Fact Sheet Date: March 12, 1998

NEW YORK STATE
-AQUATIC FACT SHEET-

Ambient Water Quality Values for Protection of Aquatic Life

SUBSTANCE: Cadmium, dissolved **CAS REGISTRY NUMBER:** Not Applicable

TYPE:	BASIS:	FRESHWATER AMBIENT WATER QUALITY VALUE (ug/L):
Chronic	Propagation	$(0.85)e^{(0.7852[\ln \text{ppm hardness}] - 2.715)}$
Acute	Survival	$(0.85)e^{(1.128[\ln \text{ppm hardness}] - 3.6867)}$

INTRODUCTION

These values apply to the water column and are derived to protect aquatic life from the effects of waterborne contaminants. Values for the protection of propagation of aquatic life are referred to as Aquatic (Chronic) or A(C) values. Values for the protection of survival of aquatic life are referred to as Aquatic (Acute) or A(A) values.

SUMMARY OF INFORMATION AND DERIVATION OF VALUE

U.S. EPA (1995a,b) has derived acute and chronic aquatic life criteria for dissolved cadmium for the Great Lakes Water Quality Initiative (GLI). The Department has reviewed these criteria and determined that they are based on appropriate data and derived according to the scientific procedures in current and proposed 6 NYCRR Part 702. They are thus determined to be appropriate ambient water quality values for protection of aquatic life for New York State.

The attachment to this fact sheet provides U.S. EPA's derivation of the values expressed as total metal. Conversion to the dissolved form is made using the factor of 0.85 presented in U.S. EPA (1995a). U.S. EPA's Criterion Continuous Concentration (CCC) and Criterion Maximum Concentration (CMC) are equivalent to New York's Aquatic (Chronic) and Aquatic (Acute) values respectively.

REFERENCES

U.S. EPA (Environmental Protection Agency). 1995a. Final Water Quality Guidance for the Great Lakes System. 60 Federal Register: 15366 - 15425. March 23, 1995.

U.S. EPA (Environmental Protection Agency). 1995b. Great Lakes Water Quality Initiative Criteria Documents for the Protection of Aquatic Life in Ambient Water. EPA-820-B-95-004. March 1995.

New York State Department of Environmental Conservation
Division of Water
SJS
January 14, 1997

ATTACHMENT

GREAT LAKES WATER QUALITY INITIATIVE

Tier 1 Aquatic Life Criterion for Cadmium

The new acceptable acute and chronic data for cadmium are given in Tables B1 and B2. These new data were used with those given in Tables 1 and 2 of the criteria document for cadmium (U.S. EPA 1985) to obtain the values given in Tables B3 and B4. Because the toxicity of cadmium is hardness-dependent, all acute and chronic values in Tables B3 and B4 have been adjusted to a hardness of 50 mg/L.

Criterion Maximum Concentration (CMC)

The SMAVs given in Table B3 for the green sunfish, bluegill, coho salmon, and rainbow trout were derived from U.S. EPA (1985) by giving preference to results of "FT,M" tests. Several SMAVs given in U.S. EPA (1985) were changed or eliminated due to deletion of tests that were conducted in river water by Spehar and Carlson (1984a,b).

The Final Acute Value (FAV) was calculated using the four lowest Genus Mean Acute Values in Table B3, resulting in an FAV of 4.134 ug/L at a hardness of 50 mg/L. This value did not need to be lowered to protect a commercially or recreationally important species of the Great Lakes System. The CMC was calculated by dividing the FAV by 2, resulting in a CMC of 2.067 ug/L, as total recoverable cadmium, at a hardness of 50 mg/L. The CMC was related to hardness using the slope of 1.128 that was derived in U.S. EPA (1985):

$$CMC = e^{1.128(\ln \text{hardness}) - 3.6867}$$

Criterion Continuous Concentration (CCC)

Two chronic values given in U.S. EPA (1985) were not used here because the tests were conducted in river water by Spehar and Carlson (1984a,b). The chronic value given in U.S. EPA (1985) for *Moina macrocopa* was not used here because the concentrations of cadmium were not measured.

Chronic toxicity tests have been conducted on cadmium with a wide variety of aquatic species and the resulting ACRs have a wide range, even within sensitive species (U.S. EPA 1985). Therefore, the Final Chronic Value (FCV) was calculated using the eight-family procedure that was used to calculate the FAV and was used to calculate the FCV for cadmium in U.S. EPA (1985). As in U.S. EPA (1985), the FCV was calculated using the value of n used in the calculation of the FAV (i.e., n = 43). The FCV was 1.4286 ug/L at a hardness of 50 mg/L. This value did not need to be lowered to protect a commercially or recreationally important species of the Great Lakes System. Thus the CCC was 1.4286

ug/L, as total recoverable cadmium, at a hardness of 50 mg/L. The CCC was related to hardness using the slope of 0.7852 that was derived in U.S. EPA (1985):

$$CCC = e^{0.7852(\ln \text{hardness}) - 2.715}$$

The Criterion

The procedures described in the GLI Tier 1 methodology indicate that, except possibly where a locally important species is very sensitive, aquatic organisms should not be affected unacceptably if the four-day average concentration of cadmium does not exceed the numerical value (in ug/L) given by the equation

$$CCC = e^{0.7852(\ln \text{hardness}) - 2.715}$$

more than once every three years on the average and if the one-hour average concentration does not exceed the numerical value (in ug/L) given by the equation

$$CMC = e^{1.128(\ln \text{hardness}) - 3.6867}$$

more than once every three years on the average.

Table B1. New Acute Values for Cadmium

Species	Method*	Hardness (mg/L as $CaCO_3$)	Acute Value (ug/L)	Adjusted Acute Value (ug/L)**	Reference
Cladoceran, Ceriodaphnia reticulata	S,U	240	184	31.36	Elnabarawy et al. 1986
Cladoceran, Daphnia pulex	S,U	120	70	26.07	Hall et al. 1986
Cladoceran, Daphnia pulex	S,U	200	50	10.47	Hall et al. 1986
Cladoceran, Daphnia pulex	S,U	200	100	20.94	Hall et al. 1986
Cladoceran, Daphnia pulex	S,U	240	319	54.37	Elnabarawy et al. 1986
Cladoceran, Daphnia magna	S,U	240	178	30.3	Elnabarawy et al. 1986
Amphipod, Crangonyx pseudogracilis	S,U	50	1700	1700	Martin and Holdich 1986
Crayfish, Orconectes virilis	S,U	26	6100	12755	Mirenda 1986
Rainbow trout, Oncorhynchus mykiss	FT,M	9.2	<0.5	<3.37	Cusimano and Brakke 1986
Rainbow trout, Oncorhynchus mykiss	FT,M	50	30	30	Van Leeuwen et al. 1985
Rainbow trout, Oncorhynchus mykiss	FT,M	50	10	10	Van Leeuwen et al. 1985
Rainbow trout (28-day egg), Oncorhynchus mykiss	FT,M	50	9200	9200***	Van Leeuwen et al. 1985
Rainbow trout (14-day egg), Oncorhynchus mykiss	FT,M	50	7500	7500***	Van Leeuwen et al. 1985
Rainbow trout (24-hr. egg), Oncorhynchus mykiss	FT,M	50	13000	13000***	Van Leeuwen et al. 1985
Rainbow trout (0-hr. egg), Oncorhynchus mykiss	FT,M	50	13000	13000***	Van Leeuwen et al. 1985

Table B1. (Cont.)

Species	Method*	Hardness (mg/L as $CaCO_3$)	Acute Value (ug/L)	Adjusted Acute Value (ug/L)**	Reference
Striped bass, Morone saxatilis	S,U	40	4	5.14	Palawski et al. 1985

Striped bass, Morone saxatilis	S,U	285	10	1.4	Palawski et al. 1985

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* FT = flow-through, M = measured, S = static, U = unmeasured.
** Adjusted to a hardness of 50 mg/L using a slope of 1.128.
*** Not used in the calculation of the SMAV because data were available for a more sensitive life stage.

Table B2. New Chronic Values for Cadmium

Species	Method*	Hardness (mg/L as $CaCO_3$)	Chronic Value (ug/L)	Adjusted Chronic Value (ug/L)**	Reference
Cladoceran, Ceriodaphnia reticulata	LC	240	0.4	0.12***	Elnabarawy et al. 1986
Cladoceran, Daphnia magna	LC	240	4.3	1.25***	Elnabarawy et al. 1986
Cladoceran, Daphnia pulex	LC	106	7.07	3.919	Ingersoll and Winner 1982
Cladoceran, Daphnia pulex	LC	65	7.49	6.096	Niederlehner 1984
Cladoceran, Daphnia pulex	LC	240	13.7	4***	Elnabarawy et al. 1986
Oligochaete, Aeolosoma headleyi	LC	65	25.19	20.50	Niederlehner 1984

* LC = life cycle.
** Adjusted to a hardness of 50 mg/L using a slope of 0.7852.
*** Not used in derivation of the criterion because the concentrations of cadmium were not measured.

Table B3. Ranked Genus Mean Acute Values for Cadmium

Rank*	Genus Mean Acute Value (ug/L)**	Species	Species Mean Acute Value (ug/L)**
43	12755	Crayfish, Orconectes virilis	12755
42	8325	Goldfish, Carassius auratus	8325
41	8100	Damselfly, (Unidentified)	8100
40	7921	Tubificid worm, Rhyacodrilus montana	7921
39	7685	Mosquitofish, Gambusia affinis	7685
38	6915	Tubificid worm, Stylodrilus heringianus	6915
37	4990	Tubificid worm, Spirosperma ferox	4401
		Tubificid worm, Spirosperma nikolskyi	5658
36	4977	Threespine stickleback Gasterosteus aculeatus	4977
35	4778	Tubificid worm, Varichaeta pacifica	4778
34	4024	Tubificid worm, Tubifex tubifex	4024
33	4024	Tubificid worm, Quistradilus multisetosus	4024
32	3800	Snail, Amnicola sp.	3800
31	3570	Guppy, Poecilia reticulata	3570
30	3514	White sucker, Catostomus commersoni	3514
29	3400	Caddisfly, (Unidentified)	3400

Table B3. (Cont.)

Rank*	Genus Mean Acute Value (ug/L)**	Species	Species Mean Acute Value (ug/L)**
28	3018	Tubificid worm, Branchiura sowerbyi	3018
27	2888	Flagfish,	2888

		Jordanella floridae	
26	2400	Northern squawfish, Ptychocheilus oregonensis	2400
25	2395	Green sunfish, Lepomis cyanellus	2399
		Pumpkinseed, Lepomis gibbosus	1347
		Bluegill, Lepomis macrochirus	4249
24	2310	Mayfly, Ephemerella grandis	2310
23	2137	Tubificid worm, Limnodrilus hoffmeisteri	2137
22	1700	Worm, Nais sp.	1700
21	1700	Amphipod, Crangonyx pseudogracilis	1700
20	1200	Midge, Chironomus sp.	1200
19	736	American eel, Anguilla rostrata	736
18	401	Isopod, Asellus bicrenata	401
17	221.9	Bryozoan, Plumatella emarginata	221.9
16	215.5	Common carp, Cyprinus carpio	215.5
15	156.9	Snail, Physa gyrina	156.9
14	142.5	Bryozoan, Pectinatella magnifica	142.5

Table B3. (Cont.)

Rank*	Genus Mean Acute Value (ug/L)**	Species	Species Mean Acute Value (ug/L)**
13	104.0	Snail, Aplexa hypnorum	104.0
12	98.79	Banded killifish, Fundulus diaphanus	98.79
11	74.99	Amphipod, Gammarus pseudolimnaeus	80.33
		Amphipod, Gammarus sp.	70.00
10	48.28	Cladoceran,	48.28

		Ceriodaphnia reticulata	
9	42.8	Isopod, Lirceus alabamae	42.8
8	40.78	Cladoceran, Moina macrocopa	40.78
7	30.54	Bryozoan, Lophopodella carteri	30.54
6	30.50	Fathead minnow, Pimephales promelas	30.50
5	29.96	Cladoceran, Simocephalus serrulatus	33.2
		Cladoceran, Simochephalus vetulus	27.03
4	21.13	Cladoceran, Daphnia magna	14.2
		Cladoceran, Daphnia pulex	31.43
3	5.421	Coho salmon, Oncorhynchus kisutch	6.48
		Chinook salmon, Oncorhynchus tshawytscha	4.254
		Rainbow trout, Oncorhynchus mykiss	5.78

Table B3. (Cont.)

Rank*	Genus Mean Acute Value (ug/L)**	Species	Species Mean Acute Value (ug/L)**
2	2.682***	White perch, Morone americana	7544
		Striped bass, Morone saxatilis	2.682****
1	1.647	Brown trout, Salmo trutta	1.647

* Ranked from most resistant to most sensitive based on Genus Mean Acute Value.
** At hardness = 50 mg/L.
*** The GMAV was set equal to the lower SMAV due to the large range in the SMAVs in this genus.
**** This SMAV was based on the results reported by Palawski et al. (1985) because they were considered better data than those given in U.S. EPA (1985), although the data reported by Hughes (1973) supported the newer data.

At hardness = 50 mg/L:

FAV = 4.134 ug/L

CMC = FAV/2 = 2.067 ug/L

As a function of hardness:

$$CMC = e^{1.128(\ln \text{hardness}) - 3.6867}$$

Table B4. Ranked Genus Mean Chronic Values for Cadmium

Rank*	Genus Mean Chronic Value (ug/L)**	Species	Species Mean Chronic Value (ug/L)**
12	20.50	Oligochaete, Aeolosoma headleyi	20.50
11	16.32	Bluegill, Lepomis macrochirus	16.32
10	15.40	Fathead minnow, Pimephales promelas	15.40
9	8.170	Smallmouth bass, Micropterus dolomieui	8.170
8	8.138	Northern pike, Esox lucius	8.138
7	7.849	White sucker, Catostomus commersoni	7.849
6	7.771	Atlantic salmon, Salmo salar	8.192
		Brown trout, Salmo trutta	7.372
5	5.336	Flagfish, Jordanella floridae	5.336
4	4.841	Snail, Aplexa hypnorum	4.841
3	4.383	Brook trout, Salvelinus fontinalis	2.362
		Lake trout, Salvelinus namaycush	8.134
2	3.399	Coho salmon, Oncorhynchus kisutch	4.289
		Chinook salmon, Oncorhynchus tshawytscha	2.694
1	0.1354***	Cladoceran, Daphnia magna	0.1354
		Cladoceran, Daphnia pulex	4.888

* Ranked from most resistant to most sensitive based on Genus Mean Chronic Value.
** At hardness = 50 mg/L.
*** The GMCV was set equal to the lower SMCV due to the large range in the SMCVs for this genus.

At hardness = 50 mg/L:

FCV = 1.4286 ug/L = CCC (calculated using n = 43)

As a function of hardness:

$$CCC = e^{0.7852(\ln \text{hardness}) - 2.715}$$

References

Cusimano, R.F., D.F. Brakke, and G.A. Chapman. 1986. Effects of pH on the Toxicities of Cadmium, Copper and Zinc to Steelhead Trout (Salmo gairdneri). Can J. Fish. Aquat. Sci. 43:1497-1503.

Elnabarawy, M.R., A.N. Wetter, and R.R. Robideau. 1986. Relative Sensitivity of Three Daphnid Species to Selected Organic and Inorganic Chemicals. Environ. Toxicol. Chem. 5:393-398.

Hall, W.S., R.L. Paulson, L.W. Hall, Jr., and D.T. Burton. 1986. Acute Toxicity of Cadmium and Sodium Pentachlorophenate to Daphnids and Fish. Bull. Environ. Contam. Toxicol. 37:308-316.

Hughes, J.S. 1973. Acute Toxicity of Thirty Chemicals to Striped Bass (Morone saxatilis). Western Assoc. State Game Fish Comm., Salt Lake City, UT. July.

Ingersoll, C.G., and R.W. Winner. 1982. Effect of Daphnia pulex (DeGeer) to Daily Pulse Exposures to Copper or Cadmium. Environ. Toxicol. Chem. 1:321-327.

Martin, S.R., and D.M. Holdich. 1986. The Acute Lethal Toxicity of Heavy Metals to Peracarid Crustaceans (with Particular Reference to Freshwater Asellids and Gammarids). Water Res. 20:1137-1147.

Mirenda, R.J. 1986. Toxicity and Accumulation of Cadmium in the Crayfish, Orconectes virilis (Hagen). Arch. Environ. Contam. Toxicol. 15:401-407.

Niederlehner, B. 1984. A Comparison of Techniques for Estimating the Hazard of Chemicals in the Aquatic Environment. M.S. Thesis. Virginia Polytechnic Institute and State University.

Palawski, D., J.B. Hunn, and F.J. Dwyer. 1985. Sensitivity of Young Striped Bass to Organic and Inorganic Contaminants in Fresh and Saline Waters. Trans. Am. Fish. Soc. 114:748-753.

Spehar, R.L., and A.R. Carlson. 1984a. Derivation of Site-Specific Water Quality Criteria for Cadmium and the St. Louis River Basin, Duluth, Minnesota. PB84-153196. National Technical Information Service, Springfield, VA.

Spehar, R.L., and A.R. Carlson. 1984b. Derivation of Site-Specific Water Quality Criteria for Cadmium and the St. Louis River Basin, Duluth, Minnesota. Environ. Toxicol. Chem. 3:651-665.

U.S. EPA. 1985. Ambient Aquatic Life Water Quality Criteria for Cadmium. EPA 440/5-84-032. National Technical Information Service, Springfield, VA.

Van Leeuwen, C.J., P.S. Griffioen, W.H.A. Vergouw, and J.L. Maas-Diepeveen. 1985.

Differences in Susceptibility of Early Life Stages of Rainbow Trout (Salmo gairdneri) to Environmental Pollutants. Aquatic Toxicol. 7:59-78.