Table 4.10 : Prediction Daily Statistics at #047 (upstream of Lake Wallace, DPI Water Station No. 212054) – Salinity mg/L

Percentile	Salinity (mg/L) – Linear Water Quality Criteria		Salinity (mg/L) – Stepped Water Quality Criteria	
	APPROVED	PROPOSED	APPROVED	PROPOSED
Minimum	148	148	147	148
5%	228	229	239	241
10%	266	268	283	286
20%	307	308	352	354
50%	359	360	396	397
80%	498	550	543	607
90%	614	670	656	694
95%	669	704	704	724
Maximum	793	793	791	791

Table 4.11 : Prediction Daily Statistics at #047 (upstream of Lake Wallace, DPI Water Station No. 212054) – Flow ML/d

Percentile	Flow (ML/d)	
	APPROVED	PROPOSED
Minimum	19.4	19.4
5%	24.6	24.6
10%	27.9	27.9
20%	29.9	29.9
50%	37.5	37.5
80%	53.8	53.8
90%	92.4	92.4
95%	158	158
Maximum	5922	5922

Predicted salinity in Lake Wallace (Node #074) is presented as time-series in **Figure 4.34** (salinity) and **Figure 4.35** (volume).

A distribution plot of the time-series output is presented in **Figure 4.36** and **Figure 4.37**.

Table 4.12 presents a summary of the distribution plot (salinity). **Table 4.13** presents a summary of the distribution plot (volume).

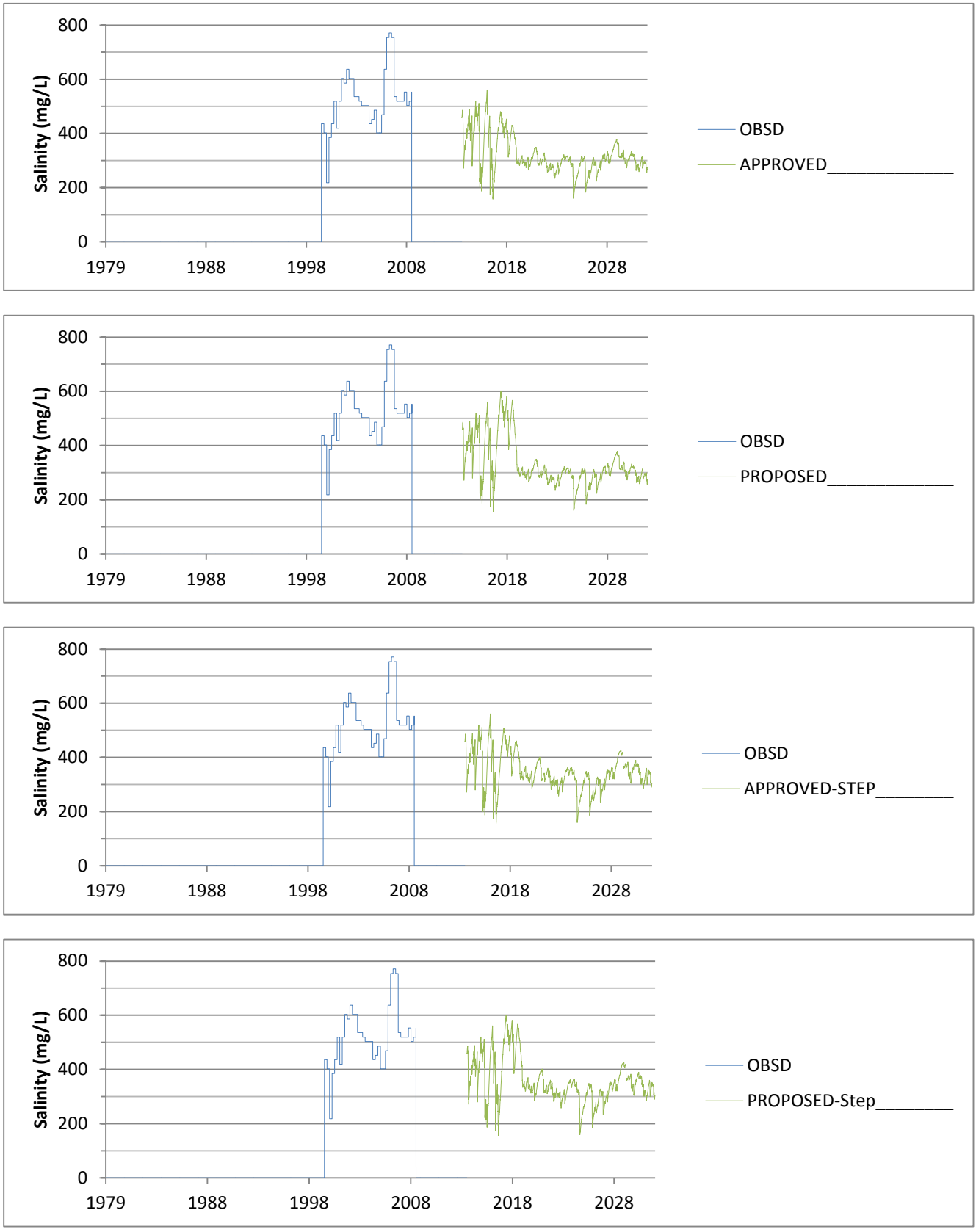


Figure 4.34 : Prediction Time-Series Chart at #074 (Lake Wallace) – Salinity mg/L

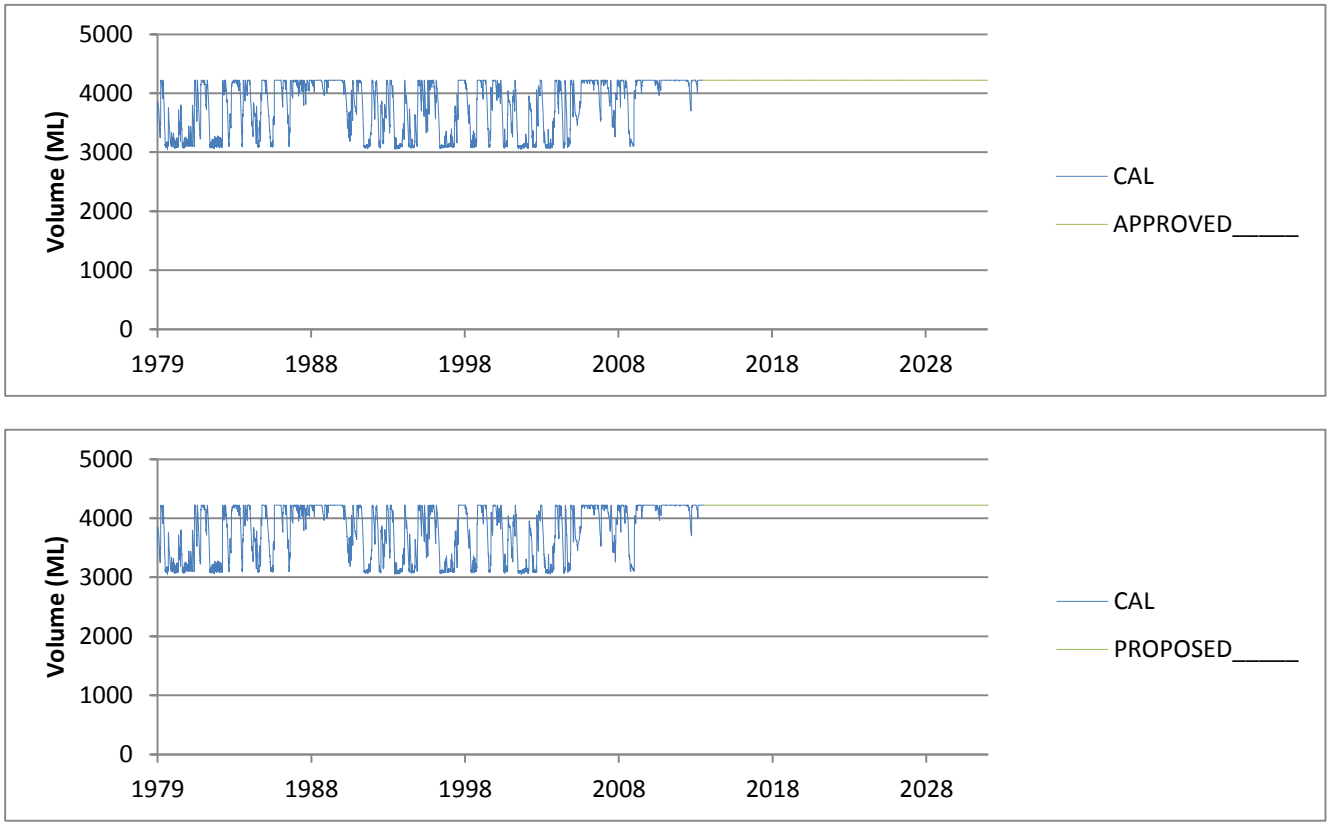


Figure 4.35 : Prediction Time-Series Chart at #074 (Lake Wallace) – Volume ML

From **Figure 4.35**, **Figure 4.37** and **Table 4.13**, there is no change in volume due to the proposed modification. Modelling indicates that Lake Wallace is full throughout the prediction simulation.

Table 4.12 indicates the change in modelled median salinity is negligible. The change in 90% distribution in **Table 4.12** is an increase from 426 to 480mg/L for the linear fit to the water quality criteria and is an increase from 443 to 482mg/L in the stepped fit to water quality criteria. The maximum modelled salinity is also increased from 561mg/L to 600mg/L in both simulations. Overall, the modelled increase in salinity is considered to be minor.

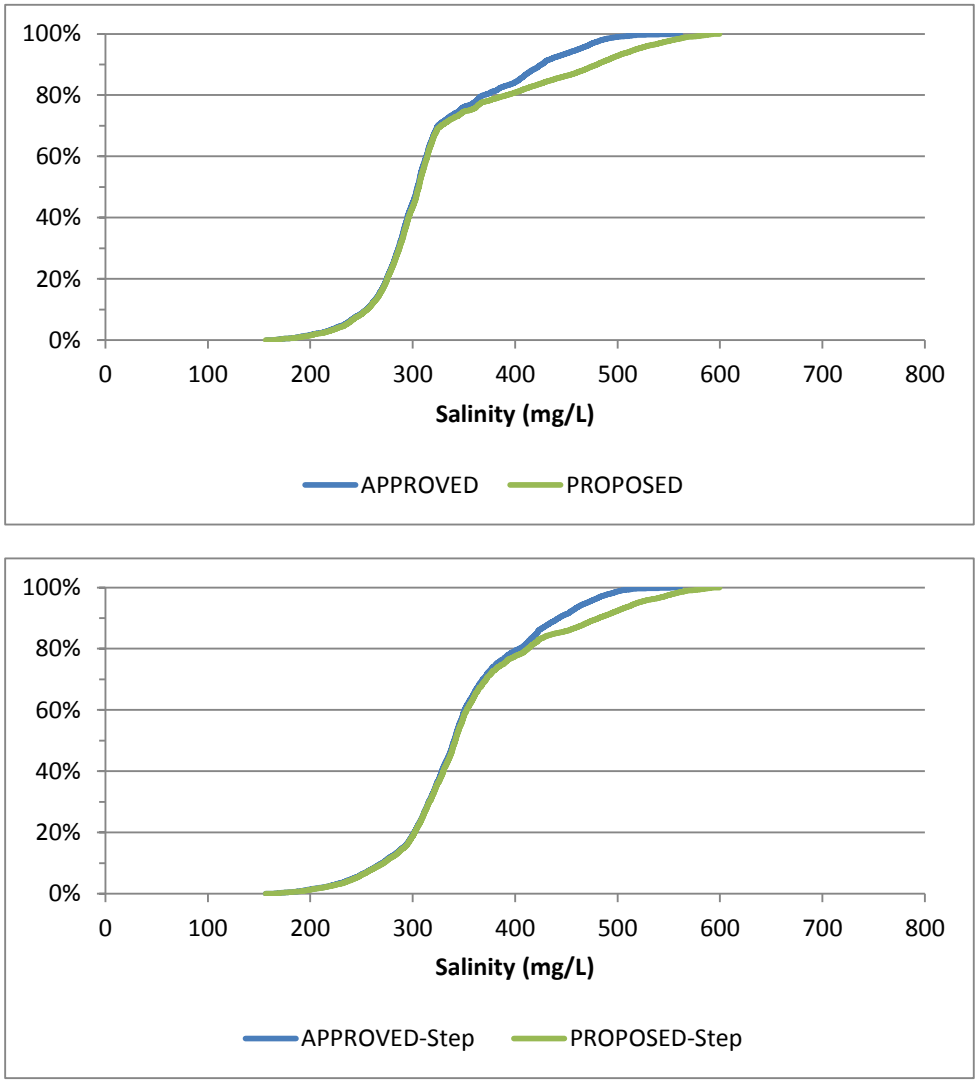


Figure 4.36 : Prediction Distribution Plot at #074 (Lake Wallace) – Salinity mg/L

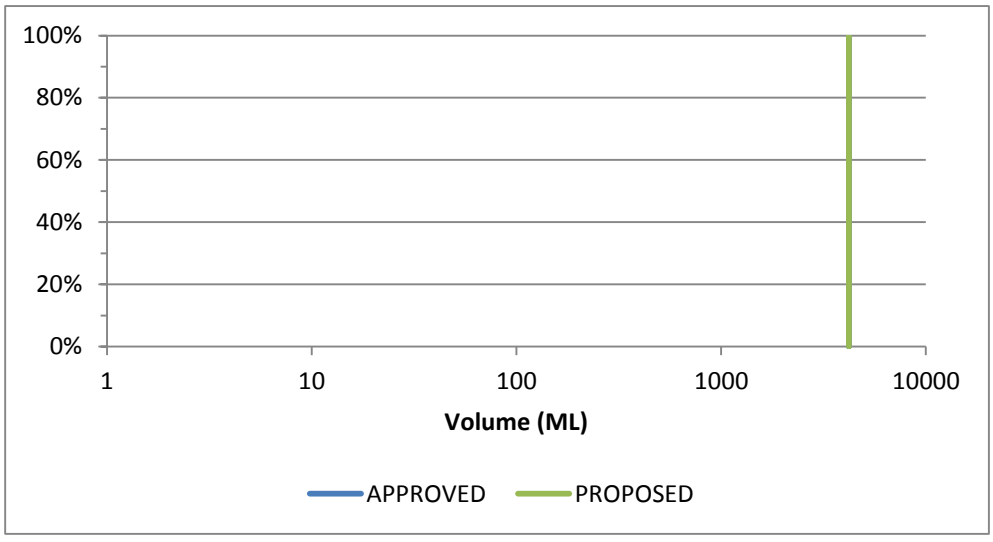


Figure 4.37 : Prediction Distribution Plot at #074 (Lake Wallace) – Volume ML

Table 4.12 : Prediction Daily Statistics at #074 (Lake Wallace) – Salinity mg/L

Percentile	Salinity (mg/L) – Linear Water Quality Criteria		Salinity (mg/L) – Stepped Water Quality Criteria	
	APPROVED	PROPOSED	APPROVED	PROPOSED
Minimum	157	157	157	157
5%	233	234	242	244
10%	255	256	270	272
20%	275	275	301	302
50%	305	306	340	342
80%	369	392	404	413
90%	426	480	443	482
95%	462	518	470	520
Maximum	561	600	561	600

Table 4.13 : Prediction Daily Statistics at #074 (Lake Wallace) – Volume ML

Percentile	Volume (ML)	
	APPROVED	PROPOSED
Minimum	4221	4221
5%	4221	4221
10%	4221	4221
20%	4221	4221
50%	4221	4221
80%	4221	4221
90%	4221	4221
95%	4221	4221
Maximum	4221	4221

Lake Lyell

Node #154 lies between Lake Wallace and Lake Lyell and corresponds with DPIWater Station No. 212058. As per the approach adopted in RPS (2014b) and Jacobs (2015a), flow is presented at Node #154 and water quality (salinity) is presented at Node #035. Model output at Node #035 is presented below.

Figure 4.38 presents the time-series modelled flow at this model node.

Figure 4.39 presents the distribution plot of modelled flow, and is summarised in **Table 4.14**.

From **Figure 4.38**, **Figure 4.39** and **Table 4.14**, there is no change in modelled flow due to the modification, as is expected, since there is no proposed change to mine water discharge (quantity).

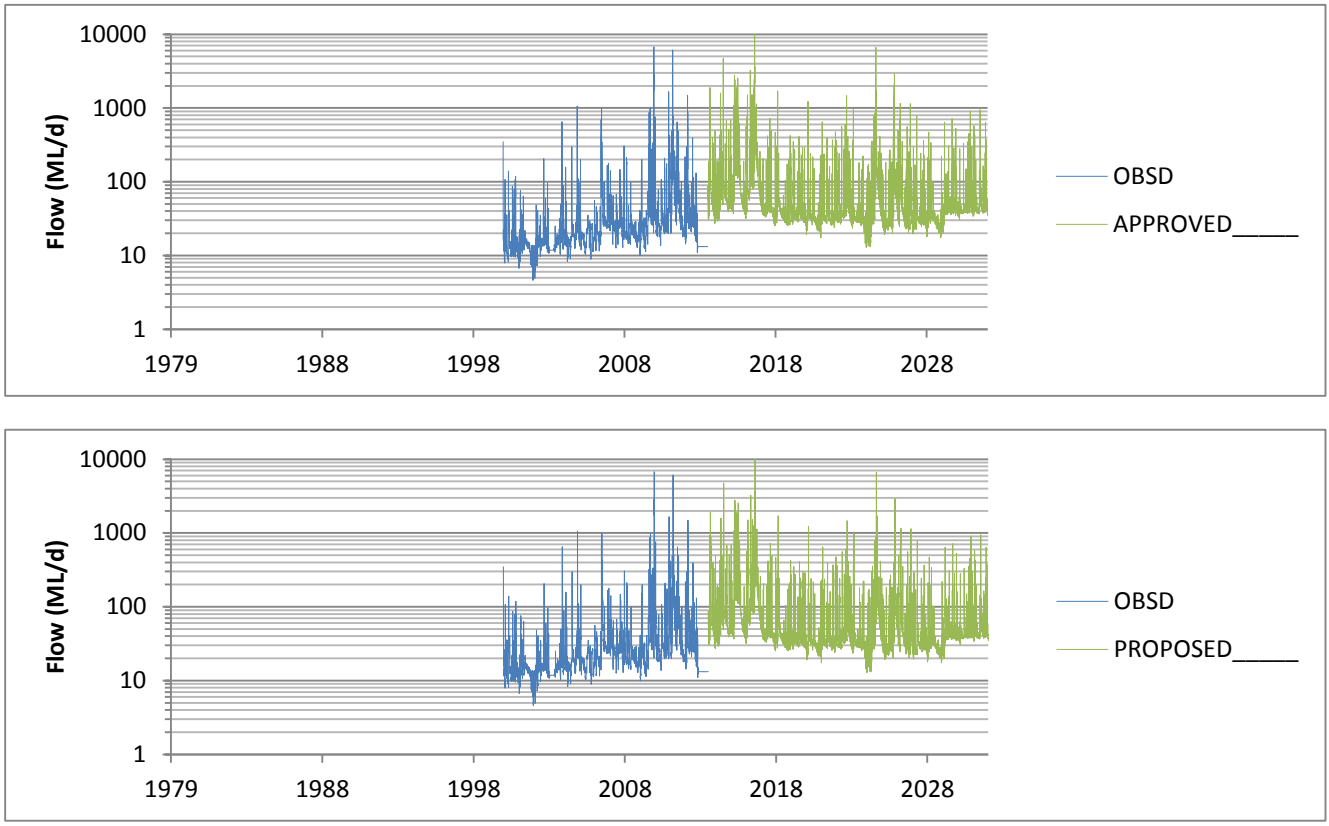


Figure 4.38 : Prediction Time-Series Chart at #154 (Coxs River above Lake Lyell, DPI Water Station No. 212058) – Flow ML/d

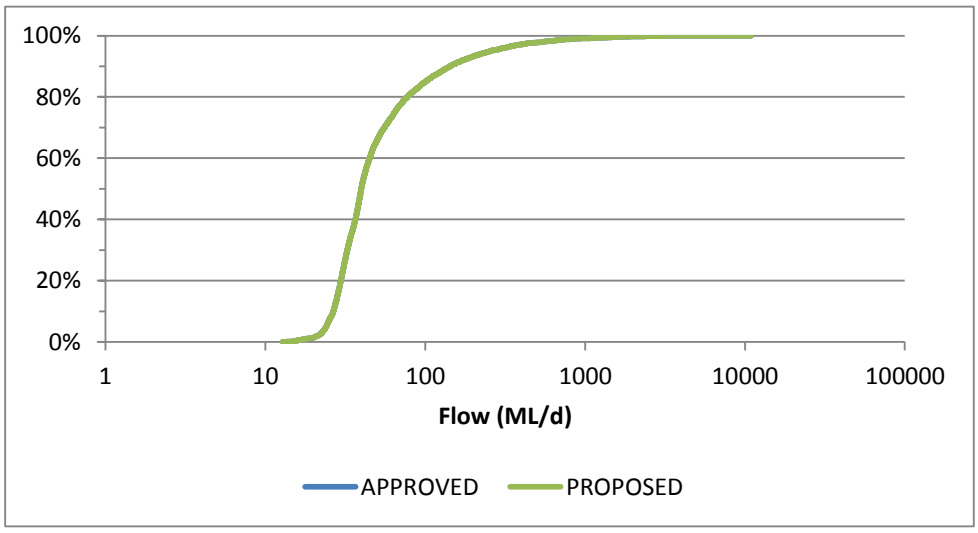


Figure 4.39 : Prediction Distribution Plot at #154 (Coxs River above Lake Lyell, DPI Water Station No. 212058) – Flow ML/d

Table 4.14 : Prediction Daily Statistics at #154 (Coxs River above Lake Lyell, DPI Water Station No. 212058) – Flow ML/d

Percentile	Flow (ML/d)	
	APPROVED	PROPOSED
Minimum	12.9	12.9
5%	24.1	24.1
10%	26.7	26.7
20%	29.7	29.7
50%	39.8	39.8
80%	77.4	77.4
90%	143	143
95%	257	257
Maximum	10916	10916

Node #035 is located between Lake Wallace and Lake Lyell and corresponds with EnergyAustralia monitoring location COX5. Water quality (salinity) is presented at this model node. Flow output in this river segment is presented at Node #154, above.

Figure 4.40 presents time-series (salinity) model output at this model node.

Figure 4.41 presents the distribution plot of model output, and is summarised in **Table 4.15**.

From **Figure 4.40**, there is a minor change in magnitude of modelled salinity in the period 1 July 2017 to 30 June 2019.

Table 4.15 indicates that this equates to a negligible change in modelled median salinity but there is an increase in 90% distribution from 383 to 429mg/L for the linear fit to water quality criteria and an increase from 410 to 432mg/L for the stepped fit to water quality criteria. Modelled maximum salinity is an increase in 546 to 593mg/L in both interpretations of the water quality criteria.

The modelled change in salinity is considered to be minor.

Lake Lyell is represented by Node #174 in the model. **Figure 4.42** presents the time-series model output (salinity) at Lake Lyell. **Figure 4.43** presents the time-series output (volume) at Lake Lyell.

Figure 4.44 presents the distribution of model output with respect to salinity and **Figure 4.45** presents the equivalent analysis of model output with respect to volume.

Table 4.16 and **Table 4.17** summarises the water quality (salinity) and volume distribution output, respectively.

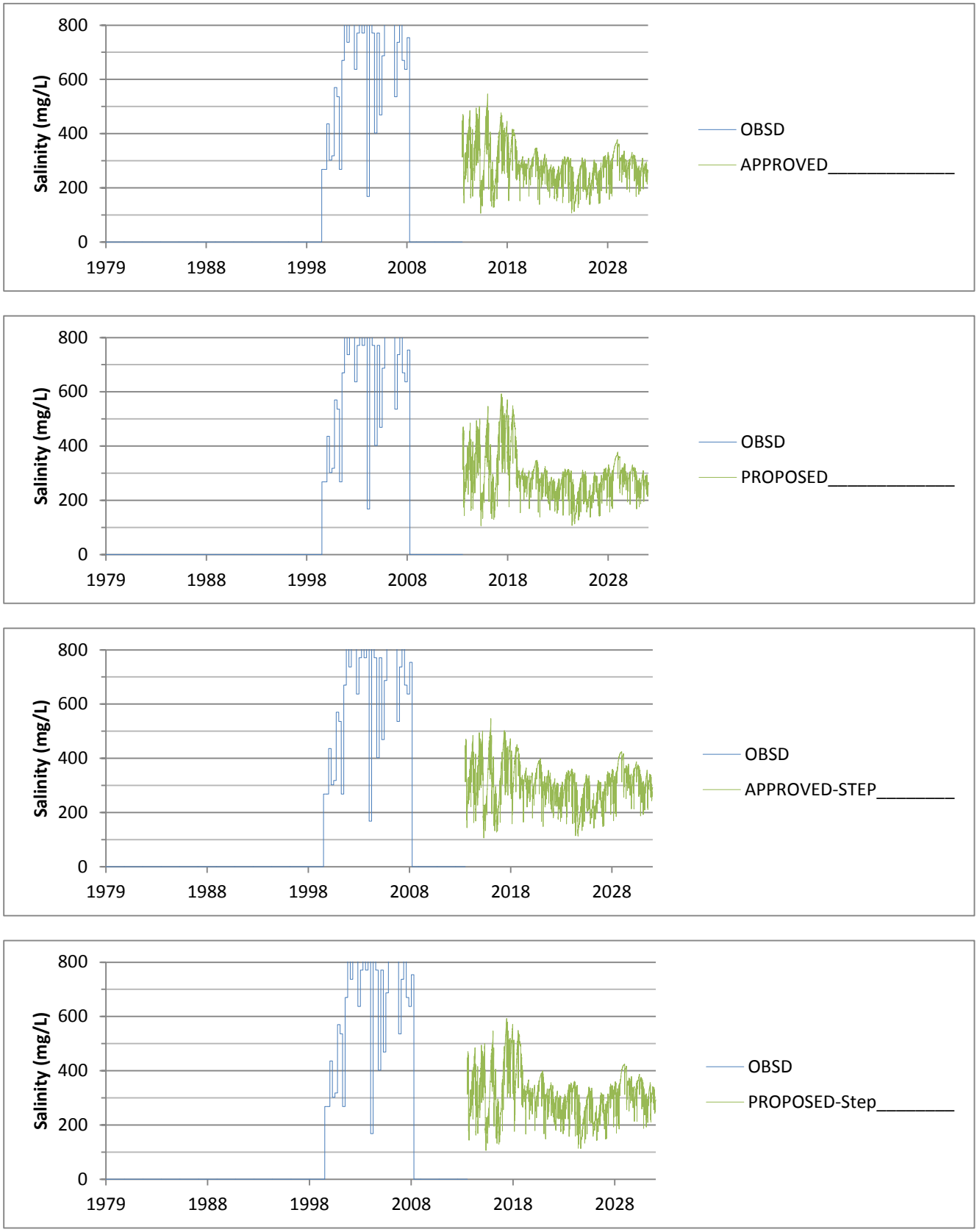
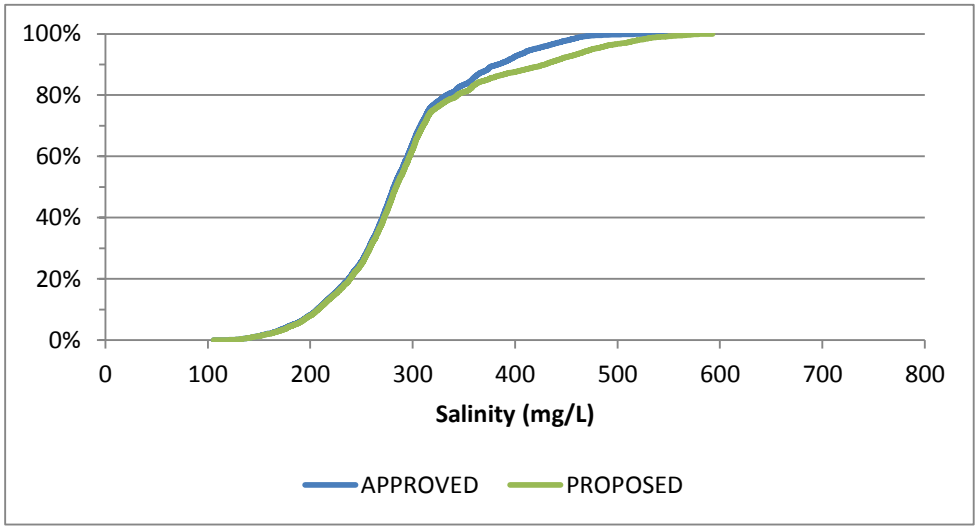


Figure 4.40 : Prediction Time-Series Chart at #035 (Coxs River above Lake Lyell, EnergyAustralia station COX5) – Salinity mg/L



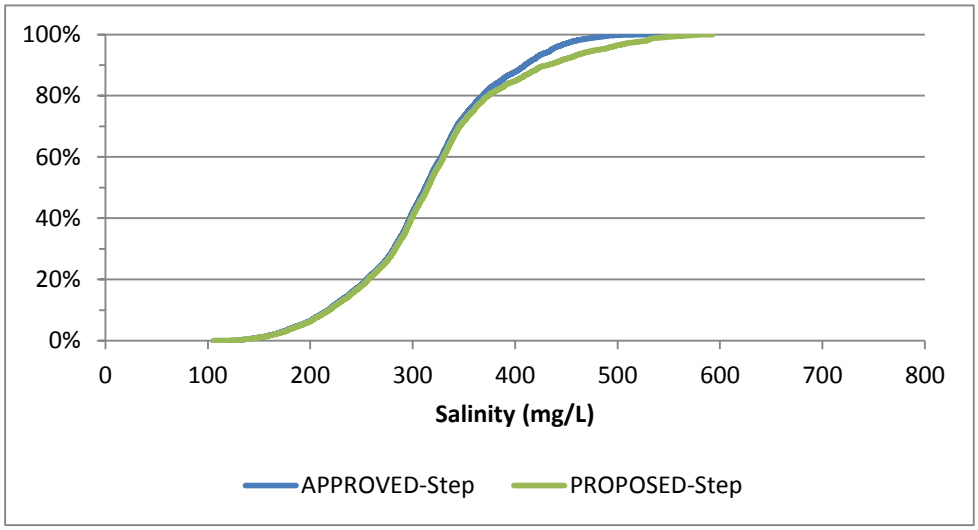


Figure 4.41 : Prediction Distribution Plot at #035 (Coxs River above Lake Lyell, EnergyAustralia station COX5) – Salinity mg/L

Table 4.15 : Prediction Daily Statistics at #035 (Coxs River above Lake Lyell, EnergyAustralia station COX5) – Salinity mg/L

Percentile	Salinity (mg/L) – Linear Water Quality Criteria		Salinity (mg/L) – Stepped Water Quality Criteria	
	APPROVED	PROPOSED	APPROVED	PROPOSED
Minimum	106	106	106	106
5%	182	184	189	190
10%	207	208	218	218
20%	237	239	255	256
50%	282	284	312	315
80%	333	343	368	374
90%	383	429	410	432
95%	418	475	436	481
Maximum	546	593	546	593

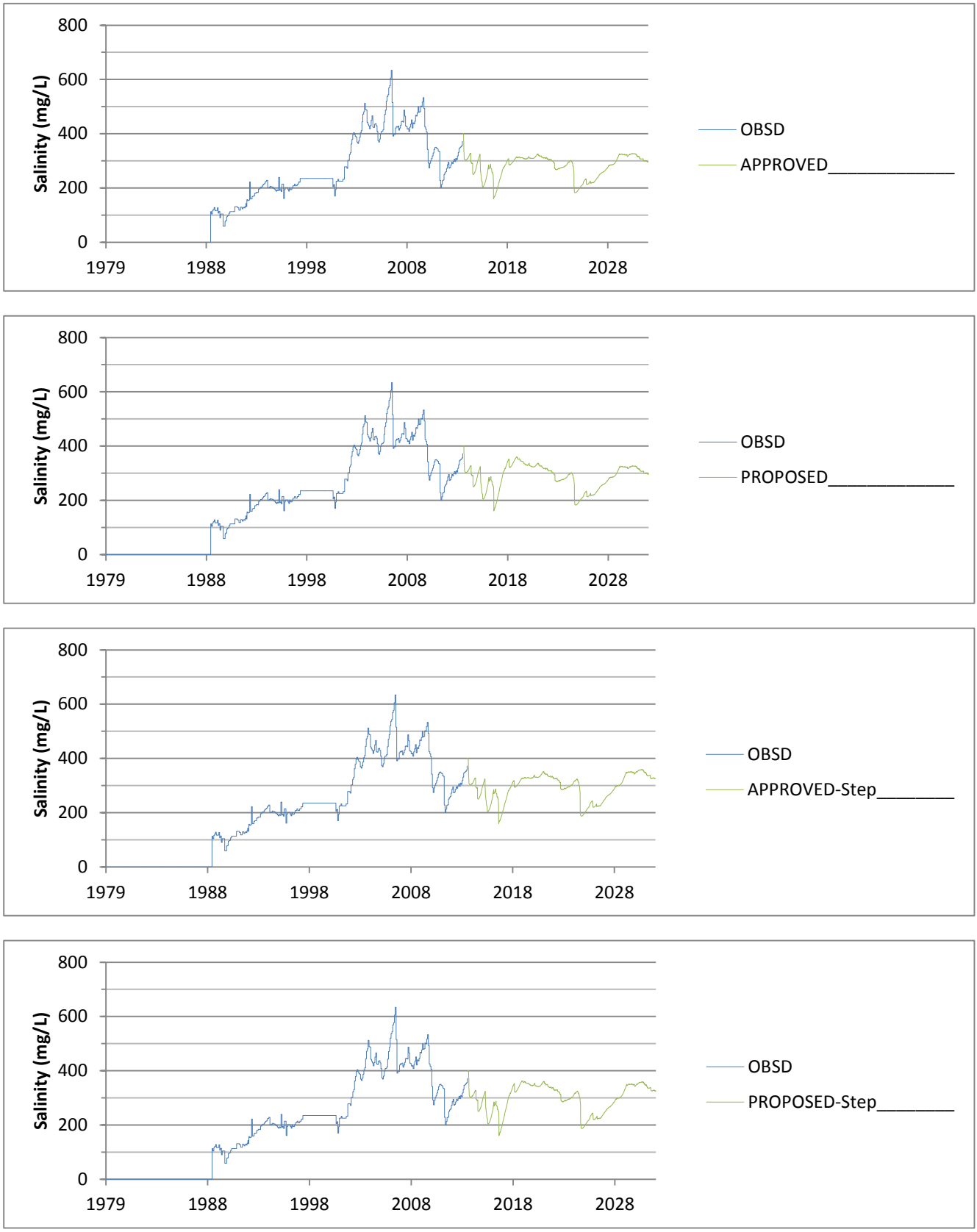


Figure 4.42 : Prediction Time-Series Chart at #174 (Lake Lyell) – Salinity mg/L

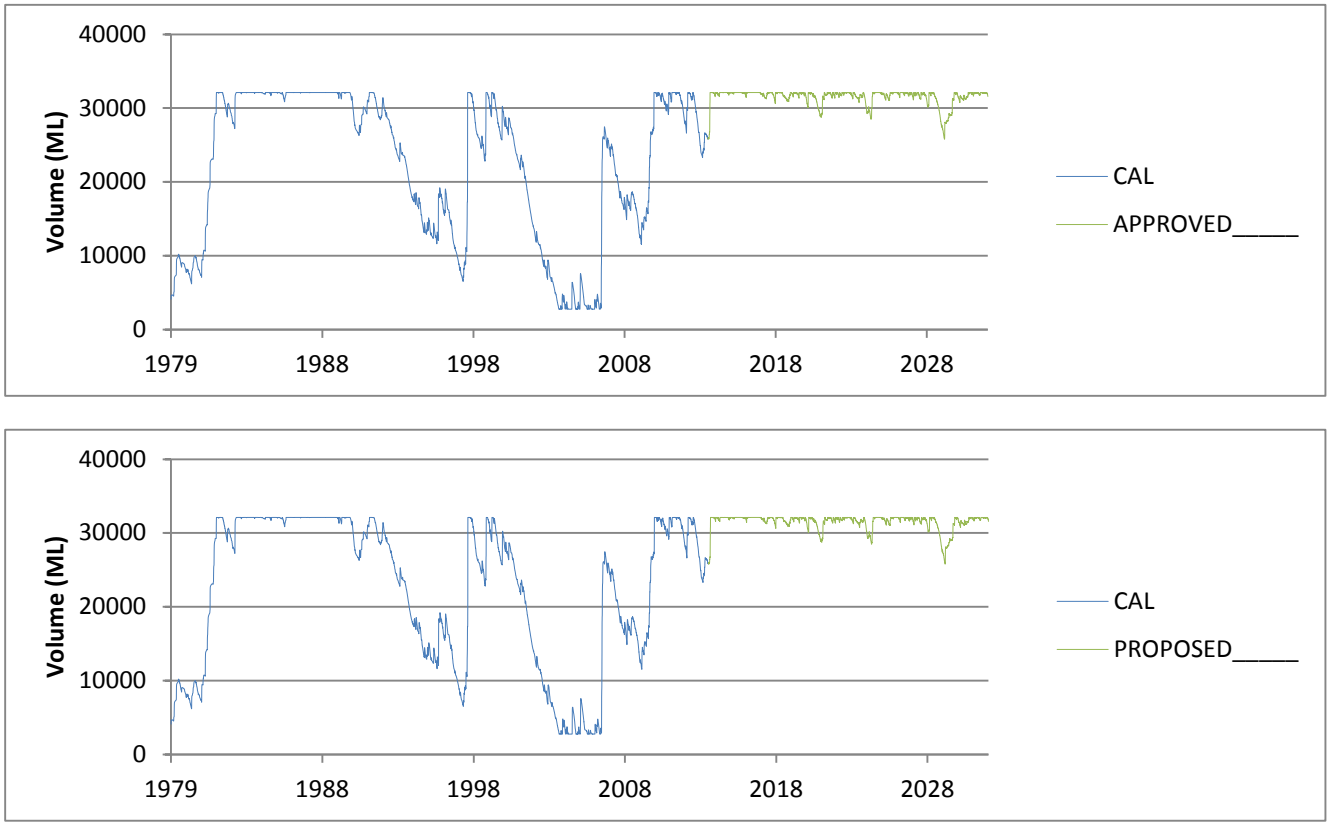


Figure 4.43 : Prediction Time-Series Chart at #174 (Lake Lyell) – Volume ML

From **Figure 4.45** and **Table 4.17**, there is no modelled change in volume due to the proposed modification.

From **Table 4.16**, the increase in modelled median salinity is a small increase from 293mg/L to 299mg/L in the linear fit to water quality criteria and is of similar magnitude (305mg/L to 313mg/L) in the stepped fit to water quality criteria. The increase in median salinity is considered insignificant.

From **Table 4.16**, the modelled change in 90% distribution is an increase from 322 to 344mg/L (Linear Fit) and is 348 to 353mg/L (Stepped Fit). There is no change in modelled maximum salinity in Lake Lyell due to the modification.

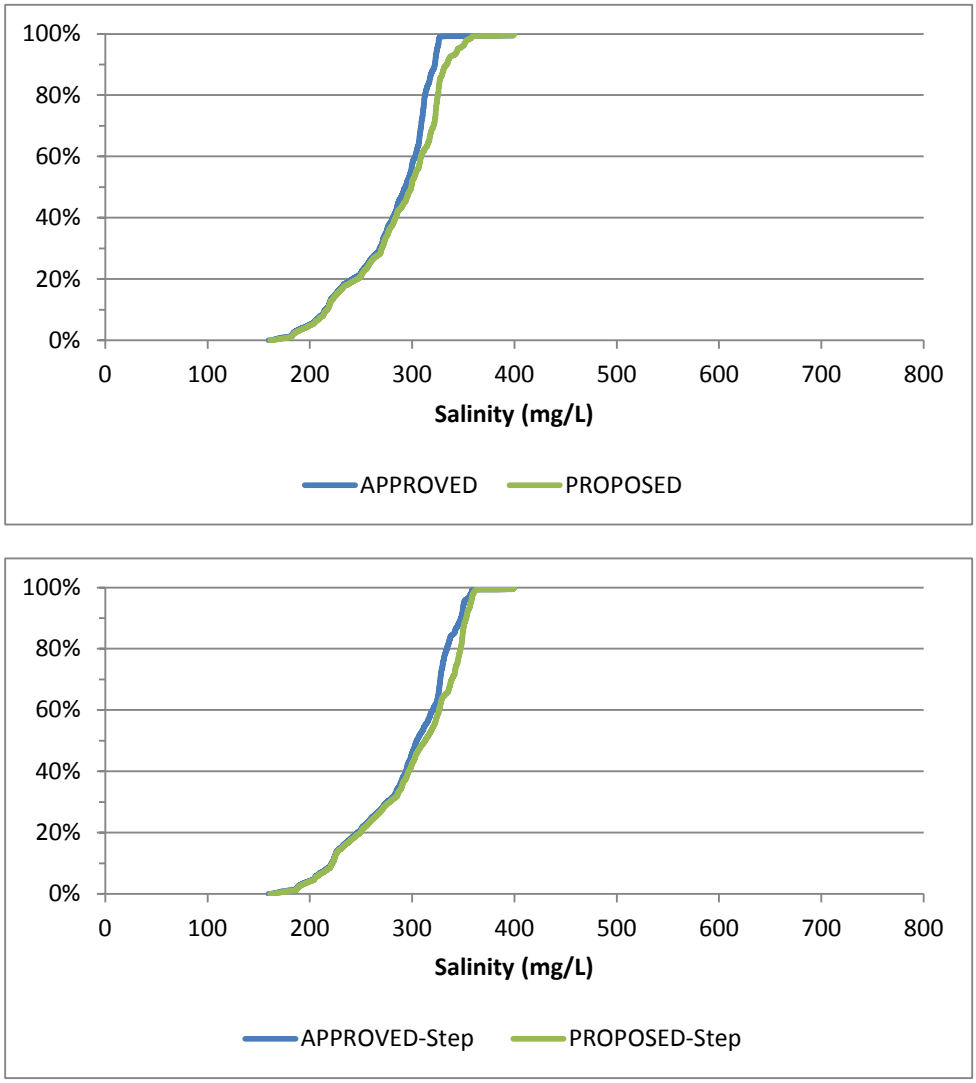


Figure 4.44 : Prediction Distribution Plot at #174 (Lake Lyell) – Salinity mg/L

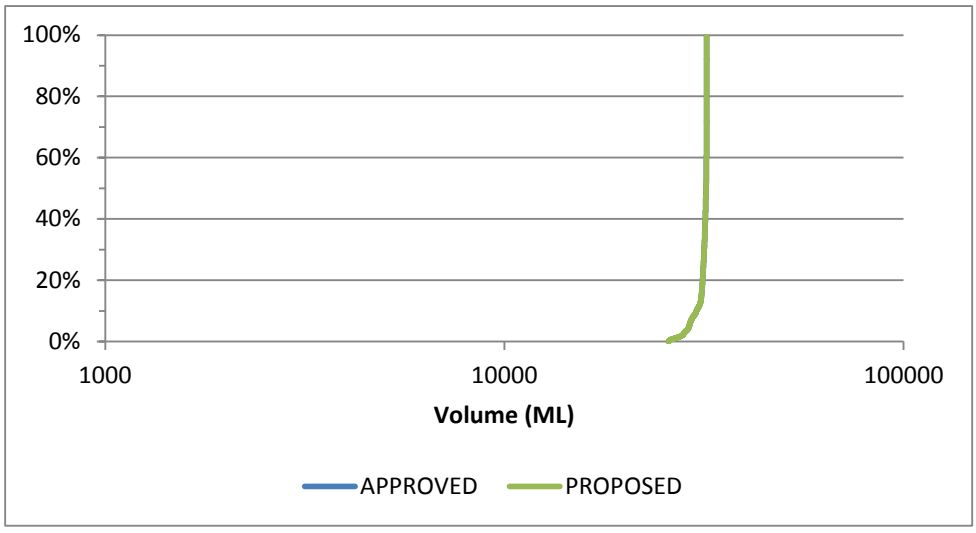


Figure 4.45 : Prediction Distribution Plot at #174 (Lake Lyell) – Volume ML

Table 4.16 : Prediction Daily Statistics at #174 (Lake Lyell) – Salinity mg/L

Percentile	Salinity (mg/L) – Linear Water Quality Criteria		Salinity (mg/L) – Stepped Water Quality Criteria	
	APPROVED	PROPOSED	APPROVED	PROPOSED
Minimum	160	161	160	161
5%	199	201	204	205
10%	215	217	221	222
20%	242	247	247	250
50%	293	299	305	313
80%	313	325	334	347
90%	322	334	348	353
95%	324	345	351	357
Maximum	400	400	400	400

Table 4.17 : Prediction Daily Statistics at #174 (Lake Lyell) – Volume ML

Percentile	Volume (ML)	
	APPROVED	PROPOSED
Minimum	25775	25775
5%	29040	29040
10%	30272	30272
20%	31361	31361
50%	31994	31994
80%	32109	32109
90%	32109	32109
95%	32109	32109
Maximum	32109	32109

Thompsons Creek Reservoir

Thompsons Creek Reservoir is the offline storage reservoir for Mount Piper Power Station. It is represented in the RWQIAM as Node #272 and is a 'stock' in GoldSIM.

Figure 4.46 and **Figure 4.47** present time-series model output with respect to salinity and flow.

Figure 4.48 and **Figure 4.49** present the distribution plots of the above output, and is summarised in **Table 4.18** and **Table 4.19**.

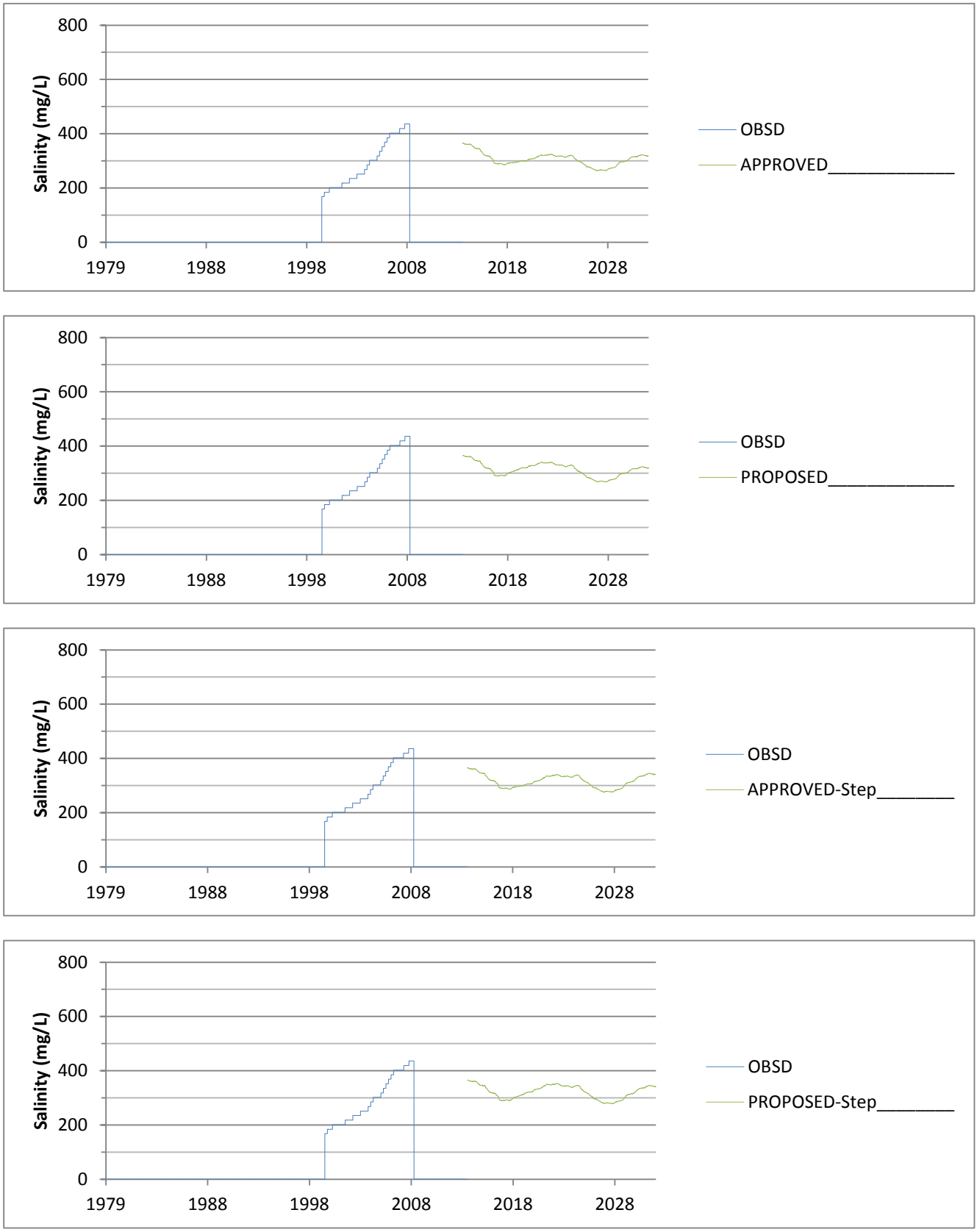


Figure 4.46 : Prediction Time-Series Chart at #272 (Thompsons Creek Reservoir) – Salinity mg/L

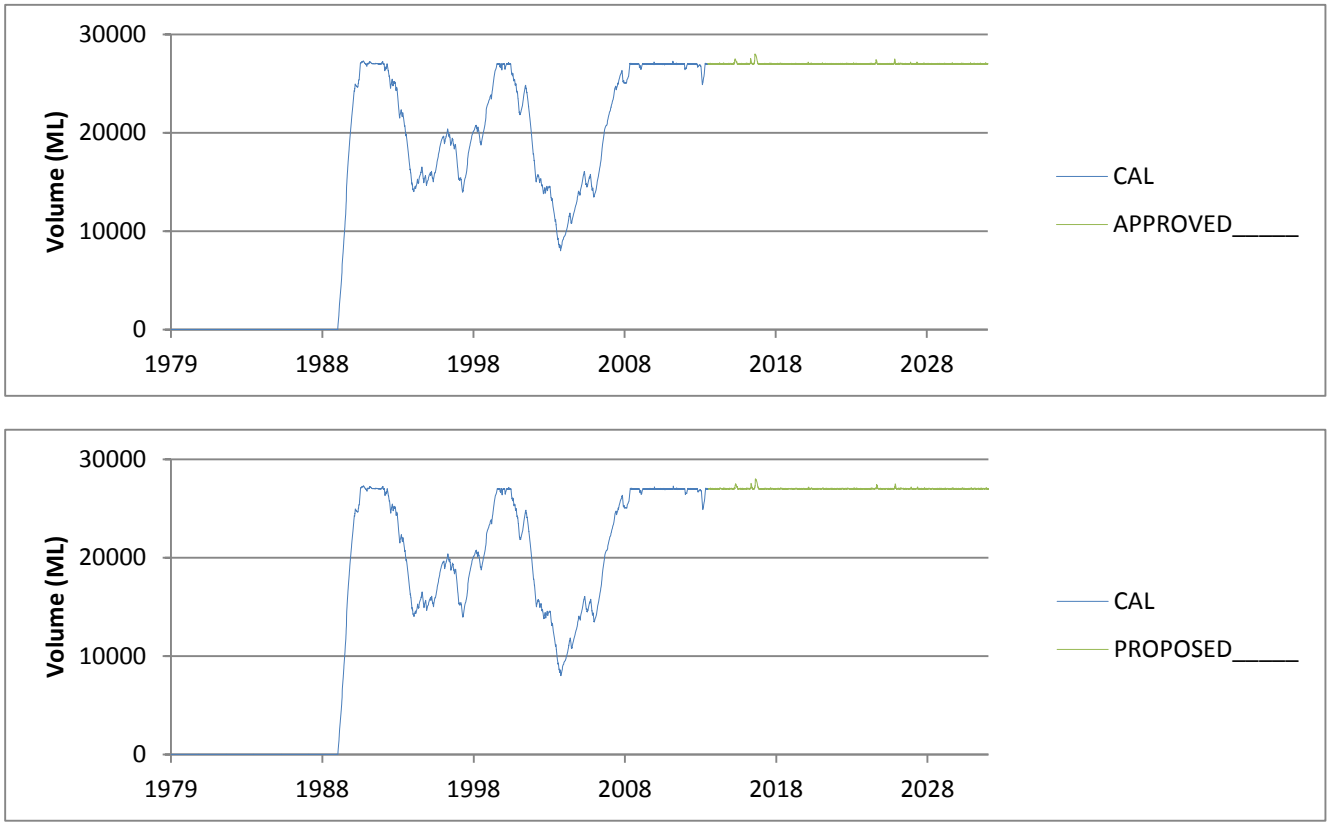


Figure 4.47 : Prediction Time-Series Chart at #272 (Thompsons Creek Reservoir) – Volume ML

From **Table 4.19**, there is no modelled change in storage volume in Thompsons Creek Reservoir, as is expected, since there is no proposed change to mine water discharge (quantity) associated with the modification.

Modelling indicates (refer **Table 4.18**) an increase in median modelled salinity in Thompsons Creek Reservoir from 307mg/L to 317mg/L (Linear Fit) and from 317mg/L to 323mg/L (Stepped Fit).

The change in the 90% distribution is also an increase, from 337 to 340mg/L (Linear Fit) and from 344 to 350mg/L (Stepped Fit). There is no modelled change in maximum salinity due to the modification.

The changes in modelled salinity in Thompsons Creek Reservoir due to the modification are considered to be minor in both magnitude and consequence.

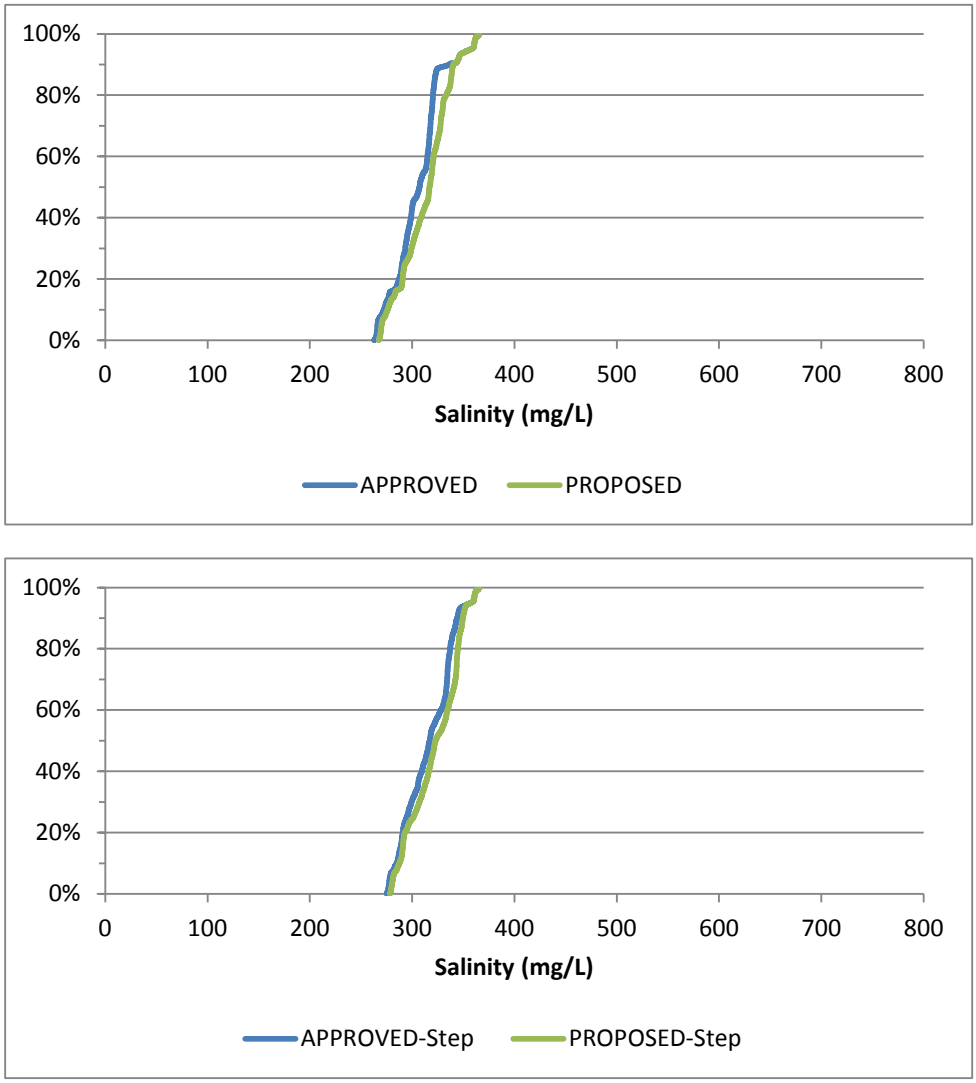


Figure 4.48 : Prediction Distribution Plot at #272 (Thompsons Creek Reservoir) – Salinity mg/L

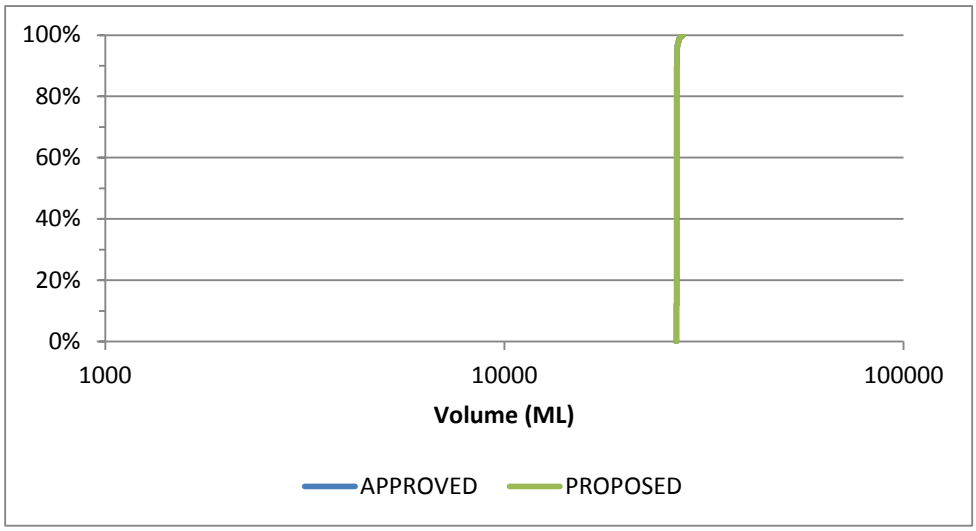


Figure 4.49 : Prediction Distribution Plot at #272 (Thompsons Creek Reservoir) – Volume ML

Table 4.18 : Prediction Daily Statistics at #272 (Thompsons Creek Reservoir) – Salinity mg/L

Percentile	Salinity (mg/L) – Linear Water Quality Criteria		Salinity (mg/L) – Stepped Water Quality Criteria	
	APPROVED	PROPOSED	APPROVED	PROPOSED
Minimum	263	267	275	278
5%	266	270	278	281
10%	273	276	285	288
20%	287	291	291	293
50%	307	317	317	323
80%	320	333	337	345
90%	337	340	344	350
95%	358	358	358	358
Maximum	366	366	366	366

Table 4.19 : Prediction Daily Statistics at #272 (Thompsons Creek Reservoir) – Volume ML

Percentile	Volume (ML)	
	APPROVED	PROPOSED
Minimum	26929	26929
5%	26976	26976
10%	26983	26983
20%	26992	26992
50%	27003	27003
80%	27020	27020
90%	27035	27035
95%	27065	27065
Maximum	28000	28000

Lake Burragorang and above Lake Burragorang

Node #225 is located immediately above Lake Burragorang. The node corresponds with DPIWater Station No. 212250.

Figure 4.50 presents the time-series prediction of salinity. **Figure 4.51** presents the equivalent prediction with respect to flow.

Figure 4.52 and **Figure 4.53** present the distribution of model output over the prediction period. **Table 4.20** and **Table 4.21** present a summary of the distribution plot figures.

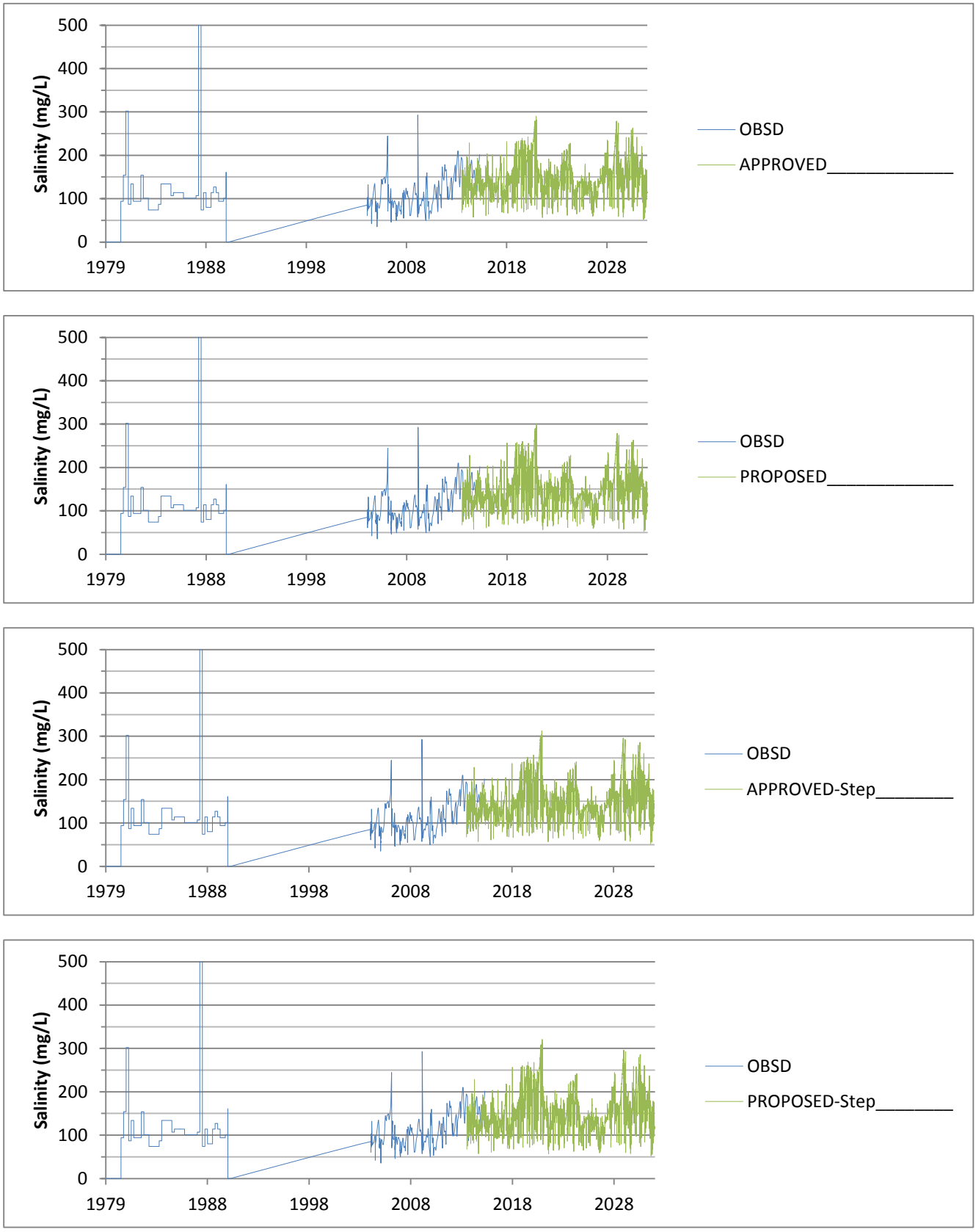


Figure 4.50 : Prediction Time-Series Chart at #225 (Coxs River above Lake Burragorang, Station No. 212250) – Salinity mg/L

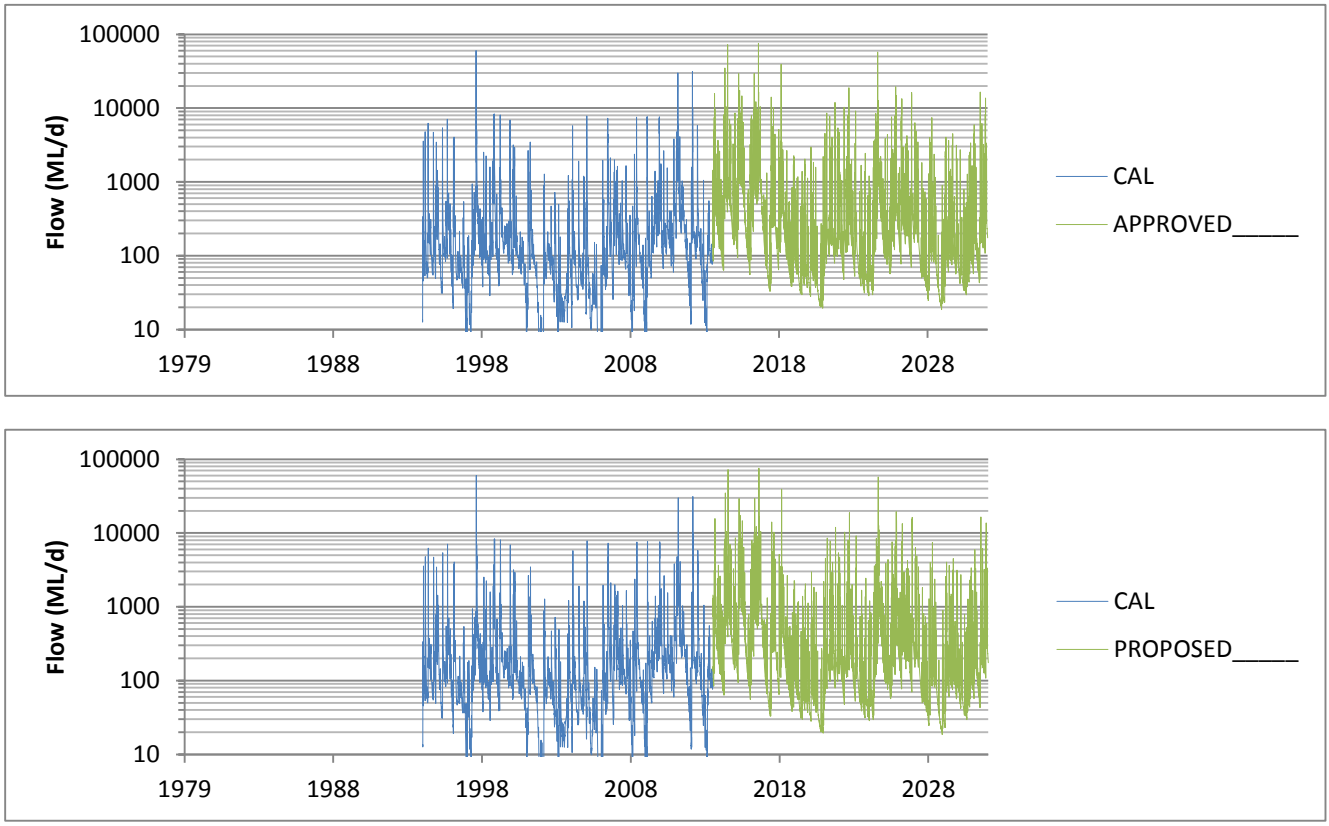


Figure 4.51 : Prediction Time-Series Chart at #225 (Coxs River above Lake Burragorang, Station No. 212250) – Flow ML/d

From **Figure 4.50**, the difference between the approved and proposed condition simulations is almost indiscernible. **Table 4.20** indicates the change is an increase in median salinity from 143mg/L to 144mg/L, in the linear fit case, and no change in the stepped fit case. At 90% distribution, the increase in salinity is 197 to 203mg/L (linear fit) and is 206 to 211mg/L (stepped fit). At maximum salinity, there is an increase from 290 to 301mg/L (linear case) and an increase from 312 to 321mg/L (stepped case).

As noted previously, there is no modelled change to flow since mine water discharge (quantity) is not proposed to change due to the modification.

With respect to the duration of the prediction period, the change in modelled salinity is considered a minor to negligible change.

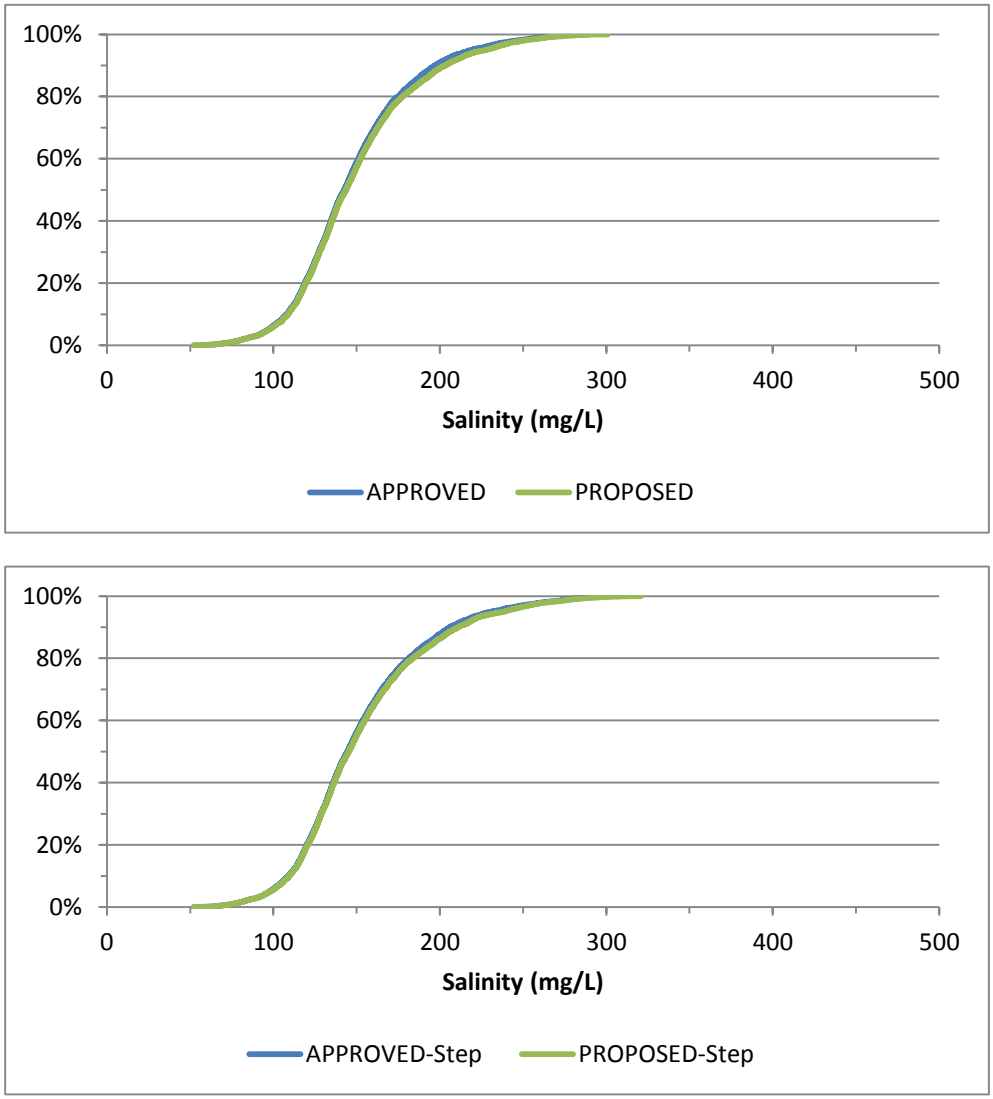


Figure 4.52 : Prediction Distribution Plot at #225 (Coxs River above Lake Burragorang, Station No. 212250) – Salinity mg/L

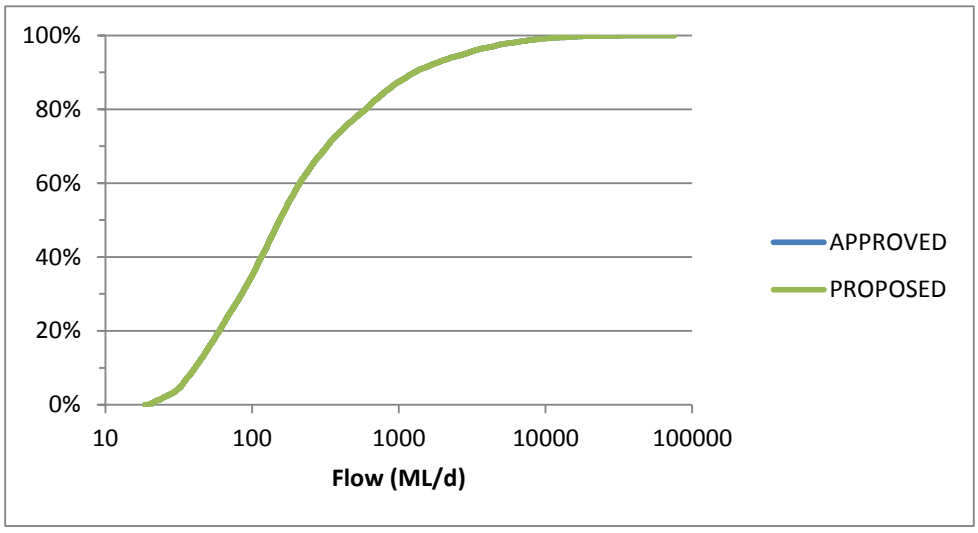


Figure 4.53 : Prediction Distribution Plot at #225 (Coxs River above Lake Lyell, DPI Water Station No. 212250) – Flow ML/d

Table 4.20 : Prediction Daily Statistics at #225 (Coxs River above Lake Burragorang, Station No. 212250) – Salinity mg/L

Percentile	Salinity (mg/L) – Linear Water Quality Criteria		Salinity (mg/L) – Stepped Water Quality Criteria	
	APPROVED	PROPOSED	APPROVED	PROPOSED
Minimum	52	52	52	52
5%	96	97	98	98
10%	108	109	109	110
20%	119	120	120	121
50%	143	144	145	145
80%	175	178	181	184
90%	197	203	206	211
95%	220	228	231	239
Maximum	290	301	312	321

Table 4.21 : Prediction Daily Statistics at #225 (Coxs River above Lake Burragorang, Station No. 212250) – Flow ML/d

Percentile	Flow (ML/d)	
	APPROVED	PROPOSED
Minimum	18.6	18.6
5%	32.8	32.8
10%	40.9	40.9
20%	59.9	59.9
50%	154.0	154.0
80%	594.2	594.2
90%	1280	1280
95%	2,821	2,821
Maximum	75422	75422

Figure 4.54 presents the time-series model output in Lake Burragorang (Node #280) with respect to salinity. **Figure 4.55** presents the equivalent output with respect to flow.

Figure 4.56 and **Figure 4.57** present the distribution of model output with respect to duration. The distribution plots are summarised in **Table 4.22** and **Table 4.23** respectively.

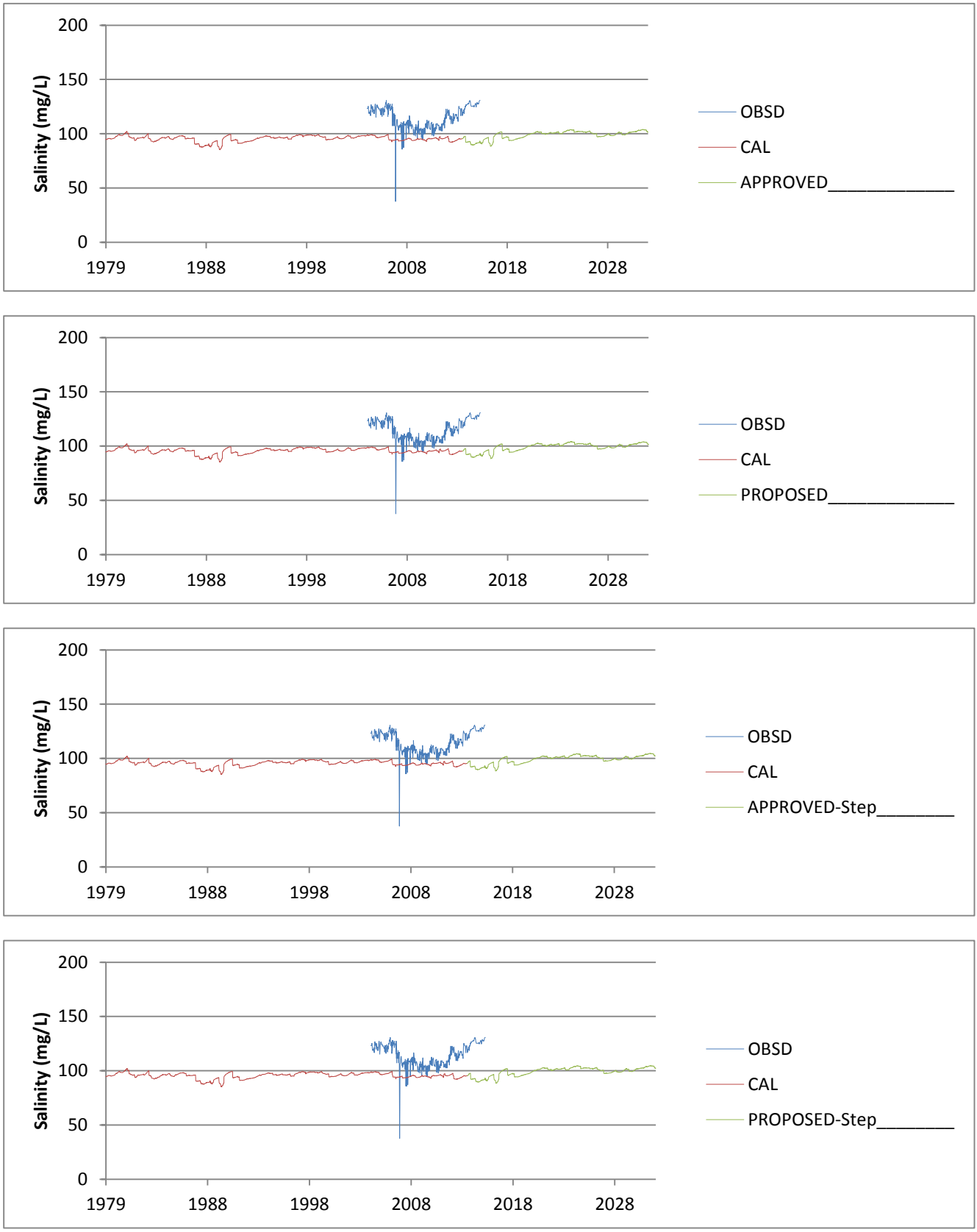


Figure 4.54 : Prediction Time-Series Chart at #280 (Lake Burragorang) – Salinity mg/L

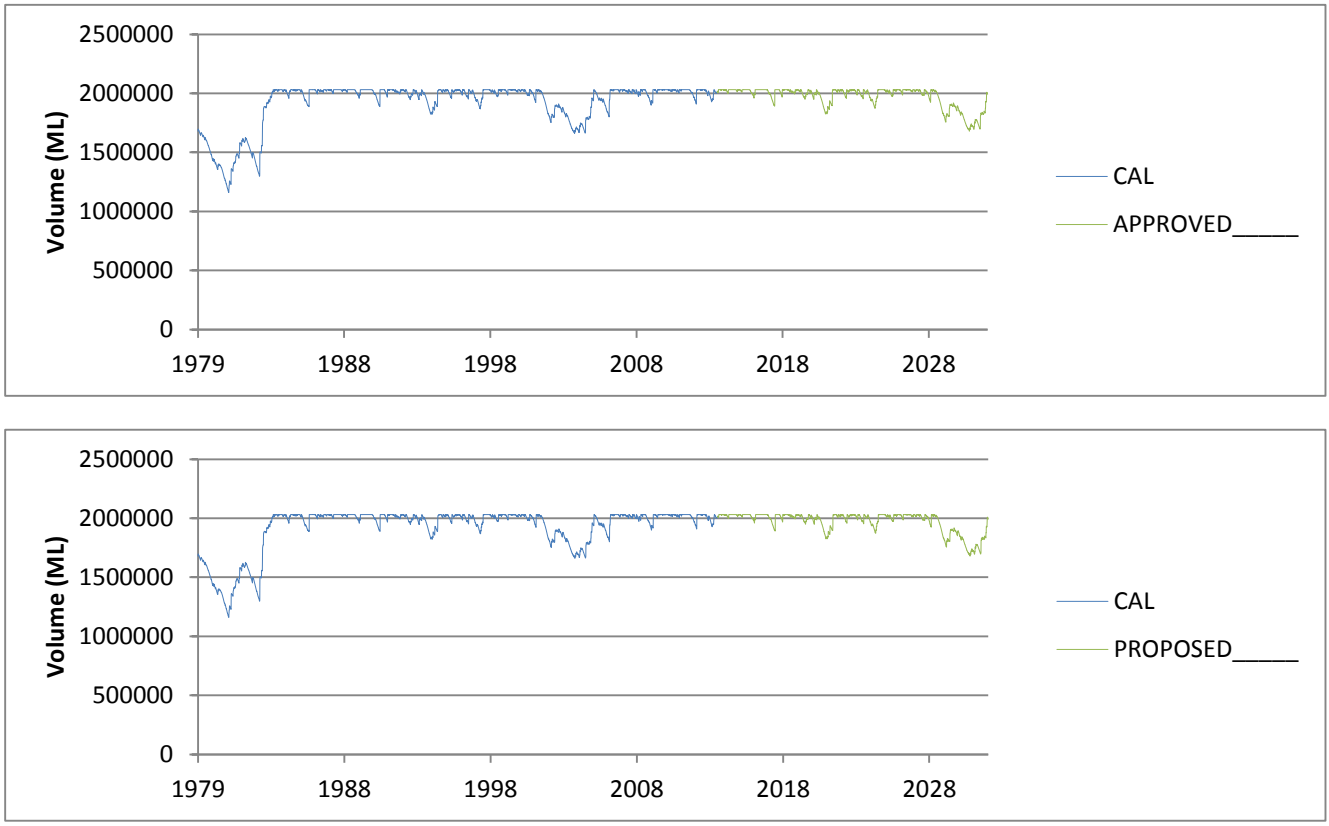


Figure 4.55 : Prediction Time-Series Chart at #280 (Lake Burragorang) – Volume ML

Results presented for Lake Burragorang (Node #280), summarised in **Table 4.22**, indicate no change in median salinity and an increase at 90% distribution from 102 to 103mg/L (linear fit) and no change with respect to the stepped fit simulation. There is no predicted change in maximum salinity in Lake Burragorang due to the modification.

With respect to the duration of the prediction period, the change in salinity is considered a negligible change. As identified per the findings presented above, **Table 4.23**, there is also no modelled change in volume in Lake Burragorang due to the modification.

Accordingly, as will be presented below, the modification is considered to meet the NorBE water quality effect test due to minor to negligible change in predicted water quality. As will be presented in **Section 4.7**, the expected change in toxicological impact, locally, is more significant.

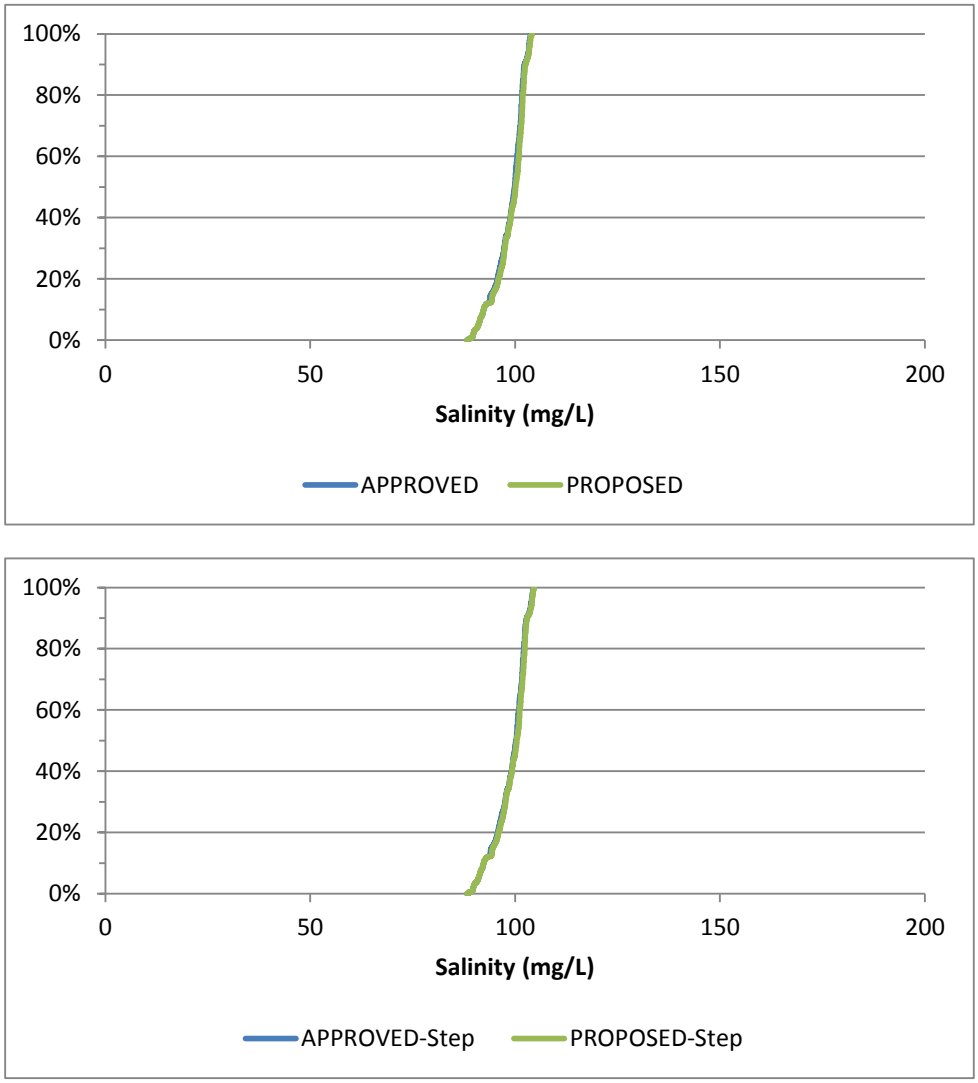


Figure 4.56 : Prediction Distribution Plot at #280 (Lake Burragorang) – Salinity mg/L

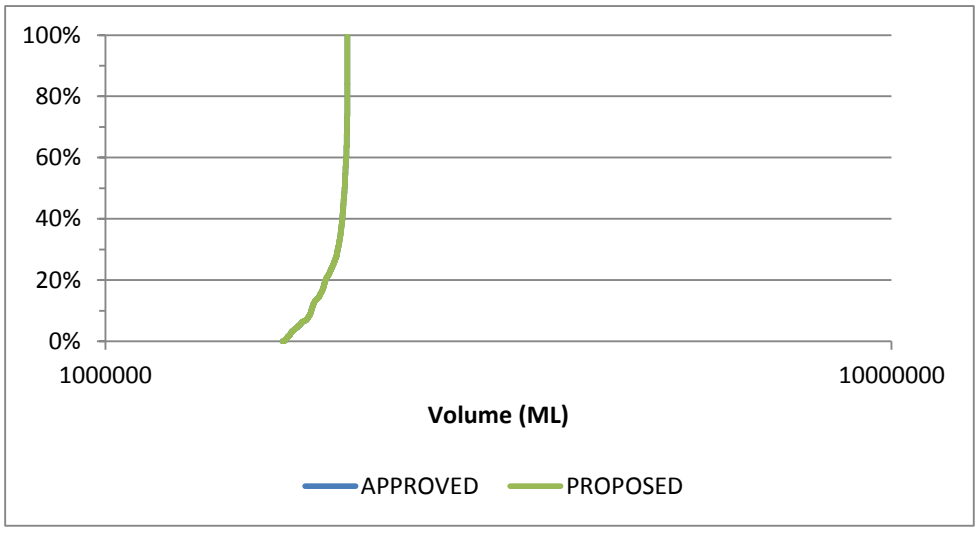


Figure 4.57 : Prediction Distribution Plot at #280 (Lake Burragorang) – Volume ML

Table 4.22 : Prediction Daily Statistics at #280 (Lake Burragorang) – Salinity mg/L

Percentile	Salinity (mg/L) – Linear Water Quality Criteria		Salinity (mg/L) – Stepped Water Quality Criteria	
	APPROVED	PROPOSED	APPROVED	PROPOSED
Minimum	88	88	88	88
5%	91	91	91	91
10%	92	92	92	92
20%	96	96	96	96
50%	100	100	100	100
80%	102	102	102	102
90%	102	103	103	103
95%	103	104	104	104
Maximum	104	104	105	105

Table 4.23 : Prediction Daily Statistics at #280 (Lake Burragorang) – Volume ML

Percentile	Volume (ML)	
	APPROVED	PROPOSED
Minimum	1679000	1679000
5%	1760900	1760900
10%	1828000	1828000
20%	1906000	1906000
50%	2015000	2015000
80%	2031000	2031000
90%	2031000	2031000
95%	2031000	2031000
Maximum	2031000	2031000

4.4.4 Uncertainty Analysis

Given the limited magnitude of predicted change compared to the as-approved simulation, uncertainty analysis with respect to high and low rainfall periods was not repeated.

Full details of the uncertainty analysis undertaken on the RWQIAM, at the time, is presented in Jacobs (2015a).

4.4.5 Treatment Options

It is highlighted that the assessment presented in this report does not consider how the water quality criteria will be met. The analysis is focussed solely on the impact of the proposed change to the water quality criteria.

Details of the proposed Springvale Water Treatment Project (GHD, 2016ab) are presented elsewhere in respective reports.

4.4.6 Results of Analysis

There are two scenarios presented from the RWQIAM, considering a linear fit to the water quality criteria or a stepped fit to the water quality criteria. Modelling indicates that the proposed modification does not lead to a change in modelled median salinity in Lake Burragorang (Node #280) as a result of the modification.

4.5 Geomorphology

4.5.1 Approach to Analysis

The potential for impact to geomorphology associated with the project includes:

- potential for scour within Sawyers Swamp Creek associated with mine water discharge.

4.5.2 Results of Analysis

Potential for Scour within Sawyers Swamp Creek

Section 6.3 of the Surface Water Assessment presented at the time of the EIS (RPS, 2014a) presents an assessment of the potential for scour due to mine water discharge. RPS (2014a) found that the potential for scour was small since the average channel velocity during a typical large rainfall event was much higher than proposed channel velocities.

There is no proposed increase in rate of mine water discharge to Sawyers Swamp Creek associated with the modification. Current rates of discharge are consistent with that presented in the EIS and the modification does not propose to change these discharge rates. It is therefore concluded there is no change to the potential for scour within Sawyers Swamp Creek as a result of the modification.

4.6 Flood Modelling

4.6.1 Approach to Analysis

The potential for impact to flooding and drainage associated with the project consists:

- mine water discharge to Sawyers Swamp Creek, which then flows into the Coxs River.

4.6.2 Results of Analysis

Section 6.3 of the Surface Water Assessment (RPS, 2014a) states that mine water discharge will not result in significant impact to flooding and drainage within Sawyers Swamp Creek or the Coxs River, since predicted daily flow will remain in-bank, defined notionally to contain the 2 year Average Recurrence Interval flood event.

There is no proposed increase in rate of mine water discharge to Sawyers Swamp Creek associated with the modification. Current rates of discharge are consistent with that presented in the EIS. Accordingly, it is concluded there will be no change to flooding and drainage as a result of the modification.

4.7 Toxicological Assessment of Mine Water Discharge Quality

Direct toxicity assessment was used to determine the toxicity of mine water discharge at Springvale Mine. Samples of treated (with flocculants) mine water discharge at LDP009 were collected in August and October 2014, April 2015 and May 2016 by GHD for toxicity screen testing (freshwater cladoceran). This testing was also undertaken on raw mine water (i.e. prior to any treatment with flocculants) collected in October 2014 and May 2016. The screening test species were selected due to their identified sensitivity in previous toxicity testing by Centennial Coal in the region.

GHD (2016a) indicate that water quality analyses of LDP009 do not contain concentration of dissolved metals in concentrations that could cause significant toxicity and conclude that salinity is the potential cause.

Toxicity testing of mine water at LDP009 and on samples collected below LDP009 within the Coxs River catchment in 2014 (GHD, 2014) has shown that the observed toxicity diminished with increasing distance downstream from LDP009, with no adverse impact observed in the upper portion of Lake Wallace or any points further downstream.

As identified in RPS (2014ab) and Jacobs (2015ab), mine water discharge does dominate flows in Sawyers Swamp Creek. It is noted that mine water discharge meets Australian Drinking Water Guidelines, with the exception of salinity where the drinking water standard considers a TDS of 600mg/L (~895µS/cm) to be good quality drinking water and a TDS of between 600mg/L and 900mg/L (~895µS/cm to 1,345µS/cm) to be fair quality drinking water. It is noted that the guidance values for salinity in the ADWG is an aesthetic-based value and is not a health-based value.

GHD (2016a) describe the toxicity effect as due to ionic imbalance. It is interpreted that this refers to the effect on osmoregulation and does not imply that the groundwater itself is outside a state of electroneutrality. As stated in the EIS (Golder Associates, 2014), groundwater quality of the deep system (mine water discharge) is fresh with pH in the order of 7.2 and is Na-HCO_3 type water. On-going monitoring of the water quality of mine water discharge indicates salinity is ~800mg/L (1,200µS/cm).

GHD (2016a) present that alga shows significant toxicity and duckweed shows no toxicity. GHD (2016a) state that cladoceran reproduction results imply chronic toxicity in all assessments for LDP009 discharge to date. GHD (2016a) note that cladoceran survival tests show improvement from 2014, with no acute toxicity detected. GHD (2016a) comment that changes to flocculent agent and dosing rates have reduced the acute toxicity of LDP009 discharge; however, chronic toxicity of mine water discharge has not changed significantly since August 2014.

Toxicological impact will continue until the Springvale Water Treatment Project becomes operational.

The Ecotoxicological Assessment report prepared by GHD (2016a) is presented in **Appendix A**.

4.8 Aquatic Ecology (Macroinvertebrates)

Given that the modification is a continuation of mine water discharge at current and historical water quality, there is no change to environmental consequences with respect to aquatic ecology (macroinvertebrates) compared to that presented in the environmental impact assessment of the Springvale Mine Extension Project.

4.9 Results of Hydrological Analysis

4.9.1 Site Water Management

There is no change to site water management (potable water supply, erosion and sediment control, sewerage) due to the modification.

4.9.2 Surrounding Land Use

There are no expected changes to surrounding land use due to the modification.

4.9.3 Rivers and Creeks

There is no direct extraction from surface watercourses associated with the project and there is no proposed extraction associated with the modification.

Modelling indicates that the removal of the interim 30 June 2017 water quality performance criteria, with respect to salinity, does not lead to a significant difference in predicted water quality within the Coxs River, over the prediction period, compared to that currently approved. Modelling indicates no change to modelled median salinity in Lake Burragorang over the prediction period due to the proposed modification.

4.9.4 Sensitive Environmental Receptors

THPSS

Discharge to the Newnes Plateau was not proposed as part of the Springvale Mine Extension Project. Potential impact to these ecosystems, as identified in the EIS, is due to subsidence and mining induced change to groundwater contribution to surface water flow.

The proposed modification will not lead to change to predicted impact to the THPSS ecosystems.

Coxs River

The proposed modification is a continuation of historical discharge at current and historical quality, for a further period, prior to the commencement of Springvale Water Treatment Project.

Modelling indicates an insignificant change in predicted water quality (salinity), over the prediction period, due to the proposed modification.

There is no change to geomorphology or flooding within the Coxs River due to the modification.

Given that the modification is a continuation of mine water discharge at current and historical water quality, there is no change to environmental consequences with respect to aquatic ecology (macroinvertebrates) compared to that presented in the environmental impact assessment of the Springvale Mine Extension Project.

4.9.5 Surface Water Users

The change to surface water flow, level and quality due to the modification to consent at relevant surface water users is presented in **Table 4.24**.

Table 4.24 : Predicted Change to Flow, Level and Quality for Surface Water Users

Surface Water User	Distance from Site	Predicted Change to Flow	Predicted Change to Level	Predicted Change to Quality
Coxs River (Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone))				
WAL25607	3.5km downstream of Springvale LDP009	No change due to the modification. Increase in flow due to the project.	No change due to the modification. Increase in level (whilst remaining in-bank) due to the project.	Continuation of current surface water quality for a further period. Salinity of surface water elevated due, in part, to the project.
WAL27428 (Lake Wallace)	7.4km downstream of Springvale LDP009	No change due to the modification. Lake Wallace already operating at full level due to closure of Wallerawang Power Station in April 2014.	No change due to the modification.	Continuation of current surface water quality due to mine water discharge for a further period. Modelling indicates a minor change in median modelled salinity due to the modification. Salinity of surface water elevated due, in part, to the project.
Coxs River (Upper Nepean and Upstream Warragamba Water Source) (far field)				
WAL27428 (Lake Lyell)	22.6km downstream of Springvale LDP009	No change due to the modification.	No change due to the modification.	Modelling indicates a minor change in median modelled salinity due to the modification. Salinity of surface water influenced due to project.
WAL27431 (Lake Burragorang)	~80 km downstream of Springvale LDP009	No change due to the modification.	No change due to the modification.	No change in modelled median salinity, over the prediction period, due to the modification. Salinity of surface water influenced due to project.

From **Table 4.24**, there is an insignificant change to water quality (salinity), over the prediction period, expected to be experienced by surface water users due to the modification.

4.9.6 Surface Water / Groundwater Interaction

Table 4.25 presents the expected change to groundwater as a result of mine water discharge to the Coxs River.

Table 4.25 : NSW Aquifer Interference Policy (Level 1 Minimal Impact Considerations) (DPIWater, 2012) – Less Productive Porous and Fractured Rock Aquifers

Level 1 Minimal Impact Consideration	Predicted Change
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan.	There are no high priority groundwater dependent ecosystems or high priority culturally significant sites downstream of the point of discharge to Sawyers Swamp Creek.
OR A maximum of a 2 metre water table decline cumulatively at any water supply work.	There is no direct extraction from surface water sources associated with the project that could lead to a decline in water table level of a water supply work. There is also no proposed extraction associated with the modification to consent and accordingly, the modification will not lead to a decline in water table level at any water supply work.
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	As above, there is no direct extraction from surface water sources associated with the project and there is no proposed extraction associated with the modification. Accordingly, the modification will not lead to a decline in water pressure at any water supply work.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Mine water discharge to the Coxs River comprises groundwater inflow to underground operations. Recharge to that deep groundwater system is via outcropping of coal seams in or immediately adjacent to the Coxs River.

5. Impact Assessment

This chapter presents and discusses the potential impacts to streamflow and quality as a result of the proposed modification to the project.

It is noted that the impact assessment is presented with respect to relevant Commonwealth and NSW legislation, guidelines and policy.

5.1 Commonwealth Legislation, Guidelines and Policy

5.1.1 Significant Impact Guidelines for Coal Seam Gas and Large Coal Mines 2013

Table 5.1 presents an assessment of the Proposal against the Significant Impact Guidelines for Coal Seam Gas and Large Coal Mines (DoE, 2013).

Table 5.1 : Impact Assessment against Significant Impact Guidelines (DoE, 2013)

Impact Guideline	Compliant	Comment
Hydrological Characteristics		
A significant impact on the hydrological characteristics of a water resource may occur where there are, as a result of the action: a) changes in the water quantity, including the timing of variations in water quantity	Yes	As established in the EIS, the Coxs River has had a long history of industrial activity. The proposed modification to consent does not include a change to approved discharge volumes.
b) changes in the integrity of hydrological or hydrogeological connections, including substantial structural damage (e.g. large scale subsidence)	Yes	The modification does not involve any change to previously presented subsidence-related impacts to surface water or groundwater resources.
c) changes in the area or extent of a water resource	Yes	There is no change in the extent of any water resource as a result of the modification, since there is no proposed change to currently approved discharge rates.
Water Quality		
A significant impact on a water resource may occur where, as a result of the action: a) there is a risk that the ability to achieve relevant local or regional water quality objectives would be materially compromised, and as a result the action: i. creates risks to human or animal health or to the condition of the natural environment as a result of the change in water quality	Yes	The project results in mine water discharge to the Coxs River catchment, which eventually discharges into Lake Burragorang. As presented during the environmental impact assessment, the RWQIAM indicates a small increase in salinity in Lake Burragorang as a result of the project. The outcomes of modelling presented in this report indicates no change in modelled median salinity in Lake Burragorang as a result of the proposed modification.
ii. substantially reduces the amount of water available for human consumptive uses or for other uses, including environmental uses, which are dependent on water of the appropriate quality	Yes	The project comprises an increase in availability of water in the Coxs River catchment. The proposed modification to consent does not change the predicted impact of the project.

Impact Guideline	Compliant	Comment
iii. causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment	Yes	Water quality criteria established in the current Conditions of Consent, expressed in Springvale Coal's EPL, have been tailored to reduce the potential impact of metals and salinity on the environment. Modelling presented in this report indicates an insignificant change in modelled salinity, over the prediction period, as a result of the modification.
iv. seriously affects the habitat or lifecycle of a native species dependent on a water resource, or	Yes	As established in the EIS, the Coxs River is an adapted ecosystem (perennial) from its long history as an industrialised catchment. The modification to consent does not result in a change to the rate of mine water discharge from that presented in the EIS. As noted in Section 4.4, an update to mine inflows was incorporated into the RWQIAM, however, is consistent with that presented in the EIS. With respect to water quality, the modification will lead to an insignificant change in modelled salinity within the Coxs River over the prediction period, compared to that already approved.
v. causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource, or	Yes	N/A
b) there is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives), or	Yes	LDP009 is located within Sawyers Swamp Creek and as presented in the EIS, is a highly altered and disturbed catchment. The modification will result in continuation of mine water discharge for a further period, however, is consistent with current and historical flow and quality within that watercourse.
c) high quality water is released into an ecosystem which is adapted to a lower quality of water.	Yes	N/A

5.1.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000

Assessment of the impact of the modification against ANZECC (2000) is presented in **Section 5.2.3** in regard to the NSW Water Quality and River Objectives (OEH, 2006).

5.1.3 Australian Drinking Water Guidelines 2011

Assessment of the impact of the modification against NHMRC (2016) is presented in **Section 5.2.3** in regard to the NSW Water Quality and River Objectives (OEH, 2006) and in **Section 5.2.2** with respect to *State Environmental Planning Policy (Sydney Drinking Water Catchment)* 2011 (NSW).

5.2 NSW Legislation, Guidelines and Policy

5.2.1 Water Management Act 2000

Water Management Plan for the Greater Metropolitan Unregulated River Water Sources 2011

Rules for granting access licences, managing access licences, water supply works approvals and access licence dealings are provided in the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources* 2011 (NSW).

There is no direct surface water extraction from the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources* 2011 (NSW).

Due to indirect change to groundwater contribution to surface watercourses, as a result of mining activity, there is a requirement for water access licences from surface water sources. The proposed modification does not include proposed change to groundwater impact on surface watercourses.

Impact to Surface Water Users

Table 5.2 presents an assessment of the impact of the predicted change to flow, level and quality due to the modification to the already approved impacts on relevant surface water users.

Table 5.2 : Impact Assessment of Changes to Flow, Level and Quality on Surface Water Users

Surface Water User	Distance from Site	Impact to Flow	Impact to Level	Impact to Quality
Coxs River (Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone))				
WAL25607	3.5km downstream of Springvale LDP009	Negligible due to modification	Negligible due to modification	Negligible due to modification
WAL27428 (Lake Wallace)	7.4km downstream of Springvale LDP009	Negligible due to modification	Negligible due to modification	Negligible due to modification
Coxs River (Upper Nepean and Upstream Warragamba Water Source) (far field)				
WAL27428 (Lake Lyell)	22.6km downstream of Springvale LDP009	Negligible due to modification	Negligible due to modification	Negligible due to modification
WAL27431 (Lake Burragorang)	~80 km downstream of Springvale LDP009	Negligible due to modification	Negligible due to modification	Negligible due to modification

5.2.2 Environmental Planning and Assessment Act 1979

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

Table 5.3 presents an assessment of the impact against the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*.

As will be presented below, the modification is considered to meet the NorBE water quality effect test due to minor to negligible change in predicted water quality, having a neutral impact compared to current conditions ('base case' as per the below).

As outlined in DP&E (2015), Section 2.3, "*The Department and Water NSW have considered the question of what is an appropriate 'base case' for Springvale, given the length of time the mine has been operating and other variables, including the closure of the Wallerawang Power Station. In the context of the long-term and existing mining operations at Springvale, the Department considers that the most appropriate position is to consider the base case as being the existing discharge limits on Springvale's EPL that existed at the time the current development application was made (ie 1,200 µS/cm EC).*" pg 14.

As noted in **Section 2.3.3**, the assessment of the project presented during the environmental impact assessment did not use the NorBE tool, because it was not suitable for the scale of the project.

Table 5.3 : Impact Assessment against Neutral or Beneficial Effect Test (WaterNSW, 2015)

Assessment Condition	Compliant	Impact Assessment
"A neutral or beneficial effect on water quality is satisfied if the development: (a) has no identifiable potential impact on water quality, or	N/A	N/A
(b) will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or	N/A	N/A
(c) will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority."	Yes	Modelling indicates that the proposed modification will not result in a significant change to water quality (salinity) within the Coxs River over the period of prediction, compared to that already approved. DP&E (2015) define the 'base case' for Springvale Mine as the EPL limit of 1,200µS/cm existing at the time of the SSD 5594 development application. Accordingly, the proposed modification will result in a neutral impact to water quality with respect to NorBE, since the modification will allow the Springvale Mine to continue to discharge mine water at the current water quality criteria until the Water Treatment Project (SSD 7592) assessment and construction has been completed.

5.2.3 NSW Water Quality and River Flow Objectives 2006

Table 5.4 presents an assessment of impact of the modification to consent against the NSW Water Quality Objectives.

Table 5.4 : Impact Assessment against NSW Water Quality Objectives (OEH, 2006)

Water Quality Objective	Compliant	Impact Assessment
Aquatic Ecosystems "Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term."	No	As stated in RPS (2014b), "*The Springvale – Delta Water Transfer Scheme (SDWTS) was commissioned in February 2006 and transmitted mine water make from Springvale and Angus Place via Springvale Mine directly to Wallerawang Power Station. When not required at Wallerawang Power Station, mine water make from the SDWTS was directed to Sawyers Swamp Creek via EnergyAustralia LDP020. In August 2012, responsibility for EnergyAustralia LDP020 transferred to Springvale Mine. The new LDP became Springvale LDP009. Prior to the SDWTS, mine water make at Springvale was discharged to the Wolgan River via the Newnes Plateau. Historical discharge at Angus Place was via Kangaroo Creek. Between 2006 and 2012, when the SDWTS was offline, there were periods when there was discharge to the Wolgan River. This ceased in approximately 2010. Currently all flow within the SDWTS is being directed to Sawyers Swamp Creek via Springvale LDP009.*". The

Water Quality Objective	Compliant	Impact Assessment
		proposed modification will result in continuation of this discharge for a further period. Toxicological assessment indicates that acute toxicity impacts have been ameliorated due to the change in flocculent agent and dosing rate. Accordingly, the proposed modification will not have a significant change to acute toxicity. With respect to chronic toxicity, the indicator species used indicates continuing impact due to difference in salinity of mine water discharge (groundwater) compared to surface water. That impact will continue until commissioning of the Springvale Water Treatment Project. The Springvale Water Treatment Project, once operational, will meet the 30 June 2019 water quality criteria.
Visual Aesthetics "Aesthetic qualities of water"	Yes	No change due to the modification. As per Section 2.3.4, there is a turbidity and suspended sediment quality limit to mine water discharge to Sawyers Swamp Creek at Springvale LDP009.
Drinking Water – Groundwater "Refers to quality of drinking water drawn from the raw surface or groundwater sources before any treatment."	Yes	No change due to the modification. Mine water discharge to the Coxs River meets the ADWG with the exception of salinity where 600 to 900mg/L is considered of fair quality.
Industrial Water Supplies "The high economic value of water taken from river and lakes for use by industry needs recognition in water quality planning and management. It has been identified as an important environmental value through community consultation."	Yes	No change due to the modification. As per the Water Sharing Plan for the Greater Metropolitan Unregulated River Water Sources 2011, water must not be taken from the Coxs River under a major utility [power generation] access licence until all available mine water is used from its storages.

Table 5.5 presents an assessment of impact of the modification to consent against the NSW River Flow Objectives.

Table 5.5 : Impact Assessment against NSW River Flow Objectives (OEH, 2006)

River Flow Objective	Compliant	Impact Assessment
Protect natural pools in dry times "Protect natural water levels in pools of creeks and rivers and wetlands during period of no flow"	Yes	No impact due to modification. There is no direct extraction of water from surface watercourses due to the project or proposed as part of the modification.
Protect natural low flows "Protect natural low flows"	No	With respect to the Coxs River, there is continuous discharge to Sawyers Swamp Creek. This was approved as part of SSD5594 and continuous discharge to Sawyers Swamp Creek will continue under the modified project.
Maintain wetland and floodplain inundation "Maintain or restore natural inundation patterns and distribution or floodwaters supporting natural wetland and floodplain ecosystems"	Yes	No change due to the modification, since there are no physical works such as hydraulic structures within the Coxs River catchment proposed, nor are there any structures associated with the project. Infrastructure associated with LDP009, in Sawyers Swamp Creek, is already established.
Maintain natural flow variability "Maintain or mimic natural flow variability in all streams"	No	No change due to the modification, as continuous discharge of mine water to Sawyers Swamp Creek

River Flow Objective	Compliant	Impact Assessment
		will continue, as currently approved. As presented in the EIS, Sawyers Swamp Creek is a heavily modified catchment, due to its previous and current land use, including open cut mining and ash disposal facilities. The Coxs River is also extensively modified due to water supply reservoirs at Lake Wallace and Lake Lyell.
Maintain groundwater ecosystems "Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems"	Yes	There is no change to the predicted impact to groundwater ecosystems on the Newnes Plateau associated with the modification.

5.2.4 Managing Urban Stormwater 2004 & 2008

There is no proposed change to site water management as a result of the proposed modification.

Accordingly, there is no impact from the modification on erosion and sediment control outcomes.

5.2.5 NSW Aquifer Interference Policy 2012

Table 5.6 presents an assessment of aquifer interference due to surface water management associated with the modification to consent.

Table 5.6 : Impact Assessment against NSW Aquifer Interference Policy (Level 1 Minimal Impact Considerations) (DPIWater, 2012) – Less Productive Porous and Fractured Rock Aquifers

Level 1 Minimal Impact Consideration	Compliant	Impact Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan.	Yes	Negligible
OR A maximum of a 2 metre water table decline cumulatively at any water supply work.	Yes	Negligible
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Yes	Negligible
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Yes	Negligible

6. Licensing, Management, Mitigation and Monitoring

This chapter presents licensing requirements from relevant water sources and presents management measures for the project, including changes due to the modification, as well as the approach to on-going monitoring.

6.1 Licensing

6.1.1 Commonwealth Legislation

6.1.1.1 Environment Protection and Biodiversity Conservation Act 1999

There are no licensing requirements under the *Environmental Protection and Biodiversity Conservation Act* 1999 (Cth) with respect to discharge to surface water sources.

6.1.2 NSW Legislation

6.1.2.1 Water Management Act 2000

Licensable Take

There is no direct surface water extraction from the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources* 2011 (NSW).

There is no change due to the modification in estimated indirect take from the above water sharing plan due to mining-related reduction in groundwater contribution to surface watercourses.

Accordingly, there are no changes to license requirements (both surface water and groundwater) under the relevant Water Sharing Plans due to the modification.

6.1.2.2 Protection of the Environment Operations Act 1997

There are no changes to mine water discharge limits in the current EPL (No. 3607, dated 26 February 2016) suggested associated with this modification to consent.

6.2 Management

Water management at Springvale Mine is governed by the Water Management Plan, as specified in Schedule 4, Condition 14, of the current Conditions of Consent (SSD 5594) (Springvale Coal, 2016a). The Water Management Plan presents the monitoring network, establishes trigger levels on expected impacts as well as presents the Trigger Action Response Plan.

There is also a tailored Water Management Plan required with respect to each Extraction Plan (Schedule 3, Condition 10 of the current Conditions of Consent). The current Extraction Plan refers to LW420-422 (Springvale Coal, 2016b).

Lastly, the current Conditions of Consent also specify a requirement to prepare an Upper Coxs River Action and Monitoring Plan (Schedule 4, Condition 13) to achieve a target salinity in the Coxs River of 500µS/cm (90th percentile) by 30 June 2019. That management plan is in the process of being finalised.

6.3 Monitoring

The monitoring network at Springvale Mine comprises:

- flow and quality monitoring in rivers and creeks
- flow and quality monitoring within shrub swamps (flow and quality)

Further detail of the monitoring network at Springvale is presented in RPS (2014a) and the current Water Management Plan (Springvale Coal, 2016ab).

Compared to the currently approved project, due to the expected minor to negligible change to flow, level and quality, there are no presented changes to surface water monitoring at Springvale Mine associated with the modification.

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Appendix A. Toxicological Assessment

Centennial Coal Company Limited

Centennial West

Ecotoxicology Assessment of Springvale Mine LDP009

November 2016

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Appendices

1. Introduction

1.1 Background

Angus Place Colliery and Springvale Mine are underground coal mining operations in the Western Coalfield of NSW near Lithgow, as shown in Figure 1-1. Angus Place Colliery is located approximately 15 km west of Lithgow and is managed by Centennial Angus Place Pty Ltd (Centennial Angus Place). Springvale Mine is located approximately 6 km south of Angus Place Colliery and is managed by Springvale Coal Pty Limited (Springvale Coal).

GHD Pty Ltd (GHD) was commissioned by Centennial Coal Company Limited (Centennial Coal) to conduct an ecotoxicology assessment of mine water discharges to determine toxicity and chemical constituents of mine water.

1.2 Overview of water management

Groundwater inflows into the underground workings at both Angus Place Colliery and Springvale Mine are transferred to the Springvale-Delta Water Transfer Scheme (SDWTS). The SDWTS consists of a pipeline network that was established to transfer water from existing dewatering facilities on the Newnes Plateau to Wallerawang Power Station. Following the decommissioning of the power station in 2014, mine water transferred to the SDWTS has been discharged through Springvale Mine's licensed discharge point (LDP) LDP009 to Sawyers Swamp Creek within the upper Coxs River catchment, which is licensed under environmental protection licence (EPL) 3607.

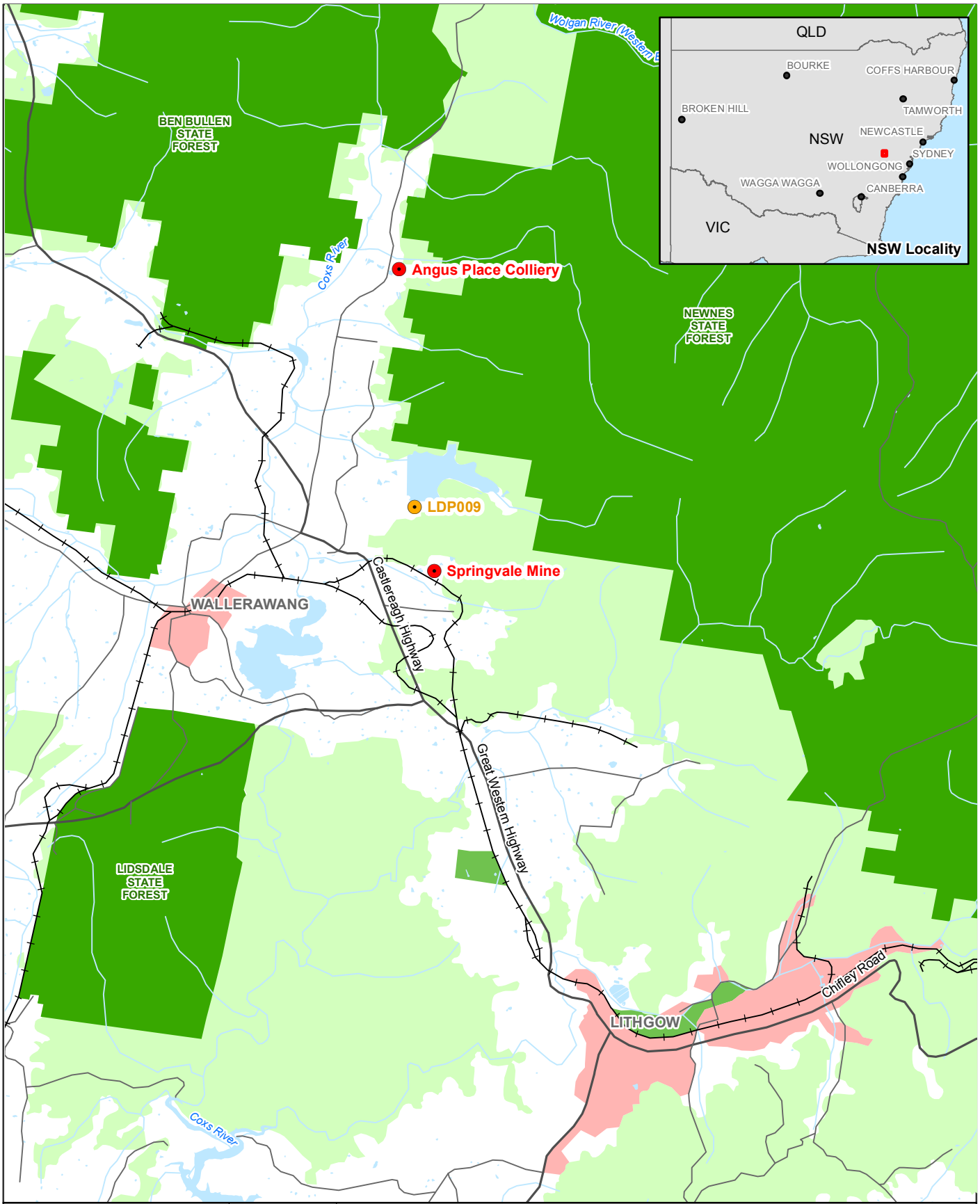
Currently, the SDWTS receives mine water from Bore 6, Bore 8 and the Ventilation Shaft No. 3 borehole at Springvale Mine and from Bore 940 at Angus Place Colliery at a rate of up to 30 ML/day. Mine water from Springvale Mine is taken as a priority, with the remaining capacity supplied by mine water from Angus Place Colliery. Dewatering of the underground workings at Angus Place Colliery is currently ongoing while the mine is under care and maintenance.

Raw mine water from Angus Place Colliery and Springvale Mine is combined in a single pipeline that finishes at the LDP009 sedimentation ponds. The raw water is treated approximately 100 m before the end of the pipeline where a polymer injection system delivers aluminium chlorohydrate as a coagulant into the pipeline for water treatment. The polymer is designed to attract any suspended solids in the water, forming strings which become heavy and settle in the sedimentation ponds. Water continues to flow through the ponds, removing suspended solids and is then discharged via a concrete spillway. LDP009 is located at the bottom of the discharge spillway. The sedimentation ponds are dredged twice annually.

1.3 Scope of work

This report details the ecotoxicology assessment and provides the results for the toxicity and water quality testing of LDP009 discharge. The scope of work included:

- Provide details of the toxicity and water quality testing conducted.
- Interpret the toxicity and water quality results.
- Compare results with site-specific guideline values (SSGVs) and EPL limits specified for LDP009 discharge.



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0 0.5 1 2 3

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Centennial Site
- Existing Rail
- Principal Road
- Minor Road
- Built Up Area
- Watercourse
- Waterbody
- State Forest
- Forest Or Shrub

LOCATION	-
SEAM	NA
DRAWN	K.S.
CHECKED	?.?
APPROVED	?.?
SCALE	Refer to scalebar

Ecotoxicology Assessment of Springvale Mine LDP009

Locality Plan

Centennial West

DATE 5/08/2016

Figure 1-1

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2218348\LPD009\2218348_001_Locality_A.mxd

2. Methodology

2.1 Sample collection

A sample of treated mine water discharged from LDP009 at Springvale Mine was collected by GHD on 3 May 2016 and sent to Ecotox Services Australasia (ESA) on 4 May 2016, where the sample was received by ESA on the same day.

Samples were also collected for water quality analysis from LDP009 and raw water upstream of LDP009 prior to treatment. These samples were collected on 3 May 2016 and sent to ALS Sydney on 4 May 2016, where they were received on the same day.

The previous ecotoxicology assessments conducted on LDP009 were undertaken in August and October 2014 (GHD, 2014) and in April 2015 (GHD, 2015). For the October 2014 testing round, a sample of LDP009 discharge prior to water quality treatment with flocculants was also collected for ecotoxicology testing. Samples collected were sent to the same laboratories as detailed above.

2.2 Direct toxicity assessment

Direct toxicity assessment (DTA) is a common method used to determine the toxicity of mixtures of compounds in ambient waters. The method provides an integrated measure of effects and accounts for interactions (synergistic, additive and ameliorative) within a mixture, therefore closely simulating the effects in the receiving waterway. To ensure a close simulation of the toxic effects of the discharge, site-specific testing was undertaken using species indigenous to, or representative of, the receiving ecosystem.

DTA was undertaken for the mine water discharge samples collected in August 2014 and May 2016. Toxicity testing in October 2014 and April 2015 was conducted using screening tests with freshwater cladoceran, which has been found to be the most sensitive test species in previous toxicity testing conducted by Centennial Coal in the region.

DTA involves exposing laboratory test species to a range of concentrations of sampled water for a specified exposure period. At the end of the exposure period, specific end points are assessed, such as species survival, reproduction or growth. Statistical analysis of the results provides the effect concentration of the discharge where 10% (EC_{10}) and 50% (EC_{50}) of test organisms exhibited an inhibition effect and the no observable effect concentration (NOEC) of the discharge, which represents the highest tested concentration that has no effect on the test organisms (when compared to the results of the control sample).

2.2.1 Species tested

August 2014

The following freshwater species and test protocols were used to test the sample collected from LDP009 in August 2014:

- Seven-day partial life-cycle test using the freshwater cladoceran *Ceriodaphnia dubia*, based on the USEPA (2002) and Bailey *et al.* (2000) protocols.
- 72-hour microalgal growth inhibition test using the freshwater alga *Selenastrum capricornutum*, based on the USEPA (2002) protocol.
- 96-hour growth inhibition test using the freshwater aquatic duckweed *Lemna disperma*, based on the OECD (2006) protocol.

- 96-hour population growth test using the freshwater hydra *Hydra viridissima*, based on the Riethmuller *et al.* (2003) protocol.
- 96-hour imbalance test using the freshwater eastern rainbowfish *Melanotaenia splendida splendida*, based on the USEPA (2002) protocol.

October 2014 and April 2015

The seven-day partial life-cycle toxicity test using the freshwater cladoceran *Ceriodaphnia dubia* was conducted on LDP009 discharge in October 2014 and April 2015, using the protocols specified by USEPA (2002) and Bailey *et al.* (2000).

May 2016

The following freshwater species and test protocols were used to test the sample collected from LDP009 in May 2016:

- Seven-day partial life-cycle test using the freshwater cladoceran *Ceriodaphnia dubia*, based on the USEPA (2002) and Bailey *et al.* (2000) protocols.
- 72-hour microalgal growth inhibition test using the freshwater alga *Selenastrum capricornutum*, based on the USEPA (2002) protocol.
- 96-hour growth inhibition test using the freshwater aquatic duckweed *Lemna disperma*, based on the OECD (2006) protocol.
- 10-day embryonic development and post-hatch survival test using the freshwater eastern rainbowfish *Melanotaenia splendida splendida*, based on the USEPA (2002) protocol.
- 10-day survival test using the freshwater shrimp *Paratya australiensis*, based on the USEPA (2002) protocol. It should be noted that this bioassay is not accredited with the National Association of Testing Authorities (NATA).

2.2.2 Concentrations tested

ESA recommends the use of laboratory dilution water to provide a more accurate indication of the toxicity of the samples and not the toxicity of the background water. ESA used in-house diluents for all dilutions and controls to ensure the toxicity observed can be attributed directly to the sample tested. All samples were serially diluted with the appropriate diluent to achieve the test concentration.

For the samples of mine discharge water collected in August 2014 and May 2016, the concentrations used in the toxicity testing were 0%, 3.1% 6.3%, 12.5%, 25%, 50% and 100%. For the samples collected in October 2014 and April 2015, screening tests with the cladoceran bioassay were conducted at 100% concentration (i.e. no dilution of samples) and compared with controls.

2.3 Water quality analysis

Water samples were tested for the parameters listed in Table 2.1 at the NATA accredited ALS Environment Division Laboratory.

Table 2.1 Summary of water quality parameters analysed

Category	Parameter
Physicochemical parameters	Electrical conductivity (EC), pH, total dissolved solids (TDS), total suspended solids (TSS), turbidity.

Category	Parameter
Nutrients	Ammonia, dissolved organic carbon (DOC), nitrate and nitrite, total Kjeldahl nitrogen (TKN), total nitrogen, total phosphorus.
Anions	Alkalinity, chloride, sulfate.
Cations	Calcium, magnesium, potassium, sodium.
Metals (dissolved and total)	Aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, strontium, vanadium, zinc.
Other parameters	Bromide, cyanide (free and total), fluoride, oil and grease.

In addition to the parameters listed in Table 2.1, LDP009 discharge was tested for the following semi-volatile organic compounds in October 2014:

- Phenolic compounds.
- Polynuclear aromatic hydrocarbons.
- Phthalate esters.
- Nitrosamines.
- Nitroaromatics and ketones.
- Haloethers.
- Chlorinated hydrocarbons.
- Anilines and benzidines.
- Organochlorine pesticides.
- Organophosphorus pesticides.

2.4 Dilution factor

The BurrliOZ 2.0 statistical analytical program (CSIRO, 2014) used the EC_{10} results from the toxicity testing in August 2014 and May 2016 to calculate the concentration of mine water discharge to protect 99%, 95%, 90% and 80% of species in the receiving environment from a 10% reduction in growth or reproduction. Where EC_{10} values where unreliable or only otherwise available through extrapolation, values were calculated following the methods set out by Warne *et al*. (2014). Dilution factors were then calculated for each species protection level, which can be used to assist in deriving site-specific concentrations of contaminants that will not adversely impact organisms within the receiving ecosystem. Concentrations of individual contaminants cannot be extrapolated from toxicity testing results for use as guideline values. However, concentrations can be used for monitoring purposes to ensure that the dilution factors are met at the appropriate monitoring site.

It should be noted that the future version of the ANZECC (2000) guidelines will require the use of a log-logistic distribution for datasets of small sample sizes. The BurrliOZ program requires a minimum of eight datasets to obtain an accurate species sensitivity distribution and results using less datasets must be interpreted with caution.

3. Results and discussion

3.1 Ecotoxicology assessment

The toxicity testing conducted by ESA on mine water discharges from LDP009 at Springvale Mine in August and October 2014, April 2015 and May 2016 fulfilled the criteria for NATA accredited tests (with the exception of the freshwater shrimp bioassay that is not NATA accredited) with all quality assurance/quality control parameters being met.

Statistical analysis of the toxicity testing results provide the concentration of the sample where 10% (EC_{10}) and 50% (EC_{50}) of test organisms exhibit the specific end point of the bioassay and the NOEC, which represents the highest concentration that has no effect upon the test species.

Screening bioassay results are considered to show toxicity if the results are less than 80% of the control. This is based on the quality control parameter for test acceptability used by the testing laboratory.

August 2014

A summary of the toxicity testing results from August 2014 is provided in Table 3.1 (GHD, 2014).

Table 3.1 Summary of ecotoxicology assessment results (August 2014)

Bioassay	Endpoint	Concentration (95% confidence limits)		
		EC_{10}	EC_{50}	NOEC
Cladoceran	Survival	34%*	59% (48%–72%)	50%
	Reproduction	9.3% (5.2%–16%)	29% (16%–50%)	25%
Microalga	Growth	3.7%*	6.0% (5.5%–6.7%)	3.1%
Duckweed	Growth	<3.1%	>96.8%	96.8%
Hydra	Growth	5.1%*	18% (14%–25%)	3.1%
Fish	Imbalance	25%*	50% (41%–62%)	25%

* 95% confidence limits not reliable

The results of the toxicity testing conducted in August 2014 (GHD, 2014) presented in Table 3.1 indicate that the discharge was toxic to the test species, with the alga, cladoceran and hydra species showing significant toxicity to the discharge. The alga was observed to have the most sensitivity to the discharge from LDP009. The duckweed test showed no toxicity to the discharge and the fish bioassay showed only slight sensitivity.

October 2014

A summary of the toxicity testing results from October 2014 is provided in Table 3.2 (GHD, 2014) for LDP009 discharges pre- and post-treatment with flocculants. The 100% concentration results from August 2014 have also been included for comparison.

Table 3.2 Summary of ecotoxicology assessment results (October 2014)

Sample	Reproduction (% of control)	Survival (%)
Laboratory control	100	100
LDP009 discharge (pre-treatment)	12	80
LDP009 discharge	4	40
LDP009 discharge (August 2014)	0	0

The results of the toxicity testing conducted in October 2014 (GHD, 2014) presented in Table 3.2 indicate the LDP009 discharge prior to water quality treatment with flocculants is not acutely toxic, however does show chronic toxicity. The discharge through LDP009 following treatment was found to be less toxic than the sample tested in August 2014. The treated discharge shows a greater toxicity than the mine water pre-treatment.

April 2015

A summary of the toxicity testing results from April 2015 is provided in Table 3.3 (GHD, 2015).

Table 3.3 Summary of ecotoxicology assessment results (April 2015)

Sample	Reproduction (% of control)	Survival (%)
Laboratory control	100	90
LDP009 discharge	12	90

The reproduction results of the screening test presented in Table 3.3 indicate that the LDP009 discharge at Springvale Mine in April 2015 showed chronic toxicity. The sample showed no acute toxicity to the cladoceran test species, with survival equal to the laboratory control.

May 2016

A summary of the toxicity testing results from May 2016 is provided in Table 3.4. A copy of the full ESA report is available in Appendix A.

Table 3.4 Summary of ecotoxicology assessment results (May 2016)

Bioassay	Endpoint	Concentration (95% confidence limits)		
		EC_{10}	EC_{50}	NOEC
Cladoceran	Survival	50%*	>100%	100%
	Reproduction	<3.1%	47% (34%–64%)	**25%**
Microalga	Growth	<3.1%	7.6% (5.4%–9.6%)	**3.1%**
Duckweed	Growth	17%*	>96.8%	**96.8%**

Bioassay	Endpoint	Concentration (95% confidence limits)		
		EC_{10}	EC_{50}	NOEC
Fish	Survival	<3.1%	>100%	**100%**
Shrimp	Survival	**17%**† (13%–20%)	28% (24%–32%)	12.5%

Values highlighted in bold have been used with BurrliOZ to determine dilution factors.

* 95% confidence limits not reliable.

† This number was divided by five prior to use with BurrliOZ in order represent chronic toxicity, as per Warne et al. (2014).

The results of the toxicity testing presented in Table 3.4 conducted in May 2016 indicate that the LDP009 discharge was toxic to the test species, with the alga and shrimp species showing significant sensitivity to the discharge. The cladoceran reproduction results indicated chronic toxicity, however the survival results showed no acute toxicity. The duckweed and fish tests showed no toxicity to the 100% sample of LDP009 discharge.

3.2 Water quality

A summary of the results of the water quality analysis for LDP009 discharge is provided in Table 3.5. A copy of the water quality testing results for May 2016 provided by ALS is presented in Appendix B. The results for the October 2014 and May 2016 testing rounds include samples of LDP009 discharge pre-and post-treatment with flocculants. It should be noted that all semi-volatile organic compounds tested in October 2014 in both pre-and post-treatment samples were found to be below the limit of reporting and are not presented in Table 3.5.

The results are compared to the limits specified by environment protection licence (EPL) 3607 for LDP009 discharge. Site-specific guideline values (SSGVs) derived for LDP009 (GHD, 2014) are also provided for comparative purposes only, as these guideline values are designed to be applied to the receiving waters and not to mine discharges at the end of pipe.

As seen in Table 3.5, all water quality results were found to exceed the adopted SSGV for electrical conductivity of 350 µS/cm, however were below the EPL limit specified for LDP009 of 1,200 µS/cm. The guideline value for total nitrogen was also exceeded for all samples. Dissolved arsenic was found to exceed the SSGV and EPL limit of 0.024 mg/L in samples analysed in October 2014 and May 2016. The changes to the flocculent agent and dosing rates used for LDP009, which were implemented between the October 2014 and April 2015 investigations, appear to have reduced dissolved arsenic concentrations.

Table 3.5 Summary of water quality results

Parameter	Units	SSGVs (GHD, 2014)	EPL 3607 limits	August 2014 (GHD, 2014)	October 2014 (GHD, 2014)		April 2015 (GHD, 2015)	May 2016	
					Pre-treatment	Post-treatment		Pre-treatment	Post-treatment
Physicochemical parameters									
EC	µS/cm	350	1,200	1,148	1,192	1,127	1,159	1,120	1,120
pH	pH units	5.9–8.0	6.5-9.0	8.0	7.3	7.9	7.9	7.6	7.9
TDS	mg/L	–	–	780	692	652	738	728	728
TSS	mg/L	25	50	19	13	9	6	7	10
Turbidity	NTU	25	50	14	22	9	3	61	–
Nutrients									
Ammonia	mg/L	0.9	–	0.44	0.14	0.43	0.56	0.47	0.41
DOC	mg/L	–	–	55	41	5	<1	8	7
Nitrite + nitrate	mg/L	–	–	0.21	0.78	0.43	0.31	0.31	0.31
TKN	mg/L	–	–	0.6	0.2	0.5	0.6	0.6	0.5
Total nitrogen	mg/L	0.6	–	0.8	1.0	0.9	0.9	0.9	0.8
Total phosphorus	mg/L	0.06	–	0.02	0.02	0.01	<0.01	0.03	0.02

Parameter	Units	SSGVs (GHD, 2014)	EPL 3607 limits	August 2014 (GHD, 2014)	October 2014 (GHD, 2014)		April 2015 (GHD, 2015)	May 2016	
					Pre-treatment	Post-treatment		Pre-treatment	Post-treatment
Anions									
Alkalinity	mg/L	–	–	625	516	531	597	657	640
Chloride	mg/L	–	–	6	5	6	6	7	7
Sulfate	mg/L	–	–	34	34	33	34	25	27
Cations									
Calcium	mg/L	–	–	1	1	1	1	4	4
Magnesium	mg/L	–	–	<1	1	1	1	3	3
Potassium	mg/L	–	–	9	8	9	11	11	10
Sodium	mg/L	–	–	291	251	252	283	305	300
Dissolved metals									
Aluminium	mg/L	0.204	0.45	0.01	<0.01	0.1	0.04	0.01	0.02
Arsenic	mg/L	0.024	0.024	0.024	0.023	0.033	0.016	0.032	0.023
Barium	mg/L	0.0368	–	0.028	0.028	0.025	0.005	0.029	0.029
Beryllium	mg/L	–	–	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.37	0.37	0.07	0.07	0.07	0.07	0.08	0.12
Cadmium	mg/L	0.0005	–	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Parameter	Units	SSGVs (GHD, 2014)	EPL 3607 limits	August 2014 (GHD, 2014)	October 2014 (GHD, 2014)		April 2015 (GHD, 2015)	May 2016	
					Pre-treatment	Post-treatment		Pre-treatment	Post-treatment
Chromium	mg/L	0.001	–	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.005	–	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.004	0.007	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Iron	mg/L	4.00	0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	mg/L	0.011	–	<0.001	<0.001	0.001	<0.001	0.001	<0.001
Manganese	mg/L	1.9	1.7	0.008	0.002	0.004	0.007	0.010	0.012
Mercury	mg/L	0.0006	–	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	–	–	0.038	0.036	0.035	0.055	0.040	0.037
Nickel	mg/L	0.025	0.047	0.004	0.002	0.004	0.003	0.004	0.003
Selenium	mg/L	0.11	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	–	–	0.03	0.028	0.018	0.005	0.019	0.019
Vanadium	mg/L	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.019	0.05	0.007	0.017	0.012	0.010	0.014	0.010
Total metals									
Aluminium	mg/L	–	–	0.19	0.24	0.24	–	0.12	0.29
Arsenic	mg/L	–	–	0.023	0.03	0.03	–	0.062	0.028

Parameter	Units	SSGVs (GHD, 2014)	EPL 3607 limits	August 2014 (GHD, 2014)	October 2014 (GHD, 2014)		April 2015 (GHD, 2015)	May 2016	
					Pre-treatment	Post-treatment		Pre-treatment	Post-treatment
Barium	mg/L	–	–	0.027	0.027	0.026	0.030	0.034	0.030
Beryllium	mg/L	–	–	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	–	–	0.06	0.07	0.07	–	0.08	0.12
Cadmium	mg/L	–	–	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	–	–	<0.001	0.001	0.005	<0.001	<0.001	<0.001
Cobalt	mg/L	–	–	<0.001	0.001	<0.001	0.001	0.005	<0.001
Copper	mg/L	–	–	0.003	0.003	<0.001	–	0.011	<0.001
Iron	mg/L	–	–	0.3	0.41	0.14	–	0.93	0.10
Lead	mg/L	–	–	<0.001	0.01	<0.001	<0.001	0.004	0.421
Manganese	mg/L	–	–	0.014	0.006	0.008	–	0.070	0.012
Mercury	mg/L	–	–	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	–	–	0.036	0.048	0.049	0.050	0.043	0.042
Nickel	mg/L	–	–	0.003	0.004	0.007	–	0.010	0.003
Selenium	mg/L	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	–	–	0.015	0.02	0.018	0.023	0.023	0.020
Vanadium	mg/L	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Parameter	Units	SSGVs (GHD, 2014)	EPL 3607 limits	August 2014 (GHD, 2014)	October 2014 (GHD, 2014)		April 2015 (GHD, 2015)	May 2016	
					Pre-treatment	Post-treatment		Pre-treatment	Post-treatment
Zinc	mg/L	–	–	0.017	0.006	<0.005	–	0.032	0.008
Other parameters									
Bromide	mg/L	–	–	0.046	0.034	0.019	–	0.027	0.012
Fluoride	mg/L	–	1.8	1.5	1.3	1.3	1.2	1.3	1.2
Oil and grease	mg/L	5	10	<5	<5	<5	<1	<5	<5
Phenols	mg/L	–	–	–	–	–	–	<0.05	<0.05
Free cyanide	mg/L	0.007	–	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Total cyanide	mg/L	–	–	<0.004	<0.004	<0.004	<0.004	0.006	<0.004

3.3 Dilution factor

The values shown in bold in Table 3.4 for the LDP009 discharge tested in May 2016 were analysed in the BurrliOZ 2.0 software package (CSIRO, 2014) and the concentration for varying species protection levels were calculated, as shown in Table 3.6. This was also performed for the LDP009 discharge tested in August 2014, as reported by GHD (2014), though it is important to note that a previous version of the BurrliOZ software was used.

As Table 3.6 shows, the LDP009 discharge in May 2016 was more toxic, and would require more dilution to reach species protection levels of 90% or greater.

Table 3.6 Dilution factors determined from ecotoxicology results

Species protection (%)	August 2014		May 2016	
	Concentration of LDP009 (%)	Dilution factor	Concentration of LDP009 (%)	Dilution factor
80	5.1	1:20	5.2	1:19
90	3.6	1:28	2.4	1:42
95	2.7	1:37	1.1	1:91
99	1.7	1:59	0.2	1:500

4. Conclusions

The results of alga and duckweed bioassays were similar in the August 2014 and May 2016 testing rounds, with the alga showing significant toxicity and the duckweed showing no toxicity. The cladoceran reproduction results have indicated chronic toxicity in all toxicity assessments for LDP009 discharge to date. The results for the cladoceran survival test in April 2015 and May 2016 show improvement from the two sets of results in 2014, with no acute toxicity detected. Comparing the water quality results indicates that the current flocculent agent and dosing rates, which were implemented between the October 2014 and April 2015 investigations, have reduced the acute toxicity of LDP009 discharge. However, chronic toxicity of the mine water discharge has not changed significantly since August 2014.

The water quality results for LDP009 discharge do not indicate any parameters that are present in significant concentrations that could cause the significant toxicity observed in the ecotoxicology results. The May 2016 water quality results showed that there were no exceedances of the SSGVs for dissolved metals, indicating that metals are unlikely to be the cause of the observed toxicity. An ionic imbalance is a potential cause of the variability in toxicity testing results observed, which may result from the composition and concentration of anions and cations in the groundwater. Toxicity associated with ionic imbalance occurs when the concentration and/or ratio of ions is not within the physiological tolerance range of test organisms. Generally, chronic toxicity end points such as growth and reproduction are more sensitive to the energy expending requirements of osmoregulation associated with ionic imbalances than the acute toxicity end point of survival.

5. References

ANZECC (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, National Water Quality Management Strategy, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Bailey, H. C., Krassoi, R., Elphick, J. R., Mulhall, A., Hunt, P., Tedmanson, L. and Lovell, A. (2000), Application of *Ceriodaphnia dubia* for whole effluent ecotoxicity tests in the Hawkesbury-Nepean watershed, New South Wales, Australia: method development and validation, *Environmental Toxicology and Chemistry*, 19(1):88–93.

CSIRO (2014), BurrliOZ 2.0 software. Available at: https://research.csiro.au/software/burrlioz/

GHD (2014), *Coxs River Ecotoxicology Assessment*, prepared for Centennial Coal Company Limited.

GHD (2015), *Springvale Mine Ecotoxicology Assessment of Treated Water*, prepared for Springvale Coal Pty Ltd.

OECD (2006), *OECD Guidelines for the Testing of Chemicals,* Organisation for Economic Co-operation and Development.

Riethmuller N., Camilleri C., Franklin N., Hogan A.C., King A., Koch A., Markich S.J., Turley C., van Dam R.A. (2003), Ecotoxicological testing protocols for Australian tropical freshwater ecosystems, Supervising Scientist Report 173, Supervising Scientist, Darwin, NT, Australia.

USEPA (2002), Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. 4th Ed. United States Environmental Protection Agency, Office of Water, Washington DC.

Warne M.StJ., Batley G.E., van Dam R.A., Chapman J.C., Fox D.R., Hickey C.W. and Stauber J.L. (2014), *Revised Method for Deriving Australian and New Zealand Water Quality Guideline Values for Toxicants*, prepared for the Council of Australian Government's Standing Council of Environment and Water.

Appendices

Appendix A – Ecotoxicology report

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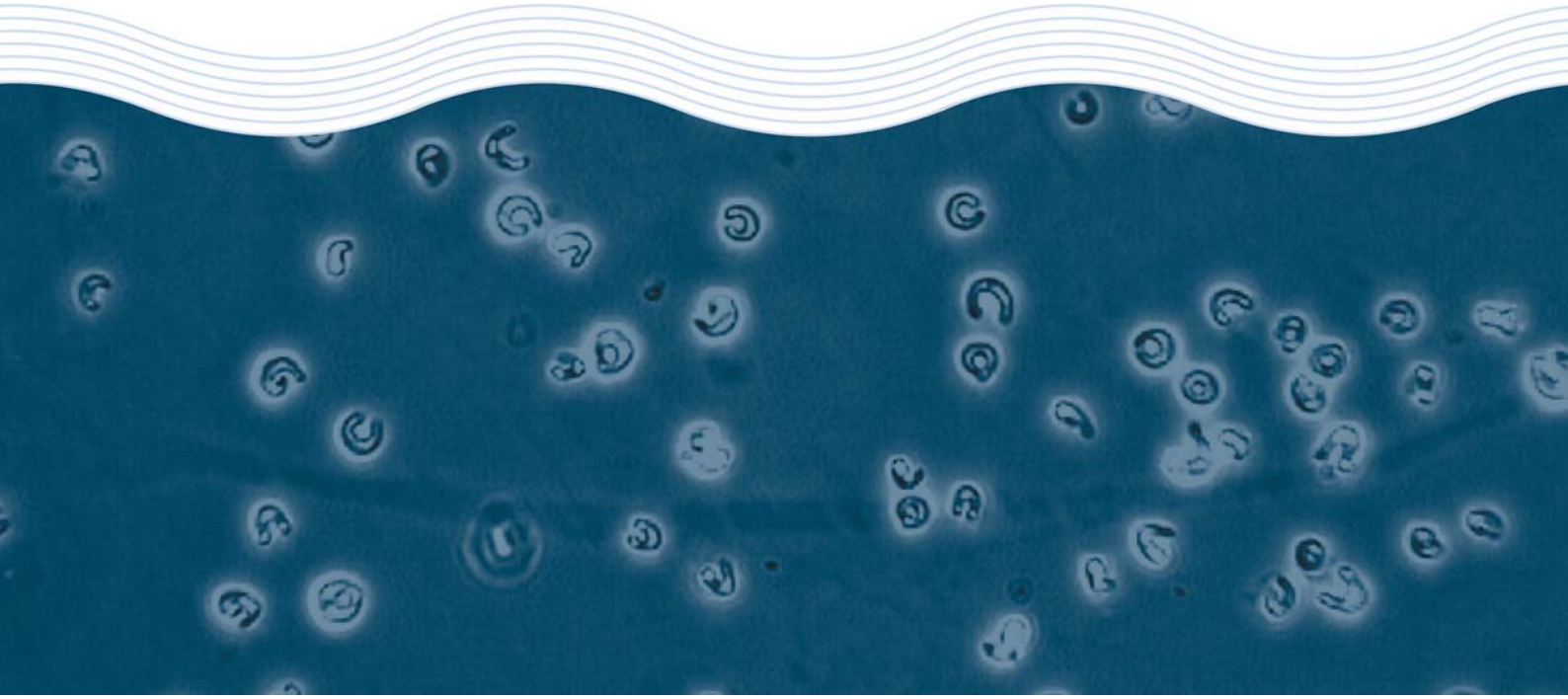
SERVICES AUSTRALASIA

Toxicity Assessment of Two Freshwater Samples from Centennial Coal

GHD Pty Ltd

Test Report

May 2016



Toxicity Test Report: TR1387/1

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1387
	GHD Tower, 24 Honeysckle Drive	**Date Sampled:**	3 & 4 May 2016
	Newcastle NSW 2300	**Date Received:**	4 May 2016
Attention:	Lachlan Hammersley	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1387_q01

Lab ID No.:	Sample Name:	Sample Description:
7641	LDP006 SCS	Aqueous sample, pH 7.1*, conductivity 4880µS/cm*, total ammonia <2.0mg/L*. Sample received at 10.5ºC* in apparent good condition.
7642	LDP009 SV	Aqueous sample, pH 8.1*, conductivity 1204µS/cm*, total ammonia <2.0mg/L*. Sample received at 10.5ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	Partial life-cycle toxicity test using the freshwater cladoceran *Ceriodaphnia cf dubia*
Test Protocol:	ESA SOP 102 (ESA 2015), based on USEPA (2002) and Bailey *et al*. (2000)
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	The test was extended to 8 days
Comments on Solution Preparation:	The samples were serially diluted with Dilute Mineral Water (DMW) to achieve the test concentrations. A DMW control was tested concurrently with the samples.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	5 May 2016 at 1300h

Sample 7641: *LDP006 SCS*

Concentration (%)	% Unaffected at 8 days (Mean ± SD)	
DMW Control	88.9 ± 33.3	
3.1	80.0 ± 42.2	
6.3	70.0 ± 48.3	
12.5	10.0 ± 31.6	*
25	0.0 ± 0.0	
50	0.0 ± 0.0	
100	0.0 ± 0.0	

8 day EC10 (unaffected) = 5.7%***
8 day EC50 (unaffected) = 8.6 (3.34-11.86)%
NOEC = 6.3%
LOEC = 12.5%

Sample 7641: *LDP006 SCS*

Concentration (%)	Number of Young (Mean ± SD)	
DMW Control	19.6 ± 7.6	
3.1	2.3 ± 1.6	**
6.3	1.3 ± 1.1	**
12.5	0.0 ± 0.0	
25	0.0 ± 0.0	
50	0.0 ± 0.0	
100	0.0 ± 0.0	

8 day IC10 (reproduction) = <3.1%
8 day IC50 (reproduction) = <3.1%
NOEC = <3.1%
LOEC = 3.1%

*Significantly lower percent unaffected compared with the DMW Control (Fisher's Exact Test, 1-tailed, P=0.05)
**Significantly lower number of young compared with the DMW Control (Wilcoxon Rank Sum Test, 1-tailed, P=0.05)
***95% confidence limits are not reliable

Toxicity Test Report: TR1387/1

Sample 7642: *LDP009 SV*	
Concentration (%)	**% Unaffected at 8 days (Mean ± SD)**
DMW Control	88.9 ± 33.3
3.1	100 ± 0.0
6.3	90.0 ± 31.6
12.5	90.0 ± 31.6
25	80.0 ± 42.2
50	90.0 ± 31.6
100	80.0 ± 42.2

8 day IC10 (unaffected) = 50.0%*
8 day EC50 (unaffected) = >100%
NOEC = 100%
LOEC = >100%

Sample 7642: *LDP009 SV*		
Concentration (%)	**Number of Young (Mean ± SD)**	
DMW Control	19.6 ± 7.6	
3.1	14.1 ± 4.6	**
6.3	13.6 ± 4.3	**
12.5	13.4 ± 4.8	**
25	15.5 ± 5.4	
50	9.2 ± 4.0	**
100	0.1 ± 0.3	**

8 day IC10 (reproduction) = <3.1%
8 day IC50 (reproduction) = 47.1 (34.21-63.57)%
NOEC = 25%
LOEC = 50%

*95% confidence limits are not available
**Significantly lower number of young compared with the DMW Control (Wilcoxon Rank Sum Test, 1-tailed, P=0.05)

QA/QC Parameter	Criterion	This Test	Criterion met?
Control mean % unaffected	≥80.0%	88.9%	Yes
Control mean number of young per surviving adult	≥15.0	22	Yes
Reference Toxicant within cusum chart limits	171.4-258.5mgKCl/L	217.8mg KCl/L	Yes

Test Report Authorised by: Dr Rick Krassoi, Director on 31 May 2016

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

Bailey, H.C., Krassoi, R., Elphick, J.R., Mulhall, A., Hunt, P., Tedmanson, L. and Lovell, A. (2000) Application of *Ceriodaphnia cf. dubia* for whole effluent toxicity tests in the Hawkesbury-Nepean watershed, New South Wales, Australia: method development and validation. *Environmental Toxicology and Chemistry* 19:88-93.

ESA (2015) ESA SOP 102 – *Acute Toxicity Test Using Ceriodaphnia dubia.* Issue No 10. Ecotox Services Australasia, Sydney, NSW.

USEPA (2002) *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.4th Ed.* United States Environmental Protection Agency, Office of Water, Washington DC.

Toxicity Test Report: TR1387/2

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1387
	GHD Tower, 24 Honeysckle Drive	**Date Sampled:**	3 & 4 May 2016
	Newcastle NSW 2300	**Date Received:**	4 May 2016
Attention:	Lachlan Hammersley	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1387_q01

Lab ID No.:	Sample Name:	Sample Description:
7641	LDP006 SCS	Aqueous sample, pH 7.1*, conductivity 4880µS/cm*, total ammonia <2.0mg/L*. Sample received at 10.5ºC* in apparent good condition.
7642	LDP009 SV	Aqueous sample, pH 8.1*, conductivity 1204µS/cm*, total ammonia <2.0mg/L*. Sample received at 10.5ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	72-hr microalgal growth inhibition test using the green alga *Selenastrum capricornutum*
Test Protocol:	ESA SOP 103 (ESA 2013), based on USEPA (2002)
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	Nil
Comments on Solution Preparation:	The samples were filtered to 0.45µm and then serially diluted with USEPA media to achieve the test concentrations. A USEPA control was tested concurrently with the samples.
Source of Test Organisms:	ESA Laboratory culture, originally sourced from CSIRO Microalgal Supply Service, TAS
Test Initiated:	6 May 2016 at 1615h

Sample 7641: *LDP006 SCS*

Concentration (%)	Cell Yield x10^4 cells/mL (Mean ± SD)
USEPA Control	68.4 ± 13.2
3.1	47.7 ± 4.0 *
6.3	18.2 ± 2.1 *
12.5	10.6 ± 1.4 *
25	7.4 ± 1.3 *
50	4.4 ± 0.8 *
100	0.0 ± 0.0

72-hr IC10 = <3.1%
72-hr IC50 = 4.6 (3.65-5.32)%
NOEC = <3.1%
LOEC = 3.1%

Sample 7642: *LDP009 SV*

Concentration (%)	Cell Yield x10^4 cells/mL (Mean ± SD)
USEPA Control	68.4 ± 13.2
3.1	60.4 ± 8.4
6.3	40.1 ± 7.3 *
12.5	12.5 ± 2.1 *
25	2.3 ± 1.7 *
50	2.7 ± 1.9 *
100	0.5 ± 0.5 *

72-hr IC10 = <3.1%
72-hr IC50 = 7.6 (5.35-9.55)%
NOEC = 3.1%
LOEC = 6.3%

Vacant

*Significantly lower cell yield compared with the USEPA Control (Wilcoxon Rank Sum Test, 1-tailed, P=0.05)

Toxicity Test Report: TR1387/2

QA/QC Parameter	Criterion	This Test	Criterion met?
Control mean cell density	≥16.0x10^4 cells/mL	69.4 x10^4 cells/mL	Yes
Control coefficient of variation	<20%	19.3%	Yes
Reference Toxicant within cusum chart limits	1.4-5.5g KCl/L	2.3g KCl/L	Yes

Test Report Authorised by: Dr Rick Krassoi, Director on 31 May 2016

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

ESA (2013) *ESA SOP 103 – Green Alga, Selenastrum capricornutum, Growth Test*. Issue No 10. Ecotox Services Australasia, Sydney, NSW.

USEPA (2002) *Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms*. Fourth Edition. EPA-821-R-02-013. United States Environmental Protection Agency, Office of Research and Development, Washington DC, USA,

Toxicity Test Report: TR1387/3

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1387
	GHD Tower, 24 Honeysckle Drive	**Date Sampled:**	3 & 4 May 2016
	Newcastle NSW 2300	**Date Received:**	4 May 2016
Attention:	Lachlan Hammersley	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1387_q01

Lab ID No.:	Sample Name:	Sample Description:
7641	LDP006 SCS	Aqueous sample, pH 7.1*, conductivity 4880µS/cm*, total ammonia <2.0mg/L*. Sample received at 10.5ºC* in apparent good condition.
7642	LDP009 SV	Aqueous sample, pH 8.1*, conductivity 1204µS/cm*, total ammonia <2.0mg/L*. Sample received at 10.5ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	7-day Growth inhibition of the freshwater aquatic duckweed *Lemna disperma*
Test Protocol:	ESA SOP 112 (ESA 2014), based on ASTM (2012)
Test Temperature:	The test was performed at 25±2°C.
Deviations from Protocol:	Test volume reduced from 100ml to 15ml; Fronds per replicate reduced form 12-16 to 3; Replicates per treatment increased from 3 to 4.
Comments on Solution Preparation:	The samples were serially diluted with Swedish standard medium (SIS) to achieve the test concentrations. A SIS control was tested concurrently with the samples.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	5 May 2016 at 1400h

Sample 7641: *LDP006 SCS*		Sample 7642: *LDP009 SV*		*Vacant*
Concentration (%)	**Specific Growth Rate (Mean ± SD)**	**Concentration (%)**	**Specific Growth Rate (Mean ± SD)**	
SIS Control	0.34 ± 0.04	SIS Control	0.34 ± 0.04	
3.0	0.28 ± 0.08	3.0	0.28 ± 0.08	
6.1	0.28 ± 0.08	6.1	0.33 ± 0.02	
12.1	0.29 ± 0.07	12.1	0.34 ± 0.09	
24.2	0.28 ± 0.08	24.2	0.29 ± 0.02	
48.4	0.15 ± 0.12 *	48.4	0.25 ± 0.06	
96.8	0.00 ± 0.00	96.8	0.20 ± 0.19	
7 day IC10 = <3.0%		**7 day IC10 = 17.0%****		
7 day IC50 = 44.4 (26.27-79.19)%		**7 day IC50 = >96.8%**		
NOEC = 24.2%		**NOEC = 96.8%**		
LOEC = 48.4%		**LOEC = >96.8%**		

*Significantly lower specific growth rate compared with the SIS Control (Dunnett's Test, 1-tailed, P=0.05)
**95% confidence limits are not available

Toxicity Test Report: TR1387/3

QA/QC Parameter	Criterion	This Test	Criterion met?
Control specific growth rate	>0.275	0.337	Yes
Reference Toxicant within cusum chart limits	3.1-4.1g KCl/L	3.6g KCl/L	Yes

Test Report Authorised by: Dr Rick Krassoi, Director on 31 May 2016

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

ESA (2014) *SOP 112 – Duckweed Growth Inhibition Test.* Issue No. 5. Ecotox Services Australasia, Sydney NSW

ASTM (2012) Designation E1415. Standard Guide for Conducting Static Toxicity Tests with *Lemna gibba* G3

Toxicity Test Report: TR1387/4

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1387
	GHD Tower, 24 Honeysckle Drive	**Date Sampled:**	3 & 4 May 2016
	Newcastle NSW 2300	**Date Received:**	4 May 2016
Attention:	Lachlan Hammersley	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1387_q01

Lab ID No.:	Sample Name:	Sample Description:
7641	LDP006 SCS	Aqueous sample, pH 7.1*, conductivity 4880µS/cm*, total ammonia <2.0mg/L*. Sample received at 10.5ºC* in apparent good condition.
7642	LDP009 SV	Aqueous sample, pH 8.1*, conductivity 1204µS/cm*, total ammonia <2.0mg/L*. Sample received at 10.5ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	Rainbowfish embryo hatching test using *Melanotaenia splendida splendida*
Test Protocol:	ESA SOP 126 (2016), based on USEPA (2002), but adapted for use with native rainbowfish
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	Nil
Comments on Solution Preparation:	The samples were serially diluted with dilute mineral water (DMW) to achieve the test concentrations. A DMW control was tested concurrently with the samples.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	6 May 2016 at 1430h

Sample 7641: *LDP006 SCS*

Concentration (%)	% Unaffected (Mean ± SD)
DMW Control	100 ± 0.0
3.1	80.0 ± 16.3
6.3	85.0 ± 10.0
12.5	90.0 ± 11.6
25	81.7 ± 21.3
50	90.0 ± 20.0
100	75.8 ± 19.5

12-d EC10 = Not reliable*
12-d EC50 = >100%
NOEC = 100%
LOEC = >100%

Sample 7642: *LDP009 SV*

Concentration (%)	% Unaffected (Mean ± SD)
DMW Control	100 ± 0.0
3.1	70.0 ± 20.0
6.3	85.0 ± 19.2
12.5	65.0 ± 34.2
25	75.0 ± 19.2
50	65.0 ± 30.0
100	70.0 ± 20.0

12-d EC10 = <3.1%
12-d EC50 = >100%
NOEC = 100%
LOEC = >100%

Vacant

*IC10 is not reliable

QA/QC Parameter	Criterion	This Test	Criterion met?
Control mean % unaffected	≥80.0%	100%	Yes
Reference Toxicant within cusum chart limit	10.0-106.1µg Cu/L	27.7µg Cu/L	Yes

Toxicity Test Report: TR1387/4

Test Report Authorised by: Dr Rick Krassoi, Director on 31 May 2016

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

ESA (2016) *SOP 126- Rainbowfish Embryo Hatching Test*. Issue N°5. Ecotox Services Australasia, Sydney NSW

USEPA (2002) *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.4th Ed.* United States Environmental Protection Agency, Office of Water, Washington DC.

Toxicity Test Report: TR1387/5

Client:	GHD Pty Ltd	**ESA Job #:**	PR1387
	GHD Tower, 24 Honeysckle Drive	**Date Sampled:**	3 & 4 May 2016
	Newcastle NSW 2300	**Date Received:**	4 May 2016
Attention:	Lachlan Hammersley	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1387_q01

Lab ID No.:	Sample Name:	Sample Description:
7641	LDP006 SCS	Aqueous sample, pH 7.1, conductivity 4880µS/cm, total ammonia <2.0mg/L. Sample received at 10.5ºC in apparent good condition.
7642	LDP009 SV	Aqueous sample, pH 8.1, conductivity 1204µS/cm, total ammonia <2.0mg/L. Sample received at 10.5ºC in apparent good condition.

Test Performed:	10 day acute survival test using the freshwater shrimp *Paratya australiensis*
Test Protocol:	ESA SOP 123 (ESA 2016), based on USEPA (1996)
Test Temperature:	The test was performed at 20±1°C.
Deviations from Protocol:	The test was extended to 10 days, as per client's request. The test solutions were renewed every 48 hours, with the organisms fed 3 hours prior to solution renewal.
Comments on Solution Preparation:	The samples were serially diluted with dilute mineral water (DMW) to achieve the test concentrations. A DMW control was tested concurrently with the samples.
Source of Test Organisms:	Hatchery reared, QLD
Test Initiated:	5 May 2016 at 1500h

Sample 7641: *LDP006 SCS*

Concentration (%)	% Unaffected (Mean ± SD)
DMW Control	90.0 ± 11.6
3.1	95.0 ± 10.0
6.3	100 ± 0.0
12.5	100 ± 0.0
25	95.0 ± 10.0
50	100 ± 0.0
100	100 ± 0.0

10-d EC10 = >100%
10-d EC50 = >100%
NOEC = 100%
LOEC = >100%

Sample 7642: *LDOP009 SV*

Concentration (%)	% Unaffected (Mean ± SD)
DMW Control	90.0 ± 11.6
3.1	85.0 ± 19.2
6.3	100 ± 0.0
12.5	100 ± 0.0
25	60.0 ± 0.0 *
50	0.0 ± 0.0
100	0.0 ± 0.0

10-d IC10 = 17.1 (12.72-19.72)%
10-d EC50 = 27.5 (23.74-31.97)%
NOEC = 12.5%
LOEC = 25%

Vacant

*Significantly lower percentage of unaffected shrimp compared with the DMW Control (Steel's Many One Rank Test, 1-tailed, P=0.05)

QA/QC Parameter	Criterion	This Test	Criterion met?
10-d Control mean % affected	≥90.0%	90.0%	Yes
96-hr Control mean % unaffected	≥90.0%	100%	Yes
96-hr Reference Toxicant within cusum chart limits	37.9-576.9µg Cu/L	192.4µg Cu/L	Yes

Toxicity Test Report: TR1387/5

Test Report Authorised by: Dr Rick Krassoi, Director on 31 May 2016

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

Citations:

ESA (2016) SOP 123 –*Acute Toxicity Test Using Freshwater Shrimp.* Issue No 2. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) Ecological Effects Test Guidelines: OPPTS 850.1035 Mysid Acute Toxicity Test. Public Draft. United States Environmental Protection Agency, Washington DC, USA.

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SERVICES AUSTRALASIA

Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 30 April 2009

Sample Receipt Notification

Attention : Lachlan Hammersley

Client : GHD Pty Ltd
GHD Tower, 24 Honeysuckle Drive
Newcastle NSW 2300

Email : lachlan.hammersley@ghd.com
Telephone : 02 4979 9040
Facsimile :

Date : 4/05/2016

Re : Receipt of Samples **Pages :** **2**

ESA Project : PR1387 ☑ For Review ☐ Additional Documentation Required - Please Respond

Sample Delivery Details

Completed Chain of Custody accompanied samples: **YES**
Samples received in apparent good condition and correctly bottled: **YES**
Security seals on sample bottles and esky intact: **YES**

Date samples received : 4/05/2016
Time samples received : 16:00
No. of samples received : 2
Sample matrix : Aqueous
Sample temperature : 10.5°C

Comments : Includes 4x5L LDP009 SCS (ESA ID# 7641) and 4x5L LDP009 SV (ESA ID# 7642)

Contact Details

Projects Manager : Tina Micevska
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : tmicevska@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

Note that the chain-of-custody provides definitive information on the tests to be performed

Ecotox Services Australia
ABN 45 094 714 904
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 15 July 2014

ecotox SERVICES AUSTRALASIA

Customer: GHD PTY LTD - NEWCASTLE
Contact Name: LACHLAN HAMMERSLEY
Phone: (02) 4979040 Email: ljhammersley@ghd.com (please provide an email address for sample receipt notification)
Sampled by: LACHLAN HAMMERSLEY

Ship To: ecotox services australasia.
Attention:

Sample Date (day/month /year)	Sample Time	Sample Name (exactly as written on the sample vessel)	Sample Method (eg. Grab, composite etc.)	Number and Volume of Containers (eg 2 x 1L)	Tests Requested (See reverse for guidance)						Comments / Instructions
					ALGAL GROWTH SC	CHRONIC ECHO	DUCKWEED LD	EMBRYO FISH	ACUTE SHRIMP		**Note that testing will be delayed if an incomplete chain of custody is received** • Additional treatment of samples (i.e. spiking) • Sub-contracted services (i.e. chemical analyses) • Dilutions required (if different than 100% down to 6.25%) • Sample holding time restriction (if applicable) • Sample used for litigation (if applicable) *Note: An MSDS must be attached if Available* **ESA Project Number: PR** 1387
4/5/16	9:30am	LDP006 SCS	Grab	4x1OL	X	X	X	X	X		
3/5/16	3:30pm	LDP009 SV	Grab	4x1OL	X	X	X	X	X		

7641
7642
10.5°C

1) Released By:	Date:	2) Received By:	Date:	3) Released By:	Date:	4) Received By:	Date:
LACHLAN HAMM.		T.M	4/5/16				
Of: GHD.	Time:	Of: ESA	Time: 1600	Of:	Time:	Of:	Time:

Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.

Ecotox Services Australasia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

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SERVICES AUSTRALASIA

Statistical Printouts for the 7-d Chronic Test with *Ceriodaphnia dubia*

Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	5/05/2016 13:00	Test ID:	PR1387/11	Sample ID:	LDP006 SCS
End Date:	13/05/2016 09:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	22.000	21.000	23.000	24.000	18.000	25.000	20.000	23.000	0.000	
3.1	2.000	1.000	0.000	3.000	4.000	0.000	2.000	3.000	4.000	4.000
6.3	0.000	2.000	0.000	3.000	2.000	1.000	2.000	2.000	0.000	1.000
12.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
DMW Control	19.556	1.0000	19.5556	0.0000	25.0000	39.037	9			19.556	1.0000
*3.1	2.300	0.1176	2.3000	0.0000	4.0000	68.131	10	64.00	75.00	2.300	0.1176
*6.3	1.300	0.0665	1.3000	0.0000	3.0000	81.488	10	63.50	75.00	1.300	0.0665
12.5	0.000	0.0000	0.0000	0.0000	0.0000	0.000	10			0.000	0.0000
25	0.000	0.0000	0.0000	0.0000	0.0000	0.000	10			0.000	0.0000
50	0.000	0.0000	0.0000	0.0000	0.0000	0.000	10			0.000	0.0000
100	0.000	0.0000	0.0000	0.0000	0.0000	0.000	10			0.000	0.0000

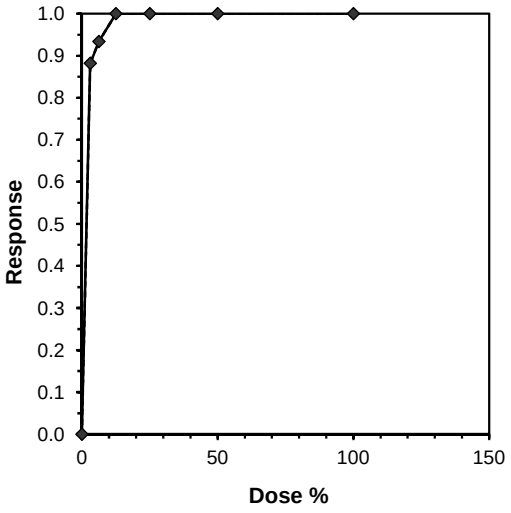
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.626004	0.926	-3.64943	17.31484
Bartlett's Test indicates unequal variances (p = 5.53E-08)	33.42246	9.21034		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	<3.1	3.1		
Treatments vs DMW Control				

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL		Skew
IC05*	0.1757	0.0055	0.1666	0.1872	0.5446
IC10*	0.3513	0.0111	0.3331	0.3744	0.5446
IC15*	0.5270	0.0166	0.4997	0.5616	0.5446
IC20*	0.7026	0.0221	0.6663	0.7488	0.5446
IC25*	0.8783	0.0277	0.8328	0.9361	0.5446
IC40*	1.4053	0.0443	1.3325	1.4977	0.5446
IC50*	1.7566	0.0554	1.6656	1.8721	0.5446

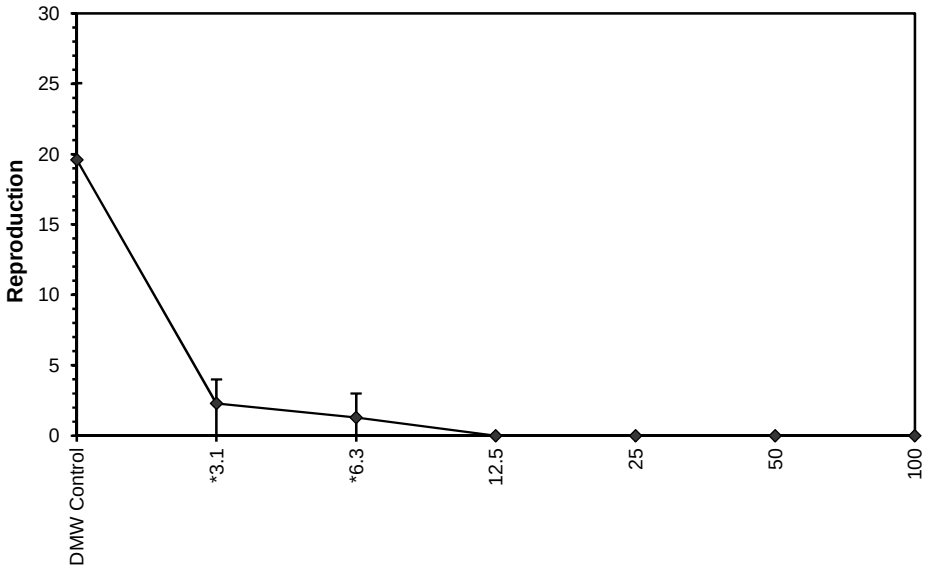
* indicates IC estimate less than the lowest concentration



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	5/05/2016 13:00	Test ID:	PR1387/11	Sample ID:	LDP006 SCS
End Date:	13/05/2016 09:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	5/05/2016 13:00	Test ID:	PR1387/11	Sample ID:	LDP006 SCS
End Date:	13/05/2016 09:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	19.56	0.00	25.00	7.63	14.13	9
3.1		2.30	0.00	4.00	1.57	54.43	10
6.3		1.30	0.00	3.00	1.06	79.17	10
12.5		0.00	0.00	0.00	0.00		10
25		0.00	0.00	0.00	0.00		10
50		0.00	0.00	0.00	0.00		10
100		0.00	0.00	0.00	0.00		10
DMW Control	% unaffected	88.89	0.00	100.00	33.33	6.50	9
3.1		80.00	0.00	100.00	42.16	8.12	10
6.3		70.00	0.00	100.00	48.30	9.93	10
12.5		10.00	0.00	100.00	31.62	56.23	10
25		0.00	0.00	0.00	0.00		10
50		0.00	0.00	0.00	0.00		10
100		0.00	0.00	0.00	0.00		10
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		8.10	8.10	8.10	0.00	0.00	1
6.3		8.00	8.00	8.00	0.00	0.00	1
12.5		8.00	8.00	8.00	0.00	0.00	1
25		7.90	7.90	7.90	0.00	0.00	1
50		7.70	7.70	7.70	0.00	0.00	1
100		7.30	7.30	7.30	0.00	0.00	1
DMW Control	DO %	98.20	98.20	98.20	0.00	0.00	1
3.1		99.80	99.80	99.80	0.00	0.00	1
6.3		100.40	100.40	100.40	0.00	0.00	1
12.5		100.30	100.30	100.30	0.00	0.00	1
25		100.70	100.70	100.70	0.00	0.00	1
50		101.30	101.30	101.30	0.00	0.00	1
100		101.10	101.10	101.10	0.00	0.00	1
DMW Control	Cond uS/cm	190.50	190.50	190.50	0.00	0.00	1
3.1		366.00	366.00	366.00	0.00	0.00	1
6.3		546.00	546.00	546.00	0.00	0.00	1
12.5		894.00	894.00	894.00	0.00	0.00	1
25		1526.00	1526.00	1526.00	0.00	0.00	1
50		2760.00	2760.00	2760.00	0.00	0.00	1
100		4810.00	4810.00	4810.00	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-8 Day Unaffected

Start Date:	5/05/2016 13:00	Test ID:	PR1387/11	Sample ID:	LDP006 SCS
End Date:	13/05/2016 09:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	
3.1	1.0000	1.0000	1.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000
6.3	0.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000
12.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

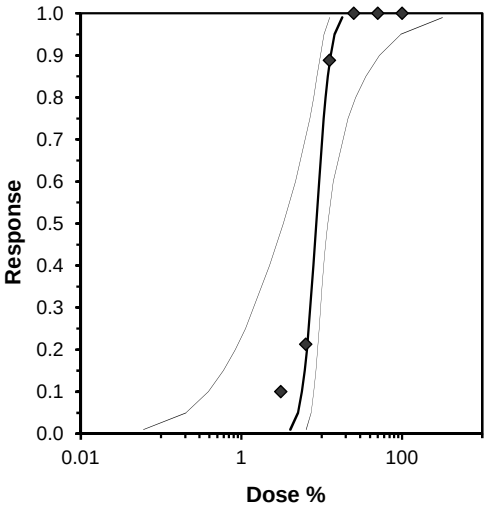
Conc-%	Mean	N-Mean	Resp	Not Resp	Total	N	Fisher's Exact P	1-Tailed Critical	Number Resp	Total Number
DMW Control	0.8889	1.0000	1	8	9	9			1	9
3.1	0.8000	0.9000	2	8	10	10	0.5418	0.0500	2	10
6.3	0.7000	0.7875	3	7	10	10	0.3328	0.0500	3	10
*12.5	0.1000	0.1125	9	1	10	10	0.0010	0.0500	9	10
25	0.0000	0.0000	10	0	10	10			10	10
50	0.0000	0.0000	10	0	10	10			10	10
100	0.0000	0.0000	10	0	10	10			10	10

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Fisher's Exact Test	6.3	12.5	8.87412	15.87302
Treatments vs DMW Control				

Maximum Likelihood-Probit

Parameter	Value	SE	95% Fiducial Limits		Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Slope	7.202966	3.026549	1.27093	13.135	0.111111	0.136157	9.487729	1	0.932094	0.138832	6
Intercept	-1.71384	2.997007	-7.58798	4.160292							
TSCR	0.157367	0.084237	-0.00774	0.322472							

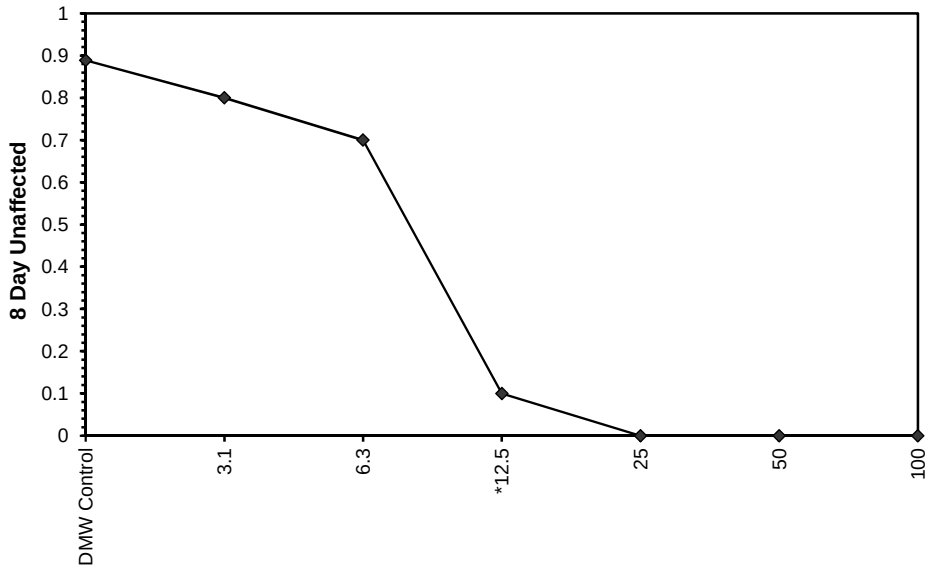
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	4.065587	0.060446	6.432191
EC05	3.355	5.055176	0.204099	7.378775
EC10	3.718	5.677722	0.38839	7.981257
EC15	3.964	6.140508	0.597318	8.446199
EC20	4.158	6.535072	0.838273	8.86331
EC25	4.326	6.893718	1.117504	9.267435
EC40	4.747	7.887175	2.253833	10.61
EC50	5.000	8.55252	3.335569	11.86029
EC60	5.253	9.273992	4.71889	13.86926
EC75	5.674	10.61047	7.141233	21.16159
EC80	5.842	11.19278	7.948035	26.50264
EC85	6.036	11.91198	8.755217	35.43209
EC90	6.282	12.88291	9.622032	52.4715
EC95	6.645	14.46945	10.73456	96.81005
EC99	7.326	17.9914	12.63174	318.6713



Ceriodaphnia Partial Life-Cycle Test-8 Day Unaffected

Start Date:	5/05/2016 13:00	Test ID:	PR1387/11	Sample ID:	LDP006 SCS
End Date:	13/05/2016 09:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-8 Day Unaffected

Start Date:	5/05/2016 13:00	Test ID:	PR1387/11	Sample ID:	LDP006 SCS
End Date:	13/05/2016 09:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	19.56	0.00	25.00	7.63	14.13	9
3.1		2.30	0.00	4.00	1.57	54.43	10
6.3		1.30	0.00	3.00	1.06	79.17	10
12.5		0.00	0.00	0.00	0.00		10
25		0.00	0.00	0.00	0.00		10
50		0.00	0.00	0.00	0.00		10
100		0.00	0.00	0.00	0.00		10
DMW Control	% unaffected	88.89	0.00	100.00	33.33	6.50	9
3.1		80.00	0.00	100.00	42.16	8.12	10
6.3		70.00	0.00	100.00	48.30	9.93	10
12.5		10.00	0.00	100.00	31.62	56.23	10
25		0.00	0.00	0.00	0.00		10
50		0.00	0.00	0.00	0.00		10
100		0.00	0.00	0.00	0.00		10
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		8.10	8.10	8.10	0.00	0.00	1
6.3		8.00	8.00	8.00	0.00	0.00	1
12.5		8.00	8.00	8.00	0.00	0.00	1
25		7.90	7.90	7.90	0.00	0.00	1
50		7.70	7.70	7.70	0.00	0.00	1
100		7.30	7.30	7.30	0.00	0.00	1
DMW Control	DO %	98.20	98.20	98.20	0.00	0.00	1
3.1		99.80	99.80	99.80	0.00	0.00	1
6.3		100.40	100.40	100.40	0.00	0.00	1
12.5		100.30	100.30	100.30	0.00	0.00	1
25		100.70	100.70	100.70	0.00	0.00	1
50		101.30	101.30	101.30	0.00	0.00	1
100		101.10	101.10	101.10	0.00	0.00	1
DMW Control	Cond uS/cm	190.50	190.50	190.50	0.00	0.00	1
3.1		366.00	366.00	366.00	0.00	0.00	1
6.3		546.00	546.00	546.00	0.00	0.00	1
12.5		894.00	894.00	894.00	0.00	0.00	1
25		1526.00	1526.00	1526.00	0.00	0.00	1
50		2760.00	2760.00	2760.00	0.00	0.00	1
100		4810.00	4810.00	4810.00	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	5/05/2016 13:00	Test ID:	PR1387/12	Sample ID:	LDP009 SV
End Date:	13/05/2016 09:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	22.000	21.000	23.000	24.000	18.000	25.000	20.000	23.000	0.000	
3.1	21.000	17.000	18.000	10.000	14.000	16.000	13.000	16.000	5.000	11.000
6.3	20.000	10.000	10.000	9.000	11.000	17.000	21.000	14.000	12.000	12.000
12.5	13.000	19.000	11.000	19.000	3.000	15.000	10.000	16.000	12.000	16.000
25	22.000	15.000	12.000	23.000	22.000	11.000	16.000	16.000	8.000	10.000
50	4.000	14.000	8.000	7.000	14.000	13.000	6.000	9.000	13.000	4.000
100	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
DMW Control	19.556	1.0000	19.5556	0.0000	25.0000	39.037	9			19.556	1.0000
*3.1	14.100	0.7210	14.1000	5.0000	21.0000	32.492	10	68.00	70.00	14.150	0.7236
*6.3	13.600	0.6955	13.6000	9.0000	21.0000	31.617	10	69.00	70.00	14.150	0.7236
*12.5	13.400	0.6852	13.4000	3.0000	19.0000	35.738	10	67.00	70.00	14.150	0.7236
25	15.500	0.7926	15.5000	8.0000	23.0000	34.710	10	77.00	70.00	14.150	0.7236
*50	9.200	0.4705	9.2000	4.0000	14.0000	43.719	10	65.00	70.00	9.200	0.4705
*100	0.100	0.0051	0.1000	0.0000	1.0000	316.228	10	60.50	70.00	0.100	0.0051

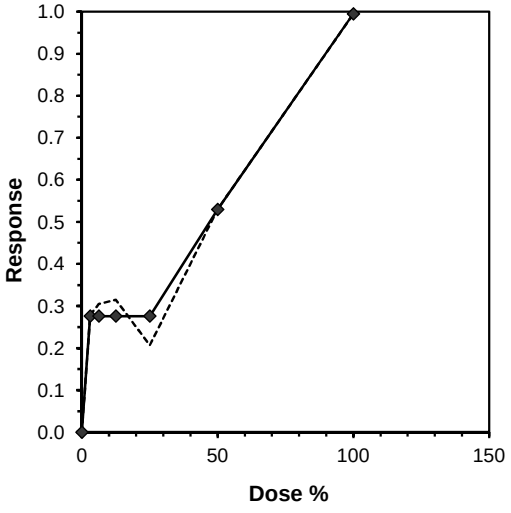
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.05)	0.792388	0.895	-1.1885	3.778205
Bartlett's Test indicates unequal variances (p = 7.70E-08)	43.91195	16.81189		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	25	50	35.35534	4
Treatments vs DMW Control				

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL		Skew
IC05*	0.561	5.060	0.387	26.540	4.8736
IC10*	1.121	6.973	0.774	30.008	3.4816
IC15*	1.682	8.625	1.161	33.497	2.8327
IC20*	2.243	11.306	1.548	36.766	1.8128
IC25*	2.804	13.944	1.936	40.489	1.0310
IC40	37.205	12.763	3.097	56.202	-0.8142
IC50	47.082	7.724	34.208	63.573	0.2772

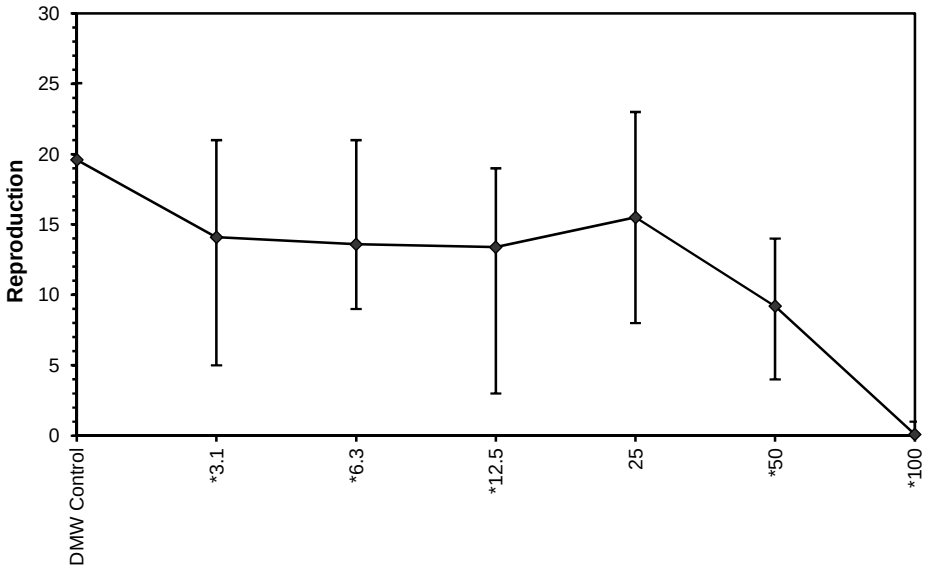
* indicates IC estimate less than the lowest concentration



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	5/05/2016 13:00	Test ID:	PR1387/12	Sample ID:	LDP009 SV
End Date:	13/05/2016 09:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	5/05/2016 13:00	Test ID:	PR1387/12	Sample ID:	LDP009 SV
End Date:	13/05/2016 09:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	19.56	0.00	25.00	7.63	14.13	9
3.1		14.10	5.00	21.00	4.58	15.18	10
6.3		13.60	9.00	21.00	4.30	15.25	10
12.5		13.40	3.00	19.00	4.79	16.33	10
25		15.50	8.00	23.00	5.38	14.96	10
50		9.20	4.00	14.00	4.02	21.80	10
100		0.10	0.00	1.00	0.32	562.34	10
DMW Control	% unaffected	88.89	0.00	100.00	33.33	6.50	9
3.1		100.00	100.00	100.00	0.00	0.00	10
6.3		90.00	0.00	100.00	31.62	6.25	10
12.5		90.00	0.00	100.00	31.62	6.25	10
25		80.00	0.00	100.00	42.16	8.12	10
50		90.00	0.00	100.00	31.62	6.25	10
100		80.00	0.00	100.00	42.16	8.12	10
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		8.20	8.20	8.20	0.00	0.00	1
6.3		8.20	8.20	8.20	0.00	0.00	1
12.5		8.20	8.20	8.20	0.00	0.00	1
25		8.30	8.30	8.30	0.00	0.00	1
50		8.30	8.30	8.30	0.00	0.00	1
100		8.20	8.20	8.20	0.00	0.00	1
DMW Control	DO %	98.20	98.20	98.20	0.00	0.00	1
3.1		97.30	97.30	97.30	0.00	0.00	1
6.3		98.20	98.20	98.20	0.00	0.00	1
12.5		99.30	99.30	99.30	0.00	0.00	1
25		98.70	98.70	98.70	0.00	0.00	1
50		98.40	98.40	98.40	0.00	0.00	1
100		99.70	99.70	99.70	0.00	0.00	1
DMW Control	Cond uS/cm	190.50	190.50	190.50	0.00	0.00	1
3.1		222.00	222.00	222.00	0.00	0.00	1
6.3		251.00	251.00	251.00	0.00	0.00	1
12.5		318.00	318.00	318.00	0.00	0.00	1
25		449.00	449.00	449.00	0.00	0.00	1
50		706.00	706.00	706.00	0.00	0.00	1
100		1213.00	1213.00	1213.00	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-8 Day Unaffected

Start Date:	5/05/2016 13:00	Test ID:	PR1387/12	Sample ID:	LDP009 SV
End Date:	13/05/2016 09:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

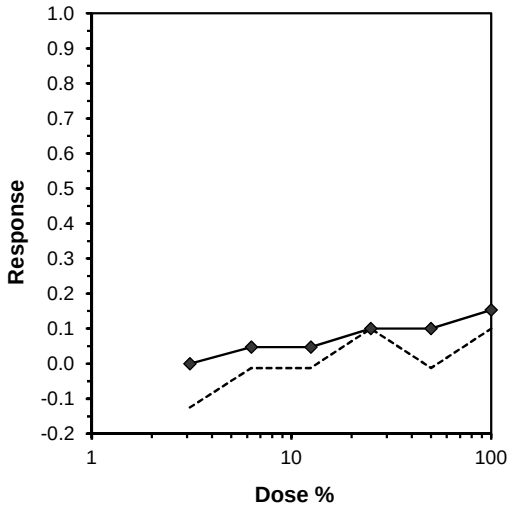
Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	
3.1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6.3	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000
25	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000
50	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
100	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000

Conc-%	Mean	N-Mean	Resp	Not Resp	Total	N	Fisher's Exact P	1-Tailed Critical	Isotonic Mean	Isotonic N-Mean
DMW Control	0.8889	1.0000	1	8	9	9			0.9444	1.0000
3.1	1.0000	1.1250	0	10	10	10	0.4737	0.0500	0.9444	1.0000
6.3	0.9000	1.0125	1	9	10	10	0.7368	0.0500	0.9000	0.9529
12.5	0.9000	1.0125	1	9	10	10	0.7368	0.0500	0.9000	0.9529
25	0.8000	0.9000	2	8	10	10	0.5418	0.0500	0.8500	0.9000
50	0.9000	1.0125	1	9	10	10	0.7368	0.0500	0.8500	0.9000
100	0.8000	0.9000	2	8	10	10	0.5418	0.0500	0.8000	0.8471

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Fisher's Exact Test	100	>100		1
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

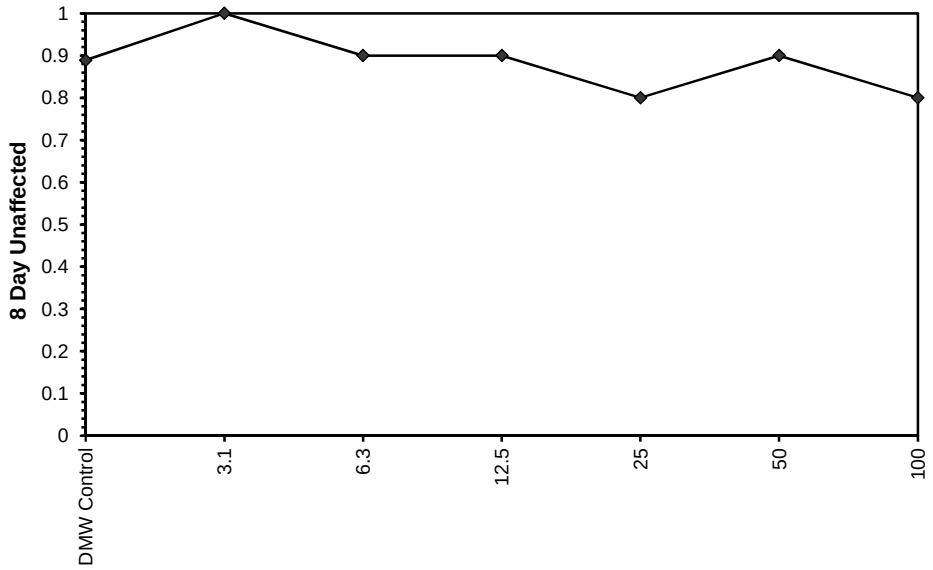
Point	%	SD	95% CL	Skew
IC05	13.096			
IC10	50.000			
IC15	96.601			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			



Ceriodaphnia Partial Life-Cycle Test-8 Day Unaffected

Start Date:	5/05/2016 13:00	Test ID:	PR1387/12	Sample ID:	LDP009 SV
End Date:	13/05/2016 09:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-8 Day Unaffected

Start Date:	5/05/2016 13:00	Test ID:	PR1387/12	Sample ID:	LDP009 SV
End Date:	13/05/2016 09:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	19.56	0.00	25.00	7.63	14.13	9
3.1		14.10	5.00	21.00	4.58	15.18	10
6.3		13.60	9.00	21.00	4.30	15.25	10
12.5		13.40	3.00	19.00	4.79	16.33	10
25		15.50	8.00	23.00	5.38	14.96	10
50		9.20	4.00	14.00	4.02	21.80	10
100		0.10	0.00	1.00	0.32	562.34	10
DMW Control	% unaffected	88.89	0.00	100.00	33.33	6.50	9
3.1		100.00	100.00	100.00	0.00	0.00	10
6.3		90.00	0.00	100.00	31.62	6.25	10
12.5		90.00	0.00	100.00	31.62	6.25	10
25		80.00	0.00	100.00	42.16	8.12	10
50		90.00	0.00	100.00	31.62	6.25	10
100		80.00	0.00	100.00	42.16	8.12	10
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		8.20	8.20	8.20	0.00	0.00	1
6.3		8.20	8.20	8.20	0.00	0.00	1
12.5		8.20	8.20	8.20	0.00	0.00	1
25		8.30	8.30	8.30	0.00	0.00	1
50		8.30	8.30	8.30	0.00	0.00	1
100		8.20	8.20	8.20	0.00	0.00	1
DMW Control	DO %	98.20	98.20	98.20	0.00	0.00	1
3.1		97.30	97.30	97.30	0.00	0.00	1
6.3		98.20	98.20	98.20	0.00	0.00	1
12.5		99.30	99.30	99.30	0.00	0.00	1
25		98.70	98.70	98.70	0.00	0.00	1
50		98.40	98.40	98.40	0.00	0.00	1
100		99.70	99.70	99.70	0.00	0.00	1
DMW Control	Cond uS/cm	190.50	190.50	190.50	0.00	0.00	1
3.1		222.00	222.00	222.00	0.00	0.00	1
6.3		251.00	251.00	251.00	0.00	0.00	1
12.5		318.00	318.00	318.00	0.00	0.00	1
25		449.00	449.00	449.00	0.00	0.00	1
50		706.00	706.00	706.00	0.00	0.00	1
100		1213.00	1213.00	1213.00	0.00	0.00	1

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Statistical Printouts for the *Selenastrum* Growth Inhibition Tests

Microalgal Cell Yield-Cell Yield

Start Date:	6/05/2016 16:15	Test ID:	PR1387/05	Sample ID:	LDP006 SCS
End Date:	9/05/2016 16:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 103	Test Species:	SC-Selenastrum capricornutum
Comments:					

Conc-%	1	2	3	4	5	6	7	8
USEPA Control	52.724	63.524	78.224	93.824	58.124	66.224	60.524	74.024
3.1	46.124	50.924	42.824	50.924				
6.3	15.824	17.924	20.924	18.224				
12.5	12.224	11.024	8.924	10.124				
25	7.424	8.624	5.624	8.024				
50	4.724	4.724	3.224	5.024				
100	0.000	0.000	0.000	0.000				

			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
USEPA Control	68.399	1.0000	68.399	52.724	93.824	19.273	8			68.399	1.0000
*3.1	47.699	0.6974	47.699	42.824	50.924	8.302	4	10.00	12.00	47.699	0.6974
*6.3	18.224	0.2664	18.224	15.824	20.924	11.484	4	10.00	12.00	18.224	0.2664
*12.5	10.574	0.1546	10.574	8.924	12.224	13.207	4	10.00	12.00	10.574	0.1546
*25	7.424	0.1085	7.424	5.624	8.624	17.460	4	10.00	12.00	7.424	0.1085
*50	4.424	0.0647	4.424	3.224	5.024	18.365	4	10.00	12.00	4.424	0.0647
100	0.000	0.0000	0.000	0.000	0.000	0.000	4			0.000	0.0000

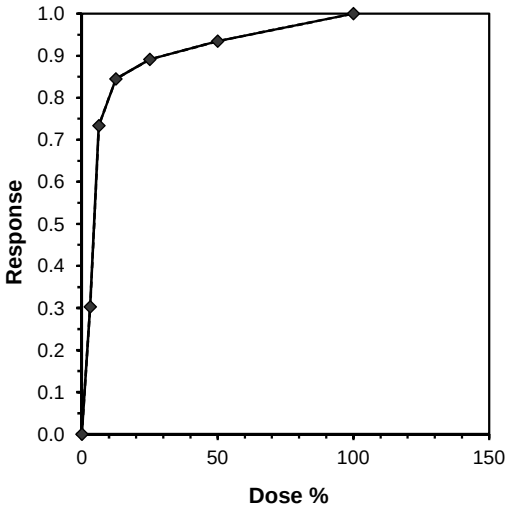
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.827174	0.924	1.445279	6.88073
Bartlett's Test indicates unequal variances (p = 1.97E-06)	34.4077	15.08627		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	<3.1	3.1		
Treatments vs USEPA Control				

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	0.5122	0.1037	0.3186	0.9842	1.2569
IC10*	1.0243	0.2074	0.6373	1.9683	1.2569
IC15*	1.5365	0.3110	0.9559	2.9525	1.2569
IC20*	2.0487	0.3815	1.2746	3.8104	0.7502
IC25*	2.5608	0.4057	1.5932	4.0065	0.0821
IC40	3.8230	0.3268	2.7205	4.7593	-0.7290
IC50	4.5656	0.2735	3.6499	5.3210	-0.9299

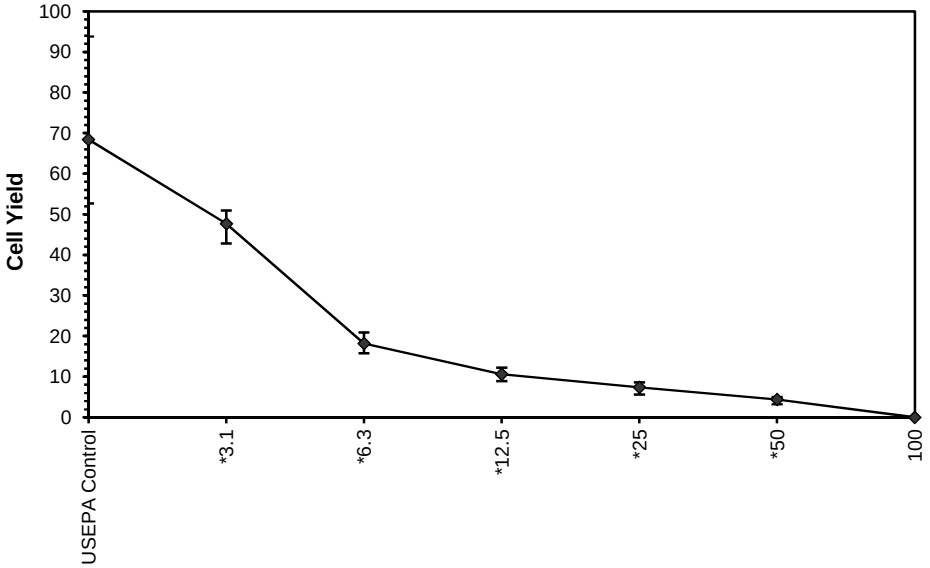
* indicates IC estimate less than the lowest concentration



Microalgal Cell Yield-Cell Yield

Start Date:	6/05/2016 16:15	Test ID:	PR1387/05	Sample ID:	LDP006 SCS
End Date:	9/05/2016 16:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 103	Test Species:	SC-Selenastrum capricornutum
Comments:					

Dose-Response Plot



Microalgal Cell Yield-Cell Yield

Start Date:	6/05/2016 16:15	Test ID:	PR1387/05	Sample ID:	LDP006 SCS
End Date:	9/05/2016 16:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 103	Test Species:	SC-Selenastrum capricornutum
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
USEPA Control	Cell Yield	68.40	52.72	93.82	13.18	5.31	8
3.1		47.70	42.82	50.92	3.96	4.17	4
6.3		18.22	15.82	20.92	2.09	7.94	4
12.5		10.57	8.92	12.22	1.40	11.18	4
25		7.42	5.62	8.62	1.30	15.34	4
50		4.42	3.22	5.02	0.81	20.38	4
100		0.00	0.00	0.00	0.00		4
USEPA Control	pH	7.40	7.40	7.40	0.00	0.00	1
3.1		7.30	7.30	7.30	0.00	0.00	1
6.3		7.30	7.30	7.30	0.00	0.00	1
12.5		7.20	7.20	7.20	0.00	0.00	1
25		7.40	7.40	7.40	0.00	0.00	1
50		7.50	7.50	7.50	0.00	0.00	1
100		7.40	7.40	7.40	0.00	0.00	1
USEPA Control	Conductivity uS/cm	97.30	97.30	97.30	0.00	0.00	1
3.1		312.00	312.00	312.00	0.00	0.00	1
6.3		506.00	506.00	506.00	0.00	0.00	1
12.5		870.00	870.00	870.00	0.00	0.00	1
25		1533.00	1533.00	1533.00	0.00	0.00	1
50		2750.00	2750.00	2750.00	0.00	0.00	1
100		4870.00	4870.00	4870.00	0.00	0.00	1

Microalgal Cell Yield-Cell Yield

Start Date:	6/05/2016 16:15	Test ID:	PR1387/06	Sample ID:	LDP009 SV
End Date:	9/05/2016 16:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 103	Test Species:	SC-Selenastrum capricornutum
Comments:					

Conc-%	1	2	3	4	5	6	7	8
USEPA Control	52.724	63.524	78.224	93.824	58.124	66.224	60.524	74.024
3.1	50.024	57.224	68.624	65.624				
6.3	50.924	35.624	36.524	37.124				
12.5	13.124	9.524	13.124	14.324				
25	4.124	2.924	1.724	0.224				
50	3.824	0.000	2.924	4.124				
100	1.124	0.824	0.000	0.224				

			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
USEPA Control	68.399	1.0000	68.399	52.724	93.824	19.273	8			68.399	1.0000
3.1	60.374	0.8827	60.374	50.024	68.624	13.946	4	20.00	12.00	60.374	0.8827
*6.3	40.049	0.5855	40.049	35.624	50.924	18.168	4	10.00	12.00	40.049	0.5855
*12.5	12.524	0.1831	12.524	9.524	14.324	16.596	4	10.00	12.00	12.524	0.1831
*25	2.249	0.0329	2.249	0.224	4.124	74.183	4	10.00	12.00	2.483	0.0363
*50	2.718	0.0397	2.718	0.000	4.124	69.257	4	10.00	12.00	2.483	0.0363
*100	0.543	0.0079	0.543	0.000	1.124	95.906	4	10.00	12.00	0.543	0.0079

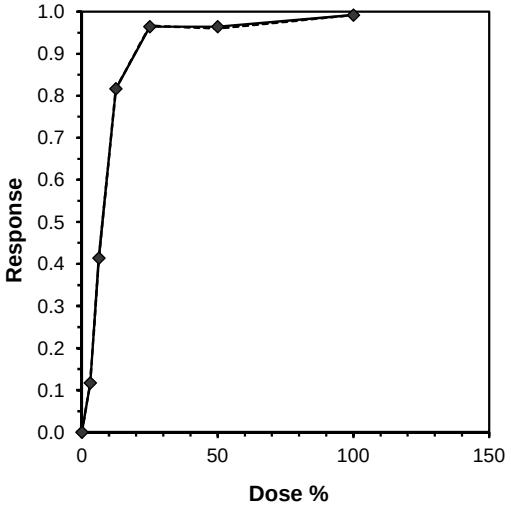
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.901526	0.93	1.153325	4.363472
Bartlett's Test indicates unequal variances (p = 1.38E-05)	32.37836	16.81189		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	3.1	6.3	4.419276	32.25806
Treatments vs USEPA Control				

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	1.3211	0.9859	0.1610	4.9830	0.6641
IC10*	2.6422	0.8781	0.3220	5.0060	-0.2849
IC15	3.4518	0.7527	0.7899	5.3470	-0.6218
IC20	3.9903	0.6872	1.4205	5.8433	-0.6667
IC25	4.5287	0.6554	2.0511	6.3751	-0.5222
IC40	6.1440	0.6574	4.4048	8.4673	0.1210
IC50	7.6176	0.6929	5.3479	9.5527	-0.2797

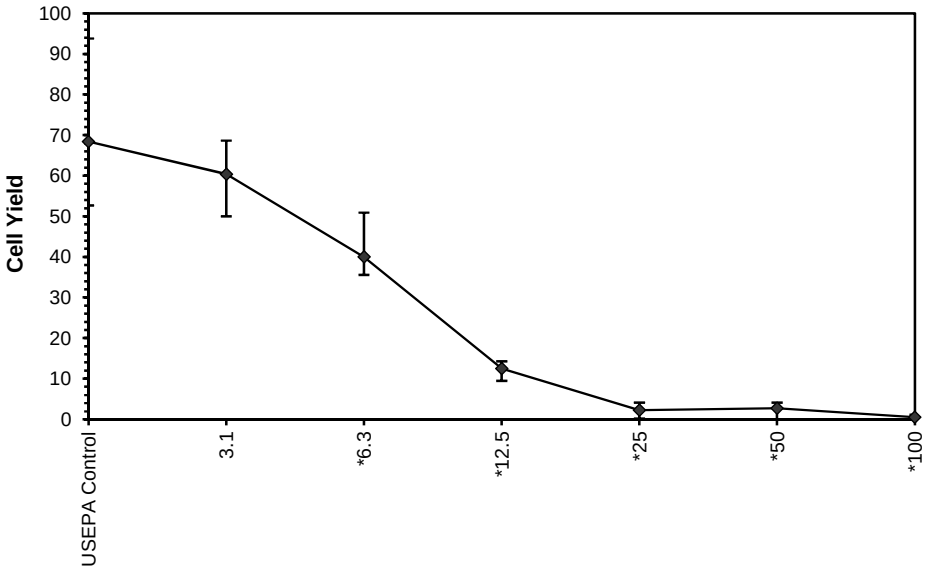
* indicates IC estimate less than the lowest concentration



Microalgal Cell Yield-Cell Yield

Start Date:	6/05/2016 16:15	Test ID:	PR1387/06	Sample ID:	LDP009 SV
End Date:	9/05/2016 16:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 103	Test Species:	SC-Selenastrum capricornutum
Comments:					

Dose-Response Plot



Microalgal Cell Yield-Cell Yield

Start Date:	6/05/2016 16:15	Test ID:	PR1387/06	Sample ID:	LDP009 SV
End Date:	9/05/2016 16:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 103	Test Species:	SC-Selenastrum capricornutum
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
USEPA Control	Cell Yield	68.40	52.72	93.82	13.18	5.31	8
3.1		60.37	50.02	68.62	8.42	4.81	4
6.3		40.05	35.62	50.92	7.28	6.74	4
12.5		12.52	9.52	14.32	2.08	11.51	4
25		2.25	0.22	4.12	1.67	57.44	4
50		2.72	0.00	4.12	1.88	50.48	4
100		0.54	0.00	1.12	0.52	132.94	4
USEPA Control	pH	7.40	7.40	7.40	0.00	0.00	1
3.1		7.80	7.80	7.80	0.00	0.00	1
6.3		7.90	7.90	7.90	0.00	0.00	1
12.5		8.20	8.20	8.20	0.00	0.00	1
25		8.30	8.30	8.30	0.00	0.00	1
50		8.40	8.40	8.40	0.00	0.00	1
100		8.30	8.30	8.30	0.00	0.00	1
USEPA Control	Conductivity uS/cm	97.30	97.30	97.30	0.00	0.00	1
3.1		130.60	130.60	130.60	0.00	0.00	1
6.3		169.10	169.10	169.10	0.00	0.00	1
12.5		247.00	247.00	247.00	0.00	0.00	1
25		401.00	401.00	401.00	0.00	0.00	1
50		698.00	698.00	698.00	0.00	0.00	1
100		1270.00	1270.00	1270.00	0.00	0.00	1

Statistical Printouts for the Duckweed Growth Inhibition Tests

Duckweed Growth Inhibtion Test-Specific Growth Rate

Start Date:	5/05/2016 14:00	Test ID:	PR1387/02	Sample ID:	LDP006 SCS
End Date:	12/05/2016 14:45	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 112	Test Species:	LD-Lemna disperma
Comments:					

Conc-%	1	2	3	4
SIS Control	0.3589	0.2780	0.3468	0.3627
3	0.3241	0.2201	0.2095	0.3627
6.1	0.3961	0.2201	0.2637	0.2478
12.1	0.3770	0.3085	0.2201	0.2637
24.2	0.3139	0.3770	0.2095	0.2201
48.4	0.2637	0.2391	0.0411	0.0411
96.8	0.0000	0.0000	0.0000	0.0000

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
SIS Control	0.3366	1.0000	0.3366	0.2780	0.3627	11.783	4				0.3366	1.0000
3	0.2791	0.8291	0.2791	0.2095	0.3627	27.248	4	1.007	2.410	0.1377	0.2844	0.8450
6.1	0.2819	0.8375	0.2819	0.2201	0.3961	27.747	4	0.957	2.410	0.1377	0.2844	0.8450
12.1	0.2923	0.8684	0.2923	0.2201	0.3770	22.927	4	0.775	2.410	0.1377	0.2844	0.8450
24.2	0.2801	0.8322	0.2801	0.2095	0.3770	28.504	4	0.989	2.410	0.1377	0.2801	0.8322
*48.4	0.1463	0.4345	0.1463	0.0411	0.2637	83.306	4	3.331	2.410	0.1377	0.1463	0.4345
96.8	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	4				0.0000	0.0000

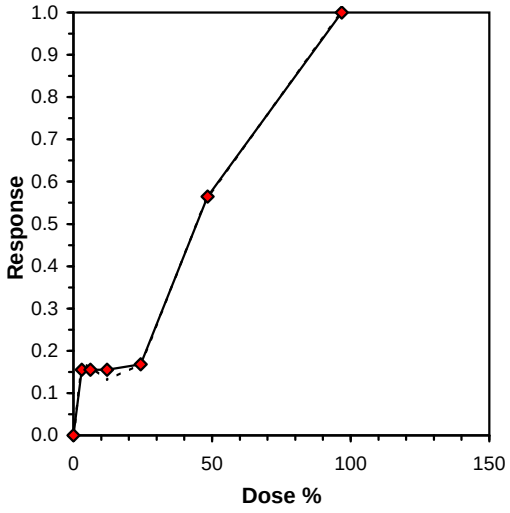
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.924675	0.916	0.240561	-1.26683
Bartlett's Test indicates equal variances (p = 0.68)	3.15472	15.08627		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	24.2	48.4	34.22397	4.132231	0.137718	0.409139	0.016457	0.006531	0.067479	5, 18
Treatments vs SIS Control										

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	0.968	4.177	0.377	23.458	3.8344
IC10*	1.936	8.394	0.754	41.490	1.5340
IC15*	2.904	10.814	1.132	48.556	0.5006
IC20	26.157	10.860	0.000	54.335	-0.0298
IC25	29.200	9.086	0.000	63.798	-0.1495
IC40	38.328	7.933	21.335	73.033	0.9321
IC50	44.414	8.767	26.266	79.190	0.6561

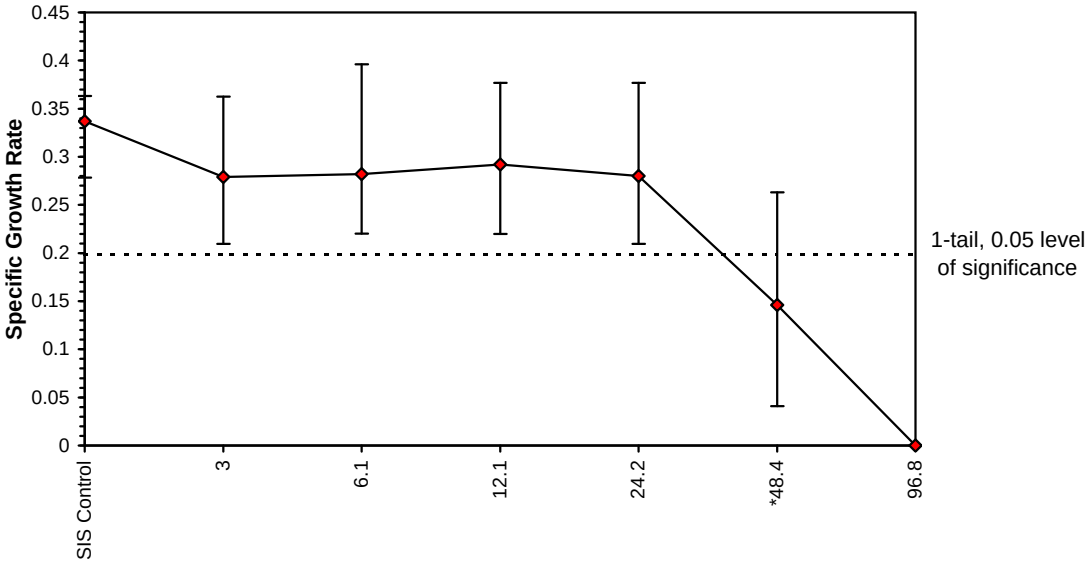
* indicates IC estimate less than the lowest concentration



Duckweed Growth Inhibtion Test-Specific Growth Rate

Start Date:	5/05/2016 14:00	Test ID:	PR1387/02	Sample ID:	LDP006 SCS
End Date:	12/05/2016 14:45	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 112	Test Species:	LD-Lemna disperma
Comments:					

Dose-Response Plot



Duckweed Growth Inhibtion Test-Specific Growth Rate

Start Date:	5/05/2016 14:00	Test ID:	PR1387/02	Sample ID:	LDP006 SCS
End Date:	12/05/2016 14:45	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 112	Test Species:	LD-Lemna disperma
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
SIS Control	Specific growth rate	0.34	0.28	0.36	0.04	59.16	4
3		0.28	0.21	0.36	0.08	98.81	4
6.1		0.28	0.22	0.40	0.08	99.21	4
12.1		0.29	0.22	0.38	0.07	88.56	4
24.2		0.28	0.21	0.38	0.08	100.88	4
48.4		0.15	0.04	0.26	0.12	238.66	4
96.8		0.00	0.00	0.00	0.00		4
SIS Control	pH	6.50	6.50	6.50	0.00	0.00	1
3		6.50	6.50	6.50	0.00	0.00	1
6.1		6.50	6.50	6.50	0.00	0.00	1
12.1		6.50	6.50	6.50	0.00	0.00	1
24.2		6.60	6.60	6.60	0.00	0.00	1
48.4		6.70	6.70	6.70	0.00	0.00	1
96.8		6.70	6.70	6.70	0.00	0.00	1
SIS Control	Cond uS/cm	282.00	282.00	282.00	0.00	0.00	1
3		455.00	455.00	455.00	0.00	0.00	1
6.1		624.00	624.00	624.00	0.00	0.00	1
12.1		948.00	948.00	948.00	0.00	0.00	1
24.2		1579.00	1579.00	1579.00	0.00	0.00	1
48.4		2770.00	2770.00	2770.00	0.00	0.00	1
96.8		4920.00	4920.00	4920.00	0.00	0.00	1

Duckweed Growth Inhibtion Test-Specific Growth Rate

Start Date:	5/05/2016 14:00	Test ID:	PR1387/03	Sample ID:	LDP009 SV
End Date:	12/05/2016 14:45	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 112	Test Species:	LD-Lemna disperma
Comments:					

Conc-%	1	2	3	4
SIS Control	0.3589	0.2780	0.3468	0.3627
3	0.1856	0.3085	0.2391	0.3770
6.1	0.3029	0.3289	0.3241	0.3550
12.1	0.4726	0.2780	0.3336	0.2780
24.2	0.3085	0.2971	0.2710	0.2637
48.4	0.1720	0.3085	0.2299	0.2780
96.8	0.3139	0.4102	0.0000	0.0730

			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
SIS Control	0.3366	1.0000	0.3366	0.2780	0.3627	11.783	4			0.3366	1.0000
3	0.2776	0.8246	0.2776	0.1856	0.3770	29.983	4	15.00	10.00	0.3153	0.9366
6.1	0.3277	0.9736	0.3277	0.3029	0.3550	6.531	4	15.00	10.00	0.3153	0.9366
12.1	0.3405	1.0117	0.3405	0.2780	0.4726	26.972	4	16.00	10.00	0.3153	0.9366
24.2	0.2851	0.8469	0.2851	0.2637	0.3085	7.434	4	12.00	10.00	0.2851	0.8469
48.4	0.2471	0.7341	0.2471	0.1720	0.3085	24.123	4	11.50	10.00	0.2471	0.7341
96.8	0.1993	0.5920	0.1993	0.0000	0.4102	97.523	4	15.00	10.00	0.1993	0.5920

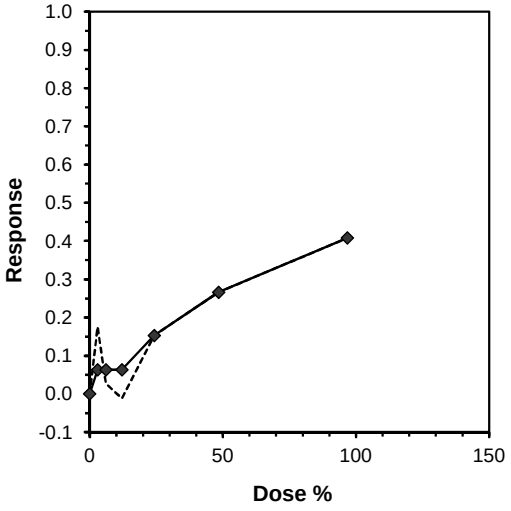
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.967898	0.924	0.196441	1.509806
Bartlett's Test indicates unequal variances (p = 4.33E-03)	18.90484	16.81189		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	96.8	>96.8		1.033058
Treatments vs SIS Control				

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05*	2.368			
IC10	17.040			
IC15	23.781			
IC20	34.260			
IC25	44.988			
IC40	94.081			
IC50	>96.8			

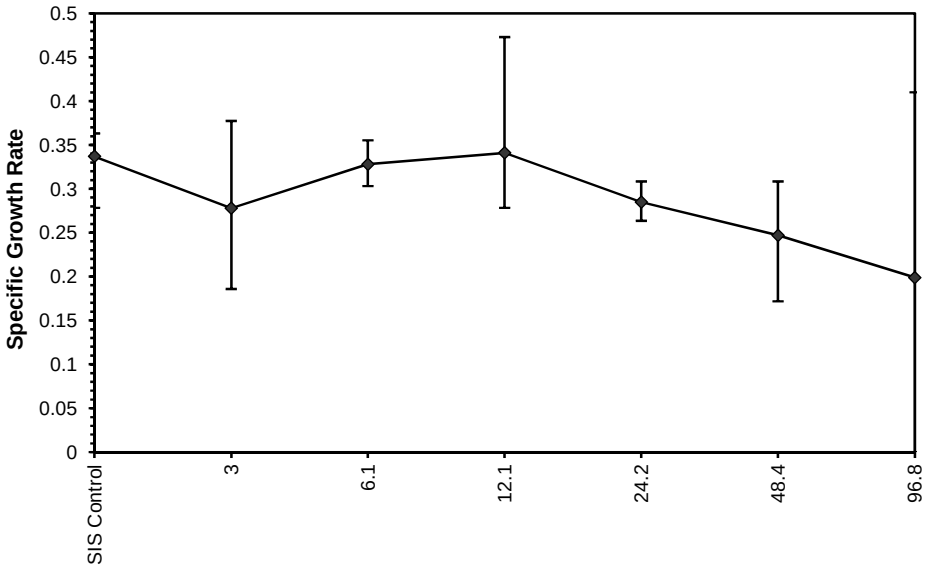
* indicates IC estimate less than the lowest concentration



Duckweed Growth Inhibtion Test-Specific Growth Rate

Start Date:	5/05/2016 14:00	Test ID:	PR1387/03	Sample ID:	LDP009 SV
End Date:	12/05/2016 14:45	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 112	Test Species:	LD-Lemna disperma
Comments:					

Dose-Response Plot



Duckweed Growth Inhibtion Test-Specific Growth Rate

Start Date:	5/05/2016 14:00	Test ID:	PR1387/03	Sample ID:	LDP009 SV
End Date:	12/05/2016 14:45	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 112	Test Species:	LD-Lemna disperma
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
SIS Control	Specific growth rate	0.34	0.28	0.36	0.04	59.16	4
3		0.28	0.19	0.38	0.08	103.93	4
6.1		0.33	0.30	0.35	0.02	44.64	4
12.1		0.34	0.28	0.47	0.09	89.00	4
24.2		0.29	0.26	0.31	0.02	51.07	4
48.4		0.25	0.17	0.31	0.06	98.81	4
96.8		0.20	0.00	0.41	0.19	221.22	4
SIS Control	pH	6.50	6.50	6.50	0.00	0.00	1
3		6.70	6.70	6.70	0.00	0.00	1
6.1		6.90	6.90	6.90	0.00	0.00	1
12.1		7.00	7.00	7.00	0.00	0.00	1
24.2		7.20	7.20	7.20	0.00	0.00	1
48.4		7.50	7.50	7.50	0.00	0.00	1
96.8		7.40	7.40	7.40	0.00	0.00	1
SIS Control	Cond uS/cm	282.00	282.00	282.00	0.00	0.00	1
3		316.00	316.00	316.00	0.00	0.00	1
6.1		347.00	347.00	347.00	0.00	0.00	1
12.1		417.00	417.00	417.00	0.00	0.00	1
24.2		561.00	561.00	561.00	0.00	0.00	1
48.4		841.00	841.00	841.00	0.00	0.00	1
96.8		1390.00	1390.00	1390.00	0.00	0.00	1

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Statistical Printouts for the 10-day Fish Embryonic Development and Post-hatch Survival Tests

Fish Embryonic Development-% Unaffected

Start Date:	6/05/2016 14:30	Test ID:	PR1387/11	Sample ID:	LDP006 SCS
End Date:	18/05/2016 12:40	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 126	Test Species:	MS-Melanotaenia splendida
Comments:					

Conc-%	1	2	3	4
DMW Control	1.0000	1.0000	1.0000	1.0000
3.1	0.8000	0.8000	1.0000	0.6000
6.3	0.8000	0.8000	1.0000	0.8000
12.5	0.8000	1.0000	0.8000	1.0000
25	1.0000	1.0000	0.6000	0.6667
50	0.6000	1.0000	1.0000	1.0000
100	1.0000	0.6000	0.6000	0.8333

			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
DMW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4			1.0000	1.0000
3.1	0.8000	0.8000	1.1114	0.8861	1.3453	16.874	4	12.00	10.00	0.8519	0.8519
6.3	0.8500	0.8500	1.1667	1.1071	1.3453	10.206	4	12.00	10.00	0.8519	0.8519
12.5	0.9000	0.9000	1.2262	1.1071	1.3453	11.212	4	14.00	10.00	0.8519	0.8519
25	0.8167	0.8167	1.1330	0.8861	1.3453	21.779	4	14.00	10.00	0.8519	0.8519
50	0.9000	0.9000	1.2305	0.8861	1.3453	18.660	4	16.00	10.00	0.8519	0.8519
100	0.7583	0.7583	1.0669	0.8861	1.3453	20.947	4	12.00	10.00	0.7619	0.7619

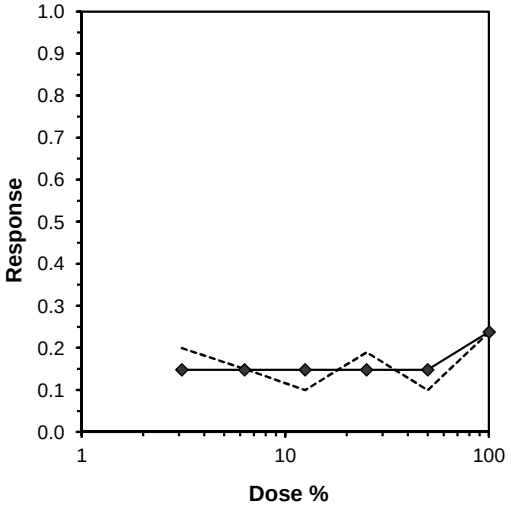
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.969545	0.924	-0.20368	-0.64544
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	>100		1
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	2.271	0.204	2.067	3.598	1.7152
IC10*	2.767				
IC15	50.900				
IC20	76.877				
IC25	>100				
IC40	>100				
IC50	>100				

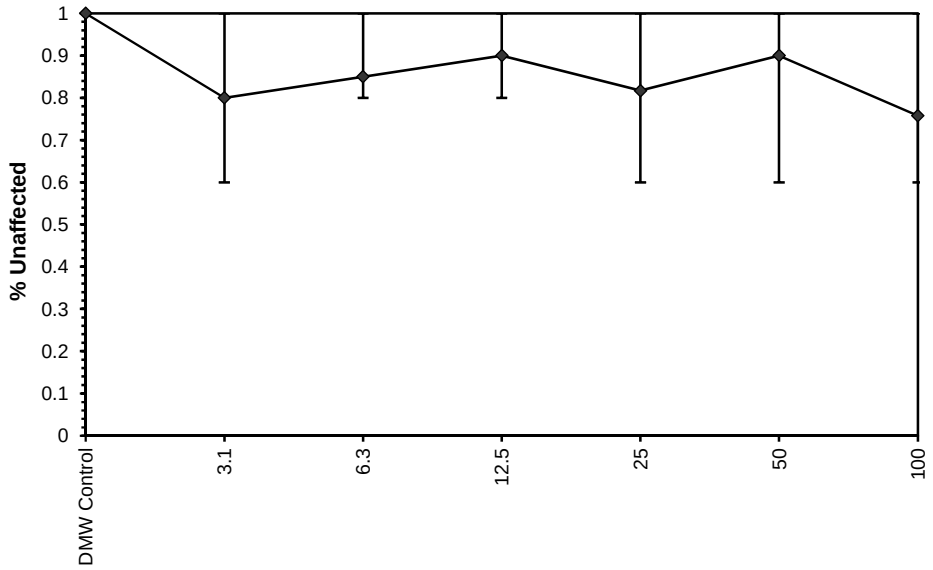
* indicates IC estimate less than the lowest concentration



Fish Embryonic Development-% Unaffected

Start Date:	6/05/2016 14:30	Test ID:	PR1387/11	Sample ID:	LDP006 SCS
End Date:	18/05/2016 12:40	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 126	Test Species:	MS-Melanotaenia splendida
Comments:					

Dose-Response Plot



Fish Embryonic Development-% Unaffected

Start Date:	6/05/2016 14:30	Test ID:	PR1387/11	Sample ID:	LDP006 SCS
End Date:	18/05/2016 12:40	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 126	Test Species:	MS-Melanotaenia splendida
Comments:					

		Auxiliary Data Summary					
Conc-%	**Parameter**	**Mean**	**Min**	**Max**	**SD**	**CV%**	**N**
DMW Control	% Unaffected	100.00	100.00	100.00	0.00	0.00	4
3.1		80.00	60.00	100.00	16.33	5.05	4
6.3		85.00	80.00	100.00	10.00	3.72	4
12.5		90.00	80.00	100.00	11.55	3.78	4
25		81.67	60.00	100.00	21.34	5.66	4
50		90.00	60.00	100.00	20.00	4.97	4
100		75.83	60.00	100.00	19.51	5.82	4
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		8.00	8.00	8.00	0.00	0.00	1
6.3		8.00	8.00	8.00	0.00	0.00	1
12.5		7.90	7.90	7.90	0.00	0.00	1
25		7.80	7.80	7.80	0.00	0.00	1
50		7.50	7.50	7.50	0.00	0.00	1
100		7.20	7.20	7.20	0.00	0.00	1
DMW Control	Cond uS/cm	195.10	195.10	195.10	0.00	0.00	1
3.1		363.00	363.00	363.00	0.00	0.00	1
6.3		547.00	547.00	547.00	0.00	0.00	1
12.5		886.00	886.00	886.00	0.00	0.00	1
25		1516.00	1516.00	1516.00	0.00	0.00	1
50		2670.00	2670.00	2670.00	0.00	0.00	1
100		4730.00	4730.00	4730.00	0.00	0.00	1
DMW Control	DO %	99.30	99.30	99.30	0.00	0.00	1
3.1		99.90	99.90	99.90	0.00	0.00	1
6.3		99.60	99.60	99.60	0.00	0.00	1
12.5		99.30	99.30	99.30	0.00	0.00	1
25		99.40	99.40	99.40	0.00	0.00	1
50		98.90	98.90	98.90	0.00	0.00	1
100		98.90	98.90	98.90	0.00	0.00	1

Fish Embryonic Development-% Unaffected

Start Date:	6/05/2016 14:30	Test ID:	PR1387/12	Sample ID:	LDP009 SV
End Date:	18/05/2016 12:40	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 126	Test Species:	MS-Melanotaenia splendida
Comments:					

Conc-%	1	2	3	4
DMW Control	1.0000	1.0000	1.0000	1.0000
3.1	0.6000	0.6000	0.6000	1.0000
6.3	1.0000	1.0000	0.6000	0.8000
12.5	0.6000	0.2000	0.8000	1.0000
25	0.8000	1.0000	0.6000	0.6000
50	0.8000	0.4000	1.0000	0.4000
100	0.6000	0.6000	0.6000	1.0000

			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
DMW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4			1.0000	1.0000
3.1	0.7000	0.7000	1.0009	0.8861	1.3453	22.940	4	12.00	10.00	0.7750	0.7750
6.3	0.8500	0.8500	1.1709	0.8861	1.3453	18.840	4	14.00	10.00	0.7750	0.7750
12.5	0.6500	0.6500	0.9505	0.4636	1.3453	39.437	4	12.00	10.00	0.7000	0.7000
25	0.7500	0.7500	1.0561	0.8861	1.3453	20.748	4	12.00	10.00	0.7000	0.7000
50	0.6500	0.6500	0.9555	0.6847	1.3453	34.266	4	12.00	10.00	0.6750	0.6750
100	0.7000	0.7000	1.0009	0.8861	1.3453	22.940	4	12.00	10.00	0.6750	0.6750

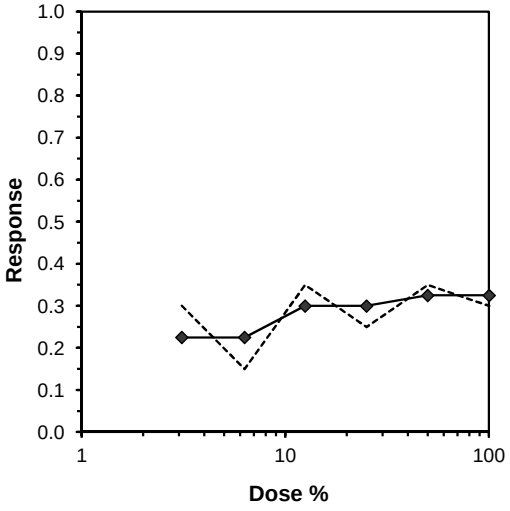
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.95341	0.924	0.167767	-0.3686
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	>100		1
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	2.0307	0.3750	1.7525	3.1708	6.8133
IC10*	2.4592	1.2737	2.1050	8.6370	6.3341
IC15*	2.7543	4.1283	2.3454	18.4573	7.7429
IC20*	2.9929	8.5147	2.5386	43.5402	3.7915
IC25	8.0790				
IC40	>100				
IC50	>100				

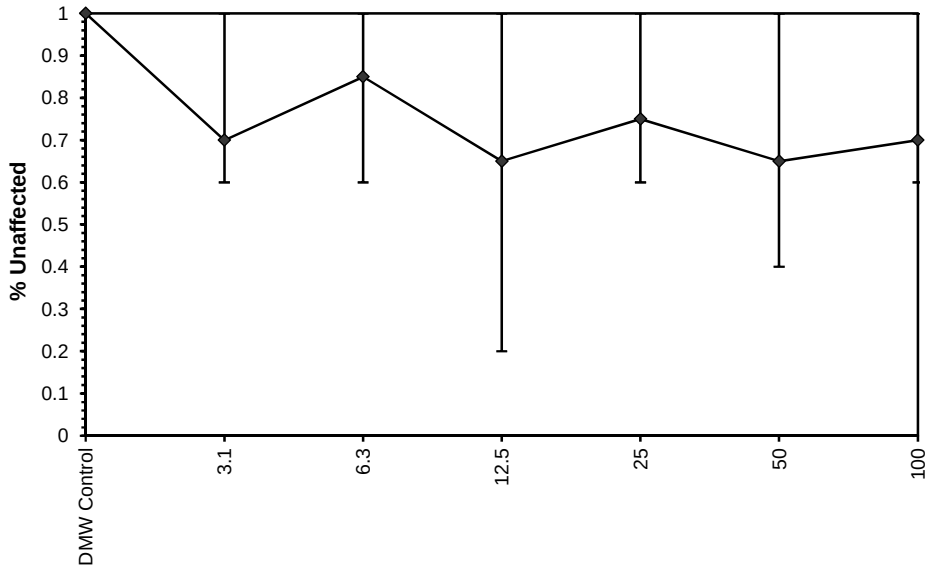
* indicates IC estimate less than the lowest concentration



Fish Embryonic Development-% Unaffected

Start Date:	6/05/2016 14:30	Test ID:	PR1387/12	Sample ID:	LDP009 SV
End Date:	18/05/2016 12:40	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 126	Test Species:	MS-Melanotaenia splendida
Comments:					

Dose-Response Plot



Fish Embryonic Development-% Unaffected

Start Date:	6/05/2016 14:30	Test ID:	PR1387/12	Sample ID:	LDP009 SV
End Date:	18/05/2016 12:40	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 126	Test Species:	MS-Melanotaenia splendida
Comments:					

		Auxiliary Data Summary					
Conc-%	**Parameter**	**Mean**	**Min**	**Max**	**SD**	**CV%**	**N**
DMW Control	% Unaffected	100.00	100.00	100.00	0.00	0.00	4
3.1		70.00	60.00	100.00	20.00	6.39	4
6.3		85.00	60.00	100.00	19.15	5.15	4
12.5		65.00	20.00	100.00	34.16	8.99	4
25		75.00	60.00	100.00	19.15	5.83	4
50		65.00	40.00	100.00	30.00	8.43	4
100		70.00	60.00	100.00	20.00	6.39	4
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		8.00	8.00	8.00	0.00	0.00	1
6.3		8.10	8.10	8.10	0.00	0.00	1
12.5		8.10	8.10	8.10	0.00	0.00	1
25		8.20	8.20	8.20	0.00	0.00	1
50		8.10	8.10	8.10	0.00	0.00	1
100		8.00	8.00	8.00	0.00	0.00	1
DMW Control	Cond uS/cm	195.10	195.10	195.10	0.00	0.00	1
3.1		207.00	207.00	207.00	0.00	0.00	1
6.3		239.00	239.00	239.00	0.00	0.00	1
12.5		304.00	304.00	304.00	0.00	0.00	1
25		433.00	433.00	433.00	0.00	0.00	1
50		685.00	685.00	685.00	0.00	0.00	1
100		1157.00	1157.00	1157.00	0.00	0.00	1
DMW Control	DO %	99.30	99.30	99.30	0.00	0.00	1
3.1		100.20	100.20	100.20	0.00	0.00	1
6.3		99.90	99.90	99.90	0.00	0.00	1
12.5		99.80	99.80	99.80	0.00	0.00	1
25		99.90	99.90	99.90	0.00	0.00	1
50		100.30	100.30	100.30	0.00	0.00	1
100		100.30	100.30	100.30	0.00	0.00	1

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Statistical Printouts for the Freshwater Shrimp Tests

Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	5/05/2016 15:00	Test ID:	PR1387/08	Sample ID:	LDP006 SCS
End Date:	15/05/2016 15:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Conc-%	1	2	3	4
DMW Control	0.8000	1.0000	1.0000	0.8000
3.1	1.0000	0.8000	1.0000	1.0000
6.3	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000
25	0.8000	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000	1.0000
100	1.0000	1.0000	1.0000	1.0000

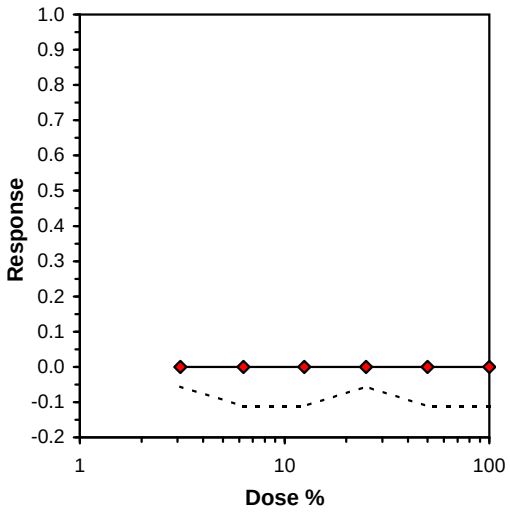
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
DMW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4			0.9714	1.0000
3.1	0.9500	1.0556	1.2857	1.1071	1.3453	9.261	4	20.00	10.00	0.9714	1.0000
6.3	1.0000	1.1111	1.3453	1.3453	1.3453	0.000	4	22.00	10.00	0.9714	1.0000
12.5	1.0000	1.1111	1.3453	1.3453	1.3453	0.000	4	22.00	10.00	0.9714	1.0000
25	0.9500	1.0556	1.2857	1.1071	1.3453	9.261	4	20.00	10.00	0.9714	1.0000
50	1.0000	1.1111	1.3453	1.3453	1.3453	0.000	4	22.00	10.00	0.9714	1.0000
100	1.0000	1.1111	1.3453	1.3453	1.3453	0.000	4	22.00	10.00	0.9714	1.0000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.800183	0.924	-1.06174	1.526123
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	>100		1
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

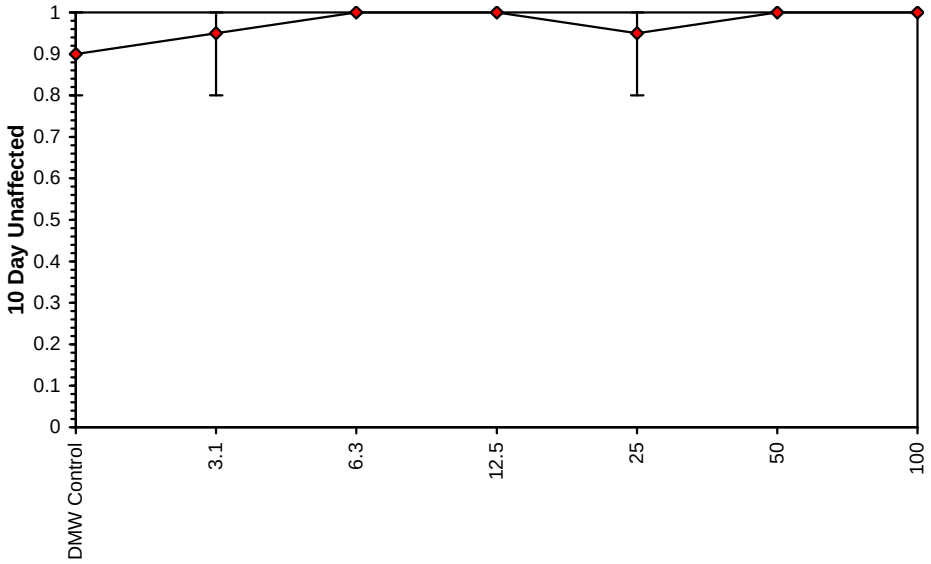
Point	%	SD	95% CL(Exp)	Skew
IC05	>100			
IC10	>100			
IC15	>100			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			



Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	5/05/2016 15:00	Test ID:	PR1387/08	Sample ID:	LDP006 SCS
End Date:	15/05/2016 15:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Dose-Response Plot



Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	5/05/2016 15:00	Test ID:	PR1387/08	Sample ID:	LDP006 SCS
End Date:	15/05/2016 15:00	Lab ID:	7641	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	% Unaffected	90.00	80.00	100.00	11.55	3.78	4
3.1		95.00	80.00	100.00	10.00	3.33	4
6.3		100.00	100.00	100.00	0.00	0.00	4
12.5		100.00	100.00	100.00	0.00	0.00	4
25		95.00	80.00	100.00	10.00	3.33	4
50		100.00	100.00	100.00	0.00	0.00	4
100		100.00	100.00	100.00	0.00	0.00	4
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		8.00	8.00	8.00	0.00	0.00	1
6.3		7.90	7.90	7.90	0.00	0.00	1
12.5		7.80	7.80	7.80	0.00	0.00	1
25		7.80	7.80	7.80	0.00	0.00	1
50		7.60	7.60	7.60	0.00	0.00	1
100		7.10	7.10	7.10	0.00	0.00	1
DMW Control	Cond uS/cm	99.50	99.50	99.50	0.00	0.00	1
3.1		100.10	100.10	100.10	0.00	0.00	1
6.3		99.80	99.80	99.80	0.00	0.00	1
12.5		99.80	99.80	99.80	0.00	0.00	1
25		98.80	98.80	98.80	0.00	0.00	1
50		97.50	97.50	97.50	0.00	0.00	1
100		99.50	99.50	99.50	0.00	0.00	1
DMW Control	DO %	174.50	174.50	174.50	0.00	0.00	1
3.1		367.00	367.00	367.00	0.00	0.00	1
6.3		543.00	543.00	543.00	0.00	0.00	1
12.5		887.00	887.00	887.00	0.00	0.00	1
25		1538.00	1538.00	1538.00	0.00	0.00	1
50		2720.00	2720.00	2720.00	0.00	0.00	1
100		4880.00	4880.00	4880.00	0.00	0.00	1

Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	5/05/2016 15:00	Test ID:	PR1387/09	Sample ID:	LDP009 SV
End Date:	15/05/2016 15:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Conc-%	1	2	3	4
DMW Control	0.8000	1.0000	1.0000	0.8000
3.1	0.6000	0.8000	1.0000	1.0000
6.3	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000
25	0.6000	0.6000	0.6000	0.6000
50	0.0000	0.0000	0.0000	0.0000
100	0.0000	0.0000	0.0000	0.0000

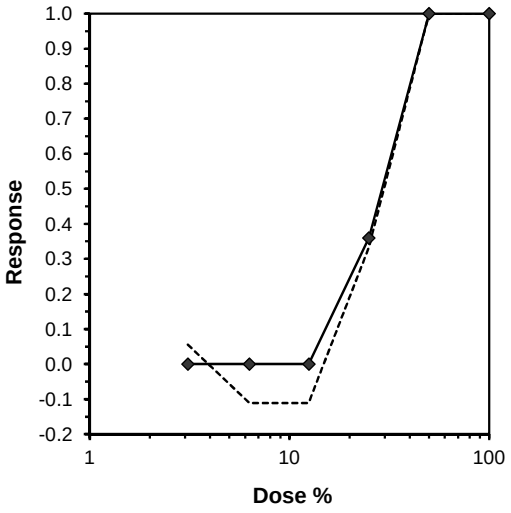
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
DMW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4			0.9375	1.0000
3.1	0.8500	0.9444	1.1709	0.8861	1.3453	18.840	4	17.00	10.00	0.9375	1.0000
6.3	1.0000	1.1111	1.3453	1.3453	1.3453	0.000	4	22.00	10.00	0.9375	1.0000
12.5	1.0000	1.1111	1.3453	1.3453	1.3453	0.000	4	22.00	10.00	0.9375	1.0000
*25	0.6000	0.6667	0.8861	0.8861	0.8861	0.000	4	10.00	10.00	0.6000	0.6400
50	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	4			0.0000	0.0000
100	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	4			0.0000	0.0000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.832517	0.905	-0.67818	2.33318
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	12.5	25	17.67767	8
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

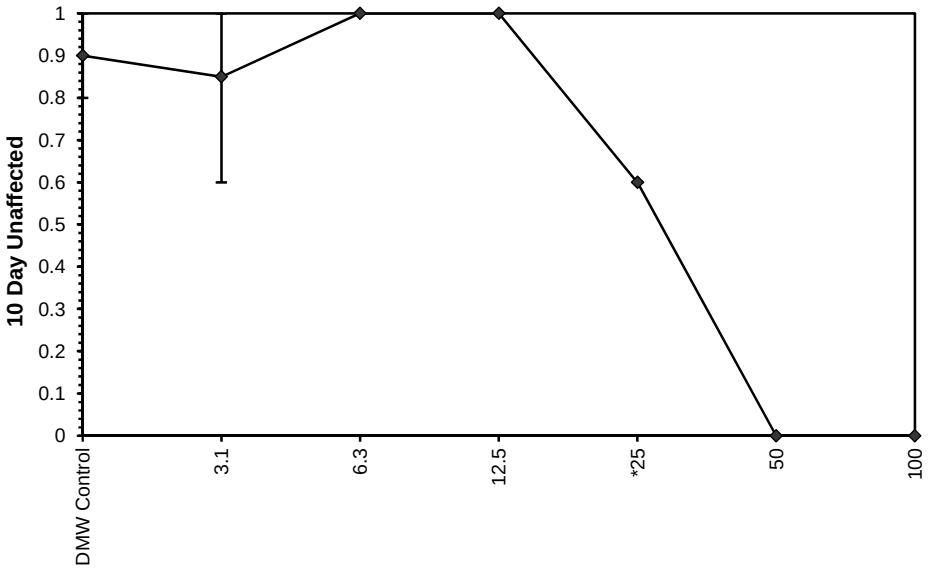
Point	%	SD	95% CL(Exp)		Skew
IC05	15.064	2.588	0.000	17.740	-4.1711
IC10	17.056	1.340	12.718	19.716	-6.1662
IC15	18.775	0.825	15.268	20.978	-2.2855
IC20	20.345	0.661	17.363	21.926	-2.8997
IC25	21.830	0.524	19.228	22.702	-3.5413
IC40	25.282	0.118	24.831	25.553	-0.1878
IC50	25.985	0.099	25.608	26.216	-0.1586



Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	5/05/2016 15:00	Test ID:	PR1387/09	Sample ID:	LDP009 SV
End Date:	15/05/2016 15:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Dose-Response Plot



Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	5/05/2016 15:00	Test ID:	PR1387/09	Sample ID:	LDP009 SV
End Date:	15/05/2016 15:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	% Unaffected	90.00	80.00	100.00	11.55	3.78	4
3.1		85.00	60.00	100.00	19.15	5.15	4
6.3		100.00	100.00	100.00	0.00	0.00	4
12.5		100.00	100.00	100.00	0.00	0.00	4
25		60.00	60.00	60.00	0.00	0.00	4
50		0.00	0.00	0.00	0.00		4
100		0.00	0.00	0.00	0.00		4
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		8.00	8.00	8.00	0.00	0.00	1
6.3		8.20	8.20	8.20	0.00	0.00	1
12.5		8.20	8.20	8.20	0.00	0.00	1
25		8.20	8.20	8.20	0.00	0.00	1
50		8.30	8.30	8.30	0.00	0.00	1
100		8.10	8.10	8.10	0.00	0.00	1
DMW Control	Cond uS/cm	99.50	99.50	99.50	0.00	0.00	1
3.1		99.00	99.00	99.00	0.00	0.00	1
6.3		98.30	98.30	98.30	0.00	0.00	1
12.5		98.20	98.20	98.20	0.00	0.00	1
25		98.20	98.20	98.20	0.00	0.00	1
50		98.40	98.40	98.40	0.00	0.00	1
100		98.50	98.50	98.50	0.00	0.00	1
DMW Control	DO %	174.50	174.50	174.50	0.00	0.00	1
3.1		206.00	206.00	206.00	0.00	0.00	1
6.3		239.00	239.00	239.00	0.00	0.00	1
12.5		305.00	305.00	305.00	0.00	0.00	1
25		436.00	436.00	436.00	0.00	0.00	1
50		696.00	696.00	696.00	0.00	0.00	1
100		1204.00	1204.00	1204.00	0.00	0.00	1

Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	5/05/2016 15:00	Test ID:	PR1387/09	Sample ID:	LDP009 SV
End Date:	15/05/2016 15:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Conc-%	1	2	3	4
DMW Control	0.8000	1.0000	1.0000	0.8000
3.1	0.6000	0.8000	1.0000	1.0000
6.3	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000
25	0.6000	0.6000	0.6000	0.6000
50	0.0000	0.0000	0.0000	0.0000
100	0.0000	0.0000	0.0000	0.0000

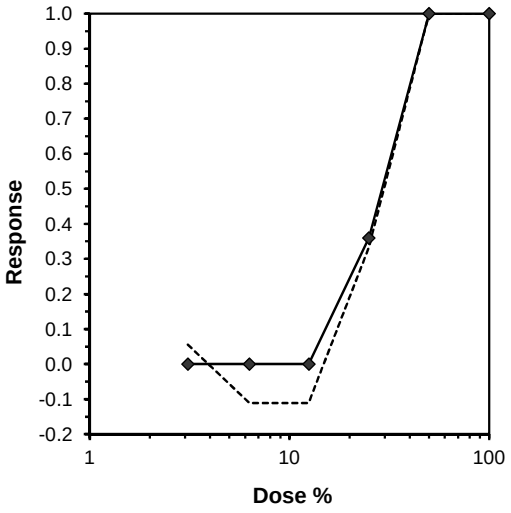
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
DMW Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4			2	20
3.1	0.8500	0.9444	1.1709	0.8861	1.3453	18.840	4	17.00	10.00	3	20
6.3	1.0000	1.1111	1.3453	1.3453	1.3453	0.000	4	22.00	10.00	0	20
12.5	1.0000	1.1111	1.3453	1.3453	1.3453	0.000	4	22.00	10.00	0	20
*25	0.6000	0.6667	0.8861	0.8861	0.8861	0.000	4	10.00	10.00	8	20
50	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	4			20	20
100	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	4			20	20

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.832517	0.905	-0.67818	2.33318
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	12.5	25	17.67767	8
Treatments vs DMW Control				

Trimmed Spearman-Karber

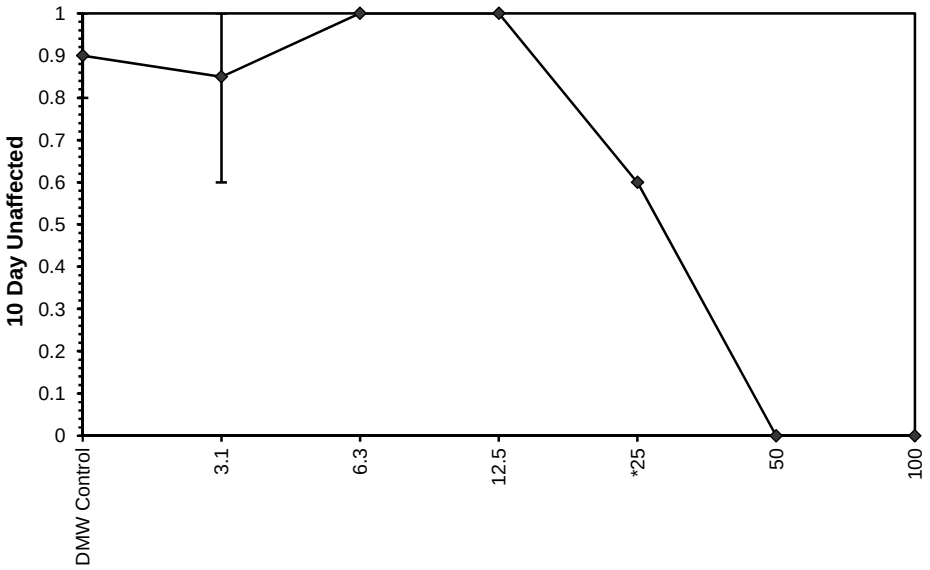
Trim Level	EC50	95% CL	
0.0%	27.548	23.739	31.967
5.0%	27.814	23.550	32.850
10.0%	28.076	23.197	33.981
20.0%	28.575	21.723	37.588
Auto-0.0%	27.548	23.739	31.967



Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	5/05/2016 15:00	Test ID:	PR1387/09	Sample ID:	LDP009 SV
End Date:	15/05/2016 15:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Dose-Response Plot



Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	5/05/2016 15:00	Test ID:	PR1387/09	Sample ID:	LDP009 SV
End Date:	15/05/2016 15:00	Lab ID:	7642	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	% Unaffected	90.00	80.00	100.00	11.55	3.78	4
3.1		85.00	60.00	100.00	19.15	5.15	4
6.3		100.00	100.00	100.00	0.00	0.00	4
12.5		100.00	100.00	100.00	0.00	0.00	4
25		60.00	60.00	60.00	0.00	0.00	4
50		0.00	0.00	0.00	0.00		4
100		0.00	0.00	0.00	0.00		4
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		8.00	8.00	8.00	0.00	0.00	1
6.3		8.20	8.20	8.20	0.00	0.00	1
12.5		8.20	8.20	8.20	0.00	0.00	1
25		8.20	8.20	8.20	0.00	0.00	1
50		8.30	8.30	8.30	0.00	0.00	1
100		8.10	8.10	8.10	0.00	0.00	1
DMW Control	Cond uS/cm	99.50	99.50	99.50	0.00	0.00	1
3.1		99.00	99.00	99.00	0.00	0.00	1
6.3		98.30	98.30	98.30	0.00	0.00	1
12.5		98.20	98.20	98.20	0.00	0.00	1
25		98.20	98.20	98.20	0.00	0.00	1
50		98.40	98.40	98.40	0.00	0.00	1
100		98.50	98.50	98.50	0.00	0.00	1
DMW Control	DO %	174.50	174.50	174.50	0.00	0.00	1
3.1		206.00	206.00	206.00	0.00	0.00	1
6.3		239.00	239.00	239.00	0.00	0.00	1
12.5		305.00	305.00	305.00	0.00	0.00	1
25		436.00	436.00	436.00	0.00	0.00	1
50		696.00	696.00	696.00	0.00	0.00	1
100		1204.00	1204.00	1204.00	0.00	0.00	1

Appendix B – Water quality report

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1609565**	Page	: 1 of 10
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MS ZOE LAGERROTH	Contact	: Mitchell Bevan
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 07 3859 7800	Telephone	: 08 9209 7619
Project	: 2218346	Date Samples Received	: 04-May-2016 15:00
Order number	: ----	Date Analysis Commenced	: 04-May-2016
C-O-C number	: ----	Issue Date	: 11-May-2016 11:59
Sampler	: ZOE LAGERROTH		
Site	: ----		
Quote number	: ----		
No. of samples received	: 6		
No. of samples analysed	: 6		

NATA Accredited Laboratory 825
Accredited for compliance with
ISO/IEC 17025.

NATA
WORLD RECOGNISED ACCREDITATION

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dian Dao		Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- Metals analysis: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WANG US	WANG DS	LDP 006	LDP 009	RAW
				Client sampling date / time	[04-May-2016]	[04-May-2016]	[04-May-2016]	[03-May-2016]	[03-May-2016]
Compound	CAS Number	LOR	Unit		ES1609565-001	ES1609565-002	ES1609565-003	ES1609565-004	ES1609565-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.37	7.50	7.21	8.24	8.03
EA006: Sodium Adsorption Ratio (SAR)									
Sodium Adsorption Ratio	----	0.01	-		3.14	6.87	7.18	27.6	28.1
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		1940	4670	4930	1120	1120
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		1260	3040	3200	728	728
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	7	6	10	7
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		685	1410	1490	22	22
ED009: Anions									
Bromide	24959-67-9	0.01	mg/L		0.451	1.09	1.16	0.012	0.027
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		84	59	64	640	657
Total Alkalinity as CaCO3	----	1	mg/L		84	59	64	640	657
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		6.8	6.9	7.1	8.5	8.6
ED040T: Total Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		6.6	7.6	7.0	8.5	8.9
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		743	1810	1900	27	25
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		147	347	368	7	7
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		111	240	254	4	4
Magnesium	7439-95-4	1	mg/L		99	196	208	3	3
Sodium	7440-23-5	1	mg/L		189	592	637	300	305
Potassium	7440-09-7	1	mg/L		13	42	47	10	11
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	0.02	0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WANG US	WANG DS	LDP 006	LDP 009	RAW
				Client sampling date / time	[04-May-2016]	[04-May-2016]	[04-May-2016]	[03-May-2016]	[03-May-2016]
Compound	CAS Number	LOR	Unit		ES1609565-001	ES1609565-002	ES1609565-003	ES1609565-004	ES1609565-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	**0.023**	**0.032**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.021**	**0.011**	**0.011**	**0.029**	**0.029**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	**0.0001**	**0.0002**	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		**0.002**	**0.067**	**0.096**	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.001**
Manganese	7439-96-5	0.001	mg/L		**1.31**	**3.39**	**4.27**	**0.012**	**0.010**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	**0.037**	**0.040**
Nickel	7440-02-0	0.001	mg/L		**0.053**	**0.398**	**0.477**	**0.003**	**0.004**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L		**0.536**	**1.66**	**1.78**	**0.019**	**0.019**
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.036**	**0.188**	**0.266**	**0.010**	**0.014**
Boron	7440-42-8	0.05	mg/L		**0.37**	**1.41**	**1.58**	**0.12**	**0.08**
Iron	7439-89-6	0.05	mg/L		**0.07**	**0.12**	**0.46**	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.02**	**0.01**	**0.01**	**0.29**	**0.12**
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	**0.028**	**0.062**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.022**	**0.012**	**0.010**	**0.030**	**0.034**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	**0.0002**	**0.0002**	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		**0.003**	**0.070**	**0.098**	<0.001	**0.005**
Copper	7440-50-8	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	**0.011**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	**0.421**	**0.004**
Manganese	7439-96-5	0.001	mg/L		**1.26**	**3.35**	**4.13**	**0.012**	**0.070**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	**0.042**	**0.043**
Nickel	7440-02-0	0.001	mg/L		**0.055**	**0.404**	**0.481**	**0.003**	**0.010**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L		**0.578**	**1.74**	**1.86**	**0.020**	**0.023**
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.011**	**0.201**	**0.268**	**0.008**	**0.032**
Boron	7440-42-8	0.05	mg/L		**0.40**	**1.48**	**1.59**	**0.12**	**0.08**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WANG US	WANG DS	LDP 006	LDP 009	RAW
				Client sampling date / time	[04-May-2016]	[04-May-2016]	[04-May-2016]	[03-May-2016]	[03-May-2016]
Compound	CAS Number	LOR	Unit		ES1609565-001	ES1609565-002	ES1609565-003	ES1609565-004	ES1609565-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		**0.30**	**0.27**	**0.77**	**0.10**	**0.93**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG049F: Dissolved Trivalent Chromium									
Trivalent Chromium	16065-83-1	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EG050F: Dissolved Hexavalent Chromium									
Hexavalent Chromium	18540-29-9	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EG052F: Dissolved Silica by ICPAES									
Silicon as SiO2	14464-46-1	0.1	mg/L		**6.8**	**6.9**	**7.1**	**8.5**	**8.6**
EK025SF: Free CN by Segmented Flow Analyser									
Free Cyanide	----	0.004	mg/L		<0.004	<0.004	<0.004	<0.004	<0.004
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	<0.004	<0.004	<0.004	**0.006**
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser									
Weak Acid Dissociable Cyanide	----	0.004	mg/L		<0.004	<0.004	<0.004	<0.004	<0.004
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.2**	**0.2**	**1.2**	**1.3**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	**0.04**	**0.08**	**0.41**	**0.47**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.01**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.04**	**0.18**	**0.16**	**0.31**	**0.30**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	**0.18**	**0.16**	**0.31**	**0.31**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.1**	**0.1**	**0.5**	**0.6**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.3**	**0.3**	**0.8**	**0.9**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	**0.05**	**0.02**	**0.03**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WANG US	WANG DS	LDP 006	LDP 009	RAW
				Client sampling date / time	[04-May-2016]	[04-May-2016]	[04-May-2016]	[03-May-2016]	[03-May-2016]
Compound	CAS Number	LOR	Unit		ES1609565-001	ES1609565-002	ES1609565-003	ES1609565-004	ES1609565-005
					Result	Result	Result	Result	Result
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**21.3**	**48.6**	**51.2**	**13.5**	**13.8**
Total Cations	----	0.01	meq/L		**22.2**	**54.9**	**58.7**	**13.8**	**14.0**
Ionic Balance	----	0.01	%		**2.16**	**6.05**	**6.80**	**0.68**	**0.47**
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		**4**	**8**	**9**	**7**	**8**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DUP 01	----	----	----	----
				Client sampling date / time	[04-May-2016]	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1609565-006	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		----	----	----	----	----
EA006: Sodium Adsorption Ratio (SAR)									
Sodium Adsorption Ratio	----	0.01	-		----	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		----	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		----	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		----	----	----	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		----	----	----	----	----
ED009: Anions									
Bromide	24959-67-9	0.01	mg/L		----	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		----	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		----	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		----	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		----	----	----	----	----
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		----	----	----	----	----
ED040T: Total Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		----	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		----	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		----	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		----	----	----	----	----
Magnesium	7439-95-4	1	mg/L		----	----	----	----	----
Sodium	7440-23-5	1	mg/L		----	----	----	----	----
Potassium	7440-09-7	1	mg/L		----	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.01**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DUP 01	----	----	----	----
				Client sampling date / time	[04-May-2016]	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1609565-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.011**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		**0.0001**	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.079**	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.003**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**4.62**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.397**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Strontium	7440-24-6	0.001	mg/L		**1.87**	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.239**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**1.51**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		**0.46**	----	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		----	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		----	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		----	----	----	----	----
Barium	7440-39-3	0.001	mg/L		----	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		----	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		----	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		----	----	----	----	----
Copper	7440-50-8	0.001	mg/L		----	----	----	----	----
Lead	7439-92-1	0.001	mg/L		----	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		----	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		----	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		----	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		----	----	----	----	----
Strontium	7440-24-6	0.001	mg/L		----	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		----	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		----	----	----	----	----
Boron	7440-42-8	0.05	mg/L		----	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DUP 01	----	----	----	----
				Client sampling date / time	[04-May-2016]	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1609565-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		----	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		----	----	----	----	----
EG049F: Dissolved Trivalent Chromium									
Trivalent Chromium	16065-83-1	0.01	mg/L		----	----	----	----	----
EG050F: Dissolved Hexavalent Chromium									
Hexavalent Chromium	18540-29-9	0.01	mg/L		----	----	----	----	----
EG052F: Dissolved Silica by ICPAES									
Silicon as SiO2	14464-46-1	0.1	mg/L		----	----	----	----	----
EK025SF: Free CN by Segmented Flow Analyser									
Free Cyanide	----	0.004	mg/L		----	----	----	----	----
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		----	----	----	----	----
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser									
Weak Acid Dissociable Cyanide	----	0.004	mg/L		----	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		----	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		----	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		----	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		----	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		----	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		----	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		----	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		----	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DUP 01	----	----	----	----
				Client sampling date / time	[04-May-2016]	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1609565-006	--------	--------	--------	--------
					Result	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		----	----	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		----	----	----	----	----
Total Cations	----	0.01	meq/L		----	----	----	----	----
Ionic Balance	----	0.01	%		----	----	----	----	----
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		----	----	----	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		----	----	----	----	----
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L		----	----	----	----	----

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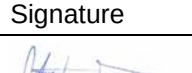
0	J. Cairns	J. Woodworth		S. Gray		01/11/2016
						

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