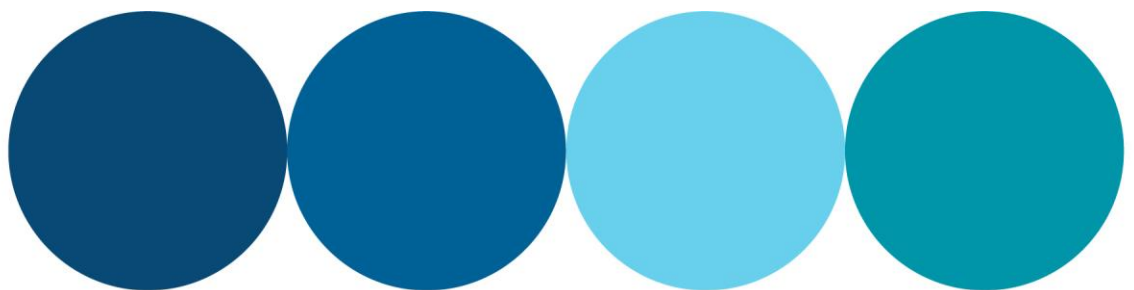


Sepia Depression Ocean Outlet Landline (SDOOL) & Perth Long Term Ocean Outlet Monitoring Program (PLOOM)

2020-2021 Annual Report





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BMT Commercial Australia Pty Ltd has prepared this report in accordance with our Integrated Management System, in compliance with OHSAS18001, ISO14001 and ISO9001

Status

This report is 'Draft' until approved for final release, as indicated below by inclusion of signatures from: (i) the author and (ii) a Director of BMT commercial Australia Pty Ltd (BMT) or their authorised delegate. A Draft report may be issued for review with intent to generate a 'Final' version but must not be used for any other purpose.

Approved for final release:

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Date: 02/09/2021



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Acronyms




ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
CFU	Colony forming unit
DoH	Western Australian Department of Health
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
MPN	Most probable number
NATA	National Association of Testing Authorities
NOEC	No observed effect concentration
OZI	Observed zone of influence
PLOOM	Perth Long Term Ocean Outlet Monitoring
SDOOL	Sepia Depression Ocean Outlet Landline
TTC	Thermotolerant coliforms
TTM	Total toxicity of the mixture
TWW	Treated wastewater
WASQAP	Western Australian Shellfish Quality Assurance Program
WET	Whole of effluent toxicity
WRRF	Water Resource Recovery Facility
WWTP	Wastewater Treatment Plant



Executive Summary

This report documents the findings of the 2020–2021 Sepia Depression ocean monitoring program. Results are reported in the context of the Environmental Quality Management Framework (EQMF) described in EPA (2017). The results are summarised in Report Card format (Table ES 1). The report card contains colour-coded results, with the individual colours representing the extent to which the Environmental Quality Criteria (EQC) were met (Table ES 1–Table ES 4).





Table ES 1 Summary report card legend

Management response	Colour
Monitor: EQG & EQS met (continue monitoring)	
Investigate: EQG not met (investigate against the EQS)	
Action: EQS not met (management response required)	







Note:

1. The required response following an exceedance of either the Environmental Quality Guideline (EQG) or Environmental Quality Standard (EQS) is shown in parentheses.

Table ES 2 Summary report card for the Environmental Quality Objective ‘Maintenance of Ecosystem Integrity’

Environmental quality indicator		EQC	Comments	Compliance
Toxicants in treated wastewater (TWW)	Bioaccumulating toxicants	EQG	Concentrations of cadmium and mercury in the undiluted TWW stream were below the analytical limit of reporting (0.1 µg/L) and the ANZG (2018) 80% species protection guideline (36 and 1.4 µg/L, respectively)	
	Non-bioaccumulating toxicants and initial dilution	EQG	Contaminant concentrations were lower than the ANZG (2018) triggers for 99% species protection guidelines after dilution equivalent to that expected at the LEPA boundary	
	Total toxicity of the mixture (TTM)	EQG	The TTM for the additive effect of ammonia, copper, and zinc after initial dilution (0.46) was below the ANZG (2018) guideline value of 1.0	
	Whole of effluent toxicity testing	EQG	The lowest NOEC during the reporting period was 6.3%. Only 16 dilutions with background seawater are required to achieve this NOEC which is lower than the dilutions typically achieved at the LEPA boundary.	






Nutrient enrichment	Chlorophyll-a	EQG	Median chlorophyll-a concentration within the high ecological protection area (HEPA) (0.20 µg/L) was lower than the 80 th percentile of historical reference site concentrations (0.4 µg/L)	
	Light attenuation coefficient (LAC)	EQG	Median LAC within the HEPA (0.076 Log ₁₀ /m) was lower than the 80 th percentile of historical reference sites (0.08 Log ₁₀ /m).	
Phytoplankton blooms	Phytoplankton biomass (measured as chlorophyll-a)	EQG	Median chlorophyll-a concentrations did not exceed three times the median of reference on any sampling occasion.	
			Median chlorophyll-a at any site did not exceed three times the median of reference sites on any sampling occasion during the summer monitoring period.	
Physical chemical stressors	Organic enrichment	EQG	Dissolved oxygen saturation within the HEPA remained above 90% saturation at all times.	
	Salinity	EQG	Median salinity was between the 20 th and 80 th percentile of the natural salinity range within the HEPA	

Notes:

1. Green (■) symbols indicate the Environmental Quality Guideline (EQG) was met; amber (■) and red (■) symbols represent an exceedance of the EQG or Environmental Quality Standard (EQS), respectively.
2. NOEC = no observed effect concentration; the highest concentration of TWW at which there is no statistically significant observed effect on gamete fertilisation.







Table ES 3 Summary report card for the Environmental Quality Objective ‘Maintenance of Seafood for Human Consumption

Environmental quality indicator		Comments	Compliance
Microbial contaminants	Thermotolerant coliforms (TTC)	Median TTC concentrations derived from 120 samples collected over the 2018–2019, 2019–2020 and 2020–2021 sampling seasons was at the limit of detection (<10 CFU/100 mL) and below the 14 CFU/100 mL criteria	
		Over the three sampling periods, there were 4 instances where TTC exceeded 21 CFU/100 mL, representing 3.3% (≤10%).	
Algal biotoxins	Toxic phytoplankton species	Toxic phytoplankton species were not recorded in excess of Western Australian Shellfish Quality Guidelines during 2020–2021 monitoring.	

Notes:

1. Green (■) symbols indicate the Environmental Quality Guideline (EQG) was met; amber (■) and red (■) symbols represent an EQG or Environmental Quality Standard (EQS), respectively.
2. TTC results below the analytical detection limit (<10 CFU/mL) were halved (=5 CFU/mL) to calculate median value.
3. TTC = Thermotolerant coliforms.

Table ES 4 Summary report card for the Environmental Quality Objective ‘Maintenance of Primary and Secondary Contact Recreation’










Environmental Quality Indicator		EQC	Comments	Compliance
Faecal streptococci	<i>Enterococci</i> spp.	EQG (primary contact; 200 MPN/100 mL)	The 95 th percentile of <i>Enterococci</i> spp. was 2000 MPN/100 mL	
		EQS (primary contact; 500 MPN/100 mL)	The 95 th percentile of <i>Enterococci</i> spp. was 2000 MPN/100 mL	
		EQG (secondary contact; 2000 MPN/100 mL)	The 95 th percentile of <i>Enterococci</i> spp. was 2000 MPN/100 mL	
Algal biotoxins	Phytoplankton (cell concentration)	EQG (15 000 cells/mL)	The median total phytoplankton cell concentration was 3 cells/mL and below the EQG (15,000 cells/mL)	

Note:

1. Green (■) symbols indicate the Environmental Quality Guideline (EQG) was met; amber (■) and red (■) symbols represent an exceedance of the EQG or Environmental Quality Standard (EQS), respectively.



Table ES 5 Summary report card for the Environmental Quality Objective ‘Maintenance of Aesthetic Values’

Environmental Quality Indicator	EQC	Comments	Compliance ¹
Nuisance organisms	EQG	Nuisance organisms were not present in excessive amounts	
Faunal deaths	EQG	There were no instances of dead marine organisms observed	
Water clarity	EQG	Measurements of light attenuation determined that the natural visual clarity of the water was reduced by ~9% (i.e. > 20%).	
Colour	EQG	There was a slight noticeable colour variation on 2 sampling occasions. No noticeable colour was recorded on any other sampling events.	
Surface films	EQG	No surface films or oil were recorded on any sampling event.	
Surface debris	EQG	No floating debris or matter was visible on the surface on any sampling occasion.	
Odour	EQG	A slight odour was noticed on 25% of sampling occasions. No noticeable odour was detected on any other sampling occasion.	
Surface films and debris	EQS	There was no overall decrease in the aesthetic water quality values of Cockburn Sound using direct measures of the community’s perception of aesthetic value.	
Fish tainting substances	EQG	There were no recorded exceedances of fish tainting substances in the 2020-2021 monitoring period.	

Note:

1. Green (■) symbols indicate the Environmental Quality Guideline (EQG) was met; amber (■) and red (■) symbols represent an exceedance of the EQG or Environmental Quality Standard (EQS), respectively.



1 Introduction

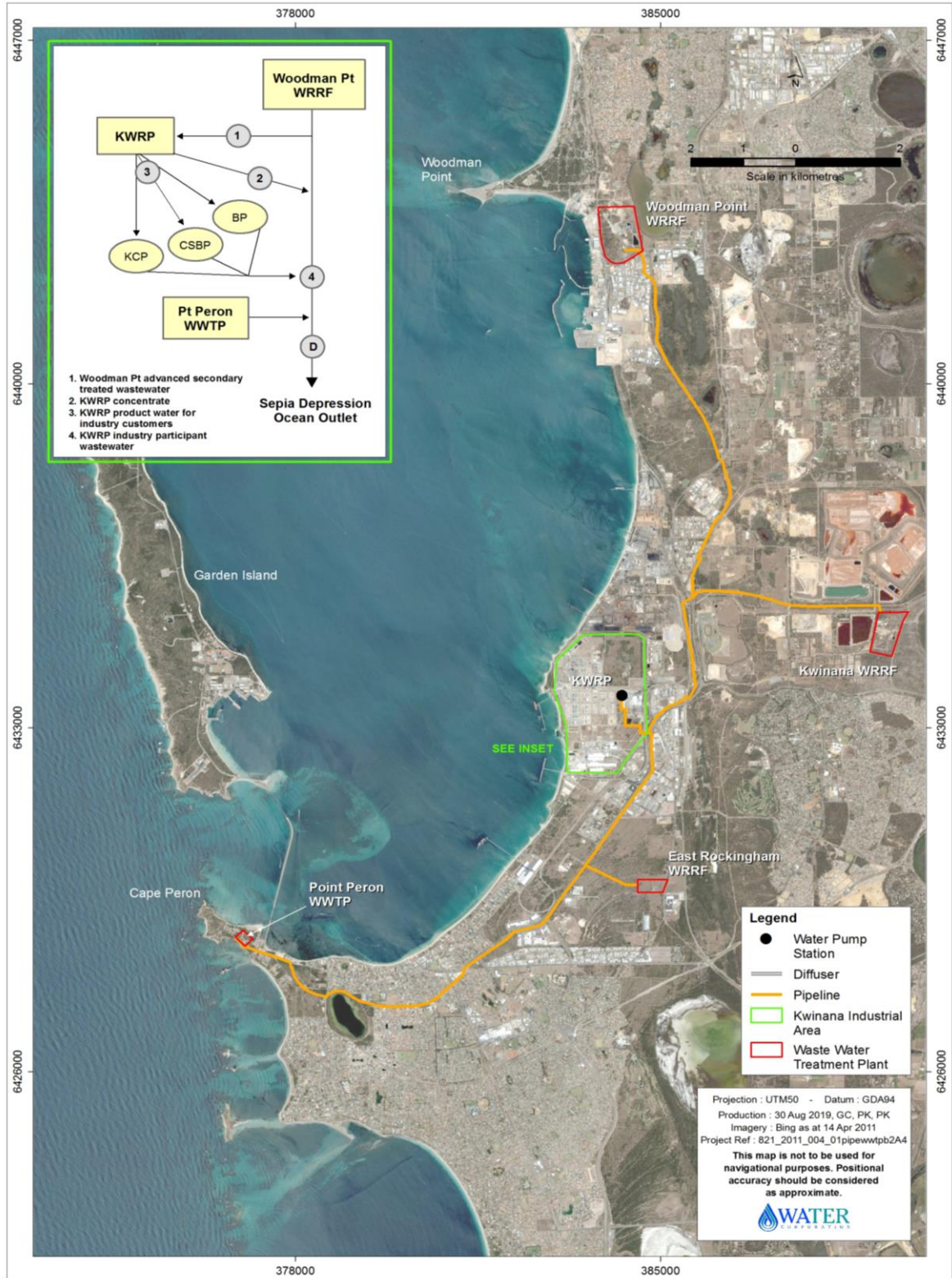
1.1 Document purpose

This annual report documents the findings of the 2020–2021 ocean monitoring around the Sepia Depression ocean outlet. Monitoring was completed according to the Sepia Depression Ocean Outlet Landline (SDOOL) Monitoring and Management Plan (SDOOL MMP; BMT Oceanica 2014).

1.2 Wastewater treatment plant infrastructure and discharge

Treated wastewater (TWW) discharged through the Sepia Depression ocean outlet comes from the Woodman Point Water Resource Recovery Facility (WRRF), East Rockingham WRRF, Kwinana WRRF, Point Peron Wastewater Treatment Plant (WWTP), and the Kwinana Water Reclamation Plant (KWRP) (Figure 1). Most TWW discharged to the Sepia Depression is from the Woodman Point WRRF.

The Woodman Point WRRF services the southern Perth metropolitan area and receives predominantly domestic wastewater (from kitchen, bathroom, toilet and laundry uses), with ~8% received from light industrial wastewater. A small volume of primary TWW is discharged from the Point Peron WWTP, located downstream of the Woodman Point WRRF (Figure 1). The KWRP processes secondary TWW from the Woodman Point WRRF to a quality suitable for use as high-grade industrial processing water by industries in the Kwinana industrial area. This high-grade industrial water is supplied to industry participants to reduce consumption of potable scheme water. The KWRP process concentrate is disposed of via the SDOOL (refer to Figure 1).



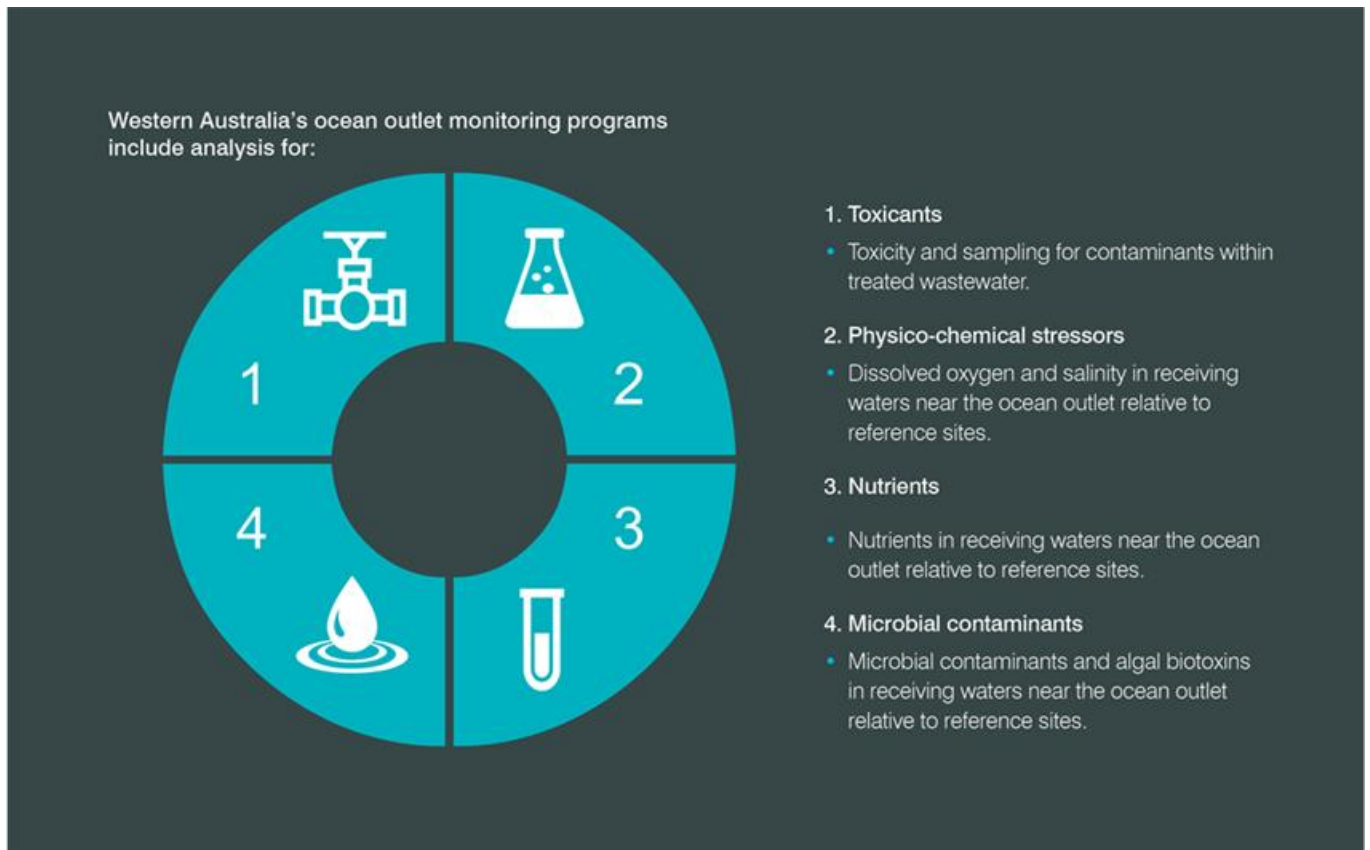
Notes:

1. WWTP = wastewater treatment plant; WRRP = Water Resource Recovery Facility; KWRP = Kwinana Water Reclamation Plant; BP = BP Refinery; KCP = Kwinana Cogeneration Plant; CSBP = CSBP Limited
2. Point D is the composite treated wastewater sample point prior to discharge

Figure 1 Location of Sepia Depression Ocean Outlet Landline (SDOOL) and its contributors



1.3 Potential stressors in treated wastewater



1.3.1 Toxicants

Metals and persistent organic compounds may be toxic to marine species or accumulate in biota at concentrations sufficient to pose a risk to human health when consumed. TWW is screened for bioaccumulating and non-bioaccumulating toxicants prior to discharge. To account for the synergistic effect of multiple toxicants and toxicants without guidelines, the overall toxicity of the discharge is determined using whole of effluent toxicity (WET) testing (also known as direct toxicity assessment).

1.3.2 Physico-chemical stressors

TWW contains organic matter, decomposition of which by microorganisms uses oxygen. If more dissolved oxygen (DO) is consumed than is produced, DO levels decline. DO saturation in receiving waters near the outfalls provides an indication of the risk posed by deoxygenation.

Reduced salinity near the outfalls, resulting from freshwater in the TWW plume, may cause osmotic stress in marine biota. Salinity in receiving waters near the outfalls is compared to the salinity at appropriate reference sites to determine whether salinity near the outfalls is within the range of natural variability.

1.3.3 Nutrients

TWW contains elevated concentrations of the biologically available nutrients, ammonia, nitrite, nitrate and orthophosphate. At times, the addition of nutrients may stimulate phytoplankton growth beyond natural levels, which can lead to shading of photosynthetic organisms such as seagrasses and macroalgae. The potential for shading is measured using in-water measures of chlorophyll-a (a measure of phytoplankton biomass) and light attenuation (a measure of water clarity).



Although most algal blooms are harmless, some contain species that produce toxins that may be harmful to swimmers (via ingestion or skin contact) or contaminated seafood. Phytoplankton species composition and cell concentrations are monitored to ensure concentrations are within acceptable limits.

1.3.4 Microbial contaminants

Disease-causing organisms in the TWW pose a risk to humans if exposed during primary and/or secondary contact activities (i.e. swimming and boating). The same organisms if ingested by marine fauna may reduce their suitability for human consumption. To assess the risk, concentrations of indicator organisms are routinely compared to the Environmental Protection Authority's (EPA's) criteria for primary and secondary contact, and the criteria for seafood safe for human consumption.

1.4 Environmental management approach

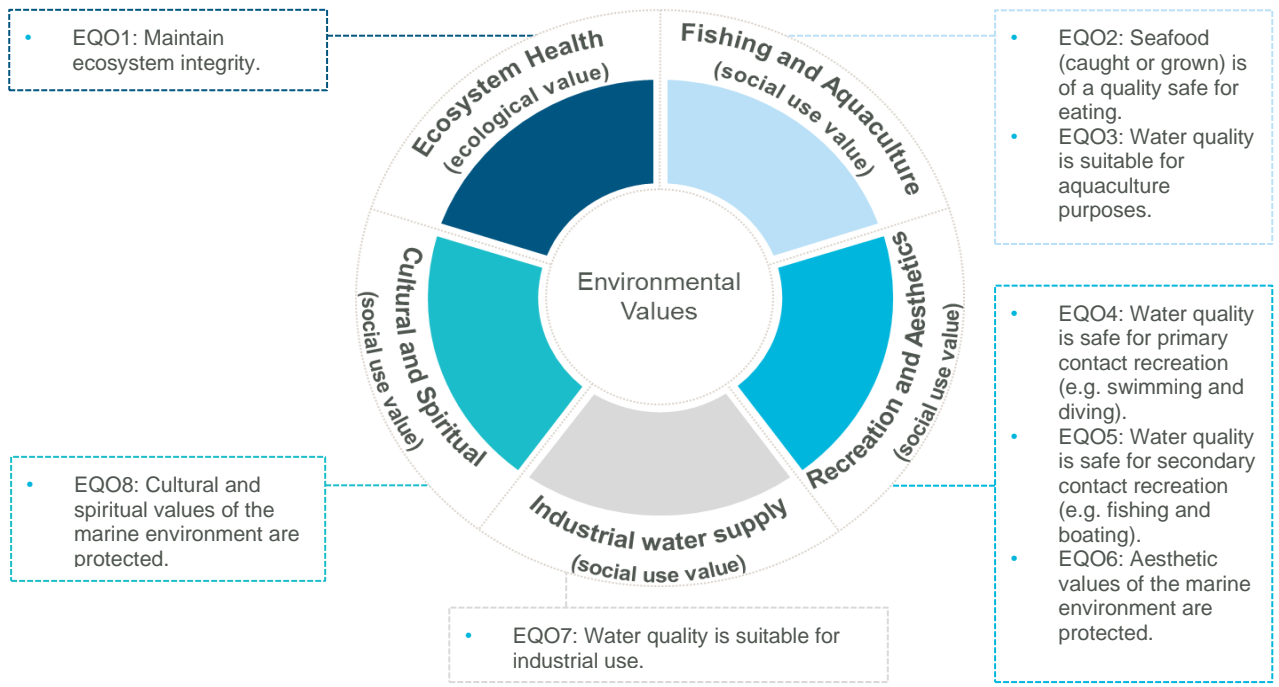
The Sepia Depression Long Term Ocean Outlet (SDOOL) and Perth Long Term Ocean Outlet Monitoring (PLOOM) programs are underpinned by the State Governments Environmental Quality Management Framework (EQMF; EPA 2017).

The EQMF is based on:

- identifying Environmental Values (EVs) (Figure 2)
- establishing and spatially defining Environmental Quality Objectives (EQOs) that need to be maintained to ensure the associated EVs are protected (Figure 2)
- 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 benchmarks or 'trigger values' against which monitoring results can be compared.

There are two levels of EQC:

1. Environmental Quality Guidelines (EQGs) are quantitative, investigative triggers, which if met, indicate there is a high degree of certainty that the associated EQO has been achieved. If the guideline is not met a more detailed assessment against the EQS is triggered.
2. Environmental Quality Standards (EQSs) are management triggers which, if exceeded, signify that the EQO is at risk of not being met and that a management response may be required.



Source: EPA (2016)

Figure 2 Environmental Values and Environmental Quality Objectives (EQO) for the marine waters off Western Australia

1.4.1 Maintenance of Ecosystem Integrity EQO

The intent of this EQO is to maintain a healthy and diverse ecosystem. There are four levels of ecological protection, with each applied depending on the designated level required: low, moderate, high or maximum (Figure 3). A low ecological protection area (LEPA) has been established at the Sepia Depression outfall and occupies the area within a 100 m radius of the diffuser (BMT Oceanica 2014). Waters outside the LEPA are maintained to a high level of ecological protection (HEPA; Figure 4).

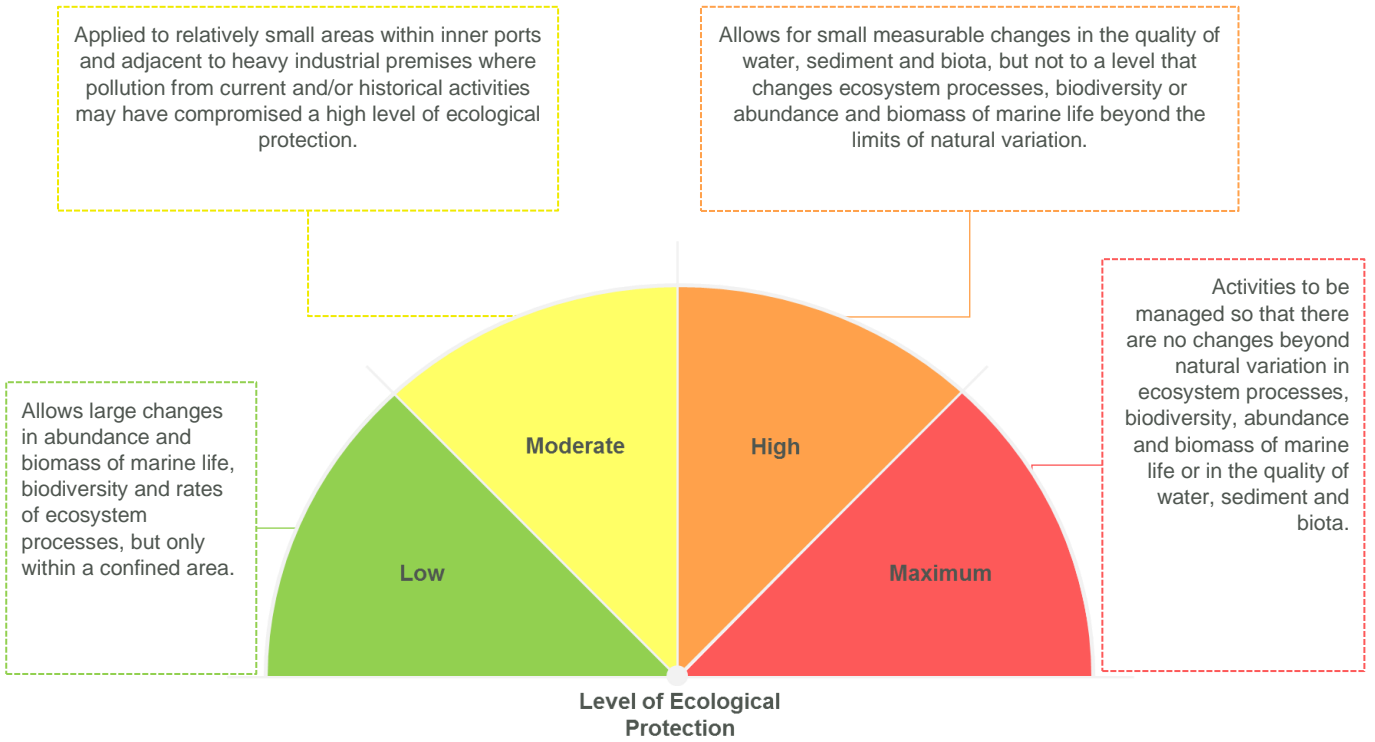


Figure 3 Level of ecological protection

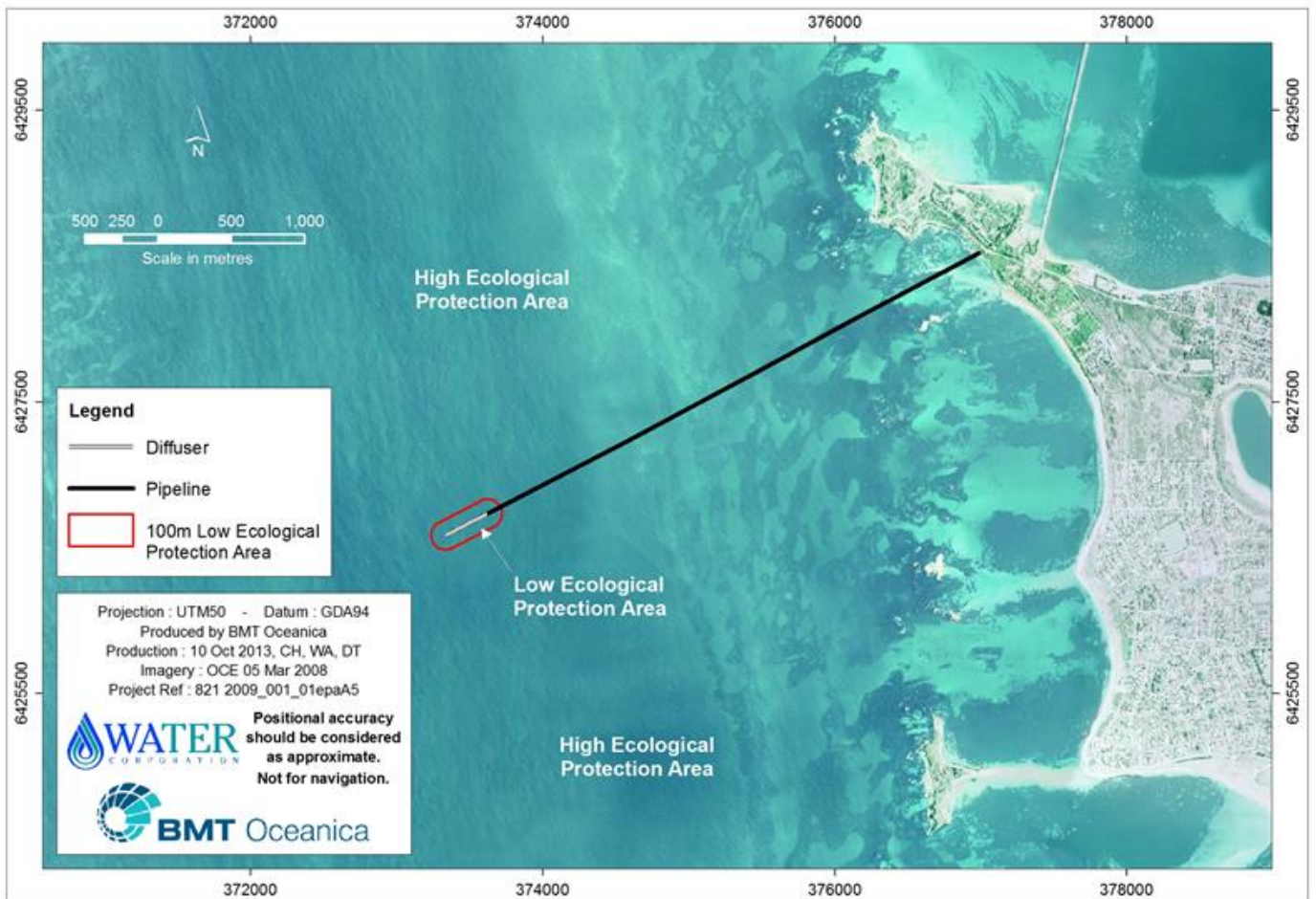


Figure 4 Sepia Depression ocean outlet and low ecological protection boundary



1.4.2 Maintenance of Seafood Safe for Human Consumption EQO

The intent of this EQO is to maintain seafood safe for human consumption (a social value), except for a small area surrounding the ocean outlet where EQO 2 may not apply and seafood may be unsafe to eat. Formal management zones have been established for the Sepia Depression outlet. Microbiological contaminants and algal biotoxins are monitored at the boundary of the Shellfish Harvesting Exclusion Zone (SHEZ) to ensure the EQO is being met.

1.4.3 Maintenance of Primary and Secondary Contact Recreation EQO

The intent of the primary and secondary contact EQOs are to support swimming and boating activities, respectively. The EQOs apply throughout Perth's coastal waters except to areas around ocean outlets, where water quality may not be suitable for swimming. An area where primary contact recreation is not recommended has been established for the Sepia Depression outlet. This is known as the recreational contact zone.

1.4.4 Maintenance of Aesthetic Value EQO

The objective of this EQO is to ensure that the aesthetic value of Perth's coastal waters is protected. To ensure this EQO is being met, monitoring routinely assesses the quality of the surface water appearance.

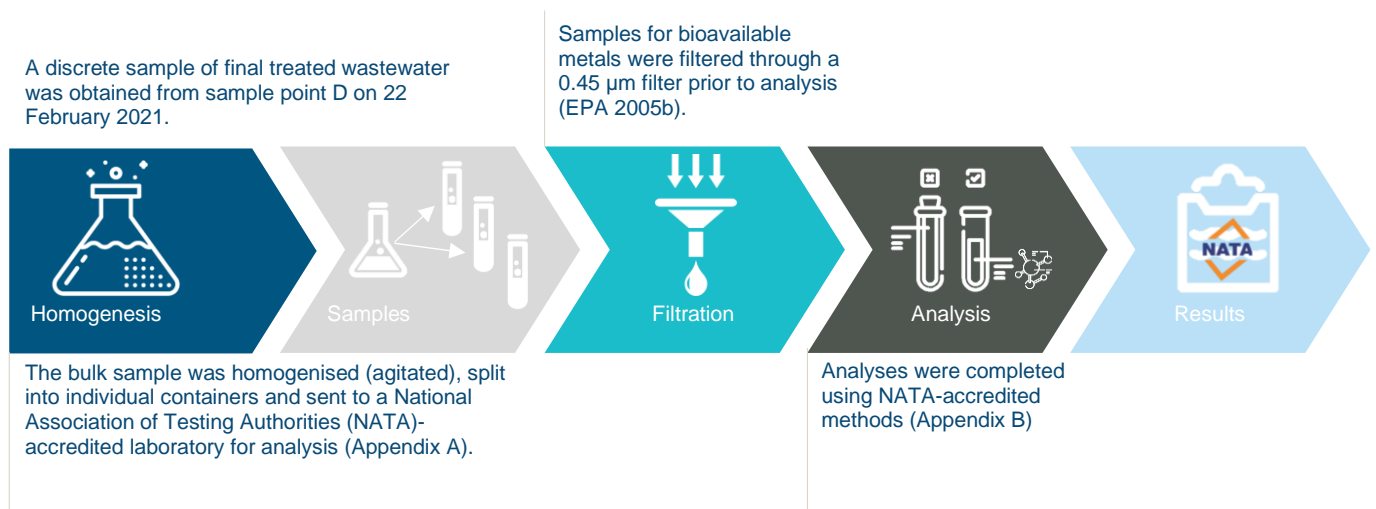


2 Toxicants in treated wastewater

2.1 Comprehensive treated wastewater characterisation

TWW (final effluent) from the Point Peron WWTP was analysed for a suit of parameters comprising the major contaminants of concern for the Sepia Depression ocean outlet:

- nutrients (total nitrogen, ammonia, nitrate+nitrite (NO_x), total phosphorus, orthophosphate)
- microbiological contaminants (thermotolerant coliforms and *Enterococci* spp.)
- bioavailable metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc)
- pesticides and herbicides (organophosphate pesticides, organochlorine pesticides, triazine herbicides)
- polyaromatic hydrocarbons
- phthalates
- polychlorinated biphenyls
- benzene, toluene, ethylbenzene, and xylenes
- petroleum hydrocarbons
- surfactants
- dissolved organic carbon



2.1.1 Bioaccumulating toxicants

Concentrations of cadmium and mercury (i.e. bioaccumulating toxicants) in the TWW sample were both below analytical limit of reporting (0.1 µg/L;



Table 8) and the EQG for bioaccumulating toxicants (36 and 1.4 µg/L, respectively) was met (Table 6).

Table 6 Environmental quality guideline for bioaccumulating toxicants

EQG	Concentrations of contaminants will not exceed the ANZG (2018) 80% species protection guideline trigger levels for bioaccumulating toxicants at the diffuser.
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Source: BMT Oceanica 2014

Note:

1. EQG = Environmental Quality Guideline.
2. ANZG (2018) used as specified by Management Plan (Oceanica 2013).

2.1.2 Non-bioaccumulating toxicants

Contaminant concentrations were below their waste stream triggers based on the ANZG (2018) 99% species protection guidelines scaled for dilution equivalent to that expected at the LEPA boundary (1:397; Appendix C). Therefore, the EQG (Table 7) was met (Table 8).

Table 7 Environmental Quality Guideline for non-bioaccumulating toxicants

EQG	Wastewater contaminant concentration corrected for minimum dilution at the LEPA boundary will ensure the ANZG (2018) 99% species protection guideline trigger levels for toxicants are being achieved at the boundary of the Low Ecological Protection Area (LEPA) (i.e. a high level of protection is met beyond a 100 m radius of the diffuser).
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Source: BMT Oceanica 2014





Table 8 Toxicants in the Sepia Depression TWW stream compared with relevant trigger levels

Toxicant	Sepia Depression TWW concentration (µg/L)	Waste stream trigger (µg/L) ^{1,2}
Ammonia-N	10 000	154 537
Cadmium*	<0.1	36
Chromium*	1.4	43
Copper*	312	68
Lead*	<1	679
Mercury*	<0.1	1.4
Nickel*	3	2016
Silver*	<0.8	248
Zinc*	53	2124
Chloropyrifos	<0.1	0.16
Endrin	<0.001	1.24
Endosulfan sulfate	<0.001	1.55
Benzene	<1	110 890
Naphthalene	0.02	15 485
Benzo(g,h,i)perylene	<0.01	15 485

Notes:

1. ANZG (20018) guidelines used as per SDOOL MMP (BMT Oceanica 2014). Assessment against ANZG (20018) 99% species protection guideline values was undertaken only for those toxicants where trigger levels were available.
2. ANZG (20018) scaled based on 5th percentile dilution at the LEPA boundary.
3. TWW = Treated wastewater.
4. The trigger values for marine waters are from Table 3.4.1 in ANZG (20018). The EPA has provided advice that in WA waters where a high level of protection applies, 99% species protection levels should be used.
5. The bioaccumulating toxicants cadmium and mercury must meet the 80% species protection guidelines at the diffuser (i.e. prior to initial dilution), and therefore a diluted concentration was not calculated.
6. Analytical limits for Chloropyrifos were not low enough to confirm exceedance of, or compliance with, the ANZG (20018) guidelines. Until detection limits required for direct comparison can be attained by commercial laboratories, WET testing will provide a test of the toxicity of the wastewater stream (See Appendix D).
7. Trigger values are for endosulfan, not endosulfan sulfate (Table 3.4.1; ANZG (20018)).
8. * = dissolved metals 0.45 µm filtered.



2.1.3 Total toxicity of the mixture

The total toxicity of the mixture (TTM, an indicator of the potential for cumulative toxic effects on marine organisms) for the combined effect of ammonia, copper and zinc following dilution (0.46, Table 10) was less than the ANZG (2018) guideline value of 1.0 and the EQG for TTM (Table 9) was met.

Table 9 Environmental Quality Guideline for the total toxicity of the mixture

EQG	The total toxicity of the mixture (TTM) for the additive effect of ammonia, copper and zinc, calculated as per ANZG (2018), will not exceed the trigger value of 1.0.
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Source: BMT Oceanica 2014

Notes:

1. EQG = environmental quality guideline; TTM = total toxicity of the mixture
2. $TTM = \sum(C_i/EQGi)$ where C_i is the concentration of the 'i'th component in the mixture and the $EQGi$ is the guideline for that component.

Table 10 Total toxicity of treated wastewater (TWW) at the edge of the initial mixing zone associated with the Sepia Depression ocean outlet

Toxicant	TWW concentration (µg/L)	Background concentration (µg/L) ¹	Dilution	Concentration after dilution (µg/L)	[contaminant] /guideline	TTM ²
Ammonia	10000	1.5	1:397	26.7	0.05	0.46
Copper	12	0.08		0.11	0.37	
Zinc	53	0.15		0.28	0.04	

Notes:

1. Background concentrations for copper and zinc from McAlpine et al. (2005); Perth marine waters (pp.19). Surface background concentrations for ammonia calculated as median of reference site data from 2003–2019 (BMT Oceanica, unpublished data).
2. $TTM = \text{total toxicity of the mixture} = [\text{ammonia}]/\text{guideline} + [\text{copper}]/\text{guideline} + [\text{zinc}]/\text{guideline}$.

2.2 Quarterly treated wastewater characterisation

Water Corporation conducts quarterly sampling of the final treated wastewater SDOOL waste stream from sample point D (Figure 1). Quarterly samples are analysed for a smaller set of the key contaminants of concern that are most likely to be present in the waste stream. Quarterly sampling occurred on 7 July 2020, 6 October 2020, 12 January 2021, 6 April 2021.

On each occasion, a composite sample (time weighted) was obtained from sample point D (Figure 1). This sample represents an average of the TWW discharged to the Sepia Depression ocean outlet for the 24 hours prior to and during the sample collection. The bulk sample was homogenised and split into separate sample containers for the various analyte groups. Samples were handled and analysed according to the NATA-accredited laboratory requirements.

The bioaccumulating toxicants cadmium and mercury met the 80% species protection guidelines (36 µg/L and 1.4 µg/L, respectively) in the TWW stream prior to dilution on each sample (Table 11).

Contaminants measured quarterly in the Sepia Depression TWW at sample point D were all below their respective waste stream triggers based on the ANZG (2018) 99% species protection scaled for dilution equivalent to that occurring at the LEPA boundary (Table 11).



Table 11 Toxicants measured quarterly in the Sepia Depression TWW stream compared with relevant guideline trigger levels after initial dilution

Toxicant ¹	Sepia Depression TWW sample point D (µg/L)				Waste Stream Trigger ² (µg/L)
	July 2020	October 2020	January 2021	April 2021	
Ammonia	25000	25000	6000	6600	154 537
Cadmium ⁵	0.1	0.1	0.1	0.1	36
Chromium	6	6	2	1	43
Cobalt	1	1	1	1	307
Copper	50	50	13	7	68
Lead	1	1	1	1	679
Mercury ⁵	0.1	0.1	0.1	0.1	1.4
Nickel	4	4	4	3	2016
Silver	1	1	1	1	248
Vanadium	10	10	10	10	14 913
Zinc	83	83	60	62	2124
Phenols	50	50	50	50	83 685

Notes:

1. Assessment undertaken only for toxicants with ANZG (2018) guideline values.
2. ANZG (2018) scale based on 5th percentile dilution at the LEPA boundary.
3. TWW = treated wastewater.
4. Bioaccumulating toxicants cadmium and mercury met the ANZG (2018) 80% species protection guidelines (of 36 and 1.4 respectively) at the diffuser (i.e. prior to dilution).

For the quarterly sampling, TTM was calculated for the additive effects of ammonia, copper and zinc using the dilution 1:397 based on that expected at the LEPA boundary. The TTM ranged between 0.41 and 0.87 on the four sampling occasions (Table 12), and all were below the ANZG (2018) guideline of 1.0.



Table 12 Total toxicity of the quarterly treated wastewater characterisation for the SDOOL combined waste stream

Quarterly sampling dates	Natural background concentration in Perth's coastal waters (µg/L) ¹			Dilution	Total toxicity of the mixture (TTM) ²
	Ammonia	Copper	Zinc		
July 2020	1.5	0.08	0.15	1:397	0.87
October 2020					0.85
January 2021					0.45
April 2021					0.41

Notes:

1. Background concentrations for copper and zinc from McAlpine et al (2005); Perth marine waters (p.19). Surface concentrations for ammonia calculated as a median of reference site data from 2003–2021 (BMT Oceanica, unpublished data).
2. Total toxicity of mixture = [ammonia]/guideline + [copper]/guideline + [zinc]/guideline.

2.3 Whole of effluent toxicity (WET) testing

WET testing is useful for assessing the toxicity of potential contaminants without guidelines, or where the effects may be cumulative. Fertilisation success in sea urchins (*Heliocidaris tuberculata*) exposed to salt-adjusted dilutions (0.5, 1.6, 3.1, 6.3, 12.5, 25, 50 and 100%) of TWW was used to calculate a No Observed Effect Concentration (NOEC; the highest concentration where no significant effect is observed) (Appendix D).



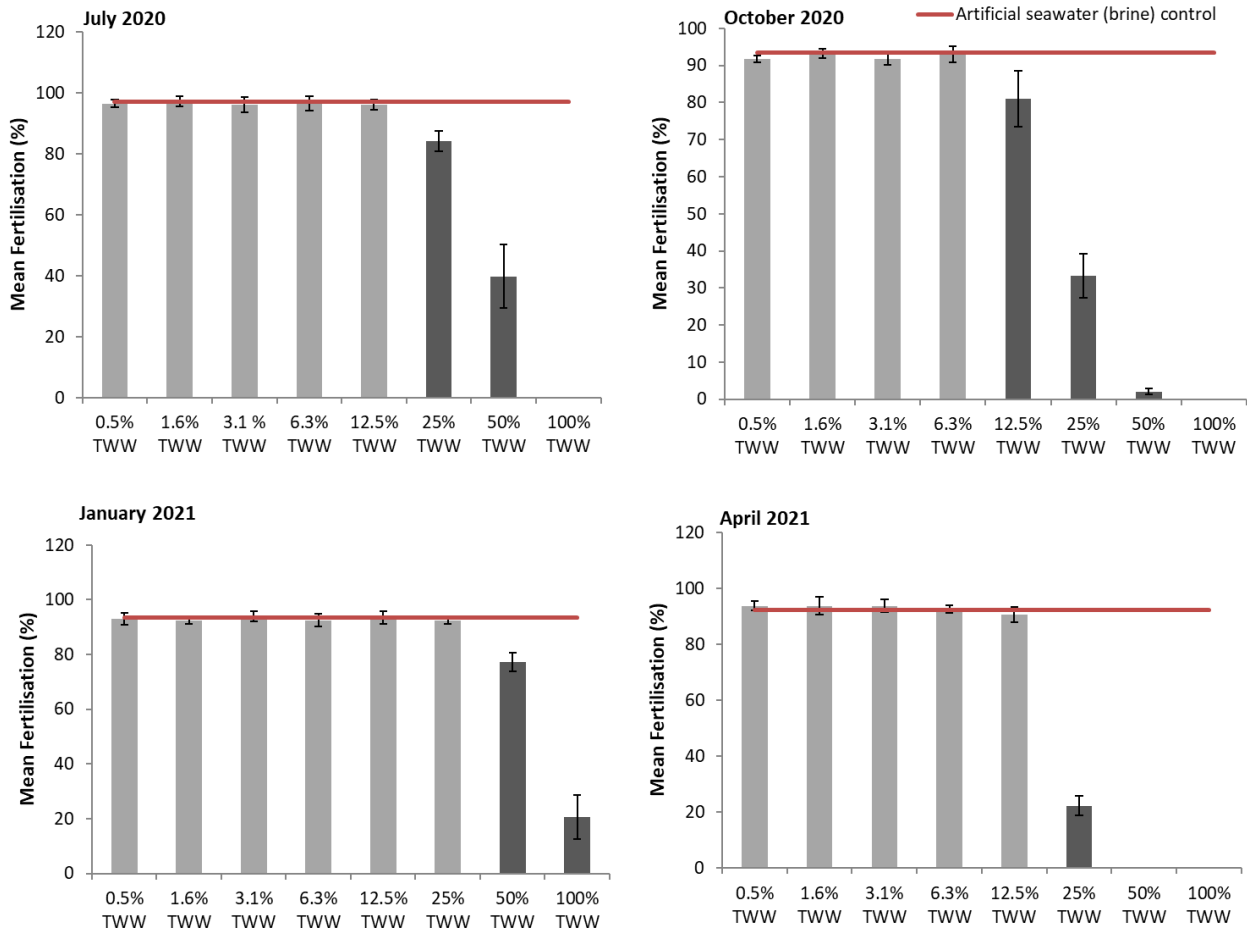
In July 2020 and April 2021, sea urchin fertilisation was significantly lower in samples exposed to 25%, 50% and 100% TWW dilutions than the artificial seawater control. All other concentrations were not significantly different to the control (Figure 5). In October 2020 sea urchin fertilisation success exposed to TWW dilutions 12.5%, 25%, 50% and 100% was significantly lower than the artificial seawater control (with all other concentrations not significantly different to the control; Figure 5). In January 2021, sea urchin fertilisation was significantly lower when exposed to 50% and 100% TWW dilutions than the artificial seawater control (with all other concentrations not significantly different to the control, Figure 5). For all four sampling dates, the NOEC was greater than 1% TWW (Table 14) and the EQG for WET testing (Table 13) was met.



Table 13 Environmental Quality Guideline for whole of effluent toxicity testing

EQG	The EQG will be exceeded if following the 1-hour sea urchin test:
	$\frac{TDA}{DRNOEC} \leq 1.0$
	where TDA = Typical Dilutions Achieved (constant based on 100-fold dilution) DRNOEC = number of dilutions required to achieve the no observed effects concentration (NOEC).
	Breaching the above triggers an investigation against the EQS, which would comprise the full suite of WET tests (minimum of five species from four trophic groups).

Source: BMT Oceanica 2014



Notes:

1. Error bars represent ± 1 standard deviation.
2. TWW = treated wastewater.
3. Light grey bars represent concentrations of treated wastewater (TWW) at which there is no observed significant effect on fertilisation. Dark grey bars represent concentrations of TWW that acted to significantly reduce the success of sea urchin fertilisation.

Figure 5 Comparison of whole effluent toxicity TWW dilution results to artificial seawater control



Table 14 **Calculated parameters from whole of effluent toxicity tests**

Indicator	July 2020	October 2020	January 2021	April 2021
NOEC (%)	12.5	6.3	25	12.5
Dilutions required to meet the NOEC	8	15.9	4	8
Dilutions required/dilution achieved	0.02	0.04	0.01	0.02
≤1	Yes	Yes	Yes	Yes

Notes:

1. NOEC = no observed effect concentration.
2. Calculation based on 310 dilutions achieved, which is expected at the LEPA boundary.



3 Water quality monitoring – receiving environment

Nutrients, phytoplankton biomass and physical and chemical stressors were monitored approximately fortnightly from the beginning of December 2020 to the end of March 2021 (coinciding the summer non-river flow period) along a down-current gradient away from the diffuser (Table 15; Appendix E).

Table 15 Water quality monitoring dates near the Sepia Depression ocean outlet between December 2020 and March 2021

Sample day	Date
1	07/12/2020
2	15/12/2020
3	08/01/2021
4	28/01/2021
5	09/02/2021
6	22/02/2021
7	04/03/2021
8	19/03/2021

Wind direction, strength, current grid direction and cloud cover on the day of sampling were recorded (Table 16).



Table 16 Weather and current grid during water quality monitoring near the Sepia Depression ocean outlets

Date	Wind direction	Wind strength (knots)	Cloud cover (%)	Current grid
07/12/2020	E, S, SW	4–15	0	SE
15/12/2020	SE, ESE, SSE	4–14	0	NW
08/01/2021	NE, NNE	1–10	0	S
28/01/2021	SSE, SSW	10–18	0–5	N
09/02/2021	W, WNW, WSW	5–12	70–80	SE
22/02/2021	SE, ESE	4–12	0	SW
04/03/2021	N, NNW	6–14	50–90	S
19/03/2021	NE	5–10	25–45	S

Notes:

1. N = north, S = south, W = west, E = east, SW = south-west, SE = south-east, NW = north-west, NE = north-east, ENE = east north-east, ESE = east south-east, SSE = south south-east, NNE = north north-east, SSW = south south-west, WNW = west, north-west, WSW = west south-west, NNW = north north-west
2. Winds are designated by the direction they come from while currents are designated by the direction they flow to.

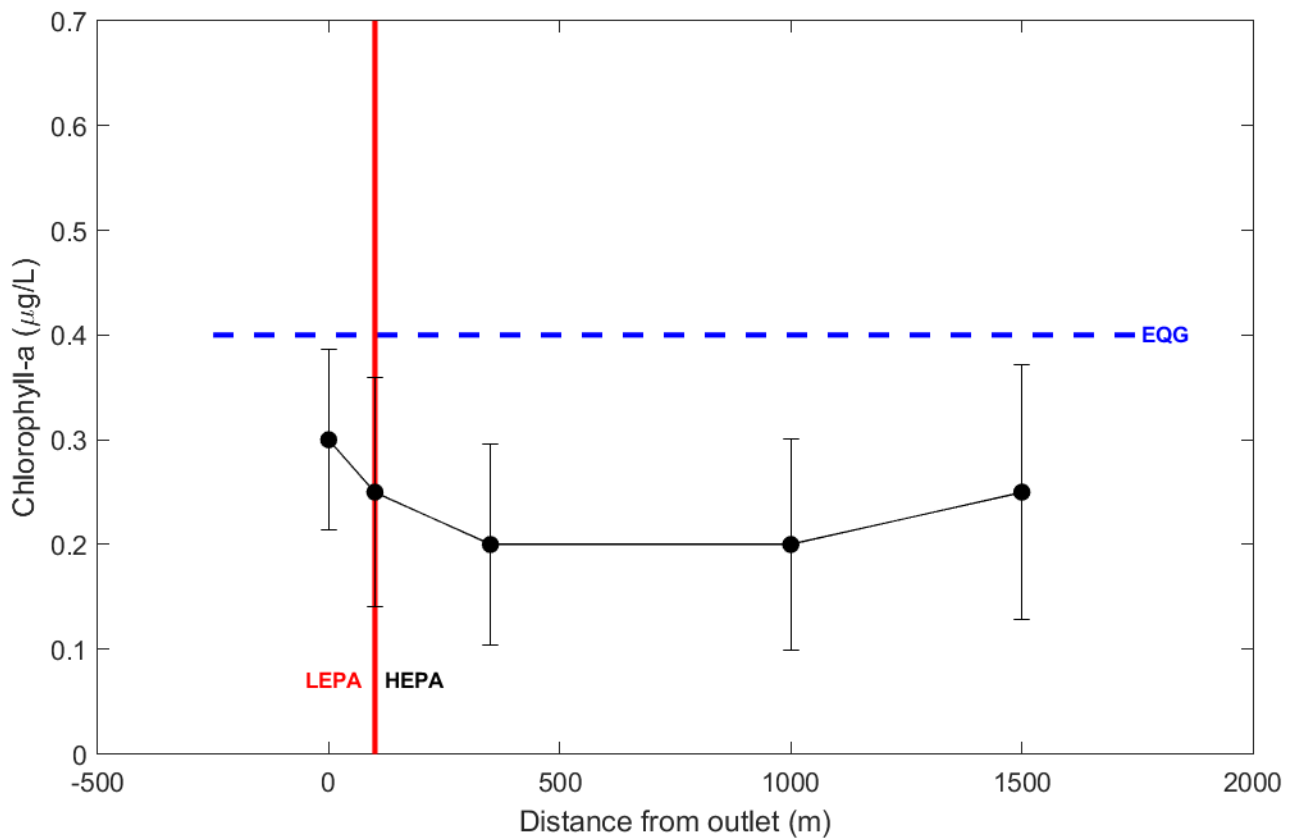
3.1 Nutrient enrichment

The median chlorophyll-a concentration in the Sepia Depression HEPA (≥ 100 m) was $0.20 \mu\text{g/L}$ and below the 80th percentile of historical reference site data ($0.4 \mu\text{g/L}$; Figure 6), meeting the EQG (Table 17, Appendix F).

Table 17 Environmental quality guidelines for nutrients

EQG	The median chlorophyll-a concentration in the HEPA (100 m plus) during the non-river flow period is not to exceed the 80 th percentile of historical reference site data.
	The median light attenuation coefficient in the HEPA (100 m plus) during the non-river flow period is not to exceed the 80 th percentile of historical reference site data.

Source: BMT Oceanica 2014

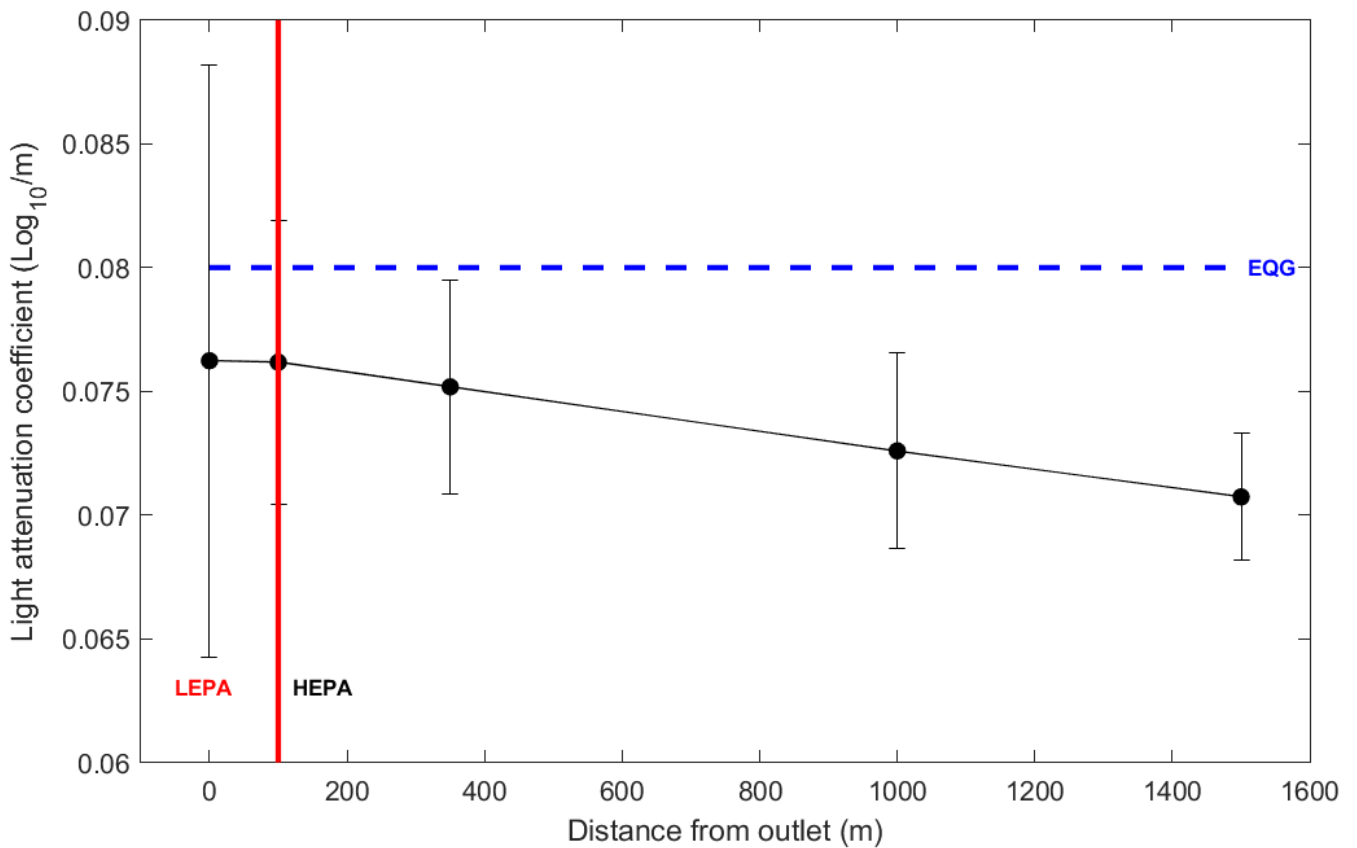


Notes:

1. Error bars represent ±95% confidence intervals
2. Dark blue dashed line = Environmental Quality Guideline (EQG) is the 80th percentile of historical reference site data.
3. LEPA = notional low ecological protection area; HEPA = high ecological protection area.
4. Data were pooled across eight sampling days (n=8) over December 2020 – March 2021.

Figure 6 Median chlorophyll-a concentration obtained at fixed monitoring sites above and down-current of the Sepia Depression outlet during the summer monitoring period

The median light attenuation in the Sepia Depression HEPA (≥ 100 m) was $0.075 \text{ Log}_{10}/\text{m}$ and was less than the 80th percentile of historical reference site data ($0.08 \text{ Log}_{10}/\text{m}$; Figure 7), meeting the EQG (Table 17).



Notes:

1. Error bars represent $\pm 95\%$ confidence intervals
2. Dark blue dashed line = Environmental Quality Guideline (EQG) is the 80th percentile of historical reference site data.
3. LEPA = notional low ecological protection area; HEPA = high ecological protection area.
4. Data were pooled across eight sampling days (n=8) over December 2020 – March 2021.

Figure 7 Median light attenuation coefficient obtained at fixed distances down-current of the Sepia Depression outlet during the summer monitoring period

3.2 Phytoplankton blooms

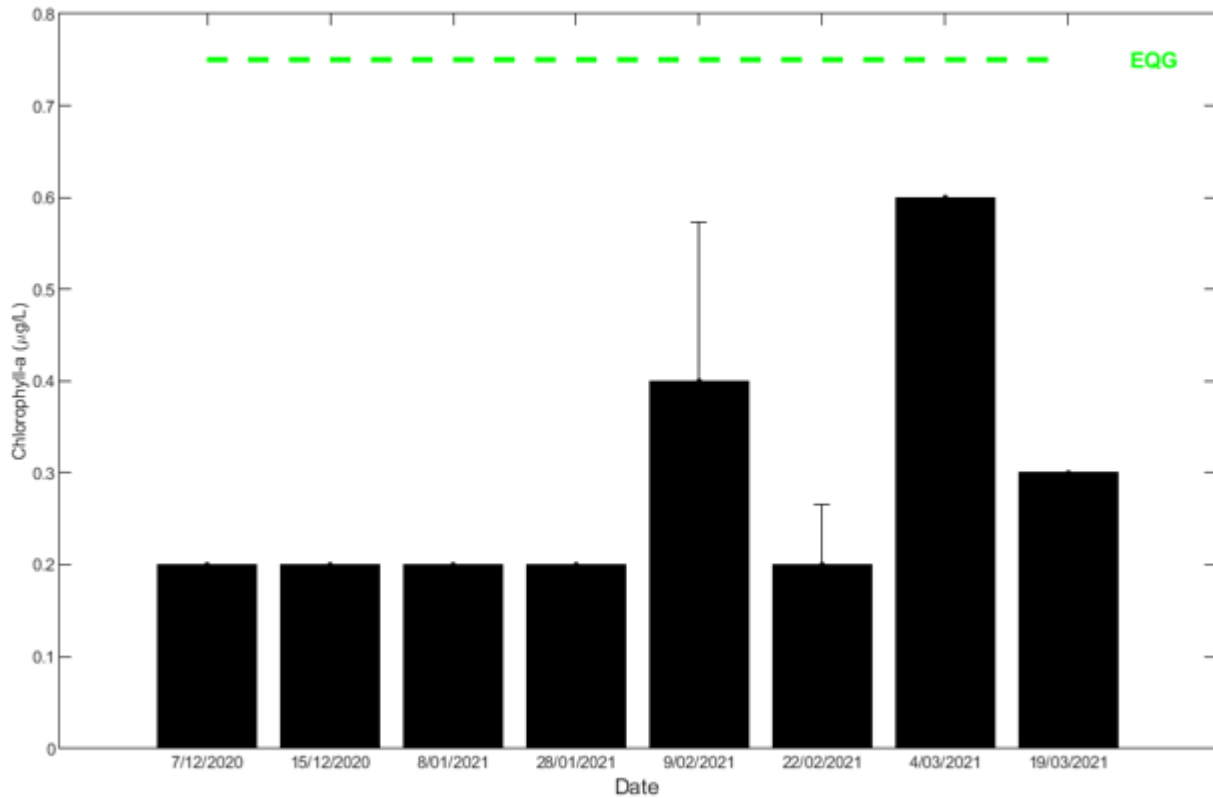
Median chlorophyll-a concentration within the HEPA did not exceed three times the median of historical reference sites (0.75 $\mu\text{g/L}$) on any sampling occasion during the summer monitoring period and EQG1 (Table 18) was met (Figure 8).

Table 18 Environmental Quality Guidelines for phytoplankton in receiving waters

EQG1	Median phytoplankton biomass, measured as chlorophyll-a is not to exceed 3 times the median chlorophyll-a concentration of reference sites, on any occasion during the non-river flow period.
EQG2	Phytoplankton biomass measured as chlorophyll-a at any site does not exceed 3 times the median chlorophyll-a concentration of reference sites, on 25% or more occasions during the non-river flow period.



Phytoplankton biomass measured as median chlorophyll-a at any site did not exceed three times the median of reference sites, on any sampling occasion during the summer monitoring period (Figure 8), meeting the requirements of EQG2 (<25% of occasions).



Notes:

1. Error bars represent $\pm 95\%$ confidence intervals
2. Green dashed line = Environmental Quality Guideline (EQG) is 3-times the median chlorophyll-a concentration of reference site data
3. Values measured at 0 m are not included in the figure or EQC assessment, as the 0 m site is situated directly above the outlets within the notional low ecological protection area (LEPA)

Figure 8 Median phytoplankton biomass during the summer monitoring period, pooling data from fixed sites ≥ 100 m down-current of the Sepia Depression outlet

3.3 Physical-chemical stressors

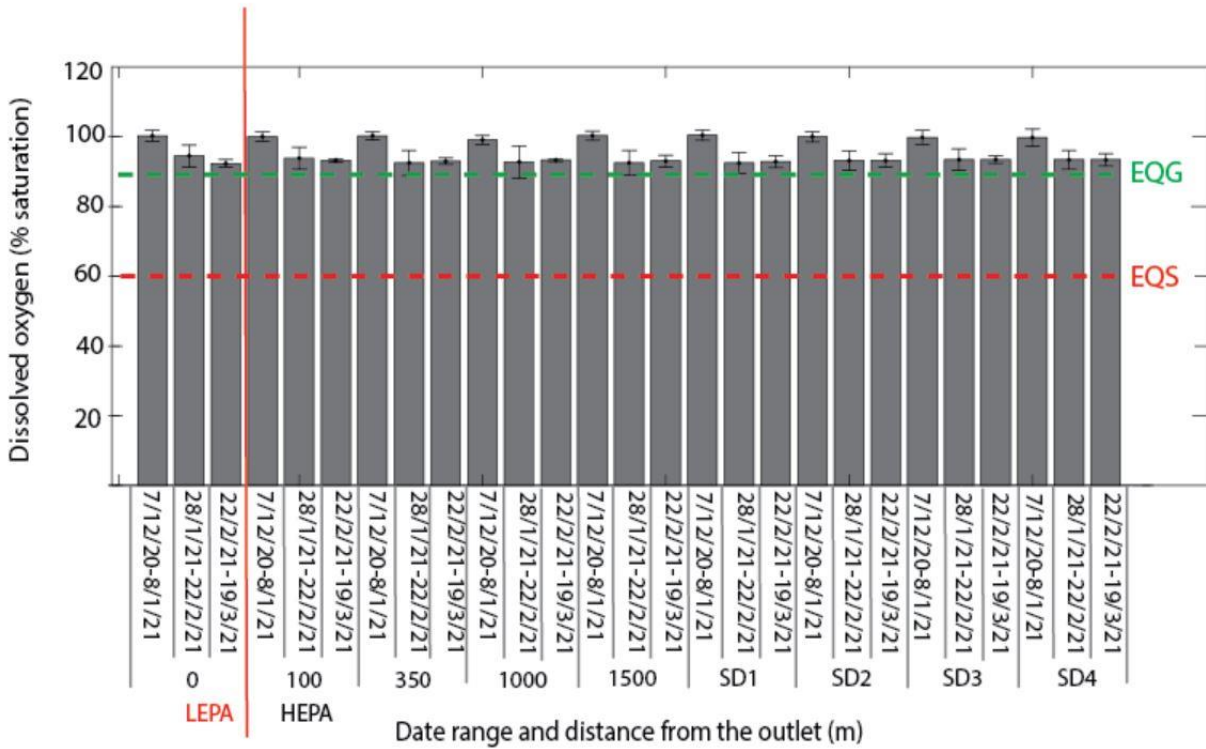
3.3.1 Dissolved oxygen (DO)

Bottom (0-0.5 m) DO saturation levels near the outlet were >90% at all times throughout the summer survey period (Figure 9) and the EQG for organic enrichment (Table 19) was met.



Table 19 Environmental Quality Guideline for dissolved oxygen

EQG	Median dissolved oxygen in bottom waters (0–0.5 m above the sediment surface) must be greater than 90% saturation at any site for a defined period of not more than 6 weeks during the non-river flow period.
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Notes:

1. Error bars ±95% confidence intervals
2. Dissolved oxygen (DO) measured 0–0.5 m above the seabed
3. Green dashed line = Environmental Quality Guideline (EQG) = 90% DO Saturation
4. Red dashed line = Environmental Quality Standard (EQS) = 60% DO saturation.
5. LEPA = low ecological protection area; HEPA = high ecological protection area.
6. Reference site data (SD1–SD4) are compared against EQG for contextual purposes only.

Figure 9 Median dissolved oxygen for defined periods of ≤6 weeks during the summer monitoring period

3.3.2 Salinity

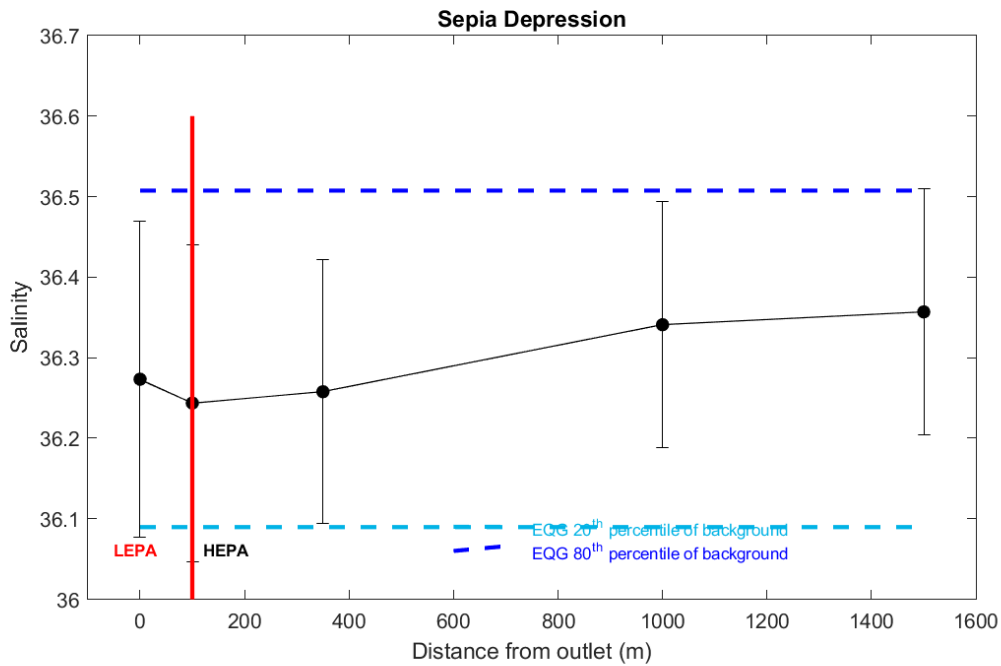
Median salinity was between the 20th and 80th percentile of the natural salinity range within the notional HEPA (at 100, 350, 1000 and 1500 m from the outlet), meeting the EQG (Table 20 and Figure 10).

Table 20 Environmental Quality Guideline for salinity

EQG	Median salinity (0.5 m below the water surface) at an individual site over any period is not to deviate beyond the 20 th and 80 th percentile of natural salinity range over the same period.
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Note:

1. EQG = Environmental Quality Guideline; EQS = Environmental Quality Standard



Notes:

1. Error bars represent $\pm 95\%$ confidence intervals
2. Salinity measured 0–0.5 m below the sea surface.
3. Dark blue line = 80th percentile of historical reference sites; light blue dashed line = 20th percentile of historical reference sites
4. LEPA = notional low ecological protection area; HEPA = high ecological protection area.
5. Data for each distance were pooled across eight sampling occasions (n=8) over December 2020–March 2021.

Figure 10 Median salinity compared to the 20th and 80th percentile of reference site data during the summer monitoring period



4 Microbiological contaminants and algal biotoxins

4.1 Thermotolerant coliforms

TTC were sampled eight times over the 2020–2021 summer period (yielding a total of 40 samples; Appendix G). NHMRC (2008) and EPA (2005) guidelines require a minimum of 100 samples for accurate assessment of the EQC. Data from multiple years can be pooled where there are <100 samples provided local pollution conditions have not changed (NHMRC 2008). Assuming conditions have not changed, data collected over three summers (since summer 2018–19) were pooled to yield 120 samples.

The median concentration of TTC derived from three years of pooled sampled was equal to the limit of detection (<10 CFU/100 mL; Table 22), meeting the EQG criterion. Over the three sampling periods, there were 4 instances where TTC exceeded 21 CFU/100 mL, representing 3.3% of samples and meeting the EQG (Table 21 and Table 23).

Table 21 Environmental Quality Guideline for thermotolerant coliform concentrations

EQG	Median TTC concentrations at sites at the boundary of the Observed Zone of Influence (OZI) are not to exceed 14 CFU/100 mL with no more than 10% of the samples exceeding 21 CFU/100 mL as measured using the membrane filtration method
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Notes:

1. OZI = Observed Zone of Influence; TTC = thermotolerant coliforms.
2. TTC concentrations are measured using the membrane filtration method.

Table 22 Median thermotolerant coliform concentration at the field monitoring sites for the Sepia Depression outlet for 2018–2021


Sampling period	Median (CFU/100 mL)	Compliance (EQG)
Dec 2018–Mar 2019	<10	■
Dec 2019–Mar 2020		■
Dec 2020–Mar 2021 (n=120)		■

Note:

1. Green (■) symbols indicate the Environmental Quality Criteria (EQC) were met; amber (■) and red (■) symbols represent an exceedance of the Environmental Quality Guideline (EQG) or Environmental Quality Standard (EQS), respectively.



Table 23 Thermotolerant coliform abundance for sites at the edge of the Sepia Depression SHEZ that exceeded concentrations of 21 CFU/100 mL

Sampling season	Date	Site	CFU/100 mL	Compliance
2018-2019	26/03/2019	SD27	130	
	26/03/2019	SD28	150	
2019-2020	05/02/2020	SD30	40	
2020-2021	09/02/2021	SD30	30	
% total samples (n = 120) > 21 CFU/100 mL (EQG) = 3.3%				

Notes:

1. Green (■) symbols indicate the Environmental Quality Criteria (EQC) were met; amber (■) and red (■) symbols represent an exceedance of the Environmental Quality Guideline (EQG) or Environmental Quality Standard (EQS), respectively.
2. CFU = colony forming units; EQG = Environmental Quality Guideline.

4.2 Toxic phytoplankton species

Cell densities of toxic phytoplankton were below relevant Western Australian Shellfish Quality Assurance Program (WASQAP; DoF 2007) guidelines (Table 25; Appendix H) meeting the EQG for toxic phytoplankton species (Table 24).

Table 24 Environmental Quality Guideline for toxic phytoplankton species

EQG	<p>Cell counts of potentially toxic algae species at sites at the boundary of the SHEZ are not to exceed the WASQAP¹ trigger concentrations for any of the following:</p> <ul style="list-style-type: none"> • <i>Alexandrium</i> spp. (100 cells/L) • <i>Gymnodinium</i> spp. (1000 cells/L) • <i>Karenia</i> spp. (1000 cells/L) • <i>Dinophysis</i> spp. (500 cells/L) • <i>Dinophysis acuminata</i> (3000 cells/L) • <i>Prorocentrum lima</i> (500 cells/L) • <i>Pseudo-nitzschia</i> spp. (250 000 cells/L) • <i>Gonyaulax cf. spinifera</i> (100 cells/L) • <i>Protoceratium reticulatum</i> (<i>Gonyaulax grindleyi</i>) (500 cells/L)
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Note:

1. Western Australian Shellfish Quality Assurance Program (WASQAP) Operations Manual (DoF 2007), as outlined in the Management Plan (BMT Oceanica 2014).



Table 25 Estimated cell densities of phytoplankton species known to produce toxins

Date	Site ¹	Species	Estimated density	WASQAP Guideline ²	Compliance
07/12/2020	SDR3	No toxic species detected	-	-	Na
	SD31	No toxic species detected	-	-	■
15/12/2020	SDR3	<i>Pseudo-nitzschia "delicatissima" group</i>	2720	250 000	Na
	SD26	<i>Gymnodinium spp.</i>	80	1000	■
		<i>Pseudo-nitzschia "delicatissima" group</i>	6880	250 000	
08/01/2021	SDR3	<i>Pseudo-nitzschia "delicatissima" group</i>	160	250 000	Na
	SD26	<i>Pseudo-nitzschia "delicatissima" group</i>	720	250 000	■
28/01/2021	SDR3	No toxic species detected	-	-	Na
	SD22	<i>Gonyaulax spp.</i>	80	100	■
09/02/2021	SDR3	<i>Gymnodinium spp.</i>	80	1000	Na
	SD30	<i>Pseudo-nitzschia "delicatissima" group</i>	320	250 000	■
22/02/2021	SDR3	No toxic species detected	-	-	Na
	SD29	<i>Gymnodinium spp.</i>	160	1000	■
04/03/2021	SDR3	<i>Gymnodinium spp.</i>	80	1000	Na
		<i>Pseudo-nitzschia "delicatissima" group</i>	320	250 000	
	SD30	No toxic species detected	-	-	■
19/03/2021	SDR3	<i>Gymnodinium spp.</i>	80	1000	Na
	SD30	<i>Gymnodinium spp.</i>	80		■

Notes:

1. Samples were analysed for one monitoring site and one reference site per sampling occasion.
2. Western Australian Shellfish Quality Assurance Program (WASQAP) (DoH 2007).
3. – = no toxic species detected, NA = not applicable.
4. Green (■) symbols indicate the Environmental Quality Criteria (EQC) were met



4.3 Faecal streptococci (*Enterococci* spp.)

Samples were collected eight times over the 2020–2021 summer monitoring period (yielding a total of 40 samples) for streptococci analyses. NHMRC guidelines and EPA (2005) require a minimum of 100 samples over the monitoring period for accurate assessment of the EQC. Data from multiple years can be pooled where there are less than 100 samples provided local pollution conditions have not changed (NHMRC 2008). Assuming conditions have not changed, data from the past three summers were pooled to yield 120 samples.

The 95th percentile of *Enterococci* spp. concentrations based on 120 samples was 2000 MPN/100 mL (Table 27), exceeding the EQG (Table 26) for primary contact recreation (200 MPN/100 mL) and triggering assessment against the EQS. The 95th percentile of *Enterococci* spp. (2000 MPN/100 mL) also exceeded the EQS for primary contact recreation (500 MPN/100 mL) (Table 27).

Table 26 Environmental quality criteria for contact recreation

Primary	EQG	The 95 th percentile of bacterial contact of marine waters should not exceed 200 <i>Enterococci</i> /100 mL
Primary	EQS	The 95 th percentile of bacterial contact of marine waters should not exceed 500 <i>Enterococci</i> /100 mL
Secondary	EQG	The 95 th percentile of bacterial contact of marine waters should not exceed 2000 <i>Enterococci</i> /100 mL




Until 2013/14, primary contact recreation had been managed (albeit informally) against the ANZECC (1992) criteria (median *Enterococci* spp. concentrations <35 MPN/100 mL). Development of the MMP formalised the monitoring regime and updated the approach to the contemporary and best practice environmental quality management framework including adopting the EPA (2005) criteria (the 95th percentile *Enterococci* spp. concentration < 200 MPN/100 mL). The informal management boundaries that applied historically were not altered accordingly and exceedance of the EPA's recreational contact criteria is an artefact of the change of criteria. The historical discharge footprint is unchanged, the exceedances are not indicative of an increased risk to Environmental Quality Objectives.

Exceedance of the EQG and EQS for primary contact recreation was reported to the Department of Health and the Department of Water and Environmental Regulation (previously the Department of Environment Regulation and the Office of the Environmental Protection Authority) as per the SDOOL MMP (BMT Oceanica 2014).

The 95th percentile of *Enterococci* spp. concentrations (2000 MPN/100 mL; Table 27) met the EQG for secondary recreation (≤ 2000 MPN/100 mL).



Table 27 The 95th percentile of *Enterococci* spp. concentrations at the boundary of the primary and secondary contact recreation zone for the Sepia Depression ocean outlet

Date	95 th percentile (MPN/100 mL)	Environmental Quality Criteria		Compliance
Dec 2018 – Mar 2019 Dec 2019 – Mar 2020 Dec 2020 – Mar 2021	2000	EQG (primary contact)	95 th percentile ≤200 MPN/100 mL	
		EQS (primary contact)	95 th percentile ≤500 MPN/100 mL	
		EQG (secondary contact)	95 th percentile ≤2000 MPN/100 mL	

Notes:

- Green symbols (■) indicate Environmental Quality Guideline (EQG) were met, amber (■) and red (■) symbols represent an exceedance of the EQG and Environmental Quality Standard (EQS) respectively.


4.4 Phytoplankton cell concentrations

The median total phytoplankton cell concentration was 3 cells/mL (Table 29) and therefore the EQG (Table 28) was met.

Table 28 Environmental Quality Guideline for phytoplankton cell count

EQG	Median total phytoplankton cell concentration for the area of concern should not exceed 15 000 cells/mL
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Table 29 Phytoplankton cell densities collected at fixed monitoring sites for contact recreation down-current of the Sepia Depression outlet

Date	Site	Total density (cells/mL)	Compliance
07/12/2020	SD1	1	
15/12/2020	SD9	2	
08/01/2021	SD9	4	
28/01/2021	SD7	1	
09/02/2021	SD3	15	
22/02/2021	SD13	2	
04/03/2021	SD14	7	
19/03/2021	SD15	4	
Median (all data)		3	



5 Aesthetics

Aesthetic quality was assessed fortnightly via a questionnaire completed by field personnel on eight occasions during the non-river flow period (Table 30). On each occasion, the questionnaire was completed at one location on the post upgrade boundary down-current of the diffuser. Water clarity around the outlet (mean LAC at 350 m from the diffuser, pooled from all days) was compared against water clarity at a greater distance from the outlet (mean LAC at 1500 m from the diffuser from all days pooled) to assess whether aesthetic differences exist. Water Corporation also maintains a complaints register for the SDOOL program.

Table 30 Environmental Quality Criteria for Recreation and Aesthetics

Indicator	Environmental Quality Criteria	
	EQG	EQS
Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae and sewage fungus should not be present in excessive amounts	There should be no overall decrease in the aesthetic water quality values of Cockburn Sound using direct measures of the community's perception of aesthetic value.
Faunal deaths	There should be no reported incidents of large-scale deaths of marine organisms relating from unnatural causes.	
Water clarity	The natural visual clarity of the water should not be reduced by more than 20%	
Colour	The natural hue of the water should not be changed by more than ten points on the Munsell scale.	
Surface films	Oil and petrochemicals should not be noticeable as a visible film on the water or detectable by odour.	
Surface debris	Water surfaces should be free of floating debris, dust and other objectionable matter, including substances that cause foaming.	
Odour	There should be no objectionable odour.	
Fish tainting substances	Concentrations of contaminants will not exceed the aesthetics guidelines for fish tainting substances at the Shellfish Harvesting Safety Zone boundary.	There should be no detectable tainting of edible fish harvested outside the Shellfish Harvesting Safety Zone boundary.

The field surveys found algae/plant material visible on the surface on 50% of occasions (Table 31). No dead marine organisms were visible on any occasion (Table 31). There was noticeable colour variation on 25% of occasions (Table 31). There were no films or oil on the surface on any sampling occasion. No floating debris was visible on the surface on any sampling occasion. There was slight noticeable odour associated with the water on 37.5% of sampling occasion (Table 31). There was no overall decrease in the aesthetic water quality values of Cockburn Sound using direct measures of the community's perception of aesthetic value.



Mean LAC at 350 m from the ocean outlet (0.076 Log₁₀/m) was slightly higher than at 1500 m distance from the outlet (0.071 Log₁₀/m) meaning that light was more quickly attenuated at 350 m than 1500 m (Table 32). Overall water clarity was reduced by ~9% and therefore the EQG that the natural visual clarity of the water should not be reduced by more than 20% was met.

Fish tainting substances in the comprehensive TWW characterisation sample collected on 22 February 2021 did not exceed the EPA (2005) aesthetic guidelines for fish tainting substances (Table 33). Hexachlorocyclopentadiene and 2, 4 dichlorophenol concentrations in the TWW sample were below the limit of reporting, however the limit of reporting was greater than the aesthetic guideline for fish tainting substances. Any potential exceedance would be considered negligible after initial dilution.





Table 31 Aesthetic observations and measurements near the Sepia Depression ocean outlet from December 2020 to March 2021

Date	Site	Algae/plant material visible on surface?	Dead marine organisms visible?	Secchi depth (m)	Noticeable colour variation?	Oil or other films on the surface?	Floating debris visible on the surface?	Noticeable odour associated with the water?
07/12/2020	SD3	Yes, Seagrass	No	7.3	No	No	No	No
15/12/2020	SD8	Yes, Seagrass	No	10	Yes	No	No	Yes
08/01/2021	SD14	Yes, Seagrass	No	>14	No	No	No	Yes (slight)
28/01/2021	SD8	No	No	11	Yes (slight)	No	No	Yes (slight)
09/02/2021	SD2	No	No	10	No	No	No	Yes (slight)
22/02/2021	SD12	No	No	7.7	No	No	No	No
04/03/2021	SD15	No	No	8.3	No	No	No	No
19/03/2021	SD13	Yes, Phytoplankton	No	13	No	No	No	No



Table 32 Light attenuation coefficient at sites 350 m and 1500 m from the Sepia Depression ocean outlet from December 2020 to March 2021

Date	Light attenuation coefficient (Log10/m)	
	350 m (site SDT-350 m)	1500 m (site SDT – 1500 m)
07/12/2020	0.071	0.071
15/12/2020	0.070	0.069
08/01/2021	0.078	0.071
28/01/2021	0.073	0.068
09/02/2021	0.076	0.066
22/02/2021	0.075	0.075
04/03/2021	0.087	0.076
19/03/2021	0.080	0.076
Mean	0.076	0.071

Table 33 EPA (2005) guidelines for fish tainting substances and parameters measured on 22 February 2021 in the SDOOL wastewater stream

Parameter (µg/L)	Aesthetics guidelines	2020/2021 treated wastewater sampling
Metals and Metalloids		
Copper (Cu)	1000	12
Zinc (Zn)	5000	53
Phenols		
Phenol	300	<10
2,4 – Dichlorophenol	0.3	<10
2,4,6 – Trichlorophenol	2	<20
Pentachlorophenol (PCP)	30	<20
Chlorinated hydrocarbons		
Hexachlorocyclopentadiene	1	<20
Ethers		
Nitrobenzene	30	<20



Parameter (µg/L)	Aesthetics guidelines	2020/2021 treated wastewater sampling
BTEX		
Toluene	250	<1
Ethylbenzene	250	<1
PAHs		
Naphthalene	1000	0.02
Acenaphthene	20	<0.01

Note:

1. BTEX = Benzene, toluene, ethylbenzene and xylene; PAHs = polycyclic aromatic hydrocarbons.
2. Bold numbers are where the limit of reporting is greater than the guideline.



6 Shoreline monitoring


6.1 Thermotolerant coliforms

TTC were sampled at eight shoreline monitoring sites eight times over the 2020–2021 summer period (yielding a total of 64 samples). NHMRC (2008) guidelines and EPA (2005) recommend that a minimum of 100 samples is needed for accurate assessment of the EQG. Data from multiple years can be pooled where there are <100 samples provided local pollution conditions have not changed (NHRMC 2008). However, this is the first year that these sites were sampled, and there is only 1 year’s data available.

The shoreline sites are not formally assessed against the EQC but the median and 90th percentile TTC concentrations derived from the 64 samples were less at the limit of detection (<10 CFU/100 mL; Table 34, Appendix G) and less than 14 and 21 CFU/100 mL criteria, respectively meeting the EQG (Table 21).

Median TTC concentrations at 0, 100 and 350m down current of the diffuser were 480, 555 and 7.5 MPN/100 mL, respectively. All other distances had median concentrations of 5 CFU/100 mL (the proxy concentrations below the LoR) (Figure 11).

Table 34 Median and 90th percentile of thermotolerant coliform concentrations at the shoreline monitoring sites for the Sepia Depression outlet for 2020–2021 and comparison to the EQG

Sampling period	Median (CFU/100 mL)	90 th percentile	Compliance (EQG)
Dec 2020–Mar 2021	<10	<10	

Notes:

1. Green symbols (■) indicate the Environmental Quality Criteria (EQC) were met, amber (■) and red (■) symbols represent an exceedance of the Environmental Quality Guideline (EQG) and Environmental Quality Standard (EQS), respectively.
2. Thermotolerant coliform results below the analytical detection limit (<10 CFU/100 mL) were halved (=5 CFU/100 mL) to calculate the median and 90th percentile.
3. Environmental Quality Criteria are based on EPA (2017).

6.2 Faecal streptococci (*Enterococci* spp.)

Samples were collected eight times at eight shoreline monitoring sites over the 2020–2021 summer monitoring period (yielding a total of 64 samples) for faecal streptococci analyses. NHMRC guideline and EPA (2005) recommend a minimum of 100 samples over the monitoring period are required for accurate assessment of the EQC. Data from multiple years can be pooled where there are less than 100 samples provided local pollution conditions have not changed (NHMRC 2008). However, this was the first year that these sites were samples, and there is only 1 year’s data available.

Shoreline sites are not formally assessed against the EQC but over the 2020–2021 summer monitoring period, the 95th percentile of *Enterococci* spp. concentrations at the shoreline monitoring sites for the Sepia Depression ocean outlets was <10 MPN/100 mL (Table 35), and met both the primary (<200) and secondary (<2000 *Enterococci* spp./100mL) contact recreation EQG criteria (Table 26) in water were met.

Median *Enterococci* spp. concentrations were 0, 100, 350 and 1000 m down current of the diffuser were 87.5, 3500, 330 and 15 MPN/100 mL, respectively. All other distances had median concentrations of 5 MPN/100 mL (the proxy for concentrations below the LoR) (Figure 11).

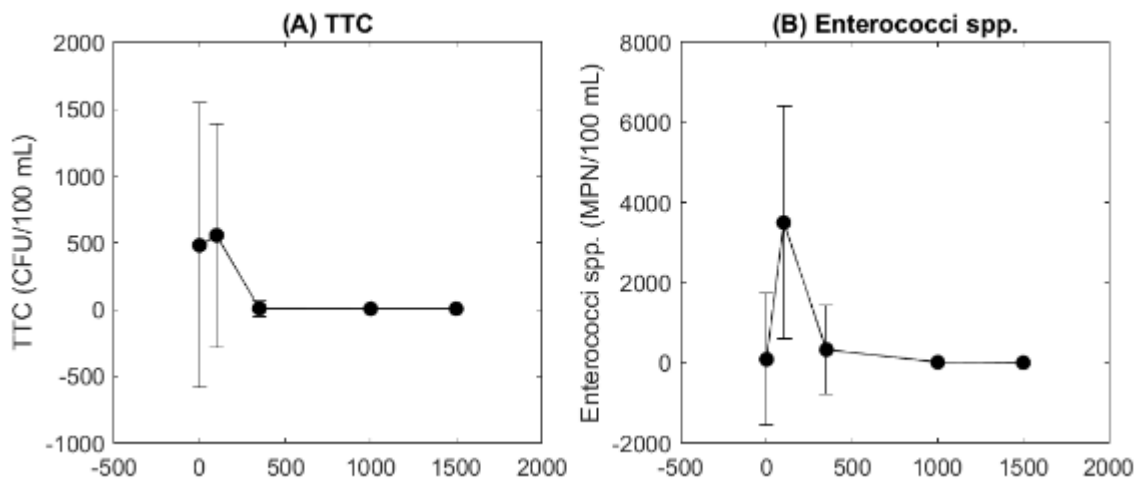


Table 35 The 95th percentile of *Enterococci* spp. concentrations at the shoreline monitoring sites for the Sepia Depression ocean outlets

Sampling period	95 th percentile (MPN/100 mL)	Compliance	
		Primary contact	Secondary contact
Dec 2020–Mar 2021	5	■	■

Notes:

1. MPN = most probable number of *Enterococci* spp.
2. *Enterococci* spp. concentrations below the analytical detection limit (<10 *Enterococci* spp. MN/100 mL) were halved (=5 MPN/100 mL) to calculate the 95th percentile.
3. Green symbols (■) indicate the Environmental Quality Criteria (EQC) were met; amber (■) and red (■) symbols represent an exceedance of the Environmental Quality Guideline (EQG) and Environmental Quality Standard (EQS), respectively.
4. Environmental Quality Criteria (EQC) based on EPA (2017) water quality guidelines for recreation waters.



Notes:

1. Error bars represent $\pm 95\%$ confidence intervals

Figure 11 Median a) *TTC* and b) *Enterococci* spp. at 0, 100, 350, 1000, 1500 and 2000 metres from the Sepia Depression outlet from December 2020 to March 2021.



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Appendices

The following Appendices are available from Water Corporation on request:



Appendix A Analytical laboratories and methods



Appendix B Treated wastewater results



Appendix C Initial dilution model output



Appendix D Whole of effluent toxicity laboratory results



Appendix E Site coordinates



Appendix F Nutrient results



Appendix G Microbiology results



Appendix H Phytoplankton results