Wheatstone Project

Construction Onshore Facilities Waste Water Discharge Plan

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS, ABBREVIATIONS AND TERMINOLOGY

AHD	Australian Height Datum
ANSIA	Ashburton North Strategic Industrial Area
ANZECC	Australia and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASP	Activated Sludge Plant
CDS	Condensate
CEO	Chief Executive Officer (of the Office of the Environmental Protection Authority)
Chevron	Chevron Australia Pty Ltd
Cth	Commonwealth
CV	Construction Village
CVWWTP	Construction Village Waste Water Treatment Plant
DEC	Department of Environment and Conservation (WA) (now known as the Department of Environment Regulation)
DOTE	Department of the Environment (formerly SEWPaC)
DO	Dissolved Oxygen
DoH	Department of Health
Domgas	Domestic gas
EIS/ERMP	Environmental Impact Statement/Environmental Review and Management Programme
EP Act (WA)	Environmental Protection Act 1986
EPBC Act (Cth)	Environment Protection and Biodiversity Conservation Act 1999
EPBC 2008/4469	The Commonwealth Primary Environmental Approval, and conditional requirements for the Wheatstone Project. Commonwealth Government of Australia, Minister for Sustainability, Environment, Water, Populations and Communities, Hon. Tony Burke, 22 September 2011.
EQC	Environmental Quality Criteria
EQO	Environmental Quality Objectives
EQVRP	Effluent Quality Validation and Reporting Plan
EV	Environmental Values
FRP	Filterable Reactive Phosphorus
HT	Hydrostatic Test
kL	kilolitre
km	kilometre(s)
LEP	Level of Ecological Protection
LNG	Liquefied Natural Gas
m	metre(s)
m^3	cubic metre(s)
m^3/hr	cubic metre(s) per hour
MOF	Materials Offloading Facility

MS 873	Ministerial Statement No. 873: The State (WA) Primary Environmental Approval, and conditional requirements for the Wheatstone Project. Government of Western Australia, Minister for the Environment; Water, Hon. Bill Marmion MLA, 30 August 2011.
MTPA	Million tonnes per annum
NATA	National Association of Testing Authorities
Nearshore	Marine habitat from the 20 m contour to the shoreline
Ntot	Total Nitrogen
O&G TSE	Oil & Grease, Total Solvent Extractable
OEPA	Office of the Environmental Protection Authority
Offshore	Marine habitat beyond the 20 m contour to the shoreline
(The) Plan	Construction Onshore Facilities Waste Water Discharge Plan
Project	Nearshore and offshore marine facilities, trunkline, and Onshore Facility
Practicable	Means reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge (*taken from the EP Act)*
Proponent	Chevron Australia Pty Ltd
Ptot	Total Phosphorous
RMS	Root-Mean-Square
RO	Reverse Osmosis
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Cth)
Site	LNG Plant Site
SWRO	Seawater Reverse Osmosis
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
Typical Conditions	Typical conditions are considered to represent the scenario when the various waste water treatment and discharge facilities (the seawater intake, WWTPs, seawater desalination system, and waste water outfall) are jointly operating within their design limits as outlined in this Plan. This includes the extraction of ambient seawater for the seawater desalination plant within the designed water quality parameters, the availability of reject brine for co-mingling of treated waste water streams, and the discharge characteristics of the treated effluent remaining within the rated design limits. Typical conditions do not include the commissioning period of any facility, the discharge of Hydrostatic Test water or the scenario(s) when one or more waste water treatment facilities are out of service or major disruptions, such as cyclonic events or incidents
UF	Ultrafiltration
WA	Western Australia
WET	Whole effluent toxicity
Wheatstone Foundation Project	The initial Project including the Domgas plant comprises the Wheatstone Foundation Project
WWTP	Waste Water Treatment Plant

1.0 BACKGROUND

1.1 Project Overview

Chevron Australia Pty Ltd (Chevron) will construct and operate a multi-train Liquefied Natural Gas (LNG) and domestic gas (Domgas) plant near Onslow on the Pilbara Coast, Western Australia. The Wheatstone Project (the Project) will process gas from various fields located offshore in the West Carnarvon Basin. The Ashburton North Strategic Industrial Area (ANSIA) is the approved site for the LNG and Domgas plants.

The Project requires installation of gas gathering, export and processing facilities in Commonwealth and State waters and on land. The initial Project will produce gas from Production Licences WA-46-L, WA-47-L and WA-48-L located 145 kilometres (km) offshore from the mainland, approximately 100 km north of Barrow Island and 225 km north of Onslow, and will also process gas from Production Licence WA-49-L operated by Woodside Petroleum Limited.. Figure 1.1 shows the location of the Wheatstone Project.

The ANSIA site is located approximately 12 km south-west of Onslow along the Pilbara coast within the Shire of Ashburton. The initial Project will consist of two LNG processing trains, each with a capacity of approximately 5 million tonnes per annum (MTPA). Environmental approval was granted for a 25 MTPA plant to allow for the expected further expansions. The Domgas plant will be a separate but co-located facility and will form part of the Project. The Domgas plant will tie-in to the existing Dampier-to-Bunbury Natural Gas Pipeline infrastructure via third party DBP Development Group Pty Ltd Domgas pipeline. Figure 1.2 shows the onshore and nearshore Project footprint.

1.2 Proponent

Chevron Australia is the proponent and the company taking the action for the Project on behalf of its joint venture participants Woodside Petroleum Limited, PE Wheatstone Pty Ltd a company part-owned by Tokyo Electric Power Company, Kuwait Foreign Petroleum Exploration Company and Kyushu Electric Power Company.

1.3 Objectives

In accordance with the Western Australia (WA) Minister for Environment, Water Ministerial Statement No. 873 (MS 873) Condition 13-11, the objective of the Construction Onshore Facilities Waste Water Discharge Plan (the Plan) is to submit a report that:

i. Spatially maps the areas where each environmental quality objective and level of ecological protection (LEP) is to be achieved.

ii. Identifies the environmental quality criteria, for constituents of the discharge considered relevant by the Department of Environment and Conservation (DEC), that should be achieved to maintain the environmental quality objectives and LEP established through Condition 13-1.

iii. Predicts the toxicity of the final discharge under typical conditions.

iv. Predicts the number of dilutions necessary to meet the required environmental quality objectives and LEP. For example, a moderate level of protection at the boundary of a Low and Moderate Ecological Protection Area and a high level of protection at the boundary of a Moderate and High Ecological Protection Area, or to meet a high level of protection at the boundary of a Low and High Ecological Protection Area (predictions are based on achieving environmental quality criteria and effluent toxicity).

v. Presents contingency options for additional treatment or extending the diffuser to achieve greater dilutions if required.

Simultaneously, this Plan will meet the objectives for the Effluent Quality Validation and Reporting Plan (EQVRP) required under MS 873 Condition 13-12 to address the following:

i. Whole Effluent Toxicity (WET) Testing program for determining:

   a. the actual toxicity of any discharge post commissioning and post operation of the outfall and following any significant change in effluent composition; and
   b. the number of dilutions required to achieve each relevant LEP, testing is to be undertaken on a minimum of five locally relevant species from four different taxonomic groups using the recommended protocols from Australia and New Zealand Environment Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000).

ii. Characterisation of any waste water discharge under typical operational conditions and after any significant changes in effluent composition.

iii. A revised set of environmental quality criteria based on the contaminants of concern identified from Condition 13-12(ii).

iv. Given the results from Conditions 13-12(i) (ii) and (iii), the number of dilutions required to achieve the environmental quality objectives and LEP identified in Condition 13-1 and described in Schedule 2.

v. Reporting to the DEC within six months of commissioning of a discharge or within six months of any significant change in composition of a discharge, including any management actions necessary to ensure ongoing compliance with the environmental quality objectives and levels of ecological protection established through Condition 13-1 and described in Schedule 2.

In accordance with Commonwealth Minister for Sustainability, Environment; Water, Populations and Communities (SEWPaC), Environmental Protection and Biodiversity Conservation Statement 2008/4469 (EPBC 2008/4469) Condition 44.a. states that as part of a Marine Discharge Management Program (MDMP) for discharges to marine and riverine habitats, the objective of the Construction Onshore Facilities Waste Water Discharge Plan (the Plan) is to submit:

   a. An Onshore facilities waste water discharge report and an Onshore EQVRP. The Onshore EQVRP must include water quality targets based on the ANZECC Water Quality Guidelines (2000), monitoring programs, trigger levels, management and corrective actions.

The Plan has been prepared for the purpose of meeting the conditions listed above as well as to inform the Works Approval process, required under Part V of the *Environmental Protection Act 1986* (EP Act). If there is any difference or inconsistency in the Works Approval/Licence application documents or conditions from time to time, the latter prevail to the extent of the inconsistency, and the Plan is taken to include any amendments that are required to ensure there is no difference or inconsistency between the documents.

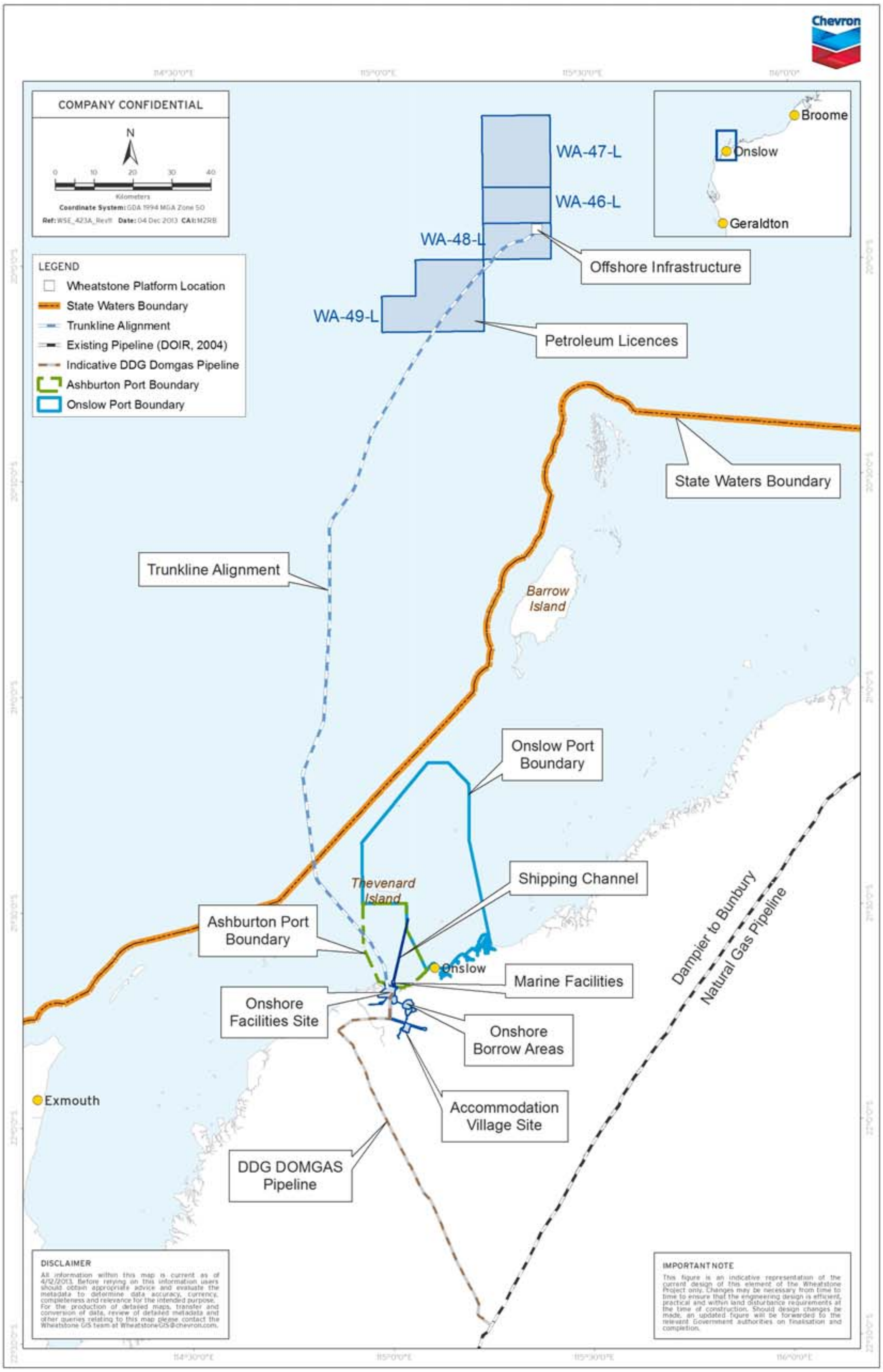


Figure 1.1: Location of Wheatstone Project Infrastructure

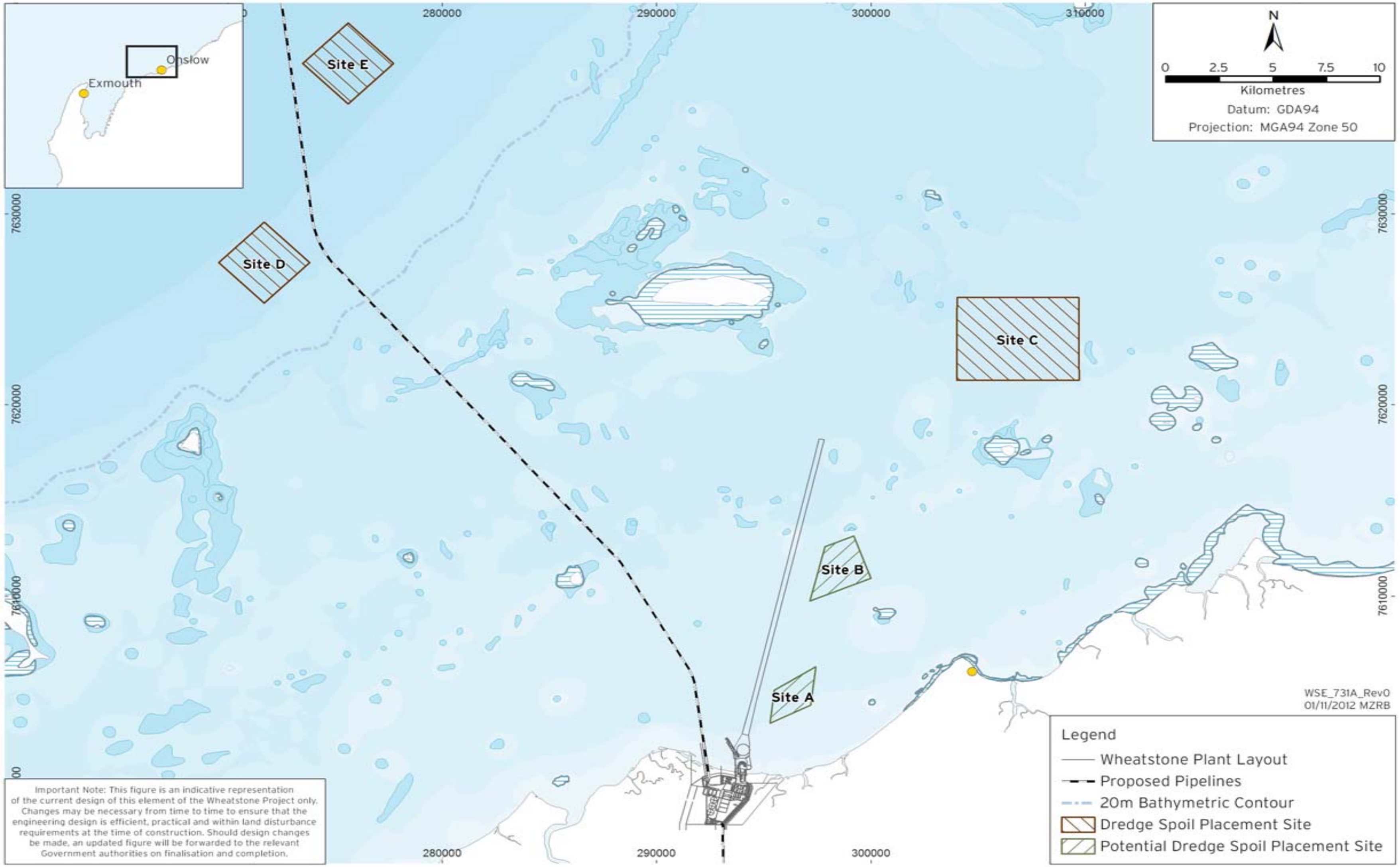


Figure 1.2: Nearshore Project Infrastructure

1.4 Scope

The Plan has been prepared to address the potential impacts associated with the commissioning and operation of the onshore facilities construction waste water outfall for the Wheatstone Foundation Project.

The Plan presents the environmental management and monitoring measures regarding onshore facilities construction waste water discharges, as well as the proposed activities required to support the EQVRP. While the Plan includes contingency management for commissioning unplanned events, the environmental quality management framework is focused on discharges from the waste water treatment plants (WWTPs) under Typical Conditions.

The Plan also details the potential for discharge of Hydrostatic Test (HT) water from the LNG and condensate (CDS) tanks. Should the discharge of HT water be required, the discharge is anticipated to be short-term. For this reason the discharge of HT water is not considered to represent typical conditions and was assessed separately as a minor waste stream and presented in Section 5.6.The construction waste water system has been designed to sufficient detail to support the development of this Plan for the construction waste water outfall only. As permitted under Condition 23 of MS 873, details addressing the operations waste water discharge system shall be filed under separate cover. The construction and installation activities which are relevant to this Plan are described in the following sections. A separate plan was submitted for the Permanent Operations Waste Water Outfall and endorsed by the OEPA via a letter dated 9 October 2014 and the Department of the Environment via letter dated 5 November 2014.

1.5 Environmental Approvals

The Wheatstone Project was assessed through an Environmental Impact Statement / Environmental Review and Management Program (EIS/ERMP) assessment process under the WA *Environmental Protection Act 1986* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Project was approved by the WA Minister for Environment; Water on 30 August 2011 by way of Ministerial Statement No.873 (MS 873) and as amended by Ministerial Statement No.903 (MS 903), Ministerial Statement No.922 (MS 922), Ministerial Statement No.931 (MS 931) and Attachments 1 to 4. The Commonwealth Minister for Sustainability, Environment, Water, Population and Communities approved the Wheatstone Project on 22 September 2011 (EPBC 2008/4469) with variations to EPBC 2008/4469 conditions made pursuant to section 143 of the EPBC Act. Other amendments may be made from time to time and if so will be reflected in the next revision of this Plan.

This Plan has been prepared to meet the following requirements (Table 1-1):

- Prior to submitting an application for a works approval to the DEC for any discharge from the onshore facilities, the Proponent shall submit a report to the DEC that meets the requirements set out in Condition 13-11 (MS 873).
- Prior to submitting an application for a works approval to the DEC for any discharge from the onshore facilities, the Proponent shall develop an Effluent Quality Validation and Reporting Plan in consultation with the DEC that addresses the matter set out in Condition 13-12 (MS 873).

The sections in this Plan that meet the conditions of EPBC 2008/4469 (refer to Table 1-2) shall be read and be interpreted as only requiring implementation of EPBC 2008/4469 for managing the impacts of the construction onshore facilities waste water discharge on, or protecting, the EPBC Act matters listed in Appendix B. The implementation of matters required only to meet the requirements of MS 873 are not the subject of EPBC 2008/4469. Similarly, the implementation of matters required only to meet the requirements of EPBC 2008/4469 are not the subject of MS 873. The species and matters protected by the EPBC Act which are relevant to this Plan are listed in Appendix B.

Table 1-1: Requirements of WA Ministerial Statement No. 873 relevant to this Plan

No.	Condition	Section
13-11	Prior to submitting an application for a works approval to the DEC for any discharge from the onshore facilities, the Proponent shall submit a report to the DEC that:	This Plan
13-11(i)	spatially maps the areas where each environmental quality objective and level of ecological protection is to be achieved;	Figure 2.2
13-11(ii)	identifies the environmental quality criteria, for constituents of the discharge considered relevant by the DEC, that should be achieved to maintain the environmental quality objectives and levels of ecological protection established through condition 13-1;	4.0
13-11(iii)	predicts the toxicity of the final discharge under typical conditions;	5.2
13-11(iv)	predicts the number of dilutions necessary to meet the required environmental quality objectives and level of ecological protection. For example, a moderate level of protection at the boundary of a Low and Moderate Ecological Protection Area and a high level of protection at the boundary of a Moderate and High Ecological Protection Area, or to meet a high level of protection at the boundary of a Low and High Ecological Protection Area (predictions are based on achieving environmental quality criteria and effluent toxicity); and	5.2, 5.3
13-11(v)	presents contingency options for additional treatment or extending the diffuser to achieve greater dilutions if required.	6.0
13-12	Prior to submitting an application for a works approval to the DEC for any discharge from the onshore facilities, the Proponent shall develop an Effluent Quality Validation and Reporting Plan in consultation with the DEC that addresses the following issues:	This Plan
13-12(i)	Whole Effluent Toxicity Testing program for determining: a. the actual toxicity of any discharge post commissioning and post operation of the outfall and following any significant change in effluent composition; and b. the number of dilutions required to achieve each relevant level of ecological protection, testing is to be undertaken on a minimum of five locally relevant species from four different taxonomic groups using the recommended protocols from ANZECC and ARMCANZ (2000)	7.1
13-12(ii)	characterisation of any waste water discharge under typical operational conditions and after any significant changes in effluent composition;	5.2, 7.1

No.	Condition	Section
13-12(iii)	a revised set of environmental quality criteria based on the contaminants of concern identified from condition 13-12(ii);	0
13-12(vi)	given the results from conditions 13-12(i) (ii) and (iii), the number of dilutions required to achieve the environmental quality objectives and levels of ecological protection identified in condition 13-1 and described in Schedule 2; and	0
13-12(v)	reporting to the DEC within six months of commissioning of a discharge or within six months of any significant change in composition of a discharge, including any management actions necessary to ensure ongoing compliance with the environmental quality objectives and levels of ecological protection established through condition 13-1 and described in Schedule 2.	8.1

Table 1-2: Requirements of Commonwealth Ministerial Conditions: EPBC 2008/4469 relevant to this Plan

No.	Condition	Section
44.	The person taking the action must submit to the Minister the following reports and plans, as component parts of the Marine Discharge Management Program (MDMP) for discharges to marine and riverine habitats: a. An Onshore facilities waste water discharge report and an Onshore Effluent Quality Validation and Reporting Plan (Onshore EQVRP). The Onshore EQVRP must include water quality targets based on the ANZECC Water Quality Guidelines (2000), monitoring programs, trigger levels, management and corrective actions.	This Plan

The OEPA exempted the hydrostatic testing of the LNG and CDS tanks from condition 13-16 (letter dated 29 October 2015; OEPA 2015). The exemption was subject to any potential impacts of the discharge water being managed through Part V approvals and the existing management detailed in this Plan.

1.6 Review, Approval and Revision of this Plan

Chevron is committed to conducting activities in an environmentally responsible manner and aims to implement reviews of its environmental management actions as part of a programme of continuous improvement. This commitment to continuous improvement means that the Proponent will review the Plan to address matters such as the overall effectiveness, environmental performance, changes in environmental risks and changes in business conditions on an as needed basis (e.g. in response to new information).

The Project elements may also be amended from time to time, for example under section 45C of the EP Act. The Project elements which are detailed in this Plan should therefore be read as subject to any Project amendments which are made from time to time. In accordance with Condition 24-1 of MS 873, Chevron may only implement an amendment to this Plan from the date of the amendment. Significant amendments may only be implemented from the date of approval of the amendment by the Chief Executive Officer (CEO) of the Office of the Environmental Protection Authority (OEPA). Significant amendments are those amendments which alter the obligations of the Proponent, that is, are not minor or administrative.

In accordance with Conditions 5 and 6 of EPBC 2008/4469, Chevron may only implement the Wheatstone Project otherwise than in accordance with the provisions of this Plan which regulate the matters of national environmental significance relevant to this Plan from the date of approval of any variation to this Plan by the Commonwealth Minister. Further, if during the Works Approval or licensing process, or as a result of the conditions of the Works Approval or licence, there is a revision(s) to this Plan, Chevron will review this Plan and if required provide the revision(s) to DEC, and in the meantime the works approval/licence documents will be preferred in the extent of any difference or inconsistency.

2.0 PROJECT DESCRIPTION

The Project elements description which follows has been included for the purpose of contextualising the management and monitoring measures which are required under this Plan. The Project elements may be amended from time to time, for example under section 45C of the EP Act. The Project elements which are detailed in this Plan should therefore be read as subject to any Project amendments which are made from time to time.

2.1 LNG Plant

The LNG Plant located in the ANSIA will initially comprise two LNG trains operating at a total capacity of approximately 8.9 MTPA, expanding to its maximum capacity of 25 MTPA with up to five LNG trains in operation. LNG will be initially stored in two 150 000 cubic metre (m^3) LNG tanks, expanding up to four 150 000 m^3 tanks. For export, the LNG is pumped from the storage tanks to the loading arms at the LNG carrier berths and into LNG carriers for delivery to foreign or domestic markets.

CDS will also be stored in tanks of approximately 120 000 m^3 and pumped to the CDS berth to transfer to tankers via the loading arms. Initially, two tanks are proposed with additional tanks being added as throughput increases over time, up to a maximum of four CDS storage tanks. The 25 MTPA LNG Plant will operate with up to eight elevated flare structures; three high pressure flares with approximate height of 125 m, three low pressure flares with approximate height of 45 m and two marine flares with approximate height of 45 m.

2.2 Construction Village

A construction village (CV) will be located approximately 12 km inland from the LNG Plant by road to accommodate the construction personnel.

2.3 Waste Water Treatment Plants

2.3.1 Construction Village Waste Water Treatment Plant

The Construction Village Waste Water Treatment Plant (CVWWTP) is to be located in the northern utilities area of the CV site and will incorporate five trains. Each train will be designed to process waste water from approximately 1280 persons or approximately 480 kilolitres (kL) of waste water per day. One train will be held in reserve for maintenance and back-up purposes, giving a total processing capacity of 1920 kL per day for the four operating trains. If necessary, the fifth train may also operate continuously as well to allow for more processing capacity across all trains via reduced loads. This will be adequate to accommodate the projected number of workers to be housed in the CV. The CVWWTP will treat all water associated with the CV (sink/shower, sanitary, and other domestic waste water) and other waste water generated from temporary construction facilities (e.g. transportable site offices). The proposed system is unlikely to receive process or industrial waste water for treatment.

There are currently two smaller WWTPs facilities operating in the Pioneer Camp and the Fly Camp. These camps are designed to accommodate a much smaller, initial workforce than the CV until the CV becomes operational. The CVWWTP will eventually replace these two smaller WWTPs.

2.3.1.1 Construction and Commissioning

The installation of the five CVWWTP trains will be staged to synchronise with the timing of the installation of the facilities and habitations of the CV, as follows:

- Stage 1: installation of trains 1 and 2
- Stage 2: installation of train 3
- Stage 3: installation of train 4
- Stage 4: installation of train 5.

The intention is for the construction waste water outfall to be installed prior to Stage 2 (train 3) for use in association with trains 1 to 3 in the first instance and eventually all trains. However, the exact timing will be determined by the volumetric capacity and/or nutrient loadings of the irrigation fields.

Commissioning of each stage of the CVWWTP will occur continuously, 24 hours per day, over a period of up to three months. Initially during this phase, the treated effluent may not be of operational quality. Stage 1 of the installation of the CVWWTP, consisting of trains 1 and 2, will be commissioned in such a way that the initial effluent can be recycled to the extent practicable back through the CVWWTP if necessary in order to better achieve the intended water quality targets.

Treated effluent water that meets “medium” quality as defined by the Department of Health (DoH) *Guidelines for the Non-potable Uses of Recycled Water in Western Australia* will be sent to an on-spec water storage tank and then pumped out for use as compaction water and dust control. If treated effluent does not meet required quality parameters “low” quality as defined by the DoH guidelines, it will be sent to an irrigation field(s) for discharge. The irrigation fields will remain in place for a period of time after the marine outfall becomes available, to serve as a short-term contingency discharge option should the marine outfall not be available during this period. The irrigation fields will eventually be decommissioned once the marine outfall has been commissioned and the WWTP is consistently operating under ‘typical conditions’, at which point the outfall will become the primary discharge method.

The sludge will be stored in the integrated sludge storage tank and pumped to the sludge digester prior to being removed offsite by a licensed controlled waste contractor to an approved, licensed facility. Effluent monitoring during the commissioning period will be conducted in accordance with the Works Approval W5306/2012/1 issued by the DEC dated 20 December 2012.

2.3.1.2 Operation

The CVWWTP will operate continuously seven days a week. The basis for design is to have one train reserved as a spare with four trains providing 100% capacity under typical conditions during the peak occupancy at the CV. Alternatively, the fifth train may be operated continuously, if required, and in order to reduce the processing load of each individual train, potentially allowing for greater processing capacity across all trains.

2.3.2 LNG Plant Site Plant

The LNG Plant Site (site) WWTP will be located at the LNG plant site and be of smaller size and capacity (1 train only) as it will only be treating waste water from site sinks/showers and sanitary facilities. The design, installation, commissioning, and operation of the site WWTP is similar to that described for the CVWWTP excepting that the effluent will be discharged through the waste water outfall as there are no irrigation fields available for this system.

2.4 Seawater Desalination System

A seawater desalination system will be installed at the site consisting of an ultrafiltration (UF) and reverse osmosis (RO) desalination system that will intake raw seawater to produce potable freshwater. The desalination process will also produce seawater RO (SWRO) product water or brine as a waste stream. A media filter(s) will initially treat the seawater. A UF unit will then be included upstream of the SWRO unit to remove particulate matter, including colloidal solids and some organic substances prior to processing through the SWRO unit.

The UF unit and SWRO unit will each consist of five trains. The UF unit will include feed pumps, guard filters, membranes and membrane banks, a backwash tank, backwash pumps, and a chemical-in-place system. The SWRO unit will include guard filters, feedwater and product water intermediate storage tanks, feed pumps and energy recovery turbines, membranes and membrane banks, flush pumps, and a chemical-in-place system.

There are currently two smaller desalination facilities operating in the Fly Camp and at the beachfront area of the site. These desalination facilities are designed to process and produce a smaller amount of freshwater than the site seawater desalination system in order to meet current Project needs. The site desalination system will eventually replace these two smaller units as the need for freshwater increases for construction and accommodation purposes.

2.5 Hydrostatic Test Water

Hydrostatic testing is required for LNG storage tanks 1 and 2 (LNG–1 and LNG–2; each approximately 90 ML) and CDS storage tanks A and B (CDS–A and CDS–B; each approximately 125 ML) to verify tank integrity. As previously described in Chevron's letter dated 6 October 2015 (Chevron, 2015a) HT of the storage tanks will consist of three phases, as detailed below.

2.5.1 Phase 1 – Source Water

Potable water for the HT program will be sourced from on-site SWRO plants. The potable water will be pumped to the HT pond ready for supply of water into the storage tanks. Water produced by the SWRO plants is expected to be consistent with the American Petroleum Institute (API) Standards (i.e. API620 and API650). Chlorine (typically between 0.1 – 2.0 mg/L) will be added to the water to ensure microbial and other biological activity is limited.

The HT pond capacity is approximately 130 ML with provision of a minimum 300 mm freeboard.

2.5.2 Phase 2 – Filling, Holding, and Emptying Tanks

Prior to filling, dust and debris will be removed from tanks by sweeping and / or blowing to minimise the risk of sediments and / or pollutants being potentially introduced into the HT water. Pumping of water from the HT pond to the LNG and CDS tanks occurs 24 hours a day, 7 days per week, and each tank will fill in approximately 9 to 14 days.

During filling, if a leak is detected, the water will be lowered, or emptied, to allow for necessary repair welds and technical checks. The tank will then be filled again towards the target level. When the target water level is reached, pumping ceases and the tank is isolated by closure of the water inlet valve. Water will stay in the tanks for 48 hours whilst visual and technical inspection of the tanks is carried out as required by API620 and API650.

HT water may be re-used to test all tanks by either transferring directly from tank to tank, or by returning it to HT pond for use to fill subsequent tanks. After testing, tanks will be drained and dried and residual water may be captured and pumped back to the HT pond or discharged per the DER approved Pre-commissioning and Hydrostatic Testing Regulatory Management Plan (Chevron 2015).

2.5.3 Phase 3 – Reuse, Evaporate or Discharge

HT water is planned to be discharged onshore via methods described in the LNG and Condensate Storage Facilities – Pre-commissioning and Hydrostatic Testing Regulatory Management Plan (Chevron 2015), which is a requirement of Works Approval W5480/2013/1 for the construction and commissioning of the LNG and Condensate Storage Facilities. A combination of the following methods was identified as management measures for the handling of the HT water:

- Evaporation occurs in the uncovered pond. Evaporation can be accelerated by assisted evaporation means, if determined required.
- Reuse of HT water on-site for other construction purposes including (but not limited to) dust suppression, compaction and hydrotesting other non-prescribed facilities.
- Discharge to the internal storm water drain system for evaporation and groundwater infiltration.

If the above handling methods are not viable, up to 250 ML of HT water may be discharged to the construction waste water outfall during the HT program. This volume is based on the unlikely scenario that the HT pond will need to be emptied on two separate occasions: once during the HT program and once at the completion of hydrotesting.

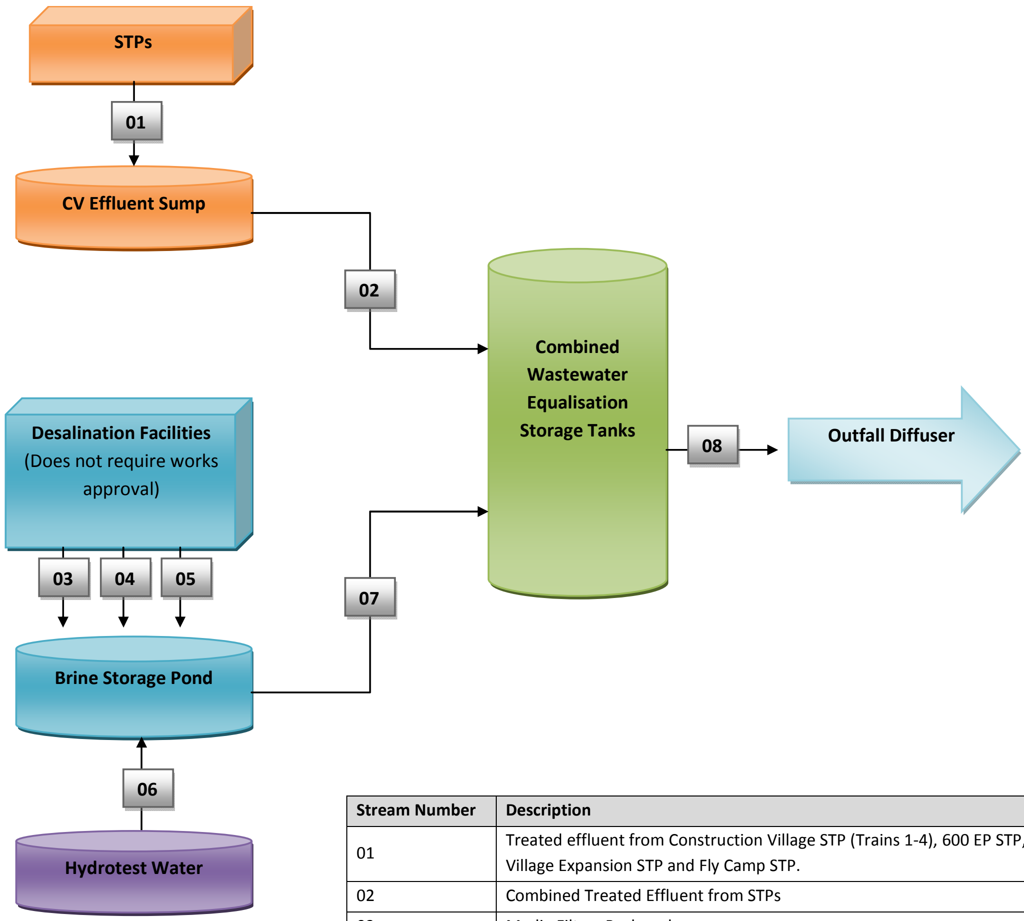
2.6 Construction Waste Water Outfall

2.6.1 Sources of Waste Water

The combined waste water equalisation tank shall receive waste water from the following listed sources:

- Treated sanitary effluent from CVWWTP
- Treated sanitary effluent from site WWTP
- Media filter backwash water
- Reject from the UF unit
- Reject from the SWRO unit
- HT from LNG and CDS tanks

CV waste streams from habitations and common areas consisting of greywater and blackwater will not be segregated. A common drain system will collect the waste water and route it to a lift station. Water from the lift station is then pumped to the CVWWTP equalisation tanks. Waste from the offices toilet facilities will be trucked to the CVWWTP equalisation tanks where it will mix with the CV waste stream. Waste water from the site WWTP and reject from the UF unit and SWRO unit will be piped to the combined waste water equalisation tank. The treated, combined waste water will then be pumped through the outfall into the marine environment. See Figure 2.1. In the event that HT water is discharged to the marine environment, discharge would occur through existing infrastructure, where HT water would be diluted with other effluent streamed (mixed brine) in the combined wastewater equalization storage tank prior to discharge at the diffusers (Figure 2.1). Dilution of HT water will be between approximately 30 and 60% and managed in accordance with relevant site documentation.



Stream Number	Description
01	Treated effluent from Construction Village STP (Trains 1-4), 600 EP STP, Construction Village Expansion STP and Fly Camp STP.
02	Combined Treated Effluent from STPs
03	Media Filters Backwash
04	Reject from Ultrafiltration System
05	Sea Water Reverse Osmosis Brine
06	Hydrotest Water
07	Combined RO Reject/Hydrotest Water
08	Combined Effluent to Outfall

Figure 2.1: Flow Diagram of Waste Water Treatment Facilities

2.6.2 Outfall Diffuser Location and Configuration

During the construction phase of the Project, Chevron will install a single, temporary waste water discharge line from the onshore facilities seaward to the marine environment east of the Materials Offloading Facility (MOF) and shipping channel (the termination point is depicted as “1” on Figure 2.2). The location of the construction waste water outfall has been approved by the WA Minister for Environment under Conditions 13-2 through 13-4 of MS 873. The outfall will be located approximately 1800 m offshore in approximately 5 m Australian Height Datum (AHD) water depth and within the zone of moderate LEP.

Waste water will be discharged via a diffuser assembly. The diffuser assembly will consist of 36 alternating duckbill valves arranged in a manifold 92.5 m long. Details of the assembly are as follows:

- Diffuser orientation: 90° to current direction (assumed to be parallel to the shoreline) (γ)
- Port area (each port): 0.00082 m^2 (with equivalent diameter of D = 0.03231 m)

- Port vertical angle: 45° from horizontal (θ)
- Port orientation: Staged type parallel to the diffuser axis (β)
- Port angle with ambient current: 90° along the diffuser axis (σ)
- Spacing between ports: 2.5 m
- Height of port above seabed: 1 m (for protection from sediment and increased dilution efficiency) (h0)
- Water depth at diffuser: Varying over tidal cycle (H).

The construction waste water outfall diffuser system design meets the effluent mixing criteria outlined in Australian and New Zealand Guidelines for Fresh and Marine Water Quality (October 2000).

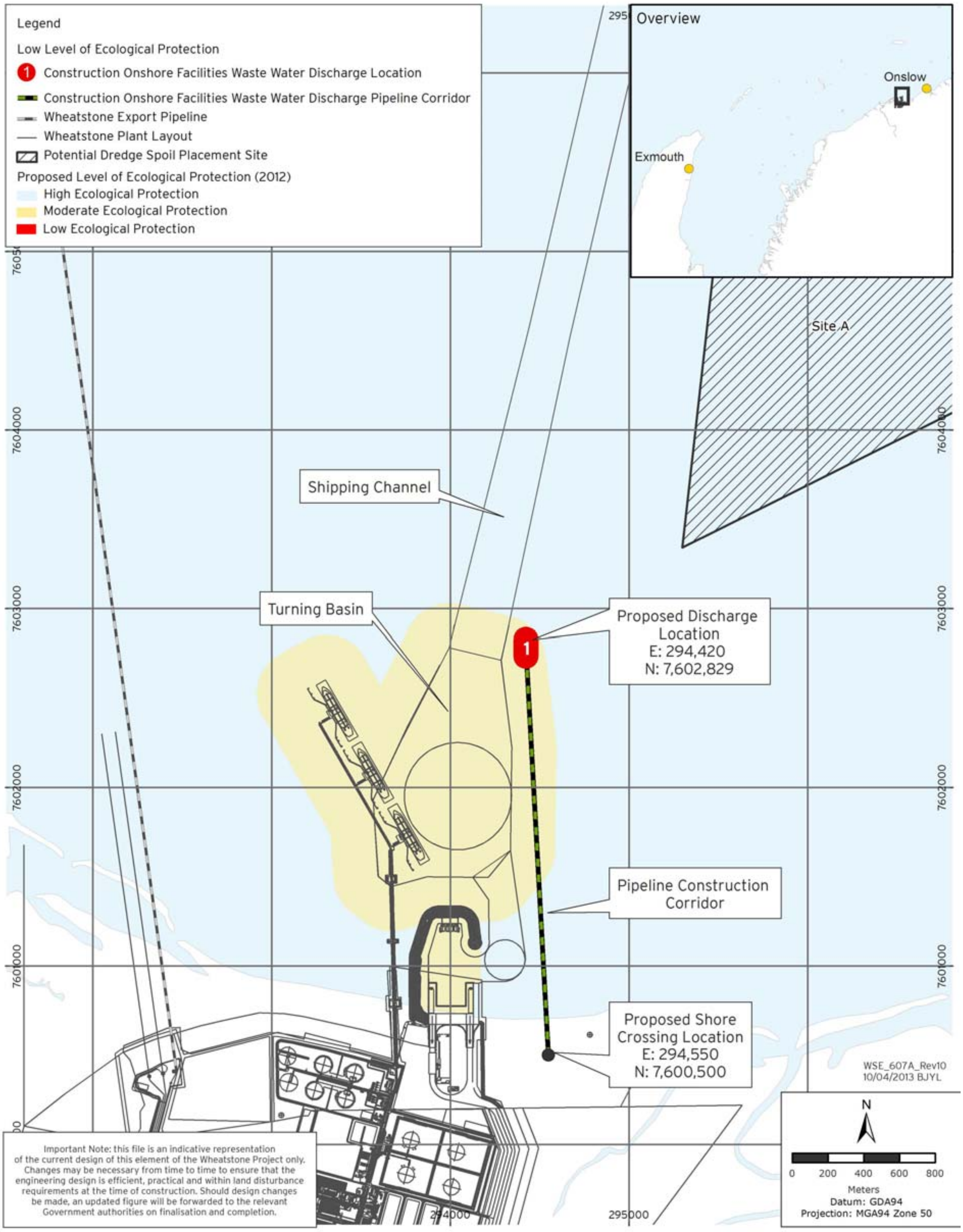


Figure 2.2: Temporary Construction Waste Water Outfall Location

3.0 CONSTRUCTION WASTE WATER TREATMENT

The waste water treatment process description which follows has been included for the purpose of contextualising the management and monitoring measures which are required under this Plan. The waste water treatment process may be amended from time to time if relevant Project elements (described in Section 2.0) are amended, for example under section 45C of the EP Act. The waste water treatment process elements which are detailed in this Plan should therefore be read as subject to any Project amendments which are made from time to time.

3.1 Construction Waste Water Philosophy

The Project is committed to health, environment, and safety excellence and achieving a "Zero" environmental incident performance by planning and executing the work using the best available resources and technology. Water is considered a resource in a dry environment where access to surface and groundwater is limited. Therefore, treated water will be reused to the extent practicable provided all environmental and health requirements are satisfied.

Treated effluent from the CV and site WWTPs that meets recognised standards outlined in the ANZECC Guidelines for Sewerage Systems – Effluent Management and DoH *Guidelines for Non-potable Uses of Recycled Water in Western Australia* may be reused for construction purposes such as dust suppression and compaction. Any treated effluent that is beyond the volume needed for reuse will be discharged to the marine environment.

3.2 Waste Water Treatment Process

The sanitary and domestic waste water shall be treated by a series of main treatment phases as depicted in Figure 3.1:

- Screening and Equalisation
- Biological Treatment (Oxidation and Settling)
- Sludge Stabilisation
- Sludge Dewatering
- Disinfection
- Filtration.

In summary, the CV and site WWTPs are Activated Sludge Plant (ASP) systems. This system uses an aerobic biological treatment system. The process involves the introduction of oxygen into waste water for aerobic biomass metabolism and a reduction in waste water organic content. With the exception of the equalisation tanks and digesters all equipment will be installed in prefabricated assemblies, on steel skids or in containerised housing.

3.2.1 Screening and equalisation

The first step of treatment will be performed by the pre-treatment devices (screening and equalisation tank) which will remove larger solid materials (e.g. plastics, rags, rocks, etc.) from the waste flow. Screened material will be collected in a roll off container. The capacity of the equalisation tank and lifting pumps will be sized in order to realise flow equalisation of fluctuating hydraulic loads. The equalisation section will allow the flows coming to the WWTP to be held and pumped at a uniform rate to the biological module. Its capacity will be the equivalent to approximately two hours of retention time at the average incoming flow rate. A pumping station will then send the waste water to a successive equalisation section composed of a 1000 m^3 tank that will store the water accumulated in the trains.

Air sparging at the bottom of the tank will allow a thorough mixing and will avoid anaerobic processes to take place, which should minimise odour and methane emissions. A pumping station will partially recycle back the equalised water and will partially send this water to a mechanical splitter that will then divide the flow rate in three distinct streams per each train, each to be sent to an aeration and clarification biological module.

3.2.2 Biological Treatment

The aeration chamber is the key part of the WWTP and it will be designed to operate as an extended aeration process. This process operates by promoting bacterial activity, in the presence of added oxygen, to metabolise and biologically flocculate the organic (biodegradable) materials in the waste stream. A foam control system and an aluminium sulphate dosing (to control phosphates) system may be installed on each aeration module. Three aeration basins operating in parallel will be provided per each train for the WWTP system. Bacteria in the aeration tank decompose the sewage to form a suspended sludge. A settling chamber is placed after the aeration chamber where physical separation between sludge and clarified water is obtained. In the settling tank the biological floc settles by gravity and accumulates in the bottom where clarified water is separated and overflows to the chlorine contact tank. Separated sludge is returned to the oxidation tank and occasionally the excess sludge is discharged in the sludge storage tank.

3.2.3 Sludge Stabilisation and Dewatering

Provisions will be made to move excess sludge from the settling tank to the sludge stabilisation tank. In this tank the sludge will be stabilised biologically in the presence of oxygen where it will then be pumped to an aerobic digester thickener. Periodically the sludge will be removed and further treated in the sludge dewatering section. Stabilised thickened sludge coming from the sludge thickeners will be fed to a mixing tank where a polymer conditioner will be added, through a polymer blending system, to improve dewatering in the belt press. The belt press then treats all the sludge produced. All of the pressed sludge will be collected in a roll off container for offsite disposal at an approved facility by a licensed contractor. This system is designed to minimise final sludge disposal volumes. The CV and site WWTPs follow the same treatment process. However, sludge from the site WWTP is trucked to the CV sludge digester for digestion, sludge dewatering, and offsite removal. The sludge “cake” will be hauled by a licensed controlled waste contractor to a licensed facility.

3.2.4 Disinfecting

The clarified water will flow to a disinfection tank, with a retention time of one hour at the average flow rate where a hypochlorite solution will be mixed to disinfect the clarified water.

3.2.5 Filtration

The disinfected water will then be sent to a dual media filtration section to further reduce the level of suspended solids in the treated water. For each train, two filters will be included. The pressurised filters will be designed for one to be on duty and one in stand-by mode for the entire flow rate of the train. Once the maximum pressure drop or maximum time elapsed has been reached, the filter will automatically be backwashed with air scouring with the stand-by filter immediately being on duty. Backwash water will be sent to the waste water influent equalisation tanks.

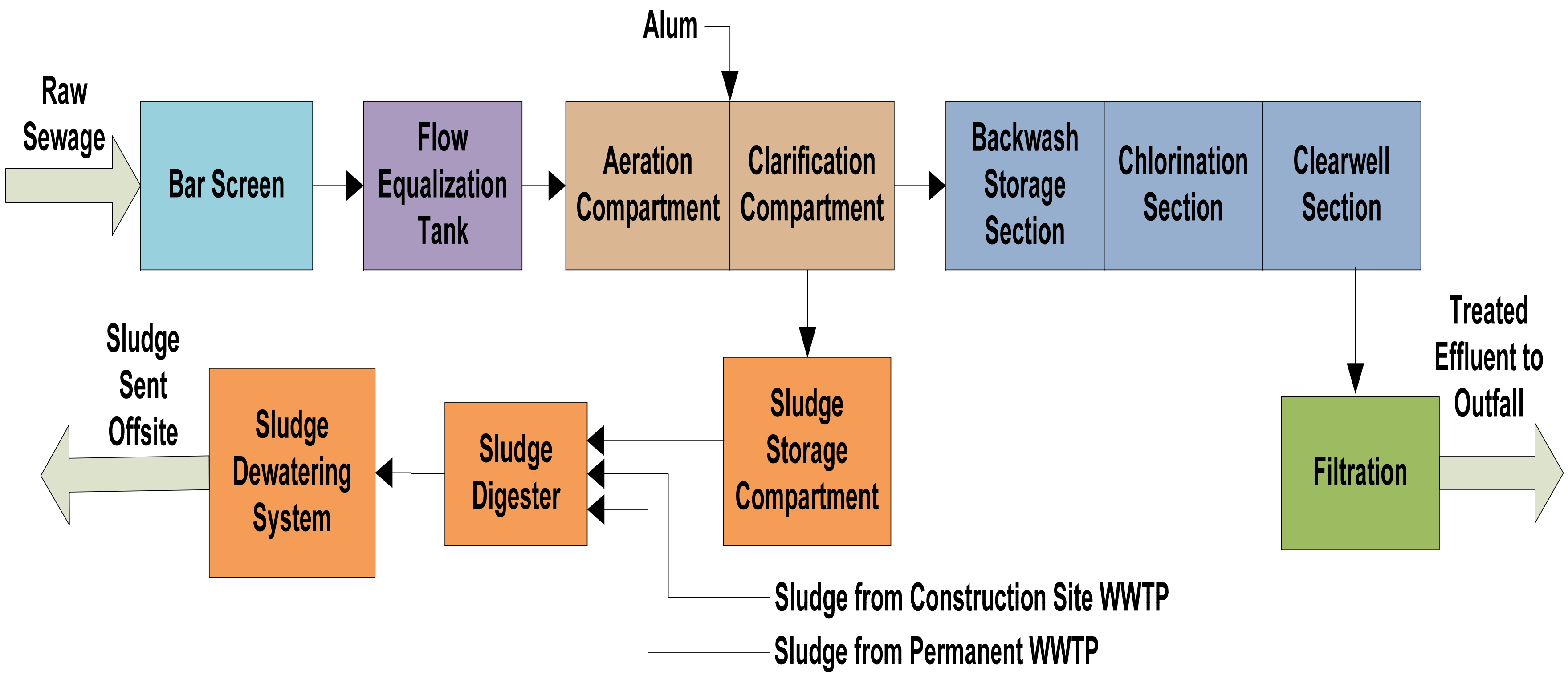


Figure 3.1: Flow Diagram Overview of an ASP System

4.0 ENVIRONMENTAL QUALITY MANAGEMENT FRAMEWORK

4.1 Overview

The area around Onslow is recognised for its high marine biodiversity and recreational value and is characterised by relatively turbid inshore/nearshore waters that are subject to strong tidal flows and episodic highly turbid runoff from the Ashburton River. The mid and outer waters are generally clear (Chevron Australia 2010). The coastal water generally have very low levels of anthropogenic contamination Wenziker et al. 2006) and are oligotrophic with low availability of nitrogen limiting rates of primary production. However on occasions, blooms of nitrogen-fixing microbes such as Trichodesmium or mangrove tidal mud-flat cyanobacteria may contribute significant amounts of nutrients into the marine environment.

High spatial and seasonal variability are evident in nutrient and chlorophyll-a concentrations within the Dampier Archipelago (Pearce et al. 2003; Buchan et al. 2003). Nitrogen and phosphorus concentrations in the marine waters around Onslow may exceed the default trigger values of 100 µgN/L (total nitrogen) and 15 µgP/L (total phosphorus) specified by ANZECC & ARMCANZ (2000). Nitrogen concentrations approaching 350 µgN/L have been reported and phosphorus may exceed 18 µgP/L (Chevron Australia 2010).

4.2 Baseline Water Quality Conditions

As part of the EIS/ERMP, a comprehensive characterisation of the existing marine environment was completed and this has provided baseline water quality values. This characterisation was based on a review of two separate studies which included a regional study of water quality area near the proposed turning basins out along the proposed trunkline adjacent to Bessieres and Thevenard Island (MScience 2011), and a localised study focussed on the water quality around the proposed nearshore outfall approximately 0.5-1.0 km from the shoreline (MScience 2011; MScience 2013). While this second study was originally intended to provide information on the composition of intake water for use in the design and construction of the desalination plant, the information collected also provides an indication of baseline water quality in this nearshore region for use in assessing outfall impact.

The following sections present the results of this second study and are derived from four short boat-based campaigns undertaken to both characterise water quality prior to construction around the proposed water intake and outfall locations close to shore. In line with Schedule 2 (MS 873), baseline water quality conditions are presented in terms of the concentrations of:

1. Toxicants
2. Other Physical and Chemical Parameters
3. Biological Parameters.

4.2.1 Toxicants

For the waters around Onslow, the background 95th percentile of concentrations of cadmium, chromium, manganese, molybdenum, nickel, vanadium and mercury were always below the ANZECC & ARMCANZ (2000) guideline values for 99 or 90% species protection. The concentrations of arsenic, copper, lead and selenium were always below the reporting limit and/or the ANZECC & ARMCANZ (2000) guideline values for 99 or 90% species protection. However the reporting limit for these elements was, at times, above the guideline or low reliability guideline value. There are no published guideline values for iron. The results of the study provide information on background concentrations; these concentrations often exceeded the lower reporting limit and varied between trips. Overall the results indicate the ANZECC & ARMCANZ (2000) guideline values are appropriate for this area.

The 95th percentile concentration of zinc exceeded the guideline value for 99% species protection (High LEP) but not 90% species protection (Moderate LEP). Occasional high zinc concentrations have been reported previously (MScience 2011). A high reliability guideline concentration for aluminium is not available; the low reliability ANZECC & ARMCANZ (2000) value is 0.5 µg/L. This published guideline for aluminium has been calculated from limited data and is provided as an indicative value only. Oil and grease was rarely detectable and median concentration was always below 5 mg/L.

The test for free chlorine was not sensitive enough to detect if chlorine concentrations approached the low reliability ANZECC & ARMCANZ guideline value. Under such circumstances a more sensitive method combined with comparison to Reference sites should be used for monitoring purposes. Overall, the results indicate that the water quality guidelines for 99% and 90% species protection for all elements, except possibly zinc, are suitable for application to the water around Onslow.

4.2.2 Other Physical and Chemical Parameters

For nitrogen based water quality parameters (total nitrogen, nitrates + nitrites) background median concentrations were above the recommended guidelines specified in ANZECC & ARMCANZ (2000). The results of this study (MScience 2013) therefore indicate that the water quality guidelines recommended in ANZECC & ARMCANZ (2000) for nutrients are not suitable for application to these nearshore waters around Onslow. On the basis of Schedule 2 of MS 873 (Environmental Protection Authority 2011), triggers for the Moderate LEP should be based on the 95th percentile of these baseline values and for the High LEP the 80th percentiles should be used. In earlier studies based on a wide range of sites further from shore (MScience 2011) total nitrogen also exceeded guideline values, but nitrate + nitrite, ammonia, total phosphorus (Ptot) and filterable reactive phosphorus (FRP) did not. This may be related to the closeness to shore of the sites.

The median concentrations for both Ptot and FRP were below the ANZECC & ARMCANZ (2000) default guideline values although total phosphorus did, at times exceed the guideline value. The local studies therefore provide the basis for calculation of locally relevant triggers for nitrogen and phosphorus compounds as recommended by ANZECC and ARMCANZ (2000). Most of the remaining Other Chemical and Physical parameters—particularly turbidity, temperature and salinity (shown as Total Dissolved Solids [TDS])—can change sharply over short periods of time. It is therefore recommended these triggers be based on a combination of long term statistics and real-time comparative Reference sites. Only by using this combination will the program be able to address both the relationship between natural and discharge parameters together with an assessment of potential impact.

4.2.3 Biological Parameters

Total coliforms measured were well below guideline values for recreational water use.

4.3 Environmental Values, Quality Objectives and Criteria and Levels of Ecological Protection

The State Water Quality Management Strategy (Department of Environment 2004) provides for the establishment of Environmental Values (EV) and Environmental Quality Objectives (EQO) in relation to the effects of waste inputs and pollution on marine water quality. Under this framework, EQOs are established in relation to prescribed Environmental Values (Table 4-1). So as to enable determination of the achievement of each EQO, a set of Environmental Quality Criteria are required which measure chemical and physical water quality parameters relevant for baseline water quality conditions at the location of the discharge and the constituents contained within the waste stream.

A comprehensive set of Environmental Quality Criteria (EQCs) have yet to be formally established by the Environmental Protection Authority (EPA) for Pilbara coastal waters. There have been recent studies on background water and sediment quality in the region as summarised above (Wenziker et al. 2006) and these have been used together with the guidelines, approaches from ANZECC & ARMCANZ (2000) and consultation with the DEC, to develop EQC appropriate for the Construction Onshore Facilities waste water discharge. These are provided in Table 4-2, Table 4-3 and Table 4-4. The microbiological EQC in Table 4-4 have been developed using ANZECC & ARMCANZ (2000) and EPA Report 20 (EPA 2005) for Cockburn Sound. The LEP for onshore facilities waste water discharges are prescribed under Schedule 2 (MS 873), and set out in Table 4-5. The LEPs have been used to derive a set of appropriate trigger values for each identified EQCs, in accordance with the recommended approaches in ANZECC & ARMCANZ (2000).

The addition of the HT discharge stream was included after development of EQCs. As such, the following initial EQCs do not include any possible HT discharge constituents. Evaluation of HT water against EQCs is presented in Section 5.6.

Table 4-1: Environmental Values and Environmental Quality Objectives for Onshore Facilities Waste Water Discharges

#	Environmental Value	Environmental Quality Objectives	EQO
1	Maintenance of ecosystem integrity (ecological)	Biodiversity is maintained	EQO1
2	Maintenance of seafood for human consumption (social).	Seafood caught within the operational area is safe to eat	EQO2
3	Maintenance of aquaculture (social).	Water quality is suitable for aquaculture	EQO3
4	Maintenance of industrial water supply (social).	Water is suitable for RO plant water intake.	EQO4
5	Maintenance of primary contact recreation (social).	Water is safe for swimming	EQO5
6	Maintenance of secondary contact recreation (social).	Secondary contact criteria are met	EQO6
7	Maintenance of aesthetic values (social).	Water remains visually attractive	EQO7
8	Maintenance of cultural and spiritual values (social).	Not applicable as there are no EQC or levels of protection in the Onslow Area relating to cultural use of marine waters.	

Table 4-2: EQCs for Toxicants in Onshore Facilities Waste Water Discharges

Environmental Quality Objectives			EQO1, EQO2, EQO3, EQO4, EQO5, EQO6			EQO7
Environmental Quality Criteria	**Units**	**Baseline**	**LOW**	**MODERATE**	**HIGH**	
Chlorine[1]	µg/L	< 100	N/A	Impact median ≤ Reference 95th percentile	3 & Impact median ≤Reference 80th percentile	N/A
Aluminium[2]	µg/L	< 10	N/A	Impact median ≤ Reference 95th percentile	0.5 & Impact median ≤ Reference 80th percentile	N/A
Cadmium[3]	µg/L	< 0.6	36	14	0.7	N/A
Chromium (III/VI)	µg/L	< 1	N/A	49/20	7.7 / 0.14	N/A
Copper	µg/L	< 1	N/A	3	0.3	N/A
Lead	µg/L	< 10	N/A	6.6	2.2	N/A
Mercury	µg/L	0.04	1.4	0.7	0.1	N/A
Nickel	µg/L	< 7	N/A	200	7	N/A
Silver	µg/L	< 10	N/A	1.8	0.8	N/A
Vanadium	µg/L	1.10	N/A	160	50	N/A
Zinc	µg/L	3.9	N/A	23	7	N/A
Hydrocarbon (TPH)	mg/L	2.5	N/A< 5	Impact median ≤ Reference 95th percentile	250 µgTPH/L and median Impact TPH ≤ 80th percentile of Reference sites4	No visible surface slicks
Mixed toxicants			Sum of concentration of (up to 5) primary toxicants < sum of relevant trigger values			

1. Derived from Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000). For the practical test, values below the LOR (20 µg/L) will be assigned a value of 10 µg/L and exceedence of the EQC will occur if Impact median exceeds 10 µg/L and also exceeds the Reference 80th percentile
2. For the practical test, values below the LOR (5 µg/L) will be assigned a value of 2.5 µg/L and exceedence of the EQC will occur if Impact median exceeds 2.5 µg/L and also exceeds the Reference 80th percentile.
3. Where not indicated otherwise, the Impact 95th percentile will be tested against the EQC.
4. For the practical test, values below the LOR (250 µg/L) will be assigned a value of 125 µg/L and exceedence of the EQC will occur if Impact median exceeds 125 µg/L and also exceeds the Reference 80th percentile.

Table 4-3: EQCs for Other Chemical and Physical Parameters of Onshore Facilities Waste Water Discharges

<table>
<tr><th colspan="2">Environmental Quality Objectives</th><th rowspan="2">Baseline</th><th colspan="5">EQO1, EQO2, EQO3, EQO4, EQO5, EQO6</th></tr>
<tr><th>Environmental Quality Criteria</th><th>Units</th><th>LOW</th><th colspan="2">MODERATE</th><th colspan="2">HIGH</th></tr>
<tr><td>Total Dissolved Solids (TDS)[1]</td><td>mg/L</td><td>37,700</td><td>N/A</td><td>39,500</td><td rowspan="8">and Impact median ≤ Reference 95^{th} percentile</td><td>39,400</td><td rowspan="8">and Impact median ≤ Reference 80^{th} percentile</td></tr>
<tr><td>Total nitrogen[1]</td><td>µg/L</td><td>147</td><td>N/A</td><td>260</td><td>225</td></tr>
<tr><td>NOx[2] (nitrate + nitrite) [1]</td><td>µg/L</td><td>9.3</td><td>N/A</td><td>16.6</td><td>12.0</td></tr>
<tr><td>Total phosphorus[1]</td><td>µg/L</td><td>5.0</td><td>N/A</td><td>17.5</td><td>7.5</td></tr>
<tr><td>Filterable reactive phosphorus[1]</td><td>µg/L</td><td>2.0</td><td>N/A</td><td>4.0</td><td>3.3</td></tr>
<tr><td>Salinity[3]</td><td>PSU</td><td>N/A</td><td>N/A</td><td>36.4</td><td>36</td></tr>
<tr><td>Temperature –winter[3]</td><td>°C</td><td>21.1</td><td>N/A</td><td>26.2</td><td>23.4</td></tr>
<tr><td>Temperature–summer[3]</td><td>°C</td><td>28.2</td><td>N/A</td><td>30.2</td><td>29.4</td></tr>
<tr><td>pH[2]</td><td></td><td>8.1</td><td>N/A</td><td colspan="2">Impact median between Reference 5^{th} and 95^{th} percentiles</td><td colspan="2">Impact median between Reference 20^{th} and 80^{th} percentiles</td></tr>
<tr><td>Turbidity[2]</td><td>NTU</td><td>5.5</td><td>N/A</td><td colspan="2">Impact median≤ Reference 95^{th} percentile</td><td colspan="2">Impact median ≤ Reference 80^{th} percentile</td></tr>
<tr><td rowspan="2">DO[4]</td><td rowspan="2">% Saturation</td><td>N/A</td><td>N/A</td><td colspan="2">60% (spot sample ≤ 0.5m from seafloor)</td><td colspan="2">60% (spot sample ≤ 0.5m from seafloor)</td></tr>
<tr><td>N/A</td><td>N/A</td><td colspan="2">80% (6 week median at any site ≤0.5m from seafloor)</td><td colspan="2">90% (6 week median at any site ≤0.5m from seafloor)</td></tr>
</table>

1. Derived from Wheatstone baseline studies (MScience 2013) and (ANZECC & ARMCANZ 2000).
2. Based on reference comparison only due to high spatial and temporal variability in regional studies.
3. Derived from Wheatstone *in situ* water quality baseline monitoring (SKM 2012) – 80^{th} and 95^{th} percentile of background.
4. Ministerial Statement 873 (Environmental Protection Authority 2011).

Table 4-4: EQCs for Biological Parameters in Onshore Facilities Waste Water Discharges

Environmental Quality Objective		Baseline	EQO2[1]	EQO5	EQO6	EQO7
Environmental Quality Criteria	**Units**					
Microbiological (Guideline) - median bacterial content in marine waters should not exceed:						
Faecal Coliform	Organisms /100 mL.	2.25	14	150	1000	N/A
Enterococci	Organisms /100 mL.	N/A	(2)	Impact 95th percentile ≤ 200	Impact 95th percentile ≤ 2000	N/A
Algal Biotoxins	cells/L	N/A	Alexandrium = 100 Dinophysis = 500 Prorocentrum = 500 Gymnodinium = 1000 Karenia = 1000 Pseudonitzchia = 5000[4]	15 000 000		N/A
Microbiological (Standard) - 80% Of Samples Contain Less Than						
Faecal Coliform	Organisms /100 mL.	N/A	21[3]	600	4000	N/A
Enterococci	Organisms /100 mL.	N/A	(2)	Impact 95th percentile ≤ 500		N/A
Algal Biotoxins	cells/L	N/A	N/A	No confirmed incidents of skin or eye irritation caused by toxic algae		N/A
Nuisance Organisms		N/A	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in excessive amounts.			

1. There are no EQCs outlined in ANZECC & ARMCANZ (2000) to meet EQO3. Criteria for achievement of EQO2 will be sufficient for achievement of both EQO3 & EQO4.
2. There are no specific EQCs for enterococci in ANZECC & ARMCANZ (2000) that relate to EQO2 (seafood consumption), they are included as part of the faecal coliform group.
3. 90% of samples contain less than EQC value
4. Pseudonitzchia EQC is 5000 cell/L when Pseudonitzchia >50% total phytoplankton & 50 000 cells/L when Pseudonitzchia <50% total phytoplankton.

Table 4-5: Levels of Ecological Protection for Onshore Facilities Waste Water Discharges

Level of Ecological Protection	Extent	Intent	Guideline Triggers		
			Toxicants[1]	Physical	Dissolved Oxygen
LOW	Within a maximum radius of 70 m around the diffuser or discharge	allow for large changes in the quality of water, sediment and biota	80% species protection guideline trigger values'	N/A	N/A
MODERATE	Within 250 m from the ship turning basin	allow moderate changes in the quality of water, sediment and biota	90% species protection guideline trigger values'[2]	95th percentile of natural background measurements	median DO concentration[3] > 80% saturation at any site, but never below 60% saturation
HIGH	Marine waters beyond the LOW and MODERATE LEPs	to allow small changes in the quality of water, sediment and biota	99% species protection guideline trigger values[2]' (except cobalt: 95% species protection guideline)	80th percentile of natural background measurements	median DO concentration[3] > 90% saturation at any site, but never below 60% saturation

1. Applies for potentially bio-accumulating toxicants in water: For discharges that contain a mixture of toxicants, the sum of the concentrations of the primary toxicants (up to 5 toxicants) should not exceed the sum of the relevant trigger values.
2. For sediments the ISQG-low applies.
3. For waters monitored within 0.5 metres of the seafloor, over a period of up to 6 weeks.

5.0 EFFLUENT CHARACTERISATION AND ENVIRONMENTAL FATE

5.1 Model Approach and Methodology

The objectives of the numerical modelling study were two-fold:

1) Assess and confirm that the construction-phase outfall discharge system design complies with the respective EQCs for the constituents modelled; and
2) Investigate and quantify the risk of recirculation of those constituents from the outfall discharge to the seawater intake of the desalination plant.

Modelling undertaken to evaluate the construction waste water outfall for the construction phase effluent is reported in the report entitled: *Wheatstone Downstream Numerical Modelling Assessment of Construction-phase Outfall Discharge and Intake Recirculation* (DHI 2013).

This modelling was based on flow with the following characteristics:

- Flow rate: 761 m^3/hr
- Total Dissolved Solids (TDS): 49,838 mg/L
- Total Nitrogen (N_{tot}): 6.837 mg/L
- Total Phosphorus (Ptot): 0.769 mg/L
- Total Suspended Solids (TSS): 34.295 mg/L
- Oil and Grease Total solvent extractable (O&G TSE) : 5.276 mg/L
- Al+++: 0.080 mg/L.

Other components expected to be ecologically insignificant will be validated during implementation of EQVRP (e.g., metals, chlorine, microbes). The EQC are specified as threshold concentrations for each of the six constituents considered “relevant” by Chevron in the treated water effluent, with different thresholds for the different ecological protection zones as outlined in the applicable conditions of MS 873. Thus the essential approach of the study was to numerically model the dilution of the outfall discharge as a function of time and space, and determine the concentrations of each relevant constituent on the boundaries between the different ecological protection zones as well as at the seawater intake location.

Due to the tidal nature of the ambient flow in the area in question, the behaviour of the discharge plume cannot be treated using a stationary approach. For example, under some conditions the discharge plume may “pool” near the outfall during slack tide, creating a slug of water with high effluent concentrations that then may be advected far away as the current increases. Also, the plume may return to the outfall location as the tide reverses, producing elevated concentrations due to re-entrainment and recirculation. Such dynamic behaviour requires time-varying dynamic modelling.

The hydrodynamics determining the behaviour of a discharge plume has different regimes. Close to the outfall the behaviour is determined by the properties of the effluent and the outfall diffuser design. This is termed the near-field region. Further away the initial properties of the discharge become relatively less significant compared to the influence of the ambient conditions in determining the plume behaviour. This is termed the far-field region. Because the boundaries of the ecological protection zones are located in the far-field but still relatively close to the outfall, both of these hydrodynamic regions must be considered in a single integrated approach. Thus, in the present study a state-of-the-art coupled approach is used where the near-field model has been dynamically linked to a far-field model in order to capture the important unsteady behaviour of the plume.

A high-resolution three-dimensional far-field model has been implemented in the numerical modelling software MIKE 3 FM. The extent of the model domain has been set to exceed the approximate tidal excursion length by more than an order of magnitude. The total extent of the model is approximately 100 km east to west and approximately 80 km north to south from the discharge diffuser location. The horizontal resolution within the model varies from 10 m at the proposed diffuser location to a couple of kilometres near the outer boundaries. Figure 5.1 shows the computational mesh without any marine infrastructure footprint. This mesh has been used to calibrate and validate the hydrodynamic response of the model by comparing the model results to in-situ measurements of water levels and currents.

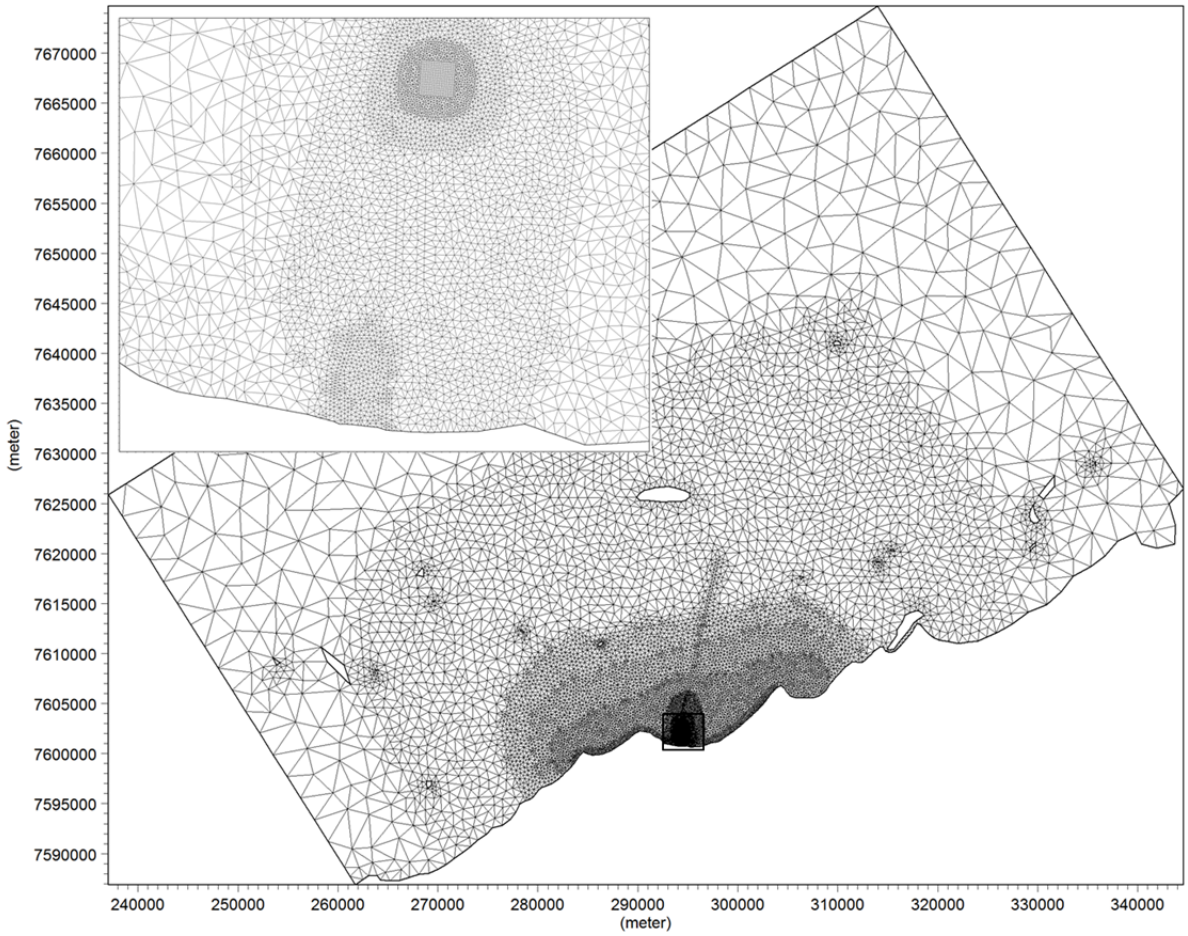


Figure 5.1: Horizontal Model Mesh including an enlarged section of the area surrounding the Planned Infrastructure and the Diffuser Site

In the vertical dimension of the model, seven sigma-layers of varying thickness are used. This yields a vertical resolution between 0.6 m and 1.2 m at the proposed diffuser location. On the water surface, the model is forced by observed winds. On the open boundaries of the model, water levels and volume fluxes have been extracted from an existing large-scale two-dimensional model – implemented in MIKE 21 – which has been calibrated and validated in previous studies on the project (please refer to Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project – Technical Appendix Q1 Dredge Spoil Modelling, July 2010). The salinity and temperature in the model were set to constant values representing the relatively stable mean conditions in the area (please refer URS, Wheatstone Project – Characterisation of the Marine Environment, 2010).

Based on existing field data, two separate one-month periods during 2009 were selected for simulation as historically representative of typical ambient conditions including conditions that are unfavourable for dilution and recirculation. The first simulation period (March, 2009) included relatively strong winds primarily from the southwest sector and variable currents influenced by both tides and wind. The second simulation period (May, 2009) included weaker winds directed more along the onshore-offshore axis (sea and land breeze) and the current is primarily dominated by the tides. The high-resolution 3D model was then run for each of these two months and satisfactorily validated against in-situ measurements of the vertically averaged current (magnitude and direction) and water levels (see Figure 5.2 and Figure 5.3). The root-mean-square (RMS) errors shown in Table 5-1 are within acceptable international standards for model-data comparisons.

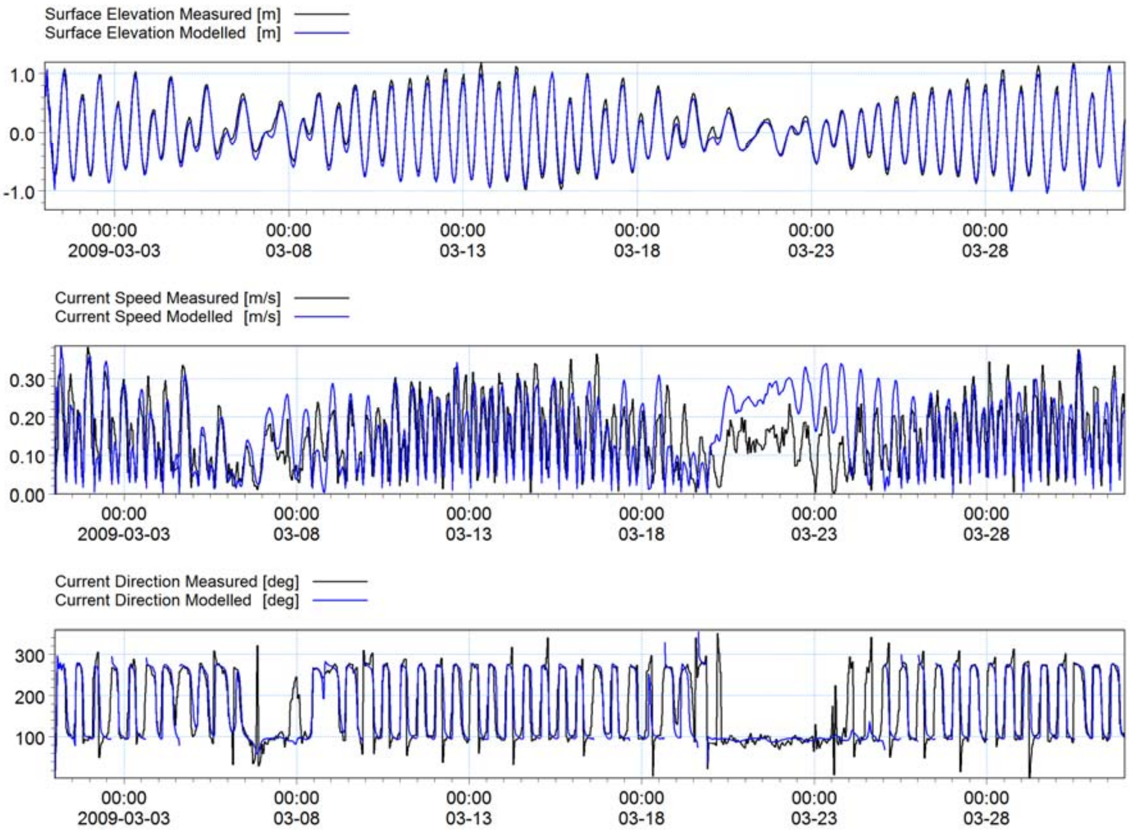


Figure 5.2: Comparison between modelled and measured surface elevation (upper panel), current speed (middle panel) and current direction (bottom panel) at the Jetty location for March 2009

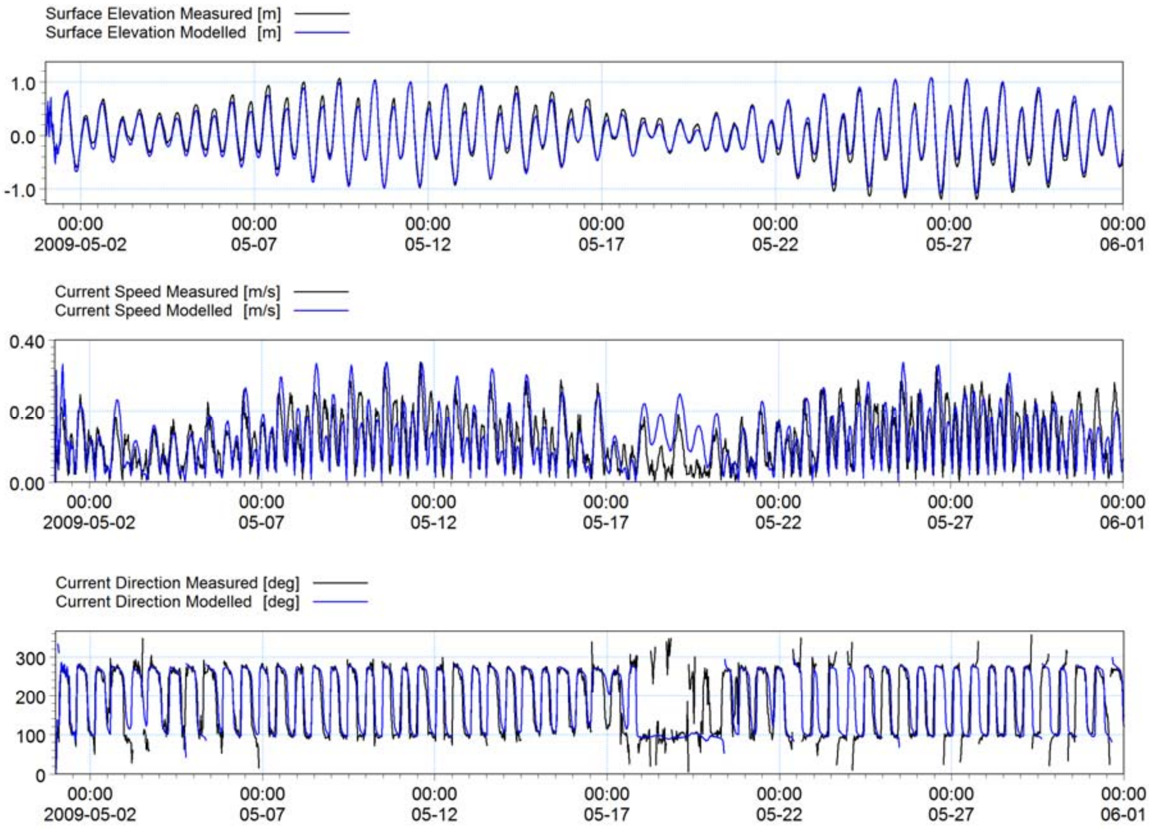


Figure 5.3: Comparison between modelled and measured surface elevation (upper panel), current speed (middle panel) and current direction (bottom panel) at the Jetty location for May 2009

Table 5-1: RMS errors between model results and in-situ measurements

Period	Current Speed (m/s)	Current Direction (degrees)	Water Level (m)
March	0.087	12.696	0.070
May	0.061	11.953	0.090

Next, two different construction-phase scenarios were implemented in the model bathymetry that represent the marine infrastructure footprint near the beginning and end stages of the outfall operation: a partial build-out footprint, including some dredging of the approach channel and MOF construction (see Figure 5.4), and the full build-out footprint including all the dredging and MOF breakwater (see Figure 5.5).

The near-field model CORMIX was used to simulate the plume evolution in the near-field for the proposed outfall diffuser design, using a set of ambient conditions that envelop the conditions at the location of the proposed diffuser. The ambient conditions in question are the water depth, the current speed and the angle between the current and the diffuser. In total 36 different combinations of these conditions have been simulated for a dense discharge representing typical operating conditions with both the WWTPs and the desalination system (UF and SWRO units) operational.

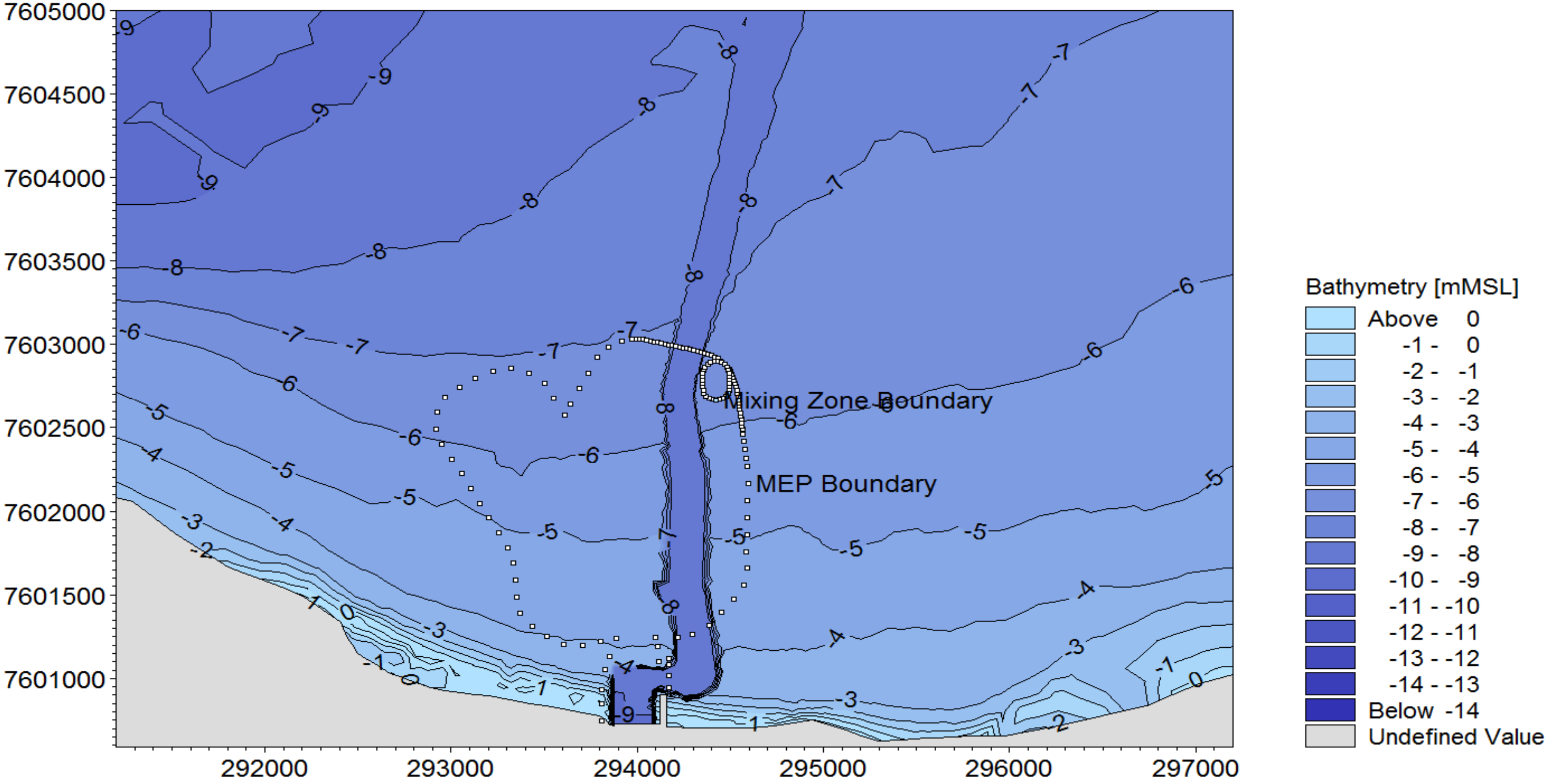


Figure 5.4: Modelled partial build-out bathymetry footprint showing the construction stage near the beginning of outfall operations

Note: The yellow dotted boundaries denote the 70 m mixing zone boundary and the outer boundary of the Moderate LEP zone (annotated as MEP in the figure). Model results are calculated at each location along both these boundaries.

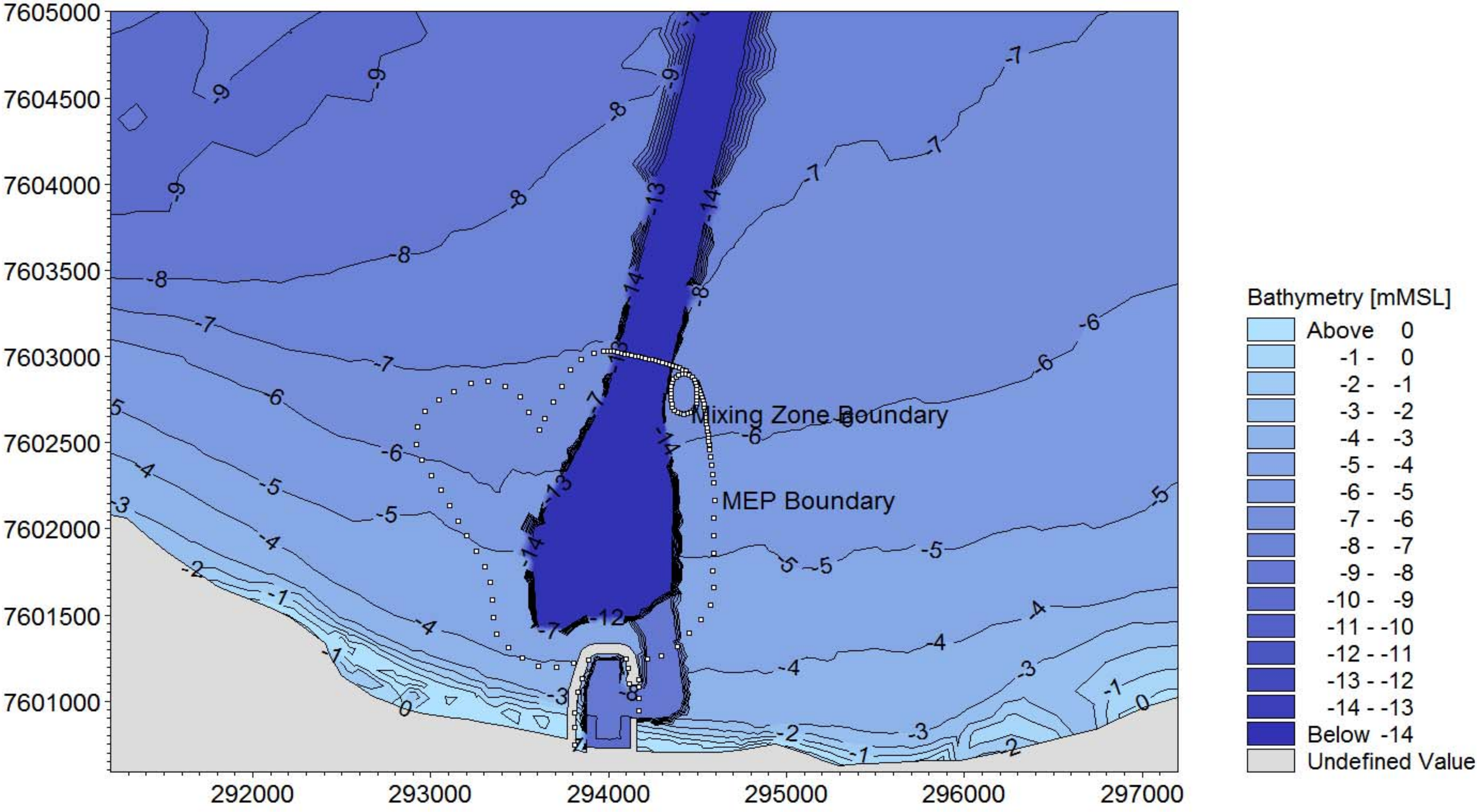


Figure 5.5: Modelled full build-out bathymetry footprint showing the construction stage near the end of outfall operations

Note: The yellow dotted boundaries denote the 70 m mixing zone boundary and the outer boundary of the Moderate LEP (annotated as MEP in the figure) zone. Model results are calculated at each location along both these boundaries.

The results of the CORMIX simulations were then used to define time-varying sources in the three-dimensional hydrodynamic model MIKE 3 FM, such that the location of the plume as well as its width and thickness are represented in the MIKE 3 model. This was done for each 3D model scenario by stepping through the time series of ambient conditions and for each time step interpolating the end-of-near-field properties of the discharge plume from the set of scenarios simulated using CORMIX. Between about 1200 and 1500 numerical source points are individually turned on and off to represent the time-varying behaviour of the plume at the end of the near-field.

Finally, all four scenarios – two different months and two different construction footprints – have been simulated in the 3D model using a single conservative tracer to represent the effluent. The full time-varying 3D fields of tracer concentration as well as various hydrodynamic variables were stored at 20 minute intervals. In addition, the tracer concentration at numerous points along the 70 m mixing zone boundary and the outer boundary of the Moderate LEP zone has been stored for all depths at two minute intervals (see Figure 5.4 and Figure 5.5). On the 70 m mixing zone boundary, the points are equally spaced 20 m apart. On the outer boundary of the Moderate LEP, the spacing varies between 50 m and 100m, depending on the proximity to the 70 m mixing zone. Finally, the time series of tracer concentration at the location of the seawater intake was also extracted.

To determine the compliance with the EQCs at the relevant ecological protection zone boundaries, the time series from different locations and depths along the zone boundaries have been analysed as follows. First, the relative tracer concentrations have been multiplied by the excess (above ambient) discharge concentration of each constituent, to yield the actual excess concentration for each constituent. Then the temporal median (50^{th} percentile) at each point was calculated for the physical constituents (TSS, TDS, Ntot and Ptot), whereas for the other constituents (Al^{+++} and OG&TSE) the temporal 95^{th} percentile was calculated. Next, the maximum of these values along the boundary was determined and compared to the EQC. If for any constituent the threshold criterion was exceeded, the percentage time exceedance of the full time series at the point of spatial maximum was calculated. These results are shown in Table 5-2 through Table 5-4 (and Appendix C). The threshold EQC for the High LEP zone were applied along the outer boundary of the Moderate LEP zone. The threshold EQC for the Moderate LEP zone were applied along the 70m mixing zone (Low LEP) boundary.

To evaluate the degree of recirculation to the seawater intake, the temporal mean, maximum and minimum predicted concentrations at the location and depth of the intake was calculated for each constituent, and compared to the expected design concentrations. In addition, the percentage time exceedance above design concentrations was calculated. These results are shown in Table 5-7 and Appendix C. The modelling results show no noticeable recirculation of the outfall plume into the seawater intake.

5.2 Effluent Characterisation, and Discharge Regime

The construction phase combined effluent includes treated sanitary waste water from the CV and site WWTPs, media filter backwash water, and reject from the UF and SWRO units. Effluent constituents are listed in Table 5-2, Table 5-3 and Table 5-4. Given that the discharge of HT water is short-term, HT water has not been included below, and the characteristics and assessment of HT water is instead presented in Section 5.6.

Table 5-2: Effluent Characterisation for Construction Onshore Facilities Waste Water Discharges - Toxicants

Stream Description		Raw Sea Water Intake[10]	Waste Water Streams Concentration			Combined Wastewater Effluent Concentration[2]	EQCs and Predicted Concentrations			
			Desalination Plant[(1)]	Site WWTP	Village WWTP		Moderate LEP		High LEP	
Average Daily Flow (m^3/hr)		695	427	20	80	527	EQC	Max Median Conc. [8, 9]	EQC	Max Median Conc. [8, 9]
Parameters	Units									
Chlorine[3,4,6,7]	µg/L	<100	-	200	200	37.95	Impact median ≤ Reference 95th percentile	NM	3 & Impact median ≤ Reference 80th percentile	NM
Aluminium[3,4]	µg/L	<10	6.28	-	-	5.09	Impact median ≤ Reference 95th percentile	NM	0.5 & Impact median ≤ Reference 80th percentile	NM
Cadmium[3,4]	µg/L	<0.6	0.38	-	-	0.31	14	NM	0.7	NM
Chromium (III/VI)[3,4]	µg/L	<1.0	0.63	-	-	0.51	49/20	NM	7.7 / 0.14	NM
Copper[3,4]	µg/L	<1.0	0.63	-	-	0.51	3	NM	0.3	NM
Lead[3,4]	µg/L	<10	6.28	-	-	5.09	6.6	NM	2.2	NM
Mercury[3]	µg/L	0.04	0.07	-	-	0.05	0.7	NM	0.1	NM
Nickel[3,4]	µg/L	<7.0	4.40	-	-	3.56	200	NM	7	NM
Silver[3,4]	µg/L	<10.0	6.28	-	-	5.09	1.8	NM	0.8	NM
Vanadium[3]	µg/L	1.1	1.79	-	-	1.45	160	NM	50	NM

Stream Description		Raw Sea Water Intake[10]	Waste Water Streams Concentration			Combined Wastewater Effluent Concentration[2]	EQCs and Predicted Concentrations			
			Desalination Plant(1)	Site WWTP	Village WWTP		Moderate LEP		High LEP	
Average Daily Flow (m^3/hr)		695	427	20	80	527	EQC	Max Median Conc. [8, 9]	EQC	Max Median Conc. [8, 9]
Parameters	Units									
Zinc[3]	µg/L	3.9	6.35	-	-	5.14	23	NM	7	NM
Oil and Grease, Total solvent extractable (TSE)[3]	mg/L	4.0	6.48	-	-	5.25	Impact median TPH ≤ Reference 95th percentile	4	250 µgTPH/L and median Impact TPH ≤ 80th percentile of Reference sites	4

(1) Desalination Plant flow is comprised of the following: 33 m^3/hr Media Filter Backwash, 66 m^3/hr UF Reject, 328 m^3/hr RO Reject (assumed 100% rejection for concentration calculation).

(2) Daily flow is equivalent average flow which occurs for approximately 3.3 hours, 5 times per day for an average rate of 527 m^3/hr. The actual pumping rate (instantaneous flow rate) during discharge is 761m^3/hr. The wastewater parameter concentrations for average and instantaneous flow rate remain same.

(3) Raw Sea Water Intake data taken from mean values in "Wheatstone LNG Development: Outfall Baseline Report - Water Quality Around The Proposed Nearshore Outfall", Report No. MSA188R1, 30 January 2013 (MScience 2013).

(4) Toxicant concentration falls below detectable limit. For calculation purposes, detectable limit was used to calculate concentration limits in subsequent streams. Only values above background are reported in this table.

(5) Sampling data is not available for this constituent

(6) Raw seawater residual chlorine value is reported as below detection limits of 100 ug/L. For purpose of this table assume raw seawater will have no residual chlorine but rather will have a net chlorine demand due to organic matter etc., in the water. Therefore, combined wastewater effluent chlorine residual is expected to be negligible once the WWTP effluent is combined with the media filter backwash. The reported 37.95 ug/L is the calculated worst case value if there were to be no chlorine demand in the raw seawater.

(7) The desalination plant waste water will include small volumes of waste water having a chlorine residual during periodic equipment cleaning procedures which are short duration events. The resulting net chlorine residual will however be consumed once the waste streams are combined in the effluent equalisation tank. Therefore, no chlorine residual value is reported in the desalination plant waste stream.

(8) The highest temporal median concentration from four different simulations (two construction stages over two different periods) modeled is shown. Please see Appendix C for detail modeling results.

(9) NM: Not Modeled. Although not directly modeled, present modeling results indicate that the effluent concentration for these constituents is not expected to exceed the EQC at either the Moderate LEP or the High LEP.

(10) Intake pumps (P-8521) are 3 x 50% at 483 m^3/hr each. Intake occurs approximately 17.25 hours per day for an average intake rate of 695 m^3/hr.

Table 5-3: Effluent Characterisation for Construction Onshore Facilities Waste Water - Other Physical and Chemical Parameters

Stream Description		Raw Sea Water Intake[10]	Waste Water Streams			Combined Wastewater Effluent[2]	EQCs and Predicted Concentrations					
			Desalination Plant[1]	Site WWTP	Village WWTP		Moderate LEP			High LEP		
Average Daily Flow (m³/hr)		695	427	20	80	527	EQC		Max Median Conc.[8, 9]	EQC		Max Median Conc.[8,9]
Parameters	Units											
Total Dissolved Solids (TDS)[3]	mg/L	37,700	61,370	600	600	49,838	39,500	and Impact median ≤ Reference 95th percentile	37,707	39,400	and Impact median ≤ Reference 80th percentile	37,707
Total nitrogen[3]	µg/L	145.6	237.02	35,000	35,000	6,834	260		150	225		150
NOx[2] (nitrate + nitrite)[3]	µg/L	9.0	14.65	-	-	11.87	16.6		NM	12.0		NM
Total phosphorus[(3)]	µg/L	7.1	11.56	4,000	4,000	768.46	17.5		7.6	7.5		7.5
Filterable reactive phosphorus[3]	µg/L	2.1	3.42	-	-	2.77	4.0		NM	3.3		NM
Salinity[4]	g/L	37.7	61.37	0.6	0.6	49.84	36.4		NM	36		NM
Temperature –winter[3,5]	°C	21.1	-	-	-	-	26.2		NM	23.4		NM
Temperature–summer[3,5]	°C	28.2	-	-	-	-	30.2		NM	29.4		NM
pH[3]		8.1	8.1	6.5-8.5	6.5-8.5	6-8	median between Reference 5th and 95th percentiles		NM	median between Reference 20th and 80th percentiles		NM
Turbidity[3,6]	NTU	6.2	38.41	8.03	8.03	32.65	median ≤ Reference 95th percentile		NM	median ≤ Reference 80th percentile		NM
Total Suspended Solids (TSS)[3,6]	mg/L	8.2	39.98	10	10	34.29	18.75		8.2	10.86		8.2

Stream Description		Raw Sea Water Intake(10)	Waste Water Streams			Combined Wastewater Effluent(2)	EQCs and Predicted Concentrations			
			Desalination Plant(1)	Site WWTP	Village WWTP		Moderate LEP		High LEP	
Average Daily Flow (m^3/hr)		695	427	20	80	527	EQC	Max Median Conc. 8, 9	EQC	Max Median Conc. 8,9
Parameters	Units									
DO Saturation	%	98%	98%	15%	17%	84%	80% (6wk median at any site ≤ 0.5m from seafloor)	NM	90% (6wk median at any site ≤ 0.5m from seafloor)	NM
5-day BOD (BOD_5)[7]	mg/L	2.0	7.05	10	10	7.61	-	NM	-	NM

Notes

(1) Desalination Plant flow is comprised of the following: 33 m^3/hr Media Filter Backwash, 66 m^3/hr UF Reject, 328 m^3/hr RO Reject (assumed 100% rejection for concentration calculation).

(2) Daily flow is equivalent average flow which occurs for approximately 3.3 hours, 5 times per day for an average rate of 527 m^3/hr. The actual pumping rate (instantaneous flow rate) during discharge is 761m^3/hr. The wastewater parameter concentrations for average and instantaneous flow rate are the same.

(3) Raw Sea Water Intake data taken from mean values in "Wheatstone LNG Development: Outfall Baseline Report - Water Quality Around The Proposed Nearshore Outfall", Report No. MSA188R1, 30 January 2013 (MScience 2013)

(4) Salinity is estimated from TDS

(5) Ambient temperatures are seasonal averages. Summertime desalination plant effluent temperatures may temporarily peak at 3 to 4 degrees above ambient seawater temperatures for a few hours during the day due to solar heating of the water while in storage tanks. Due to diurnal temperature cycles the daily average effluent temperature will however be about the same as that of the ambient seawater.

(6) EQC for TSS (mg/L) is derived from EQC for Turbidity (NTU) and correlation between TSS and Turbidity (TSS = 2.0784 + 0.9866 Turbidity), Ref: Report No: MSA188R1, 30 January 2013

(7) Raw seawater value is estimated; TOC in raw seawater reported between 0.9 and 1.2 mg/L BOD5 concentration is typically (2x) the TOC concentration in a dilute solution (Ref. Eckenfelder W.W., Principles of Water Quality Management, pp. 36 - 37).

(8) The highest temporal median concentration from four different simulations (two construction stages over two different periods) modeled is shown. Please see Appendix C for detail modeling results.

(9) NM: Not Modeled. Although not directly modeled, present modeling results indicate that the effluent concentration for these constituents is not expected to exceed the EQC at either the Moderate LEP or the High LEP.

(10) Intake pumps (P-8521) are 3 X 50% at 483 m^3/hr each. Intake occurs approximately 17.25 hours per day for an average intake rate of 695m^3/hr.

Table 5-4: Effluent Characterisation for Construction Onshore Facilities Waste Water Discharges - Biological Parameters

Stream Description		Raw Sea Water Intake(6)	Waste Water Streams			Combined Wastewater Effluent(2)	EQCs and Predicted Concentrations			
			RO Plant(1)	Site WWTP	Village WWTP		Primary Contact Recreation		Secondary Contact Recreation	
Average Daily Flow (m^3/hr)		695	427	20	80	527	EQO5	Max Median Conc. (5)	EQO6	Max Median Conc. (5)
Parameters	Units									
Microbiological (Guideline)										
Faecal Coliform(3)	Organisms /100 mL	2.83	4.61	100	100	22.71	150	NM	1000	NM
Enterococci(4)	Organisms /100 mL	-	-	-	-	-	Impact 95th percentile ≤ 200	NM	Impact 95th percentile ≤ 2000	NM
Algal Biotoxins	Cells/L						15 000 000		15 000 000	
Microbiological (Standard)										
Faecal Coliform(3)	Organisms /100 mL	2.83	4.61	100	100	22.71	600	NM	4000	NM
Enterococci(4)	Organisms /100 mL	-	-	-	-	-	Impact 95th percentile ≤ 500	NM	Impact 95th percentile ≤ 5000	NM
Algal Biotoxins	Cells/L						No confirmed incidents of skin or eye irritation caused by toxic algae			

Notes:

(1) Desalination Plant flow is comprised of the following: 33 m^3/hr Media Filter Backwash, 66 m^3/hr UF Reject, 328 m^3/hr RO Reject (assumed 100% rejection for concentration calculation).

(2) Daily flow is equivalent average flow which occurs for approximately 3.3 hours, 5 times per day for an average rate of 527 m^3/hr. The actual pumping rate (instantaneous flow rate) during discharge is 761m^3/hr. The wastewater parameter concentrations for average and instantaneous flow rate are the same.

(3) Raw Sea Water Intake data taken from mean values in "Wheatstone LNG Development: Outfall Baseline Report - Water Quality Around The Proposed Nearshore Outfall", Report No. MSA188R1, 30 January 2013 (MScience 2013)

(4) Enterococci are part of the fecal coliforms group of organisms.

(5) NM: Not Modeled. Although not directly modeled, present modeling results indicate that the effluent concentration for these constituents is not expected to exceed the EQC at either the Moderate LEP or the High LEP.

(6) Intake pumps (P-8521) are 3 X 50% at 483m3/hr each. Intake occurs approximately 17.25 hours per day for an average intake rate of 695m3/hr.

5.3 Predicted Discharge Toxicity

The following section presents an evaluation of the potential toxicity of the discharge based on two criteria: Firstly a comparison of the typical discharge constituents with the values derived from the baseline water quality surveys for seawater in the Wheatstone project area and the default EQCs derived from ANZECC and ARMCANZ (2000) has been presented with a colour coded risk scheme (Table 5-5). Secondly, the toxicity of the discharge under typical operating conditions has been evaluated by selecting the five constituents with the greatest potential for exceeding the guideline EQCs and evaluating this theoretical discharge as a simple mixture using the procedures outlined in ANZECC and ARMCANZ (2000). This is not a definitive result, since this method is only valid for simple mixtures with < five constituent toxicants. Since the current discharge contains more than five toxicants, direct toxicity assessment (DTA) of the whole effluent toxicity (WET) is required, as proposed in Section 7.1.

Appendix C presents modelling outputs, including the predictions of the number of dilutions that will be achieved and a comparison against dilutions required to ensure toxicant concentrations are below the guideline levels. At the predicted dilutions, all toxicants meet the guideline values dilution requirements.

Synergistic effects of certain chemicals contained in a mixture can have greater toxicity than the additive effects of each chemical's individual toxicity while other mixtures may result in reduced toxicity (antagonism). Mixtures of metals can also cover the full range of antagonistic, additive or synergistic effects. The most common interaction for many chemicals is additivity, i.e. total toxicity is the sum of the toxicity of the individual components. Therefore the total toxicity of a mixture (TTM) for simple mixtures of < five constituents is calculated as follows:

$$TTM = \Sigma (C_i/WQG_i)$$

- *C_i is the concentration of constituent i; and*
- *WQG_i is the concentration of the guideline trigger value.*

If TTM exceeds a value of one, the mixture has exceeded the water quality guideline. Further, if the aqueous concentration of *any* chemical in the mixture exceeds its guideline figure, then the water quality guidelines are automatically exceeded. To undertake the following hypothetical calculation, the five toxicants from Table 5-5 with the greatest probability of exceeding the EQC guideline values at the different LEP boundaries were chosen for inclusion in the mixture (Table 5-6). TTM calculations for the moderate and high LEP boundaries show that the predicted toxicity for the discharge is low. If the background concentration of constituents from raw seawater are included, then the predicted toxicity of the mixture increases above the TTM threshold of 1 (TTM_{mod} = 1.07, TTM_{high} = 2.64). For some constituents, the background levels for raw seawater were reported below the limits of detection and in these cases raw seawater concentration was set to 50% of the EQC at the high boundary. However, two important points must be considered relating to these calculations. Firstly, the TTM method is not suitable for mixtures with greater than 5 constituents, which is why the WET testing is proposed to be conducted; the results of the WET test will establish relative toxicity. Secondly, using this method for TTM calculation at the high LEP boundary, raw seawater would exceedence the TTM threshold using just two constituents, zinc (3.9 µg/l) and oil/grease (4.0 mg/l) (TTM = 1.12). The overall conclusion is that the discharge does not present a significant potential toxicity provided dilution estimates from the modelling are achieved.

Table 5-5: Evaluation of potential toxicity of the discharge using a colour coding scheme evaluating each constituent

Stream Description		EQC for Moderate LEP	EQC for High LEP	Raw Sea Water Intake	Combined Wastewater Effluent Concentration
Parameters	Units				
Chlorine	µg/L	impact median > reference 95th percentile	3 & impact median > reference 80th percentile	<100	37.95
Aluminium	µg/L	20 & impact median > reference 95th percentile	5 & impact median > reference 80th percentile	<10	5.09
Cadmium	µg/L	14	0.7	<0.6	0.31
Chromium (III/VI)	µg/L	49/20	7.7 / 0.14	<1.0	0.51
Copper	µg/L	3	0.3	<1.0	0.51
Lead	µg/L	6.6	2.2	<10	5.09
Mercury	µg/L	0.7	0.1	0.04	0.05
Nickel	µg/L	200	7	<7.0	3.56
Silver	µg/L	1.8	0.8	<10.0	5.09
Vanadium	µg/L	160	50	1.1	1.45
Zinc	µg/L	23	7	3.9	5.14
Oil and Grease, Total solvent extractable (TSE)	mg/L	8.8	7	4.0	5.25
Total Dissolved Solids (TDS)	mg/L	39 500	39 400	37 700	49 838
Total nitrogen	µg/L	260	225	145.6	6834
NOx^2 (nitrate + nitrite)	µg/L	17	12	9.0	11.87
Total phosphorus	µg/L	17.5	7.5	7.1	768.46
Filterable reactive phosphorus	µg/L	4.0	3.3	2.1	2.77
Salinity	g/L	36.4 & median > reference 95th percentile	36 & median > reference 80th percentile	37.7	49.84
pH		median between reference 5th and 95th percentiles	median between reference 20th and 80th percentiles	8.1	6-8

Stream Description		EQC for Moderate LEP	EQC for High LEP	Raw Sea Water Intake	Combined Wastewater Effluent Concentration
Parameters	**Units**				
Temperature –winter	°C	26.2 & median > reference 95th percentile	23.4 & median > reference 80th percentile	21.1	-
Temperature–summer	°C	30.2 & median > reference 95th percentile	29.4 & median > reference 80th percentile	28.2	-
Turbidity	NTU	median > reference 95^{th} percentile	median > reference 80^{th} percentile	6.2	32.65
Total Suspended Solids (TSS)	mg/L	18.75	10.86	8.2	34.29
DO $_{Saturation}$	%	80% (6wk median at any site </= 0.5 m from seafloor)	90% (6wk median at any site </= 0.5 m from seafloor)	98%	84%
5-day BOD (BOD_5)	mg/L	-	-	2.0	7.61
Faecal coliforms(1)	Orga-nisms /100 mL	43	14	2.83	22.71
Discharge concentration (end of pipe) < Raw seawater concentration					Low Risk
Discharge concentration (end of pipe) < High LEP, EQC guideline value					Moderate Risk
Discharge concentration (end of pipe) > High LEP, EQC guideline value					Elevated Risk

1. *EQC trigger values derived from EQO2 (seafood consumption) which has the most conservative guideline values; EQC for moderate LEP based on value for which 90% of samples report less than.*

Table 5-6. Calculation of the total toxicity of a simple mixture using the five constituents of the discharge with the greatest potential for exceedance

Toxicant	Concentration at end of pipe	Lowest dilution at moderate LEP	Lowest dilution at high LEP	Concentration at moderate LEP (C_m)	Concentration at high LEP (C_h)	C_m/EQC_m	C_h/EQC_h
Copper (µg/l)	0.51	1672	2224	0.000305	0.000229	0.000102	0.000764
Lead (µg/l)	5.09	1672	2224	0.003044	0.002289	0.000461	0.00104
Silver (µg/l)	5.09	1672	2224	0.003044	0.002289	0.001691	0.002861
Zinc (µg/l)	5.14	1672	2224	0.003074	0.002311	0.000134	0.00033
Oil and grease (mg/l)	5.25	96	189	0.054688	0.027778	0.006214	0.003968
TTM (ratio)						0.008602	0.008964

5.4 Environmental Fate

Table 5-2, Table 5-3 and Table 5-4 show the predicted flow rate and the predicted constituent concentrations of the seawater intake, the individual waste water streams and the combined effluent discharge under typical conditions. For each of the effluent constituents, the corresponding EQC at the zones of Moderate and High LEP are also provided. Additionally, the tables provide the numerically calculated concentrations for each relevant constituent at the boundaries of the Moderate and High LEP.

Environmental compliance is achieved at both the Moderate and High LEP boundaries for all six constituents modelled as the predicted concentrations are lower than the corresponding EQCs excepting Ptot that is equal to its corresponding EQC. Further, the present modelling results indicate that the effluent concentration for all other constituents is not expected to exceed the EQC at either the Moderate LEP or the High LEP. Appendix C provides the number of dilutions that are required and were calculated in the model to meet the environmental quality objectives and LEP.

Table 5-7 shows the highest mean and maximum concentrations from four different simulations (two construction stages over two different periods). Results for all four simulations are included in Appendix C. For all scenarios modelled, concentration levels for constituents stay within the expected operational design range of the seawater intake and there is no exceedance of the allowable upper limit of the constituent concentration at the intake. As such, no degradation in the performance of the onshore facilities is anticipated due to any seawater intake recirculation.

Table 5-7: Predicted Concentrations at the Intake for Relevant Constituents used during Discharge Modelling

Effluent Constituent	Raw Seawater Intake (mg/l)	End-of-Pipe Discharge Concentration (mg/L)	Temporal Mean Concentration(1),(4) at Intake location (mg/L)	Temporal Max Concentration(1),(4) at Intake location (mg/L)	Upper Bound of Design Concentration(3) Range for Intake (mg/L)	% Exceedance(2) above Upper Bound
Total Dissolved Solids (TDS)	37 700	49 838	37 702	37 707	39 700	0
Total Suspended Solids (TSS)(3)	8.2	34.3	8.20	8.22	500	0
Total Nitrogen (Ntot)	0.15	6.8	0.151	0.154	0.2	0
Total Phosphorus (Ptot)	0.0071	0.77	0.0072	0.0076	0.01	0
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.00	4.00	100	0
Al^{+++}	0.00	N/A	N/A	N/A	0.01	N/A

Notes:

(1) Desalination Plant flow is comprised of the following: 33 m^3/hr Media Filter Backwash, 66 m^3/hr UF Reject, 328 m^3/hr RO Reject (assumed 100% rejection for concentration calculation).

(2) Daily flow is equivalent average flow which occurs for approximately 3.3 hours, five times per day for an average rate of 527 m^3/hr. The actual pumping rate (instantaneous flow rate) during discharge is 761 m^3/hr. The wastewater parameter concentrations for average and instantaneous flow rate are the same.

(3) Raw Sea Water Intake data taken from mean values in “Wheatstone LNG Development: Outfall Baseline Report - Water Quality Around The Proposed Nearshore Outfall”, Report No. MSA188R1, 30 January 2013 (MScience 2013)

(4) NM: Not Modeled. Although not directly modeled, present modeling results indicate that the effluent concentration for these constituents is not expected to exceed the EQC at either the Moderate LEP or the High LEP.

- Intake pumps (P-8521) are 3 x 50% at 483 m^3/hr each. Intake occurs approximately 17.25 hours per day for an average intake rate of 695 m^3/hr.

5.5 Revision of EQCs and Dilution Requirements

To determine initial EQCs, baseline water quality data was reviewed from a subset of Wheatstone monitoring locations considered relevant to the construction onshore facilities waste water discharge outfall. This review provided an indication of the variation in physical parameters, most of which (particularly turbidity, temperature and salinity) can change sharply over short periods of time. To account for this variation, final triggers will be based on a combination of long term monitoring data and real-time comparative reference sites (refer to Sections 7.1, 7.2 and 7.3). Only by using this combination will the program be able to address both the relationship between natural and discharge parameters together with an assessment of potential impact.

The outcomes of the WET testing program (Section 7.1) will be used to revise the predicted number of dilutions required to achieve each LEP (Section 5.2) as prescribed by ministerial condition 13-12ib. The revised dilutions will be derived by assessing the species sensitivity distribution using the BurrliOZ software (Campbell et al 2000).

5.6 Hydrotest Water - Constituents, EQCs and Dilutions

To test the constituents of HT water prior to filling the LNG tanks (i.e. prior to the HT water being produced), coupon water was created in the laboratory to reflect expected conditions within the LNG tanks, and this water was subsequently laboratory tested for constituents. Steel plates (9% nickel content) were coated with Sigmaweld primer. The primer was then grinded away from the area to be welded and the weld left bare. Coupon water was created by immersing these steel plates in 300 ppm chloride solution for 45 days. The ratio of plate surface area to chloride solution used in the coupon testing (50:1) was greater than that anticipated during flooding of the LNG tanks (9183:1). Therefore coupon test water was pre-diluted (184 times) prior to laboratory testing for constituents to reflect site conditions.

CDS tanks will have broadly similar coating protection systems to the already constructed and hydrotested firewater tanks. Therefore results of firewater HT are used as a general proxy in the absence of CDS HT water. Firewater tank HT has been tested and has shown concentrations of contaminants less than that of coupon water. Therefore, the use of coupon water to assess contaminants of concern is therefore expected to be overly conservative compared to the HT water generated from both LNG and CDS tanks.

Water quality testing of coupon waters was undertaken for constituents already documented in the in Section 5.2 and six additional constituents identified in Hydrostatic Test Discharge Management Plan (Chevron 2015), which supports the works approval (W5480/2013/1). Testing identified a number of metals and chlorine (dosing agent) may be present in HT water, including those not previously described in Section 5.2 (Table 5-8). The current diffuser configuration will achieve ~1672 dilutions at the Moderate LEP boundary (70 m from the diffuser or discharge) and ~1867 dilutions at the High LEP boundary (250 m from the diffuser or discharge). A comparison of constituents against EQC guidelines at the Moderate and High LEP is presented in Table 5-8 for constituents not previously identified in Section 5.2 and in Table 5-9 for existing constituents in Section 5.2. For all constituents, concentrations at the boundary were below EQCs.

Table 5-8: Evaluation of coupon water and potential toxicity of the parameters not characterised in the COFWWDP against EQCs using a colour coding scheme.

Stream Description		EQC for Moderate LEP	EQC for High LEP	Raw Sea Water Intake	Combined Wastewater Effluent Concentration	HT Water (BMT) (1)	HT Water Diluted(2) at Moderate LEP	HT Water Diluted(2) at High LEP
Constituents	Units							
Chloride	mg/L			-	-	310	0.18	0.17
Arsenic	µg/L	-	n/a (3)	5.5	-	0.002	<Limit of Detection (LOD)	<LOD
Barium	µg/L	-	n/a (4)	Not Tested	-	0.10	<LOD	<LOD
Cobalt	µg/L	1.0 (3)	0.005 (5)	Not Tested	-	0.041	<LOD	<LOD
Iron	µg/L	n/a	n/a	1.2		324	0.19	0.17
Molybdenum	µg/L	n/a (6)	n/a (6)	9.7	-	0.13	<LOD	<LOD

Discharge concentration (end of pipe) < Raw seawater concentration	Low Risk
Discharge concentration (end of pipe) < High LEP, EQC guideline value	Moderate Risk
Discharge concentration (end of pipe) > High LEP, EQC guideline value	Elevated Risk

1. *Source is the BMT Oceanica Note (27/10/2015), Table 3.1.*
2. *Concentration at the High LEP boundary based on dilution of 1867.*
3. *Arsenic - ANZECC Aquaculture guidelines. No marine ecological protection guideline.*
4. *Barium - ANZECC recreational guidelines. No marine ecological protection guideline.*
5. *Cobalt - utilised marine guideline at 90% for Moderate LEP and 99% for High LEP.*
6. *Molybdenum - ANZECC irrigation and livestock drinking water guidelines. No marine ecological protection guidelines.*

Table 5-9: Evaluation of coupon water and potential toxicity of constituents against EQCs using a colour coding scheme

Stream Description		EQC for Moderate LEP	EQC for High LEP	Raw Sea Water Intake	Combined Wastewater Effluent Concentration	HT Water (BMT)(1)	HT Water Diluted(2) at Moderate LEP	HT Water Diluted(2) at High LEP
Constituents	Units							
Chlorine	µg/L	impact median > Ref 95th percentile	3 & impact median > Ref 80th percentile	<100	37.95	2000	1.19	1.07
Aluminium	µg/L	20 & impact median > Ref 95th percentile	5 & impact median > Ref 80th percentile	<10	5.09	1.13	<LOD	<LOD
Cadmium	µg/L	14	0.7	<0.6	0.31	0.004	<LOD	<LOD
Chromium (III/VI)	µg/L	49/20	7.7 / 0.14	<1.0	0.51	0.02	<LOD	<LOD
Copper	µg/L	3	0.3	<1.0	0.51	0.04	<LOD	<LOD
Lead	µg/L	6.6	2.2	<10	5.09	0.032	<LOD	<LOD
Mercury	µg/L	0.7	0.1	0.04	0.05	0.00022	<LOD	<LOD
Nickel	µg/L	200	7	<7.0	3.56	37	0.022	0.019
Silver	µg/L	1.8	0.8	<10.0	5.09	0.0003	<LOD	<LOD
Vanadium	µg/L	160	50	1.1	1.45	0.0016	<LOD	<LOD
Zinc	µg/L	23	7	3.9	5.14	60	0.035	0.032
Oil and Grease, Total solvent extractable (TSE)	mg/L	8.8	7	4.0	5.25			
Total Dissolved Solids (TDS)	mg/L	39 500	39 400	37 700	49 838			
Total nitrogen	µg/L	260	225	145.6	6834			
NOx2 (nitrate + nitrite)	µg/L	17	12	9.0	11.87			
Total phosphorus	µg/L	17.5	7.5	7.1	768.46			
FRP (phosphorus)	µg/L	4.0	3.3	2.1	2.77			
Salinity	g/L	36.4 & median > Ref 95th percentile	36 & median > Ref 80th percentile	37.7	49.84			
pH		median between Ref 5th and 95th percentiles	median between Ref 20th and 80th percentiles	8.1	6-8			

Stream Description		EQC for Moderate LEP	EQC for High LEP	Raw Sea Water Intake	Combined Wastewater Effluent Concentration	HT Water (BMT)(1)	HT Water Diluted(2) at Moderate LEP	HT Water Diluted(2) at High LEP
Constituents	Units							
Temperature – winter	°C	26.2 & median > Ref 95th percentile	23.4 & median > Ref 80th percentile	21.1	-			
Temperature– summer	°C	30.2 & median > reference 95th percentile	29.4 & median > reference 80th percentile	28.2	-			
Turbidity	NTU	median > Ref 95th percentile	median > Ref 80th percentile	6.2	32.65			
TSS	mg/L	18.75	10.86	8.2	34.29			
DO Saturation	%	80% (6wk median at any site ≤ 0.5 m from seafloor)	90% (6wk median at any site ≤ 0.5 m from seafloor)	98%	84%			
5-day BOD (BOD_5)	mg/L	-	-	2.0	7.61			
Faecal coliforms(3)	# / 100 ml	43	14	2.83	22.71			

Discharge concentration (end of pipe) < Raw seawater concentration	Low Risk
Discharge concentration (end of pipe) < High LEP, EQC guideline value	Moderate Risk
Discharge concentration (end of pipe) > High LEP, EQC guideline value	Elevated Risk

1. *Source is the BMT Oceanica Note (27/10/2015), Table 3.1.*
2. *Concentration at the Moderate LEP boundary (dilution of 1672) and High LEP boundary (dilution of 1867).*
3. *EQC trigger values derived from EQO2 (seafood consumption) which has the most conservative guideline values; EQC for moderate LEP based on value for which 90% of samples report less than.*

5.7 Hydrotest water, WET testing

Toxicity of proposed HT waters was determined by undertaking WET testing. Although comparisons of undiluted coupon water to EQCs were undertaken (Section 5.6), in practice HT water would be diluted with other effluent streams (mixed brine) in the combined wastewater equalisation storage tank prior to discharge at the diffusers (see Figure 2.1). Dilution of HT water will be between approximately 30% and 60%, and six different solutions that differ in dilution and source waters were used in WET testing, which have been presented in Table 5-10.

Table 5-10: Mixing scenarios for preparation of fully synthetic samples (synthetic HT water, brine, and effluent, Scenario 1 to 4), and synthetic HT water with real brine and effluent (Scenario 5 and 6).

Scenario 1	30% HT Water/70% Brine mixed with 100% Treated Effluent.
Scenario 2	60% HT Water/40% Brine mixed with 100% Treated Effluent.
Scenario 3	30% HT Water (where metals in HT water are increased by a factor of 3)/70% Brine mixed with 100% Treated Effluent.
Scenario 4	60% HT Water (where metals in HT water are increased by a factor of 3)/40% Brine mixed with 100% Treated Effluent.
Scenario 5	30% HT Water / 70% Brine mixed with 100% Treated Effluent (where the brine and the treated effluent are real solutions that have been shipped from site for mixing with synthetically prepared HT water).
Scenario 6	60% HT Water / 40% Brine mixed with 100% Treated Effluent (where the brine and the treated effluent are real solutions that have been shipped from site for mixing with synthetically prepared HT water).

Chronic WET tests were completed on each sample involving five species from at least four different taxonomic groups, and including at least one fish and shellfish test (ANZECC & ARMCANZ 2000) (Table 5-11). The tests were carried out by an NATA accredited facility (Ecotox Services Australasia in NSW). Dilutions of combined effluent used for the WET testing were consistent with those presented in Section 7.2.

Table 5-11: Chronic Whole Effluent Toxicity tests

Test	Species	Reference
72-hr microalgal growth inhibition test	*Isochrysis aff. galbana*	Stauber et al (1994)
72-hr macroalgal germination success	*Ecklonia radiata*	Bidwell et al (1998), Burridge et al.(1999)
48-hour bivalve larval development test	*Saccostrea echinata*	Krassoi (1995), APHA (1998)
72-hr urchin larval development test	*Heliocidaris tuberculata*	APHA (1998), Doyle et al (2003), Simon and Laginestra 1997
7-day fish Imbalance and biomass test	*Lates calcarifer*	USEPA (2002)

No observed effects concentrations (NOEC) is the concentration of contaminant at which the response of test organisms is statistically indistinguishable from organisms in an uncontaminated control, and NOEC values were calculated from the WET test dilutions. The number of dilutions required to achieve 90% (for a Moderate LEP) and 90% (for a High LEP) species protection values were calculated from NOEC data using the specifically designed BurrliOZ software (ANZECC & ARMCANZ 2000).

The wholly synthetic HT water/brine/TWW solutions were typically benign and exposure to undiluted samples had no effect on three of the five species (the microalgae, microalgae and fish) (Table 5-12). The ratio of HT water to brine had no impact on the toxicity of the final effluent with solutions 1, 3 (both 30:70 HT water: brine) and 2 (60:40 HT water: brine), having identical NOECs for each test (Table 5-12). Increasing the concentrations of expected contaminants by a factor of three also had little effect on the outcome - the only difference when undertaking the augmented concentration tests was between a NOEC of 50% for the bivalve test on Solution 3 compared to 25% for the other solutions (Table 5-12). This difference partly reflects the variability/uncertainty inherent in the use of NOECs in the ANZECC & ARMCANZ (2000) approach (Fox 2009).

The maximum number of dilutions required for the solutions to achieve a high level of ecological protection was 1:13 (Table 5-13). This is small compared to the expected dilutions (based on modelling) at the high LEP management boundary (1:1867) (Chevron Australia 2015). Previous wet testing on the existing discharge found that ~1:77 dilutions were required to achieve a high LEP (BMT Oceanica 2015). However, it should be recognised that the original survey included two acute toxicity tests and the conversions that are applied to acute test results yield end points that are typically conservative compared to chronic tests.

The microalgal test was more sensitive to solutions made of 30% synthetic HT water mixed real brine and actual wastewater (Solution 5) than the equivalent synthetic solution (Solution 1) (Table 5-12). In contrast, the bivalve test was less sensitive to the solutions derived using actual brine and wastewater (Table 5-12). As a result the number of dilutions required to achieve a high level of ecological protection was the same (1:14) as for the entirely synthetic solutions (Table 5-13).

Like the other solutions, a 100% solution consisting of 60% synthetic HT water diluted with 40% actual brine and then diluted further with actual treated wastewater had no effect on the macroalgae and the fish (Table 5-12). Solution 6 did have a greater effect on the urchin and the bivalve than the other solutions (Table 5-12). The microalgal toxicity test found low toxicity in the 100% sample but higher toxicity in subsequent dilutions. An unfavourable interaction between the test solution and the artificial seawater used as a diluent may have increased the toxicity of the diluted sample, thereby compromising the test. The source of the apparent toxicity of the diluted solution is not clear. It is unlikely due to the use of actual brine and treated effluent in the samples, since solution 5 had higher proportions of these constituents without the apparent toxicity. Solution 6 had a higher ratio of HT water relative to the other streams than solution 5; however, the same increased proportion of HT water in the entirely synthetic samples had no effect on the toxicity. Despite the uncertainty surrounding the results for solution 6, the dilutions required to achieve a high LEP (1:38) were still represent a small fraction of the expected dilutions (based on modelling) at the high LEP boundary (1:1867) (Table 5-13).

In summary, WET testing suggest that the discharge of HT water will not increase risk to the environment from the additional waste stream, and the discharge can be managed effectively by complying with existing EQCs.

Table 5-12: Whole effluent toxicity test NOEC1 end points

Test	Solution 1	Solution 2	Solution 3	Solution 4	Solution 5	Solution 6
72-hr microalgal growth inhibition test	100	100	100	100	12.5	<6.3
72-hr macroalgal germination success	100	100	100	100	100	100
48-hour bivalve larval development test	25	25	50	25	100	12.5
72-hr urchin larval development test	25	25	25	25	25	6.3
7-day fish Imbalance and biomass test	100	100	100	100	100	100

Table 5-13: ANZECC & ARMCANZ (2000) derived trigger values and dilutions required for LEP

Level of ecological protection	Moderate LEP (90% species protection)		High LEP (99% species protection)	
	Trigger (% combined effluent)	Dilutions required to meet the level of ecological protection	Trigger (% combined effluent)	Dilutions required to meet the level of ecological protection
Solution 1	28	3.6	7.8	13
Solution 2	28	3.6	7.8	13
Solution 3	38	2.6	15	6.8
Solution 4	28	3.6	7.8	13
Solution 5	26	3.8	7.0	14
Solution 6	5.2	19	2.7	38
Dilutions expected2		1:1672		1:1867

[1] NOEC = No Observed Effects Concentration or the concentration at which the response of test organisms is statistically indistinguishable from organisms in an uncontaminated control.

[2] Dilution expected based on modelling

6.0 CONTINGENCY MANAGEMENT

Contingency waste water management measures are to be implemented to control and manage construction related waste water contingencies. These include:

(1) Wet Commissioning & Planned Operations, which relate to exceedences of trigger values and EQCs associated with planned discharges to the marine environment under typical conditions.
(2) Unplanned Events which relate to unplanned events including cyclonic events, equipment breakdown, etc. and are aimed at protecting construction personnel and avoiding/ minimising potential impacts to sensitive onshore receptors such as surface and groundwater.
(3) Simultaneous Operations which relates to potential breaches of EQCs and LEP requirements associated with the cumulative impacts of dredging and nearshore construction which may occur simultaneously to planned and unplanned operations of the WWTP.

6.1 Wet Commissioning & Planned Operations

Contingency management for wet commissioning and planned operations is focused on potential breaches of trigger values and EQCs under typical conditions as required under Condition 13 and Schedule 2 (MS 873). Relevant triggers and contingency management measures therefore provide direction and recommendations for ensuring EQCs are not exceeded and associated LEPs as described in Schedule 2 (MS 873) are maintained.

A wet commissioning period is required to enable the various WWTPs and RO plants to be gradually brought ‘online” and for WWTP operations to be optimised for all input streams (Section 7.3). The end of the commissioning period (typically 3 months, the final duration of the commissioning period will be negotiation with DER and specified within the Works Approval Permit) will be determined when engineering and monitoring confirm typical operating conditions have been achieved.

The levels of environmental protection established in Schedule 2 (MS 873) will apply to typical conditions only and will not apply during the wet commissioning phase. Continuous and composite sample monitoring undertaken during wet commissioning will continue through operations to confirm achievement of the EQCs validated through the monitoring described in Section 7.3.

If effluent composition changes significantly from that expected under typical conditions (described in Section 5.0) then validation monitoring will be undertaken as per the initial wet commissioning period (Section 7.3). Significant changes to effluent composition are considered to occur when an addition or alteration is made to the onsite WWTPs or RO plants (subject to amendment to the Works Approval and/or Operating License) or as the result of input to the WWTPs from a waste source not identified in Section 2.6.1 or if the discharged flow rate described in Section 5.1 is exceeded by more than 40%.

In the event that the treatment system and construction waste water outfall are unable to achieve the intended objectives (required dilutions and/or EQCs), solutions shall be promptly investigated to mitigate the event. Contingency options for potential long-term operational issues depend upon which constituent(s) of the effluent stream is of concern and what risk it poses. Therefore, the specific constituent would be evaluated to determine if either an operational or design solution is available and can be implemented.

There are a number of potential operational and design solutions which may be used as contingency measures in response to trigger level exceedences. There are a number of potential Operational and Design based contingency triggers and management options. In the event of an exceedence requiring intervention, the first step will be to determine if the cause of exceedence relates to design or operating parameters (such as the design model itself, monitoring errors, discharge rates/volumes, met-ocean conditions). Subject to the outcomes of the investigation a combination of the following options may be implemented.

Operational contingency options may include any combination of the following:

- Redirecting of effluent to temporary storage on site for later recirculation/recycling through the WWTP(s)
- Adjust the flow process and rates
- Changes to management and treatment of wastewater (e.g. isolating a particular stream of concern and other modifications to WWTP[s] operations depending on the test results)
- Injecting seawater directly into the combined waste water equalisation tank to achieve further dilution
- Investigate available options for reuse
- Transport by a licensed controlled waste contractor for treatment offsite at an approved licensed facility.

Design contingency options may include any combination of the following:

- Conduct additional field studies or monitoring to investigate
- Modify existing equipment/facilities (e.g. adding an additional treatment method[s] for the constituent[s] of concern, replacing a particular treatment[s] with other equivalent or improved techniques
- Addition of another processing train[s] to the WWTP[s] (subject to approval)
- Modifying or relocate the diffuser (subject to approval under Condition 13.1).

Once design options are selected, an assessment of the risk that the dilutions and/or EQCs will not be met (including possible additional modelling) may be conducted and to determine if proposed contingency options are likely to correct the observed exceedence. The results of contingency options selection process and the above assessments will be reported to the OEPA/DEC, and what actions may be taken to correct the situation. Relevant approval applications will be submitted as appropriate.

6.1.1 Contingency Management Triggers

Three levels of Contingency Management are proposed for Planned Operations in order to ensure that the requirements of Condition 13 and Schedule 2 (MS 873) are met. These values are based on the modelling outputs and effluent characterisation described in Section 5.0. Inputs to the modelling results were based on maximum flow rate characteristics listed in Section 5.1 of this Plan. For the purposes of monitoring, these values will be the designated trigger values against which investigations and / or modifications will be initiated. Monitoring procedures to provide data for comparison against these triggers have been outlined in Section 7.0. A description of relevant management measures associated with Level 1, 2 and 3 trigger values are provided in the following sections. Trigger values for Toxicants, Other Chemical and Physical Parameters and Biological Parameters are listed in Table 6-1, Table 6-2 and Table 6-3, respectively.

6.1.1.1 Level 1

Level 1 Trigger Values are based on a maximum instantaneous flow rate (pumping rate) during each discharge period of 761 m^3/hr. Average daily flow of 527 m^3/hr is based on five daily discharge periods each lasting approximately 3.3 hours. The waste water parameter concentrations for average and instantaneous flow rate remain the same. Readings in excess of the projected maximum flow rate specifications will trigger an investigation to determine the source of elevated readings, beginning with an evaluation of readings at the individual WWTPs and the seawater desalination system. Investigations may also require increased monitoring at the construction waste water outfall. Should an unplanned flow rate exceedance be detected, the pumping operations will be reduced to a more acceptable level. Pumps, in-line analyser(s) and alarms, and "end of pipe" monitors shall be inspected and repaired/replaced as necessary.

6.1.1.2 Level 2

Level 2 Trigger Values are based on 'end of pipe' concentrations. The primary trigger value is set at 80% of maximum expected constituent concentration in the discharge and is intended to act as an "early warning" for possible corrective action. The secondary trigger value is set at 100% of maximum expected constituent concentration in the discharge. For the commissioning period, Level 2 trigger values are based on sampling frequency of once per week (Table 7-1). The sampling frequency for under typical conditions will be defined in a subsequent monitoring plan for the operating facility as required under Works Approval W5439/2013/1 (approval pending).

Should end-of-pipe readings reach the primary or secondary trigger values, appropriate corrective measures that may be taken immediately may include equipment maintenance, caustic solution dosing, possible recirculation/recycling of effluent through the WWTP for additional treatment, or redirecting of effluent to temporary storage on site for later recirculation/recycling as necessary.

Where Level 2 triggers values are reached, an investigation similar to the one for Level 1 Trigger Values will be initiated to determine the cause of the trigger being reached including inspection and repair of in-line analyser(s) and alarms, and "end of pipe" monitors as necessary. Monitoring readings that reach Level 2 trigger values will be recorded and reported internally on a regular basis.

6.1.1.3 Level 3

Level 3 Contingency measures are applicable only during approved wet commissioning periods. Level 3 Trigger Values are defined as EQC for the Moderate LEP and will be measured weekly at the boundary between the Low and Moderate LEP zones during wet commissioning. Measurements obtained during this period will be used to trigger adaptive management measures and will contribute to WWTP optimisation activities. Weekly medians at the LEP boundary will be tracked over time to provide assessment of the efficacy of these adaptive management procedures.

Should monitoring show that these trigger values are reached, adaptive management measures taken may include equipment maintenance, overhaul, or full replacement; caustic solution dosing; possible recirculation/recycling of effluent through the WWTP for additional treatment, redirecting of effluent to temporary storage on site for later recirculation/recycling as necessary or for transport by a licensed controlled waste contractor for treatment offsite at an approved licensed facility, and/or temporary discharge to the irrigation field(s), should the irrigation field(s) still be in operation (see Section 2.3.1.1) .

Where Level 3 triggers values are reached, an investigation similar to the one for Level 1 and Level 2 Trigger Values will be initiated to determine the cause of the trigger being reached including inspection and repair of in-line analyser(s) and alarms, and “end of pipe” monitors as necessary. Monitoring readings that reach Level 3 trigger values will be recorded and reported internally on a regular basis.

Table 6-1: Contingency Management Triggers for Toxicants in Construction Onshore Facilities Waste Water Discharges

Environmental Quality Criteria	Units	Trigger Values		
		Level 1(1)	Level 2(2)	Level 3(3)
Aluminium	µg/L	instantaneous flow rate during discharge > $761 m^3/hr$	4.10	Impact median > Reference 95th percentile
Cadmium	µg/L		0.24	14
Chlorine	µg/L		3	Impact median > Reference 95th percentile
Chromium (III/VI)	µg/L		0.41	49/20
Copper	µg/L		0.41	3
Hydrocarbon (oil & grease)	mg/L		5.6	Impact median > Reference 95th percentile
Lead	µg/L		4.10	6.6
Mercury	µg/L		0.04	0.7
Nickel	µg/L		2.85	200
Silver	µg/L		4.07	1.8
Vanadium	µg/L		1.16	160
Zinc	µg/L		4.12	23
Mixed toxicants	µg/L	Sum of concentration of (up to 5) primary toxicants < sum of relevant trigger values		

Notes:

(1) The waste water parameter concentrations for average and instantaneous flow rate remain same.
(2) Level 2 Trigger values are based on ‘end of pipe’ concentrations.
(3) Level 3 trigger values are defined as EQC at Moderate LEP.

Table 6-2: Contingency Management Triggers for other Physical and Chemical Parameters in Construction Onshore Facilities Waste Water Discharges

Environmental Quality Criteria	Units	Trigger Values			
		Level 1[1]	Level 2 [2]	Level 3 [3]	
Total Dissolved Solids (TDS)	mg/L	instantaneous flow rate during discharge > 761m^3/hr	39,870	39,500	and Impact median > Reference 95th percentile
Total nitrogen	µg/L		5467	260	
NOx (nitrate + nitrite)	µg/L		9.50	16.6	
Total phosphorus	µg/L		615	17.5	
Filterable reactive phosphorus	µg/L		2.22	4.0	
Salinity	PSU		40	36.4	
Temperature –winter	^{o}C		25	26.2	
Temperature–summer	^{o}C		31	30.2	
pH			6 to 8	Impact median between reference 5th and 95th percentile	
Turbidity	NTU		26	Impact median > reference 95th percentile	
Total Suspended Solids (TSS)	mg/L		27.5	18.75	
DO $_{Saturation}$	%		80[4]	80[4]	
5-day BOD (BOD_5)	mg/L		7.6	-	

Notes:

(1) The waste water parameter concentrations for average and instantaneous flow rate remain same.
(2) Level 2 Trigger values are based on 'end of pipe' concentrations.
(3) Level 3 trigger values are defined as EQC at Moderate LEP.
(4) 6 week median at any site ≤ 0.5m from seafloor

Table 6-3: Contingency Management Triggers for Biological Parameters in Construction Onshore Facilities Waste Water Discharges

Environmental Quality Criteria	Units	Trigger Values		
		Level 1(1)	Level 2(2)	Level 3(3)
Microbiological (Guideline)		instantaneous flow rate during discharge > $761 m^3/hr$	-	-
faecal coliform	Organisms /100 mL		18	150
enterococci	Organisms /100 mL		-	Impact 95th percentile > 200
Algal biotoxin	Cells/L		N/A	15 000 000
Microbiological (Standard)			-	-
faecal coliform	Organisms /100 mL		18	600
enterococci	Organisms /100 mL		-	Impact 95th percentile > 500
Algal biotoxin	Cells/L		N/A	No confirmed incidents of skin or eye irritation caused by toxic algae

Notes:

(1) The waste water parameter concentrations for average and instantaneous flow rate remain same.
(2) Level 2 Trigger values are based on ‘end of pipe’ concentrations.
(3) Level 3 trigger values are defined as EQC at Moderate LEP.

6.2 Unplanned Events

Unplanned Events include minor disruptions to operation/service, cyclonic events and power failures. These contingencies could result in release of black/greywater to the terrestrial environment or inundation of waste water storage and disposal systems by floodwaters. However, these releases shall be minimised to the extent practicable by expediting necessary shut-down and and/or repairs to the CV and site WWTPs and the seawater desalination system in order to ensure minimal disruption to its operation.

The CV and site WWTPs, desalination plant and waste water outfall will be equipped with monitoring devices for either continuous or composite sampling analysis as outlined in Section 7.0 of this Plan. Depending on the detected parameters, appropriate corrective measures will be taken immediately. Potential unplanned events and associated contingency actions may include, but are not limited to the following:

- In the event of a cyclone, WWTPs may experience inundation of storm surge and/or flood water. Prior to this occurring, the waste water present within the system will be discharged in-full to the irrigation field(s), or through the waste water outfall, once commissioned, and the entire WWTP system will be shut down. The emergency shelter-in-place for a reduced workforce will direct its waste water to the CVWWTP for temporary holding and until such time that the WWTP is restarted.
- In the event of power failure, particularly in the absence of the availability of the irrigation field(s), an appropriate method for disposal of waste water will be identified which may include temporary on-site storage and/or off-site disposal.
- In the event of an unplanned release, steps will be taken in accordance with Project spill procedures that include: containing the release, cleaning up the release, commencing an investigation as to the cause of the release, reviewing the current operating procedure

and inspecting equipment or area layout. Corrective actions would be based on findings of the investigations and may entail modifications to the operation procedure and equipment or area layout.

6.3 Simultaneous Operations

The construction waste water outfall is located near the top of bank of the proposed dredge channel and as such there is some likelihood that dredging activity may occur in the vicinity of the outfall, during both its commissioning and operation. If this were to occur, measurements for some water quality criteria, particularly physical parameters, at the mixing zone may be influenced by simultaneous dredging activities. Chevron will assess the “end of pipe” monitoring data for the appropriate physical parameters, measurements from the in-line analysers, location and characteristics of other activities in the area, and metocean conditions in order to determine the effect, if any, of dredging activities in relation to the effluent being discharged. Should it be determined that the construction waste water system is the main contributing factor of EQC non-compliance, the system shall be evaluated and corrective measures applied. Should it be determined that the dredging campaign is the main contributing factor of a perceived EQC non-compliance, the dredging campaign will be notified and asked to initiate corrective measures as deemed appropriate.

6.4 Changes to Effluent Stream Composition

Prior to any modifications to the waste water effluent composition where the modification consists of an addition of a new effluent stream (i.e. caused by changes in processes or changes in chemical additives) the following actions will be implemented and the plan updated with the relevant information:

Addition of new effluent stream:

- Assess new effluent stream against ANZECC water quality guidelines and determine appropriate EQCs for each constituent within the new effluent stream.
- Confirm the waste water treatment/discharge system is able to process the desired flow rates (volume) and concentrations to meet relevant EQCs, otherwise modify the equipment/facilities accordingly.
- Conduct WET testing and environmental quality validation as required.
- Once determined that the current or modified design is satisfactory to discharge the new effluent stream, assess and modify the current monitoring program accordingly (adding continuous monitoring as needed and analysing composite samples for the new constituents). Monitoring to revert to frequencies associated with commissioning period.
- If changes to EQCs, dilutions or discharge plume characteristics exceed those within the approved plan, update this plan and resubmit to OEPA/DEC for approval.

7.0 EFFLUENT QUALITY VALIDATION AND MONITORING

The aim of the Effluent Quality Validation and Reporting Plan (EQVRP) is to confirm that modelling predictions are accurate in the context of the EQCs set out in Section 4.0 and to ensure ongoing compliance with the environmental values outlined in MS 873. The program has been designed to deliver outcomes for the objectives outlined in Condition 13-12 of MS 873.

The specific objectives of the EQVRP are:

- Determine the actual toxicity and characterise actual water quality in the discharge stream
- Validate the modelling and predicted dilutions and confirm that the prescribed LEPs are being achieved at the:
  - Low-Moderate LEP boundary within 70 m from the diffuser; and
  - Moderate-High LEP boundary
- Revise the set of EQCs (where relevant) for the purpose of ongoing monitoring.

To achieve the objectives, the EQVRP comprises three components which are listed below and described in the following sections:

1. WET testing (Section 7.1) for:
   - determining the actual toxicity of the discharge; and
   - confirming the number of dilutions required to achieve the relevant LEPs as outlined in Schedule 2 (MS 873).
2. Quantitative characterisation of effluent from the CV combined effluent tank (Section 7.2).

   and
3. Testing water quality against EQCs at the Low and Moderate LEP boundaries (Section 7.3).

The results of these three programs will then be used to validate the model dilution predictions and to derive a revised set for environmentally relevant EQC to be used for ongoing monitoring. The ongoing monitoring proposed for evaluation against contingency management triggers (Section 6.0) will follow the same procedures as the monitoring for effluent quality validation outlined in Section 7.2 and Section 7.3.

7.1 Wet Commissioning

The primary component of the EQVRP is the qualitative and quantitative characterisation of effluents in the discharge. Monitoring at the WWTPs, desalination plant, and waste water outfall will be conducted during the commissioning period of each facility so that the system can be optimised for typical conditions. Continuous and composite sample monitoring will be undertaken at the “end of pipe” during the wet commissioning period on a weekly basis. The results of this program will also assist in the revision of the set of EQCs for contaminants of concern, currently outlined in Table 4-2, Table 4-3 and Table 4-4.

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Commissioning monitoring will be implemented as outlined in Table 7-1. Note: The sampling frequencies stated in Table 7-1 can be increased depending on the test results or a particular constituent can be removed from the program if it is no longer of concern. Authorisation from OEPA/DER will be requested along with the requisite information before a less frequent measurement schedule is adopted.

For the discharge of HT water, no monitoring will be done as part of the EQVRP. WET testing results are described in Section 5.7.Collected samples will be sent to a National Association of Testing Authorities (NATA) accredited laboratory for evaluation of relevant water quality parameters. At present, it is expected that analysis will be conducted by the Marine and Freshwater Research Laboratory (MAFRL, Murdoch University, Murdoch, WA) and ARL Environmental and Analytical Laboratory (ARL, Welshpool, WA). Both of these laboratories are NATA accredited for the relevant assays. However, if circumstances dictate, assays may be conducted by other NATA accredited laboratories.

Water samples will be taken for biological and chemical analyses in accordance with the laboratory specifications for the analytes listed in Table 4-2, Table 4-3 and Table 4-4 . Five replicate samples will be taken from the co-mingled effluent for each analyte during each sampling occasion. Readings for pH and salinity (by conductivity) will be taken on site. Tests for free chlorine will also be conducted in the field. Samples will be collected and sent to a NATA accredited laboratory for testing for the following parameters: Total suspended solids; Total hydrocarbons; nutrients (Nitrogen and Phosphorus): and biological oxygen demand.

In accordance with ANZECC & ARMCANZ (2000) guidelines, 10% of sites will be sampled as splits (randomly selected) and one sample will be taken as a 'blank'. As there is a single site in this sampling program, but multiple sampling occasions, an extra sample for each analyte will be taken in the first and last sampling occasion, to be sent to the alternate analytical laboratory to serve as the splits for quality assurance. The blank sample is prepared using the methods for field sampling but containers are filled with laboratory prepared distilled water, rather than discharge water.

The water quality parameters proposed for assessment for the CV and site WWTPs and the UF and SWRO units have been outlined in Table 4-2, Table 4-3 and Table 4-4. Flow rates will also be confirmed during the commissioning monitoring program.

Table 7-1: Monitoring Parameters and Locations

Waste Stream	Sample Point Location	Sampling Parameter	Sampling Frequency
Waste Water Sources			
WWTPs (CV and LNG Plant Site)	At exit of WWTPs	pH	Continuous
		Flow rate and volume	
		Total Suspended Solids (TSS)	Composite sampler: 1 / week - Commissioning
		Chlorine residual	
		Biological Oxygen Demand (BOD)	
		Chemical Oxygen Demand (COD)	
		Total nitrogen	
		Total phosphorus	
Desalination (RO) Plant	At exit of desalination (RO) plant	Salinity	Continuous
		Flow rate and volume	
Outfall			
Construction Waste Water Outfall	As close to end of pipe (outfall) as practicable - Onshore	Toxicants	
		Chlorine	Continuous
		Aluminium	Composite Sample: 1 / week - Commissioning
		Cadmium	
		Chromium (III/VI)	
		Copper	
		Lead	
		Mercury	
		Nickel	
		Silver	
		Vanadium	
		Zinc	
		Hydrocarbon (TPH)	
		Physical and Chemical Parameters	
		Total Dissolved Solids (TDS)	Continuous
		Total nitrogen	1 / week - Commissioning
		NOx (nitrate + nitrite)	
		Total phosphorus	
		Filterable reactive phosphorus	
		Salinity	Continuous
		pH	
		Temperature	
		Turbidity	
		Total Suspended Solids (TSS)	
		$DO_{Saturation}$	1 / week - Commissioning
		5-day BOD (BOD_5)	

Waste Stream	Sample Point Location	Sampling Parameter	Sampling Frequency
		Flow rate and volume	Continuous
		Biological Parameters	
		faecal coliform	1 / week - Commissioning
		enterococci	

7.2 Whole Effluent Toxicity Testing

WET testing will be conducted on samples of the co-mingled construction waste water outfall taken at the end of the wet commissioning period to identify the potential toxicity of the anticipated effluent under typical conditions. WET testing involves exposing organisms to different concentrations of an effluent and then measuring growth or reproductive characteristics after a selected period of time.

The WET testing program is anticipated to involve two processes, conducted by the same laboratory, namely:

1. Range finding test for toxicity: to determine if the effluent at the outfall is toxic and, if so, the concentration range relevant for further testing.
2. Definitive toxicity testing: to determine the EC_{50}/IC_{50}, and NOEC values for the effluent in a particular species*.

**These data will also be used to determine the number of dilutions required to achieve each LEP as prescribed by ministerial condition 13-12ib.*

Ecotoxicity tests commonly employ a preliminary range-finder test to determine what concentrations of effluent should be tested to provide precise toxicity data. As the effluent to be tested here is likely to undergo a reduction in toxicity over time, the time taken to conduct range-finding tests would see a weaker toxicity signal by the time secondary tests could start. For that reason, the primary test conducted here will be a definitive test in providing the EC_{50}/IC_{50}, and NOEC values for this effluent. These data will also be used to determine the number of dilutions required to achieve the various LEP values prescribed by Ministerial Condition 13-12(i)b.

WET testing is to be undertaken on a minimum of five locally relevant species from four different taxonomic groups using the recommended protocols from ANZECC and ARMCANZ (2000). The Wheatstone marine project development area at Onslow lies at the Southern extent of the region of Australia's coastline considered to represent tropical waters as classified by IMCRA 4.0 (Commonwealth of Australia 2006). As such, the waters in this region contain both tropical and temperate organisms, where species from both regions are relevant. WET testing is proposed to include mostly tropical species from a range of trophic levels (primary producer, herbivore and carnivore), using chronic (predominantly) tests for toxicity.

Proposed tests and locally relevant species to be used in the Wheatstone WET testing are listed below although consideration of other species is possible if these species are unavailable:

1. 72-hr microalgal growth inhibition test: *Nitzschia closterium.*
2. 48-hour larval abnormality test: *Saccostrea echinata.*
3. 72-hr larval development test: *Heliocidaris tuberculata.*

4. 96-hr acute toxicity test: *Penaeus monodon* or *Melita plumulosa.*
5. 96-hr Fish Imbalance test: *Lates calcarifer*.

A description of each WET testing method listed above, along with the method that the testing is based on are provided in Table 7-2. Samples for WET testing will be taken in accordance with the sampling kit and instructions provided by Ecotox Services Australia, the laboratory undertaking the ecotoxicological analysis. Plastic sample bottles (2.5 L) will be filled from the co-mingled discharge holding tanks once typical operating conditions for the WWTP have been reached. Samples will be chilled for 2 hours on ice to bring down to 4 ºC, packed in eskies and air freighted to the laboratory. In order to complete testing for the full suite of five species, using five dilution concentrations with four replicates at each concentration, the laboratory has indicated the a maximum volume of 15 L of effluent will be submitted if required.

For the discharge of HT water, no monitoring will be done as part of the EQVRP. WET testing results are described in Section 5.7.

Table 7-2: Whole Effluent Toxicity Testing of Construction Onshore Facilities Waste Water Discharges

Test / Species / Method		Notes
1.	72-hr microalgal growth inhibition *Nitzschia closterium* USEPA Method 1003.0 and Stauber et al. 1996 for the National Pulp Mills Research Program	A 72-h growth test using the diatom *Nitzschia closterium* is the most extensively-used marine microalgal test in Australia. *N. closterium* is both benthic and planktonic and is widely distributed in Australian coastal waters (Stauber 1995). This test utilises the temperate clone of alga which has been used in many ecotoxicological assessments and is sensitive to a wide range of metals, organic compounds and whole effluents (Florence and Stauber 1986; Hogan et al. 2005; Stauber 1995). The test is usually undertaken on a range of concentrations of a test material, e.g. 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, algae cell yield is determined.
2.	48-hour larval abnormality tropical milky oyster - *Saccostrea echinata* Krassoi et al., 1996 for the National Pulp Mills Research Program	Many oyster species are of great ecological and economic importance in Australia, in particular *Saccostrea commercialis* (Smith et al. 2004), *Pinctada maxima* (Negri et al. 2004) and *Saccostrea echinata* (Peerzada and Dickinson 1989). In northern Australian waters the black-lip oyster (*S. echinata*) are wild-harvested from rocky foreshore areas (van Dam et al. 2008). The vast majority of toxicity studies using oysters have assessed larval development and/or growth, endpoints that have provided one of the most rapid and sensitive toxicity tests (Geffard et al. 2002). The current test examines the effect of a range of concentrations of test material on the larval development of *S. echinata* from zygote to D-veliger stage, reached 48 hours after fertilisation. The test follows the standard ASTM protocol developed for North American bivalve species.
3.	72-hr larval development sea urchin *Heliocidaris tuberculata* APHA Method 8810D and Simon and Laginestra 1997	The temperate sea urchin (Echinoderm), *Heliocidaris tuberculata*, has become widely used in toxicity testing programs in Australia, with fertilisation (1-h exposure) and larval development (72-h exposure) being the major endpoints measured (as summarised by Smith et al. 2004). Although a temperate species, *H. tuberculata* has been used in the past for toxicity testing in the Pilbara (API Management Pty Ltd 2010) and is sensitive to saline effluent, making it suitable for the current discharges. This test involves exposing developing urchin embryos to the test material for 72 hours. The test is usually undertaken on a range of concentrations of a test material, e.g. 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, the number of normally developed and abnormal larvae are counted.

Test / Species / Method		Notes
4.	96-hr acute toxicity juvenile tiger prawn: *Penaeus monodon* USEPA OPPTS 850.1045	*Penaeus monodon* (Jumbo tiger prawn) are a tropical species of economic importance and have a distribution in Northern Australian waters from Moreton Bay (Queensland) to Exmouth Gulf (Western Australia). Post-larvae of *Penaeus spp.* have been chosen as test organisms in many toxicity tests for their sensitivity (Brecken-Folse et al. 1994; Das and Sahu 2005) and because they survive well under laboratory conditions (Denton and Burdon-Jones 1982). However, there have been a few chronic toxicity tests conducted in Australia using prawns (van Dam 2008). At present, this 96-h acute toxicity survival test is offered by the small number of commercial ecotoxicology laboratories operating in Australia, particularly for tropical issues (Ecotox Services Australia 2005). However, the availability of the test relies on the seasonal availability of appropriate stage post-larval prawns from various commercial hatcheries. Testing involves exposing hatchery reared PL-15 juveniles to the test material for 96 hours. The test is usually undertaken on a range of concentrations of a test material, e.g. 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, the number of surviving prawns is recorded. The intention is to use *Penaeus monodon,* however testing laboratories have advised that it is becoming increasingly difficult to get and may be unavailable at the time of testing (waiting times may be > 3 months). *Melita plumulosa* is proposed as an alternative but will only be used if *Penaeus monodon* is unavailable at the time of testing. *Melita plumulosa* represents a similar position in marine trophic food webs as post-larval prawns and while this species is typically found in temperate waters its distribution extends to marine waters off Central Queensland and therefore is considered appropriate alternative species for this test for the Wheatstone project.
5.	96-hr Fish Imbalance Larval Marine Fish (subject to availability) USEPA 1993 and OECD Method 203 (acute test)	Fish are the primary vertebrate component in aquatic systems and, as such, have comprised an integral part of toxicity assessments (Smith et al 2004), with the early life stages of fish considered to be the most sensitive to toxicant exposure (McKim 1977). The barramundi, *Lates calcarifer*, has been used regularly for toxicity assessments, although most often as part of commercial-in-confidence studies, which are rarely published in the peer-reviewed literature. In Australia, *L. calcarifer* fry are available from specialist commercial hatcheries. The predominant existing *L. calcarifer* test is a 96-h imbalance test, which measures the loss of swimming ability of juveniles, typically 20–30 mm in length, such that the fish can no longer remain upright (Smith et al. 2004). This test involves exposing fish larvae to the test material for 96 hours. The test is usually undertaken on a range of concentrations of a test material, e.g. 100, 50, 25, 12.5 and 6.3% effluent. At the end of the exposure period, the number of balanced and the number of un-balanced fish larvae are recorded.

7.3 Environmental Quality Validation

7.3.1 Overview

A key outcome from the EQVRP is to confirm that the environmental quality objectives (Table 4-1) and the levels of ecological protection are being achieved. Monitoring at the LEP boundaries is therefore required to validate and/or revise the EQC (refer Section 4.3) against which achievement of the EQOs is assessed.

Water samples will be collected at 'Impact' and 'Reference' sites at 1 m from the surface and 0.5 m from the bottom of the seafloor over a six week period following the completion of wet commissioning of the WWTP. The samples will be analysed as described in Table 4-2, Table 4-3 and Table 4-4. Analysis will be either conducted on-site or samples will be sent to a NATA accredited laboratory using the laboratories preferred chain of custody for sample transfer.

The guideline value for DO is based on both spot samples and a six week median. Spot samples will be collected and analysed as above. For the six weeks median for each impact and reference site, samples will be collected within 0.5 m of the seafloor each week, with the final 6 weeks median occurring at the end of the commissioning period. Once normal operation commences, spot samples at each site will represent the DO measure, compared against the 60 % saturation for spot samples outlined in Schedule 2 of MS 873.

Compliance with the EQCs and the prescribed levels of ecological protection will be assessed by comparing the post commissioning survey results with the EQC guideline triggers for high and moderate LEP, reported in Table 4-2, Table 4-3, Table 4-4, compliance will be achieved if water quality from all sites is below the guideline values.

Ongoing monitoring of the discharge streams will continue to ensure the revised EQC are met as part of a long term monitoring and management plan. It is expected the continued monitoring will depend on results from EQVRP. On the basis that the EQVRP indicates that EQC are being met for all Environmental Values, monitoring would continue with a revised set of EQC as an end of pipe operation (monthly samples) with additional monitoring may be initiated following a change in end of pipe effluent characteristics or discharge volume (see Section 6.4).

7.3.2 Site selection

The number of sites selected for monitoring at zone boundaries is based on the guidelines in ANZECC & ARMCANZ (2000) and the Manual of Standard Operating Procedures for Environmental monitoring against the Cockburn Sound Environmental Quality Criteria Environmental Protection Authority 2005). These documents recommend a minimum of five samples for ocean outfall monitoring. On this basis, at least five potential Impact sites (on the boundary of the Low and Moderate LEP), at least five potential Impact sites (boundary of the Low and Moderate and High LEP) and at least five Reference sites will be established for the EQVRP monitoring.

Impact sites will be located on the edge of the Low LEP boundary (70 m from any point on the diffuser) and the edge of the Moderate LEP boundary (area contained within 250 m of the shipping berths and ship turning basin). Moderate LEP impact sites are proposed to be located uniformly around the discharge point. Due to the asymmetry of the location of the discharge point in the moderate LEP zone, the high LEP impact sites are located on the closest LEP boundary (Eastern edge) to the discharge. The GPS location for impact sites will be determined when an accurate GPS location for the entire length of the diffuser is available, since the low LEP boundary (70 m) is set relative to the diffuser extent. Impact sites will remain fixed for the period of monitoring and the proposed locations have been presented in Figure 7.1

The direction of the plume emanating from the discharge will depend on the oceanographic conditions (current and tide) present at the time of sampling. Sampling of impact sites is therefore proposed to occur in during both a tidal current and slack water. The closest LEP boundary (eastern edge) will have the highest potential risk for exceeding the EQC and therefore sampling is proposed during the rising tide when the tidal current runs in a West to East direction and impact sites will be down current from the discharge point. The direction of water movement through the mixing zone will be confirmed with a mid-water drogue before sampling begins. The order of sampling is expected to occur as 1) measurement of impact sites under the influence of a rising tide, 2) measurement of reference sites in the rising tide and 3) measurement of impact sites in slack water. This order is expected to allow any residual plume to be cleared from the location of the reference sites.

Reference sites will be selected to match natural conditions expected at the Impact sites. Reference sites can account for broad scale regional effects that will result in natural perturbations above the long term 80^{th} percentile. The inclusion of both real-time Reference sites and long term percentiles will then minimise the possibility of falsely attributing change to onshore discharge. Reference sites will be selected and located as recommended by ANZECC & ARMCANZ (2000) and the EPA (Environmental Protection Authority 2005) as follows:

- Representative - same bio-geographic and climatic region as the test site
- Bathymetry, substrate and hydrodynamics of the Reference site should be similar to test site
- Independent - should be sufficiently distant from the test site to avoid disturbances in the test site affecting the Reference site - current assumption is that Reference sites will need to be > 500 m from the outfall.
- Reference sites will be located up current from the discharge location on an axis perpendicular to the direction of current. The separation between reference sites will be no less than 100 m along this axis (Figure 7.1).

In accordance with ANZECC & ARMCANZ (2000) guidelines, 10% of sites (2 sites) will be sampled as splits (randomly selected) and one sample will be taken as a 'blank'. Splits will be taken at all depth strata for the randomly selected sites and these samples will be sent to the alternate laboratory for analysis.

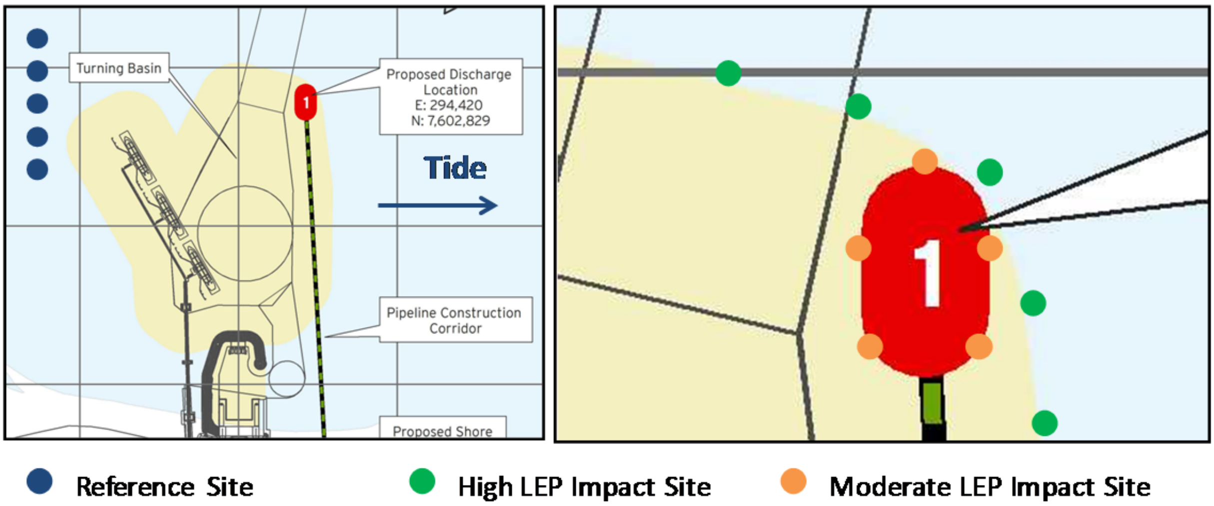

Figure 7.1: Approximate locations of reference (blue), high LEP (green) and moderate LEP (orange) impact monitoring sites.

Note: Reference sites will be measured during a rising tide with the direction of the tide indicated on the left panel by the blue arrow. Impact sites will be measured during the rising tide and in slack water.

8.0 REPORTING

This section provides a framework for external reporting to regulatory authorities relevant to this Plan, including scheduled and unplanned reporting.

8.1 Effluent Quality Validation Report

The results from the EQVRP for these objectives will be reported within six months of the end of the commissioning period (13-12v MS 873).

8.2 Annual Compliance Reporting

In accordance with MS 873 Condition 4 and EPBC Approval Condition 3, Chevron is required to submit (*or publish*) an Annual Compliance Assessment Report to the CEO of the OEPA. As part of the preparation of an Annual Compliance Report, Chevron will assess its compliance with this Plan in the relevant period. An action table is provided in Appendix A to assist with auditing for compliance with this Plan for MS 873 and EPBC 2008/4469.

8.3 Non-compliance Reporting

Any potential non-compliance, relevant to this Plan, will be reported to the CEO of the OEPA within seven days of that potential non-compliance being known as required by MS 873 Condition 4-5.

8.4 Incident and Other Reporting

In accordance with MS 873 Condition 13-13 v, Chevron is required to report to the DEC within six months of commissioning of a discharge or within six months of any significant change in composition of a discharge, including any management actions necessary to ensure ongoing compliance with the environmental quality objectives and levels of ecological protection established through MS 873 Condition 13-1 and described in Schedule 2.

9.0 REFERENCES

ANZECC & ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, National Water Quality Management Strategy Paper 4, Canberra, ACT

APHA (1998) Standard Methods for the Examination of Water and Wastewater. 20th Ed. American Public Health Association, American Water Works Association and the Water Environment Federation, Washington, DC

API Management Pty Ltd (2010) API West Pilbara Iron Ore Project - Stage 1 Desalination Discharge Management Plan. API Management Pty Ltd, Perth, WA, Australia

Brecken-Folse JA, Mayer FL, Pedigo LE, and Marking LL (1994) Acute toxicity of 4-nitrophenol, 2,4-dinitrophenol, terbufos and trichlorfon to grass shrimp (Palaemonetes spp.) and sheepshead minnows (Cyprinodon variegatus) as affected by salinity and temperature. Environmental Toxicology and Chemistry 13: 67-77

Bidwell JR, Wheeler KW, and Burridge TR (1998) Toxicant effects on the zoospore stage of the marine maroalga *Ecklonia radiata* (Phaeophyta:Laminariales). Marine Ecology Progress Series 163:259–265

Burridge TR, Karistanios M, and Bidwell J (1999) The use of aquatic macrophyte ecotoxicological assays inmonitoring coastal effluent discharges in southern Australia. Marine Pollution Bulletin 39:1–12

BMT Oceanica (2015) Wheatstone Combined Discharge – Effluent Quality Validation Report. Prepared for Kiewit Ertech Joint Venture by BMT Oceanica Pty Ltd, Report No. 1094_001/3_Rev0, Perth, Western Australia, October 2015

Campbell E, Palmer MJ, Shao Q, Wilson, D (2000) BurrliOZ: A computer program for calculating toxicant trigger values for the ANZECC & ARMCANZ water quality guidelines. In National water quality management strategy, Australian and New Zealand guidelines for fresh and marine water quality. ANZECC & ARMCANZ, Canberra, Australia

Chevron Australia (2010) Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project: Technical Appendices Q6, Q7, R1, S1, T1, U1, V1, and W1, July 2010

Chevron Australia (2013) Wheatstone Project – Construction Onshore Facilities Waste Water Discharge Plan. Report No. WS0-0000-HES-PLN-CVX-000-00096-000, Revision 3, Perth, Western Australia, October 2013

Chevron Australia (2015) LNG and Condensate Storage Facilities – Pre-commissioning and Hydrostatic Testing Regulatory Management Plan. WS0-0000-RGL-PLN-BEC-000-00003-000, Revision 1, Perth, Western Australia, December 2015

Commonwealth of Australia (2006). A guide to the integrated marine and coastal regionalisation of Australia Version 4.0. Canberra, Australia, Department of the Environment and Heritage

Das S and Sahu BK (2005). "Interaction of pH with mercuric chloride toxicity to penaeid prawns from a tropical estuary, East Coast of India: enhanced toxicity at low pH." Chemosphere 58(9): 1241-1248

Denton GRW and Burdon-Jones C (1982). "The influence of temperature and salinity upon the acute toxicity of heavy metals to the banana prawn *Penaeus merguiensis* (de Man)." Chemistry in Ecology 1: 131-143

Department of Environment (2004) State Water Quality Management Strategy No. 6. Department of Environment, SWQ 6, Perth, WA

Department of Environment (2006). Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives. Perth, WA, Department of Environment: 50

DHI (2013). Wheatstone Downstream Numerical Modelling Assessment of Construction-phase Outfall Discharge and Intake Recirculation

Doyle CJ, Pablo F, Lim RP, and Hyne RV (2003) Assessment of metal toxicity in sediment pore water from Lake Macquarie, Australia. Archives of Environmental Contamination and Toxicology 44:343–350

Ecotox Services Australia (2005) Toxicity Test Fact Sheets - www.ecotox.com.au
Environmental Protection Authority – *See EPA*

EPA (2005) Manual of Standard Operating Procedures for Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (2004). A Supporting Document for the Draft State Environmental (Cockburn Sound) Policy. EPA Report 21. Environmental Protection Authority, Perth, WA

EPA (2011) Wheatstone Development - Gas Processing, Export Facilities and Infrastructure, Shire of Ashburton and Roeburne. Ministerial Statement 873. Environmental Protection Authority, Perth, WA

EPA (2015) Wheatstone Project – Ministerial Statement 873 – Proposed Exemption from Condition 13-16 for Hydrostatic Testing Water. Letter dated 29 October 2015. Environmental Protection Authority, Perth, WAFlorence TM and Stauber JL (1986). "Toxicity of copper complexes to the marine diatom *Nitzschia closterium*." Aquatic toxicology 8(1): 11-26

Fox DR (2009) NECs, NOECs and the ECx. Australasian Journal of Ecotoxicology 14:7–10

Krassoi R (1995) Salinity adjustment of effluents for use with marine bioassays: effects on the larvae of the doughboy scallop *Chlamys asperrimus* and the Sydney rock oyster *Saccostrea commercialis*. Australasian Journal of Ecotoxicology 1:143–148

Geffard O, Budzinski H, His E, Seaman MNL, and Garrigues P (2002) Relationships between contaminant levels in marine sediments and their biological effects on embryos of oysters, Crassostrea gigas. Environmental Toxicology and Chemistry 21: 2310-2318

Government of Western Australia (2003). State Water Quality Management Strategy, Implementation Plan: Status Report, SWQ 2. Perth, WA, Water and Rivers Commission

Hogan AC, Stauber JL, Pablo F, Adams MS, and Lim RP (2005) The Development of Marine Toxicity Identification Evaluation (TIE) Procedures Using the Unicellular Alga Nitzschia closterium. Archives of Environmental Contamination and Toxicology 48: 433-443

McKim JM (1977) Evaluation of Tests with Early Life Stages of Fish for Predicting Long-Term Toxicity. Journal of the Fisheries Research Board of Canada 34: 1148-1154

MScience (2011) Wheatstone LNG Development: Water Quality Characterisation and Parameter Calibration. Unpublished Report to URS Australia Pty Ltd by MScience Pty Ltd, MSA134R9, Perth, WA

MScience (2013) Wheatstone LNG Development: Water Quality Around the Proposed Nearshore Outfall. Unpublished Report to Chevron Australia by MScience Pty Ltd, MSA188R1, Perth, WA

Negri AP, Bunter O, Jones B, and Llewellyn L (2004) Effects of the bloom-forming alga Trichodesmium erythraeum on the pearl oyster Pinctada maxima. Aquaculture 232: 91-102

Pearce AF, Buchan S, Chiffings T, D'Adamo N, Fandry C, Fearn P, Mills D, Phillips R, and Simpson C (2003) A review of the oceanography of the Dampier Archipelago. In: Wells FE, Walker DI, Jones DS (eds) Proceedings of the Twelfth International Marine Biological Workshop: The Marine Flora and Fauna of Dampier, Western Australia. Vol.1. Western Australian Museum, pp 13-50

Peerzada N. and Dickinson, C (1989). "Metals in oysters from the Arnhem Land coast, Northern Territory, Australia." Marine Pollution Bulletin 20(3): 144-145.

SKM (2012) Chevron Wheatstone Water Quality Measurement Programme: Twelve Monthly Baseline Water Quality Measurement Report: 15/05/2011 – 21/05/2012 Unpublished Report by Sinclair Knight Merz for Chevron Australia, Perth, WA

Smith R, Krazzoi R, Doyle C, Stauber J, Bacher J, Mueller J (2004) Evaluation of methods of water and effluent toxicity testing. Evaluation Report. Brisbane Water, Brisbane, QLD, Australia

Stauber, J. (1995). "Toxicity testing using marine and freshwater unicellular algae." Australasian Journal of Ecotoxicology 1: 15-24

Stauber JL, Tsai J, Vaughan GT, Peterson SM, Brockbank CI (1994) Algae as indicators of toxicity of the effluent from bleached eucalypt kraft pulp mills. National Pulp Mills Research Program, Technical Report No. 3. CSIRO, Canberra, ACT

URS (2010), Wheatstone Project – Characterisation of the Marine Environment. Chevron Australia P/L

van Dam RA, Harford AJ, Houston MA, Hogan AC, and Negri AP (2008) Tropical tarine toxicity testing in Australia: A review and recommendations. Australasian Journal of Ecotoxicology 14: 55-88

Wenziker K, McAlpine K, Apte S, and Masini R (2006) Background Quality for Coastal Marine Waters of the North West Shelf, Western Australia, North West Shelf Joint Environmental Management Study Technical Report 18

APPENDICES

CONTENTS

TABLES

Appendix A Action Table

Section	Actions	Timing
1.4	This Plan will be revised, or a separate plan will be submitted for the Permanent Operations Waste Water Outfall when relevant detailed engineering design information becomes available.	As required
1.6	... the Proponent will review the Plan to address matters such as the overall effectiveness, environmental performance, changes in environmental risks and changes in business conditions on an as needed basis (e.g. in response to new information).	As required
1.6	In accordance with conditions 5 and 6 of EPBC 2008/4469, Chevron may only implement the Wheatstone Project otherwise than in accordance with the provisions of this Plan which regulate the matters of NES relevant to this Plan from the date of approval of any variation to this Plan by the Commonwealth Minister.	As required
1.6	... if during the Works Approval or licensing process, or as a result of the conditions of the Works Approval or licence, there is a revision(s) to this Plan, Chevron will revise this Plan and provide the revision(s) to DEC, and in the meantime the works approval/licence documents will be preferred in the extent of any difference or inconsistency.	As required
3.1	... treated effluent from the CV and site WWTPs that meets recognised standards outlined in the ANZECC Guidelines for Sewerage Systems – Effluent Management and DoH Guidelines for Non-potable Uses of Recycled Water in Western Australia may be reused for construction purposes such as dust suppression and compaction. Any treated effluent that is beyond the volume needed for reuse will be discharged to the marine environment.	Wheatstone Construction Phase
5.4	...final triggers will be based on a combination of long term monitoring data and real-time comparative reference sites	six months after the end of Commissioning
5.4	The outcomes of the WET testing program (Section 7.1) will be used to revise the predicted number of dilutions required to achieve each LEP (Section 5.2) as prescribed by ministerial condition 13-12ib. The revised dilutions will be derived by applying a factor of 0.1 to the 96-hour acute toxicity test (prawn) using the BurrliOZ software (Campbell et al. 2000).	six months from the end of WWTP Commissioning
	The levels of environmental protection established in Schedule 2 (MS 873) will apply to typical conditions only and will not apply during the wet commissioning phase. Continuous and composite sample monitoring undertaken during wet commissioning will continue through operations to confirm achievement of the EQCs validated through the monitoring described in Section 7.3.	

Section	Actions	Timing
	If effluent composition changes significantly from that expected under typical conditions (described in Section 5.0) then validation monitoring will be undertaken as per the initial wet commissioning period (Section 7.3). Significant changes to effluent composition are considered to occur when an addition or alteration is made to the onsite WWTPs or RO plants (subject to amendment to the Works Approval and/or Operating License) or as the result of input to the WWTPs from a waste source not identified in Section 2.6.1 or if the discharged flow rate described in Section 5.1 is exceeded by more than 40%.	
6.1.1	Level 1 Trigger Values are based on a maximum instantaneous flow rate (pumping rate) during each discharge period of 761 m^3/hr.	WWTP Commissioning & Operation
6.1.1	Readings in excess of the projected maximum flow rate specifications will trigger an investigation to determine the source of elevated readings, beginning with an evaluation of readings at the individual WWTPs and the seawater desalination system. Investigations may also require increased monitoring at the construction waste water outfall.	WWTP Commissioning & Operation
6.1.1	Should an unplanned flow rate exceedance be detected, the pumping operations will be reduced to a more acceptable level. Pumps, in-line analyser(s) and alarms, and “end of pipe” monitors shall be inspected and repaired/replaced as necessary.	WWTP Commissioning & Operation
6.1.1.2	The primary trigger value is set at 80% of maximum expected constituent concentration in the discharge and is intended to act as an “early warning” for possible corrective action.	WWTP Commissioning & Operation
6.1.1.2	The secondary trigger value is set at 100% of maximum expected constituent concentration in the discharge.	WWTP Commissioning & Operation
6.1.1.2	For the commissioning period, Level 2 trigger values are based on sampling frequency of once per week.	WWTP Commissioning & Operation
6.1.1.2	The sampling frequency for under typical conditions will be defined in a subsequent monitoring plan for the operating facility as required under Works Approval W5439/2013/1 (approval pending).	WWTP Operations
6.1.1.2	Should end-of-pipe readings reach the primary or secondary trigger values, appropriate corrective measures that may be taken immediately may include equipment maintenance, caustic solution dosing, possible recirculation/recycling of effluent through the WWTP for additional treatment, or redirecting of effluent to temporary storage on site for later recirculation/recycling as necessary.	WWTP Commissioning & Operation
6.1.1.2	Where Level 2 triggers values are reached, an investigation similar to the one for Level 1 Trigger Values will be initiated to determine the cause of the trigger being reached including inspection and repair of in-line analyser(s) and alarms, and “end of pipe” monitors as necessary.	WWTP Commissioning & Operation

Section	Actions	Timing
6.1.2	Monitoring readings that reach Level 2 trigger values will be recorded and reported internally on a regular basis.	WWTP Commissioning & Operation
6.1.1.3	Level 3 Contingency measures are applicable only during approved wet commissioning periods. Level 3 Trigger Values are defined as EQC for the Moderate LEP and will be measured weekly at the boundary between the Low and Moderate LEP zones during wet commissioning. Measurements obtained during this period will be used to trigger adaptive management measures and will contribute to WWTP optimisation activities. Weekly medians at the LEP boundary will be tracked over time to provide assessment of the efficacy of these adaptive management procedures. .	WWTP Commissioning
6.1.1.3	Should monitoring show that these trigger values are reached, adaptive management measures taken may include equipment maintenance, overhaul, or full replacement; caustic solution dosing; possible recirculation/recycling of effluent through the WWTP for additional treatment, redirecting of effluent to temporary storage on site for later recirculation/recycling as necessary or for transport by a licensed controlled waste contractor for treatment offsite at an approved licensed facility, and/or temporary discharge to the irrigation field(s), should the irrigation field(s) still be in operation (see Section 2.3.1.1)	WWTP Commissioning
6.1.1.3	Where Level 3 triggers values are reached, an investigation similar to the one for Level 1 and Level 2 Trigger Values will be initiated to determine the cause of the trigger being reached including inspection and repair of in-line analyser(s) and alarms, and “end of pipe” monitors as necessary.	WWTP Commissioning
6.1.1.3	Monitoring readings that reach Level 3 trigger values will be recorded and reported on a regular basis.	WWTP Commissioning
6.2	Operational Contingency situations include minor disruptions to operation/service, cyclonic events and power failures. These contingencies could result in release of black/greywater to the terrestrial environment or inundation of waste water storage and disposal systems by floodwaters. However, these releases shall be minimised to the extent practicable by expediting necessary shut-down and and/or repairs to the CV and site WWTPs and the seawater desalination system in order to ensure minimal disruption to its operation.	WWTP Operations
6.2	The CV and site WWTPs, desalination plant and waste water outfall will be equipped with monitoring devices for either continuous or composite sampling analysis as outlined in Section 7.0 of this Plan.	WWTP Commissioning & Operation

Section	Actions	Timing
6.2	In the event of a cyclone, WWTPs may experience inundation of storm surge and/or flood water. Prior to this occurring, the waste water present within the system will be discharged in-full to the irrigation field(s), or through the waste water outfall, once commissioned, and the entire WWTP system will be shut down. The emergency shelter-in-place for a reduced workforce will direct its waste water to the CVWWTP for temporary holding and until such time that the WWTP is restarted.	WWTP Commissioning & Operation
6.2	In the event of power failure, particularly in the absence of the availability of the irrigation field(s), an appropriate method for disposal of waste water will be identified which may include temporary on-site storage and/or off-site disposal.	WWTP Commissioning & Operation
6.2	In the event of an unplanned release, steps will be taken in accordance with Project spill procedures that include: containing the release, cleaning up the release, commencing an investigation as to the cause of the release, reviewing the current operating procedure and inspecting equipment or area layout. Corrective actions would be based on findings of the investigations and may entail modifications to the operation procedure and equipment or area layout.	WWTP Commissioning & Operation
6.3	Chevron will assess the "end of pipe" monitoring data for the appropriate physical parameters, measurements from the in-line analysers, location and characteristics of other activities in the area, and metocean conditions in order to determine the effect, if any, of dredging activities in relation to the effluent being discharged.	WWTP Commissioning & Operation
6.3	Should it be determined that the construction waste water system is the main contributing factor of an EQC non-compliance, the system shall be evaluated and corrective measures applied. Should it be determined that the dredging campaign is the main contributing factor of a perceived EQC non-compliance, the dredging campaign will be notified and asked to initiate corrective measures as deemed appropriate.	WWTP Commissioning & Operation
7.0	The results of these three programs will then be used to validate the model dilution predictions and to derive a revised set for environmentally relevant EQC to be used for ongoing monitoring.	Six months from the end of WWTP Commissioning
7.1	Monitoring at the WWTPs, desalination plant, and waste water outfall will be conducted during the commissioning period of each facility so that the system can be optimised for typical conditions. Continuous and composite sample monitoring will be undertaken at the "end of pipe" during the wet commissioning period on a weekly basis. The results of this program will also assist in the revision of the set of EQCs for contaminants of concern, currently outlined in Table 4-2, Table 4-3 and Table 4-4.	WWTP Commissioning

Section	Actions	Timing
7.1	Commissioning monitoring will be implemented as outlined in Table 7-1. Note: The sampling frequencies stated in Table 7-1 can be increased depending on the test results or a particular constituent can be removed from the program if it is no longer of concern. Authorisation from OEPA/DER will be requested along with the requisite information before a less frequent measurement schedule is adopted.	WWTP Commissioning
7.1	Collected samples will be sent to a National Association of Testing Authorities (NATA) accredited laboratory for evaluation of relevant water quality parameters. At present, it is expected that analysis will be conducted by the Marine and Freshwater Research Laboratory (MAFRL, Murdoch University, Murdoch, WA) and ARL Environmental and Analytical Laboratory (ARL, Welshpool, WA). Both of these laboratories are NATA accredited for the relevant assays. However, if circumstances dictate, assays may be conducted by other NATA accredited laboratories.	WWTP Commissioning
7.1	Water samples will be taken for biological and chemical analyses in accordance with the laboratory specifications for the analytes listed in Table 4-2, Table 4-3 and Table 4-4 . Five replicate samples will be taken from the co-mingled effluent for each analyte during each sampling occasion. Readings for pH and salinity (by conductivity) will be taken on site. Tests for free chlorine will also be conducted in the field. Samples will be collected and sent to a NATA accredited laboratory for testing for the following parameters: Total suspended solids; Total hydrocarbons; nutrients(Nitrogen and Phosphorus): and biological oxygen demand.	WWTP Commissioning
7.1	In accordance with ANZECC & ARMCANZ (2000) guidelines, 10% of sites will be sampled as splits (randomly selected) and one sample will be taken as a 'blank'. As there is a single site in this sampling program, but multiple sampling occasions, an extra sample for each analyte will be taken in the first and last sampling occasion, to be sent to the alternate analytical laboratory to serve as the splits for quality assurance. The blank sample is prepared using the methods for field sampling but containers are filled with laboratory prepared distilled water, rather than discharge water.	WWTP Commissioning
7.1	Flow rates will also be confirmed during the commissioning monitoring program.	WWTP Commissioning

Section	Actions	Timing
7.2	WET testing will be conducted on samples of the co-mingled construction waste water outfall taken at the end of the wet commissioning period to identify the potential toxicity of the anticipated effluent under typical conditions. WET testing involves exposing organisms to different concentrations of an effluent and then measuring growth or reproductive characteristics after a selected period of time. The WET testing program is anticipated to involve two processes, conducted by the same laboratory, namely: 3. Range finding test for toxicity: to determine if the effluent at the outfall is toxic and, if so, the concentration range relevant for further testing. 4. Definitive toxicity testing: to determine the $EC_{50,}$ IC_{50}, LC_{50} and NOEC values for the effluent in a particular species*. **These data will also be used to determine the number of dilutions required to achieve each LEP as prescribed by ministerial condition 13-12ib.*	WWTP Commissioning
7.2	For that reason, the primary test conducted here will be a definitive test in providing the $EC_{50,}$ IC_{50}, LC_{50} and NOEC values for this effluent. These data will also be used to determine the number of dilutions required to achieve the various LEP values prescribed by Ministerial Condition 13-12(i)b.	WWTP Commissioning
7.2	WET testing is to be undertaken on a minimum of five locally relevant species from four different taxonomic groups using the recommended protocols from ANZECC and ARMCANZ (2000). The Wheatstone marine project development area at Onslow lies at the Southern extent of the region of Australia's coastline considered to represent tropical waters as classified by IMCRA 4.0 (Commonwealth of Australia 2006). As such, the waters in this region contain both tropical and temperate organisms, where species from both regions are relevant. WET testing is proposed to include mostly tropical species from a range of trophic levels (primary producer, herbivore and carnivore), using chronic (predominantly) tests for toxicity.	WWTP Commissioning & Operation

Section	Actions	Timing
7.2	Proposed tests and locally relevant species to be used in the Wheatstone WET testing are listed below although consideration of other species is possible if these species are unavailable: 6. 72-hr microalgal growth inhibition test: *Nitzschia closterium.* 7. 48-hour larval abnormality test: *Saccostrea echinata.* 8. 72-hr larval development test: *Heliocidaris tuberculata.* 9. 96-hr acute toxicity test: *Penaeus monodon* or *Melita plumulosa.* 10. 96-hr Fish Imbalance test: *Lates calcarifer*.	WWTP Commissioning & Operation
7.2	Samples for WET testing will be taken in accordance with the sampling kit and instructions provided by Ecotox Services Australia, the laboratory undertaking the ecotoxicological analysis. Plastic sample bottles (2.5 L) will be filled from the co-mingled discharge holding tanks once typical operating conditions for the WWTP have been reached. Samples will be chilled for 2 hours on ice to bring down to 4 ºC, packed in eskies and air freighted to the laboratory. In order to complete testing for the full suite of five species, using five dilution concentrations with four replicates at each concentration, the laboratory has indicated the a maximum volume of 15 L of effluent will be submitted if required.	WWTP Commissioning & Operation
7.3.1	Water samples will be collected at 'Impact' and 'Reference' sites at 1 m from the surface and 0.5 m from the bottom of the seafloor 6 weeks after commissioning of the discharge, assuming that the facility is operating under typical conditions. The samples will be analysed as described in Table 4-3, Table 4-4 and Table 4-5. Analysis will be either conducted on-site or samples will be sent to a NATA accredited laboratory using the laboratories preferred chain of custody for sample transfer.	WWTP Commissioning
7.3.1	The guideline value for DO is based on both spot samples and a 6 weeks median. Spot samples will be collected and analysed as above. For the 6 weeks median, samples will be collected within 0.5 m of the seafloor each week for 6 weeks from the end of the commissioning period.	WWTP Commissioning
7.3.1	Compliance with the EQCs and the prescribed levels of ecological protection will be assessed by comparing the post commissioning survey results with the EQC guideline triggers for high and moderate LEP, reported in Table 4-3, Table 4-4 and Table 4-5, compliance will be achieved if water quality from all sites is below the guideline values.	WWTP Commissioning

Section	Actions	Timing
7.3.1	Ongoing monitoring of the discharge streams will continue to ensure the revised EQC are met as part of a long term monitoring and management plan. It is expected the continued monitoring will depend on results from EQVRP. On the basis that the EQVRP indicates that EQC are being met for all Environmental Values, monitoring would continue with a revised set of EQC as an end of pipe operation with additional monitoring only initiated following a change in end of pipe effluent characteristics or discharge volume.	WWTP Commissioning
7.3.2	…at least five potential Impact sites (on the boundary of the Low and Moderate LEP), at least five potential Impact sites (boundary of the Low and Moderate and High LEP) and at least five Reference sites will be established for the EQVRP monitoring.	WWTP Commissioning
7.3.2	Impact sites will be located on the edge of the Low LEP boundary (70 m from any point on the diffuser) and the edge of the Moderate LEP boundary (area contained within 250 m of the shipping berths and ship turning basin). Moderate LEP impact sites are proposed to be located uniformly around the discharge point. Due to the asymmetry of the location of the discharge point in the moderate LEP zone, the high LEP impact sites are located on the closest LEP boundary (Eastern edge) to the discharge. The GPS location for impact sites will be determined when an accurate GPS location for the entire length of the diffuser is available, since the low LEP boundary (70 m) is set relative to the diffuser extent. Impact sites will remain fixed for the period of monitoring and the proposed locations have been presented in Figure 7.1.	WWTP Commissioning
7.3.2	Sampling of impact sites is therefore proposed to occur in during both a tidal current and slack water. The closest LEP boundary (eastern edge) will have the highest potential risk for exceeding the EQC and therefore sampling is proposed during the rising tide when the tidal current runs in a West to East direction and impact sites will be down current from the discharge point. The direction of water movement through the mixing zone will be confirmed with a mid-water drogue before sampling begins. The order of sampling is expected to occur as 1) measurement of impact sites under the influence of a rising tide, 2) measurement of reference sites in the rising tide and 3) measurement of impact sites in slack water. This order is expected to allow any residual plume to be cleared from the location of the reference sites.	WWTP Commissioning

Section	Actions	Timing
7.3.2	Reference sites will be selected to match natural conditions expected at the Impact sites. Reference sites can account for broad scale regional effects that will result in natural perturbations above the long term 80th percentile. The inclusion of both real-time Reference sites and long term percentiles will then minimise the possibility of falsely attributing change to onshore discharge. Reference sites will be selected and located as recommended by ANZECC & ARMCANZ (2000) and the EPA (Environmental Protection Authority 2005) as follows: ♦ Representative - same bio-geographic and climatic region as the test site ♦ Bathymetry, substrate and hydrodynamics of the Reference site should be similar to test site ♦ Independent - should be sufficiently distant from the test site to avoid disturbances in the test site affecting the Reference site - current assumption is that Reference sites will need to be > 500 m from the outfall. ♦ Reference sites will be located up current from the discharge location on an axis perpendicular to the direction of current. The separation between reference sites will be no less than 100 m along this axis (Figure 7.1).	WWTP Commissioning
7.3.2	In accordance with ANZECC & ARMCANZ (2000) guidelines, 10% of sites (2 sites) will be sampled as splits (randomly selected) and one sample will be taken as a 'blank'. Splits will be taken at all depth strata for the randomly selected sites and these samples will be sent to the alternate laboratory for analysis.	WWTP Commissioning
8.1	The results from the EQVRP for these objectives will be reported within six months of the end of the commissioning period (13-12v MS 873).	WWTP Commissioning & Operation
8.2	In accordance with MS 873 condition 4 and EPBC Approval Condition 3, Chevron is required to submit (or publish) an Annual Compliance Assessment Report to the CEO of the EPA. As part of the preparation of an Annual Compliance Report, Chevron will assess its compliance with this Plan in the relevant period.	WWTP Commissioning & Operation
8.3	Any potential non-compliance, relevant to this Plan, will be reported to the CEO of the EPA within seven days of that potential non-compliance being known as required by MS873 Condition 4-5.	WWTP Commissioning & Operation

Section	Actions	Timing
8.4	In accordance with MS 873 Condition 13-13 v, Chevron is required to report to the DEC within six months of commissioning of a discharge or within six months of any significant change in composition of a discharge, including any management actions necessary to ensure ongoing compliance with the environmental quality objectives and levels of ecological protection established through MS 873 Condition 13-1 and described in Schedule 2.	WWTP Commissioning & Operation

Appendix B Species and Matters Protected by the EPBC Act

Species		
Common name	**Scientific name**	**Status**
Saltwater Crocodile	*Crocodylus porosus*	Protected
Loggerhead Turtle	*Caretta caretta*	Endangered
Green Turtle	*Chelonia mydas*	Vulnerable
Hawksbill Turtle	*Eretmochelys imbricata*	Vulnerable
Flatback Turtle	*Natator depressus*	Vulnerable
Green Sawfish	*Pristis zijsron*	Vulnerable
Dwarf Sawfish	*Pristis clavata*	Vulnerable

Appendix C Modelling Results

Overview

The partial build-out and full build-out footprints represent different stages of marine infrastructure construction in the vicinity of the intake/outfall system's proposed location. These two configurations have been modelled to assess the interaction of the effluent plume with the marine infrastructure (navigation channel, MOF quays, MOF breakwater etc.), including any potential effects from the latter on the transport and dilution of the plume as well as recirculation impacts at the seawater intake.

The partial build-out footprint represents the construction stage where a portion of the navigation access channel and the MOF basin have been dredged and the MOF quays have been constructed. The intake/outfall system is scheduled to be commissioned and become operational around this stage of the marine infrastructure construction.

The full build-out footprint represents the completion stage of the marine infrastructure construction when all dredging has been completed and the MOF quays and breakwater have been constructed. This stage of marine construction is anticipated to be completed while the intake/outfall system remains operational.

Simulations for LEP Boundary Concentrations

Table A 1: Simulation Results for Blended (RO Desalination + WWTP) Discharge Scenario for March, 2009 Partial Build-out Scenario - Moderate LEP

Effluent Constituent	Seawater Intake Concentration (C_{amb}), (mg/l)	End-of-Pipe Discharge Concentration (C_{eff0}), (mg/L)	Spatial Maximum of Temporal Median Concentration[1] (C_{effm}), (mg/L)	EQC for Moderate LEP (C_{crm}), (mg/L)	Required Number of Dilutions (D_{crm})[4]	Calculated Number of Dilutions (D_{effm})[4]	Compliance with EQC (YES/NO)
Total Dissolved Solids (TDS)	37700	49838	37707	39500	7	1672	YES
Total Suspended Solids (TSS)[3]	8.2	34.3	8.2	18.75	3	1672	YES
Total Nitrogen (Ntot)	0.15	6.8	0.15	0.260	61	1672	YES
Total Phosphorus (Ptot)	0.0071	0.77	0.0076	0.0175	74	1672	YES
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.0	8.8	1	115	YES
Al^{+++}	0.00	N/A	N/A	0.020	N/A	N/A	N/A

Notes

1 - Temporal median concentration is calculated as the median value of the model results over the entire duration of the simulation (March, 2009). For O&G TSE and Al^{+++} the 95th percentile is used instead of the temporal median.

2 - Percentage Exceedance is calculated as the percentage time that the EQC is exceeded over the entire duration of the simulation (March, 2009).

3 - EQC for TSS (mg/L) is derived from EQC for Turbidity (NTU) and correlation between TSS and Turbidity (TSS = 2.0784 + 0.9866 Turbidity)

4 - $D_{crm} = (C_{eff0} – C_{amb})/(C_{crm} – C_{amb})$; D_{effm} = (Ceff0 – Camb)/(Ceffm – Camb); $D_{crh} = (C_{eff0} – C_{amb})/(C_{crh} – C_{amb})$; $D_{effh} = (C_{eff0} – C_{amb})/(C_{effh} – C_{amb})$

Table A 2: Simulation Results for Blended (RO Desalination + WWTP) Discharge Scenario for March, 2009 Partial Build-out Scenario – High LEP

Effluent Constituent	Seawater Intake Concentration (C_{amb}), (mg/l)	End-of-Pipe Discharge Concentration (C_{eff0}), (mg/L)	Spatial Maximum of Temporal Median Concentration[1] (C_{effh}), (mg/L)	EQC for High LEP (C_{crh}), (mg/L)	Required Number of Dilutions (D_{crh})[4]	Calculated Number of Dilutions (D_{effh})[4]	Compliance with EQC (YES/NO)
Total Dissolved Solids (TDS)	37700	49838	37705	39400	8	1867	YES
Total Suspended Solids (TSS)[3]	8.2	34.3	8.2	10.86	10	1867	YES
Total Nitrogen (Ntot)	0.15	6.8	0.15	0.225	89	1867	YES
Total Phosphorus (Ptot)	0.0071	0.77	0.0074	0.0075	1908	1867	YES
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.0	7.0	1	170	YES
Al^{+++}	0.00	N/A	N/A	0.005	N/A	N/A	N/A

Notes

1 - Temporal median concentration is calculated as the median value of the model results over the entire duration of the simulation (March, 2009). For O&G TSE and Al^{+++} the 95th percentile is used instead of the temporal median.

2 - Percentage Exceedance is calculated as the percentage time that the EQC is exceeded over the entire duration of the simulation (March, 2009).

3 - EQC for TSS (mg/L) is derived from EQC for Turbidity (NTU) and correlation between TSS and Turbidity (TSS = 2.0784 + 0.9866 Turbidity)

4 - $D_{crm} = (C_{eff0} – C_{amb})/(C_{crm} – C_{amb})$; D_{effm} = (Ceff0 – Camb)/(Ceffm – Camb); $D_{crh} = (C_{eff0} – C_{amb})/(C_{crh} – C_{amb})$; $D_{effh} = (C_{eff0} – C_{amb})/(C_{effh} – C_{amb})$

Table A 3: Simulation Results for Blended (RO Desalination + WWTP) Discharge Scenario for March, 2009 Full Build-out Scenario – Moderate LEP

Effluent Constituent	Seawater Intake Concentration (C_{amb}), (mg/l)	End-of-Pipe Discharge Concentration (C_{eff0}), (mg/L)	Spatial Maximum of Temporal Median Concentration[1] (C_{effm}), (mg/L)	EQC for Moderate LEP (C_{crm}), (mg/L)	Required Number of Dilutions (D_{crm})[4]	Calculated Number of Dilutions (D_{effm})[4]	Compliance with EQC (YES/NO)
Total Dissolved Solids (TDS)	37700	49838	37705	39500	7	2625	YES
Total Suspended Solids (TSS)[3]	8.2	34.3	8.2	18.75	3	2625	YES
Total Nitrogen (Ntot)	0.15	6.8	0.15	0.260	61	2625	YES
Total Phosphorus (Ptot)	0.0071	0.77	0.0074	0.0175	74	2625	YES
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.0	8.8	1	130	YES
Al^{+++}	0.00	N/A	N/A	0.020	N/A	N/A	N/A

Notes

1 - Temporal median concentration is calculated as the median value of the model results over the entire duration of the simulation (March, 2009). For O&G TSE and Al+++ the 95th percentile is used instead of the temporal median.

2 - Percentage Exceedance is calculated as the percentage time that the EQC is exceeded over the entire duration of the simulation (March, 2009).

3 - EQC for TSS (mg/L) is derived from EQC for Turbidity (NTU) and correlation between TSS and Turbidity (TSS = 2.0784 + 0.9866 Turbidity)

4 - $D_{crm} = (C_{eff0} – C_{amb})/(C_{crm} – C_{amb})$; D_{effm} = (Ceff0 – Camb)/(Ceffm – Camb); $D_{crh} = (C_{eff0} – C_{amb})/(C_{crh} – C_{amb})$; $D_{effh} = (C_{eff0} – C_{amb})/(C_{effh} – C_{amb})$

Table A 4: Simulation Results for Blended (RO Desalination + WWTP) Discharge Scenario for March, 2009 Full Build-out Scenario – High LEP

Effluent Constituent	Seawater Intake Concentration (C_{amb}), (mg/l)	End-of-Pipe Discharge Concentration (C_{eff0}), (mg/L)	Spatial Maximum of Temporal Median Concentration[1] (C_{effh}), (mg/L)	EQC for High LEP (C_{crh}), (mg/L)	Required Number of Dilutions (D_{crh})[4]	Calculated Number of Dilutions (D_{effh})[4]	Compliance with EQC (YES/NO)
Total Dissolved Solids (TDS)	37700	49838	37704	39400	8	3064	YES
Total Suspended Solids (TSS)[3]	8.2	34.3	8.2	10.86	10	3064	YES
Total Nitrogen (Ntot)	0.15	6.8	0.15	0.225	89	3064	YES
Total Phosphorus (Ptot)	0.0071	0.77	0.0073	0.0075	1908	3064	YES
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.0	7.0	1	195	YES
Al^{+++}	0.00	N/A	N/A	0.005	N/A	N/A	N/A

Notes

1 - Temporal median concentration is calculated as the median value of the model results over the entire duration of the simulation (March, 2009). For O&G TSE and Al+++ the 95th percentile is used instead of the temporal median.

2 - Percentage Exceedance is calculated as the percentage time that the EQC is exceeded over the entire duration of the simulation (March, 2009).

3 - EQC for TSS (mg/L) is derived from EQC for Turbidity (NTU) and correlation between TSS and Turbidity (TSS = 2.0784 + 0.9866 Turbidity)

4 - $D_{crm} = (C_{eff0} – C_{amb})/(C_{crm} – C_{amb})$; D_{effm} = (Ceff0 – Camb)/(Ceffm – Camb); $D_{crh} = (C_{eff0} – C_{amb})/(C_{crh} – C_{amb})$; $D_{effh} = (C_{eff0} – C_{amb})/(C_{effh} – C_{amb})$

Table A 5: Simulation Results for Blended (RO Desalination + WWTP) Discharge Scenario for May, 2009 Full Build-out Scenario – Moderate LEP

Effluent Constituent	Seawater Intake Concentration (C_{amb}), (mg/l)	End-of-Pipe Discharge Concentration (C_{eff0}), (mg/L)	Spatial Maximum of Temporal Median Concentration[1] (C_{effm}), (mg/L)	EQC for Moderate LEP (C_{crm}), (mg/L)	Required Number of Dilutions (D_{crm})[4]	Calculated Number of Dilutions (D_{effm})[4]	Compliance with EQC (YES/NO)
Total Dissolved Solids (TDS)	37700	49838	37704	39500	7	3004	YES
Total Suspended Solids (TSS)[3]	8.2	34.3	8.2	18.75	3	3004	YES
Total Nitrogen (Ntot)	0.15	6.8	0.15	0.260	61	3004	YES
Total Phosphorus (Ptot)	0.0071	0.77	0.0074	0.0175	74	3004	YES
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.0	8.8	1	96	YES
Al^{+++}	0.00	N/A	N/A	0.020	N/A	N/A	N/A

Notes

1 - Temporal median concentration is calculated as the median value of the model results over the entire duration of the simulation (May, 2009). For O&G TSE and Al+++ the 95th percentile is used instead of the median.

2 - Percentage Exceedance is calculated as the percentage time that the EQC is exceeded over the entire duration of the simulation (May, 2009).

3 - EQC for TSS (mg/L) is derived from EQC for Turbidity (NTU) and correlation between TSS and Turbidity (TSS = 2.0784 + 0.9866 Turbidity)

4 - $D_{crm} = (C_{eff0} – C_{amb})/(C_{crm} – C_{amb})$; $D_{effm} = (Ceff0 – Camb)/(Ceffm – Camb)$; $D_{crh} = (C_{eff0} – C_{amb})/(C_{crh} – C_{amb})$; $D_{effh} = (C_{eff0} – C_{amb})/(C_{effh} – C_{amb})$

Table A 6: Simulation Results for Blended (RO Desalination + WWTP) Discharge Scenario for May, 2009 Full Build-out Scenario – High LEP

Effluent Constituent	Seawater Intake Concentration (C_{amb}), (mg/l)	End-of-Pipe Discharge Concentration (C_{eff0}), (mg/L)	Spatial Maximum of Temporal Median Concentration[1] (C_{effh}), (mg/L)	EQC for High LEP (C_{crh}), (mg/L)	Required Number of Dilutions (D_{crh})[4]	Calculated Number of Dilutions (D_{effh})[4]	Compliance with EQC (YES/NO)
Total Dissolved Solids (TDS)	37700	49838	37703	39400	8	4450	YES
Total Suspended Solids (TSS)[3]	8.2	34.3	8.2	10.86	10	4450	YES
Total Nitrogen (Ntot)	0.15	6.8	0.15	0.225	89	4450	YES
Total Phosphorus (Ptot)	0.0071	0.77	0.0073	0.0075	1908	4450	YES
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.0	7.0	1	158	YES
Al^{+++}	0.00	N/A	N/A	0.005	N/A	N/A	N/A

Notes

1 - Temporal median concentration is calculated as the median value of the model results over the entire duration of the simulation (May, 2009). For O&G TSE and Al+++ the 95th percentile is used instead of the median.

2 - Percentage Exceedance is calculated as the percentage time that the EQC is exceeded over the entire duration of the simulation (May, 2009).

3 - EQC for TSS (mg/L) is derived from EQC for Turbidity (NTU) and correlation between TSS and Turbidity (TSS = 2.0784 + 0.9866 Turbidity)

4 - $D_{crm} = (C_{eff0} – C_{amb})/(C_{crm} – C_{amb})$; D_{effm} = (Ceff0 – Camb)/(Ceffm – Camb); $D_{crh} = (C_{eff0} – C_{amb})/(C_{crh} – C_{amb})$; $D_{effh} = (C_{eff0} – C_{amb})/(C_{effh} – C_{amb})$

Table A 7: Simulation Results for Blended (RO Desalination + WWTP) Discharge Scenario for May, 2009 Partial Build-out Scenario – Moderate LEP

Effluent Constituent	Seawater Intake Concentration (C_{amb}), (mg/l)	End-of-Pipe Discharge Concentration (C_{eff0}), (mg/L)	Spatial Maximum of Temporal Median Concentration[1] (C_{effh}), (mg/L)	EQC for High LEP (C_{crh}), (mg/L)	Required Number of Dilutions (D_{crh})[4]	Calculated Number of Dilutions (D_{effh})[4]	Compliance with EQC (YES/NO)
Total Dissolved Solids (TDS)	37700	49838	37706	39500	7	1903	YES
Total Suspended Solids (TSS)[3]	8.2	34.3	8.2	18.75	3	1903	YES
Total Nitrogen (Ntot)	0.15	6.8	0.15	0.260	61	1903	YES
Total Phosphorus (Ptot)	0.0071	0.77	0.0075	0.0175	74	1903	YES
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.0	8.8	1	83	YES
Al^{+++}	0.00	N/A	N/A	0.005	N/A	N/A	N/A

Notes

1 - Temporal median concentration is calculated as the median value of the model results over the entire duration of the simulation (May, 2009). For O&G TSE and Al+++ the 95th percentile is used instead of the median.

2 - Percentage Exceedance is calculated as the percentage time that the EQC is exceeded over the entire duration of the simulation (May, 2009).

3 - EQC for TSS (mg/L) is derived from EQC for Turbidity (NTU) and correlation between TSS and Turbidity (TSS = 2.0784 + 0.9866 Turbidity)

4 - $D_{crm} = (C_{eff0} – C_{amb})/(C_{crm} – C_{amb})$; D_{effm} = (Ceff0 – Camb)/(Ceffm – Camb); $D_{crh} = (C_{eff0} – C_{amb})/(C_{crh} – C_{amb})$; $D_{effh} = (C_{eff0} – C_{amb})/(C_{effh} – C_{amb})$

Table A 8: Simulation Results for Blended (RO Desalination + WWTP) Discharge Scenario for May, 2009 Partial Build-out Scenario – High LEP

Effluent Constituent	Seawater Intake Concentration (C_{amb}), (mg/l)	End-of-Pipe Discharge Concentration (C_{eff0}), (mg/L)	Spatial Maximum of Temporal Median Concentration[1] (C_{effh}), (mg/L)	EQC for High LEP (C_{crh}), (mg/L)	Required Number of Dilutions (D_{crh})[4]	Calculated Number of Dilutions (D_{effh})[4]	Compliance with EQC (YES/NO)
Total Dissolved Solids (TDS)	37700	49838	37705	39400	8	2561	YES
Total Suspended Solids (TSS)[3]	8.2	34.3	8.2	10.86	10	2561	YES
Total Nitrogen (Ntot)	0.15	6.8	0.15	0.225	89	2561	YES
Total Phosphorus (Ptot)	0.0071	0.77	0.0074	0.0075	1908	2561	YES
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.0	7.0	1	124	YES
Al^{+++}	0.00	N/A	N/A	0.005	N/A	N/A	N/A

Notes

1 - Temporal median concentration is calculated as the median value of the model results over the entire duration of the simulation (May, 2009). For O&G TSE and Al+++ the 95th percentile is used instead of the median.

2 - Percentage Exceedance is calculated as the percentage time that the EQC is exceeded over the entire duration of the simulation (May, 2009).

3 - EQC for TSS (mg/L) is derived from EQC for Turbidity (NTU) and correlation between TSS and Turbidity (TSS = 2.0784 + 0.9866 Turbidity)

4 - $D_{crm} = (C_{eff0} – C_{amb})/(C_{crm} – C_{amb})$; D_{effm} = (Ceff0 – Camb)/(Ceffm – Camb); $D_{crh} = (C_{eff0} – C_{amb})/(C_{crh} – C_{amb})$; $D_{effh} = (C_{eff0} – C_{amb})/(C_{effh} – C_{amb})$

Simulation for Intake Recirculation Concentrations

Table A 9: Simulation for Blended (RO Desalination + WWTP) Discharge Scenario for March, 2009 Partial Build-Out

Effluent Constituent	Seawater Intake Concentration (mg/l)	End-of-Pipe Discharge Concentration (mg/L)	Temporal Mean Concentration[1] at Intake location (mg/L)	Temporal Max Concentration[1] at Intake location (mg/L)	Lower Bound of Design Concentration[3] Range for Intake (mg/L)	Upper Bound of Design Concentration[3] Range for Intake (mg/L)
Total Dissolved Solids (TDS)	37700	49838	37701	37703	0	39700
Total Suspended Solids (TSS)[3]	8.2	34.3	8.20	8.21	50	500
Total Nitrogen (Ntot)	0.15	6.8	0.151	0.152	0	0.2
Total Phosphorus (Ptot)	0.0071	0.77	0.0072	0.0073	0	0.01
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.00	4.00	10	100
Al^{+++}	0.00	N/A	N/A	N/A	0	0.01

Notes

1 - Temporal Mean and Max Concentrations are calculated for a time series containing the vertical maximum concentration at each output time step at the location of the intake.

2 - Percentage Exceedance is calculated as the percentage time that the instantaneous concentration is above the upper bound over the entire duration of the simulation (March, 2009).

3 - For TDS, Ntot, Ptot and Al^{+++} no ranges have been given, but the upper bound specifies the highest expected ambient value, except for Al^{+++} where the upper bound is the detection limit.

Table A 10: Simulation for Blended (RO Desalination + WWTP) Discharge Scenario for May, 2009 Partial Build-Out

Effluent Constituent	Seawater Intake Concentration (mg/l)	End-of-Pipe Discharge Concentration (mg/L)	Temporal Mean Concentration[1] at Intake location (mg/L)	Temporal Max Concentration[1] at Intake location (mg/L)	Lower Bound of Design Concentration[3] Range for Intake (mg/L)	Upper Bound of Design Concentration[3] Range for Intake (mg/L)
Total Dissolved Solids (TDS)	37700	49838	37701	37705	0	39700
Total Suspended Solids (TSS)[3]	8.2	34.3	8.20	8.21	50	500
Total Nitrogen (Ntot)	0.15	6.8	0.151	0.153	0	0.2
Total Phosphorus (Ptot)	0.0071	0.77	0.0072	0.0074	0	0.01
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.00	4.00	10	100
Al^{+++}	0.00	N/A	N/A	N/A	0	0.01

Notes

1 - Temporal Mean and Max Concentrations are calculated for a time series containing the vertical maximum concentration at each output time step at the location of the intake.

2 - Percentage Exceedance is calculated as the percentage time that the instantaneous concentration is above the upper bound over the entire duration of the simulation (March, 2009).

3 - For TDS, Ntot, Ptot and Al^{+++} no ranges have been given, but the upper bound specifies the highest expected ambient value, except for Al^{+++} where the upper bound is the detection limit.

Table A 11: Simulation for Blended (RO Desalination + WWTP) Discharge Scenario for March, 2009 Full Build-Out

Effluent Constituent	Seawater Intake Concentration (mg/l)	End-of-Pipe Discharge Concentration (mg/L)	Temporal Mean Concentration[1] at Intake location (mg/L)	Temporal Max Concentration[1] at Intake location (mg/L)	Lower Bound of Design Concentration[3] Range for Intake (mg/L)	Upper Bound of Design Concentration[3] Range for Intake (mg/L)
Total Dissolved Solids (TDS)	37700	49838	37702	37705	0	39700
Total Suspended Solids (TSS)[3]	8.2	34.3	8.20	8.21	50	500
Total Nitrogen (Ntot)	0.15	6.8	0.151	0.153	0	0.2
Total Phosphorus (Ptot)	0.0071	0.77	0.0072	0.0074	0	0.01
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.00	4.00	10	100
Al^{+++}	0.00	N/A	N/A	N/A	0	0.01

Notes

1 - Temporal Mean and Max Concentrations are calculated for a time series containing the vertical maximum concentration at each output time step at the location of the intake.

2 - Percentage Exceedance is calculated as the percentage time that the instantaneous concentration is above the upper bound over the entire duration of the simulation (March, 2009).

3 - For TDS, Ntot, Ptot and Al^{+++} no ranges have been given, but the upper bound specifies the highest expected ambient value, except for Al^{+++} where the upper bound is the detection limit.

Table A 12: Simulation for Blended (RO Desalination + WWTP) Discharge Scenario for May, 2009 Full Build-Out

Effluent Constituent	Seawater Intake Concentration (mg/l)	End-of-Pipe Discharge Concentration (mg/L)	Temporal Mean Concentration[1] at Intake location (mg/L)	Temporal Max Concentration[1] at Intake location (mg/L)	Lower Bound of Design Concentration[3] Range for Intake (mg/L)	Upper Bound of Design Concentration[3] Range for Intake (mg/L)
Total Dissolved Solids (TDS)	37700	49838	37701	37707	0	39700
Total Suspended Solids (TSS)[3]	8.2	34.3	8.20	8.22	50	500
Total Nitrogen (Ntot)	0.15	6.8	0.151	0.154	0	0.2
Total Phosphorus (Ptot)	0.0071	0.77	0.0072	0.0076	0	0.01
Oil & Grease, Total Solvent Extractable (O&G TSE)	4.00	5.3	4.00	4.00	10	100
Al^{+++}	0.00	N/A	N/A	N/A	0	0.01

Notes

1 - Temporal Mean and Max Concentrations are calculated for a time series containing the vertical maximum concentration at each output time step at the location of the intake.

2 - Percentage Exceedance is calculated as the percentage time that the instantaneous concentration is above the upper bound over the entire duration of the simulation (March, 2009).

3 - For TDS, Ntot, Ptot and Al^{+++} no ranges have been given, but the upper bound specifies the highest expected ambient value, except for Al^{+++} where the upper bound is the detection limit.