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Executive summary

The increasing process water inventory at the Ranger uranium mine has become a major operational issue for Energy Resources of Australia Ltd (ERA). Following an assessment of potential technology options, ERA decided that brine concentration was the most viable option to reduce the inventory. The full-scale brine concentrator plant at Ranger was commissioned in September 2013 and the electrical conductivity of the distillate was stabilised in early October 2013. The aims of this study were to assess the toxicity of a distillate sample from the full-scale brine concentrator plant, and to identify the cause/s of any observed effects.

On 7 October 2013, following the stabilisation of distillate water quality, samples of the distillate were collected. Five tropical freshwater species (*Chlorella* sp. (green algae), *Lemna aequinoctialis* (duckweed), *Hydra viridissima* (green hydra), *Moinodaphnia macleayi* (cladoceran) and *Mogurnda mogurnda* (fish)) were exposed to a limited concentration range of the distillate (0, 25, 50 and 100%). Additionally, for all species except *Chlorella* sp., undiluted samples of distillate were amended by adding calcium (Ca), sodium (Na) and potassium (K) at 0.5, 1.0 and 0.4 mg L^{-1}, respectively (termed "100% amended"). Amending these salts of the distillate to concentrations representative of local natural waters aimed to determine if observed effects were due to reduced essential ions.

Chemical analyses from the full-scale plant showed that the distillate sample was a highly-purified water and contained less metals and major ions compared to the sample from the pilot plant. The toxicity of the full-scale-plant distillate was higher than that of the pilot-plant product, which was consistent with the higher purity. Some degree of toxicity was observed for all five species. Addition of Ca, Na and K to the distillate sample resulted in markedly improved performance of the organisms and indicated that a major ion deficiency is the primary cause of effects observed in the distillate. The outcomes of this study have been used to inform regulatory approvals concerning discharge of the distillate to the environment.

Abbreviations

DO	Dissolved Oxygen
EC	Electrical Conductivity
ERA	Energy Resources of Australia Ltd
GC-MS	Gas Chromatograph-Mass Spectrometry
ICP-MS/OES	Inductively Coupled Plasma Mass Spectrometry/ Optical Emission Spectrometry
MCW	Magela Creek Water
QC	Quality Control
RT-TI	Rio Tinto – Technology and Innovation
TSF	Tailings Storage Facility
VOCs/sVOCs	Volatile/semi-Volatile Organic Compound analysis

1 Introduction

The increasing process water inventory at the Ranger uranium mine has become a major operational issue for Energy Resources of Australia Ltd (ERA). Following an assessment of potential technology options, ERA decided that brine concentration was the most viable option to reduce the volume of process water on the mine site. A brine concentrator would produce large volumes of a purified water product (distillate) and a waste stream containing the salts present in the process water (brine concentrate). The distillate will be released (following approval) into the environment via a yet-to-be determined method (at the time of this study being undertaken), while the brine concentrate will be returned to the tailings storage facility (TSF) or, eventually, directly injected into the bottom of Pit 3.

In 2011, Rio Tinto – Technology and Innovation (RT-TI, Bundoora, Victoria) was engaged by ERA to conduct trials on a pilot-scale brine concentrator plant. Two key aims of the RT-TI trial were to (i) demonstrate that the distillate does not pose risks to operator health or the environment, and (ii) provide data to assist with designing water management and disposal systems. To assist with addressing the aquatic environment protection aspect, ***eriss*** undertook a comprehensive toxicity testing program of the pilot plant distillate (Harford et al. 2013). The aims of the toxicity test work were to: (i) detect and quantify any residual toxicity of the pilot distillate and, (ii) in the event that effects were observed, to identify the toxic constituent(s) of the distillate.

Five tropical freshwater species (*Chlorella* sp. (green algae), *Lemna aequinoctialis* (duckweed), *Hydra viridissima* (green hydra), *Moinodaphnia macleayi* (cladoceran) and *Mogurnda mogurnda* (fish)) were exposed to a limited concentration range of the pilot distillate sample (0, 25, 50 and 100%). The distillate was toxic to only *Hydra viridissima* (50-100% effect when exposed to 100% distillate). A series of experiments demonstrated that the effect was not due to residual ammonia (~1 mg L^{-1} N) or trace organics, and could not definitively identify manganese (Mn; 130 – 230 µg L^{-1}) as the cause. In contrast, the addition of calcium, sodium and potassium (at 0.5, 1.0 and 0.4 mg L^{-1}, respectively) resulted in 100% recovery of *H. viridissima* population growth rate. This indicated that ion deficiency must be considered as a potential stressor in risk/impact assessments of the discharge of purified waste waters, and that such waters may need to be supplemented with the deficient ions to reduce environmental impacts (Harford et al. 2013). Further assessment on the likelihood of Mn toxicity indicated that the residual Mn concentrations in the distillate were at levels that could inhibit the growth of *H. viridissima*, but further data were needed to fully assess the risk of Mn in low pH, soft waters (Harford et al. 2014).

The full-scale brine concentrator plant at Ranger was commissioned in September 2013 and the electrical conductivity of the distillate stabilised in early October 2013. The aims of the present study were to assess the toxicity of a distillate from the full-scale brine concentrator plant, and to identify the cause/s of any observed effects.

2 Method

2.1 Test water

On 7 October 2013, following the stabilisation of distillate water quality, samples of the distillate were collected in glass with Teflon septum lid and plastic containers, including samples for Volatile and semi-Volatile Organic Compound analysis (VOCs and sVOCs measured by Gas Chromatograph-Mass Spectrometry, GC-MS). The samples were transported to the Darwin laboratory and immediately measured for dissolved oxygen, pH and electrical conductivity (EC). The plastic containers were sub-sampled for a full-suite of metals and major ions by ICP-MS/OES (Envirolab, Chatswood, NSW). Additional sub-samples were analysed for alkalinity (APHA2320B), nitrate, phosphate and ammonia (Colourimetric methods, EPA 353.2, EPA 365.1, EPA 350.1).

2.2 Test diluent

Natural Magela Creek Water (MCW) was used as the control treatment and for dilution of the distillate samples in all tests, and was obtained from Bowerbird Billabong (latitude 12° 46' 15", longitude 133° 02' 20"). This natural water has been extensively characterised and has been used as a diluent in toxicity testing for over 20 years in the ***eriss*** ecotoxicology laboratory. The water was collected in 20 L acid-washed plastic containers and placed in storage at 4 ± 1°C within 1 h of collection. The water was then transported to the laboratory in an air-conditioned vehicle. At the laboratory, it was stored at 4 ± 1°C prior to filtration through 3.0 μm pore size (Sartopure PP2 depth filter MidiCaps, Sartorius, Göttingen, Germany) within 3 days of collection. Throughout the testing period, the MCW had a pH of 6.2-6.8 units, an EC of 16-27 μS cm^{-1} and DO of ≥85% saturation.

Diluent water was sub-sampled for physico-chemical analyses. Specifically pH, DO, EC and DOC were measured in-house. Additional sub-samples were analysed at Envirolab for alkalinity (APHA2320B), a limited metal and major ion suite (totals only; Al, Cd, Co, C, Cu, Fe, Mn, Ni, Pb, Se, U, Zn, Ca, Mg, Na, SO_4 (analysed as S and converted)), nitrate, phosphate and ammonia (Colourimetric methods, EPA 353.2, EPA 365.1, EPA 350.1).

2.3 Toxicity tests

Five tropical freshwater species were used to test the toxicity of the distillate, using the standard protocols described in Reithmuller et al. (2003; Table 1). The exposure regimes differed for the five species, thus:

1. *Hydra viridissima* and *M. macleayi*, were exposed to a limited concentration range of the distillate diluted in Magela Creek Water (MCW; 0, 25, 50 and 100%). Additionally, an undiluted sample of distillate was amended by adding Ca, Na and K at 0.5, 1.0 and 0.4 mg L^{-1}, respectively (termed "100% amended"). The concentrations of the added Ca, Na and K are representative of those measured in Magela Creek and were added to determine whether the adverse effects observed in the pilot-plant study could be reversed. Magnesium was not added because the distillate from the pilot-scale plant contained residual Mg that was similar to concentrations measured in the creek, ~0.5 mg L^{-1} Table 2). This differed from distillate produced by the full-scale plant, which contained Mg <0.1 mg L^{-1}.

2. *Chlorella* sp., *L. aequinoctialis* and *M. mogurnda*, were all initially exposed to 0 and 100% distillate treatments only. These species were expected to tolerate the distillate based on results from the pilot-plant study. However, toxicity observed in the 100% distillate treatment resulted in repetition of the toxicity tests for *L. aequinoctialis* (using 0, 25, 50 and 100%) and *M. mogurnda* (0, 50 and 100%). Both of the repeated toxicity tests included a 100% amended treatment, as used for the other three test species.

Table 1 Details of toxicity tests undertaken to assess distillate from the brine concentrator

Test organism	Acute/ Chronic	Test code	Date	Treatments tested (% Distillate)
Chlorella sp. (unicellular alga)	Chronic	1356G	08/10/13	0, 100
Lemna aeqinoctialis (duckweed)	Chronic	1355L	08/10/13	0, 100
	Chronic	1362L	14/10/13	0, 25, 50, 100, 100 (amended)[1]
Hydra viridissima (green hydra)	Chronic	1352B	08/10/13	0, 25, 50, 100, 100 (amended)
Moinodaphnia macleayi (cladoceran)	Chronic	1353D	10/10/13	0, 25, 50, 100, 100 (amended)
Mogurnda mogurnda (fish)	Acute	1354E	25/10/13	0, 100
	Acute	1364E	1/11/13	0, 50, 100, 100 (amended)

[1] Amended: undiluted distillate with addition of 0.5, 1.0 and 0.4 mg L^{-1} (nominal concentrations) Ca, Na and K, respectively.

2.4 Quality control

2.4.1 Chemistry

For each test, blanks and procedural blanks (i.e. ultra-pure water that has been exposed to all components of the test system) were also analysed for a limited metal and major ion suite (Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, U, Zn, Ca, Mg, Na, SO_4 - analysed as S and converted). Chemistry data for the blanks and procedural blanks were initially assessed by searching for analyte concentrations higher than detection limits. There were no instances where contamination in the blanks was greater than 2 µg L^{-1} and above background levels of MCW.

2.4.2 General water quality

For each test, data were considered acceptable if: the recorded temperature of the incubator remained within the prescribed limits (see test descriptions, above); the recorded pH was within ± 1 unit of values at test commencement (i.e. Day 0); the EC for each test solution was within 10% (or 5 µS cm^{-1} for samples with low conductivity) of the values at test commencement; and the DO concentration was greater than 70% throughout the test (see Appendix A for data). The occurrence of any significant water quality changes were investigated and discussed on a case-by-case basis.

2.4.3 Control responses

Tests were considered valid if the organisms in the Quality Control (QC) treatment (ie those in the MCW control) met the following criteria:

Chlorella sp. cell division rate test

- The algal growth rate is within the range 1.4 ± 0.3 doublings day^{-1}; and
- There is <20% variability (i.e. co-efficient of variation, CV <20%) in growth rate.

L. aequinoctialis plant growth test

- The average increase in frond number in any flask at test conclusion is at least four times that at test start (i.e. a total of 60 fronds/flask or specific growth rate (k) > 0.4 day^{-1}); and
- There is <20% variability (CV < 20%) in growth rate.

M. macleayi 3-brood reproduction test

- 80% or more of the cladocera are alive and female, and have produced three broods at the end of the test period;
- Reproduction in the control averages 30 or more live neonates per female over the test period; and

H. viridissima population growth test

- More than 30 healthy hydroids (i.e. specific growth rate specific growth rate (k) > 0.27 day^{-}1) remain in each dish at the end of the test period; and
- There is <20% variability (CV <20%) in growth rate.

M. mogurnda larval fish survival test

- The mean mortality or presence of fungus on the fish does not exceed 20%; and
- There is <20% variability (CV <20%) in survival.

3 Results and discussion

3.1 Quality Control

The quality of the toxicity tests was assessed based on criteria for water quality measurements (Appendix A), chemical analyses of blank and procedural blank samples (Appendix B, Table B3) and control performance (Appendix C). All toxicity tests met the criteria for control performance.

Two tests 1368E and 1355L exhibited a pH shift of over a unit in the new water of the 100% distillate treatment (Appendix A, Tables A7 and A2, respectively). This was not unexpected due to the low buffering capacity of the water. Dissolved oxygen concentrations in all tests were acceptable (> 80% saturation). The EC of the new waters used in all tests did not shift by more than 3 µS cm^{-1}.

Chemical analyses of the diluent, blank and procedural blank samples showed that all tests were free from confounding metal contaminants (Table B3). Hence, all tests reported here were of acceptable quality.

3.2 Distillate Chemistry

Chemical analyses from the full-scale plant showed that the distillate sample was a highly-purified water and contained less metals and major ions compared to the sample from the pilot plant (Table 2, Table B1). The EC of the distillate was 3 µS cm^{-1}, all major ions were below detection limits and the ammonia concentration was 0.25 mg L^{-1}. Manganese and uranium (U) concentrations were lower in the distillate from the full-scale plant (7 µg L^{-1} and 0.05 µg L^{-1}, respectively) compared to that produced by the pilot-scale plant (120-240 µg L^{-1} and 1.1-1.5 µg L^{-1}, respectively). The only other inorganic elements measured above 0.5 µg L^{-1} were Al and B, which were 3 and 13 µg L^{-1}, respectively (Table 2). All sVOC and VOCs were below detection limits (Table B2).

Table 2 Selected measured chemicals in the distillate (the full dataset is reported at Appendix B, Table B1).

Analyte	Detection limit	Pilot-plant 1st sample [a]	Pilot-plant 2nd sample [a]	Full-scale plant	Magela Creek Water
pH	0.1	5.8	6.7	6.1	6.1
Electrical conductivity (µS cm^{-1})	1	17	12	3	16
DOC (mg L^{-1})	0.1	0.6	NM [b]	0.6	2.1
Calcium (mg L^{-1})	0.1	0.11	<0.1	<0.1	0.2
Magnesium (mg L^{-1})	0.1	0.6	0.4	<0.1	1.1
Sodium (mg L^{-1})	0.1	<0.1	<0.1	<0.1	1.3
Potassium (mg L^{-1})	0.1	<0.1	<0.1	<0.1	0.2
Biocarbonate (mg L^{-1} $CaCO_3$)	1	7	6	<1	5
Ammonia (mg L^{-1} NH_3-N)	0.005	0.7	0.8	0.3	N.M.
Aluminium (µg L^{-1})	0.1	18.0	23.0	3.0	6.0
Manganese (µg L^{-1})	0.005	230	130	7.0	2.0
Boron (µg L^{-1})	0.5	100.0	88.0	13.0	N.M.
Uranium (µg L^{-1})	0.001	1.1	1.5	0.05	0.007

[a] Harford et al. (2013)

[b] NM: Not measured

3.3 Toxicity data

The effects of the distillate on the five freshwater species are shown in Figure 1. The full-scale-plant distillate was higher in toxicity compared to the pilot-plant distillate (Harford et al. 2013), but this was most likely due to the lower concentrations of major ions in the full-scale plant distillate (see below). All species displayed some degree of adverse effects in 100% distillate. *Chlorella* sp. and *M. mogurnda* were the most tolerant species with statistically significant 8% and 17% reductions in growth and survival, respectively. *Moinodaphnia macleayi* and *L. aequinoctialis* were equally sensitive to the 100% distillate with 71% and 73% reductions in reproduction and growth, respectively. However, *L. aequinoctialis* showed higher growth rates following the addition of the major ions, returning to levels similar to controls. The reproduction of *M. macleayi* improved with the major ion addition but was still 40% lower than the controls. As observed in the pilot-plant distillate, *H. viridissima*, did not grow in the 100% distillate and all organisms exposed to the water died in 96 h. The addition of the major ions resulted in 82% recovery (Figure 1), compared with100% recovery in the pilot-scale distillate (Harford et al. 2013). These results indicate that a major ion deficiency is the primary cause of effects observed in the distillate.

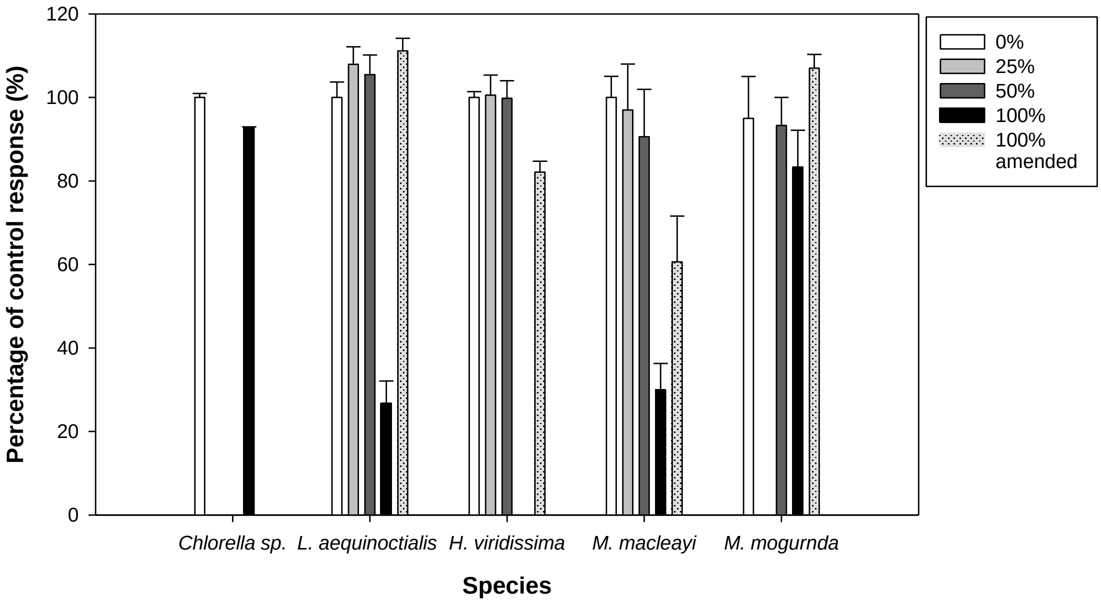


Figure 1 Toxicity of the full-scale-plant distillate to five local freshwater species. Test treatments represent percent distillate dilutions. See main text for details of the '100% amended' sample. Control responses were (mean ± se); 1.7 ± 0.02 dbl/d for *Chlorella* sp.; 0.32 ± 0.0 cm^2/d for *L. aequinoctialis*; 0.31 ± 0.0 for *H. viridissima*; 29.7 ± 1.5 neonates/adult for *M. macleayi*; and 95 ± 10.0% survival for *M. mogurnda*.

4 Conclusion

The toxicity of the full-scale-plant distillate sample was higher than that of the pilot-plant samples. These results were consistent with the higher purity of the former water. Amending the undiluted distillate sample with Ca, Na and K eliminated or reduced its toxicity. It is possible the remaining effects observed for *H. viridissima* and *M. macleayi* in the amended distillate sample were due to the concentration of Mg not being sufficient for hydra and cladoceran growth and reproduction. The major ion concentrations in the amended waters were similar to those found in MCW with the exception of Mg, which was not added to the treatments because this was not required during the pilot-plant study (Table 2). Nonetheless, the improved performance of the organisms upon addition of Ca, Na and K indicates that a major ion deficiency was the primary cause of effects observed in the distillate. The outcomes of this study have been used to inform regulatory approvals concerning discharge of the distillate to the environment.

5 References

Harford AJ, Jones DR & van Dam RA 2013. Highly treated mine waters may require major ion addition before environmental release. *Science of the Total Environment* 443(0), 1/15/, 143–151.

Harford AJ, Trenfield MA, Cheng KL & van Dam RA 2014. Ecotoxicological assessment of manganese. Internal Report 630, April, Supervising Scientist, Darwin.

Riethmuller N, Camilleri C, Franklin N, Hogan AC, King A, Koch A, Markich SJ, Turley C & van Dam R 2003. *Ecotoxicological testing protocols for Australian tropical freshwater ecosystems*. Supervising Scientist Report 173, Supervising Scientist, Darwin NT.

6 Appendices

Appendix A Water Quality Parameters

Table A1 1356G *Chlorella* sp.

Treatment (%)	MCW		100%	
Parameter	**0h**	**72h**	**0h**	**72h**
pH	6.2	6.6	6.6	6.0
EC (µS cm^{-1})	47	45	34	32
DO (%)	107	93	101	91
Temp (°C)	24.8	19.1	22.9	19.1

Table A2 1355L *L. aequinoctialis*

Treatment (%)	MCW		100%	
Parameter	**0h**	**72h**	**0h**	**72h**
pH	6.5	7.0	5.9	4.8
EC (µS cm^{-1})	23	17	16	14
DO (%)	100	89	103	89
Temp (°C)	23.7	22.6	23.0	22.0

Table A3 1362L *L. aequinoctialis*

Treatment (%)	MCW		25%		50%		100%		100% (amended)	
Parameter	**0h**	**72h**	**0h**	**72h**	**0h**	**72h**	**0h**	**72h**	**0h**	**72h**
pH	6.7	6.7	6.6	6.9	6.4	6.9	5.7	5.8	6.6	6.5
EC (µS cm^{-1})	27	19	21	15	18	12	11	10	19	11
DO (%)	106	89	105	91	103	88	104	91	101	91
Temp (°C)	25.3	23.5	24.6	22.7	22.2	24.3	21.4	23.7	21.1	23.0

Table A4 1352B *H. viridissima*

Treatment (%)		MCW		25%		50%		100%		100 % (amended)	
Parameter		**0h**	**72h**	**0h**	**72h**	**0h**	**72h**	**0h**	**72h**	**0h**	**72h**
Day 0	pH	6.5	6.5	6.5	6.8	6.4	6.6	5.7	6.0	6.1	6.3
	EC (µS cm^{-1})	16	17	13	14	11	11	3	4	11	12
	DO (%)	98	91	100	93	97	92	96	92	96	90
	Temp (°C)	22.9	24.6	21.7	23.8	21.2	22.8	21	22	20	22.1
Day 1	pH	6.3	6.5	6.4	6.5	6.3	6.6	5.6	6.5	6.0	6.3
	EC (µS cm^{-1})	16	17	13	17	10	10	6	3	11	12
	DO (%)	101	91	103	93	102	91	97	91	101	92
	Temp (°C)	21.3	23.9	21.4	23.8	21.1	23.0	21.3	22.9	21.5	22.7
Day 2	pH	6.4	6.4	6.4	6.5	6.3	6.6	5.5	6.5	6.3	6.5
	EC (µS cm^{-1})	16	18	13	14	10	11	4	3	11	12
	DO (%)	99	91	104	93	102	92	98	94	101	92
	Temp (°C)	21.3	23.8	21.2	23.3	21.4	22.8	21.6	23	21.7	22.7
Day 3	pH	6.6	6.7	6.5	6.7	6.4	6.7	5.7	6.1	6.3	6.2
	EC (µS cm^{-1})	16	17	13	14	10	10	5	3	11	12
	DO (%)	109	93	107	95	108	93	108	90	109	93
	Temp (°C)	22.5	22.3	22.5	24.0	22.5	23.8	22.3	23.4	22.2	20.9

Table A5 1353D *M. macleayi*

Treatment (%)		MCW		25%		50%		100%		100% (amended)	
Parameter		**0h**	**72h**	**0h**	**72h**	**0h**	**72h**	**0h**	**72h**	**0h**	**72h**
Day 0	pH	6.5	6.8	6.5	6.7	6.3	6.6	5.6	6.6	6.3	6.6
	EC (µS cm^{-1})	19	20	17	16	13	13	6	6	14	15
	DO (%)	108	91	103	92	105	91	109	91	106	89
	Temp (°C)	21.8	22.0	21.8	22.2	23.8	21.9	24.6	21.7	22.8	21.3
Day 1	pH	6.7	6.6	6.6	6.6	6.5	6.6	5.6	6.3	6.6	6.7
	EC (µS cm^{-1})	20	20	15	16	13	13	7	6	14	15
	DO (%)	100	91	109	92	101	90	94	88	97	91
	Temp (°C)	23.1	22.3	23.3	22.0	22.5	22.0	21.8	22.4	21.3	21.6
Day 2	pH	6.4	6.7	6.5	6.7	6.5	6.5	5.6	6.3	6.3	6.5
	EC (µS cm^{-1})	19	20	16	16	13	14	7	7	15	15
	DO (%)	105	90	97	93	103	93	98	91	102	87
	Temp (°C)	23.2	23.6	21.8	23.4	20.5	22.8	20.5	22.8	20.2	22.6
Day 3	pH	6.5	6.8	6.5	6.8	6.4	6.7	6.0	6.5	6.5	6.6
	EC (µS cm^{-1})	19	20	16	16	13	14	6	6	15	15
	DO (%)	102	91	102	91	101	89	102	87	101	88
	Temp (°C)	23.0	22.0	21.6	22.0	21.1	21.8	20.9	21.3	20.9	20.9
Day 4	pH	6.6	6.7	6.6	6.6	6.4	6.6	6.0	6.2	6.6	6.6
	EC (µS cm^{-1})	19	20	16	17	13	13	7	7	15	14
	DO (%)	102	89	105	88	106	89	101	85	104	88
	Temp (°C)	20.9	22.0	22.4	21.8	21.9	21.5	21.3	21.2	23.2	20.6
Day 5	pH	6.7	6.99	6.54	6.86	6.6	6.69	5.87	6.23	6.33	6.66
	EC (µS cm^{-1})	19	20	17	17	12	14	7	7	12	15
	DO (%)	98	92	109	93	103	90	97	94	103	92
	Temp (°C)	20.6	24.6	20.8	NM	20.7	NM	20.5	NM	20.2	NM

Table A6 1354E *M. mogurnda*

Treatment	(%)	MCW		100%	
Parameter		**0h**	**72h**	**0h**	**72h**
Day 0	pH	6.6	6.6	6.1	6.6
	EC (µS cm^{-1})	17	20	3	6
	DO (%)	96	95	101	97
	Temp (°C)	22.1	23.6	22.3	24.9
Day 1	pH	6.3	6.8	5.6	6.3
	EC (µS cm^{-1})	17	18	4	5
	DO (%)	103	91	102	92
	Temp (°C)	23.9	22.2	22.8	21.9
Day 2	pH	6.5	6.8	5.8	6.4
	EC (µS cm^{-1})	17	19	3	5
	DO (%)	100	91	106	91
	Temp (°C)	22.7	21.3	22.3	20.7
Day 3	pH	6.6	6.8	5.8	6.7
	EC (µS cm^{-1})	17	20	3	6
	DO (%)	100	85	109	91
	Temp (°C)	22.3	23.6	21.7	23.1

Table A7 1368E *M. mogurnda*

Treatment (%)		MCW		50%		100%		100% (amended)	
Parameter		**0h**	**72h**	**0h**	**72h**	**0h**	**72h**	**0h**	**72h**
Day 0	pH	6.8	6.9	6.8	6.8	6.5	6.6	6.4	6.6
	EC (µS cm^{-1})	19	20	10	13	4	6	11	14
	DO (%)	101	95	104	97	105	94	106	92
	Temp (°C)	22.7	23.6	22.1	23.2	21.7	22.8	22.1	22.4
Day 1	pH	6.6	6.7	6.7	6.6	5.4	6.3	5.9	6.4
	EC (µS cm^{-1})	17	19	10	12	6	5	11	13
	DO (%)	104	94	115	91	116	95	115	94
	Temp (°C)	22.6	25	22.7	25.6	22.7	25	22.4	24.8
Day 2	pH	6.4	6.3	6.5	6.4	5.8	6.6	6.3	6.5
	EC (µS cm^{-1})	17	19	11	12	6	5	12	13
	DO (%)	108	92	109	93	106	91	110	94
	Temp (°C)	NM	24.1	NM	24.8	0	25.4	NM	26.2
Day 3	pH	6.7	6.8	6.6	6.9	5.4	6.7	5.8	6.6
	EC (µS cm^{-1})	17	22	10	13	5	6	11	13
	DO (%)	106	94	110	95	109	92	110	91
	Temp (°C)	22.7	25.6	22.5	25	22.2	24.4	21.9	23.7

Appendix B Chemical analyses

Table B1 Inorganic analysis of distillate

Analyte	Units	Detection Limit	Concentration
Aluminium	µg/L	0.1	3
Cadmium	µg/L	0.02	<0.02
Cobalt	µg/L	0.01	0.01
Chromium	µg/L	0.1	<0.1
Copper	µg/L	0.01	0.1
Iron	µg/L	1	<1
Manganese	µg/L	0.01	7
Nickel	µg/L	0.01	<0.01
Lead	µg/L	0.01	0.2
Selenium	µg/L	0.2	<0.2
Uranium	µg/L	0.001	0.05
Zinc	µg/L	0.1	<0.1
Silver	µg/L	0.05	<0.05
Arsenic	µg/L	0.05	<0.05
Gold	µg/L	0.01	<0.01
Boron	µg/L	0.5	13
Barium	µg/L	0.02	0.06
Beryllium	µg/L	0.05	<0.05
Bismuth	µg/L	0.01	<0.01
Bromine	µg/L	1	<1
Cerium	µg/L	0.01	<0.01
Caesium	µg/L	0.01	<0.01
Dysprosium	µg/L	0.01	<0.01
Erbium	µg/L	0.01	<0.01
Europium	µg/L	0.01	<0.01
Gallium	µg/L	0.01	<0.01
Gadolinium	µg/L	0.01	<0.01
Hafnium	µg/L	0.01	<0.01
Mercury	µg/L	0.02	<0.02
Holmium	µg/L	0.01	<0.01
Indium	µg/L	5	<5
Lanthanum	µg/L	0.01	<0.01
Lithium	µg/L	0.05	<0.05
Lutetium	µg/L	0.01	<0.01
Molybdenum	µg/L	0.05	<0.05
Niobium	µg/L	0.02	<0.02
Neodymium	µg/L	0.01	<0.01
Osmium	µg/L	0.1	<0.1
Palladium	µg/L	0.05	<0.05

Table B1 (continued) Inorganic analysis of distillate

Analyte	Units	Detection Limit	Concentration
Praseodymium	µg/L	0.01	<0.01
Rubidium	µg/L	0.01	<0.01
Rhenium	µg/L	0.01	<0.01
Antimony	µg/L	0.05	<0.05
Scandium	µg/L	0.5	<0.5
Samarium	µg/L	0.01	<0.01
Tin	µg/L	0.1	0.1
Strontium	µg/L	0.01	0.05
Tantalum	µg/L	0.05	<0.05
Terbium	µg/L	0.01	<0.01
Tellurium	µg/L	0.1	<0.1
Thorium	µg/L	0.01	<0.01
Titanium	µg/L	2	<2
Thallium	µg/L	0.01	<0.01
Thulium	µg/L	0.01	<0.01
Vanadium	µg/L	0.05	<0.05
Tungsten	µg/L	0.05	<0.05
Yttrium	µg/L	0.01	0.02
Ytterbium	µg/L	0.01	<0.01
Zirconium	µg/L	0.05	<0.05
Sulfur	mg/L	0.5	<0.5
Alkalinity as $CaCO_3$	mg/L	1.0	2.0
Nitrate as N	mg/L	0.005	<0.005
Ammonia as N	mg/L	0.005	0.27
Phosphate as P	mg/L	0.005	<0.005
Calcium	mg/L	0.1	<0.1
Chloride	mg/L	1	<1.0
Magnesium	mg/L	0.1	<0.1
Sodium	mg/L	0.1	<0.1
Potassium	mg/L	0.1	<0.1

Table B2 Volatile Organic Carbon and semi Volatile Organic Carbon analysis of distillate

Analyte	Units	Detection Limit	Concentration
Dichlorodifluoromethane	µg/L	10	<10
Chloromethane	µg/L	10	<10
Vinyl Chloride	µg/L	10	<10
Bromomethane	µg/L	10	<10
Chloroethane	µg/L	10	<10
Trichlorofluoromethane	µg/L	10	<10
1,1-Dichloroethene	µg/L	1	<1
Trans-1,2-dichloroethene	µg/L	1	<1
1,1-dichloroethane	µg/L	1	<1
Cis-1,2-dichloroethene	µg/L	1	<1
Bromochloromethane	µg/L	1	<1
Chloroform	µg/L	1	<1
2,2-dichloropropane	µg/L	1	<1
1,2-dichloroethane	µg/L	1	<1
1,1,1-trichloroethane	µg/L	1	<1
1,1-dichloropropene	µg/L	1	<1
Cyclohexane	µg/L	1	<1
Carbon tetrachloride	µg/L	1	<1
Benzene	µg/L	1	<1
Dibromomethane	µg/L	1	<1
1,2-dichloropropane	µg/L	1	<1
Trichloroethene	µg/L	1	<1
Bromodichloromethane	µg/L	1	<1
trans-1,3-dichloropropene	µg/L	1	<1
cis-1,3-dichloropropene	µg/L	1	<1
1,1,2-trichloroethane	µg/L	1	<1
Toluene	µg/L	1	<1
1,3-dichloropropane	µg/L	1	<1
Dibromochloromethane	µg/L	1	<1
1,2-dibromoethane	µg/L	1	<1
Tetrachloroethene	µg/L	1	<1
1,1,1,2-tetrachloroethane	µg/L	1	<1
Chlorobenzene	µg/L	1	<1
Ethylbenzene	µg/L	1	<1
Bromoform	µg/L	1	<1
m+p-xylene	µg/L	2	<2
Styrene	µg/L	1	<1
1,1,2,2-tetrachloroethane	µg/L	1	<1
o-xylene	µg/L	1	<1
1,2,3-trichloropropane	µg/L	1	<1
Isopropylbenzene	µg/L	1	<1

Table B2 (cont) Volatile Organic Carbon and semi Volatile Organic Carbon analysis of distillate

Analyte	Units	Detection Limit	Concentration
Bromobenzene	µg/L	1	<1
n-propyl benzene	µg/L	1	<1
2-chlorotoluene	µg/L	1	<1
4-chlorotoluene	µg/L	1	<1
1,3,5-trimethyl benzene	µg/L	1	<1
Tert-butyl benzene	µg/L	1	<1
1,2,4-trimethyl benzene	µg/L	1	<1
1,3-dichlorobenzene	µg/L	1	<1
Sec-butyl benzene	µg/L	1	<1
1,4-dichlorobenzene	µg/L	1	<1
4-isopropyl toluene	µg/L	1	<1
1,2-dichlorobenzene	µg/L	1	<1
n-butyl benzene	µg/L	1	<1
1,2-dibromo-3-chloropropane	µg/L	1	<1
1,2,4-trichlorobenzene	µg/L	1	<1
Hexachlorobutadiene	µg/L	1	<1
1,2,3-trichlorobenzene	µg/L	1	<1
Phenol	µg/L	10	<10
Bis (2-chloroethyl) ether	µg/L	10	<10
2-Chlorophenol	µg/L	10	<10
1,3-Dichlorobenzene	µg/L	10	<10
1,4-Dichlorobenzene	µg/L	10	<10
2-Methylphenol	µg/L	10	<10
1,2-Dichlorobenzene	µg/L	10	<10
bis-(2-Chloroisopropyl) ether	µg/L	10	<10
3/4-Methylphenol	µg/L	20	<20
N-nitrosodi-n-propylamine	µg/L	10	<10
Hexachloroethane	µg/L	10	<10
Nitrobenzene	µg/L	10	<10
Isophorone	µg/L	10	<10
2,4-Dimethylphenol	µg/L	10	<10
2-Nitrophenol	µg/L	10	<10
bis (2-Chloroethoxy) methane	µg/L	10	<10
2,4-Dichlorophenol	µg/L	10	<10
1,2,4-Trichlorobenzene	µg/L	10	<10
Naphthalene	µg/L	10	<10
4-Chloroaniline	µg/L	10	<10
Hexachlorobutadiene	µg/L	10	<10
2-Methylnaphthalene	µg/L	10	<10
Hexachlorocyclopentadiene	µg/L	10	<10
2,4,6-Trichlorophenol	µg/L	10	<10

Table B2 (cont) Volatile Organic Carbon and semi Volatile Organic Carbon analysis of distillate

Analyte	Units	Detection Limit	Concentration
2,4,5-Trichlorophenol	µg/L	10	<10
2-Chloronaphthalene	µg/L	10	<10
2-Nitroaniline	µg/L	10	<10
Dimethyl phthalate	µg/L	10	<10
2,6-Dinitrotoluene	µg/L	10	<10
Acenaphthylene	µg/L	10	<10
3-Nitroaniline	µg/L	10	<10
Acenaphthene	µg/L	10	<10
2,4-Dinitrophenol	µg/L	100	<100
4-Nitrophenol	µg/L	100	<100
Dibenzofuran	µg/L	10	<10
Diethylphthalate	µg/L	10	<10
4-Chlorophenylphenylether	µg/L	10	<10
4-Nitroaniline	µg/L	10	<10
Fluorene	µg/L	10	<10
2-methyl-4,6-dinitrophenol	µg/L	100	<100
Azobenzene	µg/L	10	<10
4-Bromophenylphenylether	µg/L	10	<10
Hexachlorobenzene	µg/L	10	<10
Pentachlorophenol	µg/L	100	<100
Phenanthrene	µg/L	10	<10
Anthracene	µg/L	10	<10
Carbazole	µg/L	10	<10
Di-n-butylphthalate	µg/L	10	<10
Fluoranthene	µg/L	10	<10
Pyrene	µg/L	10	<10
Butylbenzylphthalate	µg/L	10	<10
Bis(2-ethylhexyl) phthalate	µg/L	10	<10
Benzo(a)anthracene	µg/L	10	<10
Chrysene	µg/L	10	<10
Di-n-octylphthalate	µg/L	10	<10
Benzo(b)fluoranthene	µg/L	10	<10
Benzo(k)fluoranthene	µg/L	10	<10
Benzo(a)pyrene	µg/L	10	<10
Indeno(1,2,3-c,d)pyrene	µg/L	10	<10
Dibenzo(a,h)anthracene	µg/L	10	<10
Benzo(g,h,i)perylene	µg/L	10	<10
Ethylmethanesulfonate	µg/L	10	<10
Aniline	µg/L	10	<10
Pentachloroethane	µg/L	10	<10

Table B2 (cont) Volatile Organic Carbon and semi Volatile Organic Carbon analysis of distillate

Analyte	Units	Detection Limit	Concentration
Benzyl alcohol	µg/L	10	<10
Acetophenone	µg/L	10	<10
N-nitrosomorpholine	µg/L	10	<10
N-nitrosopiperidine	µg/L	10	<10
2,6-Dichlorophenol	µg/L	10	<10
Hexachloropropene-1	µg/L	10	<10
N-nitroso-n-butylamine	µg/L	10	<10
Safrole	µg/L	10	<10
1,2,4,5-Tetrachlorobenzene	µg/L	10	<10
Trans-iso-safrole	µg/L	10	<10
1,3-Dinitrobenzene	µg/L	10	<10
Pentachlorobenzene	µg/L	10	<10
1-Naphthylamine	µg/L	10	<10
2,3,4,6-Tetrachlorophenol	µg/L	10	<10
2-Naphthylamine	µg/L	10	<10
5-Nitro-o-toluidine	µg/L	10	<10
Diphenylamine	µg/L	10	<10
Phenacetin	µg/L	10	<10
Pentachloronitrobenzene	µg/L	10	<10
Dinoseb	µg/L	10	<10
Methapyrilene	µg/L	10	<10
p-Dimethylaminoazobenzene	µg/L	10	<10
2-Acetylaminofluorene	µg/L	10	<10
7,12-Dimethylbenz(a)anthracene	µg/L	10	<10
3-Methylcholanthrene	µg/L	10	<10
a-BHC	µg/L	10	<10
b-BHC	µg/L	10	<10
g-BHC	µg/L	10	<10
d-BHC	µg/L	10	<10
Heptachlor	µg/L	10	<10
Aldrin	µg/L	10	<10
Heptachlor Epoxide	µg/L	10	<10
g-Chlordane	µg/L	10	<10
a-Chlordane	µg/L	10	<10
Endosulfan I	µg/L	10	<10
p,p'-DDE	µg/L	10	<10
Dieldrin	µg/L	10	<10
Endrin	µg/L	10	<10
p,p'-DDD	µg/L	10	<10
Endosulfan II	µg/L	10	<10
Endrin Aldehyde	µg/L	10	<10

Table B2 (cont) Volatile Organic Carbon and semi Volatile Organic Carbon analysis of distillate

Analyte	Units	Detection Limit	Concentration
p,p'-DDT	µg/L	10	<10
Endosulfan Sulphate	µg/L	10	<10

Table B3 Blank (Blk) and Procedural Blank (Pro Blk) chemistry for the toxicity tests

Analyte	Units	Detection Limit	MCW [a]	1355L Blk	1355L Pro Blk	1356G Blk	1356G Pro Blk	1352B Blk	1352B Pro Blk	1353D Pro Blk	1353D Blk	1368E Pro Blk	1368E Blk
Aluminium	µg/L	0.1	6	2	4	<0.1	0.4	<0.1	<0.1	0.1	<0.1	0.6	1
Cadmium	µg/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cobalt	µg/L	0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	µg/L	0.01	0.4	0.1	0.05	0.04	0.05	0.05	0.05	<0.01	<0.01	0.04	0.1
Iron	µg/L	1	31	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Manganese	µg/L	0.01	2	0.03	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.03
Nickel	µg/L	0.01	0.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
Lead	µg/L	0.01	0.05	0.03	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.04
Selenium	µg/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Uranium	µg/L	0.001	0.007	<0.001	0.03	<0.001	0.02	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Zinc	µg/L	0.1	0.5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.6
Sulphate	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

[a] Magela Creek Water batch used for the toxicity tests.

Appendix C Toxicity test raw data and statistical analyses

CETIS Analytical Report

Report Date: 13 Nov-13 11:53 (p 1 of 2)
Test Code: 1352B | 06-2500-4322

Green Hydra Population Growth Test — **eriss ecotoxicology lab**

Analysis ID:	04-5565-8920	**Endpoint:**	Specific growth rate (96h)	**CETIS Version:**	CETISv1.8.7
Analyzed:	13 Nov-13 11:52	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	03-1407-0036	**Test Type:**	Hydra population growth	**Analyst:**	Andrew J Harford
Start Date:	09 Oct-13 15:30	**Protocol:**	Hydra eriss tropical freshwater	**Diluent:**	Magela Creek Water
Ending Date:	12 Oct-13 15:30	**Species:**	Hydra viridissima	**Brine:**	Not Applicable
Duration:	72h	**Source:**	In-House Culture	**Age:**	
Sample ID:	16-7335-7126	**Code:**	315B0E11	**Client:**	Energy Resources of Australia - Enviro
Sample Date:	07 Oct-13 10:30	**Material:**	Ranger Brine Concentrator Distillate	**Project:**	Ranger Brine Concentrator Plant
Receive Date:	07 Oct-13 16:00	**Source:**	Ranger Brine Concentrator Plant		
Sample Age:	53h (25 °C)	**Station:**	N/A		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	575101	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	1.781	2.412	0.6932	No Outliers Detected

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	51.62	14.84	51.95	1.937	1.925	6.739
IC10	53.45	47.95	53.78	1.871	1.86	2.085
IC15	55.35	49.97	55.67	1.807	1.796	2.001
IC20	57.32	52.07	57.63	1.745	1.735	1.92
IC25	59.36	54.26	59.66	1.685	1.676	1.843
IC40	65.9	61.36	66.17	1.517	1.511	1.63
IC50	70.66	66.59	70.89	1.415	1.411	1.502

Specific growth rate (96h) Summary

			Calculated Variate						
C-%	**Control Type**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	Magela Creek W	3	0.3059	0.2985	0.3132	0.004247	0.007356	2.41%	0.0%
25		3	0.3075	0.2829	0.3338	0.01471	0.02549	8.29%	-0.54%
50		3	0.3053	0.2829	0.3271	0.01277	0.02212	7.25%	0.19%
100		3	0	0	0	0	0		100.0%

Specific growth rate (96h) Detail

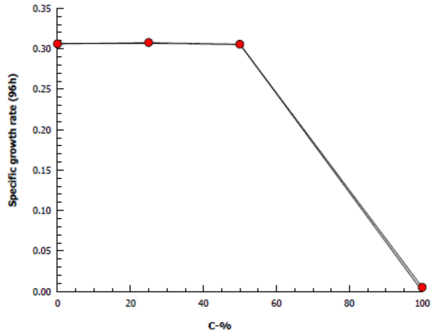
C-%	Control Type	Rep 1	Rep 2	Rep 3
0	Magela Creek Wa	0.3059	0.2985	0.3132
25		0.3338	0.3059	0.2829
50		0.2829	0.3271	0.3059
100		0	0	0

000-428-181-1 CETIS™ v1.8.7.4 Analyst:________ QA:________

Green Hydra Population Growth Test | **eriss ecotoxicology lab**

Analysis ID:	04-5565-8920	**Endpoint:**	Specific growth rate (96h)	**CETIS Version:**	CETISv1.8.7
Analyzed:	13 Nov-13 11:52	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Report Date: 13 Nov-13 11:44 (p 1 of 2)
Test Code: 1353D | 09-0341-1637

Cladoceran Reproduction Test — **eriss ecotoxicology lab**

Analysis ID:	21-4309-6132	**Endpoint:**	Total neonates	**CETIS Version:**	CETISv1.8.7
Analyzed:	13 Nov-13 11:42	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	07-2312-9691	**Test Type:**	Cladoceran reproduction	**Analyst:**	Andrew J Harford
Start Date:	10 Oct-13 14:15	**Protocol:**	Clad (chronic) eriss tropical freshwater	**Diluent:**	Magela Creek Water
Ending Date:	16 Oct-13 14:15	**Species:**	Moinodaphnia macleayi	**Brine:**	Not Applicable
Duration:	6d 0h	**Source:**	In-House Culture	**Age:**	

Sample ID:	08-2805-0961	**Code:**	315B0E11	**Client:**	Energy Resources of Australia - Enviro
Sample Date:	07 Oct-13 10:30	**Material:**	Ranger Brine Concentrator Distillate	**Project:**	Ranger Brine Concentrator Plant
Receive Date:	07 Oct-13 16:00	**Source:**	Ranger Brine Concentrator Plant		
Sample Age:	76h (28 °C)	**Station:**	N/A		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	2002751	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	3.589	3.036	0.0033	Outlier Detected

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	30.99	1.088	52.66	3.226	1.899	91.93
IC10	50.33	3.359	55.55	1.987	1.8	29.77
IC15	53.31	8.1	58.54	1.876	1.708	12.35
IC20	56.46	18	61.7	1.771	1.621	5.556
IC25	59.79	42.54	65.02	1.673	1.538	2.351
IC40	70.99	58.06	76.9	1.409	1.3	1.722
IC50	79.58	68.85	86.75	1.257	1.153	1.452

Total neonates Summary

			Calculated Variate						
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Magela Creek W	10	29.7	20	34	1.499	4.739	15.96%	0.0%
25		10	28.8	0	34	3.279	10.37	36.0%	3.03%
50		10	26.9	0	35	3.375	10.67	39.67%	9.43%
100		10	8.9	0	15	1.876	5.934	66.67%	70.03%

Total neonates Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Magela Creek Wa	24	27	33	34	34	31	34	20	30	30
25		33	31	33	33	32	0	33	33	26	34
50		31	29	32	35	34	34	31	24	0	19
100		0	0	15	8	15	10	14	7	5	15

Algal Growth Inhibition Test — **eriss ecotoxicology lab**

Analysis ID:	04-3886-0442	**Endpoint:**	Growth rate (db/d)	**CETIS Version:**	CETISv1.8.7
Analyzed:	18 Nov-13 10:41	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes
Batch ID:	12-1379-3994	**Test Type:**	Algal growth inhibition	**Analyst:**	Andrew J Harford
Start Date:	08 Oct-13 12:00	**Protocol:**	Alga eriss tropical freshwater	**Diluent:**	Magela Creek Water
Ending Date:	11 Oct-13 12:00	**Species:**	Chlorella sp.	**Brine:**	Not Applicable
Duration:	72h	**Source:**	eriss ecotoxicology lab	**Age:**	
Sample ID:	05-5790-2620	**Code:**	315B0E11	**Client:**	Energy Resources of Australia - Enviro
Sample Date:	07 Oct-13 10:30	**Material:**	Ranger Brine Concentrator Distillate	**Project:**	Ranger Brine Concentrator Plant
Receive Date:	07 Oct-13 16:00	**Source:**	Ranger Brine Concentrator Plant		
Sample Age:	26h	**Station:**	N/A		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	2.07%	Fails growth rate (db/d)

Equal Variance t Two-Sample Test

Control	vs	C-%	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Magela Creek Wate		100*	7.457	2.132	0.035	4	0.0009	CDF	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	1.723	1.887	0.2079	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.0225908	0.0225908	1	55.6	0.0017	Significant Effect
Error	0.001625167	0.0004062916	4			
Total	0.02421596		5			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Variance Ratio F	26.36	199	0.0731	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9286	0.43	0.5696	Normal Distribution

Growth rate (db/d) Summary

C-%	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	Magela Creek	3	1.699	1.629	1.768	1.691	1.675	1.73	0.01615	1.65%	0.0%
100		3	1.576	1.562	1.59	1.579	1.57	1.579	0.003151	0.35%	7.23%

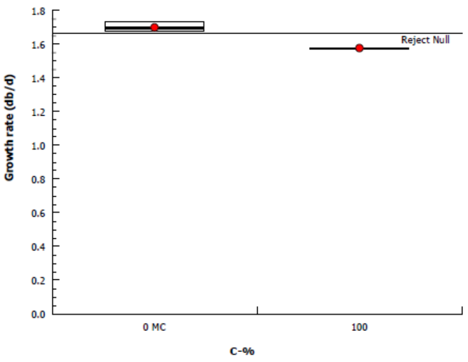
Growth rate (db/d) Detail

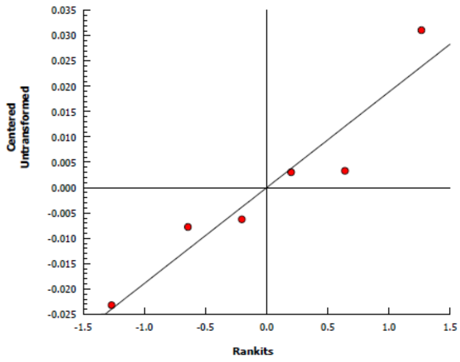
C-%	Control Type	Rep 1	Rep 2	Rep 3
0	Magela Creek	1.675	1.73	1.691
100		1.579	1.579	1.57

Algal Growth Inhibition Test **eriss ecotoxicology lab**

Analysis ID:	04-3886-0442	**Endpoint:**	Growth rate (db/d)	**CETIS Version:**	CETISv1.8.7
Analyzed:	18 Nov-13 10:41	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Graphics





CETIS Analytical Report

Report Date:	13 Nov-13 12:02 (p 1 of 2)
Test Code:	1362L | 06-4267-5903

Lemna Growth Inhibition — **eriss ecotoxicology lab**

Analysis ID:	11-0215-2872	**Endpoint:**	Growth rate (surface area)	**CETIS Version:**	CETISv1.8.7
Analyzed:	13 Nov-13 12:00	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	10-9755-9842	**Test Type:**	Lemna Growth	**Analyst:**	Andrew J Harford
Start Date:	14 Oct-13 12:30	**Protocol:**	Lemna eriss tropical freshwater	**Diluent:**	Magela Creek Water
Ending Date:	18 Oct-13 12:30	**Species:**	Lemna aequinoctialis	**Brine:**	Not Applicable
Duration:	96h	**Source:**	In-House Culture	**Age:**	

Sample ID:	08-3566-0399	**Code:**	315B0E11	**Client:**	Energy Resources of Australia - Enviro
Sample Date:	07 Oct-13 10:30	**Material:**	Ranger Brine Concentrator Distillate	**Project:**	Ranger Brine Concentrator Plant
Receive Date:	07 Oct-13 16:00	**Source:**	Ranger Brine Concentrator Plant		
Sample Age:	7d 2h (25 °C)	**Station:**	N/A		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1675564	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	1.508	2.412	1.0000	No Outliers Detected

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	52.4	27.35	52.86	1.908	1.892	3.657
IC10	54.91	47.89	55.88	1.821	1.79	2.088
IC15	57.54	50.28	59.06	1.738	1.693	1.989
IC20	60.29	52.77	62.42	1.659	1.602	1.895
IC25	63.17	55.39	65.97	1.583	1.516	1.805
IC40	72.66	64.1	77.83	1.376	1.285	1.56
IC50	79.75	72.09	86.86	1.254	1.151	1.387

Growth rate (surface area) Summary

			Calculated Variate						
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Magela Creek W	3	0.3238	0.3096	0.3476	0.01199	0.02076	6.41%	0.0%
25		3	0.3494	0.3315	0.3761	0.0136	0.02355	6.74%	-7.91%
50		3	0.3414	0.3131	0.3654	0.01523	0.02638	7.73%	-5.44%
100		3	0.08672	0.06078	0.1193	0.01723	0.02984	34.41%	73.21%

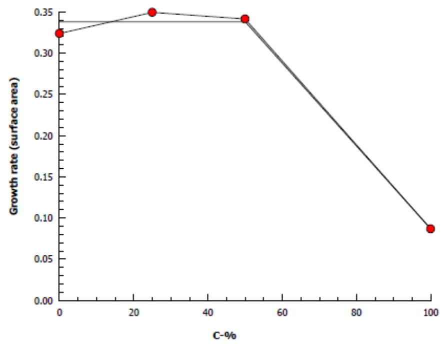
Growth rate (surface area) Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3
0	Magela Creek Wa	0.3096	0.3141	0.3476
25		0.3406	0.3315	0.3761
50		0.3456	0.3131	0.3654
100		0.1193	0.08005	0.06078

Lemna Growth Inhibition — **eriss ecotoxicology lab**

Analysis ID:	11-0215-2872	**Endpoint:**	Growth rate (surface area)	**CETIS Version:**	CETISv1.8.7
Analyzed:	13 Nov-13 12:00	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Gudgeon Sac Fry Survival Test			**eriss ecotoxicology lab**

Analysis ID:	13-7671-2480	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	18 Nov-13 10:47	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	07-0136-5224	**Test Type:**	Survival (96h)	**Analyst:**	Andrew J Harford
Start Date:	11 Nov-13 17:30	**Protocol:**	Gudgeon (acute) eriss tropical freshwater	**Diluent:**	Magela Creek Water
Ending Date:	15 Nov-13 17:30	**Species:**	Mogurnda mogurnda	**Brine:**	Not Applicable
Duration:	96h	**Source:**	eriss ecotoxicology lab	**Age:**	

Sample ID:	00-3741-7835	**Code:**	315B0E11	**Client:**	Energy Resources of Australia - Enviro
Sample Date:	07 Oct-13 10:30	**Material:**	Ranger Brine Concentrator Distillate	**Project:**	Ranger Brine Concentrator Plant
Receive Date:	07 Oct-13 16:00	**Source:**	Ranger Brine Concentrator Plant		
Sample Age:	35d 7h	**Station:**	N/A		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	NOEL	LOEL	TOEL	TU
Angular (Corrected)	NA	C > T	NA	NA	35.8%	100	>100	NA	1

Dunnett Multiple Comparison Test

Control	vs	C-%	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
1		50	-0.2214	2.337	0.408	4	0.7462	CDF	Non-Significant Effect
1		100	0.5818	2.337	0.408	4	0.4300	CDF	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	1.515	2.215	0.9958	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.03150234	0.01575117	2	0.3442	0.7219	Non-Significant Effect
Error	0.2745516	0.0457586	6			
Total	0.3060539		8			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	0.1685	9.21	0.9192	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9029	0.7007	0.2691	Normal Distribution

96h Survival Rate Summary

C-%	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
1	Magela Creek	3	0.9	0.4697	1	1	0.7	1	0.1	19.25%	0.0%
50		3	0.9333	0.6465	1	1	0.8	1	0.06667	12.37%	-3.7%
100		3	0.8333	0.4539	1	0.8	0.7	1	0.08819	18.33%	7.41%

Angular (Corrected) Transformed Summary

C-%	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
1	Magela Creek	3	1.272	0.6681	1.875	1.412	0.9912	1.412	0.1403	19.11%	0.0%
50		3	1.31	0.8731	1.748	1.412	1.107	1.412	0.1016	13.43%	-3.04%
100		3	1.17	0.6301	1.71	1.107	0.9912	1.412	0.1255	18.58%	7.99%

96h Survival Rate Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3
1	Magela Creek	1	0.7	1
50		1	0.8	1
100		0.7	0.8	1

Angular (Corrected) Transformed Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3
1	Magela Creek	1.412	0.9912	1.412
50		1.412	1.107	1.412
100		0.9912	1.107	1.412

Gudgeon Sac Fry Survival Test — **eriss ecotoxicology lab**

Analysis ID:	13-7671-2480	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	18 Nov-13 10:47	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

96h Survival Rate Binomials

C-%	Control Type	Rep 1	Rep 2	Rep 3
1	Magela Creek	10/10	7/10	10/10
50		10/10	8/10	10/10
100		7/10	8/10	10/10

Graphics