

Alkimos Wastewater Treatment Plant

Marine Treated Wastewater Discharge Monitoring and Management Plan

Water Corporation

May 2016

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Document History

Revisions History

Version	Author	Reviewed by	Date
0	G. Shiell, K. Crawley (Oceanica)	A. Baker (Water Corporation) K. Hillman (Oceanica) DEC OEPA	July 2009
1-3	G. Shiell, K. Crawley (Oceanica)	A. Baker (Water Corporation) OEPA	March 2010
4	G. Shiell, K. Crawley (Oceanica)	A. Baker (Water Corporation) OEPA	July 2010
5	G. Shiell (Oceanica)	C. Byers (Water Corporation)	January 2011
6	G. Shiell, K. Crawley (Oceanica)	A. Baker, D. Rossi (Water Corporation) K. Hillman (Oceanica) OEPA	August 2011
7	B. Coonan (Water Corporation)	C. Byers, M. Nener, G. Groth (Water Corporation) G. Motherwell, K. Taylor (OEPA)	May 2016

Front cover photographs courtesy of BMT Oceanica, 2015.

Acknowledgements

The Water Corporation would like to thank BMT Oceanica and the Office of the Environmental Protection Authority for their assistance and support in developing version 7 of the Marine Treated Wastewater Discharge Monitoring and Management Plan.

Contents

Contents

List of Tables

List of Figures

Contents

List of Acronyms

CTD	Conductivity, temperature & depth
DER	Department of Environment Regulation
DoH	Department of Health
ECR	Environmental compliance report
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
EQC	Environmental quality criteria
EQG	Environmental quality guideline
EQMF	Environmental quality management framework
EQO	Environmental quality objective
EQS	Environmental quality standard
EV	Environmental value
HEPA	High ecological protection area
LEP	Level of ecological protection
LEPA	Low ecological protection area
LOR	Limits of reporting
MS	Ministerial Statement
MTWDMMP	Marine Treated Wastewater Discharge Monitoring and Management Plan
NRMHC	National Health and Medical Research Council
OEPA	Office of the Environmental Protection Authority
TTC	Thermotolerant coliforms
TWW	Treated wastewater discharge
WET	Whole of effluent toxicity
WWTP	Wastewater treatment plant

1. Summary

This Marine Treated Wastewater Discharge Monitoring and Management Plan (MTWDMMP) is submitted in accordance with Ministerial Statement No. 755 Conditions 11-1 to 11-15 for the Alkimos Wastewater Treatment Plant by Water Corporation.

The table below presents the environmental criteria to measure achievement of the conditioned environmental outcomes that must be met through implementation of this MTWDMMP.

Title of proposal	Alkimos Wastewater Treatment Plant – Site B – City of Wanneroo
Proponent	Water Corporation
Ministerial Statement No.	Ministerial Statement No. 755
Purpose of this MTWDMMP	The MTWDMMP is submitted to fulfil the requirements of conditions 11-1 to 11-15 of the above Statement.
EPA's environmental quality objectives (EQO) for the key environmental values	**Ecosystem Health** EQO 1 Maintenance of ecosystem integrity (naturally diverse and healthy ecosystems) **Fishing and Aquaculture** EQO 2 Maintenance of aquatic life for human consumption (seafood safe to eat) **Recreation and Aesthetics** EQO 3 Maintenance of primary contact recreation values (waters safe for swimming) EQO 4 Maintenance of secondary contact recreation values (waters safe for boating)
Condition environmental outcome or proposed measurable outcome	Ensure that the discharge of Alkimos treated wastewater is managed to achieve simultaneously the Environmental Quality Objectives as described in the document, Perth's Coastal Waters: Environmental Values and Objectives (EPA 2000).
Environmental quality criteria: EQO 1 Ecosystem Integrity	
Environmental Quality Guideline (EQG)	*Toxicants in treated wastewater* **EQG 1:** Concentrations of contaminants will not exceed the ANZECC/ARMCANZ (2000) 80% species protection guideline trigger levels for bioaccumulating toxicants at the diffuser. **EQG 2:** Concentrations of contaminants will not exceed the ANZECC/ARMCANZ (2000) 99% species protection guideline trigger levels for toxicants (with the exception of cobalt, where the 95% guideline trigger level will apply) at the boundary of the LEPA. **EQG 3:** The total toxicity of the mixture for the additive effect of ammonia, copper and zinc (as per ANZECC/ARMCANZ (2000) guidelines) must be <1.0. **EQG 4:** The EQG is exceeded if, following the 1 hour sea urchin test: $\frac{TDA}{DRNOEC} \leq 1.0$ *TDA = Typical Dilutions Achieved (constant based on 200-fold dilution)* *DRNOEC = No. dilutions required to achieve the No Observed Effects Concentration (NOEC).*

	Physico-chemical Stressors **EQG 5:** Ambient value of defined area during non-river flow period for chlorophyll *a* not to exceed 80th percentile of reference sites data.
	Toxicants in Sediments **EQG 6:** If either Trigger A or Trigger B is not met, EQG 6 is exceeded A. Median sediment total contaminant concentration from a defined sampling area should not exceed the guideline value for high, moderate and low ecological protection areas (Table 6). B. Total contaminant concentration at individual sample sites should not exceed the guideline re-sampling trigger (Table 6). If so, repeat sampling will be conducted to define the extent of the contamination which will be assessed as per trigger A.
Environmental Quality Standard (EQS)	*Toxicants in treated wastewater* **EQS 1:** The EQS will be exceeded if, following full suite WET testing: $\frac{DALEPA}{DR99\%BurrliOZ} \leq 1$ *DALEPA = Dilutions achieved at the boundary of the LEPA* *DR99%BurrliOZ = No. dilutions required to achieve the 99% species protection guideline specific to treated wastewater that is calculated with BurrliOZ software using the results of the full suite of WET tests, as per ANZECC/ARMCANZ (2000).*
	Physico-chemical Stressors **EQS 2:** Ambient value of defined area during non-river flow period for light attenuation not to exceed 80th percentile of reference sites data.
	Toxicants in Sediments **EQS 3:** To exceed the EQS, Trigger A or B must be exceeded and one or more of the applicable Triggers C-G must be exceeded. A. The 80th percentile of bioavailable metal or metalloid concentrations (e.g. dilute acid extractable metals, SEM/AVS analysis) from the defined sampling area should not exceed the EQG. B. The median bioavailable concentration for non-metallic contaminants (e.g. OC normalisation) from the defined sampling area should not exceed the EQG. C. The 95th percentile of bioavailable contaminant concentrations in porewater samples from the defined sampling area should not exceed high protection water quality guideline values (Table 2a of EQC Reference document). D. Sediment toxicity tests should not result in a statistically significant effect ($P < 0.05$) on sub lethal chronic or lethal acute endpoints for any species, compared to a matched reference sediment. E. No significant change in any biological or ecological indicator beyond natural variation that can be demonstrably linked to a contaminant. F. Where TBT concentrations exceed the guideline the incidence of imposex in *Thais orbita* should be ≤5%. G. The median tissue concentration of chemicals that can adversely bioaccumulate or biomagnify should not exceed the 80th percentile of tissue concentrations from a suitable reference site.

Summary

Environmental quality criteria: EQO 2 Aquatic Life for Human Consumption	
Environmental Quality Guideline (EQG)	**EQG 1:** The median thermotolerant faecal coliform bacterial concentration should not exceed 14 CFU/100 mL, with no more than 10% of the samples exceeding 21 CFU/100 mL measured using the membrane filtration method.
Environmental Quality Standard (EQS)	**EQS 1:** Thermotolerant coliform counts not to exceed 2.3 MPN *E.coli*/g of flesh (wet wt.) in four out of five representative samples, and the fifth sample should not exceed 7 MPN *E. coli*/g of flesh (wet wt.), with a maximum total plate count of 250 000 organisms/g.
Environmental quality criteria: EQO 3&4 Primary and Secondary Contact Recreation	
Environmental Quality Guideline (EQG)	**EQG 1:** The maximum value of the pooled *Enterococci* spp. must not exceed the NHMRC 'category A' guideline value (≤40 Enterococci spp. MPN/100 ml) for recreational water bodies.
Environmental Quality Standard (EQS)	**EQS 1:** The 95th percentile value of the pooled *Enterococci* spp. data must not exceed the upper NHMRC 'category A' value (≤40 *Enterococci* spp. MPN/100 ml).

Corporate endorsement

I hereby certify that to the best of my knowledge, the MTWDMMP provisions within this Plan are true and correct and address the legal requirements of conditions 11-1 to 11-15 of Ministerial Statement No. 755.

Name: Louise Roberts
Designation: Branch Manager

Signed:
Date: 18/05/2016

2. Context, Scope and Rationale

2.1 What is the Proposal?

The Alkimos wastewater treatment plant (WWTP) is situated between Yanchep and Quinns Rocks, approximately 40 km north of Perth, Western Australia. The plant incorporates an advanced activated sludge treatment process and following secondary treatment, the treated wastewater (TWW) is gravity fed to seawater of 20 m depth, at a distance 3.7 km west of the shoreline, where it is rapidly diluted through a 300 m long diffuser (Figure 1). The average dilution of the wastewater stream in the ocean will be at least 1:300 with the dilution being above 1:200 99% of the time within 100 m of the diffuser.

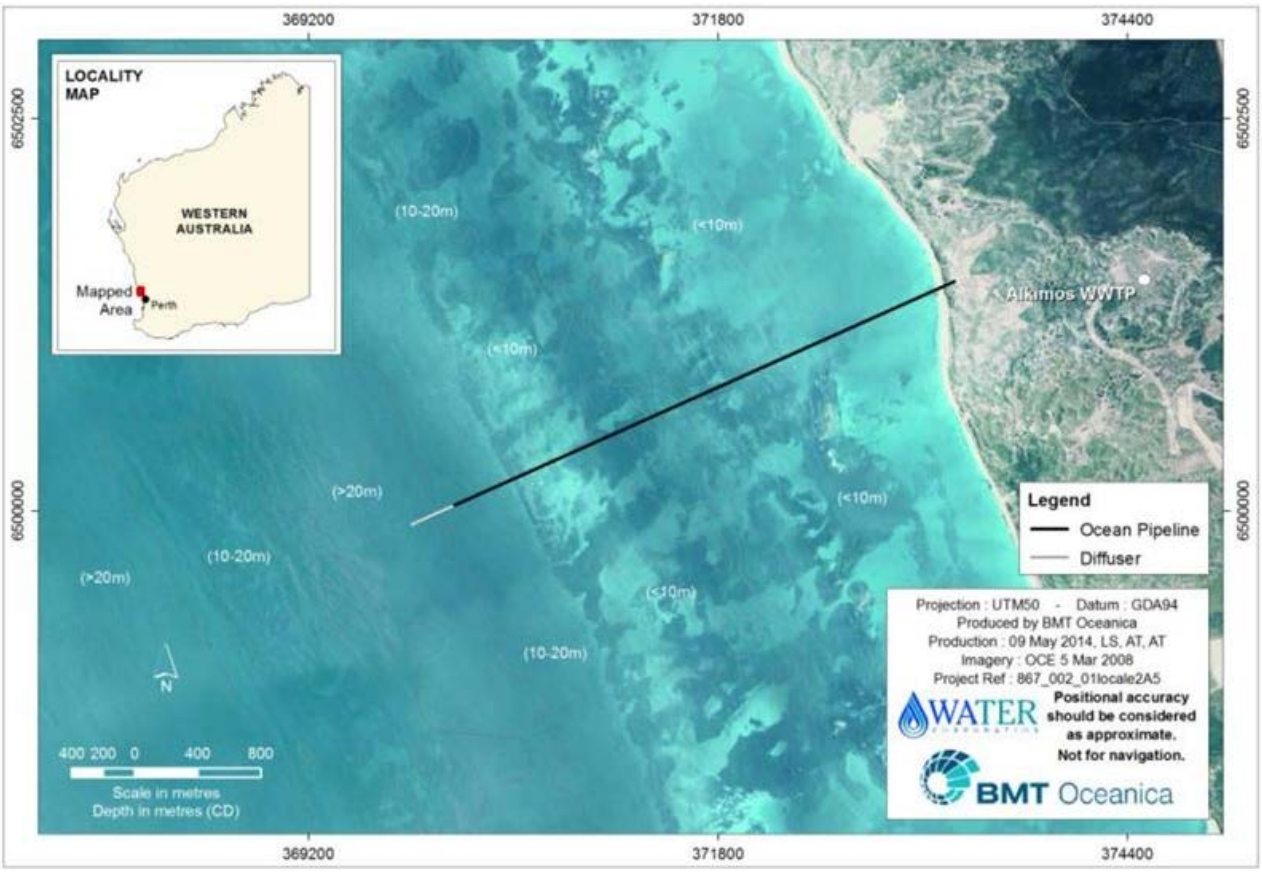

Figure 1: Location of the Alkimos WWTP and ocean outlet

Although approved to discharge a maximum of 160 ML/d, presently the Alkimos WWTP discharges only ~10 ML/d. The discharged volume is projected to increase at a rate proportional to population growth in the north-western residential corridor. It is anticipated that the TWW discharge will increase to a maximum of 160 ML/d post 2050 (Table 1).

Table 1: Alkimos WWTP predicted discharge

Timing	2010	2020	2030	2040	2050	>2050
Predicted flow (ML/d)	10	20	26	34	64	160

2.2 What Key Environmental Values does this MTWDMMP address?

This Marine Treated Wastewater Discharge Monitoring and Management Plan (MTWDMMP) specifically addresses the following Environmental Values (EV), as listed in 'Perth's Coastal Waters: Environmental Values and Objectives' (EPA 2000):

- Ecosystem Health;
- Fishing and Aquaculture; and
- Recreation and Aesthetics.

Discharge from WWTPs contains three classes of contaminants of potential environmental concern:

- **Nutrients:** dissolved inorganic forms make up the majority of nitrogen and phosphorus discharged from outlets. These nutrients enhance the growth of aquatic plants in the water column (i.e. phytoplankton) and on the seabed (e.g. reef algae), which may lead to changes in the abundance and species composition of aquatic plant communities if some species are favoured more than others by the increased nutrient supply.
- **Metals and organic compounds:** these may accumulate in biota at concentrations sufficient to be a concern for human consumption of seafood. As the Alkimos WWTP accepts no heavy industrial waste, the organic compounds of potential concern are mainly trace concentrations of pesticides or hydrocarbons from storm water runoff.
- **Pathogenic organisms from faecal material:** these pose a risk to human health via accidental swallowing of contaminated waters during recreational activities or via consumption of uncooked seafood (note: cooking eliminates the risk).

Further information on the potential direct and indirect effects from the Alkimos WWTP on the marine environment are described in the Public Environmental Review for Alkimos WWTP (Water Corporation 2005) and EPA Assessment 1529 (EPA 2006).

2.3 Requirements of the condition

Specifically, this MTWDMMP is submitted in accordance with Ministerial Statement 755 (MS 755), Conditions 11-1 to 11-15 for the Alkimos WWTP Project (Table 2).

Table 2: Requirements of MS755 and how they are met by this MTWDMMP

Condition	Section in MTWDMMP
11-1 Prior to commissioning of the wastewater treatment plant, the proponent shall prepare and submit a Marine Treated Wastewater Discharge Management Plan that meets the objective and Environmental Quality Objectives described in 11-2 and the requirements set out in 11-3 as determined by the Minister for Environment.	Entire MTWDMMP.
11-2 The objective of the Plan is to ensure that the discharge of Alkimos treated wastewater is managed to achieve simultaneously the following Environmental Quality Objectives as described in the document, Perth's Coastal Waters: Environmental Values and Objectives (EPA 2000): • EQO 1 (Maintenance of ecosystem integrity), with spatially-assigned levels of protection as shown in Figure 2 of Schedule 1	Entire MTWDMMP.

• EQO 2 (Maintenance of aquatic life for human consumption) assigned to all parts of the marine environment surrounding the Alkimos ocean outlet with the exception of zones shown in Figure 2 of Schedule 1 • EQOs 3 and 4 (Maintenance of primary contact recreation values, and Maintenance of Secondary contact recreation values) assigned to all parts of the marine environment surrounding the Alkimos ocean outlet with the exception of zones shown in Figure 2 of Schedule 1	
11-3 The Plan shall address:	
1. Within the Zone of Low Ecological Protection (i.e. within a 100 metres from the diffuser as shown in Figure 1, Schedule 2), the proponent shall seek to achieve the ANZECC & ARMCANZ 80% species protection guideline "trigger" levels (as published from time to time) for bio-accumulating toxicants.	1- Section 3.1
2. Within the Zone of High Ecological Protection (i.e. beyond a 100 metres from the diffuser as shown in Figure 1, Schedule 2), the proponent shall seek to achieve the ANZECC & ARMCANZ 99% species protection guideline "trigger" levels (as published from time to time) for toxicants (with the exception of cobalt, where the 95% guideline shall apply).	2- Section 3.1
3. The establishment of indicators and associated "trigger" levels for further investigations (EQG) for nutrients and social quality objectives.	3- Sections 3.1, 3.2, 4.1, 4.2, 5.1 & 5.2
4. The establishment of "trigger" levels for the implementation of remedial and/or preventative actions to protect the water quality and the environment off Alkimos (EQS) for toxicants, nutrients and social quality objectives.	4- Sections 3.1, 3.3, 4.1, 4.3, 5.1 & 5.3
5. The monitoring and evaluation, including remodelling, of the social and environmental effects of discharging treated wastewater into the marine environment off Alkimos to assess performance in the protection and maintenance of environmental values and objectives.	5- Section 7
6. The specific management actions that will be implemented in the event that environmental quality standard levels are not met, including the option of modifying the diffuser to increase dilution.	6- Section 3.3, 4.3, 5.3, Appendix B.
7. A program to undertake WET testing of treated wastewater.	7- Section 3.1, Appendix A.
8. The monitoring and reporting of diffuser performance in terms of achieving required number of initial dilutions within the area of low level of ecosystem protection compared to the initial dilutions in Schedule 1 under low energy/calm meteorological and sea-state conditions.	8- Section 6
9. The protocols and schedules for reporting performance against the Environmental Quality Objectives.	9- Section 7
11-4 Proponent shall implement the MTWDMMP	Sections 3, 4 & 5
11-5 Proponent shall make the MTWDMMP publicly available in a manner approved by the CEO	Section 7.3
11-6 If a guideline trigger level referred to in condition 11-3 is exceeded, the proponent shall report the matter to DER within one working day of determining that this has occurred, and shall initiate an investigation against the environmental quality standards and into the cause of the exceedance in accordance with the framework developed in the Revised Environmental Quality Criteria Reference Document (Cockburn Sound), to the requirements of the Minister for Environment on advice from the DER	Section 3.2, 4.2 & 5.2

11-7 If an EQS referred to in condition 11-3 is exceeded, the proponent shall initiate a management response to determine the source and remedy the exceedance in accordance with the implementation framework for the National Water Quality Management Strategy	Section 3.3, 4.3, 5.3 & Appendix B
11-8 The proponent shall prior to submitting a Works Approval application for the plant: 1. Estimate the expected typical physico-chemical composition and flow rates of all wastewater streams discharging into the environment from the site; 2. Estimate, for all non-negligible contaminants and nutrients, the total annual loads of contaminants and nutrients in the wastewater discharge exiting the site; 3. Estimate, for normal and worst-case conditions, the concentrations of contaminants and nutrients (for agreed averaging periods) in the wastewater discharge exiting the site; and 4. Establish a reporting process that is an inventory of toxicants that enter and leave the plant	Condition completed (not required in this MTWDMMP)
11-9 The proponent shall prior to submitting a Works Approval application for the plant provide information to show how best practicable technology and waste minimisation principles for contaminants and nutrients have been adopted for the wastewater discharge	Condition completed (not required in this MTWDMMP)
11-10 The proponent shall, within three months following commissioning and stabilizing of plant operations, conduct an analysis demonstrating that effluent properties are substantially consistent with predictions. Similar analyses shall also be conducted within three months following every major increase in the volume of treated wastewater discharged from the plant or any significant change in effluent characteristics	Section 7
11-11 The proponent shall develop a Contingency Wastewater Management Plan	Condition completed (not required in this MTWDMMP)
11-12 In the event that effluent properties are not substantially consistent with predictions (refer to condition 11-9), the proponent shall conduct toxicological studies on the actual effluent, or provide acceptable alternative information such as risk assessment, to the timing and other requirements of the Minister for the Environment	Section 7
11-13 The proponent shall implement the Contingency Wastewater Management Plan required by condition 11-11 in the event that the findings resulting from condition 11-12 indicate that the effluent poses a significant risk to the diversity of the species and biological communities and abundance/biomass of marine life	Appendix B
11-14 The proponent shall review and revise the Contingency Wastewater Management Plan	Appendix B
11-15 The proponent shall make any revisions of the Contingency Wastewater Management Plan, as required by condition 11-11, publicly available in a manner approved by the CEO	Section 7.3

2.4 Rationale and approach in meeting the Environmental Quality Objectives

2.4.1 Results of modelling and baseline surveys

The potential for environmental impacts has been considered carefully by Water Corporation and all reasonable actions have been taken to mitigate impacts through integrated and adaptive management. Best practice environmental management depends on knowledge of the potential effects of ocean wastewater disposal together with an understanding of the receiving environment, including the extent of natural environmental variation.

Coastal hydrodynamics and circulation

The offshore wave climate of Perth is dominated by a persistent low to moderate energy wave regime, and is generally far more variable in winter than in summer. The summer swell arrives from the west to south-west and is typically 1−2 m in height, while winter swell arrives from the west and is typically 1−3 m in height (Oceanica 2011). Local seas are also generated by the passage of winter storms; wave height and direction varies considerably, but the wave heights often exceed 4 m (7 m or more in severe storms).

Wind is the main factor influencing coastal circulation in the inshore waters, particularly in summer when up to 60% of the variation in the ocean currents can be explained by the wind field (Pattiaratchi & Knock 1995). The prevailing summer winds drive northward flowing littoral currents, although periods of current reversal can occur when winds come from the north, particularly in winter.

Marine ecology

The receiving sea floor environment consists of sediments, comprising medium sand grains and coarse shell fragments. Baseline and post-commissioning surveys found that sediments had low organic content (Oceanica 2005, 2011). Although the receiving environment is predominantly sand, an extensive platform of limestone reef runs parallel to the shore ~500 m shoreward of the ocean outlet. The limestone reef consists of medium and high relief structures dominated by encrusting macroalgal communities. Baselines studies found that the macroalgal communities closest to the ocean outlet were dominated by kelp, followed closely by foliose reds and foliose browns. Less prevalent were the turf and coralline algal groups (Oceanica 2009).

Hydrodynamic modelling

Prior to construction, hydrodynamic modelling was undertaken to predict the likely effect of the TWW plume, including the likely zone of influence and the expected concentrations of contaminants following initial dilution. The model took into account the tides, wind, currents, wave climate, vertical structure and bathymetry. Results found that:

- Prevailing winds and currents at Alkimos will generally carry the plume north;
- Discharge via a diffuser 3.7km offshore and at a depth 20 m will create a highly dispersive environment suitable for maximising the dilution of TWW;
- The initial dilution in 20 m deep waters would be approximately 200-fold under worst-case (calm) conditions;

- There will be no exceedances of toxicant criteria outside of the initial mixing zone;
- A diffuser that ends 3.7 km offshore will ensure that the reefs offshore of Alkimos are protected according to a high level of ecosystem protection; and
- There will be no risk to human health values (outside the designated zones) at the Alkimos Reef given the 3.7 km length of the ocean outlet.

Bacterial modelling

Bacterial modelling indicated that there would be no exceedances of human health criteria in areas used for primary contact recreation beyond an initial dilution zone, or any exceedances of shellfish harvesting criteria at the closest reefs that could possibly be used for recreational shellfish harvesting. In addition, modelling results showed that there would be no exceedance of secondary contact recreation criteria.

Results of the modelling indicated that the physical oceanographic characteristics (i.e. exposed coastline and high wave energy conditions) of the Alkimos marine environment are likely to facilitate effective dilution and dispersal of the secondary TWW, thus limiting the potential for any detrimental effects (Water Corporation 2005).

2.4.2 Key assumptions and uncertainties

This MTWDMMP, and the approaches described hereafter, have been developed in line with the environmental risks posed under present-day flow conditions. A step-wise approach is proposed whereby the frequency of monitoring will be revised as the volume and nature of the effluent changes over time. Any proposed changes to the monitoring program will be undertaken in consultation with the relevant stakeholders.

It is not economically feasible or practical to undertake detailed marine monitoring throughout the entire year, and consequently all analysis conducted as part of this MTWDMMP provides a snapshot of results at the time of sampling. In light of this, monitoring programs have been designed to ensure sampling is undertaken in high-risk areas, and throughout the summer months to account for calm conditions. This approach ensures a high level of sensitivity as assessment of any potential impact is detected in the most susceptible areas under worst-case scenarios.

2.4.3 Management approach

The EPA's Environmental Assessment Guidelines for Protecting the Quality of Western Australia's Marine Environment – EAG 15 (EPA 2015a) provides an environmental quality management framework (EQMF) to protect the environmental values of Western Australia's marine environment from waste discharges and contamination. The Alkimos WWTP EQMF has been developed in line with the approaches and framework contained in EAG 15. As outlined in condition 11-2 of MS 755, four EQOs are required to be included in the Condition MTWDMMP: these have been incorporated into the Alkimos EQMF as shown in Figure 2 below.

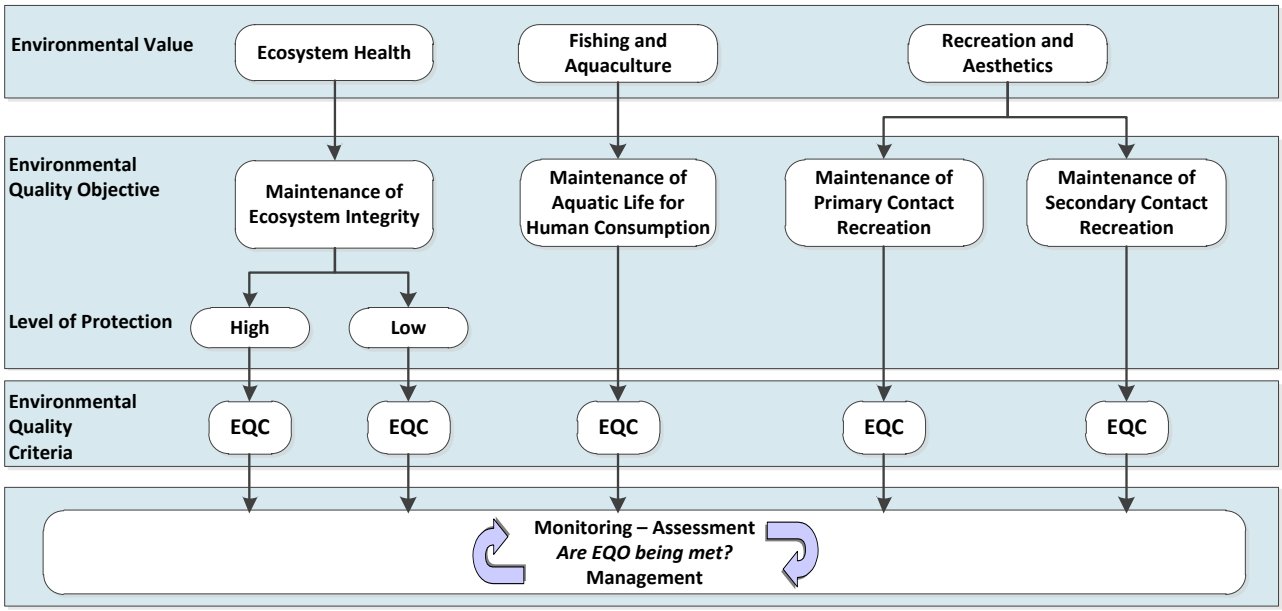

Figure 2: Alkimos WWTP environmental quality management framework

For each of the EQOs in the Alkimos WWTP EQMF, a series of Environmental Quality Criteria (EQC) have been established as per the approach in EAG 15. Unlike the EVs and EQOs, which are qualitatively described, a fundamental requirement of EQC is that they should be clear, readily measurable and auditable (EPA 2015a). If the EQC are met then it is assumed that the EQOs and EVs are protected (EPA 2005a). There are two levels of EQC:

Environmental Quality Guidelines (EQGs) are quantitative, investigative triggers set at a conservative level which, if met, indicate there is a high degree of certainty that the associated EQO has been achieved. If the guideline is not met, there is uncertainty as to whether the associated EQO has been achieved and a more detailed assessment against the EQS is triggered.

Environmental Quality Standards (EQSs) are threshold numerical value or narrative statement triggers, which if exceeded signify that the EQO is not being met and that a management response is required. Failure to meet an EQS implies non-compliance.

The subsequent sections of this MTWDMMP outline the specific EQC and monitoring programs for each EQO included in the Alkimos WWTP EQMF, along with management responses in the event of an EQC exceedance.

2.4.4 EQO 1: Rationale for choice of EQC

The environmental indicators that have been identified for EQO 1 are toxicants in treated wastewater, receiving water physico-chemical stressors (nutrient enrichment), and toxicants in sediments. In accordance with the recommended EQC contained in the EPA's Environmental Quality Criteria Reference Document for Cockburn Sound (2005a), EQC have been developed for the following:

- Treated wastewater characterisation;
- Whole of effluent toxicity (WET) testing;
- Nutrient enrichment; and

- Sediment quality monitoring.

Treated wastewater characterisation

Conditions 11-3.1 – 3.2 specify the requirement to achieve the species protection guideline levels for toxicants. The objective of treated wastewater characterisation is to monitor the TWW stream to characterise the concentration of metals, organics, nutrients and bacteria contained within the TWW and consequently determine compliance against the specified species protection guideline levels.

Total toxicity is also calculated, as it is an additional interpretative tool used for estimating the potential toxicity of TWW where the effects are 'additive'. The potential for toxicity of TWW to marine biota after initial mixing at the ocean outlet will be assessed based on the effects of the three contaminants identified as most likely to cause toxicity effects (ammonia, copper and zinc). It is noted that the effects of ammonia, copper and zinc (or other metals) in combination is assumed to be additive based on a review of literature (Brown 1968; Chen 2005).

Whole of Effluent Toxicity (WET) Testing

Condition 11-3.7 specifies that the MTWDMMP must contain a program to undertake WET testing of TWW. WET testing involves exposing organisms to different concentrations of an effluent and then measuring growth or reproduction characteristics after a selected period of time. The objectives of WET testing are to:

- determine whether further investigation of the potential toxicity of the combined effluent to marine biota is required;
- establish the potential toxicity to marine biota of the combined effluent using a full suite of WET tests, as and when required; and
- ensure that the dilution of the combined effluent at the boundary of the LEPA is protective of 99% of species, as calculated using national (ANZECC & ARMCANZ 2000) protocols.

Two types of WET tests are included as EQC:

- quarterly 1-hour sea urchin fertilisation test
- full suite of WET testing.

The 1-hour sea urchin fertilisation test will measure the rate of sea urchin sperm and egg fertilisation when exposed to a range of salt-adjusted treated wastewater solutions. The utility of this test lies in its fast turn-around time together with its sensitivity to surfactants (i.e. detergents; one of the key constituents of domestic wastewater). This test is more sensitive than most other WET tests and consequently provides an early warning indication of potential toxicity concentrations of contaminants with wastewater.

The full suite of WET testing is a more comprehensive assessment, and measures the responses of a number of biota (from a number of trophic levels) to a range of combined effluent solutions. The full suite of WET testing will use a selection of five of the available tests described in Appendix A. All WET tests are chronic short-term tests with a sub-lethal endpoint.

Nutrient Enrichment

Condition 11-3.3 – 3.4 includes the requirement to establish EQC for nutrients. The effects of excess nutrients are seen as increased biomass of fast-growing algae, which can shade or smother other slower-growing organisms causing negative impacts (EPA 2015a). The EPA recommends the establishment of EQG for physico-chemical stressors to measure ecosystem health, and rather than measuring concentrations of nutrients directly; productivity indicators should be used (e.g. chlorophyll *a*). An EQG has therefore been established to monitor water quality (chlorophyll *a*) in the vicinity of the Alkimos ocean outlet to assess the potential environmental impacts of the TWW discharge.

The EPA (2015b) recommends seagrass (*Posidonia sinuosa)* monitoring for the nutrient enrichment EQS. These recommendations however are based on the waters within Cockburn Sound, and as sea grass monitoring is not applicable to the waters surrounding the Alkimos ocean outfall, assessment against light attenuation coefficient (LAC) will be implemented as the EQS. LAC measures the level of water clarity, which can indicate whether marine flora is receiving sufficient light for growth.

2.4.5 EQO 2: Rationale for choice of EQC

Condition 11.3.3 – 3.4 includes the requirements to establish EQC for social quality objectives. The environmental quality indicator for fishing and aquaculture that has been identified for EQO 2 is thermotolerant coliforms (TTC). Many disease-causing organisms are transferred from human and animal faeces to water via sewage effluent, from where they can be ingested by marine fauna and infect them, adversely affecting their suitability for human consumption. By testing for TTC, it can be determined whether the marine environment has potentially been exposed to faecal contamination. As such, to assess if the EQO is being achieved, TTC will be monitored in water (EQG) and in the flesh of sentinel mussels (EQS).

Sedentary, filter-feeding shellfish (such as mussels or oysters) are often used as bio monitors. Filter-feeding shellfish process large volumes of water at a fixed location and have the tendency to accumulate a wide range of substances in their tissues. Sentinel mussels therefore provide a good indicator for overall levels of contaminants and pathogens in the surrounding water column.

2.4.6 EQO 3 & 4: Rationale for choice of EQC

Condition 11.3.3 – 3.4 includes the requirements to establish EQC for social quality objectives. The environmental quality indicator for recreation and aesthetics that has been identified for EQO 3 & 4 is faecal pathogens. Direct detection of pathogens is not a feasible option for routine assessment, since they occur intermittently and are difficult to recover from water. For this reason, indicator microorganisms such as *Enterococci* spp. are generally used to assess the health risks associated with pathogens in recreational waters (Elliot & Colwell 1985). As such, to assess if the EQOs are being achieved monitoring programs and associated EQC have been developed for enterococci counts.

2.4.7 Rationale for choice of management response actions

Condition 11-6 specifies that if an EQG is exceeded, the matter shall be reported to the DER within one working day of determining that it has occurred. In addition, the condition requires

that an investigation shall be initiated against the EQS. As such, these two management response actions have been included as part of all EQGs within this MTWDMMP.

Condition 11-7 specifies that if an EQS is exceeded, a management response will be implemented to determine the source and remedy of the exceedance. Management responses for all EQS exceedances will be implemented in consultation with the relevant authorities (e.g. OEPA, DER, DoH). Responses may include further investigations to determine the extent and source of the environmental impact, as well as options to reduce the impact such as modifying the diffuser to increase dilutions. A contingency wastewater management plan (required under condition 11-11) has also been developed which considers alternative options for wastewater treatment and/or disposal in the event that EQO are not met (Appendix B).

3. MTWDMMP Provisions: Maintenance of Ecosystem Integrity (EQO 1)

This section identifies the provisions that Water Corporation proposes to implement to meet EQO 1 – Maintenance of Ecosystem Integrity. It identifies the environmental quality criteria (EQC) that Water Corporation will use to measure performance, as well as monitoring that will be undertaken in relation to these EQC and the management response actions that Water Corporation will undertake in the event that the EQC are exceeded. These MTWDMMP provisions aim to fulfil the requirements of conditions 11-3.1 – 3.7 of MS 755.

EQO 1 is aimed at maintaining ecosystem integrity and biodiversity, thereby ensuring the continued health and productivity of Perth's coastal waterways (EPA 2000). As stipulated in Schedule 1 of MS 755, EQO 1 encompasses two levels of ecological protection (LEP); waters within a 100 m radius around the diffuser have been categorised as a low ecological protection area (LEPA), with waters immediately outside the LEPA categorised as a high ecological protection area (HEPA), as shown in Figure 3 below. The level of protection around the outlet is to remain high (i.e. small changes from natural variation) except within the LEPA, where large changes from natural variation are permitted.

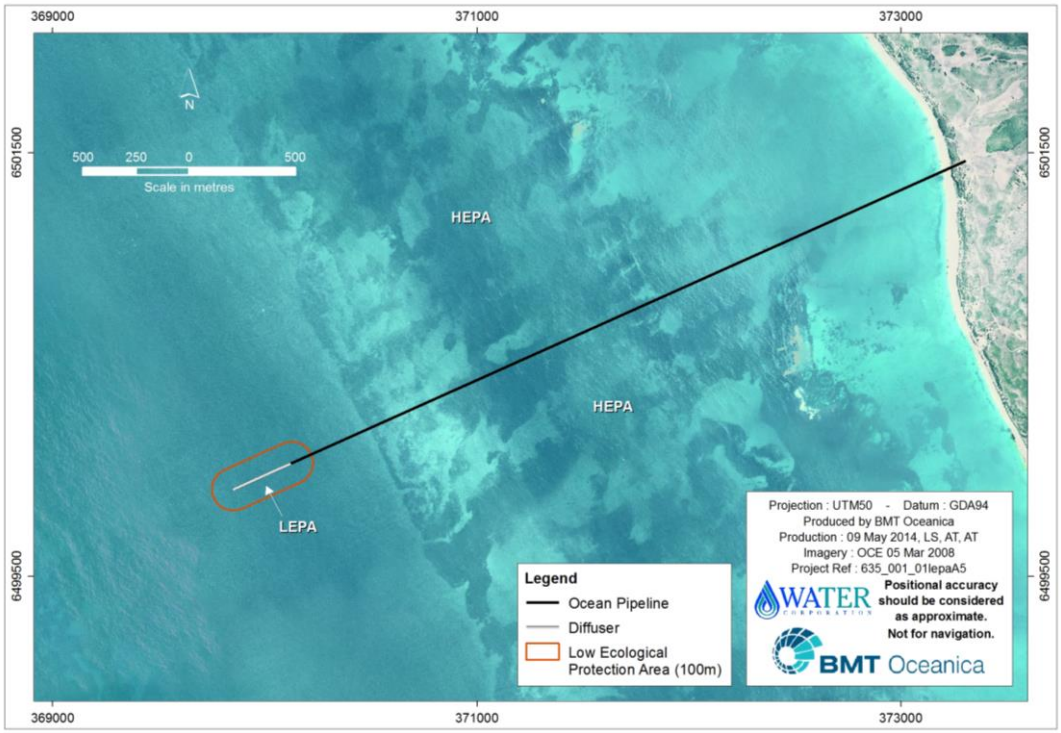

Figure 3: Ecological protection areas surrounding Alkimos ocean outfall

3.1 Environmental Quality Criteria

Table 3: Environmental quality criteria for EQO 1

Environmental Indicator	ENVIRONMENTAL QUALITY CRITERIA (EQC)	
	Environmental Quality Guideline (EQG)	**Environmental Quality Standard (EQS)**
Toxicants in treated wastewater • Ammonia • Metals • Pesticides • Herbicides • Other chemicals	**EQG 1:** Concentrations of contaminants will not exceed the ANZECC/ARMCANZ (2000) 80% species protection guideline trigger levels for bioaccumulating toxicants at the diffuser. **EQG 2:** Concentrations of contaminants will not exceed the ANZECC/ARMCANZ (2000) 99% species protection guideline trigger levels for toxicants (with the exception of cobalt, where the 95% guideline trigger level will apply) at the boundary of the LEPA.	**EQS 1:** The EQS is exceeded if, after full suite WET testing: $\frac{DALEPA}{DR99\%BurrliOZ} \leq 1$ *DALEPA = Dilutions achieved at the boundary of the LEPA* *DR99%BurrliOZ = Number dilutions required to achieve the 99% species protection guideline specific to treated wastewater that is calculated with BurrliOZ software using the results of the full suite of WET tests, as per ANZECC/ARMCANZ (2000).*
	EQG 3: The total toxicity of the mixture (TTM) for the additive effect of ammonia, copper and zinc (as per ANZECC/ARMCANZ (2000) guidelines) is less than 1.0.	
	EQG 4: The EQG will be exceeded if, following the 1 hour sea urchin test: $\frac{TDA}{DRNOEC} \leq 1.0$ *TDA = Typical Dilutions Achieved (constant based on 200-fold dilution)* *DRNOEC = Number of dilutions required to achieve the No Observed Effects Concentration (NOEC).*	
Physico-chemical stressors • Nutrient enrichment	**EQG 5:** The ambient value[1] of defined area[2] during non-river flow period[3] for chlorophyll *a* not to exceed 80th percentile of reference sites data.	**EQS 2:** The ambient value[1] of defined area[2] during non-river flow period[3] for light attenuation not to exceed 80th percentile of reference sites data.
Toxicants in sediments • Metals • Pesticides • Herbicides	**EQG 6:** If either Trigger A or Trigger B is not met the EQG is exceeded A. Median sediment total contaminant concentration from a defined sampling area should not exceed the environmental quality guideline value for high, moderate and low protection (Table 6). B. Total contaminant concentration at individual sample sites should not exceed the environmental quality guideline re-sampling trigger (Table 6). If so, repeat sampling will be conducted to define the extent of the contamination which will be assessed as per Trigger A.	**EQS 3:** To exceed the EQS, <u>either</u> Trigger A or Trigger B must be exceeded <u>and</u> one or more of the applicable[4] Triggers C – G must be exceeded: A. The 80th percentile of bioavailable metal or metalloid concentrations (e.g. dilute acid extractable metals, SEM/AVS analysis) from the defined sampling area should not exceed the EQG. B. The median bioavailable concentration for non-metallic contaminants (e.g. OC normalisation) from the defined sampling area should not exceed the EQG. C. The 95th percentile of bioavailable contaminant concentrations in porewater samples from the defined sampling area should not exceed high protection water quality guideline values (Table 2a of EPA 2015 EQC reference doc). D. Sediment toxicity tests should not result in a statistically significant effect ($P < 0.05$) on sub lethal chronic or lethal acute endpoints for any species, compared to a matched reference sediment. E. No significant change in any biological or ecological indicator beyond natural variation that can be demonstrably linked to a contaminant. F. Where TBT concentrations exceed the guideline the incidence of imposex in *Thais orbita* should be ≤5%. G. The median tissue concentration of chemicals that can adversely bioaccumulate or biomagnify should not exceed the 80th percentile of tissue concentrations from a suitable reference site.

Notes:
1. Ambient Value = median value of individual sample data for a defined area.
2. Defined Area = area to be characterised for environmental quality against pre-determined Environmental Quality Objectives and levels of ecological protection.
3. Non River-flow Period = period December–March inclusive, when river and estuarine flows are weak.
4. One or more of the applicable Triggers C – G will be assessed, depending on the results of sediment quality monitoring obtained and what type of further assessment is required to determine any adverse impacts.

3.2 EQG Monitoring and Management Response Actions

Table 4: EQG monitoring and management against EQO 1

EQG 1:	**Concentrations of contaminants will not exceed the ANZECC/ARMCANZ (2000) 80% species protection guideline trigger levels for bioaccumulating toxicants at the diffuser**			
Indicator	**Method – Comprehensive Treated Wastewater Characterisation (CTWWC)**	**Location**	**Frequency**	**Management Response Actions**
Toxicants in Treated Wastewater: • Ammonia • Metals • Pesticides • Herbicides • Other chemicals	TWW from the Alkimos WWTP will be analysed for the suite of parameters listed in Table 5. The CTWWC sample will be an average of the final TWW discharge from the Alkimos WWTP for the 24 hour period prior to and during the sample collection (composite sample). A separate grab sample for microbiological parameters will be taken, as 24 hour composites are not suitable for microbiological parameters. The bulk sample will be homogenised (agitated) and split into separate sample containers. Samples will be collected, stored and transported according to the relevant parts of AS/NZS 5667.1:1998, and all analyses will be undertaken by laboratories with NATA-accredited methods. Samples for bioavailable metals will be filtered through a 0.45 µm filter prior to analysis.	Alkimos WWTP final effluent sampling point	CTWWC will be undertaken annually, and also (i) within three months following material process or significant volume changes; and (ii) prior to plant decommissioning. CTWWC is undertaken at the same time of year as the summer nutrient enrichment monitoring (see EQG 5).	Water Corporation will report the exceedance to the OEPA and Department of Environment Regulation (DER) within one (1) working day of determining that the exceedance has occurred. Assessment will commence against EQS 1: Full suite WET testing.
EQG 2:	**Concentrations of contaminants will not exceed the ANZECC/ARMCANZ (2000) 99% species protection guideline trigger levels for toxicants (with the exception of cobalt, where the 95% guideline trigger level will apply) at the boundary of the LEPA**			
Indicator	**Method – Comprehensive Treated Wastewater Characterisation (CTWWC)**	**Location**	**Frequency**	**Management Response Actions**
Toxicants in treated wastewater: • Ammonia • Metals • Pesticides • Herbicides • Other chemicals	Methodology as per EQG 1 above. Where the toxicants do not meet the relevant guideline trigger values prior to dilution, the number of dilutions required to meet these levels will be calculated using the following formula: $\text{Minimum number of dilutions required} = \frac{[\text{Max Filtered}^1] - [\text{Background}]}{[\text{Trigger Value}^2] - [\text{Background}]}$ *[1] where there is no established trigger levels for toxicants in marine waters, an estimate of the required number of dilutions cannot be calculated.* *[2] where concentrations are reported as being less than the reporting limit, the limits of reporting will be used in the calculations.* The minimum number of dilutions required is then compared with the results of initial dilution modelling to ascertain if dilution rates are sufficient to dilute contaminants below the species protection guideline values at the LEPA boundary. *Initial Dilution Modelling* Initial dilution modelling is undertaken to identify the extent of dilution around the Alkimos ocean outlet under calm (or worst-case) conditions to determine concentrations of contaminants at the LEPA. The initial dilution model set-up parameters include: • Diffuser characteristics: port diameter, number of open ports, port spacing, diffuser pipe diameter, port orientation and water depth; • Ambient conditions at the time of sampling: temperature, salinity, current speed and current direction; and • Discharge characteristics: flow rate, temperature and salinity. This information, together with TWW physico-chemical characteristics, will be used to model the average and centreline initial dilution.	Alkimos WWTP final effluent sampling point	CTWWC will be undertaken annually, and also (i) within three months following material process or significant volume changes; and (ii) prior to plant decommissioning. CTWWC is undertaken at the same time of year as the summer nutrient enrichment monitoring. Initial dilution modelling is undertaken annually at the same time as CTWWC.	If a trigger level is exceeded, the first step will be to immediately collect and re-analyse a further sample of wastewater. If after reanalysis the EQG is still exceeded, Water Corporation will report the exceedance to the OEPA and DER within one (1) working day of determining that the exceedance has occurred. Assessment will commence against EQS 1: Full suite WET testing.

EQG 3:	The total toxicity of the mixture (TTM) for the additive effect of ammonia, copper and zinc (as per ANZECC/ARMCANZ (2000) guidelines) is less than 1.0			
Indicator	**Method – Total Toxicity Testing**	**Location**	**Frequency**	**Management Response Actions**
Toxicants in treated wastewater: • Ammonia • Metals • Pesticides • Herbicides • Other chemicals	The total toxicity calculation is based on a formula that is used on existing data collected as part of comprehensive treated wastewater characterisation. The formula used to calculate the total toxicity of the mixture is: $\text{Total Toxicity of Mixture} = \frac{[\text{ammonia}]}{[\text{Trigger Value}]} + \frac{[\text{copper}]}{[\text{Trigger Value}]} + \frac{[\text{zinc}]}{[\text{Trigger Value}]}$ An initial mixing zone dilution of 200-fold will be applied (Schedule 1 of MS 755 states that the average dilution of the wastewater stream will be least 1:300 and above 1:200 99% of the time within 100 m of the diffuser).	N/A – formula applied using results of CTWWC.	Total toxicity calculations are undertaken annually, coinciding with the comprehensive treated wastewater characterisation analysis.	Water Corporation will report the exceedance to the OEPA and DER within one (1) working day of determining that the exceedance has occurred. Assessment will commence against EQS 1: Full suite WET testing.
EQG 4:	**The EQG will be exceeded if, following the 1 hour sea urchin test:** $\frac{\text{TDA}}{\text{DRNOEC}} < 1.0$			
Indicator	**Method – 1-hr Sea Urchin WET Testing**	**Location**	**Frequency**	**Management Response Actions**
Toxicants in treated wastewater: • Ammonia • Metals • Pesticides • Herbicides • Other chemicals	The 1 hour sea urchin WET test determines the rate of fertilisation of urchin gametes over a 1-hour period. The sperm of the sea urchin are exposed to dilute wastewater for a 1 hour period, and are then added to the egg suspension. The fertilised eggs are counted and the percent fertilisation calculated. The results are used to calculate the No Observed Effects Concentration (NOEC), the Lowest Observed Effects Concentration (LOEC) and the test concentration of containment/wastewater at which 10% and 50% of the test organisms are affected (EC10 and EC50). Sea urchin fertilisation testing will be carried out by a NATA-accredited laboratory. TWW samples will be collected from the Alkimos WWTP in HDPE containers supplied by the laboratory, and stored and transported according to the laboratory protocols. The dilutions of wastewater used will typically be 0.5%, 6.25%, 12.5%, 25%, 50% and 100%, but may vary slightly for each WET test. All test dilutions for wastewater will be salt-adjusted (using artificial sea salts) to achieve marine salinities, so that only the toxicity due to the presence of contaminants is examined, not the toxic effect of freshwater on the marine organism. Testing will also be undertaken on a seawater 'control', and an artificial sea salt (brine) control.	Alkimos WWTP final effluent sampling point	1 hour sea urchin WET tests are to be conducted quarterly. Summer quarterly sampling will coincide with the comprehensive TWW wastewater characterisation.	Water Corporation will report the exceedance to the OEPA and DER within one (1) working day of determining that the exceedance has occurred. Assessment will commence against EQS 1: Full suite WET testing.
EQG 5:	**The ambient value of defined area during non-river flow period for chlorophyll *a* not to exceed 80th percentile of reference sites data**			
Indicator	**Method – Nutrient Enrichment (Chlorophyll *a*)**	**Location**	**Frequency**	**Management Response Actions**
Receiving water physico-chemical stressors: • Nutrient enrichment	Samples will be collected just below the water surface. The samples will be collected using a submersible pump and hose which is flushed with seawater for 30 seconds prior to collection of the sample at each site. Standard laboratory analytical procedures will be employed throughout and all sampling and analyses undertaken according to NATA-accredited methods. Note: ortho-phosphate, ammonia, nitrate + nitrite and dissolved inorganic nitrogen will also be analysed to aid in data interpretation.	Sampling will be undertaken at compliance, contextual and reference sites (see Figure 4). For compliance monitoring, sampling is to be undertaken at the boundary of the LEPA (~100 m down-current), with additional contextual monitoring to be undertaken at distances 0, 390, 1000 and 1500 m down-current of the outfall. The four reference sites are positioned approximately 4,000 m south of the outfall, beyond the influence of both Alkimos WWTP and Beenyup WWTP discharges.	Monitoring will commence in the first week of summer and continue at fortnightly intervals during the summer months between December and March.	Water Corporation will report the exceedance to the OEPA and DER within one (1) working day of determining that the exceedance has occurred. Assessment will commence against EQS 2: Nutrient Enrichment (Light Attenuation Coefficient).

EQG 6:	A: Median sediment total contaminant concentration from a defined sampling area should not exceed the environmental quality guideline value for high, moderate and low ecological protection areas; and B: Total contaminant concentration at individual sample sites should not exceed the environmental quality guideline re-sampling trigger. If so, repeat sampling will be conducted to define the extent of the contamination which will be assessed as per trigger A.			
Indicator	**Method – Sediment Monitoring**	**Location**	**Frequency**	**Management Response Actions**
Toxicants in Sediments: • Metals • Pesticides • Herbicides	At each site, five replicate sediment samples will be collected. Each of the replicate samples will comprise a composite from five sub-samples of the top 2 cm of sediment obtained from the four corners and the centre of a 1 m^2 quadrat, in accordance with the Manual of Standard Operating Procedures for Cockburn Sound (EPA 2005b). Of the five replicate samples per site, only three will be initially analysed in accordance with the minimum recommended replicates for analysis. Samples will be kept on ice and then frozen prior to analysis. Analyses will be undertaken by a NATA-accredited laboratory. Sample analysis will report against the lowest practical analytical limits, and where concentrations are reported as less than this limit, the limits of reporting (LOR) will be used in the calculations. Sediment samples will be analysed for the parameters listed in Table 6. If CTWWC reveals that organochlorine pesticide levels are below LOR, these contaminants will not be measured in sediment samples. If however an increase in organochlorine pesticide levels relative to the previous year's analysis is found, additional testing will be undertaken for organochlorine pesticides. Additional testing will also be undertaken under the following conditions: • For pesticides with guideline triggers > LOR: If concentrations exceed the ANZECC/ARMCANZ (2000) guidelines following worst case initial dilution; or • For pesticides with trigger values < LOR: If concentrations exceed the LOR following worst case initial dilution. When assessing sediment toxicant concentrations against the guidelines, the median sediment contaminant concentration at sites positioned at the LEPA boundary will be compared to the environmental quality guideline value for high, moderate and low protection in Table 6. Simultaneously, the total sediment contaminant concentration will be compared to the environmental quality guideline re-sampling trigger value in Table 6. If this is exceeded, repeat sampling is conducted to assess the extent of contamination which is assessed as per the methodology above.	Sediment samples will be collected at the following sites (see Figure 5): • 100 m north (AS 1), 100 m west (AS 2) and 100 m south (AS 3) of the outlet at the boundary of the LEPA; and • A single reference site located approximately 4,000 m south of the outlet (ASR 1), beyond the influence of both Alkimos WWTP and Beenyup WWTP discharges.	Sediments will be collected every five years, or when significant changes in inflow quality occur (whichever is sooner). Sediment quality monitoring is scheduled for 2015/16 and 2020/21.	Water Corporation will report the exceedance to the OEPA and DER within one (1) working day of determining that the exceedance has occurred. Assessment against the EQS for full suite WET testing will then commence.

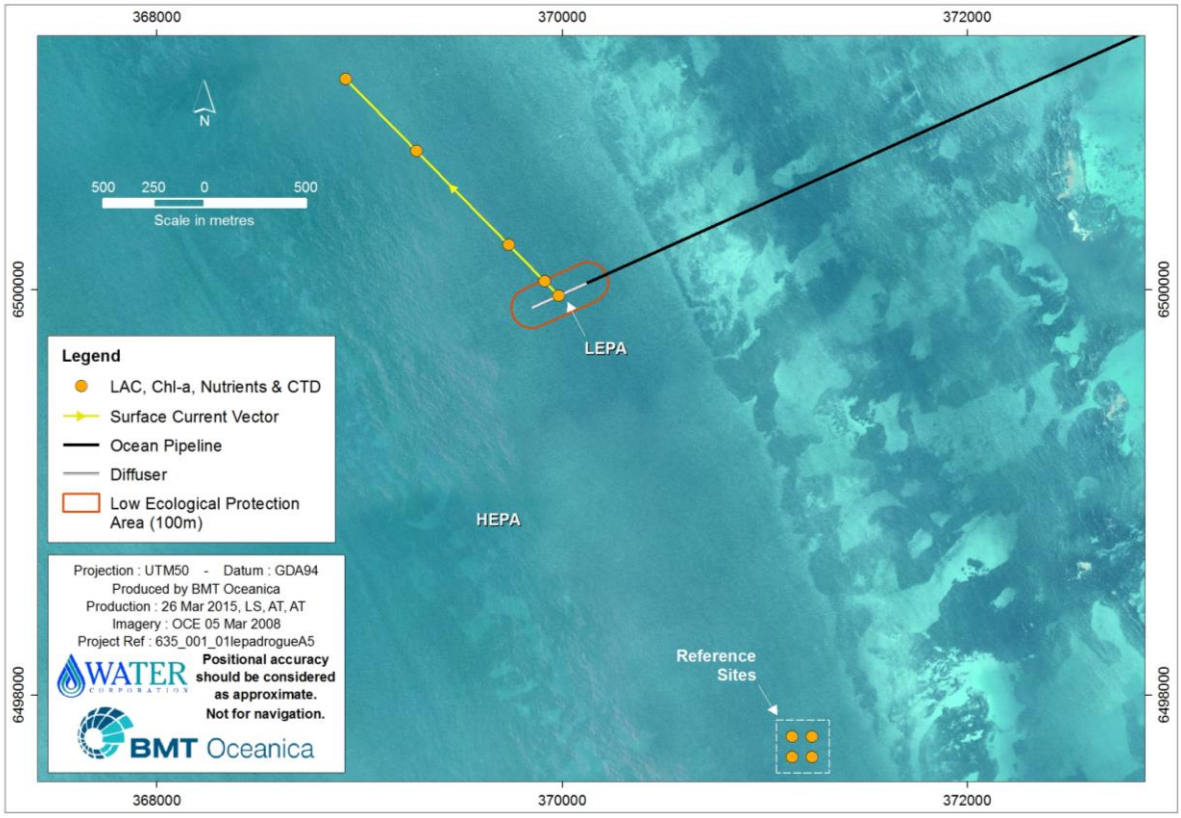

Figure 4: Nutrient enrichment monitoring sites

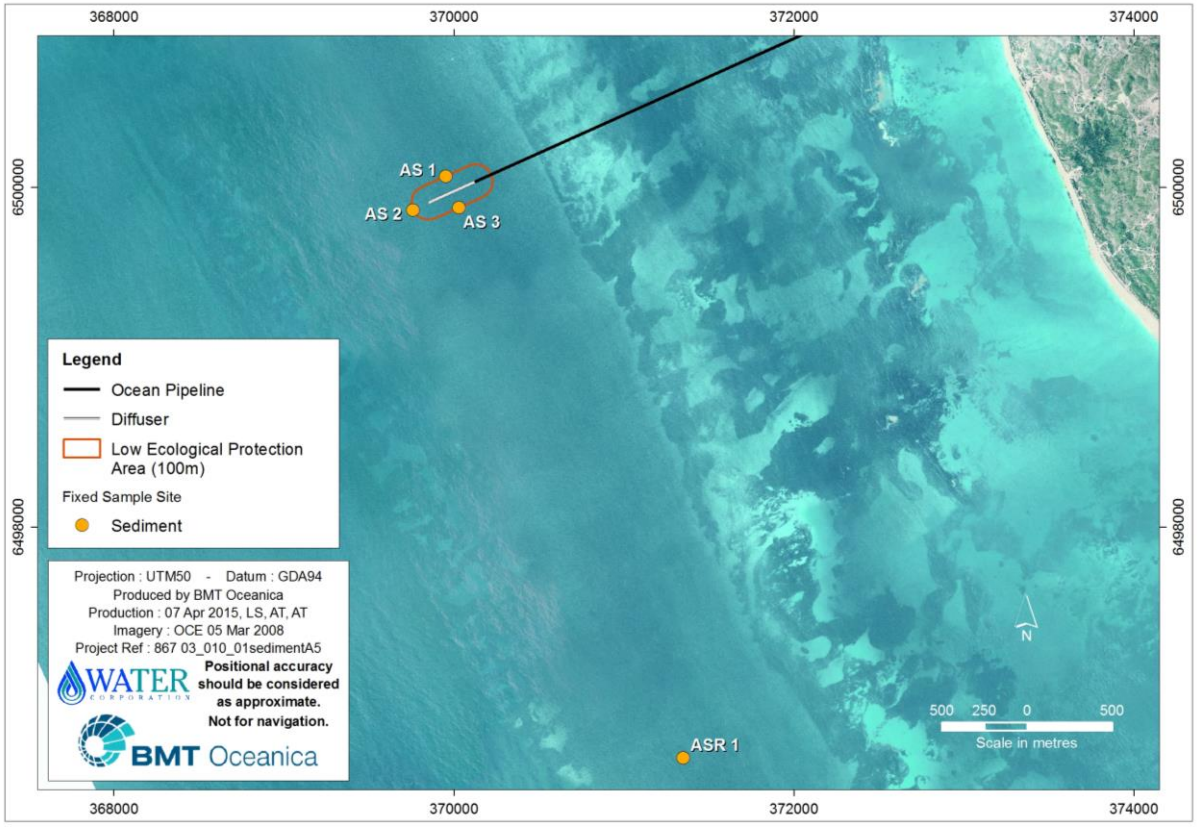

Figure 5: Sediment quality monitoring sites

Table 5: Comprehensive TWW characterisation parameters and the ANZECC/ARMCANZ (2000) guideline trigger values[1] for toxicants

Parameter	ANZECC/ARMCANZ (2000) Guidelines (µg L^{-1})				
	Level of protection				Low Reliability Value (LRV)
	99%	95%	90%	80%	
Microbiological					
Confirmed *Enterococci*[2]	n/a[3]	n/a	n/a	n/a	n/a
Presumptive Thermotolerant Coliforms (TTC)[4]	n/a	n/a	n/a	n/a	n/a
Confirmed Thermotolerant Coliforms (TTC)[4]	n/a	n/a	n/a	n/a	n/a
Escherichia coli	n/a	n/a	n/a	n/a	n/a
Nutrients					
Ammonia-N	500	910	1,200	1,700	-
Nitrate-N+ Nitrite-N	ID[5]	ID	ID	ID	13,000
Nitrogen-Total N	n/a	n/a	n/a	n/a	n/a
Phosphate-Ortho as P	n/a	n/a	n/a	n/a	n/a
Phosphorus-Total P	n/a	n/a	n/a	n/a	n/a
Metals and Metalloids					
Arsenic (As)	ID	ID	ID	ID	2.3 (As III) 4.5 (As V)
Cadmium (Cd)	0.7	5.5	14	36	-
Chromium (Cr)	7.7 (Cr III) 0.14 (Cr VI)	27.4 (Cr III) 4.4 (Cr VI)	48.6 (Cr III) 20 (Cr VI)	90.6 (Cr III) 85 (Cr VI)	-
Copper (Cu)	0.3	1.3	3	8	-
Lead (Pb)	2.2	4.4	6.6	12	-
Mercury (Hg)	0.1	0.4	0.7	1.4	-
Nickel (Ni)	7	70	200	560	-
Selenium (Se)	ID	ID	ID	ID	3
Silver (Ag)	0.8	1.4	1.8	2.6	-
Zinc (Zn)	7	15	23	43	-
Triazine herbicides					
Atrazine	ID	ID	ID	ID	13
Hexazinone	ID	ID	ID	ID	75
Metribuzine	n/a	n/a	n/a	n/a	n/a
Prometryne	n/a	n/a	n/a	n/a	n/a
Simazine	ID	ID	ID	ID	3.2
Phenoxy-acid herbicides					
Dicamba[6]	n/a	n/a	n/a	n/a	n/a
MCPA	ID	ID	ID	ID	1.4
Dichlorprop	n/a	n/a	n/a	n/a	n/a
2,4-D	ID	ID	ID	ID	280
2,4,5-T	n/a	n/a	n/a	n/a	n/a
2,4,5-TP	n/a	n/a	n/a	n/a	n/a

Parameter	ANZECC/ARMCANZ (2000) Guidelines (µg L^{-1})				
	Level of protection				Low Reliability Value (LRV)
	99%	95%	90%	80%	
2,4-DB	n/a	n/a	n/a	n/a	n/a
MCPP	n/a	n/a	n/a	n/a	n/a
Triclopyr[7]	n/a	n/a	n/a	n/a	n/a
Organophosphate pesticides					
Azinphos-Methyl	ID	ID	ID	ID	0.01
Azinphos-Ethyl	n/a	n/a	n/a	n/a	n/a
Chlorpyrifos	0.0005	0.009	0.04	0.3	-
Chlorpyrifos Methyl	n/a	n/a	n/a	n/a	n/a
Chlorfenvinphos (E)	n/a	n/a	n/a	n/a	n/a
Chlorfenvinphos (Z)	n/a	n/a	n/a	n/a	n/a
Demeton-S-Methyl	ID	ID	ID	ID	4
Dichlorvos	n/a	n/a	n/a	n/a	n/a
Diazinon	ID	ID	ID	ID	0.01
Dimethoate	ID	ID	ID	ID	0.15
Ethion	n/a	n/a	n/a	n/a	n/a
Fenthion	n/a	n/a	n/a	n/a	n/a
Fenitrothion	ID	ID	ID	ID	0.001
Malathion	ID	ID	ID	ID	0.05
Parathion (Ethyl)	ID	ID	ID	ID	0.004
Parathion Methyl	n/a	n/a	n/a	n/a	n/a
Pirimiphos-Ethyl[8]	n/a	n/a	n/a	n/a	n/a
Pirimiphos-Methyl[9]	n/a	n/a	n/a	n/a	n/a
Organochlorine pesticides					
Aldrin	ID	ID	ID	ID	0.003
trans-Chlordane[10]	ID	ID	ID	ID	0.001
cis-Chlordane[10]	ID	ID	ID	ID	0.001
Oxychlordane[10]	ID	ID	ID	ID	0.001
gamma-BHC (Lindane)	ID	ID	ID	ID	0.007
alpha-BHC	n/a	n/a	n/a	n/a	n/a
beta-BHC	n/a	n/a	n/a	n/a	n/a
delta-BHC	n/a	n/a	n/a	n/a	n/a
p,p-DDD	n/a	n/a	n/a	n/a	n/a
p,p-DDE	ID	ID	ID	ID	0.0005
p,p-DDT	ID	ID	ID	ID	0.0004
Dieldrin	ID	ID	ID	ID	0.01
Endrin	0.004	0.008	0.01	0.02	-
Endrin Aldehyde	n/a	n/a	n/a	n/a	n/a
Endrin Ketone	n/a	n/a	n/a	n/a	n/a
alpha-Endosulfan	ID	ID	ID	ID	0.0002
beta-Endosulfan	ID	ID	ID	ID	0.007

Parameter	ANZECC/ARMCANZ (2000) Guidelines (µg L^{-1})				
	Level of protection				Low Reliability Value (LRV)
	99%	95%	90%	80%	
Endosulfan Sulfate[11]	0.005	0.01	0.02	0.05	-
HCB (Hexachlorobenzene)	ID	ID	ID	ID	0.05
Heptachlor	ID	ID	ID	ID	0.0004
Heptachlor epoxide	n/a	n/a	n/a	n/a	n/a
Methoxychlor	ID	ID	ID	ID	0.004
Phthalates					
Dimethyl phthalate	ID	ID	ID	ID	3700
Diethyl phthalate	ID	ID	ID	ID	900
Di-n-butyl phthalate	ID	ID	ID	ID	25
Benzyl butyl phthalate	n/a	n/a	n/a	n/a	n/a
Bis(2-ethylhexyl)phthalate	ID	ID	ID	ID	1
Di-n-octyl phthalate	n/a	n/a	n/a	n/a	n/a
PCB Aroclors					
Aroclor 1016	ID	ID	ID	ID	0.009
Aroclor 1221	ID	ID	ID	ID	1.0
Aroclor 1232	ID	ID	ID	ID	0.3
Aroclor 1242	ID	ID	ID	ID	0.3
Aroclor 1248	ID	ID	ID	ID	0.03
Aroclor 1254	ID	ID	ID	ID	0.01
Aroclor 1260	ID	ID	ID	ID	25
Total PCB's (as above)[12]	ID	ID	ID	ID	n/a
Chlorinated hydrocarbons					
2-Chloronaphthalene	n/a	n/a	n/a	n/a	n/a
1,4-Dichlorobenzene	ID	ID	ID	ID	60
1,2-Dichlorobenzene	ID	ID	ID	ID	160
1,3-Dichlorobenzene	ID	ID	ID	ID	260
Hexachlorobenzene	ID	ID	ID	ID	0.05
1,2,4-Trichlorobenzene	20	80	140	240	-
Hexachloroethane	ID	ID	ID	ID	290
Hexachlorocyclopentadiene	ID	ID	ID	ID	0.05
Hexachloro-1,3-butadiene[13]	ID	ID	ID	ID	0.03
Ethers					
4-Bromophenyl phenyl ether[14]	n/a	n/a	n/a	n/a	n/a
4-Chlorophenyl phenyl ether	n/a	n/a	n/a	n/a	n/a
Bis(2-chloroethyl)ether	n/a	n/a	n/a	n/a	n/a
Bis(2-chloroethoxy)methane	n/a	n/a	n/a	n/a	n/a
Bis(2-chloroisopropyl)ether	n/a	n/a	n/a	n/a	n/a
Amines, Nitroaromatics & Nitrosamines					
Azobenzene	n/a	n/a	n/a	n/a	n/a
2,4-Dinitrotoluene	ID	ID	ID	ID	16

Parameter	ANZECC/ARMCANZ (2000) Guidelines (µg L^{-1})				
	Level of protection				Low Reliability Value (LRV)
	99%	95%	90%	80%	
2,6-Dinitrotoluene	n/a	n/a	n/a	n/a	0.3
Nitrobenzene	ID	ID	ID	ID	550
N-Nitrosodimethylamine	n/a	n/a	n/a	n/a	n/a
N-Nitrosodiphenylamine	ID	ID	ID	ID	6
N-Nitrosodi-n-propylamine	n/a	n/a	n/a	n/a	n/a
Aniline	ID	ID	ID	ID	8
4-Chloroaniline	n/a	n/a	n/a	n/a	n/a
2-Nitroaniline	n/a	n/a	n/a	n/a	n/a
3-Nitroaniline	n/a	n/a	n/a	n/a	n/a
4-Nitroaniline	n/a	n/a	n/a	n/a	n/a
Other organics					
Dichlorobenzidine[15]	ID	ID	ID	ID	0.5
2-Methylnaphthalene	n/a	n/a	n/a	n/a	n/a
Isophorone	ID	ID	ID	ID	130
Benzyl alcohol	n/a	n/a	n/a	n/a	n/a
Carbazole	n/a	n/a	n/a	n/a	n/a
Dibenzofuran	n/a	n/a	n/a	n/a	n/a
BTEX					
Benzene	500	700	900	1300	-
Toluene	ID	ID	ID	ID	180
Ethylbenzene	ID	ID	ID	ID	5
Xylene[16]	ID	ID	ID	ID	75
Total BTEX[12]	n/a	n/a	n/a	n/a	n/a
TPH					
TPH C6 - C9[17]	ID	ID	ID	ID	n/a
TPH C10 - C14[17]	ID	ID	ID	ID	n/a
TPH C15 - C28[17]	ID	ID	ID	ID	n/a
TPH C29 - C36[17]	ID	ID	ID	ID	n/a
Total TPH[17,18]	ID	ID	ID	ID	n/a
PAHs					
Naphthalene	50	70	90	120	-
Acenaphthylene	n/a	n/a	n/a	n/a	n/a
Acenaphthene	n/a	n/a	n/a	n/a	n/a
Fluorene	n/a	n/a	n/a	n/a	n/a
Phenanthrene	ID	ID	ID	ID	2
Anthracene	ID	ID	ID	ID	0.4
Fluoranthene	ID	ID	ID	ID	1.4
Pyrene	n/a	n/a	n/a	n/a	n/a
Benz(a)anthracene	n/a	n/a	n/a	n/a	n/a
Chrysene	n/a	n/a	n/a	n/a	n/a

Parameter	ANZECC/ARMCANZ (2000) Guidelines (µg L^{-1})				
	Level of protection				Low Reliability Value (LRV)
	99%	95%	90%	80%	
Benzo(b)&(k)fluoranthene	n/a	n/a	n/a	n/a	n/a
Benzo(a)pyrene	ID	ID	ID	ID	0.2
Indeno(1,2,3-cd)pyrene	n/a	n/a	n/a	n/a	n/a
Dibenz(ah)anthracene	n/a	n/a	n/a	n/a	n/a
Benzo(ghi)perylene	n/a	n/a	n/a	n/a	n/a
Surfactants					
Methylene Blue Active Substances (MBAS)[19]	n/a	n/a	n/a	n/a	n/a
Miscellaneous Other					
Chlorine-Free	ID	ID	ID	ID	3
Chlorine-Total	ID	ID	ID	ID	3
Dissolved Organic Carbon (DOC)	n/a	n/a	n/a	n/a	n/a
Total Organic Carbon (TOC)	n/a	n/a	n/a	n/a	n/a
Total Suspended Solids (TSS)[20]	n/a	n/a	n/a	n/a	n/a
Biological Oxygen Demand (BOD)	n/a	n/a	n/a	n/a	n/a
pH[21]	n/a	n/a	n/a	n/a	n/a

Notes:

1. Trigger values for marine water (Table 3.4.1; ANZECC/ARMCANZ 2000).
2. Primary contact guideline for recreational marine waters 35 Enterococci spp. organisms 100 mL-1 (ANZECC/ARMCANZ 2000), but now superceded by NHMRC (2008).
3. n/a = ANZECC/ARMCANZ (2000) Guideline or Low Reliability Value not available for this parameter.
4. Primary contact guideline for recreational marine waters 150 faecal coliforms 100 mL-1 (ANZECC/ARMCANZ 2000), but now superceded by NHMRC (2008).
5. ID = insufficient data to derive a reliable national trigger value.
6. Recreational guideline for Dicamba = 300 µg L-1 (Table 5.2.4; ANZECC/ARMCANZ 2000).
7. Recreational guideline for Triclopyr = 20 µg L-1 (Table 5.2.4; ANZECC/ARMCANZ 2000).
8. Recreational guideline for Pirimiphos-ethyl = 1 µg L-1 (Table 5.2.4; ANZECC/ARMCANZ 2000).
9. Recreational guideline for Pirimiphos-methyl = 60 µg L-1 (Table 5.2.4; ANZECC/ARMCANZ 2000).
10. Guideline values are for total chlordane though cis-chlordane is around 7 times more toxic than trans-chlordane (ANZECC/ARMCANZ 2000).
11. Values for Endosulphan, not Endosulphan sulfate (Table 3.4.1; ANZECC/ARMCANZ 2000).
12. ANZECC/ARMCANZ (2000) recommends using a formula to calculate total toxicity of the mixture if using total PCBs and BTEX (page 8.3-65; ANZECC/ARMCANZ 2000).
13. Environmental Concern Level (ECL) for Hexachloro-1,3-butadiene (not LRV) (definition of ECL on page 8.3-35; page 8.3-231; ANZECC/ARMCANZ 2000).
14. Recommended ECL for 4-Bromophenyl phenyl ether = 12 µg L-1 (page 8.3-232; ANZECC/ARMCANZ 2000).
15. ECL for Dichlorobenzidine (not LRV) (page 8.3-187; ANZECC/ARMCANZ 2000).
16. Guideline for o-Xylene = 350 µg/L, for m-xylene = 75 µg/L and for p-xylene = 200 µg L-1 (ANZECC/ARMZANC 2000).
17. Guideline values are for generic oils and petroleum hydrocarbons (Table 3.4.1; ANZECC/ARMCANZ 2000).
18. A generic estimate of 7 µg L-1 for a total petroleum hydrocarbon chronic value has been estimated using USEPA methods (page 8.3-297; ANZECC/ARMCANZ 2000).
19. Recreational guideline for MBAS = 200 µg L-1 (ANZECC/ARMCANZ 2000).
20. Suspended solids guidelines for the protection of saltwater aquaculture species = <10,000 µg L-1 (Table 4.4.2; ANZECC/ARMCANZ 2000).
21. pH guideline range for slightly disturbed inshore marine ecosystems in south-west Australia = 8.0 to 8.4 (Table 3.3.6; ANZECC/ARMCANZ 2000)

Table 6: Sediment quality criteria for EQO 1

Parameter	Value (high, moderate and low protection)[1]	Re-sampling trigger[1]
Metals and metalloids (mg/kg dry wt)		
Arsenic	20	70
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Mercury	0.15	1
Nickel	21	52
Silver	1	37
Zinc	200	410
Organics (µg/kg dry wt)[2]		
Acenaphthene	16	500
Acenaphthalene	44	640
Anthracene	85	1100
Fluorene	19	540
Naphthalene	160	2100
Phenanthrene	240	1500
Benzo(a)anthracene	261	1600
Benzo(a)pyrene	430	1600
Dibenzo(a,h)anthracene	63	260
Chrysene	384	2800
Fluoranthene	600	5100
Pyrene	665	2600
Total PAHs	4000	45000
Organochlorine pesticides		
Total DDT	1.6	46
pp-DDE	2.2	27
op-+pp-DDD	2	20
Chlordane	0.5	6
Dieldrin	0.02	8
Endrin	0.02	8
Lindane	0.32	1
Total polychlorinated biphenyls		
Total PCBs	23	180

Notes:

1. Values derived from Table 3 in EPA (2005a)
2. Sampling for organochlorine pesticides will only be undertaken if these contaminants are above detection in annual comprehensive treated wastewater characterisation.

3.3 EQS Monitoring and Management Response Actions

Table 7: EQS monitoring and management against EQO 1

EQS 1:	**The EQS is exceeded if, after full suite WET testing:** $\frac{\text{DALEPA}}{\text{DR99\%BurrliOZ}}$ **<1.0**			
Indicator	**Method – full suite WET testing**	**Location**	**Frequency**	**Management Response Actions**
Toxicants in Treated Wastewater: • Full suite whole of effluent toxicity (WET) testing	ANZECC/ARMCANZ (2000) guidelines require the use of a suite of chronic tests using five different species (from four different taxonomic groups, and including at least one fish and shellfish test) to obtain reliable trigger values that can be used to decide whether effluent discharge represents sufficient environmental risk to warrant further investigation. A variety of test statistics, including NOEC, LOEC, EC/IC10 and EC/IC50 values will be generated from the proposed tests to determine (in discussion with the OEPA) which derivation protocol will be used to obtain a reliable guideline to ensure a high level of ecological protection outside the mixing zone, considering the level of dilution that occurs. It will therefore be important to ensure that the test statistics generated are as accurate as possible via careful choice of the test concentrations used. The full suite of WET test will use a selection of five of the following available tests (brief methodology of each test included in Appendix A). The WET tests are all chronic short-term tests using a sub-lethal endpoint: • Microtox test • Algal growth inhibition test (*Nitzschia closterium* and *Isochrysis* sp.) • Copepod 21-28 day reproduction test • Fish 7-day larval growth test • *Ecklonia* (macroalgae) 48-hour germination test • Mussel larval development test • Sea urchin fertilisation test and • Doughboy scallop 48-hour larval development test Samples of treated wastewater will be collected from the Alkimos WWTP, stored and transported according to the protocols stipulated by the relevant NATA-accredited laboratories. Seawater will also be provided for use as the dilution water in the WET test. The dilutions of wastewater used will typically be 0.5%, 6.25%, 12.5%, 25%, 50% and 100%, but may vary slightly for each WET test. All test dilutions for wastewater will be salt-adjusted (using artificial sea salts) to achieve marine salinities, so that only the toxicity due to the presence of contaminants is examined, not the toxic effect of freshwater on the marine organism. Testing will also be undertaken on a seawater 'control', and an artificial sea salt (brine) control.	Alkimos WWTP final effluent sampling point	Full suite WET testing shall be undertaken if there is an exceedance of the following EQGs: • EQG 1: treated wastewater characterisation – bioaccumulating toxicants • EQG 2: treated wastewater characterisation – non-bioaccumulating toxicants • EQG 3: total toxicity; or • EQG 4: WET testing.	Water Corporation will report the exceedance to the OEPA and DER within one (1) working day of determining that this has occurred. Undertake a toxicity reduction evaluation to identify the contaminant(s) of concern and the management required to reduce them to acceptable levels. This would include a detailed examination of the treated wastewater and potentially include a Stage 1 toxicity identification evaluation. Management measures to reduce the contaminant(s) of concern will be implemented, along with monitoring to confirm that the required results are being achieved. The monitoring could include wastewater characterisation, further WET tests, and *in situ* monitoring, subject to further consultation with the OEPA. Additional response measures may include modifying the diffuser to increase dilutions. See also Contingency Wastewater Management Plan (Appendix B)

EQS 2:	The ambient value of defined area during non-river flow period for light attenuation not to exceed 80th percentile of reference sites data.			
Indicator	**Method – Nutrient Enrichment (Light attenuation coefficient)**	**Location**	**Frequency**	**Management Response Actions**
Receiving water physico-chemical stressors: • Nutrient enrichment	All field sampling will be conducted in accordance with the EPA's (2005b) *Manual of Standard Operating Procedures*. To correct for ambient conditions, light attenuation measurements will be conducted simultaneously at two (2) locations - with one sensor positioned 1 m below the surface and the second approximately 7 m below the surface. Light Attenuation Coefficient (LAC) is calculated as the difference between the logarithim$_{10}$ of irradiance values at each depth according to the equation: $LAC = log_{10}I_1 - log_{10}I_7 \div 6$ Note: salinity, temperature and dissolved oxygen (DO) depth profiles will also be undertaken using an approved and calibrated water quality sensor to aid in data interpretation.	Sampling will be undertaken at compliance, contextual and reference sites (see Figure 4). For compliance monitoring, sampling is to be undertaken at the boundary of the LEPA (~100 m down-current), with additional contextual monitoring to be undertaken at distances 0, 390, 1000 and 1500 m down-current of the outfall. The four reference sites are positioned approximately 4,000 m south of the outfall, beyond the influence of both Alkimos WWTP and Beenyup WWTP discharges.	LAC testing will be undertaken concurrently with nutrient enrichment (chlorophyll *a*) monitoring (see Table 4). Assessment against the EQS will proceed if there is an exceedance of EQG 5 – Nutrient Enrichment (chlorophyll *a*).	Water Corporation will report the exceedance to the OEPA and DER within one (1) working day of determining that the exceedance has occurred. A management response will be initiated in consultation with the OEPA and other relevant regulatory agencies to investigate potential effects on algal community structure and whether it has shifted by a margin beyond that expected due to natural processes alone. This will involve an assessment of algal biochemical and community composition. Response measures may also include modifying the diffuser to increase dilutions. See also Contingency Wastewater Management Plan (Appendix B)
EQS 3:	**To exceed the EQS, either Trigger A or Trigger B must be exceeded and one or more of the applicable Triggers C – F must be exceeded:** **A. The 80th percentile of bioavailable metal or metalloid concentrations (e.g. dilute acid extractable metals, SEM/AVS analysis) from the defined sampling area should not exceed the EQG.** **B. The median bioavailable concentration for non-metallic contaminants (e.g. OC normalisation) from the defined sampling area should not exceed the EQG.** **C. The 95th percentile of bioavailable contaminant concentrations in porewater samples from the defined sampling area should not exceed high protection water quality guideline values (Table 2a of EPA EQC Reference document).** **D. Sediment toxicity tests should not result in a statistically significant effect (P < 0.05) on sub lethal chronic or lethal acute endpoints for any species, compared to a matched reference sediment.** **E. No significant change in any biological or ecological indicator beyond natural variation that can be demonstrably linked to a contaminant.** **F. Where TBT concentrations exceed the guideline the incidence of imposex in *Thais orbita* should be ≤5%.** **G. The median tissue concentration of chemicals that can adversely bioaccumulate or biomagnify should not exceed the 80th percentile of tissue concentrations from a suitable reference site.**			
Indicator	**Method – sediment monitoring**	**Location**	**Frequency**	**Management Response Actions**
Toxicants in Sediments: • Sediment monitoring	Methodology is to be undertaken in accordance with the EPA's Environmental Quality Criteria Reference Document for Cockburn Sound (2015b), in consultation with the EPA.	To be determined in consultation with the EPA.	Sediment monitoring shall be undertaken if there is an exceedance of EQG 6: Toxicants in Sediments	Water Corporation will report the exceedance to the OEPA and DER within one (1) working day once determining that the exceedance has occurred. The proposed management response based on an exceedance of the EQS includes: 1. Undertaking a toxicity reduction evaluation to identify the contaminant(s) of concern and the management required to reduce them to acceptable levels. This would include a detailed examination of the treated wastewater and potentially include a Stage 1 toxicity identification evaluation. 2. Management measures to reduce the contaminant(s) of concern will be implemented, along with monitoring to confirm that the required results are being achieved. The monitoring could include wastewater characterisation, further WET tests, and in situ monitoring, subject to further consultation with the OEPA. Additional response measures may include modifying the diffuser to increase dilutions. See also Contingency Wastewater Management Plan (Appendix B)

4. MTWDMMP Provisions: Maintenance of Aquatic Life for Human Consumption (EQO 2)

This section identifies the legal provisions that Water Corporation proposes to implement to meet EQO 2 – Maintenance of Aquatic Life for Human Consumption. It identifies the environmental quality criteria (EQC) that Water Corporation will use to measure performance, as well as monitoring that will be undertaken in relation to these EQC and the management response actions that Water Corporation will undertake in the event that the EQC are exceeded. These MTWDMMP provisions aim to fulfil the requirements of conditions 11-3.3 – 3.6 of MS 755.

EQO 2 is aimed at ensuring that effluent discharge will not affect the human consumption of aquatic life within the surrounding waters of the Alkimos ocean outlet. The EQC for EQO 2 are considered protective of wild seafood populations from the effects of environmental contamination (Government of Western Australia 2005).

Schedule 1 of MS 755 stipulates the area around the ocean outfall in which it is not safe to harvest seafood. This area is depicted as the S2 zone as shown in Figure 6. In 2011, the Department of Health (DoH) recommended the inclusion of monitoring sites at 2450 m and 2800 m along the ocean outlet pipeline, due to concerns that the air release ports at these locations will, while operational, release air and small volumes of TWW to the surrounding water column.

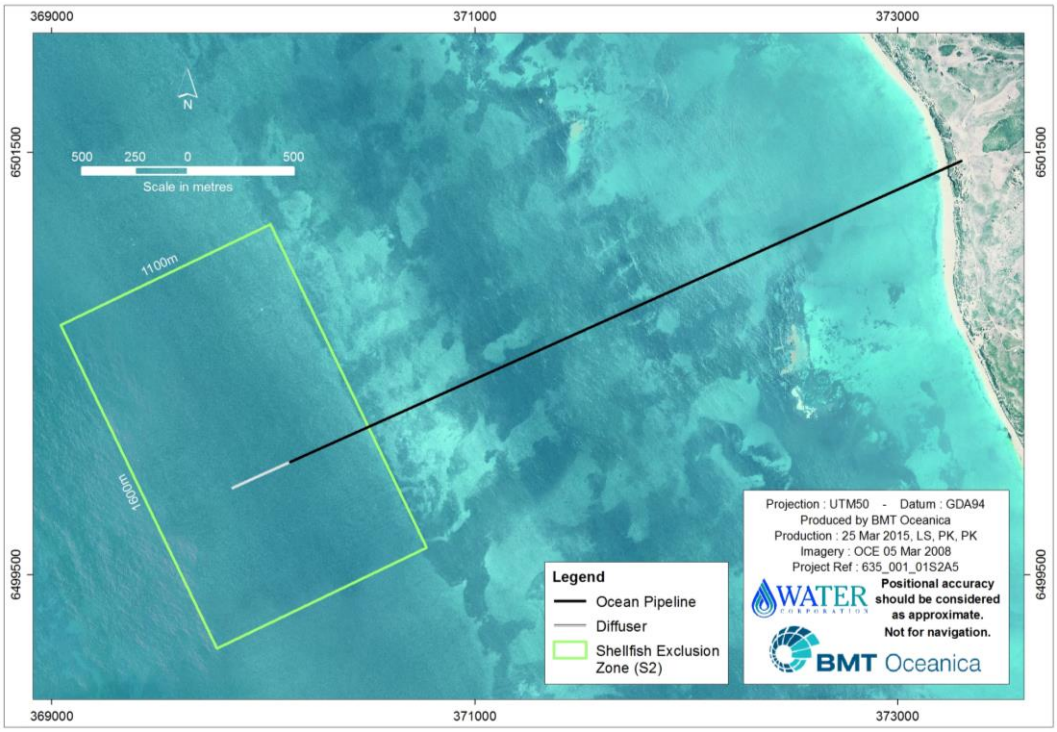

Figure 6: Zone S2 boundary surrounding the Alkimos ocean outfall

4.1 Environmental Quality Criteria

Table 8: Environmental quality criteria for EQO 2

Environmental Indicator	ENVIRONMENTAL QUALITY CRITERIA (EQC)	
	Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
Thermotolerant coliforms (TTC)	**EQG 1:** The median thermotolerant faecal coliform bacterial concentration should not exceed 14 CFU/100 mL, with no more than 10% of the samples exceeding 21 CFU/100 mL measured using the membrane filtration method.	**EQS 1:** Median thermotolerant coliform counts at sites at the boundary of the S2 zone not to exceed 2.3 MPN *E.coli*/g of flesh (wet wt.) in four out of five representative samples, and the fifth sample should not exceed 7 MPN *E. coli*/g of flesh (wet wt.), with a maximum total plate count of 250 000 organisms/g (EPA 2005).

4.2 EQG Monitoring and Management Response Actions

Table 9: EQG monitoring and management against EQO 2

EQG 1:	The median thermotolerant faecal coliform bacterial concentration should not exceed 14 CFU/100 mL, with no more than 10% of the samples exceeding 21 CFU/100 mL measured using the membrane filtration method.			
Indicator	Method – TTC counts in water	Location	Frequency	Management Response Actions
Thermotolerant coliforms (TTC)	The monitoring of TTC encompasses two components; monitoring within the S2 zone; and monitoring above air release ports. Samples will be collected in pre-sterilised bottles before being chilled in the dark to 4°C. Samples will then be transferred to a laboratory (e.g. Pathwest) and analysed according to NATA-accredited methods. *Monitoring within S2 zone:* As we are assessing contamination of bottom-dwelling marine organisms, sampling in the S2 zone will be collected at the bottom of the seafloor. Sampling will be undertaken for both compliance and contextual purposes. The collection of contextual data recognises that contaminants are more likely to be detected near the outfall than at the boundaries of the S2 zone, and this approach serves as an early warning system to determine the extent of contaminant concentrations under both current and future TWW flows. *Monitoring above air release ports:* Sampling for air release port monitoring will be taken immediately above each port.	*Sampling within S2 zone:* For compliance monitoring, sampling will be undertaken at one site at the S2 boundary (Figure 7). The site of monitoring will be determined based on the direction of the prevailing current, as determined by a surface drogue. For contextual monitoring, data will be collected at a series of dynamic sites located down-current of the ocean outfall, at 0, 100 and 390 m intervals (Figure 7). *Sampling above air release ports:* For the air release port monitoring, sampling will be undertaken at two sites - 2450 m (AR1) and 2800 m (AR2) along the ocean outlet pipeline, immediately above the air release points (see Figure 8).	*Sampling within S2 zone:* In water measures of TTC will be conducted annually, at approximately fortnightly intervals over the summer period (December-March). *Sampling above air release ports:* For sampling above air release ports, monitoring will be restricted to when the ports are open. If the ports are opened for only short periods (i.e. hours), and if these occasions are during the summer period, then monitoring will be conducted on the day the ports are opened. If the air release ports are opened permanently, monitoring will be conducted as per S2 zone monitoring.	Water Corporation will report the exceedance to the OEPA, DoH and DER within one (1) working day of determining that the exceedance has occurred. Assessment against the EQS 1: Sentinel mussel monitoring will commence.

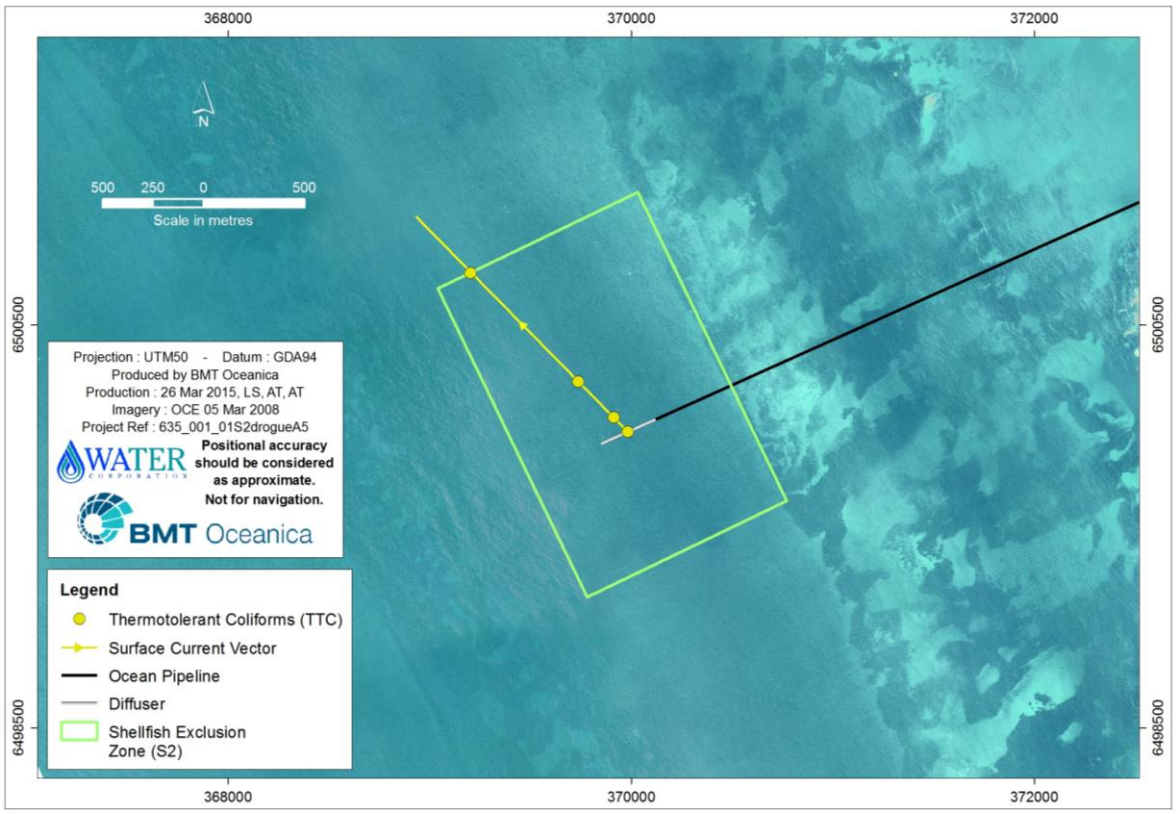

Figure 7: Thermotolerant coliform monitoring sites within zone S2

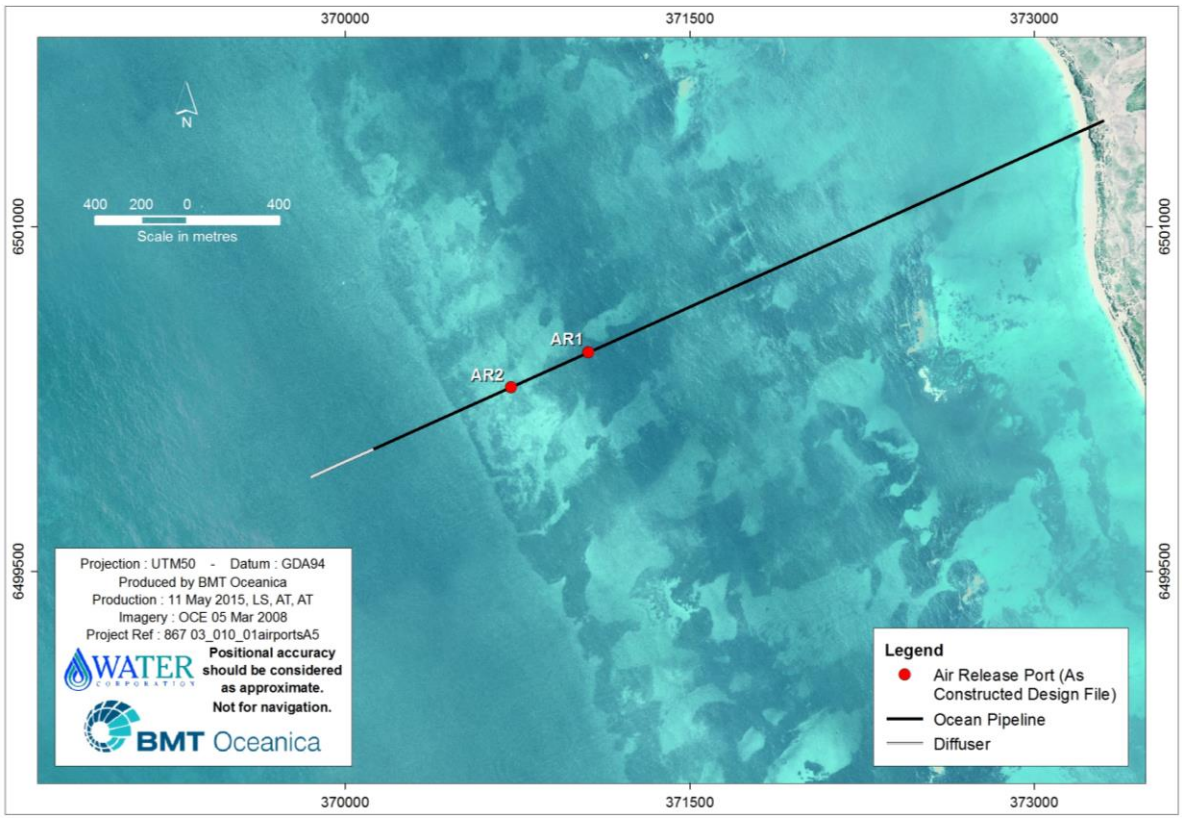

Figure 8: Thermotolerant coliform monitoring sites over air release ports

4.3 EQS Monitoring and Management Response Actions

Table 10: EQS monitoring and management against EQO 2

EQS 1:	**Median thermotolerant coliform counts at sites at the boundary of the S2 zone not to exceed 2.3 MPN E.coli/g of flesh (wet wt.) in four out of five representative samples, and the fifth sample should not exceed 7 MPN E. coli/g of flesh (wet wt.), with a maximum total plate count of 250 000 organisms/g (EPA 2005).**			
Indicator	**Method – sentinel mussel monitoring**	**Location**	**Frequency**	**Management Response Actions**
Thermotolerant coliforms	At each of the monitoring sites, three replicate mussel lines will be deployed. On each line, mussels will be suspended in mesh baskets 2-3 m below the surface and at the height of the reef surface. Mussels of uniform size will be obtained from commercially cultured stocks. The use of a consistent size of mussel reduces any influence of mussel size on bioaccumulation of contaminants. Mussels will be deployed for approximately six-weeks with mussels and mesh baskets cleaned after three weeks to prevent the accumulation of algal growth which could smother and kill the mussels. Mussels have been shown to equilibrate with environmental conditions after four weeks (Regoli & Orlando 1994). After the six week deployment period, the mussels will be retrieved and the number of live mussels recorded. The live mussels will be placed into sterile bags and kept on ice while in transit to the NATA-accredited analytical laboratory. Mussels from the same batch deployed on the mussel lines will be stored frozen prior to analysis to provide an indication of the initial toxicant load of the mussels. These will be the 'control' mussels.	Mussel deployment sites will be located above suitable reef habitat in close proximity to the S2 zone boundary (Figure 9), as well immediately above the air release ports (Figure 8).	The concentration of *E.coli* in the flesh of sentinel mussels will be measured following an exceedance of EQG 1: Thermotolerant coliforms.	Water Corporation will notify DoH, the DER and the OEPA within one (1) working day of determining that the exceedance has occurred. Management actions will be taken to reduce the concentration to a level where the EQO is achieved, and will include: • An investigation into the conditions prevailing (metocean conditions and plant operations) during the summer period; and • Development of a management response on advice of the DoH and in consultation with the OEPA, considering all relevant information collected. Additional response measures may include modifying the diffuser to increase dilutions. See also Contingency Wastewater Management Plan (Appendix B)

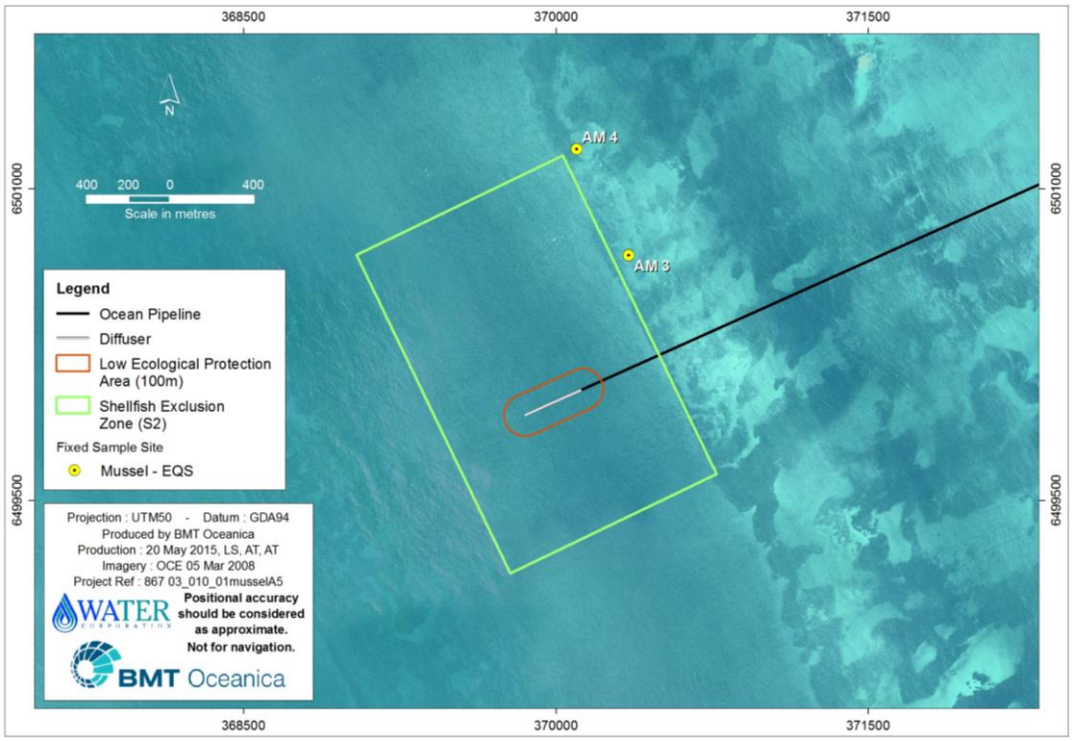

Figure 9: Sentinel mussel monitoring deployment sites

5. MTWDMMP Provisions: Maintenance of Primary and Secondary Contact Recreation (EQO 3 & 4)

This section identifies the legal provisions that Water Corporation proposes to implement to meet EQO 3 & 4 – Maintenance of Primary and Secondary Contact Recreation. It identifies the EQC that will be used to measure performance, as well as monitoring that will be undertaken in relation to these EQC and the management response actions that will be implemented in the event that the EQC are exceeded. These MTWDMMP provisions aim to fulfil the requirements of conditions 11-3.3 – 3.6 of MS 755.

EQOs 3 & 4 are aimed at ensuring coastal waters are safe for primary and secondary contact recreation activities such as swimming and boating.

Schedule 1 of MS 755 stipulates the area around the ocean outfall in which it is not safe for primary contact recreation. This area is depicted as the S3 zone in Figure 10. In 2011, the Department of Health (DoH) recommended the inclusion of monitoring sites at 2450 m and 2800 m along the ocean outlet pipeline, due to concerns that the air release ports at these locations will, while operational, release air and small volumes of TWW to the surrounding water column.

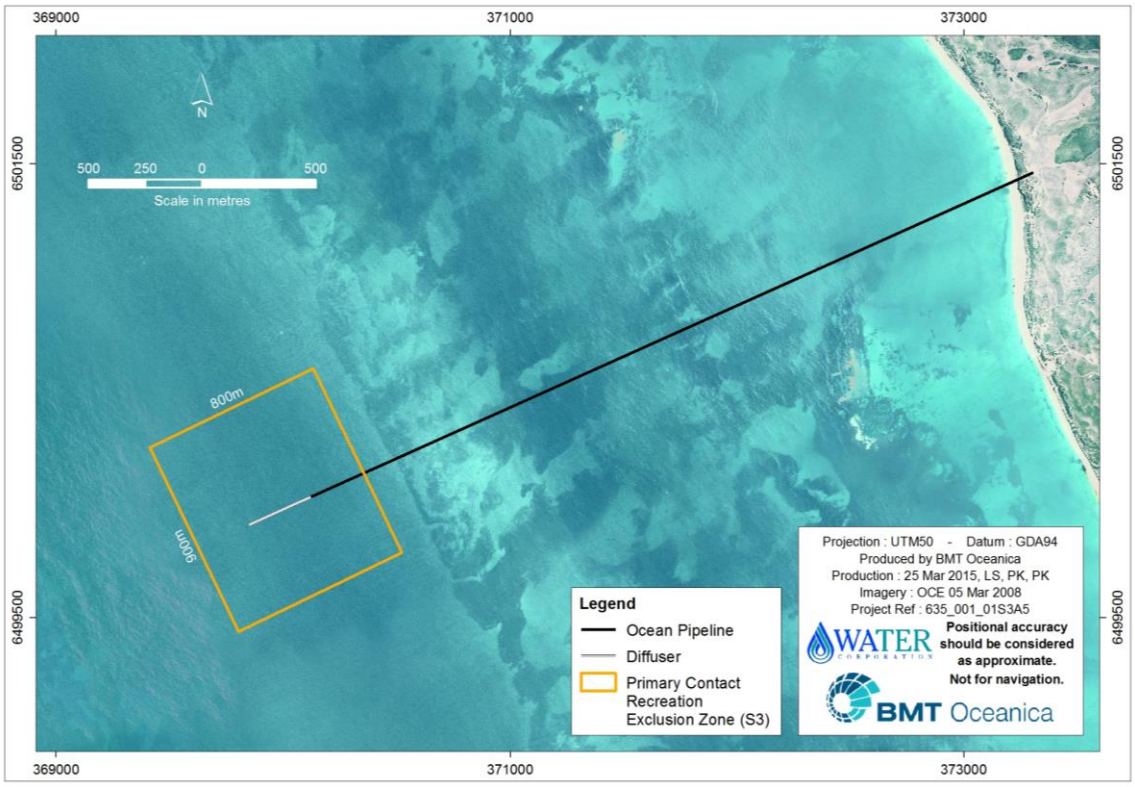

Figure 10: Zone S3 boundary surrounding Alkimos ocean outfall

5.1 Environmental Quality Criteria

Table 11: Environmental quality criteria for EQO 3 & 4

Environmental Indicator	ENVIRONMENTAL QUALITY CRITERIA (EQC)	
	Environmental Quality Guideline (EQG)	Environmental Quality Standard (EQS)
Faecal pathogens	**EQG 1:** The maximum value of the pooled *Enterococci* spp. must not exceed the NHMRC 'category A' guideline value (≤40 *Enterococci* spp. MPN/100 ml) for recreational water bodies (refer to Table 5.13 in NRMHC 2008).	**EQS 1:** The 95th percentile value of the pooled *Enterococci* spp. data must not exceed the upper NHMRC 'category A' value (≤40 *Enterococci* spp. MPN/100 ml).

5.2 EQG Monitoring and Management Response Actions

Table 12: EQG monitoring and management against EQO 3 & 4

EQG 1:	The maximum value of the pooled Enterococci spp. must not exceed the NHMRC 'category A' guideline value (≤40 Enterococci spp. MPN/100ml) for recreational water bodies (refer to Table 5.13 in NRMHC 2008).			
Indicator	Method – *Enterococci* counts	Location	Frequency	Management Response Actions
Faecal pathogens	The monitoring of faecal pathogens encompasses two components; monitoring within the S3 zone; and monitoring above pipeline air release ports. Depth-integrated samples will be collected at the surface of the water column at each of the monitoring sites. Samples will be collected in pre-sterilised 250 ml bottles and analysed for faecal streptococci (as *Enterococci* spp.). Samples will be chilled to 4°C and placed in the dark. Sample analysis will be carried out by NATA-accredited Laboratories. The S3 zone monitoring program will include sampling for both compliance and contextual purposes. The collection of contextual data recognises that contaminants are more likely to be detected near the outfall than at the boundaries of the S3 zone. This approach doubles as an 'early warning' sentinel of the extent of contaminant gradients under existing TWW flows and the extent to which contaminant concentrations may increase over time, particularly as TWW flows increase.	*Sampling within S3 zone:* For compliance monitoring, samples will be collected at one site at the S3 boundary (Figure 11). The site of monitoring will be determined based on the direction of the prevailing current, as determined by a surface drogue. For contextual monitoring, data will be collected at a series of dynamic sites located down-current of the ocean outfall, at 0, 100 and 390 m intervals (Figure 11). *Sampling above air release ports:* Sampling will be undertaken at two sites - 2450 m (AR1) and 2800 m (AR2) along the ocean outlet pipeline (see Figure 12)	*Sampling within S3 zone:* Sampling will commence in the first week of summer and continue at fortnightly intervals during the summer months between December and March. *Sampling above air release ports:* Monitoring will be restricted to when the ports are open. If the ports are opened for only short periods (i.e. hours), and if these occasions are during the summer period, then monitoring will be conducted on the day the ports are opened. If the ports are opened permanently, monitoring will be conducted as per S3 zone monitoring above.	Water Corporation will report the exceedance to the OEPA, DoH and DER within one (1) working day of determining that the exceedance has occurred. Assessment against EQS 1: *Enterococci* counts will commence.

5.3 EQS Monitoring and Management Response Actions

Table 13: EQS monitoring and management against EQO 3 & 4

EQS 1:	The 95th percentile value of the pooled Enterococci spp. data must not exceed the upper NHMRC 'category A' value (≤40 Enterococci spp. MPN/100ml).			
Indicator	Method – *Enterococci* counts	Location	Frequency	Management Response Actions
Faecal pathogens	As per Table 12 above.	As per Table 12 above.	The EQS will be measured following an exceedance of EQG 1: *Enterococci* counts	Water Corporation will report the exceedance to the OEPA, DoH and DER within one (1) working day of determining that the exceedance has occurred. A management response will be determined based on DoH advice in consultation with the OEPA. Management actions will be taken to reduce the concentration to a level where the EQOs are achieved. Additional response measures may include modifying the diffuser to increase dilutions. See also Contingency Wastewater Management Plan (Appendix B)

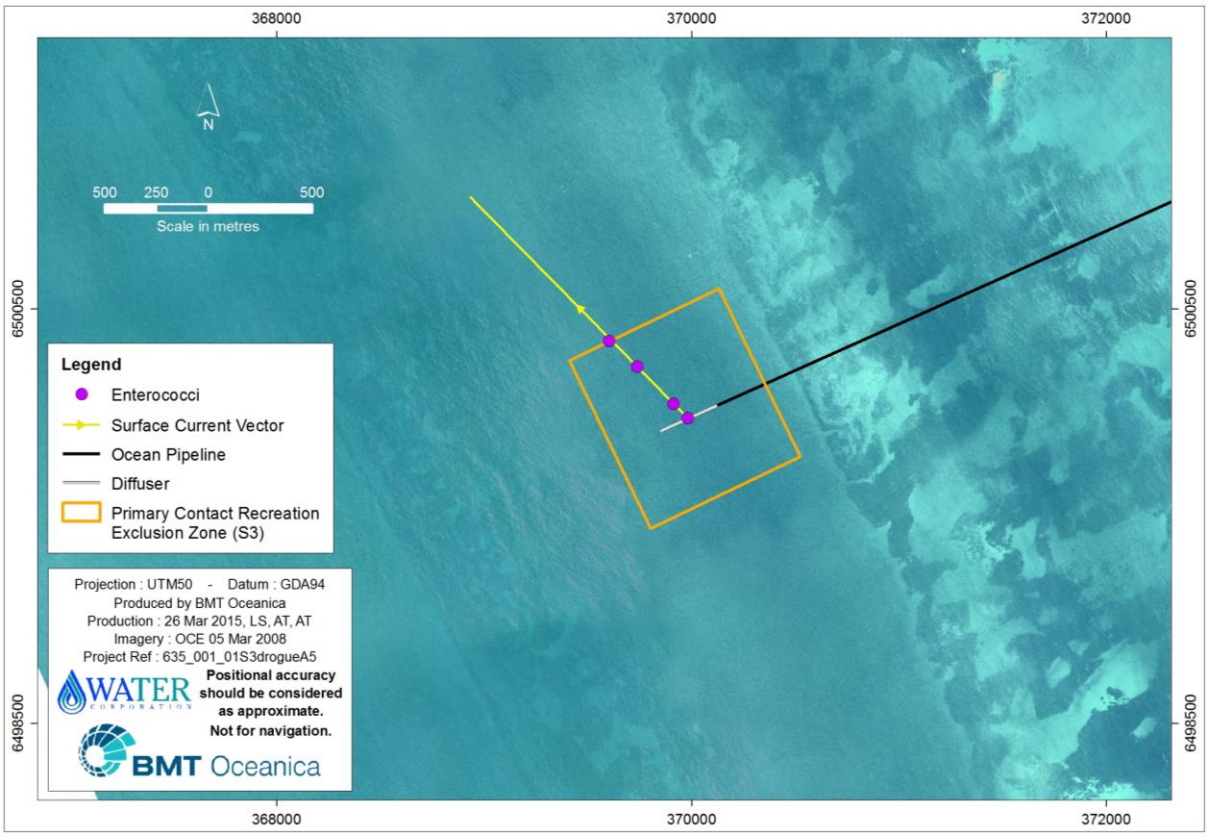

Figure 11: *Enterococci* monitoring sites in Zone S3

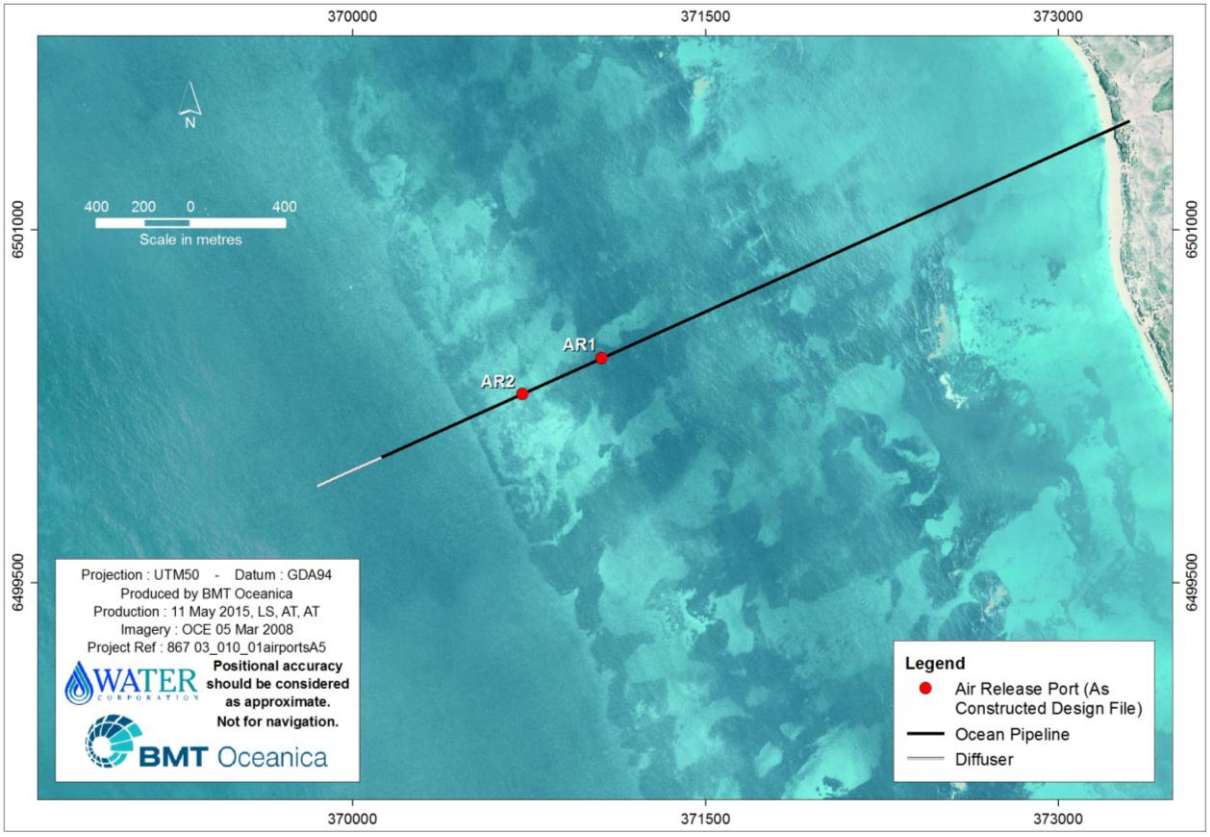

Figure 12: *Enterococci* monitoring sites over air release ports

6. MTWDMMP Provisions: Diffuser Performance

Condition 11-3.8 of MS 755 outlines Water Corporation's commitment to monitor and report diffuser performance under low energy/calm meteorological and sea state conditions. The objective of verification is to determine whether the diffuser is meeting its projected initial dilution performance (average 1:300) and further, whether it is achieving the required number of dilutions at the LEPA boundary (1:200 99% of the time) as specified in Schedule 1 of MS 755. These MTWDMMP provisions aim to fulfil the requirements of conditions 11-3.8 of MS 755.

Methodology

The speed and trajectory of the TWW plume will be determined by the deployment of six surface drogues at time-based intervals. The concentration of a suitable tracer will be determined at a number of sites downstream of the outlet diffuser. These data will be used in conjunction with CTD profiles to determine the actual rate of dilution by the diffuser.

Four CTD profiles will also be obtained at reference sites. Reference sites will be chosen based on similar depth profiles, and will be representative of ambient conditions at the time of the survey and enable comparisons between the potential impact location and the reference sites.

The diffuser performance is verified in terms of dilution and contaminants at the boundary of the LEPA using initial dilution modelling, which predicts the performance of the diffuser and the extent of dilution around the outlet given the TWW and ambient environmental conditions at the time of the survey. Results of TWW analyses contaminants (see section 3.2) are also used for the diffuser performance verification for the current sampling year.

The initial dilution model set-up parameters include:

- Diffuser characteristics: port diameter, number of open ports, port spacing, diffuser pipe diameter, port orientation and water depth;
- Ambient conditions at the time of sampling: temperature, salinity, current speed and current direction; and
- Discharge characteristics: flow rate, temperature and salinity.

This information will be used to model the average and centreline initial dilution.

The results of the diffuser performance verification will be used in accordance with Schedule 1 of MS 755 to determine whether the average dilution of the wastewater stream in the ocean is at least 1:300, with the dilution being above 1:200 99% of the time within 100 m of the diffuser.

Frequency

Verification of diffuser performance will be undertaken 3 months following post process stabilisation, every five years thereafter, or following substantial changes in flow or material process. Initial dilution modelling will be undertaken at the same time as diffuser performance verification.

7. Reporting Provisions

7.1 Annual Reporting

Condition 11-3 of MS 755 requires the MTWDMMP to include protocols and schedules for reporting performance against the EQOs.

EQOs will be reported against the EQC (using Table 14) for the period 1 July to 30 June in the annual Environmental Compliance Report (ECR), submitted to the OEPA by 30 September each year (as per requirements of MS 755 condition 4).

In the event that EQC were exceeded during the reporting period, the annual ECR will include a description of the effectiveness of any management response actions that have been implemented to manage the impact, as well as an analysis of trends.

7.2 Reporting on exceedance of EQC

In the event of exceedance of any EQG or EQS, Water Corporation will notify the OEPA in writing within one (1) working day of determining that the exceedance has occurred, as well as reporting the exceedance in the annual ECR.

7.3 Public Availability of Documents

- In accordance with condition 4-4 of MS 755, Water Corporation will make annual ECRs publicly available on its website.
- In accordance with condition 11-5 of MS 755, Water Corporation will make this MTWDMMP publicly available on its website.
- In accordance with condition 11-15 of MS 755, Water Corporation will make the Contingency Wastewater Management Plan (Appendix B) publicly available on its website.

Table 14: Condition MTWDMMP Reporting Table

Environmental Quality Objective 1: Maintenance of Ecosystem Integrity		
EQC set in MTWDMMP	**Report on EQC for July [xx] to June [xx]**	**Status**
[insert EQG]	*[insert results for EQG]*	*[insert symbol]*
[insert EQS] (if required)	*[insert results for EQS] (if required)*	*[insert symbol] (if required)*
Environmental Quality Objective 2: Maintenance of Aquaculture for Human Consumption		
EQC set in MTWDMMP	**Report on EQC for July [xx] to June [xx]**	**Status**
[insert EQG]	*[insert results for EQG]*	*[insert symbol]*
[insert EQS] (if required)	*[insert results for EQS] (if required)*	*[insert symbol] (if required)*
Environmental Quality Objective 3 & 4: Maintenance of Primary and Secondary Contact Recreation		
EQC set in MTWDMMP	**Report on EQC for July [xx] to June [xx]**	**Status**
[insert EQG]	*[insert results for EQG]*	*[insert symbol]*
[insert EQS] (if required)	*[insert results for EQS] (if required)*	*[insert symbol] (if required)*

Note: The status of achievement of environmental criteria is indicated by the following symbols:

Monitor: EQG met, continue monitoring (no assessment against EQS necessary).	
Investigative: EQG not met, EQS met	
Action: EQS not met, management response required	

8. Adaptive Management and Review of MTWDMMP

Water Corporation will also implement adaptive management to learn from the implementation of mitigation measures, monitoring and evaluation against EQG and EQS, to more effectively meet the condition EQOs. As such, a number of scheduled reviews and revisions of the ocean monitoring and management program will be undertaken.

8.1 General revision

Review and revision of this MTWDMMP will be undertaken by Water Corporation as required to incorporate the results of monitoring and/or further knowledge obtained on best practice environmental management for the operation of wastewater treatment plants and associated wastewater discharge into marine environments. If any significant changes are required, a revised MTWDMMP will be resubmitted to the OEPA (and other relevant authorities) for approval.

In anticipation of future population growth in the northern urban corridor, a review will be undertaken following major increases in operational capacity, the addition of new effluent streams, or process changes that may materially alter the composition of TWW discharge. The scale and frequency of monitoring will be reviewed in consultation with the OEPA and other relevant authorities.

8.2 Mid-term review

A condition of OEPA approval was that a mid-term review of the MTWDMMP be undertaken. The purpose of the review is to ensure that the MTWDMMP is achieving its objectives and that the EQO are being met. The review specifically aimed to evaluate the results of the algal growth monitoring data collected over two full cycles of the temporal component of the EQS, which is presently set as three years. The review assessed the appropriateness of the interim EQC and where necessary, informed the development of a new MTWDMMP. The mid-term review was completed in 2015, and this current MTWDMMP has incorporated the results and recommendations arising from the review.

8.3 Ten-year review

A major review is scheduled for 2020, when the plant is tentatively expected to be upgraded to 20 ML/d capacity. Following this period, Water Corporation will undertake a comprehensive review in consultation with the OEPA and other relevant regulatory authorities. On advice from the OEPA, a revised MTWDMMP may be prepared and implemented.

8.4 Performance Review

Condition 5 of MS 755 requires Water Corporation to undertake a performance review every five years after the start of construction. This review shall assess;

- The major environmental issues associated with implementing the project;
- The level of progress in the achievement of sound environmental performance;
- Investigations undertaken in relation to developing alternative TWW disposal options;

- Significant improvements gained in environmental management;
- Stakeholder and community consultation; and
- The proposed environmental objectives over the next five years, including improvements in technology and management processes.

The findings from this five-yearly performance review may be incorporated into a revised MTWDMMP, as appropriate and in consultation with the OEPA and other relevant authorities.

9. Stakeholder Consultation

Consistent with the EPA's expectations for this MTWDMMP to align with the principles of Environmental Impact Assessment (EIA), Water Corporation extensively consulted with stakeholders while developing the MTWDMMP. The comments raised during consultation with stakeholders were considered in the original development of the MTWDMMP, and are available upon request.

10. References

ANZECC & ARMCANZ 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, National Water Quality Management Strategy No. 4 & 7.

Brown, V 1968, *'The calculation of acute toxicity of mixtures of poisons to rainbow trout', Water Research*, vol. 2, pp. 723-733.

Chen, S 2005, 'Ecological risk assessment for aquatic species exposed to contaminants in Keelung River, Taiwan', *Chemosphere*, vol. 61, pp. 1142-1158.

Elliot, EL & Colwell, RR 1985, 'Indicator organisms for estuarine and marine waters', *Federation of European Microbiological Societies Microbiology Reviews,* vol. 32, pp. 61–79.

English, S, Wilkinson, C & Baker, V 1994, *Survey manual for tropical marine resources,* Australian Institute of Marine Science.

EPA 2000, *Perth Coastal Waters – Environmental Values and Objectives – the position of the EPA – a working document*, Environmental Protection Authority, Perth, Western Australia.

EPA 2005a, *Environmental Quality Criteria Reference Document for Cockburn Sound (2003–2004) – A supporting document to the State Environmental (Cockburn Sound) Policy 2005,* Environmental Protection Authority, Report No 20, Perth, Western Australia.

EPA 2005b, *Manual of Standard Operating Procedures - For Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (2003 - 2004) - A supporting document to the State Environmental (Cockburn Sound) Policy 2005*, Prepared by Environmental Protection Authority, Report no. 21, Perth, Western Australia.

EPA 2006, *Alkimos Wastewater Treatment Plant Site B (Assessment 1529) - Report and recommendations of the Environmental Protection Authority,* Environmental Protection Authority, Perth, Western Australia.

EPA 2015a, *Environmental Assessment Guideline for Protecting the Quality of Western Australia's Marine Environment (EAG 15),* Environmental Protection Authority, Perth, Western Australia.

EPA 2015b, *Environmental Quality Criteria Reference Document for Cockburn Sound – A supporting document to the State Environmental (Cockburn Sound) Policy 2005*, prepared by Environmental Protection Authority, Perth, Western Australia.

Gartner, A, Lavery, P & Smith, AJ 2002, 'Use of δ15N signatures of different functional forms of macroalgae and filter-feeders to reveal temporal and spatial patterns in sewage dispersal', *Marine Ecology Progress Series,* vol. 235, pp. 63–73.

Government of WA 2005, *State Environmental (Cockburn Sound) Policy 2005*, prepared by Government of Western Australia, Perth, Western Australia.

Littler, M & Littler, D 1980, 'The evolution of thallus form and survival strategies in benthic marine macroalgae: field and laboratory tests of a functional form model', *American Naturalist,* vol. 116, pp. 25–44.

References

NHMRC 2008, *Guidelines for Managing Risks in Recreational Water*, National Health and Medical Research Council, Canberra, ACT.

Oceanica 2005, *Alkimos Marine Studies Programme Detailed Project Brief: Sediment Survey*, Prepared for Water Corporation of Western Australia by Oceanica Consulting Pty Ltd, Report No. 427/8, Perth, Western Australia.

Oceanica 2009, *Alkimos Wastewater Treatment Plant. Establishment of indicators and triggers for nutrients: Proposal to meet Condition M11:3.3 of Ministerial Statement 755*, prepared for Water Corporation by Oceanica Consulting Pty Ltd, Report no. 636_001/1, Perth, Western Australia.

Oceanica 2011, *Alkimos Wastewater Treatment Plant – Marine Treated Wastewater Discharge Monitoring and Management Plan (2010 to 2020)*, prepared for Water Corporation by Oceanica Consulting Pty Ltd, Report No. 635_001/1, Perth, Western Australia.

Pattiaratchi, C & Knock, C 1995, *Perth Coastal Waters Study – Model Tuning and Validation,* prepared for Water Authority of Western Australia by Centre for Water Research University of Western Australia, Perth, Western Australia.

Regoli, F & Orlando, E 1994, 'Accumulation and subcellular distribution of metals (Cu, Fe, Mn, Pb and Zn) in the Mediterranean mussel *Mytilus galloprovincialis* during a field transplant experiment', *Marine Pollution,* Bulletin 28, pp. 592–600.

Rogers, K 2003, 'Stable carbon and nitrogen isotopes signatures indicate recovery of marine biota from sewerage pollution at Moa point New Zealand', *Marine Pollution*, Bulletin 46, pp. 821–827.

Steneck, R & Dethier, M 1994, 'A functional group approach to the structure of algal-dominated communities', *Oikos*, vol. 69, pp. 476–498.

Underwood, AJ 1991, 'Beyond BACI: experimental designs for detecting human environmental impacts on temporal variations in natural populations', *Australian Journal of Marine and Freshwater Research*, vol. 42, pp. 569–587.

Underwood, AJ 1992, 'Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world', *Journal of Experimental Marine Biology and Ecology*, vol. 161, pp. 145–178.

Underwood, AJ 1994, 'On Beyond BACI: sampling designs that might reliably detect environmental disturbances', *Ecological Applications*, vol. 4, pp. 3–15.

Water Corporation 2005, *Alkimos Wastewater Treatment Plant - Public Environmental Review*, prepared by Water Corporation of Western Australia, Leederville, Western Australia.

Appendix A – Full Suite WET Testing Methodology

1. Microtox Test

The Microtox test involves the use of luminescent bacteria, *Vibrio fischeri*, to determine toxicity in environmental samples. Bacterial luminescence is directly related to cell respiration, and hence any toxicity that inhibits cellular activity results in a decreased rate of respiration and a corresponding decrease in the rate of luminescence. The test involves exposing the bacteria to selected concentrations of wastewater for 15 minutes. Luminescence is measured at the beginning (T0) and end (T15) in a Microtox Model M500 analyser and any decrease in cellular activity is calculated by comparing the two readings. Results are then used to calculate the NOEC, LOEC and EC50.

2. Algae growth inhibition test (Nitzschia closterium and Isochrysis sp.)

This test determines the inhibition and the stimulation of growth rate (expressed as cell yield) of the marine alga *Nitzschia closterium* and *Isochrysis* sp. over 72 hours. Known concentrations of the algae are added to the test chambers and dilute wastewater is added to the algae. The algae are incubated at 22°C for 72 hours. Growth is either measured by the amount of chlorophyll present (as absorbance at 750 nm wavelength) in the test chambers and comparing this to growth in the control chambers, or by cell density. The results are used to calculate the NOEC, LOEC and EC50.

3. Copepod 21–28 day reproduction test

This test uses copepods (*Gladioferens imparipes*) collected from the Swan River. The copepods are exposed to dilute wastewater as neonates. Mature copepods are then paired (male and female) and the number of offspring produced is recorded and compared to the controls. These results are used to calculate the NOEC, LOEC and EC50.

4. Fish 7-day larval growth test

This test is based on the growth of larval pink snapper (Pagrus auratus) after 7 days exposure to dilute wastewater. Larval pink snapper are placed in dilute wastewater and after 7 days the length of each larva is measured and compared to the growth of the controls. The NOEC, LOEC and EC50 are calculated.

5. *Ecklonia* (macroalgae) 48-hour germination test

This test uses a macroalgae (*Ecklonia radiata*) collected from an uncontaminated site, dried and then the gametes collected from the alga's blades. Male and female gametes are collected separately and placed together in selected concentrations of wastewater, left for 48 hours and then the percentage of zygotes with germination tubes are assessed. The percentages are compared with control results and the EC50, LOEC and NOEC are calculated.

6. Mussel larval development test

This test uses fertilised eggs obtained from adult molluscs (*Mytilus edulis*), induced to spawn as required, which are exposed to a series of concentrations of wastewater and allowed to

develop for 48 hours under controlled conditions. One hundred larvae are counted and the numbers of abnormal and normal larvae are recorded. Abnormal larvae are considered to be any larvae not exhibiting the classic D-shaped veliger. The percentages are compared with control results and the EC50, LOEC and NOEC are calculated.

7. Sea urchin fertilisation test

The sea urchin fertilisation test determines the success of sea urchin fertilisation over a 1-hour period using the gametes of the sea urchin *Heliocidaris tuberculata*. The sperm of the sea urchin are exposed to dilute wastewater for a 1 hour period and then added to an egg suspension. The fertilised eggs are counted and the percent fertilisation calculated. These results are used to calculate the NOEC, LOEC and EC50.

8. Doughboy scallop 48-hour larval development test

This test is a 48-hour larval development (abnormality) test that uses the gametes of *Mimachlamys (Chlamys) asperrima*. Fertilised eggs of the scallop are exposed to dilute wastewater for 48 hours. The larvae are then examined to determine the percentage of abnormal larvae. These results are used to calculate the NOEC, LOEC and EC50.

Appendix B – Contingency Wastewater Management Plan

1. Background

Condition 11.11 of MS755 requires the development of a Contingency Wastewater Management Plan that will consider alternate options for wastewater treatment and/or disposal in the event that the EQS are not met.

The Alkimos WWTP has been designed to meet best practice performance and based on these specifications, the Water Corporation expects to meet all environmental quality objectives. However, in the event that that an EQS is exceeded, management responses will be initiated in consultation with the OEPA and other relevant regulatory agencies to reduce the effect of TWW contaminants on the marine environment and restore environmental quality to comply with the specified level of ecological protection and nutrient and social quality objectives.

Examples of management steps may include:

- Increase diffuser capacity by opening additional ports;
- Increase the velocity of the treated wastewater flow (to increase rates of initial dilution);
- Increase the aeration capacity of the WWTP; and
- Modify the wastewater treatment process in accordance with best practicable measures at the time as defined in EPA Guidance for Implementing Best Practice in Proposals Submitted to the Environmental Impact Assessment Process # 55 (EPA 2003).

2. Contingency responses

Upon receipt of evidence that the relevant EQS has not been met, Water Corporation will implement the contingency management responses outlined in Table 15. Management responses are outlined for each of the relevant monitoring components.

Table 15: Contingency responses in the event that an EQS is exceeded

EQO 1- Maintenance of Ecosystem Integrity	
EQS	**Contingency management response**
EQS 1: The EQS will be exceeded if, following full suite WET testing: $\frac{DALEPA}{DR99\%BurrliOZ} \leq 1$	If the EQS is exceeded, it is deemed that there is a significant risk that the EQO may have been compromised. Management actions may include (a) the option of modifying the diffuser to increase dilution, such as utilising extra contingency ports, increasing the velocity of the wastewater stream and (b) identifying the source of the major contaminants with the intention of reducing their input and/or reducing their toxicity (using chemical means). It is noted that chemical intervention would only be considered if the chemical remedy itself was not resulting in the addition of further (and more toxic) contaminants to the wastewater stream.

EQS 2: Ambient value of defined area during non-river flow period for light attenuation not to exceed 80th percentile of reference sites data.	If the EQS is exceeded, assessment of algal biochemical and community composition will be undertaken to determine if algal community structure has shifted by a margin beyond that expected due to natural processes alone. Depending on the results of this assessment, further management responses may be initiated in consultation with the OEPA and other relevant regulatory agencies to reduce the effect of nutrients and restore environmental quality so as to comply with the specified level of ecological protection. One of the specific management actions may include the option of modifying the diffuser to increase dilution, such as utilising extra contingency ports and/or increasing the velocity of the wastewater stream.
EQS 3: To exceed the EQS, Trigger A or B must be exceeded and one or more of the applicable Triggers C-G must be exceeded. A. The 80th percentile of bioavailable metal or metalloid concentrations (e.g. dilute acid extractable metals, SEM/AVS analysis) from the defined sampling area should not exceed the EQG, or B. The median bioavailable concentration for non-metallic contaminants (e.g. OC normalisation) from the defined sampling area should not exceed the EQG; and: C. The 95th percentile of bioavailable contaminant concentrations in porewater samples from the defined sampling area should not exceed high protection water quality guideline values (Table 2a of EQC Reference document). D. Sediment toxicity tests should not result in a statistically significant effect ($P < 0.05$) on sub lethal chronic or lethal acute endpoints for any species, compared to a matched reference sediment. E. No significant change in any biological or ecological indicator beyond natural variation that can be demonstrably linked to a contaminant. F. Where TBT concentrations exceed the guideline the incidence of imposex in *Thais orbita* should be ≤5%. G. The median tissue concentration of chemicals that can adversely bioaccumulate or biomagnify should not exceed the 80th percentile of tissue concentrations from a suitable reference site.	In the event that the EQS is exceeded, Water Corporation will initiate an investigation in accordance with the framework developed in the Environmental Quality Criteria Reference Document for Cockburn Sound (2003-2004) (EPA 2005a). Where necessary, management advice will be sort from OEPA and other relevant regulatory bodies.

EQO 2 – Maintenance of Seafood for Human Consumption	
EQS	**Contingency management response**
EQS 1: Thermotolerant coliform counts not to exceed 2.3 MPN *E.coli*/g of flesh (wet wt.) in four out of five representative samples, and the fifth sample should not exceed 7 MPN *E. coli*/g of flesh (wet wt.), with a maximum total plate count of 250 000 organisms/g.	If the EQS is exceeded, Water Corporation will initiate a management response which may include: • An investigation into the conditions prevailing (metocean conditions and plant operations) during the summer period; and then • Development of a management response on advice of the DoH and in consultation with the OEPA, considering all relevant information collected.
EQO 3 & 4 – Maintenance of Primary and Secondary Contact Recreation	
EQS	**Contingency management response**
EQS 1: The 95th percentile value of the pooled *Enterococci* spp. data must not exceed the upper NHMRC 'category A' value (≤40 *Enterococci* spp. MPN/100 ml).	If an EQS is exceeded, the DoH will be contacted and a management response determined based on DoH advice. Management actions will be taken to reduce the concentration to a level where the EQO is met.

3. References

EPA 2003, *Implementing Best Practice in Proposals Submitted to the Environmental Impact Assessment Process* – Guidance Statement # 55, Environmental Protection Authority, Perth, Western Australia.