QUALITY CRITERIA FOR WATER 1986

UPDATE #1

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WATER QUALITY CRITERIA SUMMARY

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER REGULATIONS AND STANDARDS
STANDARDS BRANCH (WH-585)
401 M STREET S.W.
WASHINGTON, DC 20460

Update 1.0

September 2, 1986

	PRIORITY POLLUTANT	CARCINOGEN	FRESH ACUTE CRITERIA	FRESH CHRONIC CRITERIA	MARINE ACUTE CRITERIA	MARINE CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY	DRINKING WATER M.C.L.	DATE/REFERENCE	# OF STATES WITH AQUATIC LIFE STANDARD
			CONCENTRATIONS IN ug/L				UNITS PER LITER				
ACENAPHTHENE	Y	N	*1,700.	*520.	*970.	*710.				1980 FR	1
ACROLEIN	Y	N	*68.	*21.	*55.		320.ug	780.ug		1980 FR	1
ACRYLONITRILE	Y	Y	*7,550.	*2,600.			0.058ug**	0.65ug**		1980 FR	1
ALDRIN	Y	Y	3.0		1.3		0.074ng**	0.079ng**		1980 FR	16
ALKALINITY	N	N		20,000.						1976 RB	
AMMONIA	N	N	CRITERIA ARE pH AND TEMPERATURE DEPENDENT - SEE DOCUMENT							1985 FR	24
ANTIMONY	Y	N	*9,000.	*1,600.			146.ug	45,000.ug		1980 FR	1
ARSENIC	Y	Y					2.2ng**	17.5ng**	0.05mg	1980 FR	21
ARSENIC(PENT)	Y	Y	*850.	*48.	*2,319.	*13.				1985 FR	21
ARSENIC(TRI)	Y	Y	360.	190.	69.	36.				1985 FR	21
ASBESTOS	Y	Y					30k f/L**			1980 FR	
BACTERIA	N	N	FOR PRIMARY RECREATION AND SHELLFISH USES - SEE DOCUMENT						<1/100ml	1986 FR	56
BARIUM	N	N					1.mg		1.0mg	1976 RB	8
BENZENE	Y	Y	*5,300.		*5,100.	*700.	0.66ug**	40.ug**		1980 FR	1
BENZIDINE	Y	Y	*2,500.				0.12ng**	0.53ng**		1980 FR	6
BERYLLIUM	Y	Y	*130.	*5.3			6.8ng**	117.ng**		1980 FR	8
BHC	Y	N	*100.		*0.34					1980 FR	
CADMIUM	Y	N	3.9+	1.1+	43.	9.3	10.ug		0.010mg	1985 FR	21
CARBON TETRACHLORIDE	Y	Y	*35,200.		*50,000.		0.4ug**	6.94ug**		1980 FR	1
CHLORDANE	Y	Y	2.4	0.0043	0.09	0.004	0.46ng**	0.48ng**		1980 FR	12
CHLORINATED BENZENES	Y	Y	*250.	*50.	*160.	*129.	488.ug			1980 FR	1
CHLORINATED NAPHTHALENES	Y	N	*1,600.		*7.5					1980 FR	1
CHLORINE	N	N	19.	11.	13.	7.5				1985 FR	21
CHLOROALKYL ETHERS	Y	N	*238,000.							1980 FR	1
CHLOROETHYL BIS-2	Y	Y					0.03ug**	1.36ug**		1980 FR	
CHLOROFORM	Y	Y	*28,900.	*1,240.			0.19ug**	15.7ug**		1980 FR	1
CHLOROISOPROPYL (BIS-2)	Y	N					34.7ug	4.36mg		1980 FR	
CHLOROMETHYL ETHER (BIS)	Y	N					0.00000376ng**	0.00184ug**		1980 FR	
CHLOROPHENOL 2	Y	N	*4,380.	*2,000.						1980 FR	1
CHLOROPHENOL 4	N	N			*29,700.					1980 FR	1
CHLOROPHENOXY HERBICIDES (2,4,5,-TP)	N	N					10.mg			1980 FR	
CHLOROPHENOXY HERBICIDES (2,4-D)	N	N					100.ug			1976 RB	7
CHLORO-4 METHYL-3 PHENOL	N	N	*30.							1980 FR	
CHROMIUM (HEX)	Y	N	16.	11.	1,100.	50.	50.mg		0.05mg	1985 FR	24
CHROMIUM (TRI)	N	N	1,700.+	210.+	*10,300.		170.mg	3,433.mg	0.05mg	1985 FR	24
COLOR	N	N	NARRATIVE STATEMENT - SEE DOCUMENT							1976 RB	
COPPER	Y	N	18.+	12.+	2.9	2.9				1985 FR	20
CYANIDE	Y	N	22.	5.2	1.	1.	200.ug			1985 FR	23
DDT	Y	Y	1.1	0.001	0.13	0.001	0.024ng**	0.024ng**		1980 FR	16
DDT METABOLITE (DDE)	Y	Y	*1,050.		*14.					1980 FR	
DDT METABOLITE (TDE)	Y	Y	*0.06		*3.6					1980 FR	
DEMETON	Y	N		0.1		0.1				1976 RB	
DIBUTYL PHTHALATE	Y	N					35.mg	154.mg		1980 FR	
DICHLOROBENZENES	Y	N	*1,120.	*763.	*1,970.		400.ug	2.6mg		1980 FR	1
DICHLOROBENZIDINE	Y	Y					0.01ug**	0.020ug**		1986 FR	1
DICHLOROETHANE 1,2	Y	Y	*118,000.	*20,000.	*113,000.		0.94ug**	243.ug**		1980 FR	1
DICHLOROETHYLENES	Y	Y	*11,600.		*224,000.		0.033ug**	1.85ug**		1980 FR	1
DICHLOROPHENOL 2,4	N	N	*2,020.	*365.			3.09mg			1980 FR	1
DICHLOROPROPANE	Y	N	*23,000.	*5,700.	*10,300.	*3,040.				1980 FR	1
DICHLOROPROPENE	Y	N	*6,060.	*244.	*790.		87.ug	14.1mg		1980 FR	1
DIELDRIN	Y	Y	2.5	0.0019	0.71	0.0019	0.071ng**	0.076ng**		1980 FR	16
DIETHYL PHTHALATE	Y	N					350.mg	1.8g		1980 FR	
DIMETHYL PHENOL 2,4	Y	N	*2,120.							1980 FR	
DIMETHYL PHTHALATE	Y	N					313.mg	2.9g		1980 FR	
DINITROTOLUENE 2,4	N	Y					0.11ug**	9.1ug**		1980 FR	
DINITROPHENOLS	Y	N					70.ug	14.3mg		1980 FR	
DINITROTOLUENE	N	Y	*330.	*230.	*590.	*370.				1980 FR	1
DINITRO-O-CRESOL 2,4.	Y	N					13.4ug	765.ug		1980 FR	
DIOXIN (2,3,7,8 - TCDD)	Y	Y	*<0.01	*<0.00001			0.000013ng**	0.000014ng**		1984 FR	1
DIPHENYLHYDRAZINE	Y	N					42.ng**	0.56ug**		1980 FR	1
DIPHENYLHYDRAZINE 1,2	Y	N	*270.							1980 FR	
DI-2-ETHYLHEXYL PHTHALATE	Y	N					15.mg	50.mg		1980 FR	
ENDOSULFAN	Y	N	0.22	0.056	0.034	0.0087	74.ug	159.ug		1980 FR	10
ENDRIN	Y	N	0.18	0.0023	0.037	0.0023	1.ug		0.0002mg	1980 FR	10
ETHYLBENZENE	Y	N	*32,000.								

HALOETHERS	Y	N	*360.	*122.						1980 FR	
HALOMETHANES	Y	Y	*11,000.		*12,000.	*6,400.	0.19ug**	15.7ug**		1980 FR	
HEPTACHLOR	Y	Y	0.52	0.0038	0.053	0.0036	0.28ng**	0.29ng**		1980 FR	12
HEXACHLOROETHANE	N	Y	*980.	*540.	*940.		1.9ug	8.74ug		1980 FR	1
HEXACHLOROBENZINE	Y	N					0.72ng**	0.74ng**		1980 FR	
HEXACHLOROBUTADIENE	Y	Y	*90.	*9.3	*32.		0.45ug**	50.ug**		1980 FR	3
HEXACHLOROCYCLOHEXANE (LINDANE)	Y	Y	2.0	0.08	0.16				0.004mg	1980 FR	17
HEXACHLOROCYCLOHEXANE - ALPHA	Y	Y					9.2ng**	31.ng**		1980 FR	
HEXACHLOROCYCLOHEXANE - BETA	Y	Y					16.3ng**	54.7ng**		1980 FR	
HEXACHLOROCYCLOHEXANE - GAMA	Y	Y					12.6ng**	62.5ng**		1980 FR	
HEXACHLOROCYCLOHEXANE - TECHNICAL	Y	Y					12.3ng**	41.4ng**		1980 FR	
HEXACHLOROCYCLOPENTADIENE	Y	N	*7.	*5.2	*7.		206.ug			1980 FR	3
IRON	N	N		1,000.			0.3mg			1976 RB	15
ISOPHORONE	Y	N	*117,000.		*12,900.		5.2mg	520.mg		1980 FR	
LEAD	Y	N	82.*	3.2*	140.	5.6	50.ug		0.05mg	1985 FR	20
MALATHION	N	N		0.01		0.01				1976 RB	7
MANGANESE	N	N					50 ug	100.ug		1976 RB	7
MERCURY	Y	N	2.4	0.012	2.1	0.025	144.ng	146.ng	0.002mg	1985 FR	17
METHOXYCHLOR	N	N		0.03		0.03	100.ug		0.1mg	1976 RB	12
MIREX	N	N		0.001		0.001				1976 RB	7
MONOCHLOROBENZENE	Y	N					488.ug			1980 FR	
NAPHTHALENE	Y	N	*2,300.	*620.	*2,350.					1980 FR	1
NICKEL	Y	N	1,800.*	96.*	140.	7.1	13.4ug	100.ug		1980 FR	10
NITRATES	N	N					10.mg		10.mg	1976 RB	5
NITROBENZENE	Y	N	*27,000.		*6,680.		19.8mg			1980 FR	1
NITROPHENOLS	Y	N	*230.	*150.	*4,850.					1980 FR	1
NITROSAMINES	Y	Y	*5,850.		*3,300,000		0.8ng**	1240.ng**		1980 FR	3
NITROSODIBUTYLAMINE N	Y	Y					6.4ng**	587.ng**		1980 FR	
NITROSODIETHYLAMINE N	Y	Y					0.8ng**	1,240.ng**		1980 FR	
NITROSODIMETHYLAMINE N	Y	Y					1.4ng**	16,000.ng**		1980 FR	
NITROSODIPHENYLAMINE N	Y	Y					4,900.ng**	16,100.ng**		1980 FR	
NITROSOPYRROLIDINE N	Y	Y					16.ng**	91,900.ng**		1980 FR	
OIL AND GREASE	N	N	NARRATIVE STATEMENT - SEE DOCUMENT							1976 RB	56
OXYGEN DISSOLVED	N	N	WARMWATER AND COLDWATER CRITERIA MATRIX - SEE DOCUMENT							1986 FR	56
PARATHION	N	N		0.04		0.04				1976 RB	8
PCB's	Y	Y	2.0	0.014	10.	0.03	0.079ng**	0.079ng**		1980 FR	16
PENTACHLORINATED ETHANES	Y	N	*7,240.	*1,100.	*390.	*281.				1980 FR	1
PENTACHLOROBENZENE	Y	N					74.ug	85.ug		1980 FR	
PENTACHLOROPHENOL	Y	N	*55.	*3.2	*53.	*34.	1.01mg			1980 FR	2
PH	N	N		6.5-9		6.5-8.5				1976 RB	56
PHENOL	Y	N	*10,200.	*2,560.	*5,800.		3.5mg			1980 FR	23
PHOSPHORUS ELEMENTAL	N	N				0.1				1976 RB	
PHTHALATE ESTERS	Y	N	*940.	*3.	*2,944.	*3.4				1980 FR	6
POLYNUCLEAR AROMATIC HYDROCARBONS	Y	Y			*300.		2.8ng**	31.1ng**		1980 FR	1
SELENIUM	Y	N	260.	35.	410.	54.	10.ug		0.01mg	1980 FR	15
SILVER	Y	N	4.1*	0.12	2.3		50 ug		0.05mg	1980 FR	14
SOLIDS DISSOLVED AND SALINITY	N	N					250.mg			1976 RB	56
SOLIDS SUSPENDED AND TURBIDITY	N	N	NARRATIVE STATEMENT - SEE DOCUMENT							1976 RB	44
SULFIDE-HYDROGEN SULFIDE	N	N		2.		2.				1976 RB	
TEMPERATURE	N	N	SPECIES DEPENDENT CRITERIA - SEE DOCUMENT							1976 RB	56
TETRACHLORINATED ETHANES	Y	N	*9,320.							1980 FR	
TETRACHLOROBENZENE 1,2,4,5	Y	N					38.ug	48.ug		1980 FR	
TETRACHLOROETHANE 1,1,2,2	Y	Y		*2,400.	*9,020.		0.17ug**	10.7ug**		1980 FR	1
TETRACHLOROETHANES	Y	N	*9,320.							1980 FR	1
TETRACHLOROETHYLENE	Y	Y	*5,280.	*840.	*10,200.	*450.	0.8ug**	8.85ug**		1980 FR	1
TETRACHLOROPHENOL 2,3,5,6	Y	N				*440.				1980 FR	
THALLIUM	Y	N	*1,400.	*40.	*2,130.		13.ug	48.ug		1980 FR	2
TOLUENE	Y	N	*17,500.		*6,300.	*5,000.	14.3mg	424.mg		1980 FR	1
TOXAPHENE	Y	Y	1.6	0.013	0.07		0.71ng**	0.73ng**	0.005mg	1980 FR	17
TRICHLORINATED ETHANES	Y	Y	*18,000.							1980 FR	
TRICHLOROETHANE 1,1,1	Y	N			*31,200.		18.4mg	1.03g		1980 FR	1
TRICHLOROETHANE 1,1,2	Y	Y		*9,400.			0.6ug**	41.8ug**		1980 FR	1
TRICHLOROETHYLENE	Y	Y	*45,000.	*21,900.	*2,000.		2.7ug**	80.7ug**		1980 FR	1
TRICHLOROPHENOL 2,4,5	Y	N					2,600.ug			1980 FR	
TRICHLOROPHENOL 2,4,6	N	Y		*970.			1.2ug**	3.6ug**		1980 FR	
VINYL CHLORIDE	Y	Y					2.ug**	525.ug**		1980 FR	
ZINC	Y	N	320.*	47.	170.	58.				1980 FR	19

g = grams
mg = milligrams
ug = micrograms
ng = nanograms
f = fibers

Y=YES
N=NO

* = HARDNESS DEPENDENT CRITERIA (100mg/L used)
• = INSUFFICIENT DATA TO DEVELOP CRITERIA. VALUE PRESENTED IS THE L.O.E.L. - LOWEST OBSERVED EFFECT LEVEL.
** = HUMAN HEALTH CRITERIA FOR CARCINOGENS REPORTED FOR THREE RISK LEVELS. VALUE PRESENTED IS THE 10-6 RISK LEVEL.

M.C.L. = MAXIMUM CONTAMINANT LEVEL

FR = FEDERAL REGISTER
RB = QUALITY CRITERIA FOR WATER, 1976 (REDBOOK)

Note: This chart is for general information; please use criteria documents or detailed summaries in "Quality Criteria for Water 1986" for regulatory purposes.

*ALDRIN-DIELDRIN

CRITERIA:

Aquatic Life

Dieldrin

For dieldrin the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0019 ug/L as a 24-hour average, and the concentration should not exceed 2.5 ug/L at any time.

For dieldrin the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0019 ug/L as a 24-hour average, and the concentration should not exceed 0.71 ug/L at any time.

Aldrin

For freshwater aquatic life the concentration of aldrin should not exceed 3.0 ug/L at any time. No data are available concerning the chronic toxicity of aldrin to sensitive freshwater aquatic life.

For saltwater aquatic life the concentration of aldrin should not exceed 1.3 ug/L at any time. No data are available concerning the chronic toxicity of aldrin to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects of exposure to aldrin through ingestion of contaminated water and contaminated aquatic organisms, the

*Indicates suspended, canceled or restricted by U.S. EPA Office of Pesticides and Toxic Substances ambient water concentration should be zero, based on the nonthreshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6} and 10^{-7} The corresponding recommended criteria are 0.74 ng/L, 0.074 ng/L, and 0.0074 ng/L, respectively. If these estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 0.79 ng/L, 0.079 ng/L, and 0.0079 ng/L, respectively.

For the maximum protection of human health from the potential carcinogenic effects of exposure to dieldrin through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero, based on the nonthreshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6} and 10^{-7}. The corresponding recommended criteria are 0.71 ng/L, 0.071 ng/L, and 0.0071 ng/L, respectively. If these above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 0.76 ng/L, 0.076 ng/L, and 0.0076 ng/L, respectively.

(45 F.R. 79318, November 28, 1980)
SEE APPENDIX B FOR METHODOLOGY

AMMONIA

SUMMARY:

All concentrations used herein are expressed as un-ionized ammonia (NH_3), because NH_3, not the ammonium ion (NH_4^+) has been demonstrated to be the principal toxic form of ammonia. The data used in deriving criteria are predominantly from flow through tests in which ammonia concentrations were measured. Ammonia was reported to be acutely toxic to freshwater organisms at concentrations (uncorrected for pH) ranging from 0.53 to 22.8 mg/L NH_3 for 19 invertebrate species representing 14 families and 16 genera and from 0.083 to 4.60 mg/L NH_3 for 29 fish species from 9 families and 18 genera. Among fish species, reported 96-hour LC50 ranged from 0.083 to 1.09 mg/L for salmonids and from 0.14 to 4.60 mg/L NH_3 for nonsalmonids. Reported data from chronic tests on ammonia with two freshwater invertebrate species, both daphnids, showed effects at concentrations (uncorrected for pH) ranging from 0.304 to 1.2 mg/L NH_3, and with nine freshwater fish species, from five families and seven genera, ranging from 0.0017 to 0.612 mg/L NH_3.

Concentrations of ammonia acutely toxic to fishes may cause loss of equilibrium, hyperexcitability, increased breathing, cardiac output and oxygen uptake, and, in extreme cases, convulsions, coma, and death. At lower concentrations ammonia has many effects on fishes, including a reduction in hatching success, reduction in growth rate and morphological development, and pathologic changes in tissues of gills, livers, and kidneys.

Several factors have been shown to modify acute NH_3 toxicity in fresh water. Some factors alter the concentration of un-ionized ammonia in the water by affecting the aqueous ammonia equilibrium, and some factors affect the toxicity of un-ionized ammonia itself, either ameliorating or exacerbating the effects of ammonia. Factors that have been shown to affect ammonia toxicity include dissolved oxygen concentration, temperature, pH, previous acclimation to ammonia, fluctuating or intermittent exposures, carbon dioxide concentration, salinity, and the presence of other toxicants.

The most well-studied of these is pH; the acute toxicity of NH_3 has been shown to increase as pH decreases. Sufficient data exist from toxicity tests conducted at different pH values to formulate a mathematical expression to describe pH-dependent acute NH_3 toxicity. The very limited amount of data regarding effects of pH on chronic NH_3 toxicity also indicates increasing NH_3 toxicity with decreasing pH, but the data are insufficient to derive a broadly applicable toxicity/pH relationship. Data on temperature effects on acute NH_3 toxicity are limited and somewhat variable, but indications are that NH_3 toxicity to fish is greater as temperature decreases. There is no information available regarding temperature effects on chronic NH_3 toxicity.

Examination of pH and temperature-corrected acute NH_3 toxicity values among species and genera of freshwater organisms showed that invertebrates are generally more tolerant than fishes, a notable exception being the fingernail clam. There is no clear trend among groups of fish; the several most sensitive tested species and genera include representatives from diverse families (Salmonidae, Cyprinidae, Percidae, and Centrarchidae). Available chronic toxicity data for freshwater organisms also indicate invertebrates (cladocerans, one insect species) to be more tolerant than fishes, again with the exception of the fingernail clam. When corrected for the presumed effects of temperature and pH, there is also no clear trend among groups of fish for chronic toxicity values, the most sensitive species including representatives from five families (Salmonidae, Cyprinidae, Ictaluridae, Centrarchidae, and Catostomidae) and having chronic values ranging by not much more than a factor or two. The range of acute-chronic ratios for 10 species from 6 families was 3 to 43, and acute-chronic ratios were higher for the species having chronic tolerance below the median. Available data indicate that differences in sensitivities between warm and coldwater families of aquatic organisms are inadequate to warrant discrimination in the national ammonia criterion between bodies of water with "warm" and "coldwater" fishes; rather, effects of organism sensitivities on the criterion are most appropriately handled by site-specific criteria derivation procedures.

Data for concentrations of NH_3 toxic to freshwater phytoplankton and vascular plants, although limited, indicate that freshwater plant species are appreciably more tolerant to NH_3 than are invertebrates or fishes. The ammonia criterion appropriate for the protection of aquatic animals will therefore in all likelihood be sufficiently protective of plant life.

Available acute and chronic data for ammonia with saltwater organisms are very limited, and insufficient to derive a saltwater criterion. A few saltwater invertebrate species have been tested, and the prawn Macrobrachium rosenbergii was the most sensitive. The few saltwater fishes tested suggest greater sensitivity than freshwater fishes. Acute toxicity of NH_3 appears to be greater at low pH values, similar to findings in freshwater. Data for saltwater plant species are limited to diatoms, which appear to be more sensitive than the saltwater invertebrates for which data are available.

More quantitative information needs to be published on the toxicity of ammonia to aquatic life. Several key research needs must be addressed to provide a more complete assessment of ammonia toxicity. These are: (1) acute tests with additional saltwater fish species and saltwater invertebrate species; (2) life-cycle and early life-stage tests with representative freshwater and saltwater organisms from different families, with particular attention to trends of acute-chronic ratios; (3) fluctuating and intermittent exposure tests with a variety of species and exposure patterns; (4) more complete tests of the individual and combined effects of pH and temperature, especially for chronic toxicity; (5) more histopathological and histochemical research with fishes, which would provide a rapid means of identifying and quantifying sublethal ammonia effects; and (6) studies on effects of dissolved and suspended solids on acute and chronic toxicity.

NATIONAL CRITERIA:

The procedures described in the Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses indicate that, except possibly where a locally important species is very sensitive, freshwater aquatic organisms and their uses should not be affected unacceptably if:

(1) the 1-hour* average concentration of un-ionized ammonia (in mg/L NH_3) does not exceed, more often than once every 3 years on the average, the numerical value given by 0.52/FT/FPH/2,

where:

$$FT = 10^{0.03(20-TCAP)}; \quad TCAP \leq T \leq 30$$

$$10^{0.03(20-T)}; \quad 0 \leq T \leq TCAP$$

$$FPH = 1 \quad ; \; 8 < pH < 9$$

$$\frac{1+10^{7.4-pH}}{1.25} \quad ; \; 6.5 \leq pH \leq 7.7$$

TCAP = 20 C; Salmonids or other sensitive coldwater species present

= 25 C; Salmonids and other sensitive coldwater species absent

(*An averaging period of 1 hour may not be appropriate if excursions of concentrations to greater than 1.5 times the average occur during the hour; in such cases, a shorter averaging period may be needed.)

(2) the 4-day average concentration of un-ionized ammonia (in mg/L NH_3) does not exceed, more often than once every 3 years on the average, the average* numerical value given by 0.80/FT/FPH/RATIO, where FT and FPH are as above and:

$$\text{RATIO} = 16 \qquad ;\ 7.7 \le pH \le 9$$

$$= 24\ \frac{10^{7.7-pH}}{1+10^{7.4pH}} \qquad ;6.5 \le pH \le 7.7$$

TCAP = 15 C; Salmonids or other sensitive coldwater species present

= 20 C; Salmonids and other sensitive coldwater species absent

(*Because these formulas are nonlinear in pH and temperature, the criterion should be the average of separate evaluations of the formulas reflective of the fluctuations of flow, pH, and temperature within the averaging period; it is not appropriate in general to simply apply the formula to average pH, temperature, and flow.)

The extremes for temperature (0, 30) and pH (6.5, 9) given in the above formulas are absolute. It is not permissible with current data to conduct any extrapolations beyond these limits. In particular, there is reason to believe that appropriate criteria at pH > 9 will be lower than the plateau between pH 8 and 9 given above.

Criteria concentrations for the pH range 6.5 to 9.0 and the temperature range 0 C to 30 C are provided in the following tables. Total ammonia concentrations equivalent to each un-ionized ammonia concentration are also provided in these tables. There are limited data on the effect of temperature on chronic toxicity. EPA will be conducting additional research on the effects of temperature on ammonia toxicity in order to fill perceived data gaps. Because of this uncertainty, additional site-specific information should be developed before these criteria are used in wasteload allocation modeling. For example, the chronic criteria tabulated for sites lacking salmonids are less certain at temperatures much below 20 C than those tabulated at temperatures near 20 C. Where the treatment levels needed to meet these criteria below 20 C may be substantial, use of site-specific criteria is strongly suggested. Development of such criteria should be based upon site-specific toxicity tests.

Data available for saltwater species are insufficient to derive a criterion for saltwater.

The recommended exceedence frequency of 3 years is the Agency's best scientific judgment of the average amount of time it will take an unstressed system to recover from a pollution event in which exposure to ammonia exceeds the criterion. A stressed system, for example, one in which several outfalls occur in a limited area, would be expected to require more time for recovery. The resilience of ecosystems and their ability to recover differ greatly, however, and site-specific criteria may be established if adequate justification is provided.

The use of criteria in designing waste treatment facilities requires the selection of an appropriate wasteload allocation model. Dynamic models are preferred for the application of these criteria. Limited data or other factors may make their use impractical, in which case one should rely on a steady-state model. The Agency recommends the interim use of 1Q5 or 1Q10 for Criterion Maximum Concentration design flow and 7Q5 or 7Q10 for the Criterion Continuous Concentration design flow in steady-state models for unstressed and stressed systems respectively.

(2) 4-day average concentrations for ammonia.*

pH	0 C	5 C	10 C	15 C	20 C	25 C	30 C
A. Salmonids or Other Sensitive Coldwater Species Present							
Un-ionized Ammonia (mg/liter NH_3)							
6.50	0.0007	0.0009	0.0013	0.0019	0.0019	0.0019	0.0019
6.75	0.0012	0.0017	0.0023	0.0033	0.0033	0.0033	0.0033
7.00	0.0021	0.0029	0.0042	0.0059	0.0059	0.0059	0.0059
7.25	0.0037	0.0052	0.0074	0.0105	0.0105	0.0105	0.0105
7.50	0.0066	0.0093	0.0132	0.0186	0.0186	0.0186	0.0186
7.75	0.0109	0.0153	0.022	0.031	0.031	0.031	0.031
8.00	0.0126	0.0177	0.025	0.035	0.035	0.035	0.035
8.25	0.0126	0.0177	0.025	0.035	0.035	0.035	0.035
8.50	0.0126	0.0177	0.025	0.035	0.035	0.035	0.035
8.75	0.0126	0.0177	0.025	0.035	0.035	0.035	0.035
9.00	0.0126	0.0177	0.025	0.035	0.035	0.035	0.035
Total Ammonia (mg/liter NH_3)							
6.50	2.5	2.4	2.2	2.2	1.49	1.04	0.73
6.75	2.5	2.4	2.2	2.2	1.49	1.04	0.73
7.00	2.5	2.4	2.2	2.2	1.49	1.04	0.74
7.25	2.5	2.4	2.2	2.2	1.50	1.04	0.74
7.50	2.5	2.4	2.2	2.2	1.50	1.05	0.74
7.75	2.3	2.2	2.1	2.0	1.40	0.99	0.71
8.00	1.53	1.44	1.37	1.33	0.93	0.66	0.47
8.25	0.87	0.82	0.78	0.76	0.54	0.39	0.28
8.50	0.49	0.47	0.45	0.44	0.32	0.23	0.17
8.75	0.28	0.27	0.26	0.27	0.19	0.15	0.11
9.00	0.16	0.16	0.16	0.16	0.13	0.10	0.08
B. Salmonids and Other Sensitive Coldwater Species Absent†							
Un-ionized Ammonia (mg/liter NH_3)							
6.50	0.0007	0.0009	0.0013	0.0019	0.0026	0.0026	0.0026
6.75	0.0012	0.0017	0.0023	0.0033	0.0047	0.0047	0.0047
7.00	0.0021	0.0029	0.0042	0.0059	0.0083	0.0083	0.0083
7.25	0.0037	0.0052	0.0074	0.0105	0.0148	0.0148	0.0148
7.50	0.0066	0.0093	0.0132	0.0186	0.026	0.026	0.026
7.75	0.0109	0.0153	0.022	0.031	0.043	0.043	0.043
8.00	0.0126	0.0177	0.025	0.035	0.050	0.050	0.050
8.25	0.0126	0.0177	0.025	0.035	0.050	0.050	0.050
8.50	0.0126	0.0177	0.025	0.035	0.050	0.050	0.050
8.75	0.0126	0.0177	0.025	0.035	0.050	0.050	0.050
9.00	0.0126	0.0177	0.025	0.035	0.050	0.050	0.050
Total Ammonia (mg/liter NH_3)							
6.50	2.5	2.4	2.2	2.2	2.1	1.46	1.03
6.75	2.5	2.4	2.2	2.2	2.1	1.47	1.04
7.00	2.5	2.4	2.2	2.2	2.1	1.47	1.04
7.25	2.5	2.4	2.2	2.2	2.1	1.48	1.05
7.50	2.5	2.4	2.2	2.2	2.1	1.49	1.06
7.75	2.3	2.2	2.1	2.0	1.98	1.39	1.00
8.00	1.53	1.44	1.37	1.33	1.31	0.93	0.67
8.25	0.87	0.82	0.78	0.76	0.76	0.54	0.40
8.50	0.49	0.47	0.45	0.44	0.45	0.33	0.25
8.75	0.28	0.27	0.26	0.27	0.27	0.21	0.16
9.00	0.16	0.16	0.16	0.16	0.17	0.14	0.11

* To convert these values to mg/liter N, multiply by 0.822.

† Site-specific criteria development is strongly suggested at temperatures above 20 C because of the limited data available to generate the criteria recommendation, and at temperatures below 20 C because of the limited data and because small changes in the criteria may have significant impact on the level of treatment required in meeting the recommended criteria.

(1) One-hour average concentrations for ammonia.*

pH	0 C	5 C	10 C	15 C	20 C	25 C	30 C
A. Salmonids or Other Sensitive Coldwater Species Present							
Un-ionized Ammonia (mg/liter NH_3)							
6.50	0.0091	0.0129	0.0182	0.026	0.036	0.036	0.036
6.75	0.0149	0.021	0.030	0.042	0.059	0.059	0.059
7.00	0.023	0.033	0.046	0.066	0.093	0.093	0.093
7.25	0.034	0.048	0.068	0.095	0.135	0.135	0.135
7.50	0.045	0.064	0.091	0.128	0.181	0.181	0.181
7.75	0.056	0.080	0.113	0.159	0.22	0.22	0.22
8.00	0.065	0.092	0.130	0.184	0.26	0.26	0.26
8.25	0.065	0.092	0.130	0.184	0.26	0.26	0.26
8.50	0.065	0.092	0.130	0.184	0.26	0.26	0.26
8.75	0.065	0.092	0.130	0.184	0.26	0.26	0.26
9.00	0.065	0.092	0.130	0.184	0.26	0.26	0.26
Total Ammonia (mg/liter NH_3)							
6.50	35	33	31	30	29	20	14.3
6.75	32	30	28	27	27	18.6	13.2
7.00	28	26	25	24	23	16.4	11.6
7.25	23	22	20	19.7	19.2	13.4	9.5
7.50	17.4	16.3	15.5	14.9	14.6	10.2	7.3
7.75	12.2	11.4	10.9	10.5	10.3	7.2	5.2
8.00	8.0	7.5	7.1	6.9	6.8	4.8	3.5
8.25	4.5	4.2	4.1	4.0	3.9	2.8	2.1
8.50	2.6	2.4	2.3	2.3	2.3	1.71	1.28
8.75	1.47	1.40	1.37	1.38	1.42	1.07	0.83
9.00	0.86	0.83	0.83	0.86	0.91	0.72	0.58
B. Salmonids and Other Sensitive Coldwater Species Absent							
Un-ionized Ammonia (mg/liter NH_3)							
6.50	0.0091	0.0129	0.0182	0.026	0.036	0.051	0.051
6.75	0.0149	0.021	0.030	0.042	0.059	0.084	0.084
7.00	0.023	0.033	0.046	0.066	0.093	0.131	0.131
7.25	0.034	0.048	0.068	0.095	0.135	0.190	0.190
7.50	0.045	0.064	0.091	0.128	0.181	0.26	0.26
7.75	0.056	0.080	0.113	0.159	0.22	0.32	0.32
8.00	0.065	0.092	0.130	0.184	0.26	0.37	0.37
8.25	0.065	0.092	0.130	0.184	0.26	0.37	0.37
8.50	0.065	0.092	0.130	0.184	0.26	0.37	0.37
8.75	0.065	0.092	0.130	0.184	0.26	0.37	0.37
9.00	0.065	0.092	0.130	0.184	0.26	0.37	0.37
Total Ammonia (mg/liter NH_3)							
6.50	35	33	31	30	29	29	20
6.75	32	30	28	27	27	26	18.6
7.00	28	26	25	24	23	23	16.4
7.25	23	22	20	19.7	19.2	19.0	13.5
7.50	17.4	16.3	15.5	14.9	14.6	14.5	10.3
7.75	12.2	11.4	10.9	10.5	10.3	10.2	7.3
8.00	8.0	7.5	7.1	6.9	6.8	6.8	4.9
8.25	4.5	4.2	4.1	4.0	3.9	4.0	2.9
8.50	2.6	2.4	2.3	2.3	2.3	2.4	1.81
8.75	1.47	1.40	1.37	1.38	1.42	1.52	1.18
9.00	0.86	0.83	0.83	0.86	0.91	1.01	0.82

* To convert these values to mg/liter N, multiply by 0.822.

The Agency acknowledges that the Criterion Continuous Concentration stream flow averaging period used for steady-state wasteload allocation modeling may be as long as 30 days in situations involving POTWs designed to remove ammonia where limited variability of effluent pollutant concentration and resultant concentrations in receiving waters can be demonstrated. In cases where low variability can be demonstrated, longer averaging periods for the ammonia Criterion Continuous Concentration (e.g., 30-day averaging periods) would be acceptable because the magnitude and duration of exceedences above the Criterion Continuous Concentration would be sufficiently limited. These matters are discussed in more detail in the Technical Support Document for Water Quality-Based Toxics Control (U.S. EPA, 1985a).

(50 F.R. 30784, July 29, 1985)
SEE APPENDIX A FOR METHODOLOGY

BERYLLIUM

CRITERIA:

Aquatic Life

The available data for beryllium indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 130 and 5.3 ug/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Hardness has a substantial effect on acute toxicity.

The limited saltwater data base available for beryllium does not permit any statement concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects of exposure to beryllium through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero, based on the non threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 68 ng/L, 6.8 ng/L, and 0.68 ng/L, respectively. If these estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 1170 ng/L, 117.0 ng/L, and 11.71 ng/L, respectively.

(45 F.R. 79318, November 28, 1980)
SEE APPENDIX B FOR METHODOLOGY

BORON

CRITERION:

750 ug/L for long-term irrigation on sensitive crops.

INTRODUCTION:

Boron is not found in its elemental form in nature: it is usually found as a sodium or calcium borate salt. Boron salts are used in fire retardants, the production of glass, leather tanning and finishing industries, cosmetics, photographic materials, metallurgy and for high energy rocket fuels. Elemental boron also can be used in nuclear reactors for neutron absorption. Borates are used as "burnable" poisons.

RATIONALE:

Boron is an essential element for growth of plants but there is no evidence that it is required by animals. The maximum concentration found in 1,546 samples of river and lake waters from various parts of the United States was 5.0 mg/L; the mean value was 0.1 mg/L (Kopp and Kroner, 1967). Ground waters could contain substantially higher concentrations at certain places. The concentration in seawater is reported as 4.5 mg/L in the form of borate (NAS, 1974). Naturally occurring concentrations of boron should have no effects on aquatic life.

The minimum lethal dose for minnows exposed to boric acid at 20 °C for 6 hours was reported to be 18,000 to 19,000 mg/L in distilled water and 19,000 to 19,500 mg/L in hard water (Le Clerc and Devlaminck, 1955: Le Clerc, 1960).

In the dairy cow, 16 to 20 g/day of boric acid for 40 days produced no ill effects (McKee and Wolf, 1963).

Sensitive crops have shown toxic effects at 1000 ug/L or less of boron (Richards, 1954). Bradford (1966), in a review of boron deficiencies and toxicities, stated that when the boron concentration in irrigation waters was greater than 0.75 ug/L, some sensitive plants such as citrus began to show injury. Biggar and Fireman (1960) showed that with neutral and alkaline soils of high absorption capacities, water containing 2 ug/L boron might be used for some time without injury to sensitive plants. The criterion of 750 ug/L is thought to protect sensitive crops during long-term irrigation.

(QUALITY CRITERIA FOR WATER, JULY 1976) PB-263943
SEE APPENDIX C FOR METHODOLOGY

CHLORINATED BENZENES

CRITERIA

Aquatic Life

The available data for chlorinated benzenes indicate that acute toxicity to fresh water aquatic life at concentrations as low as 250 ug/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of the more toxic of the chlorinated benzenes to sensitive freshwater aquatic life but toxicity occurs at concentrations as low as 50 ug/L for a fish species exposed for 7.5 days.

The available data for chlorinated benzenes indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 160 and 129 ug/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for monochlorobenzene. Based on available toxicity data, for the protection of public health, the derived level is 488 ug/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 20 ug/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Trichlorobenzenes

Due to the insufficiency in the available information for the trichlorobenzenes, a criterion cannot be derived at this time using the present guidelines.

1,2,4,5-Tetrachlorobenzene

For the protection of human health from the toxic properties of 1,2,4,5-tetrachlorobenzene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 38 ug/L.

For the protection of human health from the toxic properties of 1,2,4,5-tetrachlorobenzene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 48 ug/L.

Pentachlorobenzene

For the protection of human health from the toxic properties of pentachlorobenzene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 74 ug/L.

For the protection of human health from the toxic properties of pentachlorobenzene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 85 ug/L.

Hexachlorobenzene

For the maximum protection of human health from the potential carcinogenic effects due to exposure of hexachlorobenzene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefor, the levels which may result in incramental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 7.2 ng/L, 0.72 ng/L, and 0.072 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 7.4 ng/L, 0.74 ng/L and 0.074. ng/L respectively.

(45 F.R. 79318, November 28, 1980)
SEE APPENDIX B FOR METHODOLOGY

DICHLOROPROPANES/DICHLOROPROPENES

CRITERIA:

Aquatic Life

The available data for dichloropropanes indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 23,000 and 5,700 ug/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

The available data for dichloropropene indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 6,060 and 244 ug/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

The available data for dichloropropane indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 10,300 and 3,040 ug/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

The available data for dichloropropene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 790 ug/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of dichloropropene to sensitive saltwater aquatic life.

Human Health

Using the present guidelines, a satisfactory criterion cannot be derived at this time because of insufficient available data for dichloropropanes.

For the protection of human health from the toxic properties of dichloropropenes ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 87 ug/L.

For the protection of human health from the toxic properties of dichloropropenes ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 14.1 mg/L.

(45 F.R. 79318, November 28, 1980)
SEE APPENDIX B FOR METHODOLOGY

*ENDRIN

CRITERIA:

Aquatic Life

For endrin the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0023 ug/L as a 24-hour average, and the concentration should not exceed 0.18 ug/L at any time.

For endrin the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0023 ug/L as a 24-hour average, and the concentration should not exceed 0.037 ug/L at any time.

Human Health

The ambient water quality criterion for endrin is recommended to be identical to the existing water standard which is 1.0 ug/L. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 g of aquatic organisms was not derived.

*Indicates suspended, canceled or restricted by U.S. EPA Office of Pesticides and Toxic Substances

(45 F.R. 79318, November 28, 1980)
SEE APPENDIX B FOR METHODOLOGY

HEPTACHLOR

CRITERIA:

Aquatic Life

For heptachlor the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0038 ug/L as a 24-hour average, and the concentration should not exceed 0.52 ug/L at any time.

For heptachlor the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0036 ug/L as a 24-hour average, and the concentration should not exceed 0.053 ug/L at any time.

Human Health

For the maximum protection of human health from the potential carcinogenic effects of exposure to heptachlor through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero, based on the non threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 2.78 ng/L, 0.28 ng/L, and 0.028 ng/L, respectively. If these estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 2.85 ng/L, 0.29 ng/L, and 0.029 ng/L, respectively.

(45 F.R. 79318, November 28, 1980)
SEE APPENDIX B FOR METHODOLOGY

HEXACHLOROCYCLOHEXANE

CRITERIA:

Aquatic Life

Lindane

For lindane the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.080 ug/L as a 24-hour average and the concentration should not exceed 2.0 ug/L at any time.

For saltwater aquatic life the concentration of lindane should not exceed 0.16 ug/L at any time. No data are available concerning the chronic toxicity of lindane to sensitive saltwater aquatic life.

BHC

The available data for a mixture of isomers of BHC indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 100 ug/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of a mixture of isomers of BHC to sensitive freshwater aquatic life.

The available data for a mixture of isomers of BHC indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 0.34 ug/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of a mixture of isomers of BHC to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects of exposure to alpha-hexachlorocyclohexane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentrations should be zero, based on the nonthreshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 92 ng/L, 9.2 ng/L, and .92 ng/L, respectively. If these estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 310 ng/L, 31.0 ng/L, and 3.10 ng/L, respectively.

For the maximum protection of human health from the potential carcinogenic effects of exposure to beta-hexachlorocyclohexane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentrations should be zero, based on the nonthreshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 163 ng/L, 16.3 ng/L, and 1.63 ng/L, respectively. If these estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 547 ng/L, 54.7 ng/L, and 5.47 ng/L, respectively.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of gama-hexachlorocyclohexane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentrations should be zero, based on the nonthreshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 186 ng/L, 18.6 ng/L, and 1.86 ng/L, respectively. If these estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 625 ng/L, 62.5 ng/L, and 6.25 ng/L, respectively.

For the maximum protection of human health from the potential carcinogenic effects of exposure to technical-hexachlorocyclohexane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentrations should be zero, based on the nonthreshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 123 ng/L, 12.3 ng/L, and 1.23 ng/L, respectively. If these estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 414 ng/L, 41.4 ng/L, and 4.14 ng/L, respectively.

Using the present guidelines, satisfactory criteria cannot be derived at this time for delta and epsilon hexachlorocyclohexane because of insufficient available data.

(45 F.R. 79318, November 28, 1980)
SEE APPENDIX B FOR METHODOLOGY

MIREX

CRITERION:

0.001 ug/L for freshwater and marine aquatic life.

RATIONALE:

Mirex is used to control the imported fire ant *Solenopsis saevissima richteri* in the southeastern United States. Its use is essentially limited to the control of this insect and it is always presented in bait. In the most common formulation, technical grade mirex is dissolved in soybean oil and sprayed on corncob grits. The bait produced in this manner consists of 0.3 percent mirex, 14.7 percent soybean oil and 85 percent corncob grits. The mirex bait often is applied at a rate of 1.4 kg/ha, equivalent to 4.2 grams of toxicant per hectare.

Relatively few studies have been made of the effects of mirex on freshwater invertebrates of these, only Ludke et al. (1971) report chemical analyses of mirex in the water. Their study reported effects on two crayfish species exposed to mirex by three techniques. First, field-collected crayfish were exposed to several sublethal concentrations of technical grade mirex solutions for various periods of time; second, crayfish were exposed to mirex leached from bait (0.3 percent active ingredient); and third, the crayfish were fed mirex bait.

Procambarus blandingi juveniles were exposed to 1 or 5 ug/L for 6 to 144 hours, transferred to clean water and observed for 10 days. After 5 days in clean water, 95 percent of the animals exposed to 1 ug/L for 144 hours were dead. Exposure to 5 ug/L for 6, 24, and 58 hours resulted in 26, 50, and 98 percent mortality 10 days after transfer to clean water. Crayfish, *Procambarus hayi*, were exposed to 0.1 and 0.5 ug/L for 48 hours. Four days after transfer to clean water, 65 percent of the animals exposed to 0.1 ug/L were dead. At the 0.5 ug/L concentration, 71 percent of the animals were dead after 4 days in clean water. Tissue residue accumulations (wet weight basis) ranged from 940- to 27,210-fold above water concentrations. In leached bait experiments, 10 bait particles were placed in 2 liters of water but isolated from 20 juvenile crayfish. Thirty percent of the crayfish were dead in 4 days and 95 percent were dead in 7 days. Water analysis indicated mirex concentrations of 0.86 ug/L. In feeding experiments, 108 crayfish each were fed one bait particle. Mortality was noticed on the first day after feeding, and by the sixth day 77 percent were dead. In another experiment, all crayfish were dead 4 days after having been fed 2 bait particles each. From this report it is obvious that mirex is extremely toxic to these species of crayfish. Mortality and accumulation increase with time of exposure to the insecticide. Concentrations as low as 0.1 ug/L or the ingestion of one particle resulted in death.

Research to determine effects of mirex on fish has been concentrated on species which have economic and sport fishery importance. Hyde et al. (1974) applied mirex bait (0.3 percent mirex) at the standard rate (1.4 kg/ha) in four ponds containing channel catfish, *Ictalurus punctatus*. Three applications were made over an 8-month period with the first application 8 days after fingerling (average weight 18.4 g) catfish were placed in the ponds. Fish were collected at each subsequent application (approximately 4-month intervals). Two and one half months after the final application, the ponds were drained, all fish were measured and weighed, and the percent survival was calculated. Mirex residues in the fish at termination of the experiment ranged from 0.015 ug/g (ppm) in the fillet to 0.255 ug/g in the fat.

In another study, Van Valin et al. (1968) exposed bluegills, Lepomis macrochirus, and the goldfish, Carassius auratus, to mirex by feeding a mirex-treated diet (1, 3, and 5 mg mirex per kg body weight) or by treating holding ponds with mirex bait (1.3, 100, and 1000 ug/L computed water concentration). They reported no mortality or tissue pathology for the bluegills; however, after 56 days of exposure, gill breakdown in goldfish was found in the 100 and 1000 ug/L contact exposure ponds, and kidney breakdown was occurring in the 1000 ug/L ponds. Mortality in the feeding experiments was not related to the level of exposure, although growth of the bluegills fed 5 ug/L mirex was reduced.

In laboratory and field test systems, reported concentrations of mirex usually are between 0.5 and 1.0 ug/L (Van Valin et al. 1968: Ludke et al. 1971). Although mirex seldom is found above 1 ug/L in the aquatic environment, several field studies have shown that the insecticide is accumulated through the food chain. Borthwick et al. (1973) reported the accumulation of mirex in South Carolina estuaries. Their data revealed that mirex was transported from treated land and marsh to the estuary animals and that accumulation, especially in predators, occurred. In the test area, water samples consistently were less than 0.01 ug/L

Residues in fish varied from non-detectable to 0.8 ug/g with 15 percent of the samples containing residues. The amount of mirex and the percent of samples containing mirex increased at higher trophic levels. Fifty-four percent of the raccoons sampled contained mirex residues up to 4.4 ug/g and 78 percent of the birds contained residues up to 17 ug/g. Nagvi and de la Cruz (1973) reported average residues for molluscs (0.15 ug/g), fish (0.26 ug/g), insects (0.29 ug/g), crustaceans (0.44 ug/g) and annelids (0.63 ug/g). They also reported that mirex was found in areas not treated with mirex which suggests movement of the pesticide in the environment. Wolfe and Norment (1973) sampled an area for one year following an aerial application of mirex bait (2.1 g mirex/ha). Crayfish residues ranged from 0.04 to 0.16 ug/g. Fish residues were about 2 to 20 times greater than the controls and averaged from 0.01 to 0.76 ug/g. Kaiser (1974), reported the presence of mirex in fish from the Bay of Quinte, Lake Ontario, Canada. Concentrations range from 0.02 ug/g in the gonads of the northern long nose gar, Lepistosteus osseus, to 0.05 ug/g in the post-anal fin of the northern pike, Esox lucius. Mirex has never been registered for use in Canada.

Mirex does not appear to be greatly toxic to birds, with LC50's for the young of four species ranging from 547 to greater than 1667 ug/g (Heath et al. 1972). Long-term dietary dosages caused no adverse effect at 3 ug/g with mallards and 13 ug/g with pheasants (Heath and Spann, 1973). However, it has been reported (Stickel et al. 1973) that the persistence of mirex in bird tissue exceeds that of all organochlorine compounds tested except for DDE. Delayed mortality occurred among birds subjected to doses above expected environmental concentration.

A summary examination of the data available at this time shows a mosaic of effects. Crayfish and channel catfish survival is affected by mirex in the water or by ingestion of the bait particles. Bioaccumulation is well established for a wide variety of organisms but the effect of this bioaccumulation on the aquatic ecosystem is unknown. There is evidence that mirex is very persistent in bird tissue. Considering the extreme toxicity and potential for bioaccumulation, every effort should be made to keep mirex bait particles out of water containing aquatic organisms and water concentrations should not exceed 0.001 ug/L mirex. This value is based upon an application factor of 0.01 applied to the lowest levels at which effects on crayfish have been observed.

Data upon which to base a marine criterion involve several estuarine and marine crustaceans. A concentration of 0.1 ug/L technical grade mirex in flowing seawater was lethal to juvenile pink shrimp, Penaeus duorarum, in a 3-week exposure (Lowe et al. 1971). In static tests with larval stages (megalopal) of the mud crab, Rhithropanopeus harrisii, reduced survival was observed in 0.1 ug/L mirex (Bookhout et al. 1972). In three of four 28-day seasonal flow-through experiments, Tagatz et al. (1975) found reduced survival of Callinectes sapidus, Penaeus duorarum, and grass shrimp, Palaemonetes pugio, at levels of 0.12 ug/L in summer, 0.06 ug/L in fall and 0.09 ug/L in winter.

Since two reports, Lowe et al. (1971) and Bookhout et al. (1972), stated that effects of mirex on estuarine and marine crustaceans were observed only after considerable time had elapsed, it seems reasonable that length of exposure is an important consideration for this chemical. This may not be the case in fresh water since the crayfish were affected within 48 hours. Therefore, a 3- to 4-week exposure might be considered "acute" and by applying an application factor of 0.01 to a reasonable average of toxic-effect levels as summarized above, a recommended marine criterion of 0.001 ug/L results.

(QUALITY CRITERIA FOR WATER, JULY 1976) PB-263943
SEE APPENDIX C FOR METHODOLOGY

NICKEL

CRITERIA:

Aquatic Life

For total recoverable nickel the criterion (in ug/L) to protect freshwater aquatic life as derived using the Guidelines is the numerical value given by $e^{(0.76[\ln(\text{hardness})]+1.06)}$ as a 24-hour average, and the concentration (in ug/L) should not exceed the numerical value given by $e^{(0.76[\ln(\text{hardness})]+4.02)}$ at any time. For example, at hardnesses of 50, 100, and 200 mg/L as $CaCO^3$ the criteria are 56, 96, and 160 ug/L, respectively, as 24-hour averages, and the concentrations should not exceed 1,100, 1,800, and 3,100 ug/L, respectively, at any time.

For total recoverable nickel the criterion to protect saltwater aquatic life as derived using the Guidelines is 7.1 ug/L as a 24-hour average, and the concentration should not exceed 140 ug/L at any time.

Human Health

For the protection of human health from the toxic properties of nickel ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 13.4 ug/L.

For the protection of human health from the toxic properties of nickel ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 100. ug/L.

(45 F.R. 79318, November 28, 1980)
SEE APPENDIX B FOR METHODOLOGY

2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

CRITERIA:

Aquatic Life

Not enough data are available concerning the effects of 2,3,7,8-TCDD on aquatic life and its uses to allow derivation of national criteria. The available information indicates that acute values for some freshwater animal species are >1.0 ug/L; some chronic values are <0.01 ug/L; and the chronic value for rainbow trout is <0.001 ug/L. Because exposures of some species of fishes to 0.01 ug/L for <6 days resulted in substantial mortality several weeks later, derivation of aquatic life criteria for 2,3,7,8-TCDD may require special consideration. Predicted bioconcentration factors (BCFs) for 2,3,7,8-TCDD range from 3,000 to 900,000, but the available measured BCFs range from 390 to 13,000. If the BCF is 5,000, concentrations >0.00001 ug/L should result in concentrations in edible freshwater and saltwater fish and shellfish that exceed levels identified in a U.S. FDA health advisory. If the BCF is >5,000 or if uptake in a field situation is greater than that in laboratory tests, the value of 0.00001 ug/L will be too high.

Human Health

For the maximum protection of human health from the potential carcinogenic effects of 2,3,7,8-TCDD exposure through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero. This criterion is based on the nonthreshold assumption for 2,3,7,8-TCDD. However, zero may not be an attainable level at this time. Therefore, the levels that may result in an increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 1.3×10^{-7}, 1.3×10^{-8} and 1.3×10^{-9} ug/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 1.4×10^{-7}, 1.4×10^{-8} and 1.4×10^{-9} ug/L, respectively. If these estimates are made for comsumption of water only, the levels are 2.2×10^{-6}, 2.2×10^{-7} and 2.2×10^{-8} ug/L, respectively.

(49 F.R. 5831, February 15, 1984)
SEE APPENDIX B FOR METHODOLOGY

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