Memorandum

To:	**James Court, MFE**	Date:	**30 September 2002**
From:	**Chris Hickey – NIWA**	Our Ref:	**MFE02237**
Copy:	Dr Wayne Donovan, Bioresearches; Dr Michael Warne, NSW EPA, Dr John Chapman, NSW EPA		
Subject:	**Nitrate guideline values in ANZECC 2000**		

Background
The issue has been raised as to the certainty associated with the nitrate trigger values as given in Table 3.4.1 of the ANZECC 2000 water quality guidelines. These trigger values indicate that for 95% protection the toxicity of nitrate is higher than for ammonia (by 1.3-times) and for markedly higher for 99% protection (by 19-times).

The basis for the derivation of these numbers was investigated.

ANZECC guidance
The new ANZECC guidelines use acute and chronic laboratory toxicity data for the derivation of "trigger values" for nitrate. The detailed toxicity data for nitrate is provided in Appendix 1 and freshwater toxicity data used for statistical calculation is given in Appendix 2. The guideline summary for freshwaters is:
"A freshwater moderate reliability trigger value for nitrate toxicity as NO_3 (nitrate) of 700 µg/L was calculated using the statistical distribution method 95% protection and the default ACR."

The stated guideline value of 700 µg/L for 95% protection is consistent with the value given in summary table 3.4.1 of the guidelines, but not consistent with the present figure, which indicates a guideline value of approximately 10,000 g/L.

Recalculation procedure
The nitrate database is predominantly acute data, with chronic data for two Australian species (Appendix 2). Based on inspection of the data plot (Appendix 1), it would appear that a mix of acute and chronic data was used for guideline calculation, followed by application of a 10x application factor (AF).

The geometric mean values for the acute toxicity data were converted to chronic values using a 10x AF (Figure 8.3.2, and page 8.3-31, ANZECC 2000). The two chronic values were converted from NO_3-N to NO_3 prior to this analysis (the values summarised in the database were the NO_3-N data as reported in Rippon & McBride (1994), Greg Rippon, pers. comm. 11 Sept 2002). The acute and chronic data were then combined prior to guideline calculation using the BurrIII statistical program provided on the Guidelines CD. The recalculated trigger values (rounded) are summarised in the table below together with the values presented in the Guidelines.

	Chemical	Trigger values for freshwater (µg/L)			
		Level of protection (% species)			
		99%	95%	90%	80%
ANZECC 2000 values	Nitrate	17	700	3400	17000
Recalculated values	Nitrate	21,600	31,900	38,500	52,000
Recalculated values	Nitrate-N	**4900**	**7200**	**8700**	**12,000**

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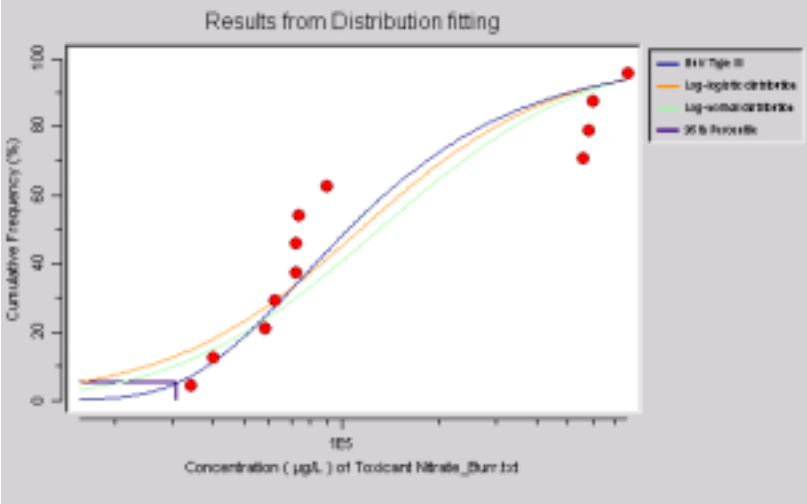


Figure. Distribution of recalculated nitrate toxicity data.

These recalculated nitrate trigger values are markedly higher than those presented in the guidelines. The recalculated values are more consistent with ambient nitrate values (see Table 8.2.6 – but multiply numbers by 4.43x to convert to nitrate as NO_3, ANZECC 2000) and relative to the toxicity trigger values for ammonia.

It appears that the nitrate values given for toxicants are as NO_3 (based on checking against values in one reference, Rubin & Elmaraghy 1977). This differs from the normal way that laboratory results would be presented and how nutrient trigger values are presented in the Guidelines.

I would suggest that the toxicant trigger values should also be presented as NO_3-N values for consistency of practice.

Christopher W. Hickey.

Dr Chris Hickey
30 September 2002

References:

ANZECC & ARMCANZ (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.

Rippon,G.D and P.McBride (1994). Biological Toxicity Testing of Gadjarrigamarndah Creek Water at Na [sic] Final Report for Project.

Rubin,A.J. and G.A.Elmaraghy 1977 Studies on the Toxicity of Ammonia, Nitrate and Their Mixtures to Guppy Fry *Water Res.* 11 (10): 927-935

Appendix 1. Nitrate section from ANZECC 2000 guidelines and graphical presentation of data as provided on the guidelines CD

Nitrate

Nitrate is essential for growth of aquatic plants. The main issue with elevated levels of nitrate is its potential to stimulate algal growth and hence to be a factor in nuisance algal blooms and eutrophication of waterways — usually from human wastes or fertilisers. At high enough levels, nitrate can be toxic to aquatic life. Toxicity data were reviewed for both potassium nitrate (KNO_3 ; CAS 7757-79-1) and sodium nitrate ($NaNO_3$; CAS 7631-99-4).

Aquatic toxicology

Potassium nitrate was generally more toxic than sodium nitrate (many of the comparative tests were reported in the same publication). Figures are given as mg NO_3 /L.
Freshwater fish: (48–96 h LC_{50}): 6 spp, 99–10 000 mg/L (i.e. x 1000 µg/L). Chronic 9-d NOEC of 14 mg/L to Australian *Mogurnda adspersa*
Freshwater crustaceans: 48–96 h LC_{50} to *Daphnia magn*a, 23–4206 mg/L
Freshwater molluscs: *Lymnaea* sp. 96-h LC_{50} , 664 mg/L
Freshwater insects: 2 spp, 72–96 h LC_{50} , 430–930 mg/L
Freshwater hydra: *Hydra viridissima* 6 d chronic NOEC (population growth) of 9 mg/L (Australian)
Marine fish: 6 spp, 96-h LC_{50} , 2536–13 280 mg/L
Marine mollusc: 1 sp, 96-h LC_{50} , 11 510–27 580 mg/L

Australian and New Zealand data

The only chronic data were for potassium nitrate were on Australian purple-spotted gudgeon *Mogurnda mogurnda* and hydra, *Hydra viridissim*a. There were no overseas chronic data for comparison. Tests with the marine prawn *Penaeus monodon* (Muir et al. 1991), indicated that nitrate had a significant effect on survival of larvae at 1000 µg/L but no dose-response figures were given.

Guideline

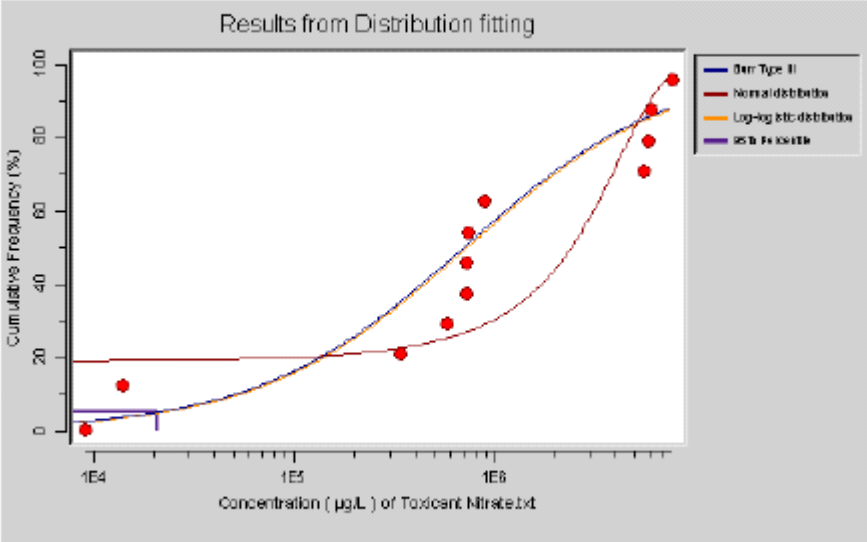
As nitrates are a known stimulant for algal growth at low concentrations, it was considered acceptable to derive trigger values on an adequate number of data without algae. Separate marine figures were derived because of the apparent differences in sensitivity on the limited marine data.

A freshwater* moderate reliability *trigger value for nitrate toxicity as NO_3 (nitrate) of 700 µg/L was calculated using the statistical distribution method 95% protection and the default ACR.

Although a marine* low reliability *figure of 13 000 µg/L (13 mg/L) could be calculated using an AF of 200 (limited data but a lesser factor due to essentiality), it is preferable to adopt the freshwater figure of 700 µg/L for nitrate toxicity as NO_3 (nitrate) as a marine* low reliability *trigger value.

Nitrate

Freshwater



Appendix 1. Nitrate toxicity data from ANZECC 2000 guidelines database

Water Quality Search Results

Date: 2/08/2002

Toxicant nitrate

Latin Name / Common	Test Media	Test Type	Duration(h	Endpoin	Effec	Temp	pH	Method	Concentration Used	Code	Unit	Ref No
					Fish							
Gambusia holbrooki Eastern mosquitofish	Freshwater	Acute	48	LC50	MORT			NR	1E+07	U	ug/L	200508
Gambusia holbrooki Eastern mosquitofish	Freshwater	Acute	48	LC50	MORT			NR	137000	U	ug/L	200508
Gambusia holbrooki Eastern mosquitofish	Freshwater	Acute	96	LC50	MORT			NR	99000	U	ug/L	200508
Gambusia holbrooki Eastern mosquitofish	Freshwater	Acute	96	LC50	MORT			NR	99000	U	ug/L	200508
Geometric									340406.42			
Lebistes reticulatus Guppy	Freshwater	Acute	48	LC50	MORT			NR	969000	U	ug/L	207635
Lebistes reticulatus Guppy	Freshwater	Acute	72	LC50	MORT			NR	881000	U	ug/L	207635
Lebistes reticulatus Guppy	Freshwater	Acute	96	LC50	MORT			NR	845000	U	ug/L	207635
Geometric									896847.91			
Lepomis macrochirus Bluegill	Freshwater	Acute	96	LC50	MORT			NR	1.4165E	U	ug/L	208037
Lepomis macrochirus Bluegill	Freshwater	Acute	96	LC50	MORT			NR	885300	U	ug/L	208037

Toxicant nitrate

Lepomis macrochirus Bluegill	Freshwater	Acute	96	LC50	MORT	NR	U 900000	ug/L	200930
Lepomis macrochirus Bluegill	Freshwater	Acute	96	LC50	MORT	NR	U 940000	ug/L	200930
Lepomis macrochirus Bluegill	Freshwater	Acute	96	LC50	MORT	NR	U 186000	ug/L	208037
Lepomis macrochirus Bluegill	Freshwater	Acute	96	LC50	MORT	NR	U 1E+07	ug/L	200930
Geometric							7630126.27		
Micropterus treculi Guadalupe bass	Freshwater	Acute	96	LC50	MORT	NR	U 558200	ug/L	211794
Geometric							5582000.00		
Oncorhynchus mykiss Rainbow trout	Freshwater	Acute	96	LC50	MORT	NR	U 599800	ug/L	205115
Geometric							5998000.00		
Oncorhynchus Chinook salmon	Freshwater	Acute	96	LC50	MORT	NR	U 579900	ug/L	205115
Geometric							5799000.00		
					crustaceans				
Daphnia magna Water flea	Freshwater	Acute	48	LC50	MORT	NR	U 358100	ug/L	200915
Daphnia magna Water flea	Freshwater	Acute	48	LC50	MORT	NR	U 358100	ug/L	202465
Daphnia magna Water flea	Freshwater	Acute	48	LC50	MORT	NR	U 301000	ug/L	200915

Toxicant nitrate

Daphnia magna Water flea	Freshwater	Acute	72	LC50	MORT	NR	U 212500	ug/L	200915
Daphnia magna Water flea	Freshwater	Acute	72	LC50	MORT	NR	U 137000	ug/L	200915
Daphnia magna Water flea	Freshwater	Acute	96	LC50	MORT	NR	U 420600	ug/L	200915
Daphnia magna Water flea	Freshwater	Acute	96	LC50	MORT	NR	U 665000	ug/L	200915
Daphnia magna Water flea	Freshwater	Acute	96	LC50	MORT	NR	U 23000	ug/L	200915
Geometric							720085.68		
				Insects					
Cheumatopsyche pettiti Caddisfly	Freshwater	Acute	72	EC50	MORT	NR	U 845000	ug/L	203879
Cheumatopsyche pettiti Caddisfly	Freshwater	Acute	72	EC50	MORT	NR	U 930000	ug/L	203879
Cheumatopsyche pettiti Caddisfly	Freshwater	Acute	96	EC50	MORT	NR	U 732000	ug/L	203879
Cheumatopsyche pettiti Caddisfly	Freshwater	Acute	96	EC50	MORT	NR	U 502000	ug/L	203879
Geometric							733058.47		
Hydropsyche Caddisfly	Freshwater	Acute	72	LC50	MORT	NR	U 657000	ug/L	203879
Hydropsyche Caddisfly	Freshwater	Acute	72	LC50	MORT	NR	U 812000	ug/L	203879

Toxicant nitrate

Hydropsyche Caddisfly	Freshwater	Acute	96	LC50	MORT	NR	U 430000	ug/L	203879
Hydropsyche Caddisfly	Freshwater	Acute	96	LC50	MORT	NR	U 482000	ug/L	203879
Geometric							576645.92		
				Molluscs					
Lymnaea sp Pond snail	Freshwater	Acute	48	EC50	HAT	NR	U 914000	ug/L	200508
Lymnaea sp Pond snail	Freshwater	Acute	72	EC50	HAT	NR	U 624000	ug/L	200508
Lymnaea sp Pond snail	Freshwater	Acute	96	EC50	HAT	NR	U 664000	ug/L	200915
Geometric							723490.70		
				Fish					
Mogurnda mogurnda Purple SpottedGudgeon	Freshwater	Chronic	216	NOEC	MORT	NR	U ~~14000~~	ug/L	300119
Geometric							~~14000.00~~ CORRECTED TO NO3 = 62020		
				Coelentrates					
Hydra viridissima Hydra	Freshwater	Chronic	144	NOEC	PGR	NR	U ~~9000~~	ug/L	300119
Geometric							~~9000.00~~ CORRECTED TO NO3 = 39870		
				Fish					
Centropristis striata Black sea bass	Marine	Acute	96	LC50	MORT	NR	U 1.0624E	ug/L	209424
Geometric							10624000.00		

Toxicant nitrate

Monacanthus hispidus Plane headFilefish	Marine	Acute	96	LC50	MORT	NR	253600 U	ug/L	209424
Geometric							2536000.00		
Oncorhynchus mykiss Rainbow trout	Marine	Acute	96	LC50	MORT	NR	465000 U	ug/L	205115
Geometric							4650000.00		
Oncorhynchus Chinook salmon	Marine	Acute	96	LC50	MORT	NR	440200 U	ug/L	205115
Geometric							4402000.00		
Pomacentrus Beaugregory	Marine	Acute	96	LC50	MORT	NR	1.328E+ U	ug/L	209424
Geometric							13280000.00		
Trachinotus carolinus Florida pompano	Marine	Acute	96	LC50	MORT	NR	442600 U	ug/L	209424
Geometric							4426000.00		
Molluscs									
Crassostrea virginica American or virginia	Marine	Acute	96	EC50	MORT	NR	1.6821E U	ug/L	205098
Crassostrea virginica American or virginia	Marine	Acute	96	EC50	MORT	NR	1.1509E U	ug/L	205098
Crassostrea virginica American or virginia	Marine	Acute	96	EC50	MORT	NR	1.8946E U	ug/L	205098
Crassostrea virginica American or virginia	Marine	Acute	96	EC50	MORT	NR	2.7578E U	ug/L	205098
Geometric							17833739.78		

Toxicant nitrate

U - Unmodified
C - Converted NOEC
H - Hardness Corrected
HC - Hardness Corrected, Converted NOEC
UI - Unmodified Unionized
UD - Unmodified Dissociated
T - Unmodified Total
Tp -Total at pH8.0
TpC -Total at pH8.0, Converted NOEC

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