendix R2.

1.2 Objectives

The main objective of this report is to investigate the potential risks posed by effluent discharges from the wastewater treatment plant (WWTP) and discharges of Reverse Osmosis Concentration (ROC) from the desalination plant to the beneficial uses/environmental values of the receiving marine waters, both in and out of the mixing zone area.

1.3 Scope of Works

The scope of this assessment was to:

- Describe the existing environmental values and legislation, in terms of water quality objectives (Section 2);
- Characterise baseline water quality at and surrounding the proposed outfall of the wastewater discharge (Section 3);
- Review and interpret outfall modelling (near and far field) of the proposed WWTP and ROC discharges, undertaken by WBM (Section 4); and
- Assess the impacts of wastewater discharge and present mitigation measures to avoid, mitigate or manage impacts within Port Curtis (Section 5).

1.4 Existing Environment

Port Curtis falls within the Shoalwater Coast bioregion as defined in the Integrated Marine and Coastal Regionalisation for Australia (Commonwealth of Australia 2006). This bioregion includes the coastal and island waters from Mackay south to Baffle Creek. Port Curtis is a natural deepwater embayment that is protected from the open ocean by Curtis and Facing Islands. Coastal geomorphology in the main study area is characterised by a partially enclosed embayment and shallow estuaries, including small, continental rocky islands, intertidal flats and estuarine islands. Port Curtis estuary is a composite estuarine system that includes the Calliope and Boyne Rivers, The Narrows, Auckland Creek and several smaller creeks and inlets that merge with deeper waters to form a naturally deep harbour protected by southern Curtis Island and Facing Island. Elevated natural turbidity occurs within the shallow marine and estuarine waters with significant input of freshwater and alluvial sediments from the Boyne and Calliope Rivers.

Legislative Context

The GLNG Project is subject to both Commonwealth and State legislation as described in the EIS. The following pieces of legislation are of particular relevance to the discharge of wastewaters into Port Curtis:

Commonwealth legislation

- Great Barrier Reef Marine Park 1975 and regulations made under this Act control sewage discharges into Commonwealth waters.

State Legislation

- *Environmental Protection (Water) Policy 2009.*

Plans and Policies

The Curtis Coast Regional Management Plan (Curtis Coastal Plan 2003) describes how the coastal zone in the Curtis Coast region is to be managed within the policy framework established by the State Coastal Management Plan – Queensland's Coastal Policy. There are two key Coastal Management Plan Policies that will apply to the wastewater discharge as follows:

- Policy 2.4.1 – Water quality management; and
- Policy 2.4.2 – Wastewater discharges to coastal waters.

2.2 Environmental Values

The *Environmental Protection (Water) Policy 2009* (EPP, 2009) seeks to protect and/or enhance the suitability of Queensland's waters for various beneficial uses. The policy identifies environmental values and management goals for waters within Queensland and guides the setting of water quality objectives to protect the environmental values of any water resource. The environmental values include the biological integrity of the aquatic ecosystem, primary industry or agricultural uses, recreation, drinking water supply, industrial, and cultural and spiritual values.

Specific environmental values and water quality objectives are not identified within the EPP 2009 for the waters within the Curtis Coast region. However, local government, industry and the Gladstone Port Authority are involved in a collaborative project as part of the Gladstone Harbour Protection and Enhancement Strategy that has identified preliminary environmental values for some waterways in the Curtis Coast region.

Environmental values adopted for Port Curtis have been identified through the Strategy's preliminary environmental values and are summarised in Table 2-1.

Cultural Heritage

The Curtis Coast region has a unique historical background with a diversity of features and places of cultural heritage significance including memorials, shipwrecks, middens and lighthouses. The region is of cultural significance to Indigenous Traditional Owners and fulfils an essential role in their traditional and contemporary lifestyle.

Marine areas and islands such as the Capricorn Group, The Narrows and Gladstone Harbour are within the Great Barrier Reef Region, most of which was inscribed on the World Heritage List in 1981. A World Heritage listing obliges governments to protect, conserve, present, rehabilitate and transmit to future generations these World Heritage Areas (Curtis Coast Regional Coastal Management Plan, 2003).

Aquatic Ecosystem

The undeveloped coastal areas within the Curtis Coast region contain sites of high conservation value such as a diversity of wetlands, seagrass beds, dugong habitat, turtle nesting beaches, coral cays and planar reefs (Curtis Coast Plan, 2003).

Primary Industries

On Curtis Island, land use is characterised largely by various areas of State owned lands (including some protected areas), forestry and cattle grazing.

The key industrial land uses in the Curtis Coast region include the Port of Gladstone; the Gladstone State Development Area and associated major infrastructure; major urban centres at Gladstone, Boyne Island, Tannum Sands and Calliope.

Commercial fisheries in the region access the inshore and offshore areas of Curtis Island and the Narrows. A significant commercial mud crab fishery exists within Port Curtis.

Recreation

The recreation amenity of Curtis Island, and more generally the Curtis Coast region, is high, due to the coastal resources available and cultural sites.

Table 2-1 Environmental Values for the Receiving Environment (Port Curtis)

Environmental Values	Relevance to Port Curtis
Protection of high ecological value waters	✓
Protection of slightly to moderately disturbed water	✓
Protection of highly disturbed waters	X
Suitability for agricultural use	X
Suitability for aquaculture (e.g. red claw, barramundi)	✓
Suitability for human consumers of aquatic food	✓
Suitability for primary recreation (e.g. swimming)	✓
Suitability for secondary recreation (e.g. boating)	✓
Suitability for drinking water supplies	X
Suitability for industrial use (including manufacturing plants, power generation)	✓
Protection of cultural and spiritual values	✓

Table Notes:

✓: Marine environment is suitable for the environmental value.

X: Marine environment is not suitable for the environmental value.

2.3 Water Quality Objectives

The water quality objectives (WQO's) for nutrients and physical parameters are presented in Table 2-2. These are based on the Queensland Water Quality Guidelines (QWQG 2006) Table 2.5.2.1, for slightly to moderately disturbed (as defined under the EPP) enclosed coastal systems in the Central Coast Queensland region. WQOs are presented for both open coastal and enclosed coastal areas. The guidelines for enclosed coastal systems were selected over those of the open coastal systems as the study area lies within the inner reaches of Port Curtis.

Table 2-2 shows the water quality parameters analysed and their corresponding WQO's.

Table 2-2 Water Quality Parameters and WQOs

Physical and Nutrient Parameters	WQO	
	Enclosed Coastal	Open Coastal
Turbidity	6 NTU	1 NTU
TSS	15 mg/L	10.0 mg/L
Total Nitrogen	200 µg/L	140 µg/L
Total Phosphorus P	20 µg/L	20 µg/L
Ammonia	8 µg/L	6 µg/L
Oxidised Nitrogen (Nitrate + Nitrite)	3 µg/L	3 µg/L
Dissolved Oxygen	lower limit-90%, upper limit-100%	lower limit-95%, upper limit-105%
pH	lower limit- 8, upper limit-8.4	lower limit-8, upper limit-8.4

Notes:

WQO's are from Queensland Water Quality Guidelines (QWQG 2006) Table 2.5.2.1, for slightly to moderately disturbed enclosed and open coastal systems in the Central Coast Queensland region.

The enclosed coastal objectives have been given preference as the survey location is within inner Port Curtis. Open Coastal objectives were presented for purposes of comparison.

Water Quality Baseline Conditions

3.1 Methodology

3.1.1 Sampling Locations

Water quality monitoring was undertaken by URS on 28th and 29th September at five locations to assess the water quality in the immediate and surrounding vicinity of the outfall for the proposed wastewater discharge. Figure 3-1 identifies the sampling locations.

3.1.2 Sampling Techniques

In-situ measurements of pH, dissolved oxygen (DO), temperature, conductivity, turbidity and salinity were recorded for the near surface, mid and near bottom depths of the water column for each location using a DKK-TOA Electronics Ltd multi-parameter water quality meter model number WQC-24 fitted with a turbidity sensor.

Grab samples from the near surface, mid and near bottom depths of the water column were then composited to form a representative sample for each site. The samples were sent to Australian Laboratory Services (ALS) laboratory within 24 hours of sampling for analysis of the following parameters: suspended solids, ammonia as N, Total N, Total P, Nitrate Nitrogen, as N and Total Chlorine.

3.1.3 Analytical Techniques

The analytical procedures used by the laboratory to analyse the water samples are in accordance with established internationally recognized procedures such as those published by the United States Environmental Protection Agency (USEPA), American Public Health Association (APHA), Australian Standards (AS) and NEPM.

N W E S

Kilometers
0 0.1 0.2 0.4 0.6

Scale 1:65 000 (A4)
Datum : GDA 94

LNG Facility Footprint
LNG Facility Indicative Site Boundary
Water Quality Sampling Locations
Wastewater Outfall

LNG

URS

GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT MARINE WATER QUALITY ASSESSMENT		**WATER QUALITY SAMPLING LOCATIONS WASTEWATER OUTFALL**
Drawn: MG	Approved: RC	Date: 05-11-2009
Job No.: **4262 6440**	File No.: 42626440-g-2159.mxd	Figure: **3-1** Rev. B A4

3.2 Results

Table 3-1 and Table 3-2 provide the results for the various parameters measured and analysed for each of the 5 sampling locations. Water quality objectives are included for reference.

Table 3-1 Physico-chemical Water Quality Results (in-situ)

	Location	1		2		3		4		5		
Parameter	Date, Time	28/08 1640h	28/08 1640h	28/09 1650h	29/09 1735h	28/09 1450h	29/09 1520h	28/09 1600h	29/09 1450h	28/09 1615h	29/09 1425h	WQO
Depth (m)		2.4	2.3	2	2	9.5	8	14	12	13.5	14	
pH	Near Surface	8.11	8.1	8.1	8.11	8	8.08	8.05	8.04	8.07	8.07	Lower: 8.0
	Mid Depth	8.12	8.1	8.1	8.11	8	8.10	8.07	8.07	8.08	8.07	Upper: 8.4
	Near Bottom	8.13	8.2	8.2	8.13	8.1	8.40	8.07	8.10	8.09	8.06	
DO (%sat)	Near Surface	105	101	106	103	101	102	102	105	106	106	Lower: 90%
	Mid Depth	105	100	104	102	100	102	102	104	105	104	Upper: 100%
	Near Bottom	103	100	102	101	99	100	100	103	102	103	
Conductivity (mS/cm)	Near Surface	5.54	5.52	5.53	5.49	5.72	5.32	5.54	5.60	5.50	5.66	
	Mid Depth	5.56	5.59	5.53	5.63	5.43	5.56	5.55	5.66	5.51	5.68	NGV
	Near Bottom	5.59	5.83	5.54	5.82	5.82	5.82	5.71	5.69	5.58	5.69	
Salinity (ppt)	Near Surface	34.9	35.2	34.6	35.4	33.8	34.5	34.6	35.2	34.9	36.9	
	Mid Depth	34.9	35.1	34.6	35.4	33.9	34.8	34.8	35.5	34.9	36.9	NGV
	Near Bottom	35.0	35.3	34.7	35.6	33.8	34.9	34.9	35.5	35.1	37.0	
Temperature (ºC)	Near Surface	23.5	23.0	23.2	23.2	23.5	23.1	23.4	23.5	23.6	23.5	
	Mid Depth	23.5	22.9	23.1	23.0	23.5	23.1	23.4	23.5	23.5	23.5	NGV
	Near Bottom	23.4	22.9	23	23.1	23.4	23.0	23.3	23.4	23.5	23.4	
Turbidity (NTU)	Near Surface	3.1	1.6	4.2	3.2	**7.3**	**7.9**	4.3	**8.8**	**6.6**	4.6	6 NTU
	Mid Depth	2.0	1.9	4	3.1	**7.3**	**8.2**	4.4	**8.7**	5.3	4.1	
	Near Bottom	1.9	2.1	4.1	3.1	**7.7**	**8.4**	5.0	**8.9**	**6.7**	4.5	

Notes (Table 3-1):

WQOs are from Queensland Water Quality Guidelines (QWQG 2006) Table 2.5.2.1, for slightly to moderately disturbed enclosed coastal systems in the Central Coast Queensland region.
NGV- stands for No Guideline Value available under QWQG 2006.

WQO for temperature: QWQG 2006 recommends that local guidelines be developed. A full seasonal cycle of measurements is required to develop guideline values. Values in bold indicate exceedances of WQOs.

Table 3-2 Physico-chemical Water Quality Indicators - Suspended Solids, Chlorine and Nutrients

	1		2		3		4		5		
Parameter	28/08 1640h	29/09 1630h	28/09 1650h	29/09 1735h	29/09 1735h	28/08 1640h	28/09 1600h	28/09 1650h	29/09 1630h	28/09 1600h	WQO
Suspended Solids (mg/L)	6	**24**	13	**30**	11	8	**16**	**29**	15	**24**	15 mg/L
Total Nitrogen (µg/L)	**400**	**400**	**400**	**400**	**400**	**400**	**400**	200	**500**	200	200 µg/L
Ammonia as N (µg/L)	**40**	**60**	**50**	**60**	**90**	**40**	**70**	**100**	**30**	**70**	8 µg/L
Nitrite + Nitrate as N (µg/L)	**40**	**30**	**30**	**20**	**70**	**200**	**30**	**20**	**20**	**70**	3 µg/L
Total Phosphorus as P (µg/L)	**50**	**140**	**90**	**170**	**90**	**90**	**60**	**80**	**210**	**40**	20 µg/L

Notes (Table 3-2):

WQO's are from Queensland Water Quality Guidelines (QWQG 2006) Table 2.5.2.1, for slightly to moderately disturbed enclosed coastal systems in the Central Coast Queensland region.
NGV- stands for No Guideline Value available under QWQG 2006.
Values in bold indicate exceedances of WQOs.
Total Chlorine WQO: 95% level of protections adopted.

Detection Limits:
Suspended Solids (SS): 1 mg/L.
Nitrite + Nitrate as N : 10 µg/L .
Chlorine – Total Residual: 0.2 mg/L.
Ammonia as N: 10 µg/L.
Total Phosphorus as P: 10 µg/L.
Total Nitrogen as N: 100 µg/L.

3.2.1 Physico-chemical Water Quality Results (In-situ)

In-situ physicochemical characteristics were recorded on the 28th and 29th September 2009 on in-coming to high tide. The weather conditions were fine and no rainfall had occurred in the preceding week. Results for temperature, conductivity, salinity, dissolved oxygen, turbidity and pH measurements at surface, middle, and near-bottom depths are presented in Table 3-1.

pH

The pH levels were within the QWQG 2006 limits and are characteristic of seawater pH. There is minimal spatial variation among the locations, with most sampling points having pH levels that vary from 8.0 to 8.4.

DO

DO levels are generally were found to be slightly higher than the upper limits of the QWQG 2006 (90% - 100% saturation). Little difference was however found on a spatial level.

Conductivity and Salinity

Conductivity and salinity levels varied only slightly between locations (range between 33.8 ppt to 37.0 ppt). Samples were taken on or near high tide and are characteristic of seawater concentrations.

Temperature

Little difference in temperature was noted between locations. Temperature readings ranged between 23.0ºC to 23.6ºC. There was no evidence of thermal stratification at any of the sampling locations during the sampling period.

3.2.2 Turbidity and Suspended Solids

Turbidity levels at surface, middle, and near-bottom depths are presented in Table 3-1, whilst composite suspended solids results are presented in Table 3-2.

The levels of turbidity and suspended solids varied between sites. The prescribed values under QWQG 2006 are 6 NTU and 15 mg/L, respectively. Turbidity levels ranged from 1.6 NTU to 8.9 NTU while suspended solids varied from 6 mg/L to 30 mg/L. The elevated levels recorded were described as being consistent for high energy environments where current-driven sediment resuspension contributes to water column sediment load (WBM, 2008).

3.2.3 Nutrient Levels

Table 3-2 provides the nutrient results for each sampling locations.

Total nitrogen levels were elevated (200-400 µg/L) compared to the QWQG limit of 200 µg/L. The levels of Total Kjeldahl Nitrogen (200-400 µg/L), indicate that the majority of nitrogen is present in organic form. Ammonium nitrogen levels were significantly higher than the QWQG limit of 8 µg/L, ranging from 30 µg/L to 100 µg/L. Oxidisable nitrogen levels also exceeded the QWQG limit of 3 µg/L.

Total phosphorus levels were also found to be significantly elevated (80-210 µg/L) compared to the QWQG limit of 20 µg/L.

Elevated total nutrient levels may be associated with suspended solids in the water column with the bedload being the most likely source of the observed nutrient levels. The study area is surrounded by intertidal flats with fringes of mangrove communities. These are potential sources of organic detritus that are known to contribute to elevated nutrient levels.

Previous studies have also reported the occurrence of elevated total nutrient levels around Port Curtis. The PCIMP Report (2007) reported elevated total nitrogen levels ranging from 200 µg/L to 260 µg/L. Total phosphorus levels were also elevated ranging from 40 µg/L to 60 µg/L.

Outfall Modelling

Water quality modelling of the proposed WWTP and ROC discharges was undertaken by WBM (WBM, 2009) and is provided as Appendix A of Attachment G4 of the EIS Supplement. The following section outlines the modelling assumptions, describes the modelling scenarios and presents the modelling results. The location of the outfall can be seen in Figure 3-1.

4.1 Modelling Assumptions

The following assumptions were made in order to undertake outfall modelling:

- The WWTP effluent and ROC will be discharged as a constant wastewater stream at the stated respective flow rates of 10 L/s and 15 L/s;
- The ROC will have a constant salinity of 63.5 g/L. In regard to the near field modelling, where receiving water density is important, 35g/L was assumed for ambient water;
- The WWTP effluent and ROC temperature will be the same as that of the adjacent receiving waters. For the near field modelling, we have assumed that this temperature was 24° C;
- Two modelling scenarios were modelled:
  - Scenario 1 comprises an WWTP effluent discharge only i.e., wastewater discharged as a single stream; and
  - Scenario 2 comprises a combined discharge of both WWTP effluent and ROC i.e., wastewater discharged in combination with the brine discharge from the desalination plant.
- No ‘exotic’ pollutants in the WWTP effluent/ROC streams would warrant detailed assessment.

4.2 Discharge Constituents

Scenario 1

The scenario 1 discharge is comprised of the wastewater discharge constituents outlined in Table 4-1.

Table 4-1 Expected WWTP Effluent Quality

Parameter	Daily Average
BOD5	20mg/L
TSS	20mg/L
TN	20mg/L
TP	10mg/L

Scenario 1

The scenario 2 discharge is comprised of the wastewater discharge constituents in Table 4-1 combined with a brine discharge from the desalination plant which is assumed to have a constant salinity of 63.5 g/L. The expected salinity of the combined discharge is predicted to be reduced to 39 g/L due to dilution of the brine by the non-saline wastewater stream.

4.3 Near Field Modelling

A CORMIX model was established of the proposed outfall. CORMIX is an industry standard mixing zone computer model and decision support system for the environmental impact assessment of mixing zones resulting from continuous point source discharges. Two scenarios were modelled as follows:

- Scenario 1 - a 5 m long diffuser, with 0.05 m diameter orifices located 0.5 m in from each end of the diffuser and every 1m along the diffuser (i.e. 5 parts in total), facing in alternate directions. This configuration would have an exit velocity from each outfall port of the order of 1.0 m/s, which will encourage maximum initial mixing; and
- Scenario 2 - a 12 m long diffuser, with 0.05 m diameter orifices located 0.5 m in from each end of the diffuser and every 1m along the diffuser (i.e. 12 parts in total), facing in alternate directions.

It was assumed that each diffuser option was oriented perpendicular to the prevailing current direction, that the minimum water depth below the diffuser at this site was 6 m (this being important for the negatively buoyant plume case in Scenario 2) and that the diffuser was at all times covered by at least 4 m of water (this being important for the positively buoyant plume case in Scenario 1.

The results of the near field modelling are shown in Figure 4-1 and Figure 4-2 for Scenario 1 and Figure 4-3 and Figure 4-4 for Scenario 2. In summary the results were as follows:

Scenario 1

— The discharge receives 30:1 dilution within 2 m of the end of the outfall; and,
— By the time the buoyant discharge plume reaches the water surface, dilution rates are of the order of 75:1.

Scenario 2

— The discharge receives greater than 30:1 dilution within 3.5 m of the end of the outfall; and
— By the time the negatively buoyant discharge plume reaches the sea bed, dilution rates exceed 125:1.

The near field modelling shows that typical near field nutrient concentration changes will be less than 0.04 mg/L for TN and 0.02 mg/L for TP for Scenario 1. Scenario 2 will see even greater dilutions (0.01 mg/L TN and 0.006 mg/L TP) and due to the negatively buoyant plume, is the preferred option. These results indicate that there are unlikely to be any detectable changes in local water quality patterns due to these small discharges.

Figure 4-1 Near Field Dilution With Distance Down Current From Outfall – Outfall Scenario1

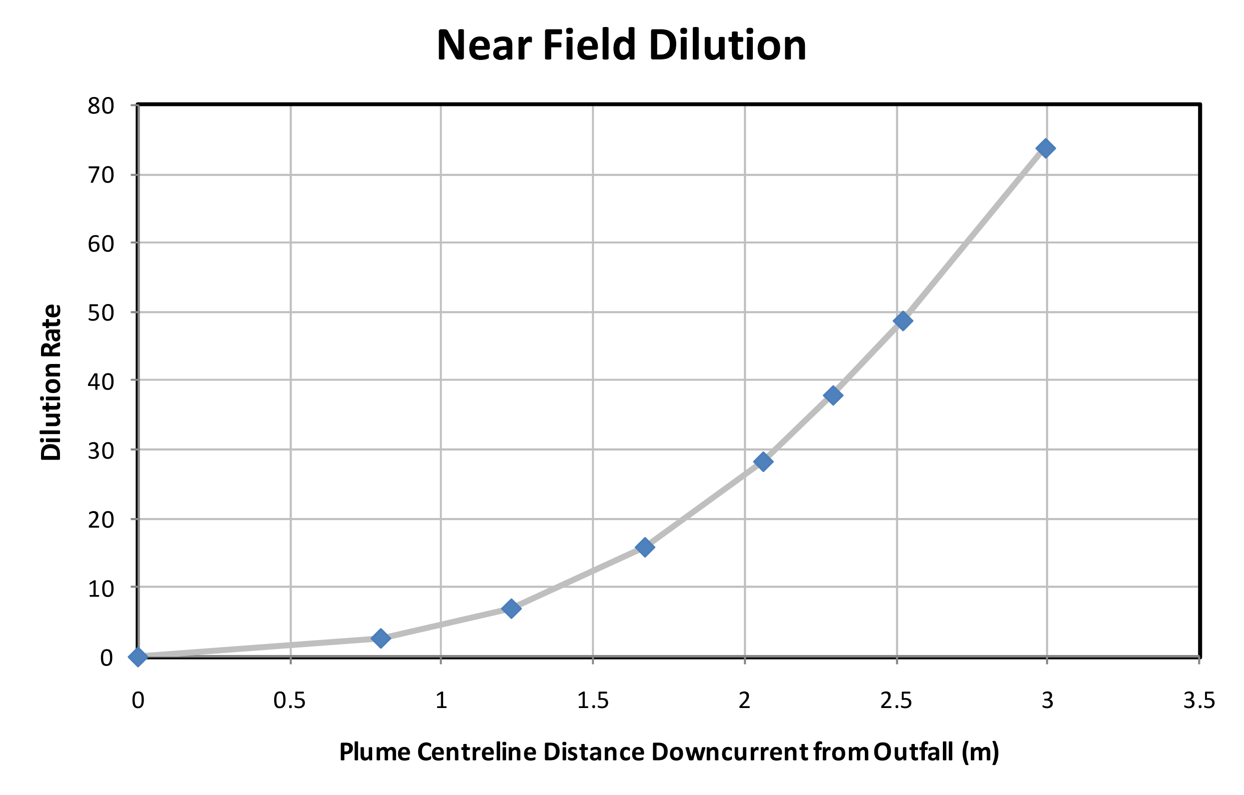


Figure 4-2 Near Field Dilution With Height Above Outfall – Outfall Scenario

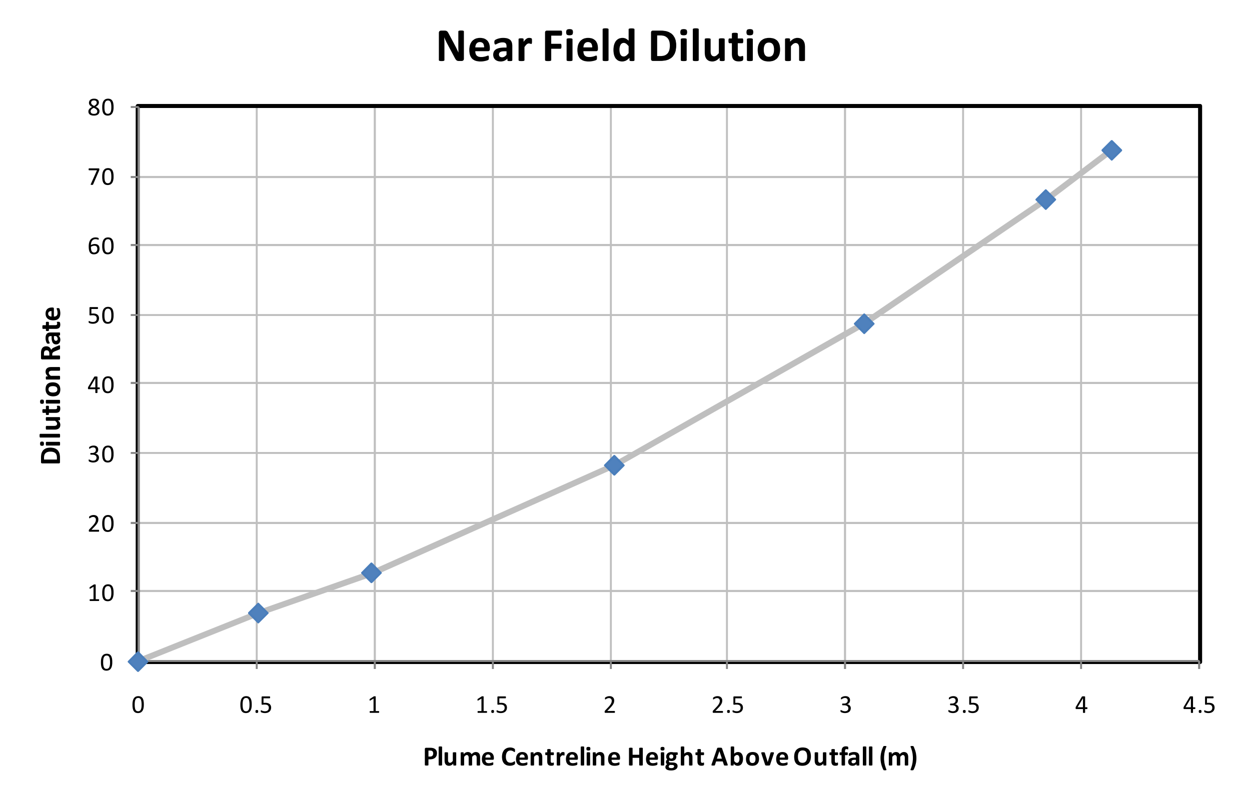


Figure 4-3 Near Field Dilution With Distance Down Current From Outfall – Outfall Scenario

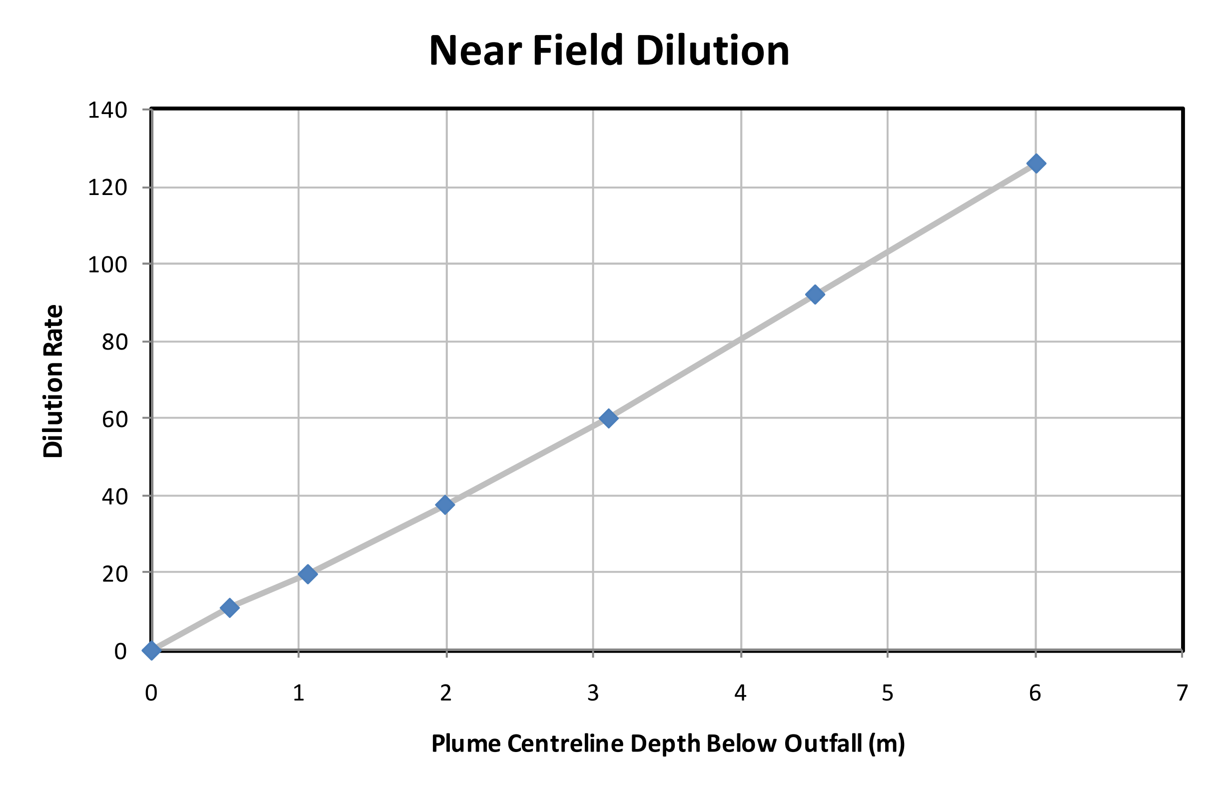
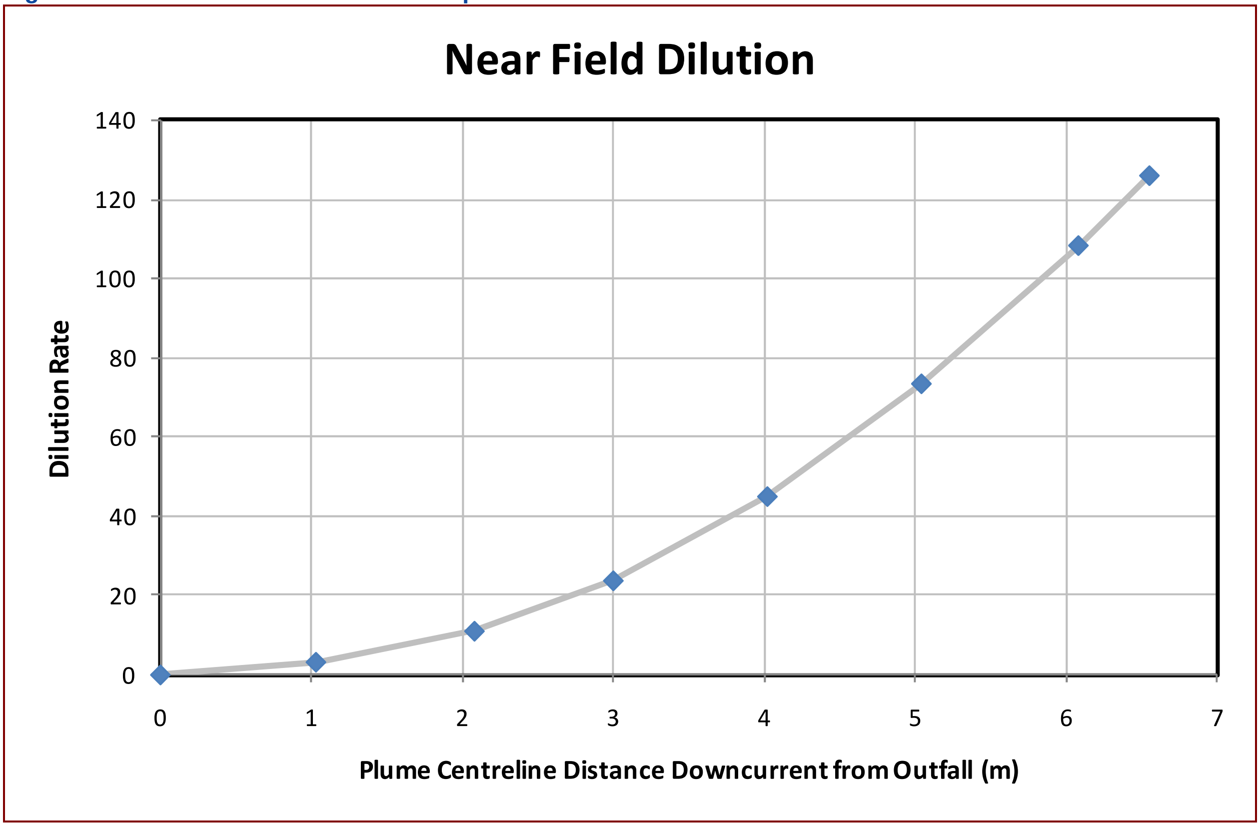


Figure 4-4 Near Field Dilution With Depth Below Outfall – Outfall Scenario 2



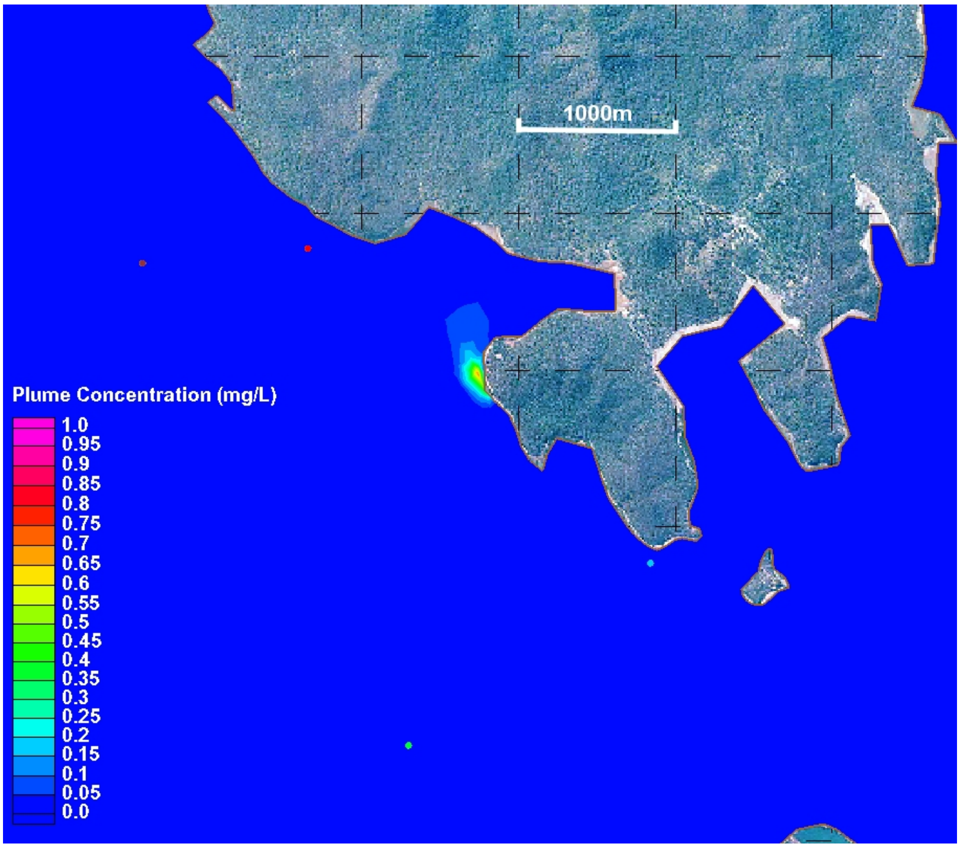
4.4 Far Field Modelling

Far field modelling was undertaken for a one month period (4/2/09 to 4/3/09) for both scenarios.

Scenario 1 – Wastewater Discharge

Far field modelling was conducted for a discharge of 34 m3/hr at a concentration of 20 mg/L of a representative pollutant. The maximum concentration over the one month period in the surrounding waters is shown in Figure 4-5. This is representative of BOD, TSS or TN, whilst the maximum TP level expected would be half of that shown in Table 4-1 In accordance with the near-field modelling results, the maximum concentration falls to below 0.2 mg/L (dilution factor of 100) within a few metres of the outfall location. This supports the findings of the near field assessment and that there are unlikely to be any detectable changes in water quality patterns within Port Curtis as a consequence of the proposed discharge.

Figure 4-5 Wastewater discharge - maximum plume concentration



Scenario 2: Combined Wastewater and Brine Discharge

Far field modelling was undertaken with a discharge of 88 m3/hr (a wastewater discharge of 34 m3/hr plus a brine discharge of 54 m3/hr) at a concentration of 39 g/L (as the brine concentration of 63.5 g/L is expected to be diluted by the addition of the non-saline wastewater stream). The maximum additional salinity (above the background level) over the one month period in the surrounding waters is shown in Figure 4-6. The above-background salinity level exceeded 10 % of the time during the one month modelling period is shown in Figure 4-7. The results show that dilution factors of greater than 100 (i.e. above-background salinity less than 0.64 g/L) are achieved at the outfall location over 90 % of the time. The maximum wastewater pollutant concentrations for this scenario were the same as for Scenario 1. As for Scenario 1 there are unlikely to be any detectable changes in water quality within Port Curtis as a consequence of the proposed combined wastewater and brine discharge.

Figure 4-6 Brine discharge - maximum above-background salinity

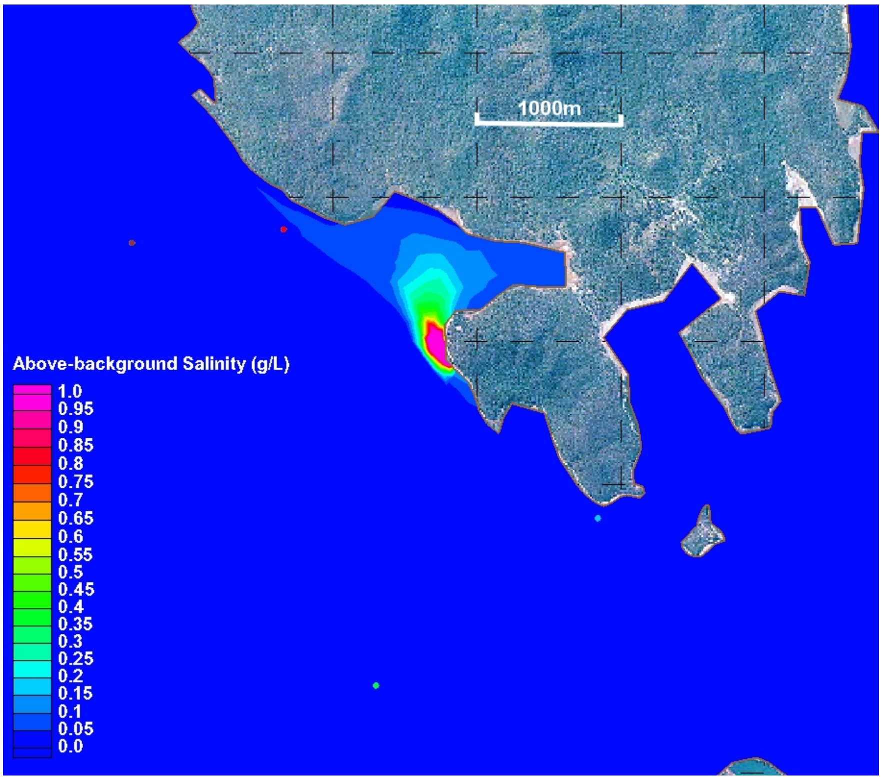
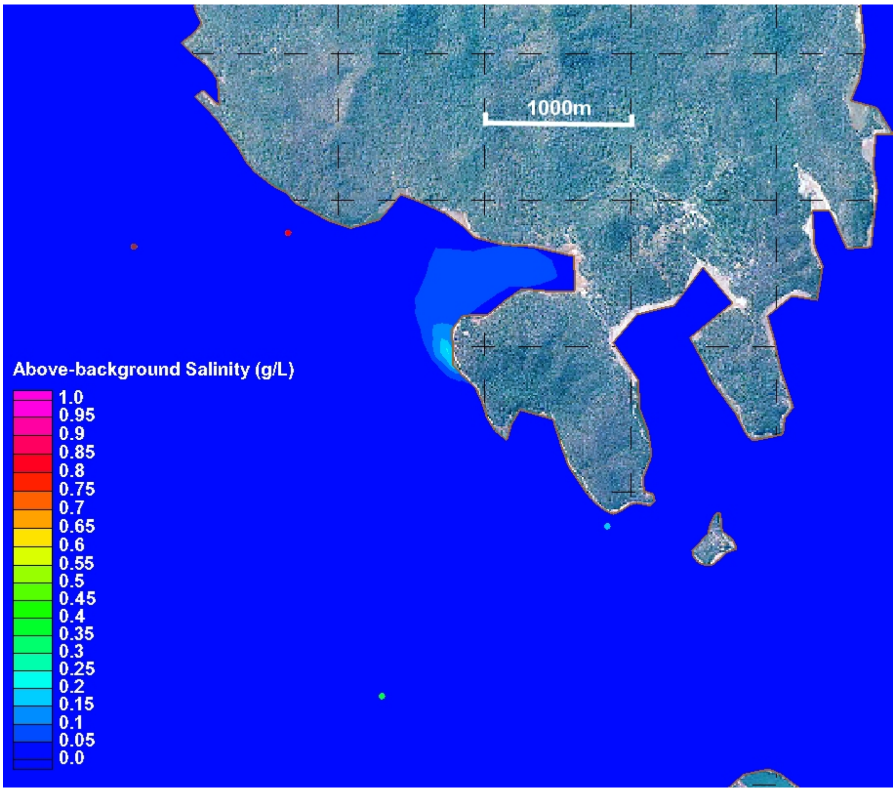


Figure 4-7 Brine discharge - above-background salinity exceeded 10 % of the time



Impacts and Mitigation Measures

5.1 Impacts

The near field and far field modelling results indicate that the proposed wastewater discharge whether discharged on its own or in combination with brine from the desalination plant is unlikely to result in any detectable changes in water quality patterns within Port Curtis. Near field modelling indicates that a brine and treated effluent stream (Scenario 2) has the minimum impact.

5.2 Mitigation Measures

Sewage from the accommodation facility and LNG facility will be treated at an on-site package sewage treatment plant which will be regularly maintained to ensure operation within the manufacturer's specifications. Relevant approvals for the wastewater treatment plant will be obtained by Santos in conjunction with the facility's approvals.

Treated sewage from the on-site package sewage treatment plant should be discharged in combination with the brine wastewater stream from the desalination plant.

Regular monitoring will be undertaken to ensure that treated effluent quality meets approval conditions prior to discharge.

Periodic monitoring of the receiving environment will be undertaken to ensure that water quality objectives are being achieved.

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Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 15th July 2009.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between 22 July and 22 August 2009 and is based on the conditions encountered in the field, laboratory results and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

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