

# Sepia Depression Ocean Outlet Landline

2017–2018 Annual Report Card





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## Document history

### Distribution

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### Review

Revision	Reviewer	Intent	Date
A	M Lourey	Technical & Editorial review	10/09/18

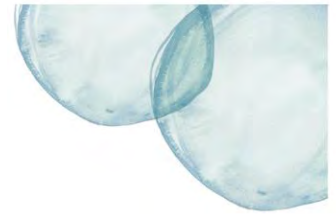
### Status

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 WA Pty Ltd 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.

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Author  
Date: 10/09/18

Director (or delegate)  
Date: 10/09/18



# Contents

## List of Tables

Table 1.1	Summary report card legend.....	1
Table 2.1	Assessment against Environmental Quality Guidelines for the Maintenance of Ecosystem Integrity EQO1 .....	2
Table 2.2	Assessment against Environmental Quality Standards for the Maintenance of Ecosystem Integrity EQO1 .....	7
Table 3.1	Assessment against Environmental Quality Guidelines for Maintenance of Aquatic Life for Human Consumption EQO2.....	8
Table 4.1	Assessment against Environmental Quality Guidelines for Maintenance of Primary Contact Recreation EQO3.....	10
Table 4.2	Assessment Against Environmental Quality Standards for Maintenance of Primary Contact Recreation EQO3.....	11
Table 5.1	Assessment against Environmental Quality Guidelines for Maintenance of Secondary Contact Recreation EQO.....	12
Table 6.1	Assessment against Environmental Quality Guidelines for Maintenance of Aesthetic values EQO5 .....	13
Table 6.2	Assessment against Environmental Quality Standards for Maintenance of Aesthetic values EQO5 .....	14

## List of Appendices




- Appendix A – Concentrations of contaminants in TWW prior to dilution compared to ANZECC & ARMCANZ (2000) Species Levels of Protection
- Appendix B – WET Testing Results
- Appendix C – Physical Properties



# 1. Introduction

This annual report card documents the findings of the 2017–2018 Sepia Depression Ocean Outlet Landline (SDOOL) monitoring program. Protocols and analyses described herein are based on the methods outlined in the Sepia Depression Ocean Outlet Monitoring & Management Plan (BMT Oceanica 2014). Results are reported in context of the Environmental Quality Management Framework (EQMF) described in EPA (2017). The results are summarised in Report Card format for each relevant Environmental Quality Objective (EQO) (EPA 2017). The report cards contain colour-coded results, with the individual colours representing the extent to which the Environmental Quality Criteria (EQC) were met (Table 1.1).

Table 1.1 Summary report card legend

Management response <sup>1</sup>	Colour
Monitor: EQG met (continue monitoring)	
Investigative: EQG not met (investigate against the EQS), EQS met (continue monitoring)	
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.




## 2. EQO1 – Maintenance of Ecosystem Integrity

The EQO 'Maintenance of Ecosystem Integrity' aims to ensure the continued health and productivity of the coastal ecosystem (Table 2.1).



Table 2.1 Assessment against Environmental Quality Guidelines for the Maintenance of Ecosystem Integrity EQO1

Indicator	Environmental Quality Guideline	Results	Compliance																														
Toxicants in treated wastewater (TWW) – comprehensive treated wastewater characterisation																																	
Bioaccumulating toxicants	Concentrations of contaminants will not exceed the ANZECC & ARMCANZ (2000) 80% species protection guideline trigger levels for bioaccumulating toxicants at the diffuser.	The concentration of cadmium in the undiluted SDOOL TWW stream was below the limit of reporting (<0.1 µg/L) and therefore below the ANZECC & ARMCANZ (2000) 80% species protection guideline (36 µg/L), prior to discharge. The concentration of mercury in the undiluted SDOOL TWW stream was 0.56 µg/L and was below the ANZECC & ARMCANZ (2000) 80% species protection guideline (1.4 µg/L), prior to discharge.																															
Non bioaccumulating toxicants	The ANZECC & ARMCANZ (2000) 99% species protection guideline trigger levels for non-bioaccumulating are met at the edge of the low ecological protection area (LEPA).	<p>Contaminant concentrations were lower than the ANZECC &amp; ARMCANZ (2000) triggers for 99% species protection guidelines after dilution equivalent to that expected at the LEPA boundary (1:310) (Table 2a).</p> <p>Table 2a Toxicants in the TWW compared to the relevant waste stream triggers</p> <table border="1"> <thead> <tr> <th>Toxicant<sup>1</sup></th> <th>Waste Stream Trigger<sup>2</sup></th> <th>Sepia Depression TWW<sup>3</sup></th> </tr> </thead> <tbody> <tr> <td colspan="3">Nutrients (µg/L)</td> </tr> <tr> <td>Ammonia-N</td> <td>154 537</td> <td>36 000</td> </tr> <tr> <td colspan="3">Dissolved metals (0.45 µm filtered) (µg/L)</td> </tr> <tr> <td>Chromium<sup>3</sup></td> <td>43</td> <td>2</td> </tr> <tr> <td>Copper</td> <td>68</td> <td>3</td> </tr> <tr> <td>Lead</td> <td>679</td> <td>&lt;1</td> </tr> <tr> <td>Nickel</td> <td>2016</td> <td>3.1</td> </tr> <tr> <td>Silver</td> <td>248</td> <td>&lt;1</td> </tr> <tr> <td>Zinc</td> <td>2124</td> <td>12</td> </tr> </tbody> </table>	Toxicant <sup>1</sup>	Waste Stream Trigger <sup>2</sup>	Sepia Depression TWW <sup>3</sup>	Nutrients (µg/L)			Ammonia-N	154 537	36 000	Dissolved metals (0.45 µm filtered) (µg/L)			Chromium <sup>3</sup>	43	2	Copper	68	3	Lead	679	<1	Nickel	2016	3.1	Silver	248	<1	Zinc	2124	12	
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	<p>The total toxicity of the mixture (TTM) for the additive effect of dissolved ammonia, copper and zinc (as per ANZECC &amp; ARM CANZ (2000) guidelines) is less than 1.0.</p>	<p>The TTM for the additive effect of ammonia, copper and zinc after dilution equivalent (1:310) to that expected at the LEPA boundary was 0.56 and lower than the ANZECC &amp; ARM CANZ (2000) guideline value of 1.0 (Table 2b and Appendix A).</p> <p><b>Table 2b Total toxicity of the TWW stream</b></p> <table border="1"> <thead> <tr> <th>Toxicant</th> <th>TWW concentration (µg/L)</th> <th>Background concentration<sup>1</sup> (µg/L)</th> <th>Dilution</th> <th>Total toxicity of the mixture (TTM)<sup>2</sup></th> </tr> </thead> <tbody> <tr> <td>Ammonium</td> <td>36 000</td> <td>1.5</td> <td rowspan="3">1:310</td> <td rowspan="3">0.56</td> </tr> <tr> <td>Copper</td> <td>3</td> <td>0.08</td> </tr> <tr> <td>Zinc</td> <td>12</td> <td>0.15</td> </tr> </tbody> </table>	Toxicant	TWW concentration (µg/L)	Background concentration <sup>1</sup> (µg/L)	Dilution	Total toxicity of the mixture (TTM) <sup>2</sup>	Ammonium	36 000	1.5	1:310	0.56	Copper	3	0.08	Zinc	12	0.15																														
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Indicator	Environmental Quality Guideline	Results	Compliance																									
		Notes: 1. Background concentrations for copper and zinc from McAlpine et al. (2005); Perth marine waters (pp. 19; Table 12). Surface background concentrations for ammonia calculated as median of reference site data from 2003–2017 (BMT Oceanica, unpublished data). 2. $TTM = [ammonia]/guideline + [copper]/guideline + [zinc]/guideline$ .																										
Whole of Effluent Toxicity (WET) testing	<p>The EQG will be exceeded if following the 1 hour sea urchin test:</p> $\frac{TDA}{DRNOEC} \leq 1.0$ <p>Where TDA = Typical Dilutions Achieved (constant based on 200-fold dilution)            DRNOEC = Number of dilutions required to achieve the No Observed Effects Concentration (NOEC).</p>	<p>The lowest NOEC recorded during the reporting period was 6.3% TWW. Only ~16 dilutions are required to achieve this NOEC which is lower than the dilutions typically achieved at the LEPA boundary (at least 1:310) (Table 2c and Appendix B).</p> <p><b>Table 2c Whole of effluent toxicity test results</b></p> <table border="1" data-bbox="680 547 1877 828"> <thead> <tr> <th>Indicator</th> <th>July 2017</th> <th>October 2017</th> <th>January 2018</th> <th>April 2018</th> </tr> </thead> <tbody> <tr> <td>NOEC</td> <td>12.5%</td> <td>25%</td> <td>12.5%</td> <td>6.3%</td> </tr> <tr> <td>Dilutions required to meet the NOEC</td> <td>8</td> <td>4</td> <td>8</td> <td>15.9</td> </tr> <tr> <td>Dilutions require/dilutions achieved</td> <td>0.01</td> <td>0.00</td> <td>0.01</td> <td>0.01</td> </tr> <tr> <td><math>\leq 1</math></td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> </tr> </tbody> </table> <p>Notes:            1. NOEC = no observed effect concentration            2. Calculation based on 310 dilutions achieved, which is expected at the LEPA boundary.</p>	Indicator	July 2017	October 2017	January 2018	April 2018	NOEC	12.5%	25%	12.5%	6.3%	Dilutions required to meet the NOEC	8	4	8	15.9	Dilutions require/dilutions achieved	0.01	0.00	0.01	0.01	$\leq 1$	Yes	Yes	Yes	Yes	
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$\leq 1$	Yes	Yes	Yes	Yes																								
<b>Receiving water physico/chemical measures</b>																												
Nutrient enrichment	Median chlorophyll-a concentration during non river-flow period not to exceed 80 <sup>th</sup> percentile of reference site data.	Median chlorophyll-a concentration within the high ecological protection area (HEPA) (0.3 µg/L) was lower than the 80 <sup>th</sup> percentile of historical reference site data (0.4 µg/L) (Appendix C).																										





Indicator	Environmental Quality Guideline	Results	Compliance
	Median light attenuation (LAC) during non river-flow period not to exceed 80 <sup>th</sup> percentile of reference site data.	Median LAC within the HEPA (0.0697 Log <sub>10</sub> /m) was lower than the 80th percentile of historical reference site data (0.078 Log <sub>10</sub> /m) (Appendix C).	
Organic enrichment	Median dissolved oxygen in bottom waters (0–0.5 m above the sediment surface) greater than 90% saturation at any site for a defined period of not more than six weeks.	Dissolved oxygen saturation remained above 90% saturation at all times, on each of the eight occasions between December 2017 and March 2018 (Appendix C).	
Salinity	Median salinity (0.5 m below the water surface) at an individual site over any period not to deviate beyond the 20 <sup>th</sup> and 80 <sup>th</sup> percentile of natural salinity range over the same period.	Median salinity was between the 20 <sup>th</sup> and 80 <sup>th</sup> percentile of the natural salinity range at all sites within the notional HEPA (at 100, 350, 1000 and 1500 m) (Appendix C).	
Receiving water biological measures			
Phytoplankton blooms	Median phytoplankton biomass measured as chlorophyll-a not to exceed 3-times median chlorophyll-a concentration of reference sites, on any occasion during non-river flow period.	On one occasion (27 March 2018; Appendix C) median chlorophyll-a concentration exceeded three times the median of reference sites, exceeding the EQG and triggering assessment against the EQS (See Table 2.2).	




Indicator	Environmental Quality Guideline	Results	Compliance
	Phytoplankton biomass measured as chlorophyll-a at any site does not exceed 3 times median chlorophyll-a concentration of reference sites, on 25% or more occasions during the non river-flow period.	Chlorophyll-a concentration exceeded 3 times the median chlorophyll-a concentration of reference sites on 12.5% of occasions, (<25% of occasions) (Appendix C).	

The Environmental Quality Guideline (EQG) for phytoplankton blooms, which requires median phytoplankton biomass measured as chlorophyll-a not to exceed 3-times the median chlorophyll-a concentration of reference sites, on any occasion during non-river flow period was not met (Table 2.1). Therefore, assessment proceeded against the EQS. Median chlorophyll-a concentration did not exceed 3 times the median chlorophyll-a concentration of reference sites on more than one occasion in the 2017–2018 non-river flow period, or in the 2016–2017 non-river flow period (BMT Oceanica 2017), and therefore the EQS was met (Table 2.2).



Table 2.2 Assessment against Environmental Quality Standards for the Maintenance of Ecosystem Integrity EQO1

Indicator	Environmental Quality Standard	Results	Compliance
Receiving water biological measures			
Phytoplankton blooms	Median phytoplankton biomass measured as chlorophyll-a not to exceed 3 times median chlorophyll-a concentration of reference sites, on more than one occasion during the non-river flow period and in two consecutive years.	Median chlorophyll-a concentration did not exceed 3 times the median chlorophyll-a concentration of reference sites on more than one occasion in the 2017–2018 non-river flow period, or in the 2016–2017 non-river flow period (BMT Oceanica 2017).	

Note:



- 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.




### 3. EQO2 – Maintenance of Aquatic Life for Human Consumption

The EQO 'Maintenance of Aquatic Life for Human Consumption' aims to ensure there is low risk to the health of human consumers of seafood, which may be exposed to toxicants within the treated wastewater (TWW) stream (Table 3.1).

Table 3.1 Assessment against Environmental Quality Guidelines for Maintenance of Aquatic Life for Human Consumption EQO2

Indicator	Environmental Quality Guideline	Results	Compliance
Thermo-tolerant Coliforms (TTC)	Median TTC counts at sites at the boundary of the Shellfish Harvesting Exclusion Zone (SHEZ) are not to exceed 14 CFU 100 mL <sup>-1</sup> .	The median value for TTC derived from 120 samples collected over the 2015–2016, 2016–2017 and 2017–2018 sampling seasons was at the limit of detection (<10 CFU/100 mL) and below the EQG (14 CFU/100 ml).	
	No more than 10% of the samples exceeding 21 CFU 100 mL <sup>-1</sup> as measured using the membrane filtration method.	Less than 10% (8.3%) of TTC samples (10/120) exceeded 21 CFU/100 mL over the 3-season pooled dataset.	



Indicator	Environmental Quality Guideline	Results	Compliance
Algal Biotoxins	<p>Concentrations of potentially toxic algae at sites at the boundary of the SHEZ not to exceed the WASQAP trigger concentrations for any of the following:</p> <ul style="list-style-type: none"> <li>• <i>Alexandrium</i> spp. (100 cells/L);</li> <li>• <i>Gymnodinium</i> spp. (1000 cells/L);</li> <li>• <i>Karenia</i> spp. (1000 cells/L);</li> <li>• <i>Dinophysis</i> spp. (500 cells/L);</li> <li>• <i>Dinophysis</i> acuminta (3000 cells/L);</li> <li>• <i>Prorocentrum</i> spp. (500 cells/L);</li> <li>• <i>Pseudo-nitzschia</i> spp. (250000 cells/L);</li> <li>• <i>Gonyaulax</i> cf. <i>spinifera</i> (100 cells/L); and</li> <li>• <i>Protoceratium reticulatum</i> (<i>Gonyaulax grindleyi</i>) (500 cells/L).</li> </ul>	<p>Results of the 2017–2018 monitoring period found there were no instances where toxic phytoplankton species were recorded in excess of WASQAP guideline values (DoF 2007).</p>	

Note:



- 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.



## 4. EQO3 – Maintenance of Primary Contact Recreation

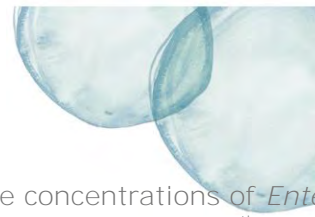
The EQO 'Maintenance of Primary Contact Recreation' aims to ensure that waters are safe for swimmers (Table 4.1).

Table 4.1 Assessment against Environmental Quality Guidelines for Maintenance of Primary Contact Recreation EQO3

Indicator	Environmental Quality Guideline	Results	Compliance
Faecal pathogens	The 95 <sup>th</sup> percentile value of <i>Enterococci</i> spp. calculated over the bathing season not to exceed 200 MPN/100 mL, outside the post-upgrade boundary.	The 95 <sup>th</sup> percentile of <i>Enterococci</i> spp. concentrations was 1100 MPN/100 mL and exceeded the EQG for primary contact recreation (200 MPN/100 mL). Assessment was triggered against the EQS (see Table 4.2)	
Algal biotoxins	Median total phytoplankton cell count for the area of concern (either from one sampling run or from a single site over agreed period of time) should not exceed 15,000 cells/mL.	The median total phytoplankton cell concentration was 107 cells/mL ( $\leq 15,000$ cells/mL)	


Note:

- 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.



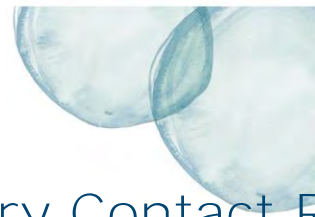
The EQG and EQS for primary contact recreation requires the 95<sup>th</sup> percentile concentrations of *Enterococci* spp. does not exceed 200 MPN/100 mL and 500 MPN/100 mL, respectively, at the post upgrade boundary. The 95<sup>th</sup> percentile *Enterococci* spp. concentration assessed based on three sampling seasons of pooled data (to achieve a sufficient sample size of n=120) was 1100 MPN/100 mL, exceeding both the EQG and EQS (Table 4.1 and Table 4.2). The exceedance is due to a change from the ANZECC & ARMCANZ (2000) limit that applied when the post-upgrade boundary was defined to the more conservative 95<sup>th</sup> percentile guideline for *Enterococci* spp. preferred by the EPA (2015). Exceedances of the EQG and EQS for primary contact recreation have triggered a management response by Water Corporation in consultation with the Department of Health (DoH), which is ongoing.

**Table 4.2 Assessment Against Environmental Quality Standards for Maintenance of Primary Contact Recreation EQO3**

Indicator	Environmental Quality Standard	Results	Compliance
Faecal pathogens	The 95 <sup>th</sup> percentile value of <i>Enterococci</i> spp. calculated over the bathing season not to exceed 500 MPN/100 mL, outside the post-upgrade boundary.	The 95 <sup>th</sup> percentile of <i>Enterococci</i> spp. concentrations was 1100 MPN/100 mL and exceeded the EQS for primary contact recreation (500 MPN/100 mL)	

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.



## 5. EQO 4 – Maintenance of Secondary Contact Recreation

The EQO 'Maintenance of Secondary Contact Recreation' aims to ensure that waters are safe for recreational water users (Table 5.1).

Table 5.1 Assessment against Environmental Quality Guidelines for Maintenance of Secondary Contact Recreation EQO

Indicator	Environmental Quality Guideline	Results	Compliance
Faecal pathogens	The 95 <sup>th</sup> percentile value of <i>Enterococci</i> spp. calculated over the bathing season not to exceed 2000 MPN/100 mL, outside the post-upgrade boundary.	The 95 <sup>th</sup> percentile of <i>Enterococci</i> spp. concentrations was 1100 MPN/100 mL and met the EQG for secondary contact recreation (2000 MPN/100 mL)	

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.











## 6. EQO5 Maintenance of Aesthetic Values

The EQO 'Maintenance of Aesthetic Values' aims to ensure that waters are of aesthetic appeal (Table 6.1).

Table 6.1 Assessment against Environmental Quality Guidelines for Maintenance of Aesthetic values EQO5

Indicator	Environmental Quality Guideline	Results	Compliance
Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae and sewage fungus should not be present in excessive amounts.	Nuisance organisms were not present in excessive amounts.	
Faunal deaths	There should be no reported incidents of large-scale deaths of marine organisms relating from unnatural causes.	There were no instances of dead marine organisms observed.	
Water clarity	The natural visual clarity of the water should not be reduced by more than 20%.	Measurements of light attenuation confirmed that the natural visual clarity of the water was reduced by more than 20%. Assessment against EQS was triggered (see Table 6.2).	
Colour	The natural hue of the water should not be changed by more than ten points on the Munsell scale.	There was a noticeable colour on three out of eight sampling occasions. Assessment against EQS was triggered (see Table 6.2).	
Surface films	Oil and petrochemicals should not be noticeable as a visible film on the water or detectable by odour.	There were no occasions where oil or petrochemicals were observed as a visible film on the surface of the water	
Surface debris	Water surfaces should be free of floating debris, dust and other objectionable matter, including substances that cause foaming.	Floating debris was visible on the surface on 13 December 2017. Assessment against EQS was triggered (Table 6.2).	



Indicator	Environmental Quality Guideline	Results	Compliance
Odour	There should be no objectionable odours.	A noticeable odour was recorded on 50% of sampling occasions. Assessment against EQS was triggered (see Table 6.2).	
Fish tainting substances	Concentrations of contaminants will not exceed the Aesthetics guidelines for fish tainting substances at the Shellfish Harvesting Safety Zone boundary.	Concentrations of contaminants did not exceed the aesthetics guidelines for fish tainting substances at the Shellfish Harvesting Safety Zone boundary	

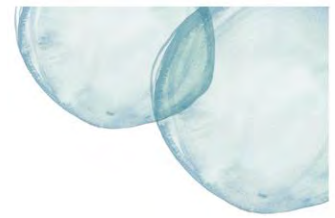
Note:

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For the EQO Maintenance of Aesthetic values, all EQG were met with the exceptions of water clarity, colour, surface debris and odour (Table 6.1), triggering assessment against the EQS. There were no complaints from the community and no overall decrease in the aesthetic water quality values of Cockburn Sound in direct measures of the community's perception of aesthetic values, therefore the EQS was met (Table 6.2).

**Table 6.2 Assessment against Environmental Quality Standards for Maintenance of Aesthetic values EQO5**

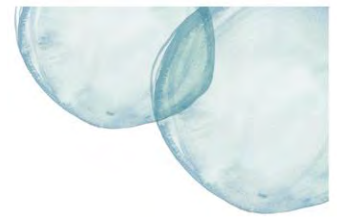
Indicator	Environmental Quality Standard	Results	Compliance
Water clarity, colour, surface debris and odour	There should be no overall decrease in the aesthetic water quality values of Cockburn Sound using direct measures of the community's perception of aesthetic value.	There was no overall decrease in the aesthetic water quality values of Cockburn Sound using direct measures <b>of the community's perception of aesthetic value.</b>	



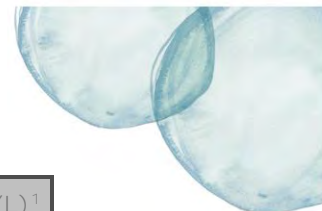
## 7. References

- ANZECC, ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1: The Guidelines. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, October 2010
- BMT Oceanica (2017) Sepia Depression Ocean Outlet Annual Report 2017–2018. Prepared for Water Corporation by BMT Oceanica Pty Ltd, Report No. 1138\_01\_006/1\_Rev0, Perth, Western Australia, September 2017
- BMT Oceanica (2014) Sepia Depression Ocean Outlet – Monitoring and Management Plan. Prepared for Water Corporation by BMT Oceanica Pty Ltd, Report No. 821\_001/1\_Rev5, Perth, Western Australia, April 2014
- DoF (2007) Western Australian Shellfish Quality Assurance Program (WASQAP) Operations Manual. Department of Fisheries, Perth, Western Australia
- EPA (2017) Environmental Quality Criteria Reference Document for Cockburn Sound – A Supporting Document to the State Environmental (Cockburn Sound) Policy 2015. Environmental Protection Authority, Perth, Western Australia, April 2017
- McAlpine KW, Wenziker KJ, Apte SC, Masini RJ (2005) Background Quality for Coastal Marine Waters of Perth, Western Australia. Department of Environment, Report No. 117, Perth, Western Australia

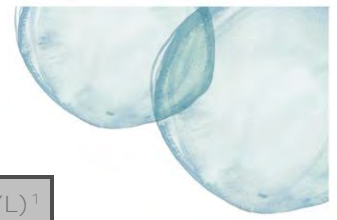




# Appendix A – Concentrations of contaminants in TWW prior to dilution compared to ANZECC & ARMCANZ (2000) Species Levels of Protection



Parameter	SDOOL TWW	ANZECC/ARMCANZ (2000) guidelines (µg/L) <sup>1</sup>					Low reliability value (LRV)
		Level of protection					
	2018	99%	95%	90%	80%		
<b>Microbiological</b>							
Confirmed Enterococci (MPN/100 mL) <sup>2</sup>	>24 000	n/a <sup>3</sup>	n/a	n/a	n/a	n/a	
Presumptive thermotolerant coliforms (TTC; CFU/100 mL) <sup>4</sup>	8 000 000	n/a	n/a	n/a	n/a	n/a	
Confirmed TTC (CFU/100 mL) <sup>4</sup>	6 400 000	n/a	n/a	n/a	n/a	n/a	
Escherichia coli (CFU/100 mL)	3 200 000	n/a	n/a	n/a	n/a	n/a	
<b>Nutrients (µg/L)</b>							
Ammonia-N	36 000	500	910	1 200	1 700	-	
Nitrate-N+Nitrite-N	57	ID <sup>5</sup>	ID	ID	ID	13 000	
Nitrogen-Total N	43 000	n/a	n/a	n/a	n/a	n/a	
Phosphate-Ortho as P	5200	n/a	n/a	n/a	n/a	n/a	
Phosphorous-Total P	7500	n/a	n/a	n/a	n/a	n/a	
<b>"Dissolved" metals (0.45 µm filtered) (µg/L)</b>							
Arsenic (As)	1	ID	ID	ID	ID	2.3 (As III) 4.5 (As V)	
Cadmium (Cd)	<0.1	0.7	5.5	14	36	-	
Chromium (Cr)	2	7.7 (Cr III) 0.14 (Cr VI)	27.4 (Cr III) 4.4 (Cr VI)	48.6 (Cr III) 20 (Cr VI)	90.6 (Cr III) 85 (Cr VI)	-	
Copper (Cu)	3	0.3	1.3	3	8	-	
Lead (Pb)	<1	2.2	4.4	6.6	12	-	
Mercury (Hg)	0.56	0.1	0.4	0.7	1.4	-	
Nickel (Ni)	3.1	7	70	200	560	-	
Selenium (Se)	<1	ID	ID	ID	ID	3	
Silver (Ag)	<1	0.8	1.4	1.8	2.6	-	
Zinc (Zn)	12	7	15	23	43	-	
<b>Total metals (acid extractable; unfiltered) (µg/L)</b>							
Arsenic (As)	1.1	ID	ID	ID	ID	2.3 (As III) 4.5 (AsV)	
Cadmium (Cd)	<0.1	0.7	5.5	14	36	-	
Chromium (Cr)	2.7	7.7 (Cr III) 0.14 (Cr VI)	27.4 (Cr III) 4.4 (Cr VI)	48.6 (Cr III) 20 (Cr VI)	90.6 (Cr III) 85 (Cr VI)	-	
Copper (Cu)	31	0.3	1.3	3	8	-	
Lead (Pb)	1.3	2.2	4.4	6.6	12	-	

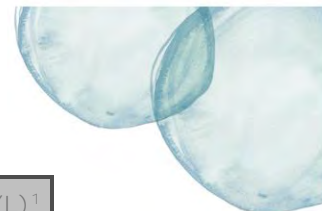


Parameter	SDOOL TWW	ANZECC/ARMCANZ (2000) guidelines (µg/L) <sup>1</sup>					Low reliability value (LRV)
		Level of protection				2018	
		99%	95%	90%	80%		
Mercury (Hg)	<0.1	0.1	0.4	0.7	1.4	-	
Nickel (Ni)	3.7	7	70	200	560	-	
Selenium (Se)	<1	ID	ID	ID	ID	3	
Silver (Ag)	<1	0.8	1.4	1.8	2.6	-	
Zinc (Zn)	81	7	15	23	43	-	
Triazine herbicides (µg/L)							
Atrazine	<0.1	ID	ID	ID	ID	13	
Hexazinone	<0.1	ID	ID	ID	ID	75	
Metribuzine	<0.1	n/a	n/a	n/a	n/a	n/a	
Prometryne	<0.1	n/a	n/a	n/a	n/a	n/a	
Simazine	<0.1	ID	ID	ID	ID	3.2	
Phenoxy acid herbicides (µg/L)							
Dicamba6	<1	n/a	n/a	n/a	n/a	n/a	
MCPA	<1	ID	ID	ID	ID	1.4	
Dichlorprop	<1	n/a	n/a	n/a	n/a	n/a	
2,4-D	1	ID	ID	ID	ID	280	
2,4,5-T	<1	n/a	n/a	n/a	n/a	n/a	
2,4,5-TP	<1	n/a	n/a	n/a	n/a	n/a	
2,4-DB	<1	n/a	n/a	n/a	n/a	n/a	
MCPP	<1	n/a	n/a	n/a	n/a	n/a	
Triclopyr7	<1	n/a	n/a	n/a	n/a	n/a	
Organophosphate pesticides (µg/L)							
Azinphos-Methyl	<0.1	ID	ID	ID	ID	0.01	
Azinphos-Ethyl	<0.1	n/a	n/a	n/a	n/a	n/a	
Chlorpyrifos	<0.1	0.0005	0.009	0.04	0.3	-	
Chlorfenvinphos (E)	<0.1	n/a	n/a	n/a	n/a	n/a	
Chlorfenvinphos (Z)	<0.1	n/a	n/a	n/a	n/a	n/a	
Demeton-S-Methyl	<0.1	ID	ID	ID	ID	4	
Dichlorvos	<0.1	n/a	n/a	n/a	n/a	n/a	
Diazinon	<0.1	ID	ID	ID	ID	0.01	
Dimethoate	<0.1	ID	ID	ID	ID	0.15	
Ethion	<0.1	n/a	n/a	n/a	n/a	n/a	
Fenthion	<0.1	n/a	n/a	n/a	n/a	n/a	
Fenitrothion	<0.1	ID	ID	ID	ID	0.001	

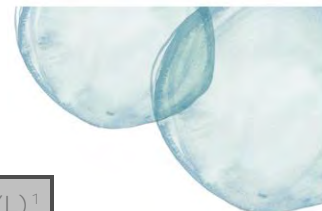


Parameter	SDOOL TWW	ANZECC/ARMCANZ (2000) guidelines ( $\mu\text{g/L}$ ) <sup>1</sup>					Low reliability value (LRV)
		Level of protection				2018	
		99%	95%	90%	80%		
Malathion	<0.1	ID	ID	ID	ID	0.05	
Parathion (Ethyl)	<0.1	ID	ID	ID	ID	0.004	
Parathion Methyl	<0.1	n/a	n/a	n/a	n/a	n/a	
Pirimiphos-Ethyl8	<0.1	n/a	n/a	n/a	n/a	n/a	
Pirimiphos-Methyl9	<0.1	n/a	n/a	n/a	n/a	n/a	
Organochlorine pesticides ( $\mu\text{g/L}$ )							
Aldrin	<0.001	ID	ID	ID	ID	0.003	
Trans-Chlordane10	<0.001	ID	ID	ID	ID	0.001	
Cis-Chlordane10	<0.001	ID	ID	ID	ID	0.001	
Oxychlordane10	<0.001	ID	ID	ID	ID	0.001	
Gamma-BHC (Lindane)	<0.001	ID	ID	ID	ID	0.007	
alpha-BHC	<0.001	n/a	n/a	n/a	n/a	n/a	
beta-BHC	<0.001	n/a	n/a	n/a	n/a	n/a	
delta-BHC	<0.001	n/a	n/a	n/a	n/a	n/a	
p,p-DDD	<0.001	n/a	n/a	n/a	n/a	n/a	
p,p-DDE	<0.001	ID	ID	ID	ID	0.0005	
p,p-DDT	<0.001	ID	ID	ID	ID	0.0004	
Dieldrin	<0.001	ID	ID	ID	ID	0.01	
Endrin	<0.001	0.004	0.008	0.01	0.02	-	
Endrin aldehyde	<0.001	n/a	n/a	n/a	n/a	n/a	
Endrin ketone	<0.001	n/a	n/a	n/a	n/a	n/a	
alpha-Endosulfan	<0.001	ID	ID	ID	ID	0.0002	
beta-Endosulfan	<0.001	ID	ID	ID	ID	0.007	
Endosulfan sulfate11	<0.001	0.005	0.01	0.02	0.05	-	
HCB (Hexachlorobenzene)	<0.001	ID	ID	ID	ID	0.05	
Heptachlor	<0.001	ID	ID	ID	ID	0.0004	
Heptachlor epoxide	<0.001	n/a	n/a	n/a	n/a	n/a	
Methoxychlor	<0.001	ID	ID	ID	ID	0.004	
Phenol ( $\mu\text{g/L}$ )							
Phenol	<1	270	400	520	720	-	
Nonylphenol	<1	ID	ID	ID	ID	1	
2-Chlorophenol	<1	ID	ID	ID	ID	340	
2-Methylphenol	<1	n/a	n/a	n/a	n/a	n/a	
2,4-Dichlorophenol	<1	ID	ID	ID	ID	120	





Parameter	SDOOL TWW	ANZECC/ARMCANZ (2000) guidelines ( $\mu\text{g/L}$ ) <sup>1</sup>					Low reliability value (LRV)
		Level of protection				2018	
		99%	95%	90%	80%		
2-Nitrophenol	<1	n/a	n/a	n/a	n/a	n/a	
4-Chloro-3-methylphenol	<2	n/a	n/a	n/a	n/a	2	
2,4,6-Trichlorophenol	<2	ID	ID	ID	ID	34	
4-Nitrophenol	<1	ID	ID	ID	ID	2	
2,4,5-Trichlorophenol	<2	n/a	n/a	n/a	n/a	n/a	
2,3,4,6-Trichlorophenol	<2	ID	ID	ID	ID	10	
Pentachlorophenol (PCP)	<2	11	22	33	55	-	
Phthalates ( $\mu\text{g/L}$ )							
Dimethyl phthalate	<10	ID	ID	ID	ID	3700	
Diethyl phthalate	<10	ID	ID	ID	ID	900	
Di-n-butyl phthalate	<10	ID	ID	ID	ID	25	
Butyl benzyl phthalate	<10	n/a	n/a	n/a	n/a	n/a	
Bis(2-ethylhexyl) phthalate	<20	ID	ID	ID	ID	1	
PCB aroclors							
Aroclor 1016	<0.1	ID	ID	ID	ID	0.009	
Aroclor 1221	<0.1	ID	ID	ID	ID	1	
Aroclor 1232	<0.1	ID	ID	ID	ID	0.3	
Aroclor 1242	<0.1	ID	ID	ID	ID	0.3	
Aroclor 1248	<0.1	ID	ID	ID	ID	0.03	
Aroclor 1254	<0.1	ID	ID	ID	ID	0.01	
Aroclor 1260	<0.1	ID	ID	ID	ID	n/a	
Total PCBs (as above) <sup>12</sup>	<0.1	ID	ID	ID	ID	n/a	
Chlorinated hydrocarbons ( $\mu\text{g/L}$ )							
2-Chloronaphthalene	<20	n/a	n/a	n/a	n/a	n/a	
1,4-Dichlorobenzene	<20	ID	ID	ID	ID	60	
1,2-Dichlorobenzene	<20	ID	ID	ID	ID	160	
1,3-Dichlorobenzene	<20	ID	ID	ID	ID	260	
Hexachlorobenzene	<20	ID	ID	ID	ID	0.05	
1,2,4-Trichlorobenzene	<20	20	80	140	240	-	
Hexachloroethane	<20	ID	ID	ID	ID	290	
Hexachlorocyclopentadiene	<20	ID	ID	ID	ID	0.05	
Hexachloro-1,3-butadiene <sup>13</sup>	<20	ID	ID	ID	ID	0.03	
Ethers ( $\mu\text{g/L}$ )							
4-Bromophenyl phenyl ether <sup>14</sup>	<20	n/a	n/a	n/a	n/a	n/a	



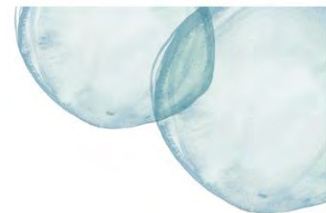
Parameter	SDOOL TWW	ANZECC/ARMCANZ (2000) guidelines (µg/L) <sup>1</sup>					Low reliability value (LRV)
		Level of protection					
	2018	99%	95%	90%	80%		
4-Chlorophenyl phenyl ether	<20	n/a	n/a	n/a	n/a	n/a	
Bis(2-chloroethyl)ether	<20	n/a	n/a	n/a	n/a	n/a	
Bis(2-chloroethoxy)methane	<20	n/a	n/a	n/a	n/a	n/a	
Bis(2-chloroisopropyl)ether	<20	n/a	n/a	n/a	n/a	n/a	
Amines, nitroaromatics nitrosamines (µg/L)							
Azobenzene	<20	n/a	n/a	n/a	n/a	n/a	
2,4-Dinitrotoluene	<20	ID	ID	ID	ID	16	
2,6-Dinitrotoluene	<20	n/a	n/a	n/a	n/a	0.3	
Nitrobenzene	<20	ID	ID	ID	ID	550	
N-Nitrosodimethylamine	<20	n/a	n/a	n/a	n/a	n/a	
N-Nitrosodiphenylamine	<20	ID	ID	ID	ID	6	
N-Nitrosodi-n-propylamine	<20	n/a	n/a	n/a	n/a	n/a	
Aniline	<20	ID	ID	ID	ID	8	
4-Chloroaniline	<20	n/a	n/a	n/a	n/a	n/a	
2-Nitroaniline	<20	n/a	n/a	n/a	n/a	n/a	
3-Nitroaniline	<20	n/a	n/a	n/a	n/a	n/a	
4-Nitroaniline	<20	n/a	n/a	n/a	n/a	n/a	
Other organics (µg/L)							
Dichlorobenzidine15	<20	ID	ID	ID	ID	0.5	
2-Methylnaphthalene	<10	n/a	n/a	n/a	n/a	n/a	
Isophorone	<20	ID	ID	ID	ID	130	
Benzyl alcohol	<20	n/a	n/a	n/a	n/a	n/a	
Carbazole	<20	n/a	n/a	n/a	n/a	n/a	
Dibenzofuran	<20	n/a	n/a	n/a	n/a	n/a	
BTEX (µg/L)							
Benzene	<1.0	500	700	900	1300	500	
Toluene	<1.0	ID	ID	ID	ID	180	
Ethylbenzene	<1.0	ID	ID	ID	ID	5	
Xylene16	<2.0	ID	ID	ID	ID	75	
Total BTEX12	<5.0	n/a	n/a	n/a	n/a	n/a	
Total petroleum hydrocarbons (TPH) (µg/L)							
TPH C6 - C917	<25	ID	ID	ID	ID	n/a	
TPH C10 - C1417	<25	ID	ID	ID	ID	n/a	
TPH C15 - C2817	<100	ID	ID	ID	ID	n/a	



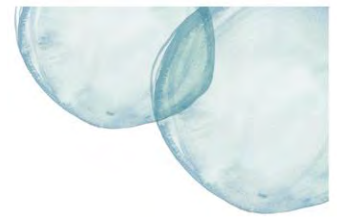
Parameter	SDOOL TWW	ANZECC/ARMCANZ (2000) guidelines (µg/L) <sup>1</sup>					Low reliability value (LRV)
		Level of protection				2018	
		99%	95%	90%	80%		
TPH C29 - C3617	<100	ID	ID	ID	ID	n/a	
Total TPH17,18	<250	ID	ID	ID	ID	n/a	
Poly aromatic hydrocarbons (PAHs) (µg/L)							
Naphthalene	<0.01	50	70	90	120	-	
Acenaphthylene	<0.01	n/a	n/a	n/a	n/a	n/a	
Acenaphthene	<0.01	n/a	n/a	n/a	n/a	n/a	
Fluorene	<0.01	n/a	n/a	n/a	n/a	n/a	
Phenanthrene	<0.01	ID	ID	ID	ID	2	
Anthracene	<0.01	ID	ID	ID	ID	0.4	
Fluoranthene	<0.01	ID	ID	ID	ID	1.4	
Pyrene	<0.01	n/a	n/a	n/a	n/a	n/a	
Benz(a)anthracene	<0.01	n/a	n/a	n/a	n/a	n/a	
Chrysene	<0.01	n/a	n/a	n/a	n/a	n/a	
Benzo(b,k)fluoranthene	<0.02	n/a	n/a	n/a	n/a	n/a	
Benzo(a)pyrene	<0.01	n/a	n/a	n/a	n/a	n/a	
Indeno(1,2,3-cd)pyrene	<0.01	n/a	n/a	n/a	n/a	n/a	
Dibenz(a,h)anthracene	<0.01	n/a	n/a	n/a	n/a	n/a	
Benzo(g,h,i)perylene	<0.01	50	70	90	120	-	
Surfactants (mg/L)							
Methylene blue active substances (MBAS) <sup>19</sup> (mg/L)	0.31	n/a	n/a	n/a	n/a	n/a	
Miscellaneous other (mg/L unless indicated)							
Chlorine-Free	<0.01	ID	ID	ID	ID	3	
Chlorine-Total	<0.01	ID	ID	ID	ID	3	
Dissolved Organic Carbon (DOC)	18	n/a	n/a	n/a	n/a	n/a	
Total organic carbon (TOC)	22	n/a	n/a	n/a	n/a	n/a	
Total suspended solids (TSS) <sup>20</sup>	76	n/a	n/a	n/a	n/a	n/a	
Biological oxygen demand (BOD)	46	n/a	n/a	n/a	n/a	n/a	
pH21	7.4	n/a	n/a	n/a	n/a	n/a	

Notes:

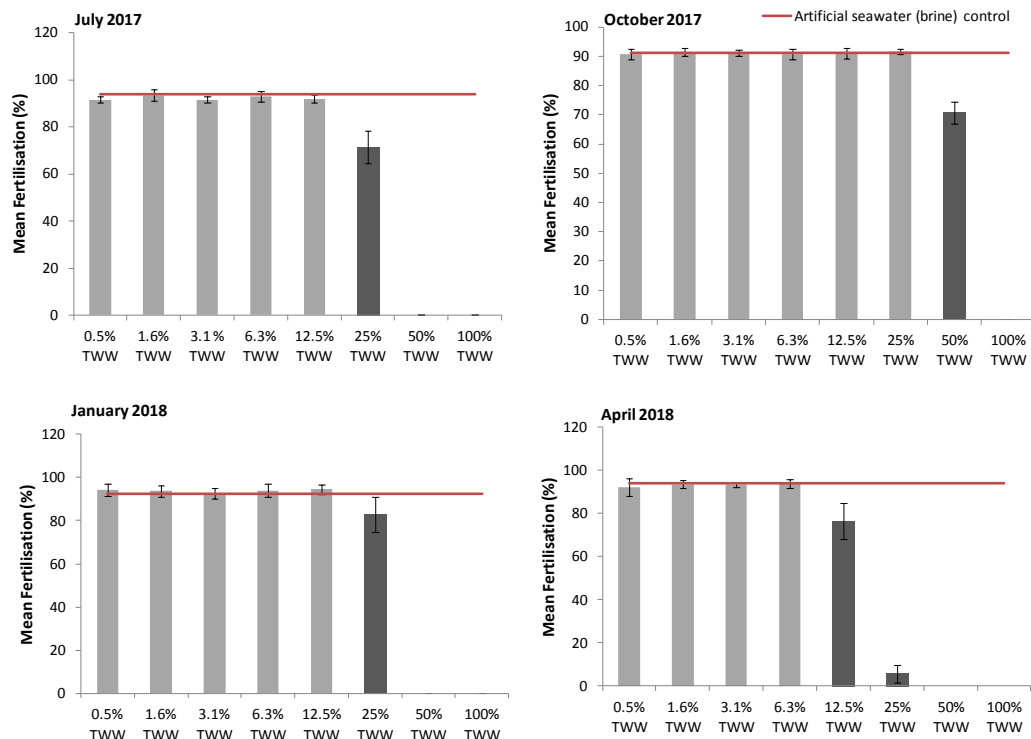
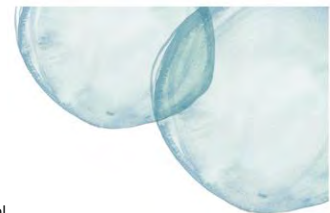
1. The trigger values for marine waters are from Table 3.4.1 in ANZECC/ARMCANZ (2000a). The EPA has provided advice that in WA waters where a high level of protection applies, that the 99% species protection levels should be used, with the exception of cobalt, where the 95% species protection levels is used. Grey bold text represents the relevant ANZECC/ARMCANZ (2000a) guideline values and amber bold text represents an exceedance of guideline values prior to initial dilution.
2. Primary and secondary contact guideline for recreational marine waters are 35 and 230 Enterococci organisms/100 mL, respectively (ANZECC/ARMCANZ 2000a).



3. n/a = ANZECC/ARMCANZ (2000a) guideline or LRV not available for this parameter.
4. Primary and secondary contact guidelines for recreational marine waters 150 and 1 000 faecal coliforms/100 mL (ANZECC/ARMCANZ 2000a), respectively.
5. ID = insufficient data to derive a reliable national trigger value.
6. Recreational guideline for Dicamba = 300 µg/L (Table 5.2.4; ANZECC/ARMCANZ 2000a).
7. Recreational guideline for Triclopyr = 20 µg/L (Table 5.2.4; ANZECC/ARMCANZ 2000a).
8. Recreational guideline for Pirimiphos-ethyl = 1 µg/L (Table 5.2.4; ANZECC/ARMCANZ 2000a).
9. Recreational guideline for Pirimiphos-methyl = 60 µg/L (Table 5.2.4; ANZECC/ARMCANZ 2000a).
10. Guideline values are for total chlordane though cis-chlordane is ~7 times more toxic than transchlordane (ANZECC/ARMCANZ 2000a).
11. Guideline values are for Endosulphan, not Endosulphan sulfate (Table 3.4.1; ANZECC/ARMCANZ 2000a).
12. ANZECC/ARMCANZ (2000b) recommends using a formula to calculate total toxicity of the mixture if using total PCBs and BTEX (page 8.3-65; ANZECC/ARMCANZ 2000b).
13. Environmental Concern Level (ECL) for Hexachloro-1,3-butadiene (not LRV) (definition of ECL on page 8.3-35; page 8.3-231; ANZECC/ARMCANZ 2000b).
14. Recommended ECL for 4-Bromophenyl phenyl ether = 12 µg/L (page 8.3-232; ANZECC/ARMCANZ 2000b).
15. ECL for Dichlorobenzidine (not LRV) (page 8.3-187; ANZECC/ARMCANZ 2000b).
16. Guideline for o-xylene = 350 µg/L, for m-xylene = 75 µg/L and for p-xylene = 200 µg/L (ANZECC/ARMZANC 2000a).
17. Guideline values are for generic oils and petroleum hydrocarbons (Table 3.4.1; ANZECC/ARMCANZ 2000a).
18. A generic estimate of 7 µg/L for a total petroleum hydrocarbon chronic value has been estimated using USEPA methods (page 8.3-297; ANZECC/ARMCANZ 2000b).
19. Recreational guideline for MBAS = 0.2 mg/L (ANZECC/ARMCANZ 2000a).
20. Suspended solids guidelines for the protection of saltwater aquaculture species = <10 mg/L (Table 4.4.2; ANZECC/ARMCANZ 2000a).
21. pH guideline range for slightly disturbed inshore marine ecosystems in southwest Australia = 8.0 to 8.4 (Table 3.3.6; ANZECC/ARMCANZ 2000a).



# Appendix B – WET Testing Results



Notes:

1. Error bars represent  $\pm 1$  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.

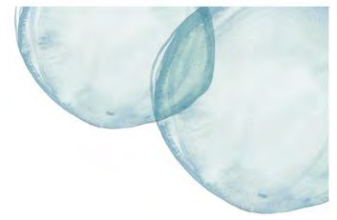
Figure B.7.1 Comparison of whole effluent toxicity TWW dilution results to artificial seawater control

Table B.1 Calculated parameters from whole of effluent toxicity tests

Indicator	July 2017	October 2017	January 2018	April 2018
NOEC <sup>1</sup>	12.5%	25%	12.5%	6.3%
Dilutions required to meet the NOEC	8	4	8	15.9
Dilutions required/dilutions achieved <sup>2</sup>	0.01	0.00	0.01	0.01
$\leq 1$	Yes	Yes	Yes	Yes

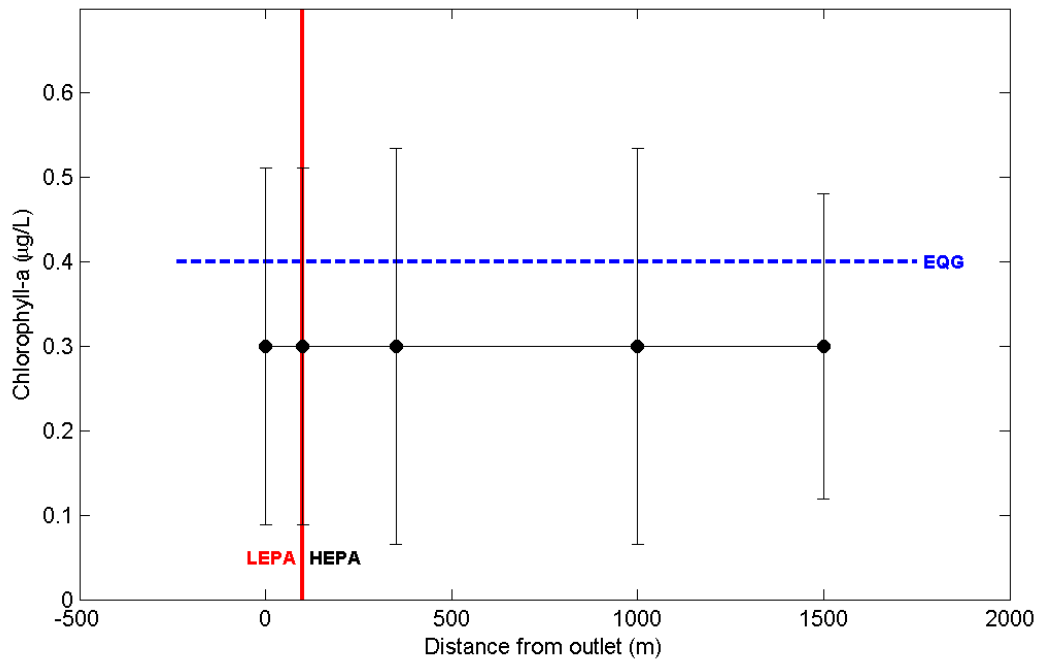
Notes:

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



# Appendix C – Physical Properties

## Nutrient enrichment

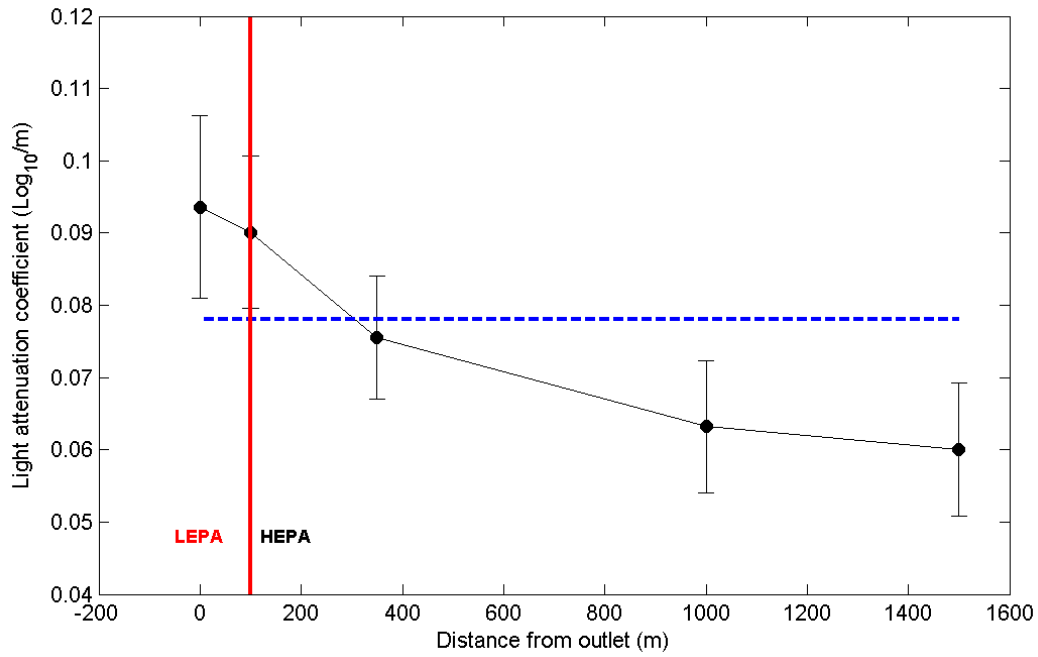


### Notes:

1. Error bars represent  $\pm 95\%$  confidence intervals
2. Environmental Quality Guideline (EQG) is the 80<sup>th</sup> 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 2017–March 2018.

Figure C.2 Median chlorophyll-a concentrations obtained at fixed monitoring sites above and down-current of the Sepia Depression outlet during the summer monitoring period

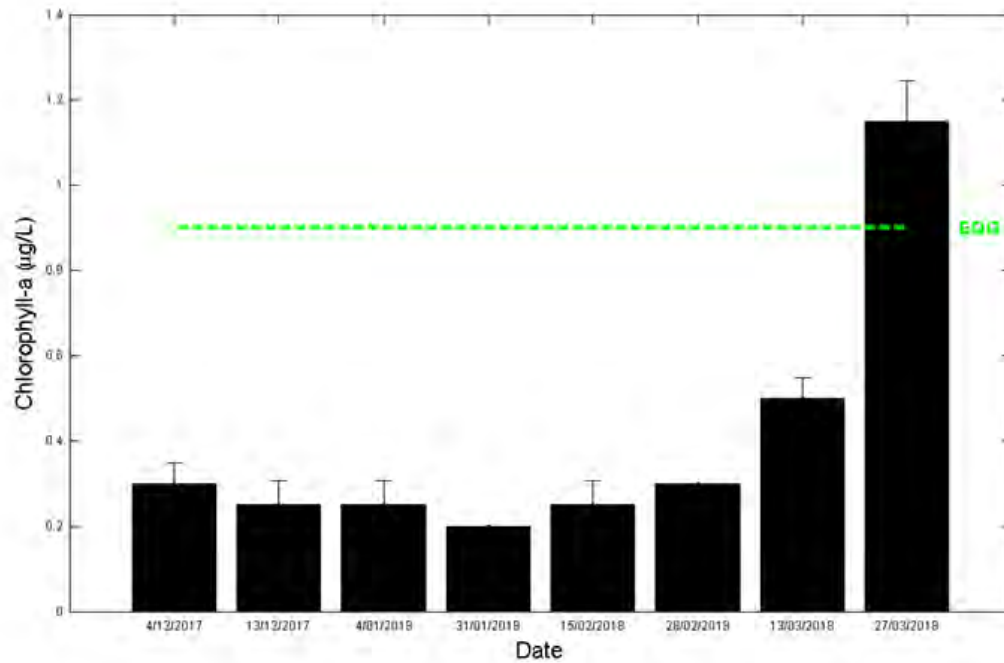




Notes:

1. Error bars represent  $\pm 95\%$  confidence intervals.
2. Environmental Quality Guideline (EQG) is the 80<sup>th</sup> percentile of historical reference site data (0.078 Log<sub>10</sub>/m).
3. LEPA = notional low ecological protection area; HEPA = high ecological protection area.
4. Data for each distance were pooled across eight sampling occasions (n=8) over December 2017–March 2018.

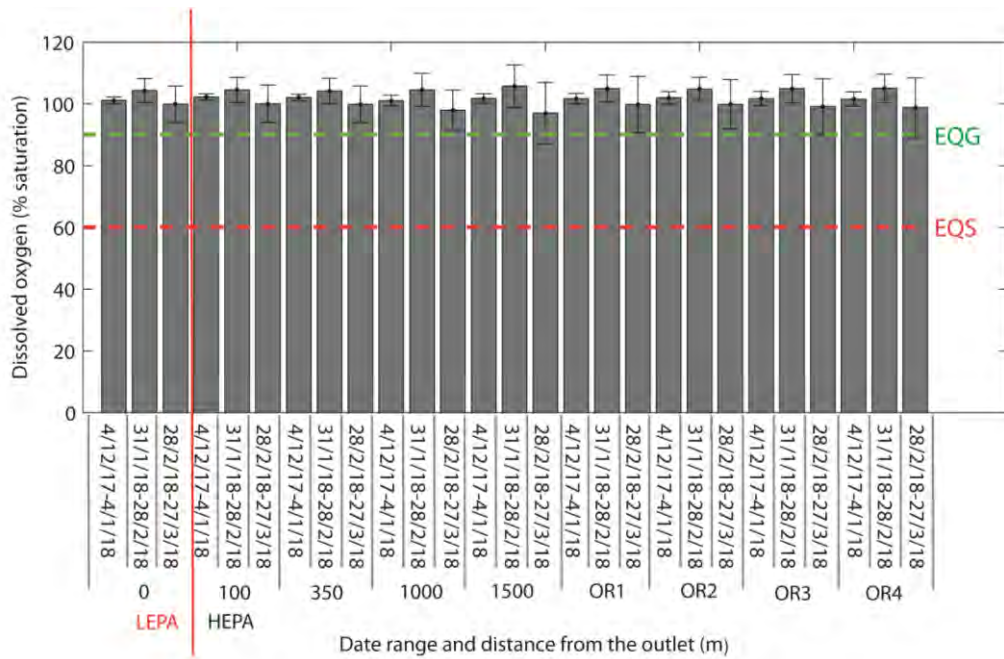
Figure C.3 Median light attenuation coefficient obtained at fixed distances down-current of the Sepia Depression outlet during the summer monitoring period



Notes:

1. Error bars represent +95% confidence intervals.
2. 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 EQG assessment, as the 0 m site is situated directly above the outlet within the notional low ecological protection area (LEPA).
4. Data were pooled across four sites within the high ecological protection area (HEPA) (n=4).

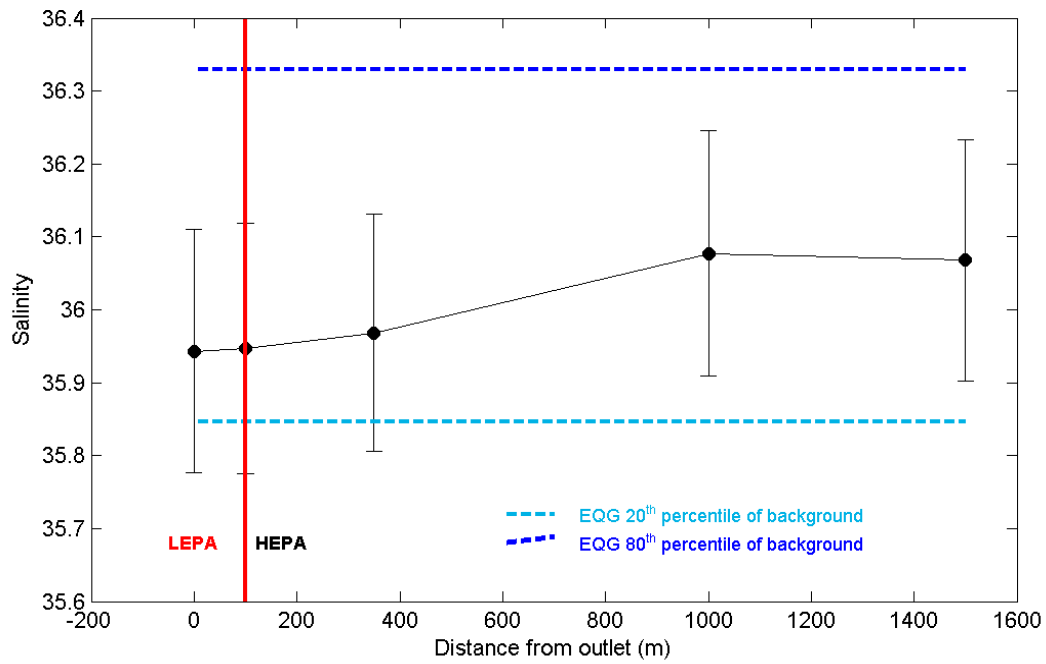
Figure C.4 Median phytoplankton biomass during the summer monitoring period, pooling data from fixed sites  $\geq 100$  m down-current of the Sepia Depression ocean outlet



Notes:

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

Figure C.5 **Median dissolved oxygen for defined periods of  $\leq 6$  weeks during the summer monitoring period**



Notes:

1. Error bars represent  $\pm 95\%$  confidence intervals.
2. Salinity measured 0–0.5 m below the sea surface.
3. LEPA = notional low ecological protection area; HEPA = high ecological protection area.
4. Data for each distance were pooled across eight sampling occasions (n=8) over December 2017 to March 2018.

Figure C.6 Median salinity compared to the 20<sup>th</sup> and 80<sup>th</sup> percentile of reference site data during the summer monitoring period



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