



BRITISH
COLUMBIA

Ministry of Water, Land
and Air Protection

PROTOCOL 10 FOR CONTAMINATED SITES

Hardness Dependent Site-Specific Freshwater Water Quality Standards for Cadmium and Zinc

Prepared pursuant to Section 53 of the
Contaminated Sites Regulation under the
Waste Management Act

Approved: Original signed by Eric Partridge
Director of Waste Management

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Date

2.0 INTRODUCTION

This protocol provides a procedure whereby site-specific water quality standards (SSSw) to protect freshwater aquatic life can be developed for cadmium and zinc. For cadmium and zinc, a table of precalculated, pre-approved aquatic life protective site-specific water quality standards for water hardness up to 500 mg/L as CaCO₃ is also presented.

Schedule 6 of the Contaminated Sites Regulation provides hardness dependent water quality standards for a number of substances. For cadmium and zinc, freshwater aquatic life protective standards are truncated for water hardness values of 210 and 400 mg/L CaCO₃ respectively.

However, Canadian Council of Ministers of the Environment (CCME) and ministry water quality guidelines upon which the cadmium and zinc standards are based also provide formulas by which guidelines, and by inference, SSSw can be calculated should water hardness exceed 210 or 400 mg/L CaCO₃.

The general intent of these site-specific standards is to allow limited modification of the scheduled numerical standards of the Contaminated Sites Regulation based on information compiled for a particular site. For cadmium and zinc, ministry approved SSSw may be used instead of corresponding Schedule 6 water quality standards, for the site for which they were developed to determine if:

- a site is a contaminated site; or
- a contaminated site has been satisfactorily remediated.

Site-specific standards developed for use under the regulation represent objective, quantitative standards. The ministry will not approve SSSw developed on the basis of qualitative or subjective rationale.

2.0 OVERVIEW

For cadmium and zinc, freshwater aquatic life protective site-specific water standards may be calculated for water having hardness values in excess of 210 or 400 mg/L CaCO₃ by use of the following formulas:

For cadmium:

$$\text{SSSw fw aq. life (ug/L)} = 10 \times 10^{\{[(0.86)(\log \text{hardness}) - 3.2]\}} \quad (\text{adapted from (1)}).$$

For zinc:

$$\text{SSSw fw aq. life (ug/L)} = 10 \times [7.5 + \{(0.75)(\text{hardness} - 90)\}] \quad (\text{adapted from (2)}).$$

3.0 METHODOLOGY

Either of the following two methods may be used to derive freshwater aquatic life protective site-specific water standards for cadmium and zinc.

3.1 Calculation (Hardness \geq 500 mg/L)¹

1. In accordance with Technical Guidance on Contaminated Sites 6 (3) and Schedule 6 of the Contaminated Sites Regulation (CSR), determine if Schedule 6 aquatic life standards are applicable at the site.
2. In accordance with good industry practice and in consideration of Technical Guidance on Contaminated Sites 10 and 11 (4, 5) and sampling and analytical requirements provided in the ministry laboratory manual (6), determine the site-specific hardness of water (surface and/or groundwater) present on site.
3. Determine if CSR Schedule 6 aquatic life standards for cadmium and/or zinc are exceeded in water at the site.
4. If measured water hardness at the site exceeds the corresponding water hardness upper bound identified for freshwater aquatic life cadmium (210 mg/L as CaCO₃) or zinc (400 mg/L as CaCO₃) schedule 6 standards, use the appropriate equation in section 2 above to calculate freshwater aquatic life protective site-specific water standards (SSSw) for the site-specific water hardness values obtained on site.

3.2 Look up Table (Hardness < 500 mg/L)

1. In accordance with Technical Guidance on Contaminated Sites 6 (3) and Schedule 6 of the Contaminated Sites Regulation (CSR) determine if Schedule 6 aquatic life standards are applicable at the site.
2. In accordance with good industry practice and in consideration of Technical Guidance on Contaminated Sites 10 and 11 (4, 5) and sampling and analytical requirements provided in the ministry laboratory manual (6), determine the site-specific hardness of water (surface and/or groundwater) present on site.
3. Determine if Schedule 6 aquatic life standards for cadmium and/or zinc are exceeded in water at the site.
4. If measured water hardness at the site exceeds the corresponding water hardness upper bound identified for freshwater aquatic life cadmium (210

¹ Naturally attributable ambient water hardness values in excess of 500 mg/L as CaCO₃ would be considered extremely unusual within the Province and may be indicative of anthropogenic pollution (e.g. waste disposal leachate, acid rock drainage, etc.).

mg/L as CaCO₃) or zinc (400 mg/L as CaCO₃) schedule 6 standards but does not exceed 500 mg/L as CaCO₃, select from Table 1 corresponding precalculated, extended range freshwater aquatic life protective site-specific water standards (SSSw) for the site-specific water hardness values obtained on site.

4.0 MINISTRY APPROVAL AND DATA REPORTING REQUIREMENTS

4.1 Calculation Method

If freshwater aquatic life protective cadmium and/or zinc SSSw were calculated for site-specific water hardness values at the site, submit the site-specific water hardness investigative and characterization data (including analytical results) and the SSSw calculations to the ministry for review and approval by a manager prior to use as SSSw.¹

4.2 Look up Table Method

If extended range, precalculated, aquatic life protective SSSw were selected from Table 1 for cadmium and/or zinc for the site-specific water hardness values obtained at the site, the SSSw may be used directly for contaminated site regulatory purposes without additional ministry approval².

5.0 REFERENCES

1. **Canadian Council of Ministers of the Environment. 1999.** *Canadian Water Quality Guidelines for the Protection of Aquatic Life – Cadmium.* Canadian Environmental Quality Guidelines. Vol. 1., Chapter 4., CCME. Winnipeg, Canada.
2. **British Columbia. Ministry of Environment, Lands and Parks. 1999.** *Ambient Water Quality Guidelines for Zinc.* Water Management Branch., Environment and Resource Management Department. Victoria, British Columbia.
3. **British Columbia. Ministry of Environment, Lands and Parks. 1999.** *Technical Guidance on Contaminated Sites 6 - Applying Water Quality Standards to*

² The SSSw of Table 1 have been pre-approved for use. Consequently no additional ministry approval is required. However, should a Certificate of Compliance ultimately be requested for the site, the site-specific water hardness investigative and characterization data (including analytical results) are a required component of any preliminary or detailed site investigation prepared for the site.

Groundwater and Surface Water. Pollution Prevention and Remediation Branch. Victoria, British Columbia.

4. **British Columbia. Ministry of Environment, Lands and Parks. 2001.** *Technical Guidance on Contaminated Sites 10 - Checklist for Reviewing a Preliminary Site Investigation (PSI)*. Pollution Prevention and Remediation Branch. Victoria, British Columbia.
5. **British Columbia. Ministry of Environment, Lands and Parks. 1999.** *Technical Guidance on Contaminated Sites 11 - Checklist For Reviewing a DSI Detailed Site Investigation*. Pollution Prevention and Remediation Branch. Victoria, British Columbia.
6. **British Columbia. Ministry of Environment, Lands and Parks. 1994.** *British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials*. Laboratory Services Branch., Environmental Protection Department. Victoria, British Columbia.

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Table 1. Precalculated, extended range aquatic life protective site-specific water standards (SSSw) for cadmium and zinc for site-specific water hardness to 500 mg/L as CaCO₃.¹

COLUMN I	COLUMN II	COLUMN III	COLUMN IV	COLUMN V
Substance	Aquatic Life ² (AW)	Irrigation ^{2,3} (IW)	Livestock ² (LW)	Drinking Water ⁴ (DW)
INORGANIC SUBSTANCES				
Cadmium	0.1 @ H ≤ 30 ^{6,10} 0.3 @ H = 30 - < 90 ^{6,10} 0.5 @ H = 90 - < 150 ^{6,10} 0.6 @ H = 150 - < 210 ^{6,10} 0.8 @ H = 210 - < 270 ^{6,10} 0.9 @ H = 270 - < 330 ^{6,10} 1.1 @ H = 330 - < 390 ^{6,10} 1.2 @ H = 390 - < 450 ^{6,10} 1.3 @ H = 450 - < 500 ^{6,10} 1 ⁸	5	80	5
Zinc	75 @ H ≤ 90 ^{6,10} 150 @ H = 90 - < 100 ^{6,10} 900 @ H = 100 - < 200 ^{6,10} 1 650 @ H = 200 - < 300 ^{6,10} 2 400 @ H = 300 - < 400 ^{6,10} 3 150 @ H = 400 - < 500 ^{6,10} 100 ⁸	1 000 @ pH ≤ 6.0 ²⁸ 2 000 @ pH 6.0 - < 7.0 ²⁸ 5 000 @ pH ≥ 7.0 ²⁸	2 000	5 000 ¹¹

Footnotes

- 1 Tabled values for precalculated extended range aquatic life SSSw for cadmium and zinc appear in **bold**. For easy reference, additional CSR schedule 6 standards for cadmium and zinc, with ancillary corresponding schedule 6 footnotes, are also presented. All values are in ug/L. Substances must be analyzed using methods specified in protocols approved under section 53 or alternate methods acceptable to the director.
- 2(a) Aquatic life standards assume minimum 1:10 dilution available. Aquatic life standards are to protect freshwater life unless otherwise indicated.
- (b) Standards for all organic substances are for total substance concentrations. Any water sample to be analyzed for organic substances should not be filtered.
- (c) Standards for surface water samples to be analyzed for heavy metals, metalloids and inorganic ions are for total substance concentrations. In addition, it is recommended that surface water samples being analyzed for heavy metals, metalloids and inorganic ions should also be analyzed for dissolved substance concentrations.
- (d) Standards for groundwater samples to be analyzed for heavy metals, metalloids and inorganic ions are for

dissolved substance concentrations. In addition, it is recommended that groundwater samples being analyzed for heavy metals, metalloids and inorganic ions should also be analyzed for total substance concentrations.

- ³ Applies to irrigation of all soil types.
- ⁴ Drinking water standards are for unfiltered samples obtained at the point of consumption. Heavy metals, metalloids and inorganic ions are expressed as total substance concentrations unless otherwise indicated.
- ⁶ Standard to protect freshwater aquatic life.
- ⁸ Standard to protect marine and/or estuarine life.
- ¹⁰ H means water hardness in mg/L CaCO₃.
- ¹¹ Standard to protect against taste and odour concerns.
- ²⁸ Standard varies with soil pH.