

# Alkimos Seawater Desalination Plant

Commissioning and Operational Marine Environmental Management Plan (COMEMP)

February 2023





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### Review

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2	DWER	Regulator review	09/11/22



## Corporate endorsement

I hereby certify that to the best of my knowledge, the content of this Alkimos Seawater Desalination Plant Commissioning and Operational Marine Environmental Management Plan is true and correct.

Name: Scott Moorhead

Signed:

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Designation: Manager - Integrated Water  
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Date:

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## Acronyms

Abbreviation	Definition
ASDP	Alkimos Seawater Desalination Plant
COMEMP	Commissioning and Operational Marine Environmental Management Plan
DoH	Department of Health
DWER	Department of Water and Environmental Regulation
EP Act	<i>Environmental Protection Act 1986</i>
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
IWSS	Integrated Water Supply Scheme
LEPA	Low Ecological Protection Area
RO	Reverse osmosis
WWTP	Wastewater treatment plant



## Executive Summary

<b>Proposal name</b>	<b>Alkimos Seawater Desalination Plant (ASDP)</b>	
<b>Proponent name</b>	Water Corporation	
<b>Ministerial Statement number</b>	N/A	
<b>Purpose of the EMP</b>	This Commissioning and Operational Marine Environmental Management Plan (COMEMP) is submitted in support of an application to construct and operate the Alkimos Seawater Desalination Plant (ASDP) pursuant to the provisions of Section 38 of the <i>Environmental Protection Act 1986</i> (EP Act 1986). It aims to identify and manage potential impacts on marine quality from the desalinated waste stream during commissioning and operation; and specifically protect the EPA’s environmental factors of Marine Environmental Quality, Benthic Communities and Habitats, Marine Fauna and Social Surroundings.	
<b>Key Environmental Factors, Objectives</b>	<b>Key Environmental Factor</b>	<b>Environmental Objective</b>
	Marine Environmental Quality	To maintain the quality of water, sediment and biota so that environmental values are protected.
	Benthic Communities and Habitats	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.
	Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.
	Social Surroundings	To protect social surroundings from significant harm.
<b>Condition clauses (if applicable)</b>	N/A	
<b>Proposed construction date</b>	TBC	
<b>EMP required pre-construction?</b>	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	



## 1. Context, scope and rationale

### 1.1 Proposal

Due to a combination of drying climate and increasing demand, Water Corporation is moving to secure Perth's potable water supply, via the construction and operation of the Alkimos Seawater Desalination Plant (ASDP) and Eglinton Groundwater Treatment Plant. The proposed Plants will be located adjacent to the existing Alkimos Wastewater Treatment Plant (WWTP) and within Water Corporation's 'Alkimos Water Precinct' at Alkimos, Western Australia (**Figure 1.1**).

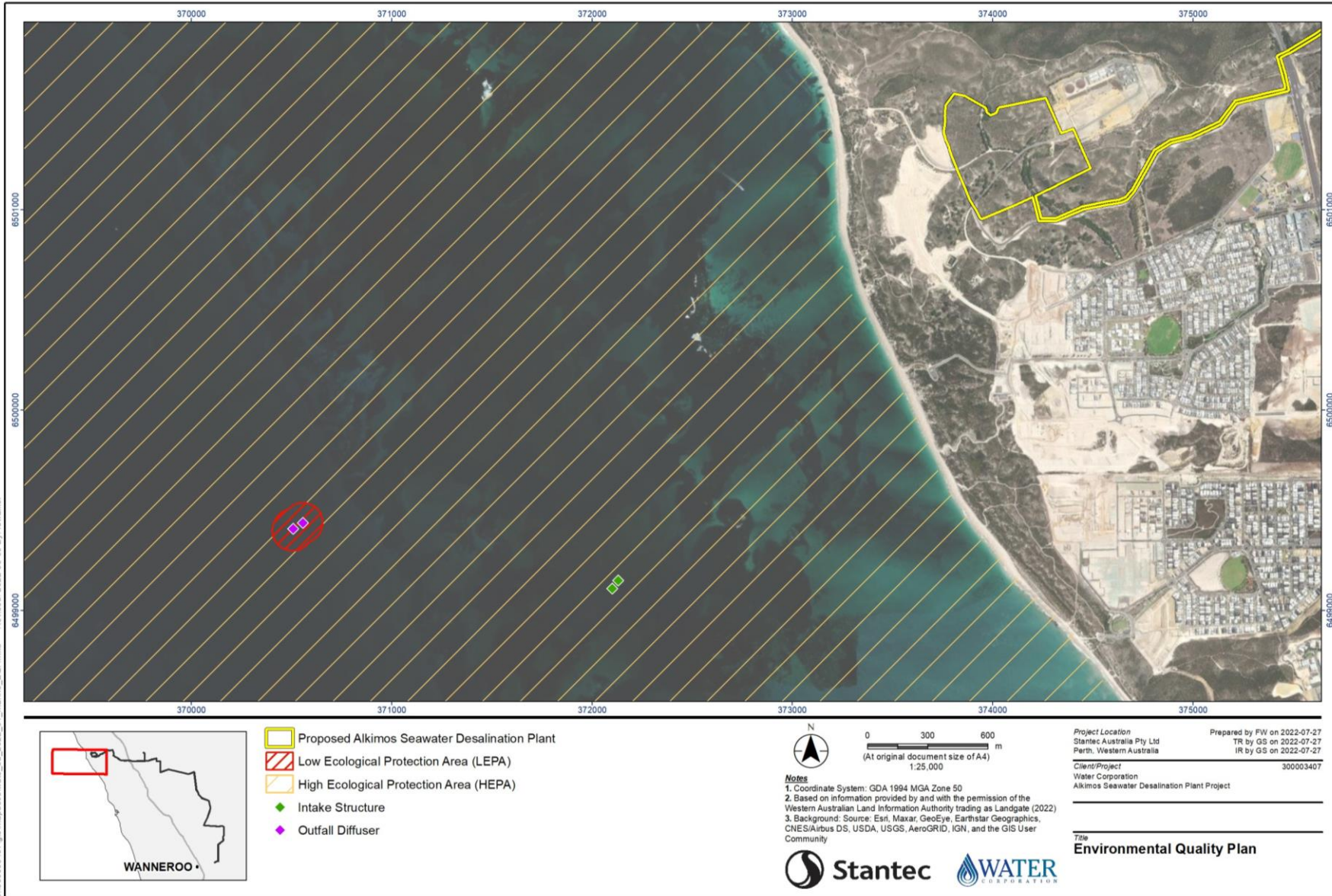
At maximum plant capacity (100 GL/a), the ASDP will generate approximately 420 ML of concentrated seawater per day (hereafter waste stream), which will be discharged to the ocean via two rosette diffusers; each designed to achieve a 1:30 dilution within 70 m of discharge point (**Figure 1.1**). The waste stream will consist primarily of concentrated seawater with small inputs of backwash supernatant (0.27%) from the Eglinton Groundwater Treatment Plant. There is also a periodic requirement to add cleaning chemicals (hereafter referred to as Clean in Place (CIP) chemicals) to the waste stream for descaling and removal of fouling in the reverse osmosis (RO) system, as detailed in **Table 1.1**.

**Table 1.1 ASDP waste stream characteristics at maximum capacity**

Contaminant / Stressor	Concentration	Duration
Waste stream temperature	~4°C above background	Continuous
Waste stream salinity	Maximum 75 ppt	Continuous
CIP	Variable	Intermittent (<10% of time)

This Commissioning and Operational Marine Environmental Management Plan (COMEMP) is submitted in support of the Water Corporation application to construct and operate the ASDP pursuant to the provisions of Section 38 of the *Environmental Protection Act 1986* (EP Act 1986). It aims to identify and manage potential for impacts on marine quality from the desalination waste stream during commissioning and operation; and specifically protect the EPA's environmental factors of Marine Environmental Quality, Benthic Communities and Habitats, Marine Fauna and Social Surroundings.





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**Figure 1.1 Environmental Quality Plan for the Alkimos Seawater Desalination Plant**

Alkimos SDP – Commissioning & Operational Marine Environmental Management Plan, Rev 3, Feb 2023



## 1.2 Key environmental factors

The EPA’s key environmental factors are listed in ‘Statement of Environmental Principles, Factors and Objectives’ (EPA 2021b). The factors and associated Environmental Objectives relevant to this COMEMP are summarised in **Table 1.2**. All factors relate to the EPA’s Sea and People themes. It is anticipated that commissioning and operation will have a negligible impact on the EPA’s remaining themes of inland waters, air and land.

**Table 1.2 Key environmental factors and objectives**

EPA Theme	EPA Factor	Environmental Objective
Sea	Marine Environmental Quality	To maintain the quality of water, sediment and biota so that environmental values are protected
	Benthic Communities and Habitats	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained
	Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained
People	Social Surroundings	To protect human health from significant harm

## 1.3 Condition requirements

This COMEMP is submitted in support of an application to construct and operate the ASDP by Water Corporation pursuant to the provisions of Section 38 of the *Environmental Protection Act 1986* (EP Act 1986).

## 1.4 Rational and Approach

### 1.4.1 Key environmental impacts

Risks associated with the commissioning and operation of the development are detailed in the Environmental Review Document (Water Corporation 2022). Those deemed to pose a moderate (or higher) risk to the marine environment (**Table 1.3**) will be managed during commissioning and operation using the outcome-based provisions described in EPA (2021b).

**Table 1.3 Potential commissioning and operational environmental impacts**

Phase	Impact / Risk	Driver
Operations	Osmotic stress	Increased salinity
	Thermal stress	Temperature differential
	Water clarity	Increased density
	Reduced dissolved oxygen	Stratification
Commissioning	Toxicity	Periodic introduction of cleaning chemicals (CIP); sub-optimal diffuser performance

### 1.4.2 Survey and study findings

The EIA for the ASDP involved numerous studies on the marine environment including hydrodynamic modelling, marine water quality surveys, mapping of benthic communities and desktop assessments of salinity thresholds, occurrence of marine fauna and potential social impacts. These investigations were used to inform the design of the ASDP with the intent to avoid and or minimise potential impacts to the marine environment, as required by the EPA’s mitigation hierarchy (EPA 2021b). The outcomes of the studies are described in the subsequent sections.



### Osmotic stress

Risks associated with osmotic stress were assessed using a hydrodynamic model (DHI 2019) and published salinity tolerances of local marine flora and fauna. Modelling investigated the dispersal, dilution and trajectory of the wastewater, in the marine environment. Salinity was assessed as a ‘stressor’ using a threshold of +1.3 ppt above background. A 1:30 dilution was sufficient to restrict salinity elevations to +1.1 ppt (the tolerance limits of local marine species<sup>1</sup>) (Table 1.4).

Hydrodynamic modelling confirmed the proposed diffusers would achieve a 1:30 dilution within 70 m of the outlet, under worst case conditions.

**Impacts associated with salinity are therefore considered manageable under the EPA’s environmental quality management framework and are not expected to compromise the EPA’s environmental objectives for the factors listed in Table 1.2 (EPA 2021b).**

**Table 1.4 Published maximum salinity tolerances (ppt) for temperate marine species**

Common name	Scientific name	Tolerance	Reference	
Western Rock Lobster	<i>Panulirus cygnus</i>	45	Dall (1974)	
Pink Snapper	<i>Chrysophrys auratus</i>	Adults 70 Larva 50	McGlennon (2003)	
Blue Manna Crab <sup>2</sup>	<i>Portunus pelagicus</i>	45	Romano & Zeng (2011)	
Western King Prawn <sup>3</sup>	<i>Penaeus latisulcatus</i>	46	Sang & Fotedar (2004)	
Australia Cuttlefish <sup>4</sup>	<i>Sepia apama</i>	50	Dupavilion & Gillanders (2009)	
Scallop	<i>Pecten furnatus</i>	40	Nell & Gibbs (1986)	
Pipi	<i>Plebidonax deltoides</i>	45		
Flay oyster	<i>Ostrea angassi</i>	45		
Blue mussel	<i>Mytilus edulis</i>	45		
Sydney cockle	<i>Anadara trapezia</i>	45		
Greenlip abalone	<i>Haliotis laevigata</i>	40		Burke et al. (2001); Freeman (2001)
Blacklip abalone	<i>Haliotis rubra</i>	40		
Penaeid shrimp	<i>Metapenaeus stebbingi</i>	50	Ahmed & Ayub (1999)	
Seagrass	<i>Posidonia australis</i>	55	Walker et al. (1988)	
Seagrass	<i>Posidonia coriacea</i>	50		
Kelp <sup>1</sup>	<i>Ecklonia radiata</i>	54-61	Intertek (2018, 2022)	
Yellow tail kingfish <sup>1</sup>	<i>Seriola lalandi</i>	+3 to +9	Intertek (2018, 2022)	

Notes: 1. Based on EC10 values from WET testing applied to brine; 2. Tolerance range for juveniles; 3. Adult tolerance for continued growth; 4. Highest salinity tolerance for embryos to develop; with 28–38 ppt considered optimal for species development.

### Thermal stress

The ASDP will produce a waste stream that is ~4°C above ambient (DHI 2019). Sustained elevations in water temperature may impact marine biota if temperatures exceed the normal range at a particular site, over extended periods (EPA 2017). Modelling suggests water temperature elevations will be reduced to +0.13°C above background within 70 m of the outfall (DHI 2019). A +0.13°C temperature elevation is within the thermal tolerances of marine organisms in general (Nguyen et al. 2011) and in the Alkimos region based on natural seawater temperature variation.

**Impacts associated with water temperature elevations at the LEPA, which is of a 100 m radius, are considered manageable under the EPA’s environmental quality management**

<sup>1</sup> Assuming a background salinity range at Alkimos circa 34.8-36.6 ppt (based on limited data).



**framework and not expected to compromise the EPA’s environmental objectives for the factors listed in Table 1.2 (EPA 2021b).**

### ***Dissolved oxygen***

Discharge of return seawater brine may lead to stratification (a persistent layer of saline water at the bottom of the water column). The potential for reduced mixing between the surface and bottom of the water column may lead to oxygen drawdown. The potential for dissolved oxygen drawdown was assessed using a simple model which considered atmospheric supply and sediment oxygen demand. The model considered worst case conditions, assuming peak water temperatures and zero influence from wave action, which otherwise contributes significantly to mixing. The model indicated the environment at Alkimos is well mixed and characterised by median dissolved oxygen saturation between 88% and 100% saturation. While the addition of the effluent may result in an increase in the cumulative area under the 90% trigger criteria, the increase in area was negligible, and median saturation did not fall below 88% for longer than 7 days (the threshold is 60% saturation).

**Impacts associated with stratification/oxygen depletion are considered manageable under the EPA’s environmental quality management framework and not expected to compromise the EPA’s environmental objectives for the factors listed in Table 1.2 (EPA 2021b).**

### ***Toxicity***

Routine ASDP maintenance may require the addition of CIP chemicals for RO cleaning purposes. WET testing completed on a sample of SSDP waste stream containing CIP chemicals suggested the dilutions required to maintain a high level of ecological protection (~1:21) for brine are similar to those after the addition of CIP chemicals (+CIP) (1:29). The sample toxicity is predominantly due to the osmotic imbalance caused by salinity, rather than the addition of the CIP chemicals (Intertek 2018). The risk of toxicity due to the addition of CIP chemicals is therefore considered low. CIP chemicals will be used intermittently (<10% of the time) and present at low concentrations once diluted in the waste stream.

**The risk posed by the discharge of CIP chemicals is considered negligible relative to the effects of brine, and not expected to compromise the EPA’s environmental objectives for the factors listed in Table 1.2 (EPA 2021b).**

### **1.4.3 Key assumptions and uncertainties**

The EPA’s method for maintaining a high level of ecological protection is to compare the median salinity at impact sites to the 80th percentile of salinity at reference sites. This approach requires further investigation prior to application at Alkimos. Salinity data in the receiving environment is limited because previous monitoring was not contiguous, short-term and/or conducted some distance from the proposed ASDP diffuser.

Given the paucity of baseline data, Water Corporation is unable to commit to meeting a percentile-based trigger. **Water Corporation proposes to establish a site-specific science-based trigger related to the salinity tolerances of local marine biota, within the next two years.** To support the development of the trigger, Water Corporation proposes to:

1. Conduct a comprehensive baseline monitoring campaign over a 24-month period commencing in late 2022, with the objective of capturing the variability in salinity in the local receiving environment.
2. At the completion of the baseline monitoring campaign, the trigger and the COMEMP will be revised based upon:
  - a. the findings of the monitoring campaign
  - b. the results of relevant studies, including the SSDP and PSDP monitoring outcomes
  - c. published salinity tolerances of temperate marine species.



3. In the interim, a precautionary approach based on **interim** trigger and threshold criteria will be adopted:
  - a. Trigger (EQG): Median salinity at the individual LEPA sites over the monitoring period not to exceed the median salinity of the pooled reference sites by more than 1.3 ppt
  - b. Threshold (EQS): The number of dilutions achieved at the LEPA boundary is sufficient to meet the EC<sub>10</sub> (%) for at least two of three taxa: e.g. macroalgae, fish and crustaceans, based on sub-lethal chronic WET testing.



## 1.5 Management framework

The EPA has prepared an Environmental Quality Management Framework (EQMF) for application in Western Australia's coastal waters (EPA 2016). This EQMF is based on:

- identifying Environmental Values (EVs)
- establishing and spatially defining Environmental Quality Objectives (EQOs) that need to be maintained to ensure the associated Environmental Values are protected
- monitoring and managing to ensure the EQOs are achieved and/or maintained in the long-term in the areas they have been designated
- establishing Environmental Quality Criteria (EQC), which are quantitative bench-marks against which monitoring results can be compared.

There are two levels of EQC:

- Trigger Criteria (Environmental Quality Guidelines (EQGs)) are quantitative, investigative guidelines which signify low risk of an environmental effect if they are met, and trigger further investigations if an exceedance occurs; and
- Threshold Criteria (Environmental Quality Standards (EQSs)) are management guidelines based on multiple lines of evidence, which if exceeded signify that the Environmental Quality Objective is not being met and that a management response is required.

By protecting the EVs and achieving the EQOs under the EQMF, it is expected that the EPA's factors for marine environmental quality, benthic communities and habitats, marine fauna and social surroundings, will also be protected.

If monitored values are below the EQG then the Environmental Quality Objectives (EQO) are considered to have been met. If a trigger/EQG is exceeded, there is an increased risk that the associated EQO may not be achieved and assessment against the threshold/EQS is triggered. If a threshold/EQS is exceeded, it is considered there is a significant risk that the associated EQO has not been achieved and a management response is required to ensure the EQO is achieved.

## 1.6 Rationale for choice of indicators and/or management actions

Outcome-based provisions are performance-based and may be used where the part of the environment is capable of objective measurement and reporting (EPA 2021b). This COMEMP falls under an existing marine environmental quality plan (EQP) (EPA 2000).

This section updates the EQP for waters around the plant by spatially defining the area where the relevant Levels of Ecological Protection (LEP) apply (**Figure 1.1**). The proposed ASDP intake and outlet structures are within a High Ecological Protection Area (HEPA). Water Corporation is seeking to create a 100 m radius Low Ecological Protection Area (LEPA) in the area around the ASDP outlet diffusers and within the existing HEPA.

The EQC are based on the examples in the Environmental Quality Criteria Reference Document for Cockburn Sound (EPA 2017); the framework adopted for applying EQC to Cockburn Sound is consistent with the recommended approaches in ANZG (2018; formerly ANZECC & ARMCANZ 2000).





## 2. COMEMP Components

An outcome-based framework of monitoring, management triggers, thresholds and responses has been developed to ensure EQOs are achieved and ensure the associated EVs are protected during commissioning and operation (**Table 2.1** and Notes:

OEPA = Office of the Environmental Protection Authority; EQO = Environmental Quality Objective; LEPA = Low ecological protection area; WET = Whole of Effluent; CIP = Clean in Place





Table 2.2).



**Table 2.1 Outcome-based provisions for commissioning**

EPA factors:		Marine Environmental Quality, Benthic Communities and Habitats, Marine Fauna		
<ul style="list-style-type: none"> <li>Indicator</li> <li>Monitoring</li> </ul>	<ul style="list-style-type: none"> <li>Trigger criteria</li> <li>Threshold criteria</li> </ul>	<b>Response actions:</b> <ul style="list-style-type: none"> <li>Trigger level actions</li> <li>Threshold contingency actions</li> </ul>	Timing / frequency of monitoring	Reporting
<p><b>Diffuser performance validation</b></p> <p>Diffuser performance will be validated during commissioning to confirm the number of dilutions achieved at the individual LEPA sites is sufficient to meet the 99% species protection guideline.</p> <p>Validation will proceed based on measurements of water temperature and salinity in the waste stream prior to release, AND at three compliance sites on the LEPA boundary and at reference sites located north and south of the diffuser, at a depth 0.5 m above the seafloor (Figure 2.1).</p>	<p>Threshold:</p> <ul style="list-style-type: none"> <li>Median salinity at the individual LEPA boundary sites not to exceed the median salinity of the pooled reference sites by more than 1.3 ppt.</li> <li>Median temperature at the individual LEPA boundary sites not to exceed the median temperature of the pooled reference sites by more than 2.0°C.</li> <li>The number of dilutions at the individual LEPA boundary sites must be sufficient to meet the 99% species protection guideline, based on WET testing.</li> </ul>	<p>If a threshold is exceeded, then the management response may include, but should not necessarily be limited to:</p> <ul style="list-style-type: none"> <li>Investigate the potential sources of higher than predicted salinity and/or temperature</li> <li>If possible, review and adjust ASDP processes to reduce the waste stream salinity and temperature</li> <li>Increase the dilution ratio of the waste stream prior to discharge, to reduce salinity and water temperature</li> <li>Adjust discharge regime (e.g. timing, flow rate, volume) where possible.</li> </ul>	<p>The program should be implemented during commissioning and will include:</p> <ul style="list-style-type: none"> <li>In-line measurements of waste stream salinity and temperature prior to release at least once every hour for six weeks</li> <li>In situ measurements of seawater salinity and temperature at the individual LEPA boundary and reference sites, at least once every hour for six weeks.</li> </ul>	<p>A diffuser performance and validation report will be completed within two months following completion of commissioning.</p> <p>Threshold exceedances will be reported to the Office of the EPA (OEPA) within five working days of an exceedance being determined, along with the proposed management action(s) to increase the number of dilutions and provide confidence that the EQO has not been compromised.</p> <p>All trigger and threshold exceedances, along with results of the management actions will be reported to OEPA in the Annual Compliance Report.</p>
<p><b>Dissolved oxygen validation</b></p> <p>Dissolved oxygen (DO) projections will be validated during commissioning to confirm the modelling has not underestimated the potential for DO depletion.</p> <p>Validation will proceed based on a comparison between near bottom measurements of salinity, temperature and DO in the far field (collected by loggers and as profiles) and dedicated model runs of the corresponding periods.</p> <p>The validated hydrodynamic model will be rerun under representative metocean conditions and discharge flow rates representative of future stages.</p>	<p>Trigger:</p> <ul style="list-style-type: none"> <li>The validated hydrodynamic modelling for future stages suggests that median dissolved oxygen concentration in bottom waters at any site calculated over a period of no more than one week is less than 90% saturation.</li> </ul> <p>Threshold:</p> <ul style="list-style-type: none"> <li>The validated hydrodynamic modelling for future stages suggests that median dissolved oxygen concentration in bottom waters at any site calculated over a period of no more than one week is lower than 60% saturation.</li> </ul>	<p>If the validated hydrodynamic modelling for future stages suggests that a trigger is at risk of being exceeded, Water Corporation will commence investigations against the threshold criteria. A management response (see below) may be implemented if appropriate depending on the scale of the projected risk.</p> <p>If the validated hydrodynamic modelling for future stages suggests that a threshold is at risk of being exceeded, then the management response may include, but should not necessarily be limited to:</p> <ul style="list-style-type: none"> <li>Investigate the potential contributors that caused the model to underestimate deoxygenation (i.e. low DO in the discharge, stratification, organic matter load)</li> <li>If possible, review and adjust ASDP processes to increase DO and/or reduce the waste stream salinity and/or organic load</li> <li>Introduce seawater recirculation to increase DO in the discharge</li> <li>Increase the dilution ratio of the waste stream prior to discharge</li> <li>Adjust discharge regime (e.g. timing, flow rate, volume) where possible.</li> </ul>	<p>The program should be implemented during commissioning and will include:</p> <ul style="list-style-type: none"> <li>both fixed instruments and profiles</li> <li>fixed instruments should be at two depths in the water column at the same location, to capture the differential DO, temperature and salinity between the plume and background at each site</li> <li>water column profiles of DO, temperature and salinity need to be collected occasionally (at the minimum during deployment and retrieval) to capture vertical plume extent</li> <li>the commissioning phase sampling and model validation must be conducted when the plant is running in steady state (i.e. at a constant discharge rate) so that the far-field plume reaches a steady state for that discharge rate</li> <li>validating the far-field hydrodynamic model by direct comparison between the salinity, temperature and DO data collected during wet commissioning and data from dedicated model runs of the corresponding periods</li> <li>re-running the validated hydrodynamic model under representative metocean conditions and discharge flow rates representative of future stages</li> </ul>	<p>A diffuser performance and validation report assessing the potential for future trigger and/or threshold exceedances will be completed and submitted to DWER within two months of completion of commissioning.</p> <p>If the validated hydrodynamic modelling for future stages suggests that a management response is necessary, proposed management action(s) necessary to get projected DO back below threshold/trigger will be reported to the DWER to provide confidence that the EQO will not be compromised.</p>



EPA factors:	Marine Environmental Quality, Benthic Communities and Habitats, Marine Fauna			
<p><b>Waste stream toxicity evaluation</b> Undertake WET testing on up to 8 species from at least 4 trophic groups using a sample of the waste stream obtained during the addition of CIP chemicals. Confirm the number of dilutions needed to achieve 99% species protection.</p>	<p>Threshold: Fifth percentile dilution at the LEPA boundary as defined by modelling must be sufficient to maintain 99% species protection as determined from WET testing.</p>	<p>If the threshold is exceeded, then the management response may include, but should not necessarily be limited to:</p> <ul style="list-style-type: none"> <li>• Investigate the potential sources of higher than predicted toxicity</li> <li>• If possible, review and adjust ASDP processes to reduce the waste stream toxicity</li> <li>• Increase the dilution ratio of the waste stream prior to discharge, to reduce toxicity</li> <li>• Adjust discharge regime (e.g. timing, flow rate, volume) where possible.</li> <li>• Revise CIP usage regime or pursue less toxic alternatives.</li> </ul>	<p>During ASDP commissioning or as soon as a waste stream sample is available</p> <p>AND</p> <p>Whenever the composition of the waste stream has permanently changed.</p>	<p>A WET testing report will be completed within two months following receipt of the waste stream sample.</p> <p>Threshold exceedances will be reported to OEPA within five working days of an exceedance being determined, along with the proposed management action(s) to reduce salinity and provide confidence that the EQO has not been compromised.</p> <p>All trigger and threshold exceedances, along with the results of the management actions, will be reported to OEPA in the Annual Compliance Report.</p>

Notes:  
OEPA = Office of the Environmental Protection Authority; EQO = Environmental Quality Objective; LEPA = Low ecological protection area; WET = Whole of Effluent; CIP = Clean in Place



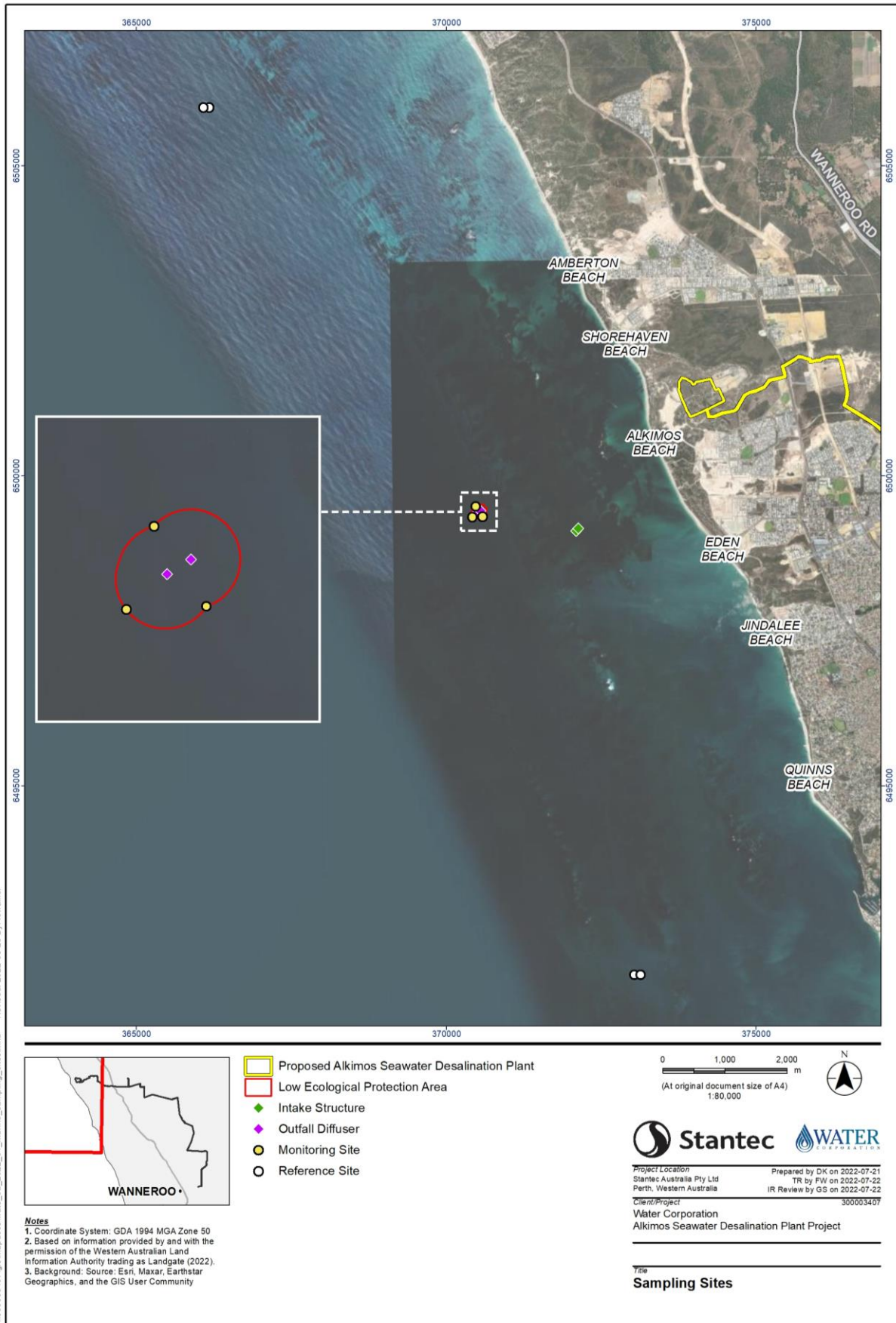
**Table 2.2 Outcome-based provisions for operations**

EPA factors:	Marine Environmental Quality			
<ul style="list-style-type: none"> <li>Indicator</li> <li>Monitoring</li> </ul>	<ul style="list-style-type: none"> <li>Trigger criteria</li> <li>Threshold criteria</li> </ul>	<b>Response actions:</b> <ul style="list-style-type: none"> <li>Trigger level actions</li> <li>Threshold contingency actions</li> </ul>	Timing / frequency of monitoring	Reporting
<p><b>Thermal stress</b></p> <p><b>Trigger:</b> Water temperature loggers deployed at three compliance sites on the LEPA boundary AND at reference sites located north and south of the diffuser, at a depth 0.5 m above the seafloor (see <b>Figure 2.1</b>).</p> <p><b>Threshold:</b> As per the approach for the water temperature trigger.</p>	<p>Trigger (<b>EQG</b>): Median water temperatures at the individual LEPA sites over the monitoring period must be less than the 80<sup>th</sup> percentile of the pooled reference sites.</p> <p>Threshold (<b>EQS</b>): Median water temperatures at the individual LEPA sites over the monitoring period must not exceed the median temperature of the pooled reference sites by more than 2.0°C.</p>	<p>If the trigger is exceeded, Water Corporation will commence investigations against the threshold criteria, within 5 days of detecting the exceedance.</p> <p>If the threshold is exceeded, then the management response may include, but should not necessarily be limited to:</p> <ul style="list-style-type: none"> <li>Investigate the potential sources of higher than predicted temperature</li> <li>If possible, review and adjust ASDP processes to reduce the waste stream temperature</li> <li>Increase the dilution ratio of the waste stream prior to discharge, to reduce water temperature</li> <li>Adjust discharge regime (e.g. timing, flow rate, volume) where possible.</li> </ul>	<p>Monitoring will be conducted annually over a 24-week period between December and May, as per <b>Section 4.2</b>. The 6-month data set will be divided into Summer and Autumn periods.</p>	<p>Trigger exceedances will be reported to OEPA within five working days of an exceedance being determined and commence assessment against the threshold criteria.</p> <p>Threshold (<b>EQS</b>) exceedances will be reported to OEPA within five working days of an exceedance being determined, along with the proposed management action(s) to reduce water temperature and provide confidence that the EQO has not been compromised.</p> <p>All trigger and threshold exceedances, along with the results of the management actions, will be reported to OEPA in the Annual Compliance Report.</p>
<p><b>Osmotic stress</b></p> <p><b>Trigger:</b> Salinity loggers deployed at three compliance sites on the LEPA boundary AND at reference sites located north and south of the diffuser, at a depth 0.5 m above the seafloor (see <b>Figure 2.1</b>).</p> <p><b>Threshold:</b> Undertake WET testing on at least three taxa: e.g. macroalgae, fish and crustaceans, using a sample of the waste stream obtained during typical operations. Ensure the dilutions achieved at the LEPA boundary are greater than the EC<sub>10</sub>(%) values for the individual taxa.</p>	<p><b>Interim Trigger (EQG):</b> Median salinity at the individual LEPA sites over the monitoring period not to exceed the median salinity of the pooled reference sites by more than 1.3 ppt.</p> <p><b>Interim Threshold (EQS):</b> The number of dilutions achieved at the LEPA boundary is sufficient to meet the EC<sub>10</sub>(%) for at least two of three taxa: e.g. macroalgae, fish and crustaceans, based on sub-lethal chronic WET testing.</p>	<p>If the trigger is exceeded, Water Corporation will commence investigations against the threshold criteria, within 5 days of detecting the exceedance.</p> <p>If the threshold is exceeded for more than two of the three taxa, then the management response may include, but should not necessarily be limited to:</p> <ul style="list-style-type: none"> <li>Review the WET testing results and if necessary, repeat the testing using a more robust assessment (i.e. using 8 species) to eliminate the possibility of false positives.</li> <li>If possible, review and adjust ASDP processes to reduce the waste stream salinity</li> <li>Increase the dilution ratio of the waste stream prior to discharge, to reduce salinity</li> <li>Adjust discharge regime (e.g. timing, flow rate, volume) where possible to improve dilution.</li> </ul>	<p>Salinity monitoring will be conducted annually over a 24-week period between December and May, as per <b>Section 4.1</b>. The 6-month data set will be divided into Summer and Autumn periods.</p> <p>WET testing will be conducted upon exceedance of the trigger and at least annually between December and May.</p>	<p>Trigger (<b>EQG</b>) exceedances will be reported to OEPA within five working days of an exceedance being determined and commence assessment against the threshold criteria.</p> <p>Threshold (<b>EQS</b>) exceedances will be reported to OEPA within five working days of an exceedance being determined, along with the proposed management action(s) to reduce salinity and provide confidence that the EQO has not been compromised.</p> <p>All trigger and threshold exceedances, along with the results of the management actions, will be reported to OEPA in the Annual Compliance Report.</p>



EPA factor:	Social Surroundings			
<ul style="list-style-type: none"> <li>Indicator</li> <li>Monitoring</li> </ul>	<ul style="list-style-type: none"> <li>Trigger criteria</li> <li>Threshold criteria</li> </ul>	<b>Response actions:</b> <ul style="list-style-type: none"> <li>Trigger level actions</li> <li>Threshold contingency actions</li> </ul>	Timing / frequency of monitoring	Reporting
<p><b>Aesthetics</b> Visual assessments made by field personnel over the December and May sampling period, in the vicinity of the diffusers.</p>	<p>Trigger (<b>EQG1</b>): There should be no reported incidents of large-scale deaths of marine organisms relating from unnatural causes, or</p> <p>Trigger (<b>EQG2</b>): The natural visual clarity of the water should not be reduced by more than 20%, or</p> <p>Trigger (<b>EQG3</b>): The natural hue of the water should not be changed by more than 10 points on the Munsell scale.</p> <p>Threshold (<b>EQS</b>): There should be no overall decrease in the aesthetic water quality values of waters influenced by the waste stream using direct measures of the community's perception of aesthetic value.</p>	<p>If a trigger is exceeded, Water Corporation will commence investigations against the threshold criteria, within 5 days of detecting the exceedance.</p> <p>If possible, the marine organisms referred to in EQG1 should be collected for forensic analysis to determine the cause of death, and/or exclude non-ASDP contributions to mortality (e.g. an algal bloom, a disease, the WWTP discharge).</p> <p>If the threshold is exceeded, then the management response may include, but should not necessarily be limited to:</p> <ul style="list-style-type: none"> <li>Investigate the potential sources of contamination, osmotic stress, thermal stress and/or deoxygenation (i.e. low DO in the discharge, stratification, organic matter load)</li> <li>If possible, review and adjust the ASDP procedures to remedy the cause</li> <li>Increase the dilution ratio of the waste stream prior to discharge</li> <li>Adjust discharge regime (e.g. timing, flow rate, volume) where possible to improve dilution performance.</li> <li>Initiate any other relevant management responses specific to the cause of the trigger/threshold exceedance.</li> </ul>	<p>Monitoring will be conducted annually between December and May, as per <b>Section 4.3</b>.</p>	<p>Trigger exceedances will be reported to OEPA within five working days of an exceedance being determined and commence assessment against the threshold criteria. If/when the Marmion Marine Park extension is gazetted any triggering of the EQG1 criterion will be reported to the DBCA.</p> <p>Threshold exceedances will be reported to OEPA within five working days of an exceedance being determined, along with the proposed management action(s) to reduce contaminants and provide confidence that the EQO has not been compromised.</p>

Notes:  
OEPA = Office of the Environmental Protection Authority; EQG = Environmental Quality Guideline; EQS = Environmental Quality Standard; LEPA = Low ecological protection area; WET = Whole of Effluent



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**Figure 2.1 Proposed sampling locations for collection of data relevant to the EQC**

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### 3. Commissioning monitoring

#### 3.1 Diffuser performance validation

##### 3.1.1 Threshold criteria assessment

Monitoring will be conducted to validate the number of dilutions achieved at the LEPA boundary, against those predicted by modelling. The program will be implemented during commissioning, which is scheduled to occur over a 6–8-month period following construction. Sampling for diffuser performance assessment will include:

- In-line measurement prior to release should be taken at least once every hour for six weeks
- In situ measurements at the LEPA boundary should be taken at least once every hour for six weeks.

In-line and in situ measurements of salinity and water temperature will be conducted using calibrated loggers deployed for a minimum period of six-weeks during commissioning. Loggers will be positioned at the northern, southern and western LEPA boundaries and at reference sites located north and south of the diffuser, at a height ~0.5 m above the seafloor (**Figure 2.1**).

Once retrieved, the data will be filtered to remove spurious points and the additional data recorded during deployment and retrieval. The data will be subject to validation against a logger standard; if a significant data drift is identified, data will be post-processed to correct for drift in accordance with the manufacturer's recommendations.

Median salinity and water temperature will be calculated for each of the individual LEPA sites, the reference sites and the in-line data series, using the time series data obtained over the full six-weeks of the campaign. The number of dilutions achieved at the LEPA boundary will be determined based on the differences between the in-line data series, and the results obtained at the individual LEPA sites. These dilution estimates will be compared to equivalent dilution estimates from the model.

To validate the salinity threshold criteria, the difference between the median salinities at the individual LEPA boundary sites and the median salinity of the pooled reference sites must be  $\leq +1.3$  ppt (the criteria applied by the modelling). To validate the temperature threshold criteria, the difference between the median temperature at the individual LEPA sites and the median of the pooled reference sites must be less than  $+2^{\circ}\text{C}$  (the criteria applied by the modelling). To validate the dilution threshold, the number of dilutions achieved at the LEPA boundary must be sufficient to meet the 99% species protection guidelines, based on WET testing.

If a threshold for diffuser performance is exceeded, Water Corporation will initiate management as per the contingency actions outlined in **Table 2.1**.

##### 3.1.2 Dissolved oxygen

Dissolved oxygen (DO) projections will be validated during commissioning to confirm the modelling has not underestimated the potential for DO depletion. Validation will proceed based on a comparison between near bottom measurements of salinity, temperature and DO in the far field (collected by loggers and as profiles) and dedicated model runs of the corresponding periods.

During the wet commissioning phase sampling and model validation will be conducted when the plant is running in steady state (i.e. at a constant discharge rate) so that the far-field plume reaches a steady state for that discharge rate. In situ measurements of salinity, temperature and DO saturation in near bottom waters will be collected using fixed loggers and as water column profiles. Fixed instruments should be at two depths in the water column at the same location, to capture the differential DO, temperature and salinity between the plume and background at each site. Water column profiles of DO, temperature and salinity will be collected occasionally (at the minimum during deployment and retrieval) to capture vertical plume extent.



Once retrieved, the data will be filtered to remove spurious points and the additional data recorded during instrument deployment and retrieval. The data will be subject to validation against a logger standard; if a significant data drift is identified, data will be post-processed to correct for drift in accordance with the manufacturer's recommendations.

The far-field hydrodynamic model will be validated and refined based on direct comparison between the salinity, temperature and DO data collected during wet commissioning and data from dedicated model runs of the corresponding periods. The validated hydrodynamic model will be rerun under representative metocean conditions and discharge flow rates representative of future stages.

Median DO concentration in bottom waters will be calculated. Median estimates of DO, capturing periods of no more than one week derived from the validated/revised model scenarios, will be compared to the DO trigger of 90% saturation in the first instance and to the DO threshold of 60% saturation if the trigger is exceeded. If the trigger for DO is at risk of being exceeded in any of the future scenarios, Water Corporation may initiate management as per the contingency actions outlined in **Table 2.1** depending on the scale and duration of the risk. If the threshold for DO is at risk of being exceeded in any of the future scenarios, Water Corporation will initiate management as per the contingency actions outlined in **Table 2.1**.

Ongoing monitoring, if required, will be dependent on risk as indicated by the model and developed in consultation with the DWER as an adaptive management measure (see **Section 5.3**).

### **3.2 Waste stream toxicity evaluation (WET testing)**

#### **3.2.1 Threshold criteria assessment**

WET testing will be conducted during commissioning to determine the number of dilutions required to achieve 99% species protection, as per ANZECC/ARMCANZ (2000). To maximise the rigour of the assessment, WET testing shall be undertaken on eight species from at least four taxonomic groups.

The 99% species protection dilution will be statistically inferred using a Burr Type III regression in the BurliOZ (v2.0) software. The dilution considered will be compared to the validated number of dilutions achieved at the LEPA boundary to determine whether the dilution is adequate to meet the 99% species protection guideline.

The test sample will be collected at a time coinciding with the inputs of the CIP, to capture the theoretical worst-case conditions as described in **Section 1.4.2**. If the performance threshold is exceeded, Water Corporation will initiate management as per the contingency actions outlined in **Table 2.1**.

## **4. Operational monitoring**

### **4.1 Osmotic stress**

#### **4.1.1 Trigger criteria assessment**

Salinity will be monitored at the LEPA boundary and at two reference sites using calibrated loggers deployed for a minimum period of six months between December and May. Loggers will be positioned at the northern, southern and western sides of the LEPA boundary and at reference sites located north and south of the diffuser, approximately 0.5 m from the seafloor (**Figure 2.1**).

Once retrieved, the data will be filtered to remove spurious points or data recorded during deployment and retrieval. The data will be subject to validation against a logger standard; if a significant data drift is identified, data will be post-processed to correct for drift in accordance with the manufacturer's recommendations.





Median salinity will be calculated at each of the individual LEPA boundary sites and compared to the median of the combined reference sites. The 6-month data set for salinity at LEPA and Reference sites will be divided into Summer and Autumn and monitoring data for each season assessed against the relevant seasonal trigger. To achieve the salinity trigger criteria, the difference in median salinities between the individual LEPA sites and the pooled reference sites must be  $\leq +1.3$  ppt over the same period. Upon an exceedance of the osmotic stress criteria (at any of the LEPA sites), investigations shall commence against the threshold criteria, as per the response framework in **Figure 4.1**.

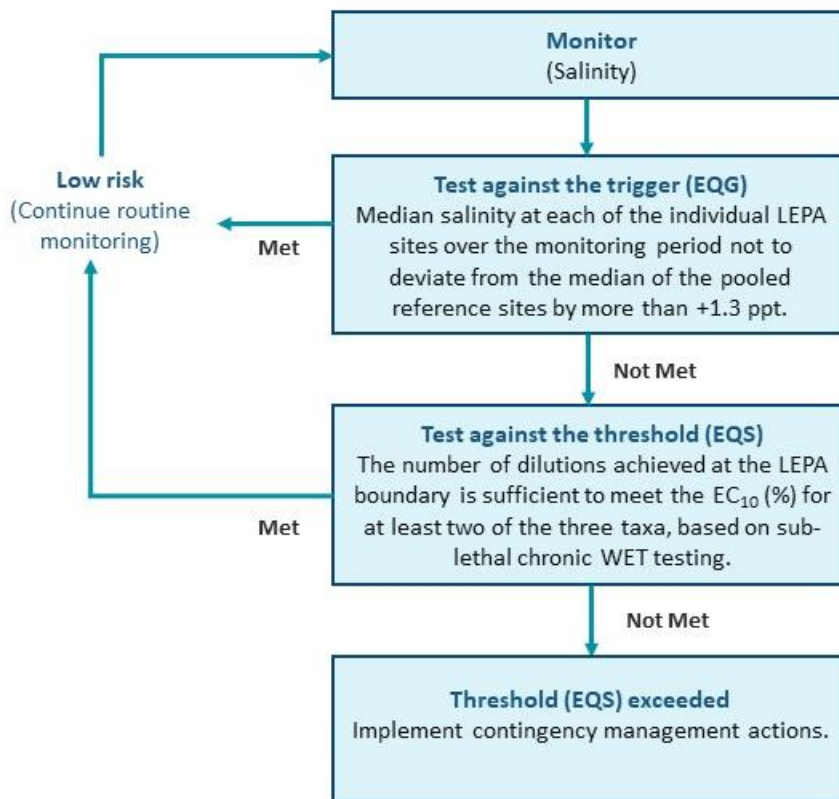


Figure note:

EQG = Environmental Quality Guideline; EQS = Environmental Quality Standard; LEPA = Low Ecological Protection Area; WET = whole of effluent toxicity.

**Figure 4.1 Management response framework for salinity**

#### 4.1.2 Threshold criteria assessment

WET testing shall be conducted annually between December and May to ensure the number dilutions achieved at the LEPA boundary is sufficient to meet the  $EC_{10}(\%)$  values for at least three local taxa, based on sub-lethal chronic tests applied to macroalgae, fish and crustaceans. Testing shall be conducted using a sample of the waste stream obtained during normal operations, without specifically targeting or avoiding the addition of CIP<sup>2</sup>.

The  $EC_{10}(\%)$  values will be compared to the validated number of dilutions at the LEPA boundary to determine if the dilution is adequate to meet the  $EC_{10}(\%)$  thresholds. To achieve the osmotic stress threshold criterion, the number of dilutions must be sufficient to achieve the  $EC_{10}(\%)$  value for at least two of the three species.

If the threshold is exceeded, Water Corporation will initiate management as per the contingency actions outlined in **Notes**:

OEPA = Office of the Environmental Protection Authority; EQO = Environmental Quality Objective; LEPA = Low ecological protection area; WET = Whole of Effluent; CIP = Clean in Place

<sup>2</sup> Cleaning chemicals will form part of the wastewater composition <10% of the time.





Table 2.2.

## 4.2 Thermal stress

### 4.2.1 Trigger criteria assessment

Temperature loggers will be deployed for a minimum period of six months period between December and May (following the same rationale for salinity logger deployments). Loggers will be positioned on the northern, southern and western sides of the LEPA and at reference sites located north and south of the diffuser, at a height approximately 0.5 m above the seafloor (**Figure 2.1**).

Once retrieved, the data will be filtered to remove spurious points or data recorded during deployment and retrieval. The data will be subject to validation against a logger standard; if significant data drift is identified, data will be post-processed to correct for drift in accordance with the manufacturer’s recommendations.

To achieve the water temperature trigger criteria, the median water temperature at the individual LEPA sites must be less than the 80<sup>th</sup> percentile of the combined reference sites. The 6-month data set for temperature will be divided into Summer and Autumn and median and 80<sup>th</sup> percentile trigger values calculated from the LEPA and Reference site data, respectively. Impact site medians for each site/season are assessed against the relevant seasonal trigger. Upon an exceedance of the water temperature trigger criteria, investigations shall commence against the threshold criteria, as per the response framework in **Figure 4.2**.

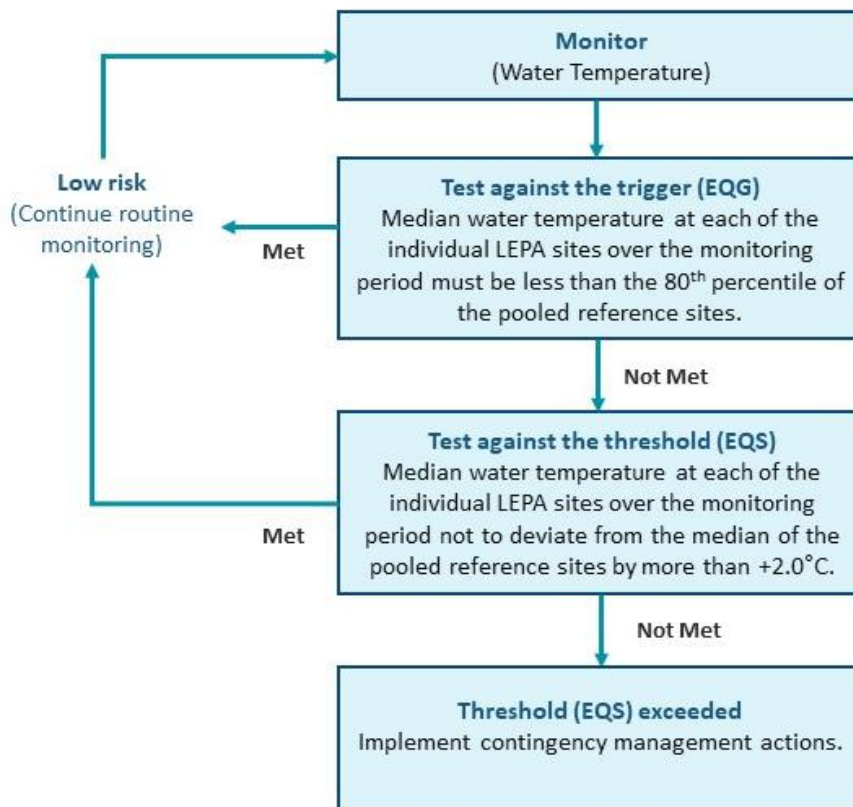


Figure note:

EQC = Environmental Quality Criteria; EQG = Environmental Quality Guideline; EQS = Environmental Quality Standard; LEPA = Low Ecological Protection Area

**Figure 4.2 Management response framework for water temperature**



#### 4.2.2 Threshold criteria assessment

Water temperature will be measured using the approach described in **Section 4.2.1**. To achieve the water quality threshold, median water temperature values at the individual LEPA boundary sites must not exceed the median value of the combined reference sites by more than +2.0°C. If the threshold is exceeded, Water Corporation will initiate management as per the contingency actions outlined in **Notes**:

OEPA = Office of the Environmental Protection Authority; EQO = Environmental Quality Objective; LEPA = Low ecological protection area; WET = Whole of Effluent; CIP = Clean in Place



Table 2.2.

## 4.3 Aesthetics

### 4.3.1 Trigger criteria assessment

A visual assessment will be completed at the individual LEPA sites and at the reference sites with the results recorded against the proforma shown in **Table 4.1**. Aesthetic appearance will be assessed at times coinciding with logger deployment and recovery between December and May.

The reduction in water clarity will be assessed as a 20% increase in the light attenuation coefficient or a 20% reduction in Secchi depth relative to an unimpacted reference site. Variation in water colour will be determined as the difference in colour estimated by comparison to the Munsell scale between an impact site water sample colour and one from the reference site.

As per EPA guidance (2017), many of the guidelines for aesthetic quality are subjective and relate to the general appreciation and enjoyment of the Alkimos marine environment by the community. Consequently, when using these criteria to determine if aesthetic value is being maintained, consideration will be given to whether the observed change is in a location, or of an intensity, likely to trigger community concern and to whether the changes are transient, persistent or regular events.

Upon an exceedance of the aesthetics criteria, investigations shall commence against the threshold criteria, as per the response framework in **Figure 4.3**. If possible, the marine organisms referred to in EQG1 should be collected for forensic analysis to determine the cause of death, and/or exclude non-ASDP contributions to mortality (e.g. an algal bloom or a disease).

**Table 4.1 Example field observations template for aesthetics**

Environmental Quality Guideline	Result	Comments
Dead marine organisms visible?	Yes/No	
Visual clarity (Secchi depth)	Metres	
Noticeable change in hue?	Yes/No	

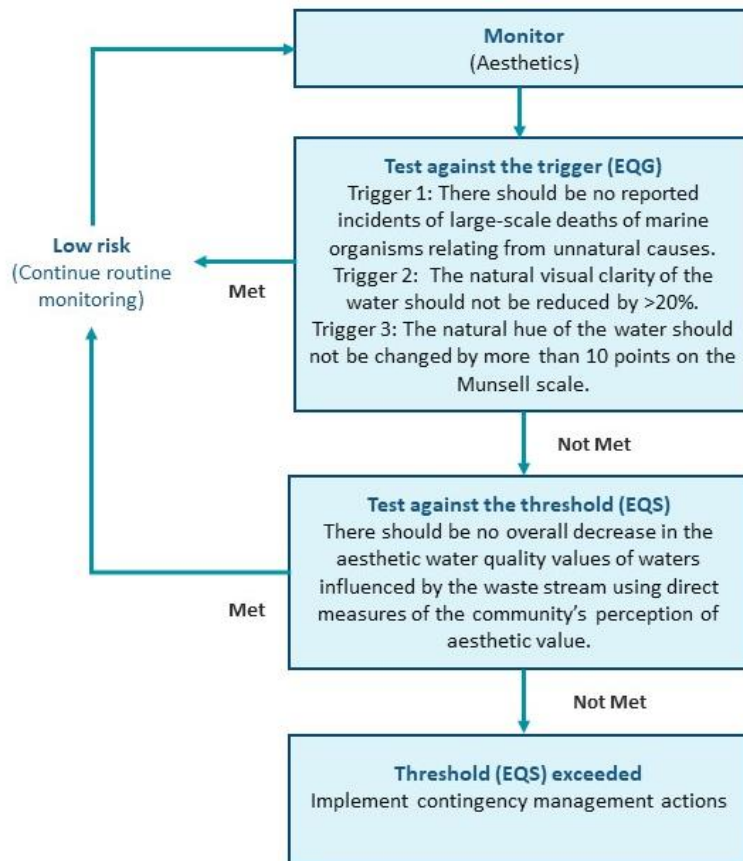


Figure note:  
EQC = Environmental Quality Criteria; EQG = Environmental Quality Guideline; EQS = Environmental Quality Standard.

### Figure 4.3 Management response framework for aesthetics

#### 4.3.2 Threshold criteria assessment

A complaints register shall be established and trends in complaints determined to serve as a threshold criteria assessment of community perception of aesthetic values. If the performance threshold is exceeded, Water Corporation will initiate management as per the contingency actions outlined in **Notes**:

OEPA = Office of the Environmental Protection Authority; EQO = Environmental Quality Objective; LEPA = Low ecological protection area; WET = Whole of Effluent; CIP = Clean in Place



Table 2.2.

## 5. Adaptive Management and Review of the COMEMP

### 5.1 COMEMP implementation

This COMEMP pertains to the commissioning and operation of the ASDP. The commissioning requirements of the COMEMP will be implemented during commissioning, which is scheduled to occur over a 6 to 8-month period following construction. The operational requirements of the COMEMP will be implemented upon completion of commissioning.

Operational monitoring will be suspended should production cease and/or if the plant is placed into “care and maintenance.” Review and revision of this COMEMP will be undertaken as required to incorporate the results of monitoring and/or further knowledge on effective environmental management of the waste stream. Any significant changes to this COMEMP will result in it being resubmitted for approval.

### 5.2 Roles and responsibilities

The proponent is responsible for implementing this COMEMP and maintaining compliance with its provisions.

### 5.3 Adaptive management for dissolved oxygen/stratification

Model projections (DHI 2019) will be validated during a dedicated DO sampling campaign during wet commissioning (see **Section 3.1.2**). Potential salinity-based stratification may need ongoing management if monitoring and revised modelling during the wet commissioning phase suggests that there is a risk modelled DO fields underestimated depletion and will be developed in consultation with the DWER.

### 5.4 Reporting and auditing

The extent to which the environmental objectives have been achieved will be assessed against the trigger and threshold criteria and reported in the annual report. If the trigger or threshold criteria (or both) were exceeded during the reporting period, the annual report will include a description of the effectiveness of trigger criteria level actions, and threshold criteria contingency actions that have been implemented to manage the impact, as well as an analysis of trends. The Annual Report will be submitted to the OEPA and made publicly available via Water Corporation’s website.





## 6. Stakeholder Consultation

The Proponent has undertaken stakeholder consultation during the development of the Environmental Review Document (Water Corporation 2022) for the ASDP Proposal. This consultation has included relevant regulatory, industry and community stakeholders. Stakeholder consultation will continue on an as-required basis, through the approvals, design, construction and operation phases of the Proposal. For further description of the stakeholder consultation process refer to Section 4 of the Environmental Review Document (Water Corporation 2022).



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