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Hydrobiology

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Dear Vanesa

RE – Interpretation of Adelaide desalination plant ecotoxicity reports

Please find below a letter report outlining the findings of the ecotoxicity testing undertaken on discharge collected from the Adelaide desalination plant.

Kind Regards,

Dustin Hobbs
Project Manager/Ecotoxicologist

1 INTRODUCTION

As part of AdelaideAqua's EPA Licence compliance conditions, an evaluation of the discharge effluent needed to be undertaken. This involved the collection of discharge samples for ecotoxicity testing, as the plant increased its output from mid 2011 up to October 2013. This testing was undertaken at Ecotox Services Australasia (ESA). The results of the testing were supplied to Hydrobiology and an assessment of the toxicity of the discharge from the plant was undertaken in the context of the dilution targets set during the pre-commissioning work.

1.1 Background

Ecotoxicity testing was undertaken before the construction of the desalination plant in order to define the possible toxicity of the saline concentrate discharge to the receiving environment. This involved an initial program undertaken for SA Water that used Port Stanvac water, processed by the Penneshaw reverse osmosis desalination plant located on Kangaroo Island. This water was mixed with a number of possible treatment chemicals and assessed for toxicity using a suite of organisms.

A second program was undertaken for AdelaideAqua where a saline concentrate sample was provided by processing Port Stanvac seawater through a pilot plant. The saline concentrate samples were treated with a range of chemicals and assessed for toxicity using a suite of organisms. The resulting concentrations were then used to develop species sensitivity distributions to derive the discharge concentration that would protect 95% of species in the receiving ecosystem. This discharge concentration was used to derive a safe dilution that would achieve the desired level of protection. This lead to the condition that an evaluation of the toxicity of the desalination plant's discharge was to be undertaken as the plant's output increased between 2011 and 2013.

Five samples were tested during the period of study. The samples were taken from the desalination plant before being discharged to the ocean, i.e. dilution of the discharge effluent in the receiving waters is not a factor that would affect the composition of the samples.

1.2 Objectives

AdelaideAqua is required to undertake toxicity testing of the discharge from the desalination plant at different stages of the plant commissioning and operation as part of their EPA Licence conditions. The objective of this report is to assess the toxicity of the discharge effluent with regards to the required level of dilution in the mixing zone around the discharge point.

2 METHODS

A comparison of the toxicity from five samples was undertaken.

Due to the unavailability of the polychaete *Diopatra aciculata* for the testing with the 3 month and 6 month after full commissioning discharges, the sea urchin, *Heliocidaris tuberculata* was used. This meant that direct comparisons of results for all stages of commissioning were not possible for this species.

Given that only two species were tested, the calculation of a safe dilution was done using the assessment/safety factor method. This entails dividing the results of the test by a safety factor to add a level of conservatism before deriving a safe dilution.

As the majority of the toxicity is attributed to the increased salinity of the discharge, as determined in previous studies (Hydrobiology 2008), a safety factor of 2 was used for the chronic tests while a safety factor of 10 was used for the acute tests.

Safe dilutions, the amount of dilution needed for the discharge to have little to no effect on the receiving ecosystem, were then compared to the stated achievable dilution within the mixing zone to determine the potential harm to the receiving environment.

3 RESULTS

The IC10 (the concentration of a chemical that is estimated to cause a response in 10% of the test organisms) results of the desalination plant ecotoxicity testing for thee different samples are given in Table 1 (e.g. for *H. tuberculata* at the 3 month stage after the plant was fully operational, 12.9% of the sample collected had a 10% effect.)

Table 1 Percentage sample for IC10 values for each discharge for the species tested

Sample	10% of total production	20% of total production	30% of total production	3 months after fully operational	6 months after fully operational
Date collected	12/10/2011	15/5/2012	17/05/2012	25/03/2013	19/8/2013
Plant production at the time	30ML/d	60ML/d	90ML/d	165ML/d	90ML/d
Mytilus galloprovincialis 48-h larval dev	12.9 (12.8-12.9)	10.9 (8.9-13.4)	12.5 (8.2-13.0)	6.4*	6.3*
Diopatra aciculata 14-d growth	19.5 (2.4-76.3)	4.1^ (0.5-38.9)	2.1^ (0.6-11.9)	NA	NA
Heliocidaris tuberculata 72-h larval dev	NA	NA	NA	12.9 (12.6-13.1)	7.3 (6.7-7.8)

* Confidence intervals are not reliable

^ Below lowest test concentration (<6.3% sample concentration)

The chronic IC10 values were divided by a safety factor of 2 and the acute IC10 values were divided by a safety factor of 10 and a safe dilution was then derived for each species and discharge. This safe dilution was then assessed to be acceptable if it was within the minimum 50 fold diffusion that occurs within the designated mixing zone. These safe dilutions are presented in Table 2.

Table 2 Calculated safe dilutions for each discharge scenario

Sample	10% of total production	20% of total production	30% of total production	3 months after fully operational	6 months after fully operational
Date collected	12/10/2011	15/5/2012	17/05/2012	25/03/2013	19/8/2013
Plant production at the time	30ML/d	60ML/d	90ML/d	165ML/d	90ML/d
Mytilus galloprovincialis 48-h larval dev	15.5	18.4	16	31.3	31.8
Diopatra aciculata 14-d growth	10.3	48.8	95.3	NA	NA
Diopatra aciculata 14-d survival	20.9	30.7	36.8	NA	NA
Heliocidaris tuberculata 72-h larval dev	NA	NA	NA	15.5	27.4

Results indicated that the level of dilution within the mixing zone would protect the receiving ecosystem for each of the species tested for each scenario, except for the *D. aciculata* growth test for the 30% of total production discharge, where a safe dilution of 95.3 was calculated for the weight endpoint. Upon inspection of the data for the 20% and the 30% of total production discharge, the weight endpoint had a high amount of variability around each concentration tested, as demonstrated by the standard deviation for each concentration tested including the control, and the results were affected by the results oscillating above and below the level of significance for these tests. The survival endpoint indicated a much lower level of toxicity with a safe dilution a magnitude lower than that calculated for the weight endpoint. Therefore, the results for the weight endpoint of the polychaete test were not used for considering the toxicity of the discharge samples. The polychaete 14 day survival test results were all within the achievable dilution of the mixing zone for the 3 samples tested using this species.

Given that the only species tested for all five samples was *M. galloprovincialis*, the results for this species were used to assess the toxicity of the desalination plant effluent. These levels of toxicity were well below the level of dilution expected to be achieved within the mixing zone around the discharge point.

This result was also seen for the sea urchin, *Heliocidaris tuberculata*, which was used to assess the toxicity of the discharges collected 3 months and 6 months after full plant commissioning. Both these discharges indicated a level of toxicity that was within the expected dilution of the mixing zone.

4 DISCUSSION

The toxicity of the desalination plant discharge is still being driven predominantly by the salinity of the samples and this is reflected to some degree in the results of the toxicity testing.

The mussel *Mytilus galloprovincialis* was the only species that was used to test all five discharges. It is unfortunate that a second species was not used to test all five discharges. And from the results, the use of the weight endpoint for polychaete test was not a consistently reliable measure of toxicity and wouldn't be recommended for future ecotoxicity assessments of the desalination plant discharge.

The chronic IC10 results of the tests were first divided by a safety factor of two, which is typically used when dealing with salinity as the major toxicant, and the acute IC10 results were divided by a safety factor of 10, and were then converted to the dilution factor needed to render them safe to the receiving ecosystem. This dilution factor was compared with the dilution factor of 50:1 that is considered to be the minimum achieved from the discharge point to the edge of the 100m mixing zone surrounding the discharge point. All the results for the mussel and the sea urchin tests were within the 50:1 dilution ratio for samples collected as was the survival results for the polychaete worm. The discharges collected whilst the plant was operational required safe dilutions of 31.3 and 31.8 for the mussel and 15.5 and 27.4 for the sea urchin which are well within the 50:1 achievable dilution.

5 CONCLUSIONS

- The mussel, *Mytilus galloprovincialis*, was used for all five discharge samples collected;
- All results for the mussel tests indicated that the discharge for all samples was within the achievable dilution of the mixing zone;
- The data for the polychaete growth test was highly variable and were not considered for assessing the toxicity of the desalination plant discharge;
- The results for the polychaete survival test indicated that the first three samples were within the achievable dilution of the mixing zone;
- The results for the sea urchin tests indicated that the discharge collected for the last two samples was within the achievable dilution of the mixing zone; and
- The ecotoxicity results indicate that the desalination plant is operating within the required performance criteria.

6 REFERENCES

Hydrobiology 2008. Ecotoxicity evaluation for Adelaide Desalination Plant saline concentrate and process chemicals. Report prepared for Connell Wagner. pp. 54.