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C.T.A. Moermond | E.H.W. Heugens

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C.T.A. Moermond
E.H.W. Heugens

Contact:
Caroline Moermond
Expertise Centre for Substances
caroline.moermond@rivm.nl

This investigation has been performed by order and for the account of Directorate-General for Environmental Protection, Sustainable Production Directorate (DP), within the framework of the project ‘Standard setting for other relevant substances within the WFD’.

RIVM, P.O. Box 1, 3720 BA Bilthoven, the Netherlands Tel +31 30 274 91 11 www.rivm.nl

Abstract

Environmental risk limits for monochlorophenols, 4-chloro-3-methylphenol and aminochlorophenol

The National Institute for Public Health and the Environment (RIVM) has derived Environmental Risk Limits (ERLs) for 2-, 3- and 4-monochlorophenol, 4-chloro-3-methylphenol and aminochlorophenol in fresh and marine surface waters. The ERLs represent environmental concentrations of a substance offering different levels of protection to man and ecosystems. They serve as advisory values for the Dutch Steering Committee for Substances, which is appointed to set the final environmental quality standard.

Four different ERLs are distinguished in the Netherlands: a concentration at which effects are considered negligible (NC); a concentration at which no harmful effects are to be expected (maximum permissible concentration, MPC); a maximum acceptable concentration for ecosystems specifically for short-term exposure (MAC_{eco}), and a concentration at which possible serious effects are to be expected (serious risk concentration, SRC_{eco}). Based on a preliminary screening of monitoring data, there is no indication that any of the newly derived ERLs is exceeded.

RIVM used the methodology as required by the European Water Framework Directive for derivation and selection of the ERLs. Potential risks for humans as well as effects on the aquatic ecosystem are taken into account.

The environmental quality standards are to be set by the Steering Committee for Substances. The ERLs as presented in this report are thus preliminary values that do not have an official status.

This report is part of a series. ERLs for 2,4-dichlorophenol and trichlorophenols are reported separately.

Key words:
environmental risk limits, monochlorophenols, 4-chloro-3-methylphenol, aminochlorophenol, maximum permissible concentration

Rapport in het kort

Milieurisicogrenzen voor monochloorfenolen, 4-chloor-3-methylfenol en aminochloorfenol

Het RIVM heeft milieurisicogrenzen voor zoet en zout oppervlaktewater afgeleid voor monochloorfenolen, 4-chloor-3-methylfenol en aminochloorfenol. Deze dienen als advieswaarden voor de Nederlandse Interdepartementale Stuurgroep Stoffen. De stuurgroep stelt de uiteindelijke milieukwaliteitsnormen vast.

Milieurisicogrenzen zijn maximale concentraties van een stof in het milieu om mens en ecosysteem op verschillende niveaus te beschermen tegen nadelige effecten. Nederland onderscheidt hierbij vier milieurisicogrenzen: een niveau waarbij het risico verwaarloosbaar wordt geacht (VR), een niveau waarbij geen schadelijke effecten zijn te verwachten (maximaal toelaatbaar risiconiveau, MTR), de maximaal aanvaardbare concentratie voor ecosystemen, specifiek voor kortdurende blootstelling ($\mathrm{MAC}_{\mathrm{eco}}$) en een niveau waarbij mogelijk ernstige effecten voor ecosystemen zijn te verwachten ($\mathrm{ER}_{\mathrm{eco}}$). De nu afgeleide milieurisicogrenzen lijken op basis van een eerste vergelijking met monitoringsgegevens niet te worden overschreden.

Het RIVM heeft de afleiding en selectie van de milieurisicogrenzen uitgevoerd volgens de methodiek die is voorgeschreven door de Europese Kaderrichtlijn Water. Hierbij is zowel rekening gehouden met mogelijke risico’s voor de mens als met eventuele effecten op het ecosysteem.

Omdat de uiteindelijke milieukwaliteitsnormen worden vastgesteld door de Nederlandse Interdepartementale Stuurgroep Stoffen, zijn de milieurisicogrenzen zoals afgeleid in dit rapport voorlopige waarden zonder officiële status.

Dit rapport is onderdeel van een serie. De milieurisicogrenzen voor 2,4-dichloorfenol en trichloorfenolen zijn in afzonderlijke rapporten opgenomen.

Trefwoorden:
milieurisicogrenzen, monochloorfenolen, 4-chloor-3-methylfenol, aminochloorfenol, maximaal toelaatbaar risiconiveau

Preface

The goal of this report is to derive risk limits that protect both man and the environment. This is done in accordance with the methodology of the Water Framework Directive (WFD) that is incorporated in the methodology for the project ‘International and National Environmental Quality Standards for Substances in the Netherlands’ (INS), following the Guidance for the derivation of environmental risk limits within the INS framework (Van Vlaardingen and Verbruggen, 2007).

Acknowledgements

Thanks are due to J.M.C. Appelman, M.Sc., who was contact person at the Ministry of Housing, Spatial Planning and the Environment (VROM-DP) and to Dr. M.P.M. Janssen who is program coordinator for the derivation of ERLs within the RIVM.

The results of the present report have been discussed in the scientific advisory group INS (WK INS). The members of this group are acknowledged for their contribution.

Contents

Summary

Environmental risk limits (ERLs) are derived using ecotoxicological, physico-chemical, and human toxicological data. They represent environmental concentrations of a substance offering different levels of protection to man and ecosystems. It should be noted that the ERLs are scientifically derived values. They serve as advisory values for the Dutch Steering Committee for Substances, which is appointed to set the Environmental Quality Standards (EQSs) from these ERLs. ERLs should thus be considered as preliminary values that do not have an official status.

In this report, the risk limits negligible concentration (NC), maximum permissible concentration (MPC), maximum acceptable concentration for ecosystems (MAC_{eco}), and serious risk concentration for ecosystems (SRC_{eco}) are derived for monochlorophenols, aminochlorophenol and 4-chloro-3-methylphenol in water. No risk limits were derived for the sediment compartment because the trigger values to derive such risk limits were not reached.

For the derivation of the MPC and MAC_{eco} for water, the methodology used is in accordance with the Water Framework Directive. This methodology is based on the Technical Guidance Document on risk assessment for new and existing substances and biocides (European Commission, 2003), and is incorporated in the guidance for the project 'International and National Environmental Quality Standards for Substances in the Netherlands' (Van Vlaardingen and Verbruggen, 2007). An overview of the derived ERLs is given in Table 1.

It should be noted that due to the mode of action of the monochlorophenols (narcosis), and the fact that 2-, 3- and 4-chlorophenol often occur together, the use of the toxic unit approach is recommended for the assessment of water quality. The toxic unit approach assumes that compounds that act similar, have concentration additive toxicity. This means that the sum of the ratio between measured concentration and risk limits for all monochlorophenols should not exceed 1. A preliminary screening of monitoring data indicates that concentrations are always below the detection limits. Since detection limits are much lower than the newly derived ERLs, it is not likely that the ERLs are exceeded.

Table 1 Derived MPC, MAC$_{eco}$, NC, and SRC$_{eco}$ values for monochlorophenols,4-chloro-3-methylphenol and aminochlorophenol (in µg/L).

	Unit	MPC	MAC$_{eco}$	NC	SRC$_{eco}$
2-chlorophenol					
Freshwater	µg/L	35	1.1×10^{2}	0.35	1.2×10^{4}
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	3.5	11	3.5×10^{-2}	1.2×10^{4}
3-chlorophenol					
Freshwater	µg/L	4.0	4.0×10^{2}	4.0×10^{-2}	1.4×10^{3}
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	0.4	40	4.0×10^{-3}	1.4×10^{3}
4-chlorophenol					
Freshwater	µg/L	16	89	0.16	3.6×10^{3}
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	3.2	18	3.2×10^{-2}	3.6×10^{3}
4-chloro-3-methylphenol					
Freshwater	µg/L	6.4	64	6.4×10^{-2}	3.7×10^{2}
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	0.64	6.4	6.4×10^{-3}	3.7×10^{2}
Aminochlorophenol					
Freshwater	µg/L	n.d.[b]	n.d.[b]	n.d.[b]	n.d.[b]
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	n.d.[b]	n.d.[b]	n.d.[b]	n.d.[b]

[a] n.a. = not applicable.

[b] n.d. = not derived due to lack of data

1 Introduction

1.1 Project framework

In this report, environmental risk limits (ERLs) for surface water (freshwater and marine) are derived for monochlorophenols, 4-chloro-3-methylphenol and aminochlorophenol for the project ‘Standard setting for other relevant substances within the WFD’, which is closely related to the project INS (International and national environmental quality standards for substances in the Netherlands). The following ERLs are considered:

- negligible concentration (NC) – concentration at which effects to ecosystems are expected to be negligible and functional properties of ecosystems must be safeguarded fully. It defines a safety margin which should exclude combination toxicity. The NC is derived by dividing the MPC (see next bullet) by a factor of 100.
- maximum permissible concentration (MPC) – concentration in an environmental compartment at which:
  1. no effect to be rated as negative is to be expected for ecosystems;
  2a no effect to be rated as negative is to be expected for humans (for non-carcinogenic substances);
  2b for humans no more than a probability of 10^{-6} per year of death can be calculated (for carcinogenic substances). Within the scope of the Water Framework Directive, a probability of 10^{-6} on a life-time basis is used.
  Within the scope of the Water Framework Directive the MPC is specifically referring to long-term exposure.
- maximum acceptable concentration (MAC_{eco}) – concentration protecting aquatic ecosystems for effects due to short-term exposure or concentration peaks.
- serious risk concentration (SRC_{eco}) – concentration at which possibly serious ecotoxicological effects are to be expected.

The results presented in this report have been discussed by the members of the scientific advisory group for the INS-project (WK-INS). It should be noted that the Environmental Risk Limits (ERLs) in this report are scientifically derived values, based on (eco)toxicological, fate and physico-chemical data. They serve as advisory values for the Dutch Steering Committee for Substances, which is appointed to set the Environmental Quality Standards (EQSs). ERLs should thus be considered as preliminary values that do not have any official status.

1.2 Selection of substances

ERLs are derived for monochlorophenols, 4-chloro-3-methylphenol and aminochlorophenol (Table 2), which are selected by the Netherlands in the scope of the Water Framework Directive (WFD; 2000/60/EC). The derivation of environmental risk limits for dichlorophenols and trichlorophenols will be reported in separate reports (Moermond and Heugens, 2009ab).

Table 2. Selected compounds.

Compound	CAS number
2-chlorophenol	95-57-8
3-chlorophenol	108-43-0
4-chlorophenol	106-48-9
4-chloro-3-methylphenol	59-50-7
aminochlorophenol	95-85-2

2 Methods

2.1 General

The methodology for the data selection and derivation of ERLs is described in detail in Van Vlaardingen and Verbruggen (2007), further referred to as the 'INS-Guidance'. This guidance is in accordance with the guidance of the Fraunhofer Institute (FHI; Lepper, 2005) and prepared within the context of the WFD.

The process of ERL-derivation contains the following steps: data collection, data evaluation and selection, and derivation of the ERLs on the basis of the selected data. Specific items will be discussed below.

2.2 Data collection, evaluation and selection

In accordance with the WFD, data of existing evaluations were used as a starting point. An on-line literature search was performed on TOXLINE (literature from 1985 to 2001) and Current Contents (literature from 1997 to 2007). In addition to this, all potentially relevant references in the RIVM e-tox base and EPA's ECOTOX database were checked.

Ecotoxicity studies were screened for relevant endpoints (i.e. those endpoints that have consequences at the population level of the test species). All ecotoxicity and bioaccumulation tests were then thoroughly evaluated with respect to the validity (scientific reliability) of the study. A detailed description of the evaluation procedure is given in the INS-Guidance (section 2.2.2 and 2.3.2).

After data collection and validation, toxicity data were combined into an aggregated data table with one effect value per species according to section 2.2.6 of the INS-Guidance. When for a species several effect data were available, the geometric mean of multiple values for the same endpoint was calculated where possible. Subsequently, when several endpoints were available for one species, the lowest of these endpoints (per species) is reported in the aggregated data table.

2.3 Derivation of ERLs

2.3.1 Drinking water

The INS-Guidance includes the MPC for surface waters intended for the abstraction of drinking water ($MPC_{dw,\ water}$) as one of the MPCs from which the lowest value should be selected as the general MPC_{water} (see INS-Guidance, section 3.1.6 and 3.1.7). According to the proposal for the daughter directive Priority Substances, however, the derivation of the AA-EQS (= MPC) should be based on direct exposure, secondary poisoning, and human exposure due to the consumption of fish. Drinking water was not included in the proposal and is thus not guiding for the general MPC_{water} value. The exact way of implementation of the $MPC_{dw,\ water}$ in the Netherlands is at present under discussion within the framework of the 'AMvB Kwaliteitseisen en Monitoring Water'. No policy decision has been taken yet, and the $MPC_{dw,\ water}$ is therefore presented as a separate value in this report. The MPC_{water} is thus derived considering the individual MPCs based on direct exposure ($MPC_{eco,\ water}$), secondary poisoning ($MPC_{sp,\ water}$) or human consumption of fishery products ($MPC_{hh\ food,\ water}$); the need to derive the latter two depends on the characteristics of the compound. Although the $MPC_{dw,\ water}$ is not taken into account for the derivation of the MPC_{water}, it is used for the derivation of the groundwater risk limit, MPC_{gw}.

2.3.2 $MAC_{eco,\ marine}$

In this report, the $MAC_{eco,\ marine}$ value is based on the $MAC_{eco,water}$ value when acute toxicity data for at least two specific marine taxa are available, using an additional assessment factor of 5 when acute toxicity data for only one specific marine taxon is available and an additional assessment factor of 10 when no acute toxicity data is available for specific marine taxa (analogous to the derivation of the MPC according to Van Vlaardingen and Verbruggen, 2007). It has to be noted that this procedure is currently not agreed upon. Therefore, the $MAC_{eco,\ marine}$ value needs to be re-evaluated once an agreed procedure is availabe.

2.3.3 Toxic unit approach

Due to the mode of action of the monochlorophenols (narcosis), and the fact that these compounds often occur together, the use of the toxic unit approach is recommended. The toxic unit approach assumes that compounds that act similar, have concentration additive toxicity. This means that the sum of the ratio between measured concentration and risk limits for all monochlorophenols should not exceed 1.

3 Derivation of environmental risk limits

3.1 2-chlorophenol

3.1.1 Substance identification, physico-chemical properties, fate and human toxicology

3.1.1.1 Identity

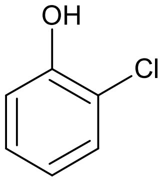

Figure 1. Structural formula of 2-chlorophenol.

Table 3. Identification of 2-chlorophenol.

Parameter	Result
Chemical name	2-chlorophenol
Common/other name	o-chlorophenol
CAS number	95-57-8
EC number	202-433-2
Annex I index number	604-008-00-0
SMILES code	Oc(c(ccc1)Cl)c1

3.1.1.2 Use

The main use of chlorophenols in general, is as an intermediate for manufacturing pesticides, biocides, dyes and pharmaceuticals (Muller, 2008), but they have also been used as mothproofing agents, miticides, germicides, algicides, fungicides, biocides, and wood preservatives (National Pollutant Inventory, 2005).

3.1.1.3 Physico-chemical properties

Table 4. Physico-chemical properties of 2-chlorophenol. Bold values are used for ERL derivation.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	128.56		
Water solubility	[mg/L]	**24650**	20 ºC; recommended by reference	Mackay et al., 2000
		28500	20 ºC	EC, 2000
		5170	EpiWin	US EPA, 2007
pK_a	[-]	8.49	Recommended by reference	Mackay et al., 2000
		8.35	Recommended by reference	BioByte, 2006
		8.48	25 ºC	EC, 2000
log K_{OW}	[-]	**2.17**	Recommended by reference	Mackay et al., 2000
		2.15	Recommended by reference	BioByte, 2006
		2.15	calculated	BioByte, 2006
		2.15		EC, 2000
		2.16	EpiWin	US EPA, 2007
log K_{OC}	[-]	**3.64**	Geomean of recommended sediment values	Mackay et al., 2000
		2.25	Calculated using log K_{OW} = 2.15	According to Sabljic et al., 1995
		2.65	EpiWin	US EPA, 2007
Vapour pressure	[Pa]	132	25 ºC; recommended by reference	Mackay et al., 2000
		133	12.1 ºC	EC, 2000
		18.0	EpiWin	US EPA, 2007
Melting point	[°C]	9.0	Recommended by reference	Mackay et al., 2000
		9.3		EC, 2000
		8.7		Muller, 2008
		28.6	EpiWin	US EPA, 2007
Boiling point	[°C]	175-176	Recommended by reference	Mackay et al., 2000
		175		EC, 2000
		203		Muller, 2008
		174.5	EpiWin	US EPA, 2007
Henry's law constant	[Pa.m^3/mol]	0.6884	Calculated by Mackay	Mackay et al., 2000
		0.448	EpiWin	US EPA, 2007

3.1.1.4 Behaviour in the environment

Table 5. Selected environmental properties of 2-chlorophenol.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	No hydrolysis		
Photolysis half-life	DT50 [h]	0.38	313 nm	Mackay et al., 2000
Biodegradation	DT50 [d]	16.8	Sludge	Mackay et al., 2000
		55.2	Polluted river water	Mackay et al., 2000
Relevant metabolites		Unknown		

Biodegradation of chlorophenols must be induced, because the antimicrobial activities of these products require that the bacteria adapt. Biodegradation is rapid when adapted bacteria are present (Muller, 2008).

3.1.1.5 Bioconcentration and biomagnification

Bioaccumulation data for 2-chlorophenol are tabulated in Table 6. Details on experimental data are included in Appendix 1.

Table 6. Overview of bioaccumulation data for 2-chlorophenol.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	14-29		EC, 2000
		14	Calculated using log K_{OW} = 2.17	According to Veith et al., 1979
BMF	[kg/kg]	1	Default value for compounds with BCF < 2000 L/kg.	

3.1.1.6 Human toxicological treshold limits and carcinogenicity

2-chlorophenol is not classified as a possible carcinogen, and has the following R-phrases: R20/21/22; R50/53. The TDI for 2,4-dichlorophenol of 3 μg/kg$_{bw}$/day (U.S. EPA, 1986) was considered to be valid for all mono-, di-, tri-, and tetrachlorophenol compounds (Baars et al., 2001).

3.1.2 Trigger values

This section reports on the trigger values for ERLwater derivation (as demanded in WFD framework).

Table 7. 2-chlorophenol: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp\text{-}water}$	2.64	[-]	$K_{OC} \times f_{OC,susp}$[1]	K_{OC}: 3.1.1.3
BCF	14-29	[L/kg]		3.1.1.5
BMF	1	[kg/kg]		3.1.1.5
Log K_{OW}	2.15	[-]		3.1.1.3
R-phrases	R20/21/22; R50/53	[-]		3.1.1.6
A1 value	1	[μg/L]	Mandatory for phenols	
DW standard	-	[μg/L]		

1 $f_{OC,susp}$ = 0.1 kg$_{OC}$/kg$_{solid}$ (European Commission (Joint Research Centre), 2003).

- 2-chlorophenol has a log $K_{p,\ susp\text{-}water}$ < 3; derivation of MPC$_{sediment}$ is not triggered.
- 2-chlorophenol has a log $K_{p,\ susp\text{-}water}$ < 3; expression of the MPC$_{water}$ as MPC$_{susp,\ water}$ is not required.
- 2-chlorophenol has a BCF < 100 L/kg; assessment of secondary poisoning is not triggered.
- 2-chlorophenol is not classified as a possible carcinogen and does not have a BCF ≥ 100 L/kg combined with relevant R-phrases. Therefore, an MPC$_{water}$ for human health via food (fish) consumption (MPC$_{hh\ food,\ water}$) does not have to be derived.
- For 2-chlorophenol, no compound-specific A1 value or Drinking Water value is available from Council Directives 75/440, EEC and 98/83/EC, respectively. Therefore, the general mandatory A1 value for phenols applies.

3.1.3 Aquatic toxicity data

3.1.3.1 Toxicity data

An overview of the selected freshwater toxicity data for 2-chlorophenol is given in Table 8. Marine toxicity data are given in Table 9. Detailed toxicity data for 2-chlorophenol are tabulated in Appendix 2.

Table 8. 2-chlorophenol: selected freshwater toxicity data for ERL derivation.

Chronic[a]		**Acute**[a]	
Taxonomic group	**NOEC/EC10 (mg/L)**	**Taxonomic group**	**L(E)C50 (mg/L)**
Bacteria	170	Bacteria	476[d]
Bacteria	217	Bacteria	28
Bacteria	48	Bacteria	122[e]
Algae	42[b]	Bacteria	122
Macrophyta	**0.35**[c]	Bacteria	167
Crustacea	0.5	Algae	170[f]
Pisces	2.5	Algae	70
		Algae	85[g]
		Protozoa	60[h]
		Macrophyta	**1.1**[i]
		Crustacea	5.9
		Crustacea	4.8[j]
		Crustacea	6.9
		Pisces	12
		Pisces	8.2[k]
		Pisces	10
		Pisces	17
		Pisces	12[l]
		Pisces	7.1[m]
		Pisces	6.6
		Amphibia	122

[a] For detailed information see Appendix 2. Bold values are used for ERL-derivation.

[b] Preferred endpoint (growth rate) for *Scenedesmus subspicatus.*

[c] Most sensitive endpoint (frond number) for *Salvinia minima.*

[d] Preferred endpoint (growth) for *Bacillus subtilis.*

[e] Most sensitive endpoint (specific growth rate) for *Escherichia coli.*

[f] Preferred endpoint (growth rate), for *Chlorella vulgaris.*

[g] Preferred endpoint (growth rate), for *Scenedesmus subspicatus.*

[h] Geometric mean of 84.9, 36.7, and 68.0, parameter population growth for *Tetrahymena pyriformis.*

[i] Most sensitive endpoint (frond number) for *Salvinia minima.*

[j] Most relevant exposure duration (48 h), parameter mortality/immobility for *Daphnia magna.*

[k] Geometric mean of 10, 6.6, 8.1, and 8.4 mg/L, parameter mortality for *Lepomis macrochirus.*

[l] Most relevant exposure duration (96 h), geometric mean of 11, 13, 14.5, 11.6, 9.4, and 13.8 mg/L; parameter mortality for *Pimephales promelas.*

[m] Most sensitive pH (6), parameter mortality for *Poecilia reticulata.*

Table 9. 2-chlorophenol: selected marine toxicity data for ERL derivation.

Chronic [a] Taxonomic group	NOEC/EC10 (mg/L)	Acute [a] Taxonomic group	L(E)C50 (mg/L)
No data		Bacteria	27[b]
		Pisces	6.6[c]
		Pisces	6.6

[a] For detailed information see Appendix 2.

[b] Most relevant exposure duration (15-30 min), geometric mean of 33.8, 37.9, 28.5, 43.4, and 9.3 mg/L, parameter bioluminescence for *Vibrio fischeri.*

[c] Geometric mean of 6.99 and 6.29 mg/L, parameter mortality for *Platichthys flesus.*

3.1.3.2 Treatment of fresh- and saltwater toxicity data

Following Lepper (2005), freshwater and marine datasets can be combined if it can not be shown that marine species are more sensitive than freshwater species. Endpoints for both bacteria and fish are in the range fo those observed for freshwater species. Thus, freshwater and marine datasets are combined.

3.1.4 Derivation of Environmental Risk Limits

3.1.4.1 Derivation of MPC_{water} and MPC_{marine}

$MPC_{eco,\ water}$ and $MPC_{eco,\ marine}$

Acute toxicity data are available for seven taxonomic groups, amongst which algae, crustacea (*Daphnia*) and fish. Thus, the base set is complete. Chronic toxicity data are available for algae, macrophyta, crustacea and fish. The lowest NOEC for MPC derivation is 0.35 mg/L for the macrophyte *Salvinia minima*.

For the freshwater environment, an assessment factor of 10 can be used on the lowest NOEC, which results in an $MPC_{eco,\ water}$ of 0.35 / 10 = 0.035 mg/L = 35 µg/L.

No chronic toxicity data are available for specific marine taxa. With an assessment factor of 100 the $MPC_{eco,\ marine}$ becomes $0.35 / 100 = 3.5 \times 10^{-3}$ mg/L = 3.5 µg/L.

$MPC_{sp,\ water}$ and $MPC_{sp,\ marine}$

2-chlorophenol has a BCF < 100 L/kg, thus assessment of secondary poisoning is not triggered.

$MPC_{hh\ food,\ water}$

Derivation of $MPC_{hh\ food,\ water}$ for 2-chlorophenol is not triggered (Table 7).

$MPC_{dw,\ water}$

The $MPC_{dw,\ water}$ is 1 µg/L according to the general A1 value for phenols.

Selection of the MPC_{water} and MPC_{marine}

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. However, the derivation of $MPC_{hh\ food,\ water}$ and $MPC_{sp,\ water}$ was not triggered. Thus, the general MPCs are based on ecotoxicity ($MPC_{eco,\ water}$ and $MPC_{eco,\ marine}$) which results in an MPC_{water} of 35 µg/L and and MPC_{marine} of 3.5 µg/L.

3.1.4.2 Derivation of MAC_{eco}

The base set is complete. LC50s are available for a large number of taxa. However, because the insects are missing and there are no reasons to assume that they are less sensitive than other taxa, the requirements to perform an SSD are not met. For informative reasons, an SSD was calculated, which resulted in a HC5 of 1.8 mg/L.

The lowest LC50 is 1.1 mg/L for the macrophyte *Salvelina minima*. Given the following arguments:

- the bioconcentration factor is lower than 100 L/kg;
- the mode of action (narcosis) is non-specific;
- the variation is not too high in view of the large number of data;

an assessment factor of 10 is used and the $MAC_{eco,\ water}$ becomes 1.1 / 10 = 0.11 mg/L = 110 µg/L.

For the marine environment, no additional specific marine taxa are present and thus an additional assessment factor of 10 is used. The $MAC_{eco,\ marine}$ becomes 11 µg/L.

3.1.4.3 Derivation of NC

The NC is derived by dividing the final MPC by a factor of 100.

NC_{water} = 0.35 µg/L.
$NC_{marine} = 3.5 \times 10^{-2}$ µg/L.

3.1.4.4 Derivation of SRC_{eco}

The geometric mean of all chronic data is 11.8 mg/L. These data are normally distributed (significant at all levels using the Anderson-Darling test for normality). Because more than three NOECs are available, no comparison has to be made with the geometric mean of the acute data. The $SRC_{eco,\ water}$ and $SRC_{eco,\ marine}$ are set at 11.8 mg/L = 1.2×10^4 µg/L.

3.1.5 Sediment toxicity data

The log $K_{p,\ susp\text{-}water}$ of 2-chlorophenol is below the trigger value of 3, therefore, ERLs are not derived for sediment.

3.1.6 Comparison of derived ERLs with monitoring data

An overview of the derived ERLs is given in Table 10.

Table 10. Derived MPC, MAC_{eco}, NC, and SRC_{eco} values for 2-chlorophenol (in µg/L).

ERL	Unit	MPC	MAC_{eco}	NC	SRC_{eco}
Freshwater[a]	µg/L	35	1.1×10^2	0.35	1.2×10^4
Drinking water[a]	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	3.5	11	3.5×10^{-2}	1.2×10^4

[a] n.a. = not applicable.

Due to the mode of action of the monochlorophenols (narcosis), and the fact that these compounds often occur together, the use of the toxic unit approach is recommended. The toxic unit approach assumes that compounds that act similar, have concentration additive toxicity. This means that the sum of the ratio between measured concentration and risk limits for all monochlorophenols combined should not exceed 1.

Monitoring data for the Rhine from the years 2001-2006, obtained from RIWA (Association of River Waterworks), show that at all sampling occasions and locations, the concentration of 2-chlorophenol in water was below detection limits (0.02 – 0.5 μg/L).

3.2 3-chlorophenol

3.2.1 Substance identification, physico-chemical properties, fate and human toxicology

3.2.1.1 Identity

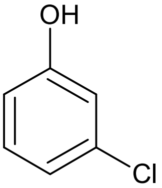

Figure 2. Structural formula of 3-chlorophenol.

Table 11. Identification of 3-chlorophenol.

Parameter	Result
Chemical name	3-chlorophenol
Common/other name	m-chlorophenol
CAS number	108-43-0
EC number	203-582-6
Annex I index number	604-008-00-0
SMILES code	Oc(cccc1Cl)c1

3.2.1.2 Use

The main use of chlorophenols in general, is as an intermediate for manufacturing pesticides, biocides, dyes and pharmaceuticals (Muller, 2008), but they have also been used as mothproofing agents, miticides, germicides, algicides, fungicides, biocides, and wood preservatives (National Pollutant Inventory, 2005).

3.2.1.3 Physico-chemical properties

Table 12. Physico-chemical properties of 3-chlorophenol. Bold values are used for ERL derivation.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	128.56		
Water solubility	[mg/L]	**22000**	25 ºC; Recommended by reference	Mackay et al., 2000
		2600	EpiWin	US EPA, 2007
pK_a	[-]	8.85	Recommended by reference	Mackay et al., 2000
		9.11	Recommended by reference	BioByte, 2006
log K_{OW}	[-]	**2.50**	Recommended by reference	Mackay et al., 2000
		2.50	Recommended by reference	BioByte, 2006
		2.48	calculated	BioByte, 2006
		2.16	EpiWin	US EPA, 2007
log K_{OC}	[-]	**2.48**	Calculated using log K_{OW} = 2.50	According to Sabljic et al., 1995
		2.64	EpiWin	US EPA, 2007
Vapour pressure	[Pa]	35	25 ºC; solid; selected from ref's	Mackay et al., 2000
		41.99	25 ºC; liquid; selected from ref's	Mackay et al., 2000
		18.0	EpiWin	US EPA, 2007
Melting point	[°C]	33	Recommended by reference	Mackay et al., 2000
		32.8		Muller, 2008
		28.6	EpiWin	US EPA, 2007
Boiling point	[°C]	214	Recommended by reference	Mackay et al., 2000
		203		Muller, 2008
		216	EpiWin	US EPA, 2007
Henry's law constant	[Pa.m^3/mol]	0.2045	Calculated by Mackay	Mackay et al., 2000
		0.892	EpiWin	US EPA, 2007

3.2.1.4 Behaviour in the environment

Table 13. Selected environmental properties of 3-chlorophenol.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	No hydrolysis		
Photolysis half-life	DT50 [hr]	0.25	Aqueous solutions	Mackay et al., 2000
Biodegradability	DT50 [d]	30	Sediment from a farm stream; 20 ºC	Mackay et al., 2000
Relevant metabolites		Unknown		

Biodegradation of chlorophenols must be induced, because the antimicrobial activities of these products require that the bacteria adapt. Biodegradation is rapid when adapted bacteria are present (Muller, 2008).

3.2.1.5 Bioconcentration and biomagnification

Bioaccumulation data for 3-chlorophenol are tabulated in Table 14. Details on experimental data are included in Appendix 1.

Table 14. Overview of bioaccumulation data for 3-chlorophenol.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	17.8		Butte et al., 1987
BMF	[kg/kg]	1	Default value for compounds with BCF < 2000 L/kg.	

3.2.1.6 Human toxicological treshold limits and carcinogenicity

3-chlorophenol is not classified as a possible carcinogen and has the following R-phrases: R20/21/22; R50/53. The TDI for 2,4-dichlorophenol of 3 μg/kg$_{bw}$/day (U.S. EPA, 1986) was considered to be valid for all mono-, di-, tri-, and tetrachlorophenol compounds (Baars et al., 2001).

3.2.2 Trigger values

This section reports on the trigger values for ERLwater derivation (as demanded in WFD framework).

Table 15. 3-chlorophenol: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp\text{-}water}$	1.48	[-]	$K_{OC} \times f_{OC,susp}$[1]	K_{OC}: 3.2.1.3
BCF	17.8	[L/kg]		3.2.1.5
BMF	1	[kg/kg]		3.2.1.5
Log K_{OW}	2.50	[-]		3.2.1.3
R-phrases	R20/21/22; R50/53	[-]		3.2.1.6
A1 value	1	[μg/L]	Mandatory for phenols	
DW standard	-	[μg/L]		

1 $f_{OC,susp}$ = 0.1 kg$_{OC}$/kg$_{solid}$ (European Commission (Joint Research Centre), 2003).

- 3-chlorophenol has a log $K_{p,\ susp\text{-}water}$ < 3; derivation of MPC$_{sediment}$ is not triggered.
- 3-chlorophenol has a log $K_{p,\ susp\text{-}water}$ < 3; expression of the MPC$_{water}$ as MPC$_{susp,\ water}$ is not required.
- 3-chlorophenol has a BCF < 100 L/kg; assessment of secondary poisoning is not triggered.
- 3-chlorophenol is not classified as a possible carcinogen, has a BCF < 100 L/kg and does not have any relevant R-phrases. Therefore, an MPC$_{water}$ for human health via food (fish) consumption (MPC$_{hh\ food,\ water}$) does not have to be derived.
- For 3-chlorophenol, no compound-specific A1 value or Drinking Water value is available from Council Directives 75/440, EEC and 98/83/EC, respectively. Therefore, the general mandatory A1 value for phenols applies.

3.2.3 Aquatic toxicity data

3.2.3.1 Toxicity data

An overview of the selected freshwater toxicity data for 3-chlorophenol is given in Table 16. Marine toxicity data are given in Table 17. Detailed toxicity data for 3-chlorophenol are tabulated in Appendix 2.

Table 16. 3-chlorophenol: selected freshwater toxicity data for ERL derivation.

Chronic[a] Taxonomic group	NOEC/EC10 (mg/L)	Acute[a] Taxonomic group	L(E)C50 (mg/L)
Bacteria	**32**	Bacteria	83[c]
Pisces	**6.0**[b]	Bacteria	22
		Bacteria	35
		Bacteria	9.4
		Algae	38[d]
		Protozoa	21[e]
		Crustacea	9.8
		Crustacea	12
		Crustacea	16
		Crustacea	5.6
		Pisces	15
		Pisces	5.5
		Pisces	6.4[f]

[a] For detailed information see Appendix 2. Bold values are used for ERL-derivation.

[b] Most sensitive endpoint, parameter malformations for *Cyprinus carpio*.

[c] Preferred endpoint (growth) for *Bacillus subtilis*.

[d] Geometric mean of 32.3 and 45.6, parameter cell density for *Chlorella vulgaris*.

[e] Geometric mean of 17.3, 36.7, and 14.1, parameter population growth for *Tetrahymena pyriformis*.

[f] Most sensitive pH (6.1 and 7.3), parameter mortality for *Poecilia reticulata*.

Table 17. 3-chlorophenol: selected marine toxicity data for ERL derivation.

Chronic [a] Taxonomic group	NOEC/EC10 (mg/L)	Acute [a] Taxonomic group	L(E)C50 (mg/L)
No data		Bacteria	12[b]
		Pisces	**4.0**

[a] For detailed information see Appendix 2. Bold values are used for ERL-derivation.

[b] Most relevant exposure duration (15-30 min), parameter bioluminescence for *Vibrio fischeri*.

3.2.3.2 Treatment of fresh- and saltwater toxicity data

Following Lepper (2005), freshwater and marine datasets can be combined if it can not be shown that marine species are more sensitive than freshwater species. The endpoints for marine bacteria and fish are in the same range as those for freshwater species. Thus, freshwater and marine datasets are combined.

3.2.4 Derivation of Environmental Risk Limits

3.2.4.1 Derivation of MPC_{water} and MPC_{marine}

$MPC_{eco, water}$ and $MPC_{eco, marine}$

Acute toxicity data are available for 5 taxonomic groups, amongst which algae, crustacea (*Daphnia*) and fish. Thus, the base set is complete. Chronic data for bacteria may not be used for MPC derivation (Lepper, 2005), but are included in the aggregated data table because they can be used for SRC derivation. Thus, for MPC derivation chronic toxicity data are only available for fish, with one NOEC of 6.0 mg/L for *Cyprinus carpio*. However, this value is higher than the lowest LC50 (4.0 mg/L for the marine fish *Platichthys flesus).*

This means that an assessment factor of 1000 should be used on the lowest LC50, which results in an $MPC_{eco, water}$ of 4 / 1000 = 4×10^{-3} mg/L = 4 µg/L.

No chronic toxicity data are available for specific marine taxa. Thus, with an assessment factor of 10000 the $MPC_{eco, marine}$ becomes 4 / 10000 = 4×10^{-4} mg/L = 0.4 µg/L.

$MPC_{sp, water}$ and $MPC_{sp, marine}$

3-chlorophenol has a BCF < 100 L/kg, thus assessment of secondary poisoning is not triggered.

$MPC_{hh\ food, water}$

Derivation of $MPC_{hh\ food, water}$ for 3-chlorophenol is not triggered (Table 15).

$MPC_{dw, water}$

The $MPC_{dw, water}$ is 1 µg/L according to the general A1 value for phenols.

Selection of the MPC_{water} and MPC_{marine}

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. However, the derivation of $MPC_{hh\ food, water}$ and $MPC_{sp, water}$ was not triggered. Thus, the general MPCs are based on ecotoxicity ($MPC_{eco, water}$ and $MPC_{eco, marine}$) which results in an MPC_{water} of 4 µg/L and and MPC_{marine} of 0.4 µg/L.

3.2.4.2 Derivation of MAC_{eco}

The base set is complete. LC50s are available for 5 taxa.

The lowest LC50 is 4 mg/L for the marine fish *Platichthys flesus*. Given the following arguments:

- the bioconcentration factor is lower than 100 L/kg;
- the mode of action (narcosis) is non-specific;
- the variation is not too high in view of the large number of data;
- given the presumed mode of toxic action, delayed mortality will most likely be limited for fish;

an assessment factor of 10 is used and the $MAC_{eco, water}$ becomes 4 / 10 = 0.4 mg/L = 400 µg/L.

For the marine environment, no additional specific marine taxa are present and thus an additional assessment factor of 10 is used. The $MAC_{eco, marine}$ then becomes 40 µg/L.

3.2.4.3 Derivation of NC

The NC is derived by dividing the final MPC by a factor of 100.

$NC_{water} = 4.0 \times 10^{-2}$ µg/L.
$NC_{marine} = 4.0 \times 10^{-3}$ µg/L.

3.2.4.4 Derivation of SRC_{eco}

Two NOECs are available, the geomean of which is 13.8 mg/L. The geometric mean of all acute data is also 13.8 mg/L. These data are normally distributed (significant at all levels using the Anderson-Darling test for normality). Because the geometric mean of the acute data divided by 10 is smaller than the geometric mean of the NOECs, the SRC_{eco} is calculated using the geometric mean of the acute data with an assessment factor of 10. Thus, the $SRC_{eco, water}$ and $SRC_{eco, marine}$ are set at 13.8 / 10 = 1.4 mg/L = 1.4 x 10^3 µg/L.

3.2.5 Sediment toxicity data

The log $K_{p, susp-water}$ of 3-chlorophenol is below the trigger value of 3, therefore, ERLs are not derived for sediment.

3.2.6 Comparison of derived ERLs with monitoring data

An overview of the derived ERLs is given in Table 18.

Table 18. Derived MPC, MAC_{eco}, NC, and SRC_{eco} values for 3-chlorophenol (in µg/L).

ERL	Unit	MPC	MAC_{eco}	NC	SRC_{eco}
Freshwater	µg/L	4.0	4.0×10^2	4.0×10^{-2}	1.4×10^3
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	0.4	40	4.0×10^{-3}	1.4×10^3

[a] n.a. = not applicable.

Due to the mode of action of the monochlorophenols (narcosis), and the fact that these compounds often occur together, the use of the toxic unit approach is recommended. The toxic unit approach assumes that compounds that act similar, have concentration additive toxicity. This means that the sum of the ratio between measured concentration and risk limits for all monochlorophenols combined should not exceed 1.

Monitoring data for the Rhine from the years 2001-2006, obtained from RIWA (Association of River Waterworks), shows that at all sampling occasions and locations, the concentration of 3-chlorophenol in water was below detection limits (0.02 – 0.5 µg/L).

3.3 4-chlorophenol

3.3.1 Substance identification, physico-chemical properties, fate and human toxicology

3.3.1.1 Identity

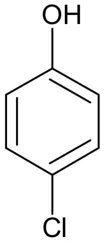

Figure 3. Structural formula of 4-chlorophenol.

Table 19. Identification of 4-chlorophenol.

Parameter	Result
Chemical name	4-chlorophenol
Common/other name	p-chlorophenol
CAS number	106-48-9
EC number	203-402-6
Annex I index number	604-008-00-0
SMILES code	Oc(ccc(c1)Cl)c1

3.3.1.2 Use

The main use of chlorophenols in general, is as an intermediate for manufacturing pesticides, biocides, dyes and pharmaceuticals (Muller, 2008), but they have also been used as mothproofing agents, miticides, germicides, algicides, fungicides, biocides, and wood preservatives (National Pollutant Inventory, 2005).

3.3.1.3 Physico-chemical properties

Table 20. Physico-chemical properties of 4-chlorophenol. Bold values are used for ERL derivation.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	128.56		
Water solubility	[mg/L]	**27000**	Recommended by reference	Mackay et al., 2000
		27100	20 ºC	EC, 2000
		3220	EpiWin	US EPA, 2007
pK_a	[-]	9.18	Recommended by reference	Mackay et al., 2000
		9.40	Recommended by reference	BioByte, 2006
		9.38	20 ºC	EC, 2000
log K_{OW}	[-]	**2.4**	Recommended by reference	Mackay et al., 2000
		2.39	Recommended by reference	BioByte, 2006
		2.48	calculated	BioByte, 2006
		2.39		EC, 2000
		2.16	EpiWin	US EPA, 2007
log K_{OC}	[-]	**2.41**	Calculated using log K_{OW} = 2.39	According to Sabljic et al., 1995
		2.64	EpiWin	US EPA, 2007
Vapour pressure	[Pa]	20	25 ºC; solid; Recommended by reference	Mackay et al., 2000
		30.13	25 ºC; liquid; Recommended by reference	Mackay et al., 2000
		133	49.8 ºC	EC, 2000
		18.0	EpiWin	US EPA, 2007
Melting point	[°C]	43	Recommended by reference	Mackay et al., 2000
		43		EC, 2000
		42.8		Muller, 2008
		28.6	EpiWin	US EPA, 2007
Boiling point	[°C]	220	Recommended by reference	Mackay et al., 2000
		217		EC, 2000
		217		Muller, 2008
		203	EpiWin	US EPA, 2007
Henry's law constant	[Pa.m^3/mol]	0.0952	Calculated by Mackay	Mackay et al., 2000
		0.718	EpiWin	US EPA, 2007

3.3.1.4 Behaviour in the environment

Table 21. Selected environmental properties of 4-chlorophenol.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	No hydrolysis		
Photolysis half-life	DT50 [hr]	28-99		Mackay et al., 2000
Biodegradability	DT50 [d]	3-20	In water	Mackay et al., 2000
Relevant metabolites		Unknown		

Biodegradation of chlorophenols must be induced, because the antimicrobial activities of these products require that the bacteria adapt. Biodegradation is rapid when adapted bacteria are present (Muller, 2008).

3.3.1.5 Bioconcentration and biomagnification

Bioaccumulation data for 4-chlorophenol are tabulated in Table 22. Detailed bioaccumulation data for 4-chlorophenol are tabulated in Appendix 1.

Table 22. Overview of bioaccumulation data for 4-chlorophenol.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	6-52		EC, 2000
		22	Calculated using log K_{OW} = 2.4	According to Veith et al., 1979
BMF	[kg/kg]	1	Default value for compounds with BCF < 2000 L/kg.	

3.3.1.6 Human toxicological treshold limits and carcinogenicity

4-chlorophenol is not classified as a possible carcinogen and has the following R-phrases: R20/21/22; R50/53. The TDI for 2,4-dichlorophenol of 3 µg/kg$_{bw}$/day (U.S. EPA, 1986) was considered to be valid for all mono-, di-, tri-, and tetrachlorophenol compounds (Baars et al., 2001).

3.3.2 Trigger values

This section reports on the trigger values for ERLwater derivation (as demanded in WFD framework).

Table 23. 4-chlorophenol: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp-water}$	1.41	[-]	$K_{OC} \times f_{OC,susp}{}^{1}$	K_{OC}: 3.3.1.3
BCF	6-52	[L/kg]		3.3.1.5
BMF	1	[kg/kg]		3.3.1.5
Log K_{OW}	2.39	[-]		3.3.1.3
R-phrases	R20/21/22; R50/53	[-]		3.3.1.6
A1 value	1	[µg/L]	Mandatory for phenols	
DW standard	-	[µg/L]		

1 $f_{OC,susp}$ = 0.1 kg$_{OC}$/kg$_{solid}$ (European Commission (Joint Research Centre), 2003).

- 4-chlorophenol has a log $K_{p,\ susp-water}$ < 3; derivation of MPC$_{sediment}$ is not triggered.
- 4-chlorophenol has a log $K_{p,\ susp-water}$ < 3; expression of the MPC$_{water}$ as MPC$_{susp,\ water}$ is not required.
- 4-chlorophenol has a BCF < 100 L/kg; assessment of secondary poisoning is not triggered.
- 4-chlorophenol does is not classified as a possible carcinogen, has a BCF < 100 L/kg and does not have any relevant R-phrases. Therefore, an MPC$_{water}$ for human health via food (fish) consumption (MPC$_{hh\ food,\ water}$) does not have to be derived.
- For 4-chlorophenol, no compound-specific A1 value or Drinking Water value is available from Council Directives 75/440, EEC and 98/83/EC, respectively. Therefore, the general mandatory A1 value for phenols applies.

3.3.3 Aquatic toxicity data

3.3.3.1 Toxicity data

An overview of the selected freshwater toxicity data for 4-chlorophenol is given in Table 24. Marine toxicity data are given in Table 25. Detailed toxicity data for 4-chlorophenol are tabulated in Appendix 2.

Table 24. 4-chlorophenol: selected freshwater toxicity data for ERL derivation.

Chronic[a]		Acute[a]	
Taxonomic group	**NOEC/EC10 (mg/L)**	**Taxonomic group**	**L(E)C50 (mg/L)**
Bacteria	53	Bacteria	107[g]
Bacteria	133	Bacteria	23
Bacteria	96	Bacteria	117[h]
Algae	13	Bacteria	12
Algae	1.7[b]	Algae	39
Algae	5.8[c]	Algae	29
Cnidaria	0.76	Algae	19[i]
Cnidaria	9.9	Algae	17
Rotifera	20	Protozoa	37
Crustacea	0.20[d]	Fungi	145
Crustacea	0.30[e]	Fungi	63
Pisces	**0.16**[f]	Cnidaria	45
		Cnidaria	32
		Crustacea	9
		Crustacea	3.9[j]
		Crustacea	3.5
		Pisces	5.6[k]
		Pisces	3.8
		Pisces	3.8
		Pisces	1.9
		Pisces	8.9
		Pisces	4.6[l]
		Pisces	7.8[m]
		Pisces	4.5
		Amphibia	63

[a] For detailed information see Appendix 2. Bold values are used for ERL-derivation.
[b] Preferred endpoint (growth rate) for *Pseudokirchneriella subcapitata.*
[c] Preferred endpoint (growth rate) for *Scenedesmus subspicatus.*
[d] Most sensitive endpoint (mortality) for *Ceriodaphnia dubia.*
[e] Most sensitive endpoint (mean brood size) for *Daphnia magna.*
[f] Most sensitive endpoint (larval weight) for *Oncorhynchus mykiss.*
[g] Preferred endpoint (growth) for *Bacillus subtilis.*
[h] Preferred endpoint (growth rate); geometric mean of 107 and 129 mg/L for *Escherichia coli.*
[i] Preferred endpoint (growth rate); geometric mean of 38 and 10 mg/L for *Pseudokirchneriella subcapitata.*
[j] Most relevant exposure duration (48 h), geometric mean of 4.1, 2.5, 4.8, 6, 4.4, and 2.5 mg/L; parameter mortality/immobility for *Daphnia magna.*
[k] Most relevant exposure duration (96 h), parameter mortality for *Danio rerio.*
[l] Geometric mean of 4, 3.8, 5, and 6.11 mg/L; parameter mortality for *Pimephales promelas.*
[m] Most sensitive pH (6), geometric mean of 7.8 and 7.7 mg/L; parameter mortality for *Poecilia reticulata.*

Table 25. 4-chlorophenol: selected marine toxicity data for ERL derivation.

Chronic [a]		**Acute** [a]	
Taxonomic group	**NOEC/EC10 (mg/L)**	**Taxonomic group**	**L(E)C50 (mg/L)**
Bacteria	3.2	Bacteria	3.9
Algae	0.32	Algae	51
Algae	0.39[b]	Algae	7.7
Crustacea	19	Algae	7.7[c]
Mollusca	3	Algae	12[d]
		Mollusca	**0.89**[e]
		Annelida	13
		Crustacea	49[f]
		Crustacea	21
		Crustacea	21
		Pisces	5.4
		Pisces	1.9
		Pisces	5

[a] For detailed information see Appendix 2. Bold values are used for ERL-derivation.
[b] Lowest endpoint, parameter cell volume for *Skeletonema costatum.*
[c] Preferred endpoint (growth) for *Nitschia closterium.*
[d] Most sensitive endpoint, parameter cell volume for *Skeletonema costatum.*
[e] Most relevant exposure duration (48 h), parameter mortality for *Octopus pallidus.*
[f] Geometric mean of 59.7 and 40.3 mg/L, parameter mortality for *Mesidotea entomon.*

3.3.3.2 Treatment of fresh- and saltwater toxicity data

Following Lepper (2005), freshwater and marine datasets can be combined if it can not be shown that marine species are more sensitive than freshwater species. Marine toxicity data for the individual taxa are in the range of freshwater toxicity data and results from the t-test show that datasets are not different ($p = 0.12$ for the acute data and $p = 0.34$ for the chronic data).Thus, freshwater and marine datasets are combined.

3.3.4 Derivation of Environmental Risk Limits

3.3.4.1 Derivation of MPC$_{water}$ and MPC$_{marine}$

MPC$_{eco,\ water}$ and MPC$_{eco,\ marine}$

Acute toxicity data are available for 10 taxonomic groups, amongst which algae, crustacea (Daphnia) and fish. Thus, the base set is complete. Chronic are available for 7 taxonomic groups. Data for bacteria may not be used for MPC derivation (Lepper, 2005), but are included in the aggregated data table because they can be used for SRC derivation. The lowest NOEC is 0.16 mg/L for the fish *Oncorhynchus mykiss*.

This means that an assessment factor of 10 should be used on the lowest NOEC, which results in an MPC$_{eco,\ water}$ of $0.16 / 10 = 1.6 \times 10^{-2}$ mg/L = 16 µg/L.

Chronic toxicity data are available for one specific marine taxon (the mollusc *Octopus pallidus*). With an assessment factor of 50 the MPC$_{eco,\ marine}$ becomes $0.16 / 50 = 3.2 \times 10^{-3}$ mg/L = 3.2 µg/L.

$MPC_{sp,\ water}$ and $MPC_{sp,\ marine}$

4-chlorophenol has a BCF < 100 L/kg, thus assessment of secondary poisoning is not triggered.

$MPC_{hh\ food,\ water}$

Derivation of $MPC_{hh\ food,\ water}$ for 4-chlorophenol is not triggered (Table 23).

$MPC_{dw,\ water}$

The $MPC_{dw,\ water}$ is 1 μg/L according to the general A1 value for phenols.

Selection of the MPC_{water} and MPC_{marine}

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. However, the derivation of $MPC_{hh\ food,\ water}$ and $MPC_{sp,\ water}$ was not triggered. Thus, the general MPCs are based on ecotoxicity ($MPC_{eco,\ water}$ and $MPC_{eco,\ marine}$) which results in an MPC_{water} of 16 μg/L and and MPC_{marine} of 3.2 μg/L.

3.3.4.2 Derivation of MAC_{eco}

The base set is complete. LC50s are available for 10 taxa. The lowest LC50 is 0.89 mg/L for the marine mollusc *Octopus pallidus*.

Because data for insects and macrophytes are missing and there are no reasons to assume that they are less sensitive than other taxa, the requirements to perform an SSD are not met. For informative reasons, an SSD was calculated, which resulted in a HC5 of 1.6 mg/L.

Given the following arguments:
- the bioaccumulation factor is lower than 100;
- the mode of action (narcosis) is non-specific;
- the variation is not too high in view of the large number of data;

an assessment factor of 10 is used and the $MAC_{eco,\ water}$ becomes 0.89 / 10 = 0.089 mg/L = 89 μg/L.

For the marine environment, one additional specific marine taxon is present (mollusca) and an additional assessment factor of 5 is used. The $MAC_{eco,\ marine}$ then becomes 18 μg/L.

3.3.4.3 Derivation of NC

The NC is derived by dividing the final MPC by a factor of 100.

NC_{water} = 0.16 μg/L.
NC_{marine} = 0.032 μg/L.

3.3.4.4 Derivation of SRC_{eco}

The geometric mean of all chronic data is 3.6 mg/L. These data are normally distributed (significant at all levels using the Anderson-Darling test for normality). Because more than three NOECs are available, no comparison has to be made with the geometric mean of the acute data. The $SRC_{eco,\ water}$ and $SRC_{eco,\ marine}$ are set at 3.6 mg/L = 3.6×10^3 μg/L.

3.3.5 Sediment toxicity data

The log $K_{p,\ susp\text{-}water}$ of 4-chlorophenol is below the trigger value of 3, therefore, ERLs are not derived for sediment.

3.3.6 Comparison of derived ERLs with monitoring data

An overview of the derived ERLs is given in Table 26.

Table 26. Derived MPC, MAC_{eco}, NC, and SRC_{eco} values for 4-chlorophenol (in µg/L).

ERL	Unit	MPC	MAC_{eco}	NC	SRC_{eco}
Freshwater	µg/L	16	89	0.16	3.6×10^3
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	3.2	18	3.2×10^{-2}	3.6×10^3

[a] n.a. = not applicable.

Due to the mode of action of the monochlorophenols (narcosis), and the fact that these compounds often occur together, the use of the toxic unit approach is recommended. The toxic unit approach assumes that compounds that act similar, have concentration additive toxicity. This means that the sum of the ratio between measured concentration and risk limits for all monochlorophenols combined should not exceed 1.

Monitoring data for the Rhine from the years 2001-2006, obtained from RIWA (Association of River Waterworks), shows that at all sampling occasions and locations, the concentration of 4-chlorophenol in water was below detection limits (0.02 – 0.5 µg/L).

3.4 4-chloro-3-methylphenol

3.4.1 Identity

3.4.1.1 Substance identification, physico-chemical properties, fate and human toxicology

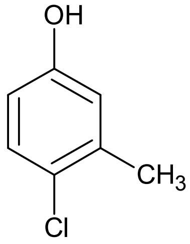

Figure 4. Structural formula of 4-chloro-3-methylphenol.

Table 27. Identification of 4-chloro-3-methylphenol.

Parameter	Result
Chemical name	4-chloro-3-methylphenol
Common/other name	4-chloro-m-cresol
Commercial names	Aptal, Raschitk, Attafact, Baktol, Baktolan, Candaseptic, Chlorocresol, Ottafect, Parmatol, Parol, PCMC, Peritonan, Prevento 1 cmk, Preventol CMK, Raschit
CAS number	59-50-7
EC number	200-431-6
Annex I Index number	604-014-00-3
SMILES code	Oc(ccc(c1C)Cl)c1

3.4.1.2 Use

The main use of 4-chloro-3-methylphenol is as a pesticide, bactericide and preserving agent.

3.4.1.3 Physico-chemical properties

Table 28. Physico-chemical properties of 4-chloro-3-methylphenol. Bold values are used for ERL derivation.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	142.59		
Water solubility	[mg/L]	**3600-4000**		EC, 2000
		699	EpiWin	US EPA, 2007
pK_a	[-]	9.59	Recommended by reference	BioByte, 2006
log K_{OW}	[-]	**3.10**		Mackay et al., 2000
		3.10	Recommended by reference	BioByte, 2006
		2.98	calculated	BioByte, 2006
		3.10		EC, 2000
		2.70	EpiWin	US EPA, 2007
log K_{OC}	[-]	**2.85**	Calculated using log K_{OW} = 3.10	According to Sabljic et al., 1995
		2.86	EpiWin	US EPA, 2007
Vapour pressure	[Pa]	6.67	25 ºC	Mackay et al., 2000
		ca. 8	20 ºC	EC, 2000
		5.40	EpiWin	US EPA, 2007
Melting point	[°C]	66-68		Mackay et al., 2000
		63-66		EC, 2000
		36.2	EpiWin	US EPA, 2007
Boiling point	[°C]	235		Mackay et al., 2000
		235-239		EC, 2000
		222	EpiWin	US EPA, 2007
Henry's law constant	[Pa.m^3/mol]	0.253	20 ºC; calculated	Mackay et al., 2000
		1.10	EpiWin	US EPA, 2007
		0.28	20 ºC; calculated	Mackay et al., 2000

3.4.1.4 Behaviour in the environment

No data is known on hydrolysis, photolysis, biodegradability and relevant metabolites of 4-chloro-3-methylphenol.

3.4.1.5 Bioconcentration and biomagnification

An overview of the bioaccumulation data for 4-chloro-3-methylphenol is given in Table 29. Detailed bioaccumulation data for 4-chloro-3-methylphenol are tabulated in Appendix 1.

Table 29. Overview of bioaccumulation data for 4-chloro-3-methylphenol.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	120	Muscles	Jennings et al., 1996
		16	Whole body	Ramos et al., 1998
BCF (mollusc)	[L/kg]	38		Jennings et al., 1996
		16		Ramos et al., 1998
BMF	[kg/kg]	1	Default value for compounds with BCF < 2000 L/kg.	

3.4.1.6 Human toxicological treshold limits and carcinogenicity

4-chloro-3-methylphenol is not classified as a possible carcinogen by IARC and has the following R-phrases: R21/22; R41; R43; R50. A RfD of 100 μg/kg$_{bw}$/day (NSF International, 2002) can be used as an ADI.

3.4.2 Trigger values

This section reports on the trigger values for ERLwater derivation (as demanded in WFD framework).

Table 30. 4-chloro-3-methylphenol: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp-water}$	1.85	[-]	$K_{OC} \times f_{OC,susp}$[1]	K_{OC}: 3.4.1.3
BCF	16	[L/kg]		3.4.1.5
BMF	1	[kg/kg]		3.4.1.5
Log K_{OW}	3.10	[-]		3.4.1.3
R-phrases	R21/22; R41; R43; R50	[-]		3.4.1.6
A1 value	1	[μg/L]	Mandatory for phenols	
DW standard	-	[μg/L]		

1 $f_{OC,susp}$ = 0.1 kg$_{OC}$/kg$_{solid}$ (European Commission (Joint Research Centre), 2003).

- 4-chloro-3-methylphenol has a log $K_{p, susp-water}$ < 3; derivation of MPC$_{sediment}$ is not triggered.
- 4-chloro-3-methylphenol has a log $K_{p, susp-water}$ < 3; expression of the MPC$_{water}$ as MPC$_{susp, water}$ is not required.
- 4-chloro-3-methylphenol has a BCF < 100 L/kg; assessment of secondary poisoning is not triggered.
- 4-chloro-3-methylphenol is not classified as a possible carcinogen, has a BCF < 100 L/kg and no relevant R-phrases. Therefore, an MPC$_{water}$ for human health via food (fish) consumption (MPC$_{hh\ food,\ water}$) does not have to be derived.
- For 4-chloro-3-methylphenol, no compound-specific A1 value or Drinking Water value is available from Council Directives 75/440, EEC and 98/83/EC, respectively. Therefore, the general mandatory A1 value for phenols applies.

3.4.3 Aquatic toxicity data

3.4.3.1 Toxicity data

An overview of the selected freshwater toxicity data for 4-chloro-3-methylphenol is given in Table 31 and marine toxicity data is given in Table 32. Detailed toxicity data for 4-chloro-3-methylphenol are tabulated in Appendix 2.

Table 31. 4-chloro-3-methylphenol: selected freshwater toxicity data for ERL derivation.

Chronic[a] **Taxonomic group**	**NOEC/EC10 (mg/L)**	**Acute**[a] **Taxonomic group**	**L(E)C50 (mg/L)**
Algae	2.3	Algae	15
Algae	4.7	Algae	4.2
Crustacea	**1.3**	Protozoa	23
		Mollusca	14
		Crustacea	3.7
		Crustacea	3.3
		Crustacea	1.7[b]
		Crustacea	3.1
		Pisces	2.4
		Pisces	0.92
		Pisces	5.9[c]
		Pisces	6.7
		Pisces	1.3

[a] For detailed information see Appendix 2. Bold values are used for ERL-derivation.

[b] Most relevant exposure duration (48 h), geometric mean of 1.5 and 2 mg/L, parameter mortality/immobility for *Daphnia magna.*

[c] Geometric mean of 5.72, 7.38, 4.05, 5.47, and 7.56 mg/L, parameter mortality for *Pimephales promelas.*

Table 32. 4-chloro-3-methylphenol: selected marine toxicity data for ERL derivation.

Chronic [a] **Taxonomic group**	**NOEC/EC10 (mg/L)**	**Acute** [a] **Taxonomic group**	**L(E)C50 (mg/L)**
No data		Bacteria	**0.64**[b]

[a] For detailed information see Appendix 2. Bold values are used for ERL-derivation.

[b] Most relevant exposure duration (15-30 min), geometric mean of 1.8, 0.95, 0.29, and 0.34 mg/L; parameter bioluminescence for *Vibrio fischeri.*

3.4.3.2 Treatment of fresh- and saltwater toxicity data

Following Lepper (2005), freshwater and marine datasets can be combined if it cannot be shown that marine species are more sensitive than freshwater species. Data for marine algae and crustacea are in the range of freshwater data. Thus, freshwater and marine datasets are combined.

3.4.4 Derivation of Environmental Risk Limits

3.4.4.1 Derivation of MPC$_{water}$ and MPC$_{marine}$

MPC$_{eco, water}$ and MPC$_{eco, marine}$

Acute toxicity data are available for six taxonomic groups, amongst which algae, crustacea (*Daphnia*) and fish. Thus, the base set is complete. Chronic are available for algae and crustacean, not for fish. The lowest NOEC is 1.3 mg/L for the crustacea *Daphnia magna*. However, the lowest LC50 of 0.64 mg/L for *Vibrio fischeri* is lower than the lowest NOEC.

With NOECs for two taxa, and an LC50 lower than the NOECs, an assessment factor of 100 should be used on the LC50. This results in an MPC$_{eco, water}$ of 0.64 / 100 = 6.4 × 10^{-3} mg/L = 6.4 µg/L.

No chronic toxicity data are available for specific marine taxa. With an assessment factor of 1000 the $MPC_{eco,\ marine}$ becomes 0.64 / 1000 = 6.4×10^{-4} mg/L = 0.64 µg/L.

$MPC_{sp,\ water}$ and $MPC_{sp,\ marine}$

4-chloro-3-methylphenol has a BCF < 100 L/kg, thus assessment of secondary poisoning is not triggered.

$MPC_{hh\ food,\ water}$

Derivation of $MPC_{hh\ food,\ water}$ for 4-chloro-3-methylphenol is not triggered (Table 30).

$MPC_{dw,water}$

The $MPC_{dw,water}$ is 1 µg/L according to the general A1 value for phenols.

Selection of the MPC_{water} and MPC_{marine}

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. However, the derivation of $MPC_{hh\ food,\ water}$ and $MPC_{sp,\ water}$ was not triggered. Thus, the general MPCs are based on ecotoxicity ($MPC_{eco,\ water}$ and $MPC_{eco,\ marine}$) which results in an MPC_{water} of 6.4 µg/L and and MPC_{marine} of 0.64 µg/L.

3.4.4.2 Derivation of MAC_{eco}

The base set is complete. LC50s are available for six taxa. The lowest LC50 is 0.64 mg/L for the bacterium *Vibrio fischeri*.

Given the following arguments:
- the bioaccumulation factor is lower than 100;
- the mode of action (narcosis) is non-specific;
- the variation is not too high in view of the large number of data;

an assessment factor of 10 is used and the $MAC_{eco,\ water}$ becomes 0.64 / 10 = 0.064 mg/L = 64 µg/L.

For the marine environment, no specific marine taxa are present and an additional assessment factor of 10 should be used. The $MAC_{eco,\ marine}$ then becomes 6.4 µg/L.

3.4.4.3 Derivation of NC

The NC is derived by dividing the final MPC by a factor of 100.

$NC_{water} = 6.4 \times 10^{-2}$ µg/L.
$NC_{marine} = 6.4 \times 10^{-3}$ µg/L.

3.4.4.4 Derivation of SRC_{eco}

Three chronic NOECs are available from two different taxa, with a geometric mean of 2.4 mg/L. Because NOECs are available for only two taxa, a comparison has to be made with the geometric mean of the acute data (3.7 mg/L). Because the geometric mean of the acute data divided by 10 is smaller than the geometric mean of the NOECs, the SRC_{eco} is based on the geometric mean of the acute data with an assessment factor of 10. The $SRC_{eco,\ water}$ and $SRC_{eco,\ marine}$ are set at
3.7 / 10 = 0.37 mg/L = 3.7×10^{2} µg/L.

3.4.5 Sediment toxicity data

The log $K_{p,\ susp\text{-}water}$ of 4-chloro-3-methylphenol is below the trigger value of 3, therefore, ERLs are not derived for sediment.

3.4.6 Comparison of derived ERLs with monitoring data

An overview of the derived ERLs is given in Table 33.

Table 33. Derived MPC, MAC_{eco}, NC, and SRC_{eco} values for 4-chloro-3-methylphenol (in µg/L).

ERL	Unit	MPC	MAC_{eco}	NC	SRC_{eco}
Freshwater	µg/L	6.4	64	6.4×10^{-2}	3.7×10^{2}
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	0.64	6.4	6.4×10^{-3}	3.7×10^{2}

[a] n.a. = not applicable.

Monitoring data for the Rhine from the years 2004 and 2006, obtained from RIWA (Association of River Waterworks), shows that at all sampling occasions and locations, the concentration of 4-chloro-3-methylphenol in water was below detection limits (0.01 – 0.15 µg/L).

3.5 Aminochlorophenol

3.5.1 Substance identification, physico-chemical properties, fate and human toxicology

3.5.1.1 Identity

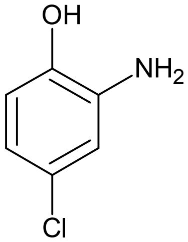

Figure 5. Structural formula of aminochlorophenol.

Table 34. Identification of aminochlorophenol.

Parameter	Result
Chemical name	aminochlorophenol
CAS number	95-85-2
EC number	202-458-9
SMILES code	Oc(c(N)cc(c1)Cl)c1

3.5.1.2 Physico-chemical properties

Table 35. Physico-chemical properties of aminochlorophenol. Bold values are used for ERL derivation.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	143.57		
Water solubility	[mg/L]	**2300**	EpiWin	US EPA, 2007
pK_a	[-]	Unknown		
log K_{OW}	[-]	**1.81**	Recommended by reference	BioByte, 2006
		1.71	calculated	BioByte, 2006
		1.24	EpiWin	US EPA, 2007
log K_{OC}	[-]	**2.04**	Calculated using log K_{OW} = 1.81	According to Sabljic et al., 1995
		2.08	EpiWin	US EPA, 2007
Vapour pressure	[Pa]	0.188	EpiWin	US EPA, 2007
Melting point	[°C]	69.8	EpiWin	US EPA, 2007
Boiling point	[°C]	270	EpiWin	US EPA, 2007
Henry's law constant	[Pa.m^3/mol]	0.0117	EpiWin	US EPA, 2007

3.5.1.3 Behaviour in the environment

No data is known on hydrolysis, photolysis, biodegradability and relevant metabolites of 4-chloro-3-methylphenol.

3.5.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for aminochlorophenol is given in Table 36. No experimental bioaccumulation data are available.

Table 36. Overview of bioaccumulation data for aminochlorophenol.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	6.9	Calculated using log K_{OW} = 1.81	According to Veith et al., 1979
BMF	[kg/kg]	1	Default value for compounds with log K_{OW} < 4.5	

3.5.1.5 Human toxicological treshold limits and carcinogenicity

Aminochlorophenol is not classified as a carcinogenic compound and does not have any R-phrases. No ADI was found in the relevant databases.

3.5.2 Trigger values

This section reports on the trigger values for ERLwater derivation (as demanded in WFD framework).

Table 37. Aminochlorophenol: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{\mathrm{p,susp\text{-}water}}$	1.04	[-]	$K_{\mathrm{OC}} \times f_{\mathrm{OC,susp}}$[1]	K_{OC}: 3.5.1.2
BCF	6.9	[L/kg]		3.5.1.4
BMF	1	[kg/kg]		3.5.1.4
Log K_{OW}	1.81	[-]		3.5.1.2
R-phrases	No R-phrases	[-]		3.5.1.5
A1 value	1	[µg/L]	Mandatory for phenols	
DW standard	-	[µg/L]		

1 $f_{\mathrm{OC,susp}} = 0.1$ $\mathrm{kg_{OC}/kg_{solid}}$ (European Commission (Joint Research Centre), 2003).

- aminochlorophenol has a log $K_{\mathrm{p,\ susp\text{-}water}} < 3$; derivation of $\mathrm{MPC_{sediment}}$ is not triggered.
- aminochlorophenol has a log $K_{\mathrm{p,\ susp\text{-}water}} < 3$; expression of the $\mathrm{MPC_{water}}$ as $\mathrm{MPC_{susp,\ water}}$ is not required.
- aminochlorophenol has a log $K_{\mathrm{OW}} < 3$; assessment of secondary poisoning is not triggered.
- aminochlorophenol does not have an R-classification. Therefore, an $\mathrm{MPC_{water}}$ for human health via food (fish) consumption ($\mathrm{MPC_{hh\ food,\ water}}$) does not have to be derived.
- For aminochlorophenol, no compound-specific A1 value or Drinking Water value is available from Council Directives 75/440, EEC and 98/83/EC, respectively. Therefore, the general mandatory A1 value for phenols applies.

3.5.3 Aquatic toxicity data

3.5.3.1 Toxicity data

An overview of the selected freshwater toxicity data for aminochlorophenol is given in Table 38. There are no marine toxicity data for aminochlorophenol. Detailed toxicity data for aminochlorophenol are tabulated in Appendix 2.

Table 38. Aminochlorophenol: selected freshwater toxicity data for ERL derivation.

Chronic[a] Taxonomic group	NOEC/EC10 (mg/L)	Acute[a] Taxonomic group	L(E)C50 (mg/L)
No data		Bacteria	33

[a] For detailed information see Appendix 2.

3.5.4 Derivation of Environmental Risk Limits

3.5.4.1 Derivation of $\mathrm{MPC_{water}}$ and $\mathrm{MPC_{marine}}$

$\mathrm{MPC_{eco,\ water}}$ and $\mathrm{MPC_{eco,\ marine}}$

Only one LC50 is available, 33 mg/L for the bacteria *Escherichia coli*. This means that the base set is not complete. Environmental risk limits based on ecotoxicity data cannot be derived.

$\mathrm{MPC_{sp,\ water}}$ and $\mathrm{MPC_{sp,\ marine}}$

Aminochlorophenol has a BCF < 100 L/kg, thus assessment of secondary poisoning is not triggered.

MPC$_{\text{hh food, water}}$

Derivation of MPC $_{\text{hh food, water}}$ for aminochlorophenol is not triggered (Table 37).

MPC$_{\text{dw,water}}$

The MPC$_{\text{dw,water}}$ is 1 µg/L according to the general A1 value for phenols.

Selection of the MPC$_{\text{water}}$ and MPC$_{\text{marine}}$

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. The derivation of MPC$_{\text{hh food, water}}$ and MPC$_{\text{sp, water}}$ was not triggered, while derivation of the MPC based on ecotoxicity (MPC$_{\text{eco, water}}$ and MPC$_{\text{eco, marine}}$) is not possible. The MPC$_{\text{water}}$ and MPC$_{\text{marine}}$ cannot be derived.

3.5.4.2 Derivation of MAC$_{\text{eco}}$

Derivation of the MAC$_{\text{eco}}$ is not possible.

3.5.4.3 Derivation of NC

Derivation of NCs is not possible.

3.5.4.4 Derivation of SRC$_{\text{eco}}$

Derivation of the SRC$_{\text{eco}}$ is not possible.

3.5.5 Comparison of derived ERLs with monitoring data

No ERLs could be derived. Monitoring data for the Rhine from the year 2005, obtained from RIWA (Association of River Waterworks), shows that at all sampling occasions and locations, the concentration of aminochlorophenol in water was below detection limits (0.5 µg/L).

4 Conclusions

In this report, the risk limits negligible concentration (NC), maximum permissible concentration (MPC), maximum acceptable concentration for ecosystems (MAC$_{eco}$), and serious risk concentration for ecosystems (SRC$_{eco}$) are derived for monochlorophenols, 4-chloro-3-methylphenol and aminochlorophenol in water. No risk limits were derived for the sediment compartment because the trigger values to derive such risk limits were not reached.

The ERLs that were obtained are summarised in the table below. Please note that for the three monochlorophenols, due to the mode of action (narcosis) and the fact that these compounds often occur together, the use of the toxic unit approach is recommended. The toxic unit approach assumes that compounds that act similar, have concentration additive toxicity. This means that the sum of the ratio between measured concentration and risk limits for the three monochlorophenols combined should not exceed 1.

Table 39. Derived MPC, MAC$_{eco}$, NC, and SRC$_{eco}$ values (in µg/L).

	Unit	**MPC**	**MAC$_{eco}$**	**NC**	**SRC$_{eco}$**
2-chlorophenol					
Freshwater	µg/L	35	1.1×10^{2}	0.35	1.2×10^{4}
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	3.5	11	3.5×10^{-2}	1.2×10^{4}
3-chlorophenol					
Freshwater	µg/L	4.0	4.0×10^{2}	4.0×10^{-2}	1.4×10^{3}
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	0.4	40	4.0×10^{-3}	1.4×10^{3}
4-chlorophenol					
Freshwater	µg/L	16	89	0.16	3.6×10^{3}
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	3.2	18	3.2×10^{-2}	3.6×10^{3}
4-chloro-3-methylphenol					
Freshwater	µg/L	6.4	64	6.4×10^{-2}	3.7×10^{2}
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	0.64	6.4	6.4×10^{-3}	3.7×10^{2}
Aminochlorophenol					
Freshwater	µg/L	n.d.[b]	n.d.[b]	n.d.[b]	n.d.[b]
Drinking water	µg/L	1	n.a.[a]	n.a.[a]	n.a.[a]
Marine water	µg/L	n.d.[b]	n.d.[b]	n.d.[b]	n.d.[b]

[a] n.a. = not applicable.

[b] n.d. = not derived due to lack of data

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Appendix 1. Information on bioconcentration

Table A1.1 Bioconcentration data for 2-chlorophenol.

Species	Species properties	Substance purity [%]	Analysed	Test type	Test water	pH	Hardness $CaCO_3$ [mg/L]	Temp. [°C]	Exp. time	Exp. concn. [mg/L]	BCF [L/kg]	BCF type	Calculation method	Ri	Notes	Reference
Carassius auratus	2.2 g	100	deriv GC/ECD (not in water)	S	tw	6		20-21	5 h	5	3.7	whole body	Cbiota/Cw	3	3	Kishino and Kobayashi, 1995
Carassius auratus	2.2 g	100	deriv GC/ECD (not in water)	S	tw	8		20-21	5 h	5	3.8	whole body	Cbiota/Cw	3	3	Kishino and Kobayashi, 1995
Carassius auratus	2.2 g	100	deriv GC/ECD (not in water)	S	tw	10		20-21	5 h	5	0.6	whole body	Cbiota/Cw	3	3	Kishino and Kobayashi, 1995
Carassius auratus	2 g		colorimetric	R				20	12- 24 h	20	6.4	whole body	Cbiota/Cw	3	4	Kobayashi et al., 1979
Cyprinus carpio								25	42 d	0.004	16 - 29			2	1,5	EC, 2000
Cyprinus carpio								25	42 d	0.04	14 - 24			2	1,5	EC, 2000
Lepomis macrochirus	0.37-0.95 g; 25-35 mm		LSC	CF	nw	6.3-7.9	35	16±1	28 d	0.00918	214	whole body ww	Cbiota/Cw	3	6	Barrows et al., 1980; Veith et al., 1980; EC, 2000
Pimephales promelas	0.68±0.3g; 4.4±2.5% lipid	>99	HPLC-UV	S	am	6.2		18.0-18.4	1.1 - 5.9 h	36.5	4.6	LBB	Cbiota/Cw	3	7	Van Wezel and Opperhuizen, 1995
fish											214	whole body	Cbiota/Cw	4	2	Lu et al., 2000

Notes:

1 Original source: Rhone-Poulenc Chimie Courbevoie Cedex, 1992
2 Review article; specific references per compound not specified
3 Exposure duration is short, equilibrium might not be fully reached; aqueous concentration presumably not measured
4 Exposure duration is short; aqueous concentration presumably not measured
5 According to OECD 305C
6 total 14C concentration; BCF thus includes possible metabolites
7 Lethal body burdens

Table A1.2 Bioconcentration data for 3-chlorophenol.

Species	Species properties	Substance purity [%]	Analysed	Test type	Test water	pH	Hardness $CaCO_3$ [mg/L]	Temp. [°C]	Exp. time	Exp. concn. [mg/L]	BCF [L/kg]	BCF type	Calculation method	Ri	Notes	Reference
Unspecified											17.8		Cbiota/Cw	4	1,2	Klamer & Beekman, 1995
Pisces																
Brachydanio rerio	2.9 - 3.5 cm; 3-5% lipids		Deriv-GLC-ECD	CF	tw	7.6-8.0		25	50 + 100 h ?	0.98	17.8	whole body ww	k1/k2	1	3,4	Butte et al., 1987
Carassius auratus	2.2 g	100	deriv GC/ECD (not in water)	S	tw	6		20-21	5 h	5	10	whole body	Cbiota/Cw	3	5	Kishino and Kobayashi, 1995
Carassius auratus	2.2 g	100	deriv GC/ECD (not in water)	S	tw	8		20-21	5 h	5	9.7	whole body	Cbiota/Cw	3	5	Kishino and Kobayashi, 1995
Carassius auratus	2.2 g	100	deriv GC/ECD (not in water)	S	tw	10		20-21	5 h	5	2	whole body	Cbiota/Cw	3	5	Kishino and Kobayashi, 1995
fish											17.8	whole body	Cbiota/Cw	4	1	Lu et al., 2000
fish											17.8			4	1	Park & Lee, 1993

Notes:
1 Review; originial reference not clear but probably Butte
2 Mentioned in review that metabolic transformation does not occur.
3 According to OECD 305E test protocol
4 Seems well performed, but not all data presented.
5 Exposure duration is short, equilbrium might not be fully reached; aquaeous concentration presumably not measured

Table A1.3 Bioconcentration data for 4-chlorophenol.

Species	Species properties	Substance purity [%]	Analysed	Test type	Test water	pH	Hardness $CaCO_3$ [mg/L]	Temp. [°C]	Exp. time	Exp. concn. [mg/L]	BCF [L/kg]	BCF type	Calculation method	Ri	Notes	Reference
Pisces																
Carassius auratus	2.2 g	100	deriv GC/ECD (not in water)	S	tw	6		20-21	5 h	3	7.6	whole body	Cbiota/Cw	3	2	Kishino and Kobayashi, 1995
Carassius auratus	2.2 g	100	deriv GC/ECD (not in water)	S	tw	8		20-21	5 h	3	6.9	whole body	Cbiota/Cw	3	2	Kishino and Kobayashi, 1995
Carassius auratus	2.2 g	100	deriv GC/ECD (not in water)	S	tw	10		20-21	5 h	3	3.1	whole body	Cbiota/Cw	3	2	Kishino and Kobayashi, 1995
Carassius auratus	2 g		colorimetric	R				20	12- 24 h	10	10.1	whole body	Cbiota/Cw	3	2	Kobayashi et al., 1979
Cyprinus carpio								25	42 d	0.004	11 - 52			2	1,3	EC, 2000
Cyprinus carpio								25	42 d	0.04	6 - 18			2	1,3	EC, 2000
Pimephales promelas	0.68±0.3g; 4.4±2.5% lipid	>99	HPLC-UV	S	am	6.2		18.0-18.4	1.1 - 5.9 h	36.5	9.8214286	LBB	Cbiota/Cw	3	4	Van Wezel and Opperhuizen, 1995

Notes:
1 Original source: Rhone-Poulenc Chimie Courbevoie Cedex, 1979
2 Exposure duration is short, equilbrium might not be fully reached; aquaeous concentration presumably not measured
3 According to OECD 305C
4 Lethal body burdens

Table A1.4 Bioconcentration data for 4-chloro-3-methylphenol.

Species	Species properties	Substance purity [%]	Analysed	Test type	Test water	pH	Hardness $CaCO_3$ [mg/L]	Temp. [°C]	Exp. time	Exp. concn. [mg/L]	BCF [L/kg]	BCF type	Calculation method	Ri	Notes	Reference
Mollusca																
Lymnaea stagnalis	2-3 mo old	99	SPME	R	tw	8.0-8.3		21-24	96 h		15.6	ww	LBB x EC50	2	1	Urrestarazu Ramos et al., 1998
Mytilus edulis	obtained from fish market	ag	GC-MS	R	seawater			15	7 d	0.1	37.75	soft tissue body ww		2	4	Jennings et al, 1996
Pisces																
Cyprinus carpio								25	42 d	0.002	2.2 - 11			4	2,5	EC, 2000
Cyprinus carpio								25	42 d	0.02	6.7 - 13			4	2,5	EC, 2000
Poecilia reticulata	2-3 mo old ♀; 1.8 cm and 69 mg	99	SPME	R	tw	8.0-8.3		20-25	96 h		15.5	whole body ww	LBB x EC50	2	1	Urrestarazu Ramos et al., 1998
Trachurus novaezelandiae	caught in Sidney Harbour	ag	GC-MS	R	seawater			21	7 d	0.1	120.8	muscles ww		2	3,4	Jennings et al, 1996

Notes
1 Calculated using values for LBB and EC50; Whole body without shell and gut
2 Source: Bayer AG Leverkusen,
3 no bioconcentration detected in the liver
4 steady state was reached after 40 hours
2 According to MITI/OECD guidelines

No data were available for bioconcentration of aminochlorophenol.

Appendix 2. Detailed aquatic toxicity data

Table A2.1 Acute toxicity of 2-chlorophenol to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg /L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Pure culture	isolated from lab. act. sludge			98	am			A	30 - 60 min	EC50	dehydrogenase act.	> 500	4	1,37	Liu, 1985
Pure culture	isolated from lab. act. sludge			98	am			B	30 - 60 min	EC50	dehydrogenase act.	130	4	1,37	Liu, 1985
Pure culture	isolated from lab. act. sludge			98	am			C	30 - 60 min	EC50	dehydrogenase act.	125	4	1,37	Liu, 1985
Pure culture	isolated from adaptated act. sludge			98	am			E	30 - 60 min	EC50	dehydrogenase act.	170	4	1,37	Liu, 1985
Pure culture	isolated from adaptated act. sludge			98	am			F	30 - 60 min	EC50	dehydrogenase act.	> 500	4	1,37	Liu, 1985
Pure culture	isolated from Lake Erie sediment			98	am			G	30 - 60 min	EC50	dehydrogenase act.	> 500	4	1,37	Liu, 1985
Pure culture	grown in medium with phenol as pure carbon source	N	S		am	7.2	ca. 20 (room temp.)		exp. growth phase	EC50	growth on phenol	114	3		Banerjee, 1987
Bacillus sp.	isolated from act. sludge, cell age 18 - 20 h						21		30 min	EC50	dehydrogenase act.	700	2	2	Liu et al., 1982
Bacillus subtilis						7.2				EC50	spore germination	72.2	4	3,38	Yasuda et al., 1982
Bacillus subtilis		N	S		am		37	0.17	log. growth phase	EC50	growth	476	2		Ogawa et al., 1991
Burkholderia RASC c2	*lux*-marked, Gram-negative	N	S	≥ 98	am	7.1	25		20 min	EC50	bioluminescence	28.3	2	3	Boyd et al., 2001
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	EC50	specific growth rate	122	2		Cenci et al., 1987
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	EC50	dehydrogenase act.	512	2		Cenci et al., 1987
Pseudomonas fluorescens	isolated from soil, *lux*-marked, Gram-negative	N	S	≥ 98	am	7.1	25		20 min	EC50	bioluminescence	122	2	3,4	Boyd et al., 2001
Pseudomonas I	able to grow on benzoate	N	S		am		30			EC19	oxygen uptake rate	424	2,39		Huang and Tseng, 1996
Pseudomonas II	isolated from soil, able to grow on phenol	N	S		am		30			EC63.3	oxygen uptake rate	424	2,39		Huang and Tseng, 1996
Salmonella typhimurium	TA98				am	6.6	37		30 min	EC50	specific growth rate	411	3	5	Pill et al., 1991
Spirochaeta aurantia	ATCC 25082				am	7	30		30 min	EC50	specific growth rate	167	2		Pill et al., 1991
Algae															
Chlorella pyrenoidosa			S			7			72 h	EC50	chlorophyll reduction	96	4		Huang and Gloyna, 1968 and Jones, 1971. In: Krijgsheld and van der

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg /L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
															Gen, 1986
Chlorella vulgaris	ca. 7.5 x 10^6 cells/mL				am		36.5		6 h	EC50	cell density	97.5	2	6,7	Kramer and Trümper, 1986
Chlorella vulgaris	ca. 7.5 x 10^6 cells/mL				am		36.5		6 h	EC50	cell density	126	2	7,8	Kramer and Trümper, 1986
Chlorella vulgaris	5E+04 cells/mL	N	S		am		21 ± 1		96 h	EC50	growth rate	170	2		Shigeoka et al., 1988
Pseudokirchneriella subcapitata	5E+04 cells/mL	N	S		am		21 ± 1		96 h	EC50	growth rate	70	2		Shigeoka et al., 1988
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		48 h	EC50	biomass (AUC)	50	2		Kühn and Pattard, 1990
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		48 h	EC50	growth rate	85	2		Kühn and Pattard, 1990
Protozoa															
Tetrahymena pyriformis	strain GL-C, ca. 2500 cells/mL from logarithmic growing culture	N	S		am	7.35	27 ± 1	75	40 h	EC50	population growth (density)	84.9	2	9	Schultz et al., 1996
Tetrahymena pyriformis	strain GL-C		S	≥ 95	am		28		60 h	EC50	growth	36.7	2	9	Schultz, 1987a
Tetrahymena pyriformis									48 h	EC50	population growth (density)	68.0	2	9	Schultz, 1986
Tetrahymena pyriformis	ca. 36000 cells/mL, in log phase	N	S	≥ 95	am	7.35	27 ± 1		48 h	EC50	population growth (density)	67.5	4*	9	Schultz et al., 1990
Tetrahymena pyriformis			S						60 h	EC50	population growth (density)	68.0	4*	9	Schultz et al., 1986
Tetrahymena pyriformis	2500 cells/mL, in log-phase	N	S	≥ 95	am	7.35	27 ± 1		48 h	EC50	population growth (density)	68.0	4*		Bryant and Schultz, 1994
Macrophyta															
Salvinia minima	collected in field				am		25		7 d	EC50	growth (fwt)	19.7	2	10	Gallardo et al., 1998
Salvinia minima	collected in field				am		25		7 d	EC50	growth (dwt)	19.8	2	10	Gallardo et al., 1998
Salvinia minima	collected in field				am		25		7 d	EC50	frond number	1.08	2	10,11	Gallardo et al., 1998
Cnidaria													Ri		
Hydra vulgaris	adult									LOEC	maternal toxicity	0.088	4	12,40	Fu et al., 1990
Hydra vulgaris	adult	N	R	purified prior to use	am	7			92 h	LOEC	tulip stage	100	2	13	Mayura et al., 1991
Crustacea															
Ceriodaphnia dubia	< 24 h old	Y	S				23 ± 1		48 h	EC50	immobility	9.93	2	37	Mulhall, 1997. In: Warne and Westbury, 1999
Daphnia									24 h	EC50		10-35	4		Devillers, 1984. In: Bazin et al., 1987
Daphnia carinata	< 24 h old	Y	S				20 ± 1		48 h	EC50	immobility	5.89	2		Azim, 1998. In: Warne and Westbury, 1999
Daphnia magna	< 24 h old		S		am				24 h	LC50	mortality	23.8	2	10,14,15	LeBlanc et al. 1988
Daphnia magna	< 24 h old	N	S	≥ 80%	rw	7.4 - 9.4	22 ± 1	173 ± 13	48 h	LC50	mortality	2.6	2	14	LeBlanc, 1980
Daphnia magna	< 24 h old	N	S	≥ 80%	rw	7.4 - 9.4	22 ± 1	173 ± 13	48 h	NOEC	mortality	1	2	14	LeBlanc, 1980
Daphnia magna						8.25 - 8.35			24 h	EC50	immobility	21.5	2	16	Trapido et al., 1997

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg /L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Daphnia magna		Y	Sc	ag	nw				24 h	EC50	immobility	8	2		Bazin et al., 1987
Daphnia magna	≤ 24 h old	Y			am	8.0 ± 0.2	25 ± 1	250	24 h	EC50	immobility	6.3	2	17	Kühn et al., 1989a
Daphnia magna	(<24 h old)		S		nw		18 ± 1		48 h	LC50	mortality	7.4	2		Kopperman et al., 1974
Daphnia magna		N	S		am		20	250	24 h	EC50	immobility	23	2	18	Knie et al., 1983
Daphnia magna		Y			rw	5.2	20 ± 2	250 ± 25	24 h	EC50	immobility	11.7	3	41	Tissot et al., 1985
Daphnia magna	(<24 h old)	Y	Sc		nw		18 ± 1		48 h	EC50	immobility	3.91	2		Keen and Baillod, 1985
Daphnia magna	6 - 24 h old	N	S	> 95	am		22 ± 1		24 h	EC50	immobility	14.4	2		Zhao et al., 1995
Daphnia magna	< 72 h old	N	S	> 95%	rw	7.8 - 8.2	20 ± 1	200	24 h	EC50	immobility	18.0	2	19	Devillers and Chambon, 1986
Daphnia magna	<24h	N	S		rw	8	25	150	48 h	LC50	mortality	5.71	2		Kim et al., 2006
Daphnia magna	<24 h old		S		nw	7.0-8.2	22	154.5	48h	EC50	immobility	6.2	2	20	Randall and Knopp, 1980
Daphnia pulex	12 h old	N	R		nw		20 ± 1		96 h	LC50	mortality	6.9	2		Trabalka and Burke, 1978
Pisces															
Carassius auratus	3.8 - 6.4 cm, 1 - 2 g	N	S, open	practical	5% nw + 95% dw	7.5	25	20 mg/L	96 h	LC50	mortality	12.4	2	21,22	Pickering and Henderson 1966
Carassius auratus	1.0 ± 0.1 g		S	ca. 100	tw	7.0 ± 0.1	27 - 28		5 h	LC50	mortality	92.7	3	42,43	Kishino and Kobayashi, 1996
Carassius auratus	1.0 ± 0.1 g	N	S	ca. 100	tw	7.0 ± 0.1	27 - 28		2.5 h	LC50	mortality	92.6	3	42,43	Kishino and Kobayashi, 1996
Carassius auratus	2.2 ± 0.2 g		S	ca. 100	tw	6	20 - 21		5 h	LC50	mortality	70 - 100	3	23,42,43	Kishino and Kobayashi, 1995
Carassius auratus	2.2 ± 0.2 g		S	ca. 100	tw	8	20 - 21		5 h	LC50	mortality	100 - 150	3	23,42,43	Kishino and Kobayashi, 1995
Carassius auratus	2.2 ± 0.2 g		S	ca. 100	tw	10	20 - 21		5 h	LC50	mortality	> 500	3	23,42,43	Kishino and Kobayashi, 1995
Carassius auratus	2 g		R				20		24 h	LC50	mortality	16	3	44	Kobayashi et al., 1979
Carassius auratus	fingerlings < 10.2 cm					7	12.8	300	24 h	NOEC	mortality	≥ 5	3	24,45	Wood, 1953
Carassius auratus	2 - 4 g						27		8 h	LC50	mortality	36.7	3	10,25,43	Gersdorf and Smith, 1940
Danio rerio	160 - 185 mg	N		> 95	am		22 ± 1		24 h	LC50	mortality	15.17	2		Devillers and Chambon, 1986b
Lepomis macrochirus	3.8 - 6.4 cm, 1 - 2 g	N	S, open	practical	5% nw + 95% dw	7.5	25	20 mg/L	96 h	LC50	mortality	10	2	21,22	Pickering and Henderson 1966
Lepomis macrochirus	0.32 - 1.2 g ww	N	Sc	≥ 80%	am	6.5 - 7.9	21 - 23	32 - 48	96 h	LC50	mortality	6.6	2	14,26	Buccafusco et al. 1981
Lepomis macrochirus	juveniles, 4.2 cm, 2.2 g	Y	R	am		7.6 - 8.5	20	105	48 h	LC50	mortality	8.1	2	27	Lammering and Burbank, 1960
Lepomis macrochirus	fingerlings								96 h	LC50	mortality	8.4	2		Henderson et al., 1961
Lepomis macrochirus	fingerlings < 10.2 cm					7	12.8	300	24 h	NOEC	mortality	≥ 5	3	24,45	Wood, 1953
Lepomis macrochirus	fingerlings								96 h	LC50	mortality	8.4	4*	22	McKee and Wolf, 1963. In: Verschueren, 1983
Lepomis macrochirus	fingerlings, ca. 10 cm	N	S		nw	7.5 - 8.2	13		24 h	NOEC	mortality/ obvious distress	≥ 5	3	24,45	Applegate et al., 1957
Leuciscus idus							20	267	48 h	LC50	mortality	8	4	46	Dietz, 1978
Leuciscus idus							20	267	48 h	LC0	mortality	5	4	46	Dietz, 1978
Leuciscus idus melanotus			S			7 - 8	20	267	48 h	LC50	mortality	10.3	2	36	Rübelt et al., 1982
Oncorhynchus mykiss									96 h	LC50	mortality	2.6	4		Sletten and Burbank, 1972. in: Krijgsheld and Van der Gen, 1986

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg /L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Oncorhynchus mykiss	fingerlings, ca. 10 cm	N	S		nw	7.5 - 8.2	13		13 h	LOEC	mortality/ obvious distress	5	3	24,45	Applegate et al., 1957
Oryzias latipes			S				25 ± 2		48 h	LC50	mortality	16.7	2		CITI data. In: EC, 2000
Petromyzon marinus	larvae, 7.6 - 13 cm, collected from the field	N	S		nw	7.5 - 8.2	13		24 h	NOEC	mortality/ obvious distress	≥ 5	3	24,45,47	Applegate et al., 1957
Pimephales promelas									96 h	LC50	mortality	12.3	4	28	COMPUTOX database. In: Eldred et al., 1999
Pimephales promelas	30 - 35 d old	Y	F		nw	ca. 7.5	25 ± 2	43.3 - 48.5	96 h	LC50	mortality	11	2	29	Phipps et al., 1981
Pimephales promelas	30 - 35 d old	Y	F		nw	ca. 7.5	25 ± 2	43.3 - 48.5	96 h	LC50	mortality	13	2	30	Phipps et al., 1981
Pimephales promelas	30 - 35 d old	Y	F		nw	ca. 7.5	25 ± 2	43.3 - 48.5	192 h	LC50	mortality	6.3	2	29	Phipps et al., 1981
Pimephales promelas	30 - 35 d old	Y	F		nw	ca. 7.5)	25 ± 2	43.3 - 48.5	192 h	LC50	mortality	6.3	2	30	Phipps et al., 1981
Pimephales promelas	30 - 35 d old	Y	S, open		nw	ca. 7.5	21.6 - 25.4	43.3 - 48.5	48 h	LC50	mortality	9.7	2		Phipps et al., 1981
Pimephales promelas	3.8 - 6.4 cm, 1 - 2 g	N	S, open	practical	5% nw + 95% dw	8.2	25	360 mg/L	96 h	LC50	mortality	14.5	2	21,22	Pickering and Henderson 1966
Pimephales promelas	3.8 - 6.4 cm, 1 - 2 g	N	S, open	practical	5% nw + 95% dw	7.5	25	20 mg/L	96 h	LC50	mortality	11.6	2	21,22	Pickering and Henderson 1966
Pimephales promelas	30 - 35 d		F		nw		25 ± 2	43.3 - 48.5	192 h	LC50	mortality	12.3	4*	31	Hall et al., 1984
Pimephales promelas	28 d, 14.3 mm, 43 mg	Y	F		nw/dtw	7.8	25.4	42.6	96 h	LC50	mortality	9.41	1		Geiger et al., 1988
Pimephales promelas	34 d, 0.069 g	Y	F	rg	nw/dtw	7.47	24.7	44.9	96 h	LC50	mortality	13.8	1		Geiger et al., 1985
Pimephales promelas		Y	F		nw/dtw				96 h	LC50	mortality	11.4	4*		Geiger et al., 1990
Pimephales promelas	juv. 26 - 34 d, lab.-cultured	Y	CF	> 95	nw	7.8	25	45	96 h	LC50	mortality	9.41	4*	32	Veith and Broderius 1987; Broderius et al. 1995
Poecilia reticulata	6 mo, 1.9 - 2.5 cm, 0.1 - 0.2 g	N	S, open	practical	5% nw + 95% dw	7.5	25	20 mg/L	96 h	LC50	mortality	20.2	2	21,22	Pickering and Henderson 1966
Poecilia reticulata	2 - 3 mo		R		am or rw	6.1	22 ± 1	25	7 or 14 d	LC50	mortality	7.1	2	33	Könemann and Musch 1981
Poecilia reticulata	2 - 3 mo		R		am or rw	7.3	22 ± 1	25	7 or 14 d	LC50	mortality	11.2	2	33	Könemann and Musch 1981
Poecilia reticulata	2 - 3 mo		R		am or rw	7.7 - 7.9	22 ± 1	25	7 or 14 d	LC50	mortality	13.5	2	33	Könemann and Musch 1981
Poecilia reticulata	40 - 60 mg		R			7	26 ± 1		96 h	LC50	mortality	13.8	2		Saarikoski and Viluskela, 1982
Poecilia reticulata	2 - 3 mo old males			rg	tw	7.7 ± 0.1			24 h	LC50	mortality	1.72	4	48	Benoit-Guyod et al., 1984
Poecilia reticulata	just before animals revealed sexual dimorphism	Y	S		tw	7.6 - 8		262	96 h	LC50	mortality	12	2		Dojlido, 1979
Salmo trutta	fingerlings < 10.2 cm					7	12.8	300	6 h	LOEC	mortality	5	3	24	Wood, 1953
Tilapia zilli	2 - 6 cm	N	R	rg		6.6	25 ± 1	215		LC50	mortality	6.5	2	34	Yen et al., 2002
Amphibia															
Rana japonica	tadpoles from eggs collected in the field, 2.5 ± 0.1 cm, 0.09 ± 0.01 g	N	R		nw		22-25		24 h	LC50	mortality	121.6	4	35	Wang et al., 2000

Notes

1 Resazurin reduction procedure: Incubation time is not critical as long as no more than 90 - 95% of the dye in the control is reduced.
2 Dehydrogenase activity represents immediate metabolic activities.
3 Test result is average of three replicates.
4 Soil bacteria which also occurs in water

5 Mutant is more sensitive to toxicants than natural strain.
6 Obtained from extinction measurements at 680 nm
7 Value recalculated from mol/L
8 Obtained from extinction measurements at 750 nm
9 Final DMSO concentration of 0.35 mL DMSO / 50 mL not toxic to Tetrahymena; 8-9 cell cycles
10 L(E)C50 was calculated with data provided by author using GraphPad Prism 4
11 EC50 is extrapolated value since effects were observed at the lowest test concentration
12 Reported as Minimal Affective Concentration. LOEC recalculated from 0.07 mL/mL (assumably) using a density of 1.2634 g/mL.
13 Criterion (tulip stage) considered relevant because it preceeds desintegration (mortality).
14 In accordance with U.S. EPA (1975).
15 Ethanol as solvent (< 0.05%).
16 In accordance with Finnish standard SFS 5062.
17 Test result based on measured concentrations, which were > 80% of nominal.
18 In accordance with DIN 38412 Teil 11.
19 Test performed in closed system; test was considered valid when dissolved oxygen concentration ≥ 2.27 mg/L which is slightly lower than the oxygen level given in OECD 202 (≥ 3 mg/L).
20 Test performed in accordance with EPA methods; Results based on nominal concentrations
21 Method in accordance with recommendations of American Public Health Association.
22 Result reported as TLm.
23 A 5-h exposure period was chosen, because within this period, no detoxification of the test substance occurred.
24 Reported as time to effect. Only two fish tested.
25 Methods previously described in Gersdorf, 1930
26 Dissolved oxygen concentrations too low (range: 9.7 at start - 0.3 mg/L after 96 h) for a number of the compounds tested). Not clear if this was also the case for this compound.
27 Control solutions were not renewed; analysis in additional vessels
27a According to standard german test methods (1974)
28 COMPUTOX database
29 Replicate 1
30 Replicate 2
31 Unit of endpoint not reported. Unit of endpoint not reported. Assumed that unit is mol/L. In accordance with EPA-660/3-75-009.
32 In accordance with ASTM 1980. Unclear if the LC50 is based on nominal or mean measured concentrations, but recovery of the test substance was > 90% of nominal. Not clear if tested together with phenol or separately
33 Exposure duration (7 or 14 days) not clear; influence of pH on toxicity tested.
34 Test duration not reported, most probably 96 hours.
35 Renewed every 6 hours
36 According to standard test german test methods (1974)
37 Species unknown.
38 Test duration unclear, not enough data
39 Exposure time not reported.
40 Effects, exposure time, methods not reported. Unclear is LOEC is reported in mL/mL.
41 pH too low for Daphnia (6 - 9 is acceptable according to OECD guideline).
42 No control group included (based on dose-response curves given in Kishino and Kobayashi (1995)
43 Exposure duration too short
44 No clear dose-response relationship observed (higher mortality at low test substance concentrations).
45 Too few fish tested.
46 test methods poorly reported
47 Larvae live in freshwater, but length of the fish is rather large for larvae, so this may have been a saltwater fish
48 Unit of LC50 not reported.

Table A2.2 Acute toxicity of 2-chlorophenol to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		Y		rg	dw	7			15 min	EC50	bioluminescence	24.7	4	1,8	Shang et al. 2002
Vibrio fischeri		N	S		am		15	21.9	30 min	EC50	bioluminescence	33.8	2	1,2	Ribo and Kaiser, 1983
Vibrio fischeri									20 min	EC50	bioluminescence	102	4	1,9	Lee et al., 1999
Vibrio fischeri		N	S, open		am	6.5 – 7.5	15		5 min	EC50	bioluminescence	18	2	1	Blum and Speece, 1991
Vibrio fischeri								21.9	30 min	EC50	bioluminescence	37.9	2	3	Schüürmann and Segner, 1994. In: Schüürmann et al. 1997
Vibrio fischeri		N			am			21.9		EC50	bioluminescence	48.07	3	1,4,10,11	Kafka et al. 1995
Vibrio fischeri		N		ag	am				15 min	EC50	bioluminescence	28.5	2	1	Ribo and Rogers, 1990
Vibrio fischeri		Y	S	ag			15		10 min	EC50	bioluminescence	34	2	1	Bazin et al., 1987
Vibrio fischeri		N	S				15	21.9	15 min	EC50	bioluminescence	43.37	2		Kafka et al., 1999
Vibrio fischeri										EC50	bioluminescence	1040000	4	1,5	Heck et al., 1992
Vibrio fischeri		N	S				15		5 min	EC50	bioluminescence	21.6	4	1	Mulhall, 1997. In: Warne and Westbury, 1999
Vibrio fischeri						ca. 7	15 ± 0.5	21.9	5 min	EC50	bioluminescence	14	2	1	Aitken et al., 1994
Vibrio fischeri									30 min	EC50	bioluminescence	33.8	4*	1	COMPUTOX database. In: Sixt and Altshuh, 1997
Vibrio fischeri		N	S		am		20		15 min	EC50	bioluminescence	9.31	2	1	Zhao et al., 1993
Vibrio fischeri										EC50	bioluminescence	22.1	4	11	Indorato et al., 1984. In: WHO. 1989.
Vibrio fischeri										EC50	bioluminescence	3.36	4	11	Indorato et al., 1984. In: WHO. 1989.
Crustacea															
Crangon septemspinosa	6.4 – 8.3 cm, 2.4 – 4.5 g	Y	R		nw		10	30	96 h	LC50	mortality	5.3	3	6,12	McLeese et al., 1979
Pisces															
Platichthys flesus	field collected; 56 ± 2.5 g	Y	R	≥ 98		8 ± 0.1	6	5	96 h	LC50	mortality	6.99	2	7,13	Smith et al. 1994
Platichthys flesus	field collected; 56 ± 2.5 g	Y	R	≥ 98		8 ± 0.1	6	5	96 h	LC50	mortality	6.29	2	7,13	Smith et al. 1994
Solea solea	field collected; 45 ± 2.5	Y	R	≥ 98		8 ± 0.1	6	22	96 h	LC50	mortality	6.6	2	7,13	Smith et al. 1994

Notes

1 Microtox test.
2 Data from 15 and 30 min-exposures are most accurate.
3 In accordance with DIN 38412 L34.
4 2% 2-propanol was added to the test medium in order to test toxicity of poorly soluble substances.
5 Result given as 5.8% of the reaction product mixture.
6 Exposure time not fixed (time to lethality experiment). Unclear if LC50 is based on nominal or measured concentrations, but concentrations remained practically constant. 3 shrimp and 3 clams were exposed simultaneously.
7 In accordance with OECD 203 (1981). Fish loading exceeds recommended value (34 g/L instead of 1 g/L).
8 Unclear if EC50 expressed in mg/L substance or TOC; unclear if test is performed as a mixture toxicity test.
9 Unclear which chlorophenol was tested.
10 Too high level of solvent (2% 2-propanol)
11 Test duration not reported.
12 Number of test animals (3) too small
13 Fish loading higher than recommended in guideline, but concentrations are measured and control included.

Table A2.3 Chronic toxicity of 2-chlorophenol to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Bacillus subtilis		N	S		am		37	0.17	log. growth phase	EC10	growth	170	2	1	Ogawa et al., 1991
Pseudomonas pictorum		N	R		am				96 - 192 h (24 - 48 h per test concentration)	NOEC	growth	1000	3	2,10	Chitra and Chandrakasan, 1996
Pseudomonas I	able to grow on benzoate	N	S		am		30		ca. 20 h	NOEC	growth	217	2		Huang and Tseng, 1996
Escherichia coli	ATCC 23820, labelled with radiolabelled thymidine, cells in stationary growth phase	N	S		am				50 h	NOEC	lysis rate	175	4		Perez-Padilla and Grady, 1998
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	NOEC	maximum growth yield	47.6	2	3	Cenci et al., 1987
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	NOEC	specific growth rate	47.6	2	3	Cenci et al., 1987
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	NOEC	lag time	47.6	2	3,4	Cenci et al., 1987
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	NOEC	dehydrogenase activity	47.6	2	3	Cenci et al., 1987
Pseudomonas										LOEC		30	4	5	Meinck et al., 1970. In: Verschueren, 1983
Algae															
Chlorella pyrenoidosa										LOEC		96	4	5	Jones, 1971. In: Verschueren, 1983
Chlorella pyrenoidosa		N	S		am	7	22		72h	NOEC	chlorophyll/ oxygen production	10	3	11	Huang and Gloyna, 1968
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		48 h	EC10	biomass (AUC)	24	2		Kühn and Pattard, 1990
Scenedesmus subspicatus		N	S		am	8.0 9.3	24 ± 1		48 h	EC10	growth rate	42	2		Kühn and Pattard, 1990
Scenedesmus										LOEC		60	4	5	Meinck et al., 1970. In: Verschueren, 1983
Protozoa															
Coldopa										LOEC		30	4	5	Meinck et al., 1970. In: Verschueren, 1983
Macrophyta															
Salvinia minima	collected in the field				am		25		7 d	NOEC	growth (fresh weight)	2.5	2		Gallardo et al., 1998
Salvinia minima	collected in the field				am		25		7 d	EC10	growth (fresh weight)	4.67	2	1	Gallardo et al., 1998
Salvinia minima	collected in the field				am		25		7 d	NOEC	growth (dry weight)	2.5	2		Gallardo et al., 1998
Salvinia minima	collected in the field				am		25		7 d	EC10	growth (dry weight)	5.78	2	1	Gallardo et al., 1998
Salvinia minima	collected in the field				am		25		7 d	NOEC	frond number	< 2.5	2	6	Gallardo et al., 1998
Salvinia minima	collected in the field				am		25		7 d	EC10	frond number	0.35	2	1,7	Gallardo et al., 1998

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Crustacea															
Daphnia magna	≤ 24 h old	Y	R		am	8.0 ± 0.2	25 ± 1	250	21 d	NOEC	survival, reproduction rate, time to 1st reproduction	0.5	2	8	Kühn et al., 1989a
Pisces															
Pimephales promelas	embryos	Y	F						until hatching	NOEC	hatching of embryos	≥ 4	2	9	LeBlanc, 1984
Pimephales promelas	larvae	Y	F						30-d post-hatch	EC10	survival	2.46	2	1,9	LeBlanc, 1984
Pimephales promelas	larvae	Y	F						30-d post-hatch	NOEC	length	≥ 4	2	9	LeBlanc, 1984
Pimephales promelas	larvae	Y	F						30-d post-hatch	NOEC	weight	≥ 4	2	9	LeBlanc, 1984

Notes
1 EC10 calculated with data provided by author using Graphpad
2 Concentrations were tested in a stepwise approach: colonies were exposed to the lowest concentration, if growth was observed, then they were transferred to a higher concentration, etc. NOEC not statistically determined and based on a qualitative endpoint (growth (colonies formed), absence of growth (no colonies formed). Minimal medium.
3 Exposure time not clear.
4 Lag time is defined as the time (h) required to attain the mid-point of the growth curve.
5 Toxic at reported value; assumed that the LOEC is meant.
6 Effects were observed at the lowest tested concentration.
7 EC10 is extrapolated value since effects were observed at the lowest test concentration
8 Test result based on measured concentrations, which were > 80% of nominal.
9 In accordance with US EPA 1972.
10 No standard approach (bacteria were not exposed to a range of concentrations, but well-performing colonies were transferred to higher concentrations). NOEC qualitatively and not statistically determined.
11 Cell densitiy too high

Table A2.4 Chronic toxicity of 2-chlorophenol to marine organisms.

No data were available for chronic toxicity of 2-chlorophenol to marine organisms.

Table A2.5 Acute toxicity of 3-chlorophenol to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Pure culture	isolated from laboratory activated sludge			98	am			A	30 - 60 min	EC50	dehydrogenase activity	> 500	3	1,2,19	Liu, 1985
Pure culture	isolated from laboratory activated sludge			98	am			B	30 - 60 min	EC50	dehydrogenase activity	54	4	2,20	Liu, 1985
Pure culture	isolated from laboratory activated sludge			98	am			C	30 - 60 min	EC50	dehydrogenase activity	50	4	2,20	Liu, 1985
Pure culture	isolated from adaptated activated sludge			98	am			E	30 - 60 min	EC50	dehydrogenase activity	66	4	2,20	Liu, 1985
Pure culture	isolated from adaptated activated sludge			98	am			F	30 - 60 min	EC50	dehydrogenase activity	320	4	2,20	Liu, 1985
Pure culture	isolated from Lake Erie sediment			98	am			G	30 - 60 min	EC50	dehydrogenase activity	> 500	4	2,20	Liu, 1985
Pure culture	grown in medium with phenol as pure carbon source	N	S		am	7.2	ca. 20 (room temperature)		exponential growth phase	EC50	growth on phenol	154	3	20	Banerjee, 1987
Bacillus sp.	isolated from activated sludge, cell age 18 - 20 h						21		30 min	EC50	dehydrogenase activity	450	2		Liu et al., 1982
Bacillus subtilis		N	S		am		37	0.17	logarithmic growth phase	EC50	growth	83.2	2		Ogawa et al., 1991
Burkholderia RASC c2	*lux*-marked, Gram-negative	N	S	≥ 98	am	7.1	25		20 min	EC50	bioluminescence	21.9	2	3	Boyd et al., 2001
Pseudomonas fluorescens	soil and water bacteria, *lux*-marked, Gram-negative	N	S	≥ 98	am	7.1	25		20 min	EC50	bioluminescence	34.7	2	3,4	Boyd et al., 2001
Vibrio qinghaiensis sp. Nov.	strain Q67	N	S		am	5-9	22 ± 1	431	20 min	EC50	bioluminescence	9.43	2	5	Ma et al., 1999
Algae															
Chlorella pyrenoidosa			S			7			72 h	EC50	chlorophyll reduction	14.1	4		Huang and Gloyna, 1968 and Jones, 1971. In: Krijgsheld and van der Gen, 1986
Chlorella vulgaris	ca. 7.5 x 10^6 cells/mL				am		36.5		6 h	EC50	cell density	32.3	2	6,7	Kramer and Trümper, 1986
Chlorella vulgaris	ca. 7.5 x 10^6 cells/mL				am		36.5		6 h	EC50	cell density	45.6	2	7,8	Kramer and Trümper, 1986
Pseudokirchneriella subcapitata	5E+04 cells/mL	N	S		am		21 ± 1		96 h	EC50	growth rate	29	2		Shigeoka et al., 1988
Protozoa															
Tetrahymena pyriformis		Y		≥ 95					48 h	EC50	population growth (density)	17.3	2	9,10	Schultz et al. 1996
Tetrahymena pyriformis	strain GL-C		S	≥ 95	am		28		60 h	EC50	growth	36.7	2		Schultz, 1987a
Tetrahymena pyriformis	strain GL-C	N	S	> 95	am	7.35	27 ± 1	75	40 h	EC50	population growth (cell density)	17.3	4*	11	Schultz, 1999
Tetrahymena pyriformis	ca. 36000 cells/mL, in log phase	N	S	≥ 95	am	7.35	27 ± 1		48 h	EC50	population growth (density)	14.1	2	9	Schultz et al., 1990
Tetrahymena pyriformis	2500 cells/mL, in log-phase	N	S	≥ 95	am	7.35	27 ± 1		48 h	EC50	population growth (density)	14.2	4*	9	Bryant and Schultz, 1994
Tetrahymena pyriformis	strain GL-C, ca. 2500		S		am	7.35	27 ± 1		40 h	EC50	population growth	17.3	4*		Schultz et al., 1997

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
	cells/mL from logarithmic growing culture										(density)				
Cnidaria															
Hydra vulgaris	adult	N	R	purified prior to use	am	7			20 h	LOEC	tulip stage	100	2	12	Mayura et al., 1991
Crustacea															
Ceriodaphnia dubia	< 24 h old	Y	S				23 ± 1		48 h	EC50	immobility	9.84	2		Westbury, 1998. In: Warne and Westbury, 1999
Daphnia carinata	< 24 h old	Y	S				20 ± 1		48 h	EC50	immobility	11.88	2		Azim, 1998. In: Warne and Westbury, 1999
Daphnia magna	< 72 h old	N	S	> 95%	rw	7.8 - 8.2	20 ± 1	200	24 h	EC50	immobility	15.8	2	13	Devillers and Chambon, 1986a
Daphnia pulex	< 24 h	N	R		nw		20 ± 1		96 h	LC50	mortality	5.6	2		Trabalka and Burke, 1978
Pisces															
Carassius auratus	1.0 ± 0.1 g		S	ca. 100	tw	7.0 ± 0.1	27 - 28		5 h	LC50	mortality	50	3	14,21,22	Kishino and Kobayashi, 1996b
Carassius auratus	1.0 ± 0.1 g	N	S	ca. 100	tw	7.0 ± 0.1	27 - 28		2.5 h	LC50	mortality	60	3	14,21,22	Kishino and Kobayshi, 1996a
Carassius auratus	2.2 ± 0.2 g		S	ca. 100	tw	6	20 - 21		5 h	LC50	mortality	50	3	14,21,22	Kishino and Kobayashi, 1995
Carassius auratus	2.2 ± 0.2 g		S	ca. 100	tw	8	20 - 21		5 h	LC50	mortality	50 - 70	3	14,21,22	Kishino and Kobayashi, 1995
Carassius auratus	2.2 ± 0.2 g		S	ca. 100	tw	10	20 - 21		5 h	LC50	mortality	> 100	3	14,21,22	Kishino and Kobayashi, 1995
Carassius auratus	fingerlings < 10.2 cm				7	12.8	300		24 h	NOEC	mortality	5	3	15,23	Hollis and Lennon, 1954
Carassius auratus	2 - 4 g						27		8 h	LC50	mortality	16.3	3	16,17,21,24	Gersdorf and Smith, 1940
Danio rerio	160 - 185 mg	N		> 95	am		22 ± 1		24 h	LC50	mortality	15.33	2		Devillers and Chambon, 1986a
Lepomis macrochirus	fingerlings < 10.2 cm				7	12.8	300		5 h	LOEC	mortality	5	3	15,21,23	Hollis and Lennon, 1954
Lepomis macrochirus	fingerlings, ca. 10 cm	N	S		nw	7.5 - 8.2	13		13 h	LOEC	mortality/obvious distress	5	3	15,21,23	Applegate et al., 1957
Lepomis macrochirus	fingerlings < 10.2 cm				7	12.8	300		5 h	LOEC	mortality	5	3	15,21,23	Hollis and Lennon, 1954
Leuciscus idus							20	267	48 h	LC50	mortality	3	4	25	Dietz, 1978
Leuciscus idus melanotus			S			7 - 8	20	267	48 h	LC50	mortality	5.5	2	17a	Rubelt et al., 1982
Oncorhynchus mykiss	fingerlings, ca. 10 cm	N	S		nw	7.5 - 8.2	13		13 h	LOEC	mortality/obvious distress	5	3	15,21	Applegate et al., 1957
Petromyzon marinus	larvae, 7.6 - 13 cm, collected from the field	N	S		nw	7.5 - 8.2	13		24 h	NOEC	mortality/obvious distress	≥ 5	3	15,23	Applegate et al., 1957
Poecilia reticulata	2 - 3 mo old males			rg	tw	7.7 ± 0.1			24 h	LC50	mortality	3.47	4	26	Benoit-Guyod et al., 1984
Poecilia reticulata	2 - 3 mo		R		am or rw	6.1	22 ± 1	25	7 or 14 d	LC50	mortality	6.44	2	18,27	Könemann and Musch, 1981
Poecilia reticulata	2 - 3 mo		R		am or rw	7.3	22 ± 1	25	7 or 14 d	LC50	mortality	6.44	2	18,27	Könemann and Musch, 1981
Poecilia reticulata	2 - 3 mo		R		am or rw	7.7 - 7.9	22 ± 1	25	7 or 14 d	LC50	mortality	7.9	2	18,27	Könemann and Musch, 1981
Salvelinus fontinalis	fingerlings < 10.2 cm				7	12.8	300		1 h	LOEC	mortality	5	3	15,21,23	Hollis and Lennon, 1954

Notes

1 Resazurin reduction procedure: Incubation time is not critical as long as no more than 90 - 95% of the dye in the control is reduced.
2 Dose-response relationship at lower concentrations, but lower toxicity at highest concentration.
3 Test result is average of three replicates.

4 Soil bacteria which also occurs in water.
5 1% DMSO; optimal pH range reported as 5-9, unclear at what pH test was performed. Freshwater microtox test
6 Obtained from extinction measurements at 680 nm.
7 Value recalculated from mol/L
8 Obtained from extinction measurements at 750 nm
9 Final DMSO concentration of 0.35 mL DMSO / 50 mL not toxic to Tetrahymena.
10 Unclear if the EC50 is based on nominal or mean measured concentrations. Recovery of the test substance was > 80% of nominal in an abiotic control.
11 8 - 9 cell cycles
12 Criterion (tulip stage) considered relevant because it preceeds desintegration (mortality).
13 Test performed in closed system; test was considered valid when dissolved oxygen concentration ≥ 2.27 mg/L which is slightly lower than the oxygen evel given in OECD 202 (≥ 3 mg/L).
14 A 5-h exposure period was chosen, because within this period, no detoxification of the test substance occurred.
15 Reported as time to effect. Only two fish tested.
16 L(E)C50 calculated with data provided by author using graphpad
17 Methods previously described in Gersdorf, 1930
17a According to standard german test methods (1974)
18 Influence of pH on toxicity tested.
19 EC50 not reliable, see notes. Species unknown.
20 Species unknown.
21 Exposure duration too short
22 No control group included (based on dose-response curves given in Kishino and Kobayashi (1995)
23 Too few fish tested.
24 Not enough data
25 test methods poorly reported
26 Unit of LC50 not reported.
27 Exposure duration unclear.

Table A2.6 Acute toxicity of 3-chlorophenol to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S		am		15	21.9	30 min	EC50	bioluminescence	14.1	2	1,2	Ribo and Kaiser, 1983
Vibrio fischeri									30 min	EC50	bioluminescence	14.1	4*	1	COMPUTOX database. In: Six and Altschuh, 1997
Vibrio fischeri									20 min	EC50	bioluminescence	102.12	4	1,3	Lee et al., 1999
Vibrio fischeri		N	S, open		am	6.5 - 7.5	15		5 min	EC50	bioluminescence	6.1	2	1	Blum and Speece, 1991
Vibrio fischeri		N	S	ag					30 min	EC50	bioluminescence	7	2	4	Strotmann and Eglsäer, 1995
Vibrio fischeri		N		ag	am				15 min	EC50	bioluminescence	19.0	2	1	Ribo and Rogers, 1999
Vibrio fischeri		Y		rg	dw	7			15 min	EC50	bioluminescence	9.62	4	1,6	Shang et al. 2002
Vibrio fischeri		N	S				15		5 min	EC50	bioluminescence	10.69	2	1	Westbury, 1998. In: Warne and Westbury, 1999
Pisces															
Platichthys flesus	collected in the field, 56 ± 2.5 g	Y	R	≥ 98		8 ± 0.1	6	5	96 h	LC50	mortality	3.99	2	5,6	Smith et al., 1994

Notes
1 Microtox test.
2 Data from 15 and 30 min-exposures are most accurate.
3 Unclear which chlorophenol was tested
4 In accordance with DIN 38412, Part 341 (1993).
5 In accordance with OECD 203 (1981). Fish loading exceeds recommended value (34 g/L instead of 1 g/L).
6 Fish loading higher than recommended in guideline, but concentrations are measured and control included.

Table A2.7 Chronic toxicity of3-chlorophenol to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Bacillus subtilis		N	S		am		37	0.17	logarithmic growth phase	EC10	growth	32	2	1	Ogawa et al., 1991
Algae															
Chlorella pyrenoidosa										LOEC		40	4	2	Jones, 1971. In: Verschueren, 1981
Chlorella pyrenoidosa		N	S		am	7	22		72h	NOEC	chlorophyll/ oxygen production	10	3	4	Huang and Gloyna, 1968
Pisces															
Cyprinus carpio	eggs		R		nw		23.5		7d	EC10	hatching	8.63	2	1,3	Trabalka and Burch, 1979
Cyprinus carpio	eggs		R		nw		23.5		7d	EC10	malformations	5.97	2	1,3	Trabalka and Burch, 1979

Notes

1 EC10 calculated with data provided by author using Graphpad
2 Toxic at reported value; assumed that the LOEC is meant.
3 Test water was spring water; reported NOEC = 1 mg/L; LOEC = 10 mg/L
4 Cell densitiy too high (1 mg/L)

Table A2.8 Chronic toxicity of 3-chlorophenol to marine organisms.

No data were available for chronic toxicity of 3-chlorophenol to marine organisms.

Table A2.9 Acute toxicity of 4-chlorophenol to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness CaCO$_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Pure culture	grown in medium with phenol as pure carbon source	N	S		am	7.2	ca. 20 (RT)		exp. growth phase	EC50	growth on phenol	86.9	4	38	Banerjee, 1987
Bacillus sp.	isolated from activated sludge, cell age 18 - 20 h						21		30 min	EC50	dehydrogenase activity	400	2		Liu et al., 1982
Bacillus subtilis						7.2				EC50	spore germination	102	4	1,39	Yasuda et al., 1982
Bacillus subtilis		N	S		am		37	0.17	log. growth phase	EC50	growth	107	2		Ogawa et al., 1991
Burkholderia RASC c2	*lux*-marked, Gram-negative	N	S	≥ 98	am	7.1	25		20 min	EC50	bioluminescence	23.1	2	1	Boyd et al., 2001
Escherichia coli	K-12, in exponential growth phase	N			am					EC50	growth	165	4	2,40	Heipieper et al., 1991
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	EC50	specific growth rate	107	2	39	Cenci et al., 1987
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	EC50	dehydrogenase activity	206	2	39	Cenci et al., 1987
Escherichia coli	ATCC11775 strain; 10E4 cells/mL	N	S	ag	am		37		7.5h	EC50	growth rate	129	2		Nendza and Seydel, 1990
Escherichia coli	10E4 cells/mL	N	S	ag	am		37		8h, 15 min	EC50	growth rate	131	4*		Nendza and Seydel, 1988
Pseudomonas fluorescens	soil bacteria, *lux*-marked, Gram-negative	N	S	≥ 98	am	7.1	25		20 min	EC50	bioluminescence	12.2	2	1,3	Boyd et al., 2001
Algae															
Chlorella protothecoides	log growth phase	Y	S				21		72 h	EC50	cell division	38.6	2	4	Stauber et al., 1994. In: Warne and Westbury, 1999.
Chlorella pyrenoidosa			S			7			72 h	EC50	chlorophyll reduction	40	3	41	Huang and Gloyna, 1968 and Jones, 1971. In: Krijgsheld and van der Gen, 1986
Chlorella vulgaris	ca. 7.5 x 10^6 cells/mL				am		36.5		6 h	EC50	cell density	30.8	3	5,39	Kramer and Trümper, 1986
Chlorella vulgaris	ca. 7.5 x 10^6 cells/mL				am		36.5		6 h	EC50	cell density	64.4	3	6,39	Kramer and Trümper, 1986
Chlorella vulgaris	5E+04 cells/mL	N	S		am		21 ± 1		96 h	EC50	growth rate	29	2		Shigeoka et al., 1988
Chlorella vulgaris		Y	S	rg	nw	7.5 - 8.2	19 - 22		96 h	EC50	growth rate	> 0.1	2	7	Gokcen, 1998
Pseudokirchneriella subcapitata			S						96 h	EC50	growth	4.8	4		US EPA, 1980. In: Krijgsheld and Van der Gen 1986.
Pseudokirchneriella subcapitata	5E+04 cells/mL	N	S		am		21 ± 1		96 h	EC50	growth rate	38	2		Shigeoka et al., 1988
Pseudokirchneriella subcapitata	log growth phase	Y	S				21		72 h	EC50	cell division	51.4	2	4	Stauber et al., 1994. In: Warne and Westbury, 1999.
Pseudokirchneriella subcapitata									96 h	EC50		5.01	4	8,43	LeBlanc, 1984.
Pseudokirchneriella subcapitata									72 h	EC50	biomass (AUC)	4	2		CITI data
Pseudokirchneriella subcapitata									72 h	EC50	growth rate	10	2		CITI data
Scenedesmus pannonicus									96 h	EC50	growth	38	4		Adema et al 1982

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Scenedesmus pannonicus									96 h	EC50	growth	10	4		Kuiper, 1992. In: EC, 2000
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		72 h	EC50	biomass (AUC)	8.3	2		Kühn and Pattard, 1990
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		72 h	EC50	growth rate	17	2		Kühn and Pattard, 1990
Protozoa															
Tetrahymena pyriformis									48 h	EC50	population growth	251	4		TerraBase 1999. In: Niculescu et al., 2000
Tetrahymena pyriformis	strain GL-C	Y	S		am	7.3	28		48 h	EC50	population growth (density)	36.7	4*	9,10	Schultz et al., 1989
Tetrahymena pyriformis	strain GL-C		S	≥ 95	am		28		60 h	EC50	growth	36.7	2	9,11	Schultz, 1987a
Tetrahymena pyriformis	strain GL-C	N	S	> 95	am	7.35	27 ± 1	75	40 h	EC50	population growth (cell density)	37.1	4*	12	Schultz, 1999
Tetrahymena pyriformis									40 of 48 h	EC50	growth	36.2	4*		Bearden and Schultz, 1998
Tetrahymena pyriformis	ca. 36000 cells/mL, in log phase	N	S	≥ 95	am	7.35 (initially)	27 ± 1		48 h	EC50	population growth (density)	36.2	4*		Schultz et al., 1990
Tetrahymena pyriformis			S						60 h	EC50	population growth (density)	36.7	4*		Schultz et al., 1995
Tetrahymena pyriformis	2500 cells/mL, in log-phase	N	S	≥ 95	am	7.35	27 ± 1		48 h	EC50	population growth (density)	36.7	4*		Bryant and Schultz, 1994
Tetrahymena pyriformis	strain GL-C, ca. 2500 cells/mL from logarithmic growing culture		S		am	7.35 (initially)	27 ± 1		40 h	EC50	population growth (density)	37.1	4*	13	Schultz et al., 1996
Macrophyta															
Lemna gibba		Y							7 d	EC50	vegetative frond reproduction	23.5	3	14,44	Sharma et al., 1997
Lemna gibba L.	G-3, 5 plants, 15 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	number of plants	56	3	15,44	Cowgill et al, 1991
Lemna gibba L.	G-3, 5 plants, 15 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	number of fronds	55	3	15,44	Cowgill et al, 1991
Lemna gibba L.	G-3, 5 plants, 15 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	dry weight	54	3	15,44	Cowgill et al, 1991
Lemna minor		N	S			5.1	25 ± 1		48 h	LC50	mortality (chlorosis)	280	3	16,44	Blackman et al., 1955
Lemna minor L.	clone 6591, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	number of plants	41	3	15,44	Cowgill et al, 1991
Lemna minor L.	clone 6591, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	number of fronds	35	3	15,44	Cowgill et al, 1991
Lemna minor L.	clone 6591, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	dry weight	25	3	15,44	Cowgill et al, 1991
Lemna minor L.	clone 7101, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	number of plants	28	3	15,44	Cowgill et al, 1991
Lemna minor L.	clone 7101, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	number of fronds	30	3	15,44	Cowgill et al, 1991
Lemna minor L.	clone 7101, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	dry weight	26	3	15,44	Cowgill et al, 1991

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness CaCO$_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Lemna minor L.	clone 7120, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	number of plants	38	3	15,44	Cowgill et al, 1991
Lemna minor L.	clone 7120, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	number of fronds	34	3	15,44	Cowgill et al, 1991
Lemna minor L.	clone 7120, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	dry weight	38	3	15,44	Cowgill et al, 1991
Lemna minor L.	clone 7136, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	number of plants	39	15,44	3	Cowgill et al, 1991
Lemna minor L.	clone 7136, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	number of fronds	34	3	15,44	Cowgill et al, 1991
Lemna minor L.	clone 7136, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	EC50	dry weight	31	3	15	Cowgill et al, 1991
Fungi															
Pichia	fermentative strain from dinitrification stage of STP	N	S		am	7	22 ± 2		12 h	EC50	growth (turbidity)	145	2	17	Kwasniewska and Kaiser, 1983
Rhodotorula rubra	oxidative strain from shore of Lake Ontario	N	S		am	7	22 ± 2		12 h	EC50	growth (turbidity)	62.5	2	17	Kwasniewska and Kaiser, 1983
Saccharomyces cerevisiae		N		ag	am	3.2	28		16 - 18 h	EC20	fermentation	45	3	18,45	Weber et al., 2000
Cnidaria															
Hydra viridissima	non-budding hydra	Y	S	> 99	tw	7.07 - 7.3	24.2 - 24.8		96 h	LC50	mortality	45	2	19	Pollino and Holdway, 1999
Hydra vulgaris	non-budding hydra	Y	S	> 99	tw	7.07 - 7.3	24.2 - 24.8		96 h	LC50	mortality	32	2	19	Pollino and Holdway, 1999
Hydra vulgaris	adult	N	R	purified prior to use	am	7			4 h	LOEC	tulip stage	100	2	20	Mayura et al., 1991
Hydra vulgaris	adult	N	R	purified prior to use	am	7			92 h	LOEC	mortality (disintegration)	30	2		Mayura et al., 1991
Crustacea															
Ceriodaphnia dubia	< 12 h old, from 4th brood	N	R	rg	nw	8.2 ± 0.2	25 ± 2	90 - 110	48 h	LC50	mortality	9	2		Cowgill and Milazzo, 1991
Daphnia magna	< 24 h old	N	S	≥ 80%	rw	7.4 - 9.4	22 ± 1	173 ± 13	48 h	LC50	mortality	4.1	2	21	LeBlanc, 1980
Daphnia magna						8.25 - 8.35			24 h	EC50	immobility	12.81	2	22	Trapido et al., 1997
Daphnia magna	6 - 24 h old	N	S		am	8.0 ± 0.2	20	240	48 h	EC50	immobility	2.5	2	23	Kühn et al., 1989a
Daphnia magna	12 ± 12 h old		S		nw		18 ± 1		48 h	LC50	mortality	4.82	2		Kopperman et al., 1974
Daphnia magna	< 12 h old, from 4th brood	N	R	rg	nw	8.2 ± 0.2	25 ± 2	160 - 180	48 h	LC50	mortality	6	2		Cowgill and Milazzo, 1991
Daphnia magna		Y			rw	5.2	20 ± 2	250 ± 25	24 h	EC50	immobility	6.2	3	46	Tissot et al., 1985
Daphnia magna	< 24 h old	N	S	> 98			20 ± 1		48 h	EC50	immobility	6.8	3	24,47	Steinberg et al., 1992
Daphnia magna	< 24 h old	N	S	> 98			20 ± 1		48 h	EC50	immobility	8.78	3	25,47	Steinberg et al., 1992
Daphnia magna	6 - 24 h old	N	Sc	> 95	am		22 ± 1		24 h	EC50	immobility	9.5	2		Zhao et al., 1995
Daphnia magna	< 72 h old	N	S	> 95%	rw	7.8 - 8.2	22 ± 1	200	24 h	EC50	immobility	8.1	2	26	Devillers and Chambon, 1986a
Daphnia magna	< 24 h old	N	S		am				24 h	LC50	mortality	21.2	3	21,27	LeBlanc et al., 1988
Daphnia magna									48 h	EC50		8.9	4		Kuiper. 1982. In: EC, 2000
Daphnia magna	<24h	N	S		rw	8	25 ± 1	150	48 h	LC50	mortality	4.41	2		Kim et al., 2006
Daphnia magna									48 h	LC50	mortality	2.5	2		CITI data
Daphnia pulex	12 h old	N	R		nw		20 ± 1		96 h	LC50	mortality	3.5	2		Trabalka and Burke, 1978
Pisces															
Carassius auratus	1.0 ± 0.1 g		S	ca. 100	tw	7.0 ± 0.1	27 - 28		5 h	LC50	mortality	30.1	3	28,48,49	Kishino and Kobayshi, 1996b

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness CaCO$_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Carassius auratus	1.0 ± 0.1 g	N	S	ca. 100	tw	7.0 ± 0.1	27 - 28		2.5 h	LC50	mortality	50.0	3	28,48,49	Kishino and Kobayshi, 1996a
Carassius auratus	2.2 ± 0.2 g			ca. 100	tw	6	20 - 21		5 h	LC50	mortality	50-70	3	28,48,49	Kishino and Kobayshi, 1995
Carassius auratus	2.2 ± 0.2 g			ca. 100	tw	8	20 - 21		5 h	LC50	mortality	50 - 70	3	28,48,49	Kishino and Kobayshi, 1995
Carassius auratus	2 g		R				20		24 h	LC50	mortality	9	3	29	Kobayashi et al., 1979
Carassius auratus	fingerlings < 10.2 cm					7	12.8	300	23 h	LOEC	mortality	5	3	30,50	Wood, 1953
Carassius auratus	2 - 4 g						27		8 h	LC50	mortality	8.26	3	2,31,49	Gersdorf and Smith, 1940
Carassius auratus									8 hr	LC54	mortality	6.3	3	49	Gersdorf and Smit, 1940. In: Krijgsheld and Van der Gen 1986
Carassius auratus			R						25 h	LC50	mortality	3.8	4		Kobayashi et al., 1979. In: Krijgsheld and Van der Gen 1986
Danio rerio									96 h	LC50	mortality	5.6	4		Kuiper, 1982. In: Krijgsheld and Van der Gen 1986
Danio rerio	160 - 185 mg	N		> 95	am		22 ± 1		24 h	LC50	mortality	8.67	2		Devillers and Chambon, 1986a
Danio rerio									96 h	LC50	mortality	5.6	2		Adema et al., 1982
Jordanella floridae	8 d old larvae	N	S/CF	best grade available		7.97	25.1	333	2 h exposure, 96 h test duration	LC50	mortality	> 100	3	32,48	Holdway et al., 1991
Lepomis macrochirus	0.32 - 1.2 g ww	N	S	≥ 80%	am	6.5 - 7.9	21 - 23	32 - 48	96 h	LC50	mortality	3.8	2	33	Buccafusco et al. 1981
Lepomis macrochirus	fingerlings < 10.2 cm					7	12.8	300	5 h	LOEC	mortality	5	3	30,49,50	Wood, 1953
Lepomis macrochirus	fingerlings, ca. 10 cm	N	S		nw	7.5 - 8.2	13		4 h	LOEC	mortality/ obvious distress	5	3	30,49,50	Applegate et al., 1957
Leuciscus idus							20	267	48 h	LC50	mortality	3	4	51	Dietz, 1978
Leuciscus idus melanotus			S			7 - 8	20	267	48 h	LC50	mortality	3.8	2	34	Rübelt et al., 1982
Oncorhynchus ishawytscha						7.2 - 7.6			0 - 1 h	LOEC	mortality	10	3	15,49	MacPhee and Ruelle, 1969
Oncorhynchus kisutch						7.2 - 7.6			0 - 1 h	LOEC	mortality	10	3	15,49	MacPhee and Ruelle, 1969
Oncorhynchus mykiss										NOEC		0.0249	4		Hodson, unpublished data. In: McCarty et al. 1985
Oncorhynchus mykiss										LOEC		0.499	4		Hodson, unpublished data. In: McCarty et al. 1985
Oncorhynchus mykiss	4.6 - 6.4 cm, 1.2 - 3.8 g	Y	CF	highest available	tw	7.60 - 8.19	14.1 - 16.5		96 h	LC50	mortality	1.90	2	1,35	Hodson et al., 1984
Oncorhynchus mykiss	fingerlings, ca. 10 cm	N	S		nw	7.5 - 8.2	13		3 h	LOEC	mortality/ obvious distress	5	3	30,49,50	Applegate et al., 1957
Oryzias latipes			S				25 ± 2		48 h	LC50	mortality	3.4	4		US EPÁ, 1980. In: EC, 2000
Oryzias latipes									96 h	LC50	moratlity	8.9	2		CITI database
Perca flavescens	fingerlings < 10.2 cm					7	12.8	300	1 h	LOEC	mortality	5	3	30,49,50	Wood, 1953
Petromyzon marinus	larvae, 7.6 - 13 cm, collected from the field	N	S		nw	7.5 - 8.2	13		24 h	NOEC	mortality/ obvious distress	≥ 5	3	30,50	Applegate et al., 1957
Pimephales promelas									96 h	LC50	mortality	6.15	4		COMPUTOX. In: Eldred et al., 1999
Pimephales promelas	10 - 15-d old fry, 11.6 mg, 9.5 mm	N	Sc	rg	nw	7.2 - 8.5	21 - 23	96 - 125	96 h	LC50	mortality	4	2		Mayes et al., 1983

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness CaCO$_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Pimephales promelas	30 - 35-d old juveniles, 76.8 mg, 14.9 mm	N	Sc	rg	nw	7.2 - 8.5	21 - 23	96 - 125	96 h	LC50	mortality	3.8	2		Mayes et al., 1983
Pimephales promelas	60 - 100-d old subadults, 391 mg, 28 mm	N	Sc	rg	nw	7.2 - 8.5	21 - 23	96 - 125	96 h	LC50	mortality	5	2		Mayes et al., 1983
Pimephales promelas		Y	F		nw/dtw				96 h	LC50	mortality	6.11	1		Geiger et al., 1990
Poecilia reticulata	40 - 60 mg	Y	R	≥ purissimum grade	dw	5 ± 0.1	26 ± 1	80 - 100	96 h	LC50	mortality	6.30	3	36,53	Saarikoski and Viluksela, 1981
Poecilia reticulata	40 - 60 mg	Y	R	≥ purissimum grade	dw	6 ± 0.1	26 ± 1	80 - 100	96 h	LC50	mortality	7.84	2	36	Saarikoski and Viluksela, 1981
Poecilia reticulata	40 - 60 mg	Y	R	≥ purissimum grade	dw	7 ± 0.1	26 ± 1	80 - 100	96 h	LC50	mortality	8.48	2	36	Saarikoski and Viluksela, 1981
Poecilia reticulata	40 - 60 mg	Y	R	≥ purissimum grade	dw	8 ± 0.1	26 ± 1	80 - 100	96 h	LC50	mortality	8.999	2	36	Saarikoski and Viluksela, 1981
Poecilia reticulata	40 - 60 mg		R			6	26 ± 1		96 h	LC50	mortality	7.75	2		Saarikoski and Viluksela, 1982
Poecilia reticulata	40 - 60 mg		R			7	26 ± 1		96 h	LC50	mortality	8.49	2		Saarikoski and Viluksela, 1982
Poecilia reticulata	40 - 60 mg		R			8	26 ± 1		96 h	LC50	mortality	9.106	2		Saarikoski and Viluksela, 1982
Poecilia reticulata	2 - 3 mo old males			rg	tw	7.7 ± 0.1	20-22	18H	24 h	LC50	mortality	1.16	4	54	Benoit-Guyod et al., 1984
Poecilia reticulata									96 h	LC50	mortality	11	4		Adema et al., 1982
Poecilia reticulata	40 - 60 mg	Y	R		dtw	7	25-27		96 h	LC50	mortality	9.5	2		Salkinoja-Salonen et al., 1981
Ptychochelilus oregonensis						7.2 - 7.6			0 - 1 h	LOEC	sublethal effects	10	3	49,52	MacPhee and Ruelle, 1969. In: Lipnicket al. 1985
Ptychochelilus oregonensis						7.2 - 7.6			17 - 21 h	LOEC	mortality	10	4	49,52	MacPhee and Ruelle, 1969. In: Lipnicket al. 1985
Salmo trutta	fingerlings < 10.2 cm					7	12.8	300	5 h	LOEC	mortality	5	3	30,49,50	Wood, 1953
Tilapia zilli	2 - 6 cm	N	R	rg		6.6	25 ± 1	215		LC50	mortality	4.49	2	55	Yen et al, 2002
Amphibia															
Rana japonica	tadpoles from eggs collected in the field, 2.5 ± 0.1 cm, 0.09 ± 0.01 g	N	R		nw		22-25		24 h	LC50	mortality	63.3	2	37	Wang et al, 2000

Notes
1 Test result is average of three replicates.
2 Calculated with data provided by author using GraphPad Prism 4.
3 Soil bacteria which also occurs in water
4 Species was grouped under marine species, but is freshwater alga.
5 Obtained from extinction measurements at 680 nm.
6 Obtained from extinction measurements at 750 nm.
7 Test result based on nominal concentrations; measured concentrations were ≥ 80% of nominal.
8 In accordance with US EPA guideline (1975).
9 Final DMSO concentration of 0.35 mL DMSO / 50 mL not toxic to Tetrahymena.
10 Unclear if the EC50 is based on nominal or mean measured concentrations. Recovery of the test substance was > 80% of nominal in an abiotic control containing a concentration equal to the EC50.
11 log(1/EC50)=0.5447.Method described in Schultz, 1983

12 8 - 9 cell cycles
13 log(1/EC50)=0.54
14 Test result based on measured concentrations, which were probably < 80% of nominal.
15 In accordance with US EPA guidelines.
16 Fronds were considered dead when they were colorless over more than half the surface of the bath
17 Turbidity test.Exposure duration fitted to logarithmic growth
18 The test was performed in minimal medium in order to increase the sensitivity of the yeast cells.
19 In accordance with ASTM E729-88a 1991.
20 Criterion (tulip stage) considered relevant because it preceeds desintegration (mortality).
21 In accordance with U.S. EPA (1975).
22 In accordance with Finnish standard SFS 5062.
23 In accordance with DIN 38412, Part II 1982.
24 No dissolved humic material (DHM)
25 5 ppm DHM; 2 h pretest contact time of DHM and test substance.
26 Test performed in closed system; test was considered valid when dissolved oxygen concentration ≥ 2.27 mg/L which is slightly lower than the oxygen level given in OECD 202 (≥ 3 mg/L).
27 Ethanol as solvent (< 0.05%). LC50 calculated from graph using GraphPad Prism 4 but calculation did not converge well.
28 A 5-h exposure period was chosen, because within this period, no detoxification of the test substance occurred.
29 No clear dose-response relationship observed (higher mortality at low test substance concentrations).
30 Reported as time to effect. Only two fish tested.
31 Methods previously described in Gersdorf, 1930
32 A LC50 of 2400 mg/L was reported, which is above the highest tested concentration of 100 mg/L (nominal). Larvae were fed.
33 Dissolved oxygen concentrations too low (range: 9.7 at start - 0.3 mg/L after 96 h) for a number of the compounds tested). Not clear if this was also the case for this compound. In accordance with U.S. EPA 1975.
34 According to standard german test methods (1974)
35 Oxygen concentration may have been low (range of all experiments: 5.6 - 9.4 mg/L O_2 at 14.1 - 16.5 °C). Temperature increased from 15 to 17 °C over 18 h due to failure in temperature control system. Problems with measurement of test substance because of turbidity due to fish waste particles in control.
36 Test result based on measured concentrations, which were ≥ 80% of nominal.
37 Renewed every 6 hours
38 Species unknown.
39 Test duration unclear
40 Exposure time not reported.
41 Too many cells at t=0 (1 g/L)
42 Cell density too high
43 Test criterion not reported (unclear if this is growth rate or biomass).
44 Test substances remained unchanged in abiotic control, but tests with 2,4-dichlorophenol, 2,4,5-trichlorophenol and pentachlorophenol indicate that duckweed can metabolise chlorophenols.
45 Minimal medium and temparature and pH were chosen to induce stress in order to increase the sensitivity of the yeast cells.
46 pH too low for Daphnia (6 - 9 is acceptable according to OECD guideline).
47 > 100 mg/L of organic solvent (120 mg/mL DMSO) was used.
48 No control group included (based on dose-response curves given in Kishino and Kobayashi (1995)
49 exposure time too short
50 Too few fish tested.
51 Test methods poorly reported
52 Endpoint unclear
53 pH 5 may have caused additional stress
54 Unit of LC50 not reported.
55 Test duration not reported but assumed it is 96 hours since renewal took place after 48 hours

Table A2.10 Acute toxicity of 4-chlorophenol to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri						ca. 7	15 ± 0.5	21.9	5 min	EC50	bioluminescence	0.57	2	1	Aitken et al., 1994
Vibrio fischeri		N	S		am		15	21.9	15 min	EC50	bioluminescence	9.10	2	1,2	Ribo and Kaiser, 1983
Vibrio fischeri									3 min	EC50	bioluminescence	143	4	1,3	Lee et al., 1999
Vibrio fischeri									10 min	EC50	bioluminescence	103	4	1,3	Lee et al., 1999
Vibrio fischeri									20 min	EC50	bioluminescence	102	4	1,3	Lee et al., 1999
Vibrio fischeri		N	S, open		am	6.5 - 7.5	15		5 min	EC50	bioluminescence	0.95	2	1	Blum and Speede, 1991
Vibrio fischeri	ahs98 (1.0E+06 cells/mL)				am		20	21.9	30 min	EC50	bioluminescence	45.3	3	4,17,18	Wagner et al., 1989
Vibrio fischeri										EC50	bioluminesence	58000	4	5	Heck et al., 1992
Vibrio fischeri		Y		99			15		5 min	EC50	bioluminesence	1.56	2		Kuo, 1999
Vibrio fischeri		N	S		am	6 - 8.5	room	21.9	30 min	EC50	bioluminescence	35	3	6,19	Hakkila et al., 2004
Vibrio fischeri		N	S		am	6 - 8.5	room	21.9	30 min	EC50	bioluminescence	8.9	2	6,7	Hakkila et al., 2004
Vibrio fischeri		Y	S				15		15 min	EC50	bioluminescence	0.797	2	1	Stauber et al., 1994. In: Warne and Westbury, 1999
Vibrio fischeri		N	S		am		20		15 min	EC50	bioluminescence	4.26	2	1	Zhao et al., 1993
Vibrio fischeri		Y		rg	dw	7			15 min	EC50	bioluminescence	4.6	4	1,8,20	Shang et al., 2002
Algae															
Dunaliella tertiolecta	log growth phase	Y	S				21		72 h	EC50	cell division	51.4	2		Stauber et al., 1994. In: Warne and Westbury, 1999
Glenodinium halli				tg	nw		20	25	7 d	EC50	cell division	>8	2		Erickson and Freeman, 1978
Hormosira banksii	gametes from macroalgae collected from the field	N	S		nw	8.1 - 8.2	room (eggs), 15 (sperm)	30 - 34	30 min (gametes) + 2 h fertilisation without toxicant	EC50	fertilisation	3.97 - 8.66	2	9	Gunthorpe et al., 1995
Hormosira banksii			S			7.5	16		2.5 h	EC50	fertilisation	7.71	2		Stauber et al., 1994. In: Warne et al., 1999
Isochrysis galbana				tg	nw		20	25	7 d	EC50	cell division	>8	2		Erickson and Freeman, 1978
Nitzschia closterium	log growth phase	Y	S				21		72 h	EC50	cell division	7.71	2		Stauber et al., 1994. In: Warne et al., 1999
Nitzschia closterium	log growth phase	Y	S				21		72 h	EC50	cell division	7.97	2		Stauber et al., 1994. In: Warne et al., 1999
Nitzschia closterium	log growth phase		S			7.5	21		72 h	EC50	growth	7.71	2		Stauber et al., 1994. In: Warne et al., 1999
Phaeodactylum tricornutum									96 h	EC50	growth	9.6	2		Adema et al., 1982
Skeletonema costatum			S						96 h	EC50	cell density	3.6	4		US EPA, 1980. In: Krijgsheld and Van der Gen 1986.
Skeletonema costatum			S						96 h	EC50	chlorophyll reduction	3.3	4*		US EPA, 1980. In: Krijgsheld and Van der Gen 1986.
Skeletonema costatum	1E+05 cells/mL, strain SKEL			rg	am	8.25	19.9		5 d	EC50	cell density	13.8	2	10	Cowgill and Milazzo, 1989
Skeletonema costatum	1E+05 cells/mL, strain SKEL			rg	am	8.25	19.9		5 d	EC50	cell volume	11.6	2	10	Cowgill and Milazzo, 1989
Skeletonema costatum									96 h	EC50		3.27	4	11,21	LeBlanc, 1984

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Skeletonema costatum				tg	nw		20	25	7 d	EC50	cell division	>8	2		Erickson and Freeman, 1978
Thalassiosira pseudonana				tg	nw		20	25	7 d	EC50	cell division	>8	2		Erickson and Freeman, 1978
Mollusca															
Octopus pallidus	24 - 96 h post hatch, decending from animals captured in the field	Y	R		nw	7.78 - 7.93	16.2 - 18.5	35.8 - 36.6	24 h	LC50	mortality	1.35	2	12	Long and Holdway, 2002
Octopus pallidus	24 - 96 h post hatch, decending from animals captured in the field	Y	R		nw	7.78 - 7.93	16.2 - 18.5	35.8 - 36.6	48 h	LC50	mortality	0.89	2	12	Long and Holdway, 2002
Annelida															
Platynereis dumerilii	7-d old larvae	N	S	> 99	nw	8.01 - 8.13	19.2 - 20.3	34.85 - 34.95	96 h	LC50	mortality	13.3	2		Palau and Hutchinson, 1998
Crustacea															
Chaetogammarus marinus									96 h	LC50	mortality	4.1	4		Adema et al., 1982
Crangon septemspinosa	6.4 - 8.3 cm length, 2.4 - 4.5 g	Y	R		nw		10	30	96 h	LC50	mortality	4.6	3	13,22	McLeese et al., 1979
Mesidotea entomon	3.8 ± 0.4 cm, 0.9 ± 0.3 g, collected in the field	Y	CF		nw	7.7 ± 0.1	5 ± 0.6	6	96 h	LC50	mortality	59.7	2		Oksama and Kristoffersson, 1979
Mesidotea entomon	3.8 ± 0.4 cm, 0.9 ± 0.3 g, collected in the field	Y	CF		nw	7.7 ± 0.1	10 ± 0.7	6	96 h	LC50	mortality	40.3	2		Oksama and Kristoffersson, 1979
Mysidopsis bahia	6-10 mm								96 h	LC50	mortality	29.7	4	11,23	LeBlanc, 1984
Nitocra spinipes	adults		S	99	nw	7.8	21 ± 1	7	96 h	LC50	mortality	21	2		Lindén et al., 1979
Pontoporeia affinis	field collected from clean site	Y	F	ag	nw		4	5-6	24h	LC50	mortality	>10	3	14,24	Lindstrom and Lindstrom, 1980
Pontoporeia affinis	field collected from clean site	Y	F	ag	nw		4	5-6	5 d	LC50	mortality	>5	3	14,24	Lindstrom and Lindstrom, 1980
Pontoporeia affinis	field collected from clean site	Y	F	ag	nw		4	5-6	10 d	LC50	mortality	>5	3	14,24	Lindstrom and Lindstrom, 1980
Tisbe battagliai	6 d old copepodid stages		S	≥ 98	nw	8.0 ± 0.1	20	30	24 h	LC50	mortality	21	2		Smith et al., 1994
Pisces															
Cyprinodon variegatus	juveniles, 14 - 28 d posthatch, 8 - 15 mm		S	≥ 80	nw		25 - 31	10 - 31	96 h	LC50	mortality	5.4	2	15	Heitmuller et al., 1981
Cyprinodon variegatus									96 h	LC50	mortality	5.35	4*	11,23	LeBlanc, 1984
Macquaria novemaculeata	0.42 ± 0.03 g	N	R		nw	7.8 ± 0.08	16.3 ± 0.2	35.2 ± 0.1	96 h	LC50	mortality	1.92	2		Cohen and Nugegoda, 2000
Platichthys flesus	collected in the field, 56 ± 2.5 g	Y	R	≥ 98		8 ± 0.1	6	5	96 h	LC50	mortality	5	2	16,25	Smith et al., 1994

Notes

1	Microtox test.
2	Data from 15 and 30 min-exposures are most accurate.
3	Unclear which chlorophenol was tested.
4	L(E)C50 calculated with data provided by author using Graphpad
5	Result given as 5.8% of the reaction product mixture.Microtox test.
6	Flash method: photobacteria reagent is despensed on top of sample and changes in luminescence signal are recorded at several readings per second.
7	EC50 calculated using control peak hight (in accordance with Microtox test method).
8	The EC50-values expressed as TOC are used in this study. In order to further discuss the contribution of toxicity for ozonated intermediates, EC50 values are transformed to TUs
9	Test result given as range of 7 experiments.
10	Large confidence intervals due to stimulation at lower test concentrations.
11	In accordance with US EPA guideline (1975).

12 Unclear if test result is based on measured or nominal concentrations.
13 Exposure time not fixed (time to lethality experiment). Unclear if LC50 is based on nominal or measured concentrations, but concentrations remained practically constant. 3 shrimp and 3 clams were exposed simultaneously.
14 Results based on nominal concentrations
15 In accordance with EPA-660/3-75-009.
16 In accordance with OECD 203 (1981)
17 Mutagenesis induced by chemical to obtain more sensitive mutant.
18 Unit of EC50 is not reported.
19 No standard Microtox test method.
20 Unclear if EC50 expressed in mg/L substance or TOC; unclear if test is performed as a mixture toxicity test.
21 Test criterion not reported (unclear if this is growth rate or biomass).
22 Number of test animals (3) too small, exposure duration too short.
23 Review with little test information
24 Experimental systems contained mud
25 Fish loading higher than recommended in guideline, but concentrations are measured and control included.

Table A2.11 Chronic toxicity of 4-chlorophenol to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Bacillus subtilis		N	S		am		37	0.17	logarithmic growth phase	EC10	growth	53	2	1	Ogawa et al., 1991
Escherichia coli	ATCC 23820, radiolabelled thymidine, stationary growth phase	N	S		am				50 h	EC10	lysis rate	133.6595517	2	1,2	Perez-Padilla and Grady, 1998
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	NOEC	max. growth yield	96.417	2	14	Cenci et al., 1987
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	LOEC	specific growth rate	47.56572	2	14	Cenci et al., 1987
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	NOEC	lag time	96.417	2	3,14	Cenci et al., 1987
Escherichia coli	NCTC 9001, 1E+07 cells/mL	N	S		am	7	37		≤ 24 h	NOEC	dehydrogenase activity	96.417	2	14	Cenci et al., 1987
Escherichia coli	strain K12 W3110 *thy*-F-	N	S		am		37		exp. growth phase (4 - 5 h)	LOEC	growth rate	62.5	2	4	Espigares et al., 1990
Escherichia coli	strain K12 W3110 *thy*-F-	N	S		am		37		exp. growth phase (4 - 5 h)	LOEC	doubling time	250	2	4	Espigares et al., 1990
Pseudomonas pictorum		N	R		am				96 - 192 h (24 - 48 h per test conc.)	NOEC	growth	1000	3	5,15	Chitra and Chandrakasan, 1996
Pseudomonas										LOEC		20	4	6,16,17	Jones, 1971. In: Verschueren, 1983
Algae															
Chlorella protothecoides	log growth phase	Y	S				21		72 h	NOEC	cell division	12.8556	2		Stauber et al., 1994. In: Warne et al., 1999
Chlorella pyrenoidosa										LOEC		40	4	6	Jones, 1971. In: Verschueren, 1983
Chlorella pyrenoidosa		N	S		am	7	22		72h	NOEC	chlorophyll/ oxygen production	10	3	18	Huang and Gloyna, 1968
Chlorella vulgaris		Y	S	rg	nw	7.5 - 8.2	19 - 22		96 h	NOEC	growth rate	≥ 0.1	2	7	Gokcen, 1998
Pseudokirchneriella subcapitata	log growth phase	Y	S				21		72 h	NOEC	cell division	25.7112	2		Stauber et al., 1994. In: Warne et al., 1999
Pseudokirchneriella subcapitata									72 h	NOEC	biomass (AUC)	0.93	2		CITI data
Pseudokirchneriella subcapitata									72 h	NOEC	growth rate	1.7	2		CITI data
Scenedesmus										LOEC		20	4	6	Jones, 1971. In: Verschueren, 1983
Scenedesmus pannonicus									96 h	NOEC	growth	18	4		Adema et al., 1982
Scenedesmus pannonicus									96 h	NOEC	growth	3.2	4		EC, 2000
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		72 h	EC10	biomass (AUC)	1.9	2		Kühn and Pattard, 1990

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		72 h	EC10	growth rate	5.8	2		Kühn and Pattard, 1990
Scenedesmus subspicatus		N	S		am	7	27	550	8 d	LOEC	growth	1.9026288	3	8,19	Schmidt and Schnabl, 1988
Protozoa															
Coldopa										LOEC		5	4	6,16	Meinck et al., 1970 In: Verschueren, 1983
Macrophyta															
Lemna gibba L.	G-3, 5 plants, 15 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	number of plants	21.6	3	9,17	Cowgill et al., 1991
Lemna gibba L.	G-3, 5 plants, 15 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	number of fronds	21.6	3	9,17	Cowgill et al., 1991
Lemna gibba L.	G-3, 5 plants, 15 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	dry weight	21.6	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 6591, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	number of plants	13	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 6591, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	number of fronds	13	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 6591, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	dry weight	13	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 7101, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	number of plants	7.8	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 7101, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	number of fronds	7.8	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 7101, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	dry weight	13	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 7120, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	number of plants	7.8	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 7120, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	number of fronds	7.8	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 7120, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	dry weight	13	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 7136, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	number of plants	13	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 7136, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	number of fronds	13	3	9,17	Cowgill et al., 1991
Lemna minor L.	clone 7136, 10 plants, 30 fronds		S		am	4.9 ± 0.2	25 ± 0.7	636	7 d	NOEC	dry weight	13	3	9,17	Cowgill et al., 1991
Cnidaria															
Hydra vulgaris	budding	Y	S	> 99	tw	7.07 - 7.3	24.2 - 24.8		6 d	NOEC	population growth rate	< 1.1	2	10	Pollino and Holdway, 1999
Hydra vulgaris	budding	Y	S	> 99	tw	7.07 - 7.3	24.2 - 24.8		6 d	EC10	population growth rate	0.762605617	2	1,10	Pollino and Holdway, 1999
Hydra viridissima	budding	Y	S	> 99	tw	7.07 - 7.3	24.2 - 24.8		6 d	NOEC	population growth rate	10.3	2	10	Pollino and Holdway, 1999
Hydra viridissima	budding	Y	S	> 99	tw	7.07 - 7.3	24.2 - 24.8		6 d	EC10	population growth rate	9.9	2	1,10	Pollino and Holdway, 1999
Rotifera															
Brachionus calyciflorus	newly hatched	N	S	99	am	7.5	25		48 h	NOEC	reproduction	30	2		Radix et al., 1999

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness CaCO$_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Brachionus calyciflorus	newly hatched	N	S	99	am	7.5	25		48 h	EC10	reproduction	19.5	2		Radix et al., 1999
Crustacea															
Ceriodaphnia dubia	< 12 h old, from 4th brood	N	R	rg	nw	8.2 ± 0.2	25 ± 2	90 - 110	9 d	NOEC	mortality	0.2	2	11	Cowgill and Milazzo, 1991
Ceriodaphnia dubia	< 12 h old, from 4th brood	N	R	rg	nw	8.2 ± 0.2	25 ± 2	90 - 110	9 d	NOEC	progeny	1.6	2	11	Cowgill and Milazzo, 1991
Ceriodaphnia dubia	< 12 h old, from 4th brood	N	R	rg	nw	8.2 ± 0.2	25 ± 2	90 - 110	9 d	NOEC	number of broods	1.6	2	11	Cowgill and Milazzo, 1991
Ceriodaphnia dubia	< 12 h old, from 4th brood	N	R	rg	nw	8.2 ± 0.2	25 ± 2	90 - 110	9 d	NOEC	mean brood size	1.6	2	11	Cowgill and Milazzo, 1991
Daphnia magna									14 d	NOEC		1	4*		Kuiper, 1982. In: Krijgsheld and Van der Gen, 1986
Daphnia magna	≤ 24 h old	Y	R		am	8.0 ± 0.2	25 ± 1	250	21 d	NOEC	survival, reproduction rate, time to 1st reproduction	0.63	2	12	Kühn et al., 1989b
Daphnia magna									21 d	LC50	mortality	3.6	4		Kuiper and Hanstveit, 1984
Daphnia magna	< 12 h old, from 4th brood	N	R	rg	nw	8.2 ± 0.2	25 ± 2	160 - 180	9 d	NOEC	mortality	2.6	2	11	Cowgill and Milazzo, 1991
Daphnia magna	< 12 h old, from 4th brood	N	R	rg	nw	8.2 ± 0.2	25 ± 2	160 - 180	9 d	NOEC	progeny	0.6	2	11	Cowgill and Milazzo, 1991
Daphnia magna	< 12 h old, from 4th brood	N	R	rg	nw	8.2 ± 0.2	25 ± 2	160 - 180	9 d	NOEC	number of broods	2.6	2	11	Cowgill and Milazzo, 1991
Daphnia magna	< 12 h old, from 4th brood	N	R	rg	nw	8.2 ± 0.2	25 ± 2	160 - 180	9 d	NOEC	mean brood size	0.3	2	11	Cowgill and Milazzo, 1991
Daphnia magna									14 d	NOEC	mortality, reproduction	1	4		Adema et al., 1982
Daphnia magna									14 d	EC50	mortality	6.1	4		Adema et al., 1982
Daphnia magna									21 d	EC50	reproduction	0.59	2		CITI data
Daphnia magna									21 d	NOEC	reproduction	0.2	2		CITI data
Pisces															
Oncorhynchus mykiss	fertilised eggs	Y	CF	highly purified standards or repurified	nw	8.08 - 8.10	10 ± 1 (egg dev.), 12 ± 1 (yolk resorption), 15 ± 1 (fry growth)	135	until hatching	NOEC	larval weight	0.03085344	2	13	Hodson et al., 1991
Oncorhynchus mykiss	fertilised eggs	Y	CF	highly purified standards or repurified	nw	8.08 - 8.10	10 ± 1 (egg dev.), 12 ± 1 (yolk resorption), 15 ± 1 (fry growth)	135	until hatching	EC10	larval weight	0.16	2	1,13	Hodson et al., 1991
Oncorhynchus mykiss	fertilised eggs	Y	CF	highly purified standards or repurified	nw	8.08 - 8.10	10 ± 1 (egg dev.), 12 ± 1 (yolk resorption), 15 ± 1 (fry growth)	135	85 d	NOEC	post-hatch mortality	0.24939864	2	13	Hodson et al., 1991
Oncorhynchus mykiss	fertilised eggs	Y	CF	highly purified standards or repurified	nw	8.08 - 8.10	10 ± 1 (egg dev.), 12 ± 1 (yolk resorption), 15 ± 1 (fry growth)	135	10 d post hatch	NOEC	larval weight	0.24939864	2	13	Hodson et al., 1991
Oncorhynchus mykiss	fertilised eggs	Y	CF	highly purified standards or repurified	nw	8.08 - 8.10	10 ± 1 (egg dev.), 12 ± 1 (yolk resorption), 15 ± 1 (fry growth)	135	85 d	NOEC	fry mortality	0.24939864	2	13	Hodson et al., 1991

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Oncorhynchus mykiss	fertilised eggs	Y	CF	highly purified standards or repurified	nw	8.08 - 8.10	10 ± 1 (egg dev.), 12 ± 1 (yolk resorption), 15 ± 1 (fry growth)	135	4 wk post swim-up	NOEC	fry weight	0.24939864	2	13	Hodson et al., 1991

Notes

1 EC10 calculated with data provided by author using graphpad
2 Concentrations recalculated from mg COD/L. Cells were in stationary phase
3 Lag time is defined as the time (h) required to attain the mid-point of the growth curve.
4 Reported as Minimum Effective Concentration
5 Concentrations were tested in a stepwise approach: colonies were exposed to the lowest concentration, if growth was observed, then they were transferred to a higher concentration, etc. NOEC not statistically determined and based on a qualitative endpoint (growth (colonies formed), absence of growth (no colonies formed). Minimal medium.
6 Toxic at reported value; assumed that the LOEC is ment.
7 Test result based on nominal concentrations; measured concentrations were ≥ 80% of nominal.
8 Reported as an IC10, which was defined as the lowest concentration that differs statistically from the control.
9 In accordance with US EPA guidelines.
10 In accordance with ASTM E729-88a 1991.
11 Three-brood test.
12 Test result based on measured concentrations, which were > 80% of nominal.
13 Test result based on measured concentrations. Unclear if these were were ≥ 80% of nominal.
14 Exposure time not clear.
15 No standard approach (bacteria were not exposed to a range of concentrations, but well-performing colonies were transferred to higher concentrations). NOEC qualitatively and not statistically determined.
16 Test duration not reported.
17 Little or no info on test methods
18 Cell densitiy too high (1 mg/L)
19 Test duration too long
20 tests with 2,4-dichlorophenol, 2,4,5-trichlorophenol and pentachlorophenol indicate that duckweed can metabolise chlorophenols

Table A2.12 Chronic toxicity of 4-chlorophenol to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S	99	am	7.5	27	38.4	22 h	EC50	bioluminescence	3.23	2	1	Radix et al., 1999
Algae															
Dunaliella tertiolecta	log growth phase	Y	S				21		72 h	NOEC	cell division	10.28448	2		Stauber et al., 1994. In: Warne et al., 1999
Nitzschia closterium	log growth phase	Y	S				21		72 h	NOEC	cell division	1.28556	2	2	Stauber et al., 1994. In: Warne et al., 1999
Phaeodactylum tricornutum									96 h	NOEC	growth	0.32	2		Adema et al., 1982
Skeletonema costatum	1E+05 cells/mL, strain SKEL			rg	am	8.25	19.9		5 d	NOEC	cell density	1.08	2		Cowgill and Milazzo, 1989
Skeletonema costatum	1E+05 cells/mL, strain SKEL			rg	am	8.25	19.9		5 d	NOEC	cell volume	0.39	2		Cowgill and Milazzo, 1989
Field community			F	tg	am		13	23.5	24 h	NOEC	14C uptake	>2.0	3	3	Erickson and Hawkins, 1980
Crustacea															
Mesidotea entomon	3.8 ± 0.4 cm, 0.9 ± 0.3 g, collected in the field	Y	CF		nw	7.7 ± 0.1	5 ± 0.6	6	14 d	LC5	mortality	18.9	2		Oksama and Kristoffersson, 1979
Mesidotea entomon	3.8 ± 0.4 cm, 0.9 ± 0.3 g, collected in the field	Y	CF		nw	7.7 ± 0.1	10 ± 0.7	6	7 d	LC5	mortality	23	2		Oksama and Kristoffersson, 1979
Mollusca															
Chlamys asperrima	fertilised eggs	N	S		nw		18	32 - 34	48 h	NOEC	development (larval abnormalities)	3	2		Krassoi et al., 1997
Annelida															
Platynereis dumerilii	newly fertilised embryos (< 6 h post-fertilization)	N	S	> 99	nw	8.01 - 8.13	19.2 - 20.3	34.85 - 34.95	48 h	EC50	embryo development	23.6	2	4	Palau and Hutchinson, 1998
Platynereis dumerilii	larvae	N	S	> 99	nw	8.01 - 8.13	19.2 - 20.3	34.85 - 34.95	96 h	EC50	mortality	13.3	2		Palau and Hutchinson, 1998

Notes
1 Microtox chronic toxicity test
2 Two experiments with same result.
3 Siginificant effect at 1 mg/L, but not at 2 mg/L
4 Percentage of embryos developing normally was calculated in accordance with ASTM 1989.

Table A2.13 Acute toxicity of 4-chloro-3-methylphenol to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Bacillus sp.									6 h	EC2 - EC82	spore germination	62.7	4	1,20	Kirk and Lester, 1989
Bacillus subtilis							28		24 h	EC25	cell multiplication	28	3	21	Voets et al., 1976
Bacillus subtilis	spores				am	7.5	31		24 h	EC100	spore germination	1000	2		Parker and Bradley, 1967
Pseudomonas aeruginosa					am	7.4	20		40 min	LC100	mortality	657	4	22	Burton et al., 1964
Pseudomonas aeruginosa	strain NCTC 6750				am		37		7 d	LC100	mortality	1000	4		Richards, 1971. In: Gesellschaft Deutscher Chemiker, 1984
Pseudomonas putida									30 min	EC50	oxygen consumption	> 250	4	2	Bayer AG, 1981. In: Gesellschaft Deutscher Chemiker, 1984
Algae															
Chlorella pyrenoidosa		Y	S	99	am	ca. 7.4	ca. 22		72 h	EC50	growth rate	15	2	3	Ramos et al., 1999
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		72 h	EC50	biomass (AUC)	> 10	2		Kühn and Pattard, 1990
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		72 h	EC50	growth rate	> 10	2		Kühn and Pattard, 1990
Scenedesmus subspicatus			S						72 h	EC50	growth rate	4.2	4	4	Bayer AG, 1983. In: Gesellschaft Deutscher Chemiker , 1984
Protozoa															
Tetrahymena pyriformis	strain GL-C, ca. 2500 cells/mL from log. growing culture		S		am	7.35 (initially)	27 ± 1		40 h	EC50	population growth (density)	22.6	4*	5	Schultz, 1996 and Schultz, 1997
Tetrahymena pyriformis	strain GL-C	N	S	> 95	am	7.35	27 ± 1	75	40 h	EC50	population growth (cell density)	22.6	4*	5	Schultz, 1999
Tetrahymena pyriformis									48 h	EC50	population growth (density)	22.86	2	6,7	Schultz et al., 1986. And Schultz, 1987
Tetrahymena pyriformis	ca. 36000 cells/mL, in log phase	N	S	≥ 95	am	7.35 (initially)	27 ± 1		48 h	EC50	population growth (density)	22.6	4*	6,7	Schultz et al., 1990
Mollusca															
Lymnaea stagnalis	2 - 3 mo old, 814 ± 332 mmg	Y	R	99	tw	6.6 - 8.5	21 - 24		96 h	LC50	mortality	14	2	8	Ramos et al. 1998
Crustacea															
Ceriodaphnia dubia	< 24 h old	Y	S				23 ± 1		48 h	EC50	immobility	3.69	2		Mulhall, 1997. In: Warne and Westbury, 1999
Daphnia carinata	< 24 h old	Y	S				20 ± 1		48 h	EC50	immobility	3.34	2		Azim, 1998. In: Warne and Westbury, 1999
Daphnia magna	24 h old	N	S	99	am	8.0 - 8.3	18 - 20		48 h	EC50	immobility	1.5	2	9	Ramos et al. 1998
Daphnia magna	≤ 24 h old	Y			am	8.0 ± 0.2	25 ± 1	250	24 h	EC50	immobility	4.4	2	10	Kühn et al., 1989
Daphnia magna	< 24 h old	N	S	> 99	tw	7.5 - 8.0	19.6 - 20.8	77 ± 4.3	48 h	LC50	mortality	2	2	11	Gersich and Mayes, 1986
Daphnia magna	< 72 h old	N	S	> 95%	rw	7.8 - 8.2	22 ± 1	200	24 h	EC50	immobility	4.55	2	12	Devillers et al., 1987
Daphnia magna			S				20 ± 2		24 h	EC50	immobility	5.6	4		Bayer AG, 1983. In: Gesellschaft Deutscher Chemiker , 1984
Daphnia magna			S				20 - 25		24 h	EC50	immobility	3.5 - 10	2		Devillers et al., 1987
Daphnia pulex	12 h old	N	R		nw		20 ± 1		96 h	LC50	mortality	3.1	2		Trabalka and Burke, 1978
Pisces															
Danio rerio			F		am	7.1 - 7.8	21 ± 1	267	14 d	NOEC	mortality	1	2		Bayer AG, 1991. In: Gesellschaft Deutscher Chemiker , 1984
Danio rerio			F		am	7.1 - 7.8	21 ± 1	267	3 d	EC90	mortality	3.2	2		Bayer AG, 1991. In: Gesellschaft Deutscher Chemiker , 1984

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Danio rerio		Y	F	> 99.97	am	7.1 - 7.8	21 ± 1	267	14 d	NOEC		1	4*	23	Bayer AG, 1985. In: EC, 2000
Danio rerio		Y	F	> 99.97	am	7.1 - 7.8	21 ± 1	267	5 d	LC100	mortality	3.2	4*		Bayer AG, 1985. In: EC, 2000
Danio rerio	mature; 2.5 cm		S	ag	tw	7.8-8	22 ± 0.5	150	24 h	LC50	mortality	1 - 3.5	2		Devillers et al., 1985
Leuciscus idus melanotus			S			7 - 8	20	267	48 h	LC50	mortality	2.4	2	13	Rubelt et al., 1982
Leuciscus idus									48 h	LC50	mortality	1.2	4	12,25	Bayer AG, 1980. In: Gesellschaft Deutscher Chemiker , 1984
Leuciscus idus			S	> 99.9					48 h	LC50	mortality	1.2	4	12	Bayer AG, 1985. In: EC, 2000
Oncorhynchus mykiss		Y	R	99.97					96 h	NOEC		0.366	4	14,23	Gagliano and Bowers, 1993. In: EC, 2000
Oncorhynchus mykiss		Y	R	99.97					96 h	LC50	mortality	0.917	2	14	Gagliano and Bowers, 1993. In: EC, 2000
Oryzias latipes									48 h	LC50	mortality	4.6	4	26	CITI data. In: EC, 2000
Pimephales promelas									96 h	LC50	mortality	5.7	4	15	COMPUTOX database. In: Eldred et al., 1999
Pimephales promelas	30 - 35 d		F		nw		25 ± 2	43.3 - 48.5	192 h	LC50	mortality	7.7	4	16,27	Hall et al., 1984
Pimephales promelas	26 - 34 d old (juveniles), laboratory-cultured	Y	CF	> 95	nw	7.8	25	45	96 h	LC50	mortality	5.72	2	17,18	Veith and Broderius 1987
Pimephales promelas	26 - 34 d old (juveniles), laboratory-cultured	Y	CF	> 95	nw	7.8	25	45	96 h	LC50	mortality	4.05	4*	18	Broderius et al. 1995
Pimephales promelas	31 d, 0.106 g	Y	F	99	nw/dtw	7.24	25.2	45.6	96 h	LC50	mortality	7.38	1		Geiger et al., 1985
Pimephales promelas	30 d, 19.1 mm, 0.1 g	Y	F	99	nw/dtw	7.74	24.6		96 h	LC50	mortality	4.05	1		Geiger et al., 1985
Pimephales promelas		Y	F		nw/dtw				96 h	LC50	mortality	5.47	1		Geiger et al., 1990
Pimephales promelas	31-35 d old	Y	F	99	nw	6.9 - 7.7	24.6 ± 1.4	44	96 h	LC50	mortality	7.56	1	10	Holcombe et al., 1984
Pimephales promelas		N	S		tw				96 h	LC50	mortality	0.03	3	19,28	MCA, 1972. In: Verschueren, 1983
Poecilia reticulata	females, 2 - 3 mo old, 1.8 ± 0.3 cm and 69 ± 34 mg	Y	R	99	tw	7.1 - 8.2	20 - 25		96 h	LC50	mortality	6.71	2	8	Ramos et al. 1998
Poecilia reticulata	2 - 3 mo old males			rg	tw	7.7 ± 0.1			24 h	LC50	mortality	2.2	27	4	Benoit-Guyod et al., 1984
Salmo trutta	average 4.5 g						ca. 5		24 h	LC50	mortality	1.3	2		Hattula et al. 1981.
Salmo trutta			S				5		24 h	LC50	mortality	50	4	24	Kirk and Lester, 1989. In: EC, 2000

Notes

1 Inhibition of spore germination depended on medium with different pHs.
2 In accordance with DIN 38 412, Part 27,
3 In accordance with OECD 201 (1984).
4 In accordance with ISO 147/SC 5/WG 5 N 75).
5 8-9 cell cycles
6 Final DMSO concentration of 0.35 mL DMSO / 50 mL not toxic to Tetrahymena,
7 Unclear if the EC50 is based on nominal or mean measured concentrations. Recovery of the test substance was > 80% of nominal in an abiotic control.
8 In accordance with OECD 203 (1992) (adapted for snails). Dissolved oxygen concentrations ranged from 0.0 - 9.4 mg/L (range for several tests with different test substances). It is unclear if this affected the test result (no raw data was provided).
9 In accordance with OECD 202 (1984).
10 Test result based on measuredal concentrations, which were > 80% of nominal.
11 In accordance with ASTM (1980).
12 In accordance with draft DIN 38 412/15.
13 According to standard test german test methods (1974)
14 In accordance with FIFRA guideline 72-1 Acute toxicity test for freshwater fish.

15 COMPUTOX database
16 Unit of endpoint not reported. Assumed that unit is mol/L. In accordance with EPA-660/3-75-009.
17 In accordance with ASTM 1980.
18 Unclear if the LC50 is based on nominal or mean measured concentrations. Recovery of the test substance was > 90% of nominal.
19 Reported as TLm.
20 Results reported in EC, 2000 were not reported in the original article.
21 Tests methods not according to standard methods; test performed using partly saline solutions which differed per test concentration; EC25 not calculated using accepted methods (but no raw data available).
22 Reported is a 'killing concentration' without any description of methods. Data in this table were taken from EC, 2000, but were not found int he article.
23 No endpoint reported
24 Little info on test design, no info on guideline followed
25 Little info on test design, but according to specified guideline and same result also presented in EC, 2000 database
26 No data on 4-chloro-3-methylphenol present in CITI database, so origin of this data is unclear
27 Unit of LC50 not reported.
28 Extrapolated value, 80% mortality at lowest test concentration (1 mg/L)

Table A2.14 Acute toxicity of 4-chloro-3-methylphenol to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri				tg	am			21.9	5 min	EC50	bioluminescence	1.91	2	1	Vismara et al. 1996
Vibrio fischeri				tg	am			21.9	15 min	EC50	bioluminescence	1.8	2	1	Vismara et al. 1996
Vibrio fischeri		N	S				15	21.9	15 min	EC50	bioluminescence	0.95	2		Kafka et al., 1999
Vibrio fischeri		N	S				15		15 min	EC50	bioluminescence	0.28659183	2	1	Mulhall, 1997. In: Warne and Westbury, 1999
Vibrio fischeri		N	S	99					30 min	EC50	bioluminescence	0.342032794	2	1	Kaiser and Palabrica, 1991

Notes
1 Microtox test.

Table A2.15 Chronic toxicity of 4-chloro-3-methylphenol to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Escherichia coli							37		72 h	LOEC		250	4	5,6	Beilfuss and Nolte, 1977. In: Gesellschaft Deutscher Chemiker, 1984
Pseudomonas aeruginosa							37		72 h	LOEC		500	4	5,	Beilfuss and Nolte, 1977. In: Gesellschaft Deutscher Chemiker, 1984
Pseudomonas pictorum		N	R (growing colonies were transferred to higher test concentrations)		am				48 - 96 h (24 - 48 h per test conc.)	NOEC	growth	250	3	1,7	Chitra and Chandrakasan, 1996
Pseudomonas putida	strain Berlin 33/2						25		16 h	LOEC	growth	70	4	6	Rubelt et al., 1982. In: Gesellschaft Deutscher Chemiker, 1984
Staphylococcus aereus							37		72 h	LOEC		250	4	5,6	Beilfuss and Nolte, 1977. In: Gesellschaft Deutscher Chemiker, 1984
Algae															
Chlorella pyrenoidosa		Y	S	99	am	ca. 7.4	ca. 22		72 h	EC10	growth rate	2.3	2	2	Ramos et al. 1999
Chlorella pyrenoidosa		Y	S	99	am	ca. 7.4	ca. 22		72 h	NOEC	growth rate	1.9	2	2	Ramos et al. 1999
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		72 h	EC10	biomass (AUC)	4.7	2		Kühn and Pattard, 1990
Scenedesmus subspicatus		N	S		am	8.0 - 9.3	24 ± 1		72 h	EC10	growth rate	11	3	8	Kühn and Pattard, 1990
Scenedesmus subspicatus			S						72 h	EC10	growth rate	1.85	4	3,6	Bayer AG, 1983. In: Gesellschaft Deutscher Chemiker, 1984
Crustacea															
Daphnia magna	≤ 24 h old	Y	R		am	8.0 ± 0.2	25 ± 1	250	21 d	NOEC	survival, repro. rate, time to 1st repro.	1.3	2	4	Kühn et al., 1989b

Notes
1 Concentrations were tested in a stepwise approach: colonies were exposed to the lowest concentration, if growth was observed, then they were transferred to a higher concentration, etc. NOEC not statistically determined and based on a qualitative endpoint (growth (colonies formed), absence of growth (no colonies formed). Minimal medium.
2 In accordance with OECD 201 (1984).
3 In accordance with ISO 147/SC 5/WG 5 N 75).
4 Test result based on nominal concentrations, which were > 80% of nominal.
5 Test endpoint not reported.
6 Little info on test design.
7 No standard approach (bacteria were not exposed to a range of concentrations, but well-performing colonies were transferred to higher concentrations). NOEC qualitatively and not statistically determined.
8 Extrapolated value, EC10 is above highest tested concentration.

Table A2.16 Chronic toxicity of 4-chloro-3-methylphenol to marine organisms.

No data were available for chronic toxicity of 4-chloro-3-methylphenol to marine organisms.

Table A2.17 Acute toxicity of aminochlorophenol to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria															
Escherichia coli	10E4 cells/mL	N	S		am		37		8h, 15m	EC50	growth rate	33.02	2		Nendza and Seydel 1988

Table A2.18 Acute toxicity of aminochlorophenol to marine organisms.

No data were available for acute toxicity of aminochlorophenol to marine organisms.

Table A2.19 Chronic toxicity of aminochlorophenol to freshwater organisms.

No data were available for chronic toxicity of aminochlorophenol to freshwater organisms.

Table A2.20 Chronic toxicity of aminochlorophenol to marine organisms.

No data were available for chronic toxicity of aminochlorophenol to marine organisms.

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National Institute
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P.O. Box 1
3720 BA Bilthoven
The Netherlands
www.rivm.com