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CSR OMNIBUS UPDATING: Proposed Amendments to Schedule 5 Environmental Protection Standards

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Summary of Proposed Updates for 2015/2016 Stage 10 amendment to CSR

Where time, resource and data constraints allow, the ministry proposes to:

1. Update, to incorporate new science, the CSST, 1996 [1] protocol in respect to the derivation of environmental protection, soil invertebrate and plants matrix soil standards.

2. The updated protocol to include derivation of soil invertebrate and plant soil standards for Wildlands (WL) and High Density Residential (RL_{HDR}) land uses.

3. Repeal the existing CSR Schedule 5 and incorporate Schedule 5 listed substances into a proposed new single schedule of consolidated Schedule 4, 5 and 10 soil standards (i.e. proposed new Schedule "X").

4. For the existing prescribed substances of Schedule 5, update the soil invertebrate and plant standard in accordance with the proposed updated CSST 1996 [1] protocol.

5. For substances which have had new CCME soil environmental protection guidelines derived since 1995, develop soil invertebrate and plant standards in accordance with the proposed updated CSST 1996 [1] protocol.

6. For substances currently listed in Schedule 4, derive new soil invertebrate and plant standards in accordance with the proposed updated CSST 1996 [1] protocol .

7. For existing Schedule 4 prescribed substances, where toxicological data is insufficient to calculate the two mandatory components of Schedule 5 matrix soil standards (i.e. Human Health Protection – intake of contaminated soil and Environmental Protection – toxicity to soil invertebrates and plants), incorporate the existing Schedule 4 soil standard as the mandatory matrix standard and footnote accordingly.

8. Calculate in accordance with the original CSST, 1996 [1] protocol, livestock ingesting soil and fodder matrix soil standards for substances for which new matrices are proposed.

9. Derive for some currently non-prescribed substances (i.e. emerging contaminants of concern, PFOS, selenium, etc.) new environmental protection matrix soil standards.

10. Due to toxicity data limitations, the ministry does not propose to derive soil invertebrate or plant standards for substances currently prescribed in CSR Schedule 10.

Introduction

In 1995, an *ad hoc* joint BC Ministry of Environment and BC Ministry of Health, Contaminated Soil Standards Task Group (CSST) was formed to develop a standardized, consistent and scientifically defensible derivation protocol to develop soil quality guidelines for use under the Contaminated Sites Regulation. The resulting CSST protocol, CSST, 1996 [1] was developed in parallel to, and in consideration of, the 1996 Canadian Council of Ministers of the Environment (CCME) soil protocol CCME, 1996 [2]. In 2006 the CCME soil protocol was updated CCME, 2006 [3].

Currently, Schedule 5 of the Contaminated Sites Regulation (CSR) provides matrix soil quality standards for the protection of human and environmental health. The Schedule 5 standards differ depending on applicable site specific factors as shown in Table 1 below.

Table 1. CSR Schedule 5 Site specific Factors by Land Use.

Site-specific Factor	Land Use				
	Agri.	U. Park	Res.	Com.	Ind.
HUMAN HEALTH PROTECTION					
Intake of contaminated soil	X	X	X	X	X
Groundwater used for drinking water	X	X	X	X	X
ENVIRONMENTAL PROTECTION					
Toxicity to soil invertebrates and plants	X	X	X	X	X
Livestock ingesting soil and fodder	X				
Major microbial functional impairment	X				
Groundwater flow to surface water used by aquatic life (freshwater)	X	X	X	X	X
Groundwater flow to surface water used by aquatic life (marine)	X	X	X	X	X
Groundwater used for livestock watering	X				
Groundwater used for irrigation	X	X	X		

In 2009 the British Columbia Science Advisory Board (SABCS) reviewed the CSST1996 [1] protocol and the CCME, 2006 [3] updated protocol. As a component of their review, SABCS provided recommendations for updating the CSST, 1996 [1] protocol [4, 5].

The ministry now proposes to update the CSST, 1996 [1] protocol and generate updated new soil invertebrate and plants standards to reflect current science and to incorporate new wildlands and high density residential land uses. The updated CSST, 1996 [1] protocol will also be used to derive new standards for some substances not currently included in CSR Schedule 5. Finally, where sufficient data is available for CSR Schedule 4 substances, new matrix standards will be derived.

Due to the limited time available to complete the Stage 10 amendment to the CSR, the ministry will rely on toxicity data compiled by and currently available from government sources which has been screened against quality criteria. The primary source of such data is the CCME toxicity data used in the development of CCME soil quality guidelines.

Levels of Ecological Protection

The assignation of differential levels of protection for soil standards based on land use is well established in Canada.[1] Typically industrial and commercial land uses are not expected to fully support sensitive soil invertebrate and plant communities as the activities on these land can be inherently disruptive of such communities. Conversely wildlands soils are expected to be self-sustaining and supportive of a diverse soil invertebrate and plants community including more sensitive species and thus, would be provided a relatively high level of protection.

High Density Residential and Wildlands Land Uses

As more fully described in CSR Omnibus Updating: Proposed High Density Residential Soil Standards, BC MoE, 2015 [6] it is proposed for each substance to set the High Density Residential Land Use (RL_{HDR}) soil invertebrate and plant matrix standard equal to ½ the corresponding Commercial Land Use (CL) standard for that substance.

For Wildlands (WL), it is proposed to set purpose-derived WL soil invertebrate and plant standards, representing a 15% Effects Concentration (EC15) level of ecological protection using the new proposed Method 1 – Modified CSST, 1996 [1] Regression based method detailed below, or alternately where Method 1 cannot be used, the new proposed Method 2 – Modified SABCS. 2009 [4, 5] Geometric Mean based method.

Land Use Receptors and Pathways[2]

In deriving the proposed new environmental protection matrix standards, it is proposed that the receptors and direct and indirect pathways considered relevant to the existing CSST, 1996 [1] Residential Land Use be adopted for both the proposed new Low Density Residential Land Use (RL_{LDR}) and High Density Residential Land Use (RL_{HDR}). In the case of Wildlands, it is proposed that the receptors and direct and indirect pathways considered for the existing CSST, 1996 [1] Parkland Land Use be adopted for use in deriving new environmental protection matrix standards for Wildlands.

[1] Appendix A, Table A1, details the various levels of ecological protection associated with land use as provided in CSST, 1996 [1], Landis et. al., 1998 [7], British Columbia, 1998 [8], CCME, 2006 [3], SABCS, 2009 [4, 5], the CSR Stage 6 amendment, 2006 [9] and those now proposed in this document for the stage 10 amendment to the Regulation.

[2] Appendix B, Table B1 , provides details on the various ecological receptors and direct and indirect exposure pathways considered relevant to the various CSR land uses, including the proposed new RL_{HDR} and WL land uses.

Current BC Soil Protocol - CSST, 1996 [1]

The current BC soil protocol is the CSST, 1996 [1] protocol. The toxicity data used to derive the existing Schedule 5 ecological protection soil standards was largely sourced from 1996 draft unpublished CCME Ecological Health Substances Assessment documents. For most Schedule 5 substances, the data represented in the 1996 CSST toxicity database was compiled circa 1995.

Under the CSST 1996 protocol [1], the "Toxicity to soil invertebrates and plants" standard is derived according to the linear regression method which uses the following steps:

1. Consider all appropriate invertebrate and plant toxicity data from CCME "Substance Assessment" documents.

2. Separate data into discrete lethal and non-lethal effect distributions.

3. Calculate median effects concentrations for each effects level for both lethal and non-lethal distributions.

4. Fit linear regression lines to the respective lethal and non-lethal distributions.

5. If the lethal and non-lethal regression correlation coefficients are > 0.25 for the respective regressed distributions, then the predicted values for EC50-NL and LC20 are used to establish the soil invertebrate and plants standards for the various land uses, as follows:
   - For AL, RL. PL the standard is the lesser of the EC50-NL or LC20 predicted concentration,
   - For Cl, IL the standard is the greater of the EC50-NL or LC20 predicted concentration.

6. If the lethal and non-lethal regression correlation coefficients are < 0.25 for the respective regressed distributions, set the standards using the "Empirical Exception" rule.[3]

For the purpose of deriving new updated soil invertebrate and plants standards, the ministry proposes to use a modified CSST, 1996 [1] regression based derivation method (Method 1, below).

SABCS, 2009 [4, 5] Review of the CSST, 1996 [1] and CCME, 2006 [3] Protocols and Recommendations for Derivation of Soil Invertebrate and Plants Matrix Standards

In 2009 the SABCS (SABCS, 2009 [4, 5]) reviewed the CSST, 1996 [1] protocol and compared it to the then recently updated CCME, 2006 [3] protocol for the derivation of environmental health protection matrix soil standards.

[3] "Empirical Exception" rule: Estimate EC50-NL and/or LC20 via empirical extrapolation from median effects Distributions.

The two main recommendations forthcoming from the SABCS 2009 review [4, 5] were to:

- change the method of standards derivation from the CSST, 1996 [1] regression based approach to a new SABCS recommended geometric mean based approach, and
- adopt a wildlands land use in the updated protocol.

The SABCS, 2009 [1] recommended geometric mean based derivation method is as follows:

1. Segregate the toxicity data for the substance into discrete plant and invertebrate groups.

2. Split the plant and invertebrate groups into two further subgroups:
   a. non-lethal data, and
   b. lethal data

3. For each subgroup identify two median effects range values
   a. Lower Effects Range (LER) : 15 – 35% effects response range
   b. Moderate Effects Range (MER) : 35 – 65% effects response range

   Step 3 results in 8 critical value estimates:

Plant LER_{NL}	**Plant LER_{L}**
Invertebrate LER_{NL}	**Invertebrate LER_{L}**
Plant MER_{NL}	**Plant MER_{NL}**
Invertebrate MER_{NL}	**Invertebrate MER_{NL}**

4. Recombine the two plant and invert LER_{NL} estimates by setting a single LER_{NL} as the lesser of the two plant and invert LER_{NL}

5. Recombine the two plant and invert LER_{L} estimates by setting a single LER_{L} as the lesser of the two plant and invert LER_{L}

6. Recombine the two plant and invert MER_{NL} estimates by setting a single MER_{NL} as the lesser of the two plant and invert MER_{NL}

7. Recombine the two plant and invert MER_{L} estimates by setting a single MER_{L} as the lesser of the two plant and invert MER_{L}

   Steps 4-7 results in 4 critical values:

Combined lowest LER_{NL}	**Combined lowest LER_{L}**
Combined lowest MER_{NL}	**Combined lowest MER_{L}**

8. Finally, set the land use soil invertebrate and plants standards as follows:
    a. For **PL and RL** the standard is the lessor of the above determined $\mathbf{LER_{NL}}$ and $\mathbf{LER_{L}}$ values
    b. For **CL and IL** the standard is the lessor of the above determined $\mathbf{MER_{NL}}$ and $\mathbf{MER_{L}}$ values
    c. For **WL** set the standard as **PL times the ratio of AL, PL, RL to CL, IL:**

$$\mathbf{WL} = \mathbf{PL} \times \frac{\mathbf{AL, PL, RL}}{\mathbf{CL, IL}}$$

Appendix C, Figure C1 presents in more detail, the SABCS, 2009 [4,5] recommended geometric mean based derivation process for soil invertebrate and plant, environmental protection matrix soil standards.

The ministry subjected the SABCS, 2009 [4, 5] above methodology to review and trial for a limited number of substances. Based on this experience with the method, the ministry noted the following concerns. The method:

a. is very labour intensive and is somewhat complicated in practise,
b. is often unworkable for the typically limited toxicity datasets available for most substances
c. discards both low effects data (< 35% effect) and high effects data (> 65% effect)
d. does not consider the slope of the dose:response curve for the substance
e. typically produces more stringent soil to invertebrate standards when compared to the CSST, 1991 [1] regression based method.

In light of the above concerns the ministry does not propose to use the SABCS, 2009 [4, 5] recommended geometric mean based method to derive updated soil invertebrate and plants matrix standards. Rather, the ministry has developed a simplified new proposed SABCS, 2009 [4, 5] geometric mean based method for use when the ministry's preferred proposed new modified CSST, 1996 [1] regression based method cannot be used.

CCME, 2006 [3] Protocol

Details of the CCME, 2006 [3] protocol to derive soil invertebrate and plants soil quality guidelines is provided in Appendix D. The ministry notes that the CCME, 2006 [3] derivation method produces soil invertebrate and plant guidelines which are either significantly more conservative (i.e. more stringent) or which do not substantively differ from the guidelines produced by the original CCME, 1996 [2] protocol. As the original CCME, 1996 [2] protocol was rejected largely on the basis of producing overly conservative soil standards for use under the Province's contaminated site regulatory regime CSST, 1996 [8] and as the CCME, 2006 [3] derivation methodology produces equally overly conservative soil standards, the ministry does not propose any further consideration of the CCME, 2006 [3] derivation methodology for the purposes of establishing new soil invertebrate and plant standards.

Proposed Updates – Stage 10 Amendment

For the purpose of updating the Schedule 5 Environmental Protection Soil Invertebrate and Plants standards, the ministry proposes that the following two new derivation methods be used:

Method 1 – Modified CSST, 1996 [1] Regression Based Method, or
Method 2 – Modified SABCS. 2006 [4, 5] Geometric Mean Based Method.

Method 1 is the preferred method for all substances. Method 2 is only used in the case that the data do not support regression based standard derivation.

Proposed New Derivation Methods – Method 1 and 2

Method 1 – Modified CSST, 1996 [1] Method (Preferred) – Calculate linear regression based Effects Concentrations estimates using geometric means of quartile or quintile data bins of combined EC-NL and LC toxicity data for a substance as follows:

1. Toxicity data for a substance is compiled and assessed for acceptability against data quality assurance/quality control criteria.

2. No Observed Effect Concentration data lacking an associated percent effect are binned in the first quartile (or quintile) data bin.

3. All data[4] are combined into a single data set comprising non-lethal Effect Concentration (EC-NL) and Lethal Effect Concentration (LC) data.

4. Calculate a linear regression line for the resulting combined EC-NL and LC effects distribution based on quartile geometric means for following classes:
    a. 1st quartile – EC-NL and LC effects in the range of 0% to 24% (inclusive)
    b. 2nd quartile – EC-NL and LC effects in the range of 25% to 49% (inclusive)
    c. 3rd quartile – EC-NL and LC effects in the range of 50% to 74% (inclusive)
    d. 4th quartile – EC-NL and LC effects in the range of 75% to 100% (inclusive)

5. If the quartile regression returns an $r^2 \geq 0.75$, calculate from the regression line, land use soil invertebrate and plants soil standards as follows:
    a. WL: standard is predicted EC15 concentration
    b. AL/RL/PL: standard is predicted EC25 concentration
    c. CL/IL: standard is predicted EC50 concentration

[4] In addition to assessment against data quality assurance/quality control criteria, data is subject to review for data bias (e.g. excessive lethality data influence or dominance by one species). Uncertainty factors may be used to compensate for biased data.

6. If the quartile regression returns an $r^2 < 0.75$, recalculate the regression using quintile data bins:
    a. 1st quintile – EC and LC effects in the range of 0% to 19% (inclusive)
    b. 2nd quintile – EC and LC effects in the range of 20% to 39% (inclusive)
    c. 3rd quartile – EC and LC effects in the range of 40% to 59% (inclusive)
    d. 4th quartile – EC and LC effects in the range of 60% to 79% (inclusive)
    e. 5th quintile – EC and LC effects in the range of 80% to 100% (inclusive)

7. If the quintile regression returns an $r^2 \geq 0.75$, calculate from the regression line, land use soil invertebrate and plants soil standards as follows:
    d. WL: standard is predicted EC15 concentration
    e. AL/RL/PL: standard is predicted EC25 concentration
    f. CL/IL: standard is predicted EC50 concentration

8. If the quintile regression returns an $r^2 < 0.75$, do not use Method 1. Instead use Method 2 to derive the standard.

Method 2 – Simplified SABCS, 2009 [4, 5] Method (Alternate) – Calculate Effects Concentrations estimates using geometric means of combined EC-NL and LC data as follows:

1. Toxicity data for a substance is compiled and assessed for acceptability against data quality assurance/quality control criteria.

2. No Observed Effect Concentration data lacking an associated percent effect are discarded.

3. All data[4] are combined into a single data set comprising non-lethal Effect Concentration (EC-NL) and Lethal Effect Concentration (LC) data.

4. Calculate geometric means for following data sub-sets:
    a. Low Effect Range (LER): EC25 estimate equal to the geometric mean of EC15 – EC34 range of data (inclusive)
    b. Moderate Effects Range (MER) : EC50 estimate equal to the geometric mean of EC35 – EC 65 range of data (inclusive)

4. Derive land use soil invertebrate and plants standards as followings:
    a. WL: standard is the LER/ 2
    b. AL/RL/PL: standard is the LER
    c. CL/IL: standard is the MER

Substances to be Updated

Subject to time, resource and data constraints, it is proposed to update the environmental protection standards for the substances currently listed in Schedule 4 and 5. Appendix E, Table E1 provides the listing of Schedule 5 substances to be updated.

Appendix E, Table E2 provides a listing of Schedule 4 substances for which CCME has developed soil quality guidelines since 1996. Assuming sufficient toxicity data exists for Table

E2 listed substances, the ministry expects to be able to also derive proposed new soil invertebrate and plant matrix standards for the Stage 10 amendment to the CSR.

Appendix E, Table E3 provides a listing of substances currently undergoing soil quality guideline development by CCME. Toxicity data may be sufficient for the ministry to also derive proposed new soil invertebrate and plant matrix standards for some Table E3 listed substances for the Stage 10 amendment to the CSR.

Other Issues – Next Cycle Revisions

Potential items for review in a future soil environmental protection standard update

In addition to the more immediate updates proposed for the stage 10 amendment to the environmental protective matrix soil standards, the ministry is aware of several additional issues and improvements to the environmental protective standards that could be considered in the proposed longer term, next cycle revision of the CSR standards. For example, the following might be considered:

- Conduct a dedicated literature review for new eco-toxicity information, to include review of new eco-toxicity data as vetted by other jurisdictions and data obtained directly from the scientific literature;
- Review of wildlife soil and food ingestion data for application to wildlands and agricultural lands
- Assessment of soil invertebrate and plant bioavailability of substances from soil, and
- Assessment of soil invertebrate and plant bioaccumulation and trophic transfer from soil.

In addition, the SABCS, 2009 [4, 5] noted that other agencies (e.g. CCME, 2006 [3] and US EPA, 2005 [10]) have developed guidelines to protect terrestrial vertebrate receptors. The SABCS concluded that the guidelines produced "would be protective at a very conservative end of the exposure and effects species distribution"… "However, the SABCS is of the opinion that additional databases and further development and clarification of existing models are required before procedures (in regard to developing soil standards to protect terrestrial vertebrates) can be recommended."

While the time available to develop a methodology to derive soil standards to protect terrestrial vertebrates precludes its inclusion for the Stage 10 amendment to the CSR, development of a protocol for the derivation of terrestrial vertebrate protective soil standards should be considered for the next cycle of future revision to the CSR standards.

References

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[4] SABCS. (2009). *Report on: Review of CSST (1996) Soil Matrix Derivation Approach and Related Policy Decisions. Volume I: SABCS Review and Recommendations for Revision of the Soil Quality Matrix Standards for Contaminated Sites.* A Report Submitted to the B.C. Ministry of Environment. Prepared by: Science Advisory Board for Contaminated Sites in British Columbia (SABCS), Victoria, British Columbia, November, 2009.

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[9] Contaminated Sites Regulation (2006) B.C. Reg. 375/96, a regulation under the B.C. Environmental Management Act.

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Appendix A

Various Levels of Ecological Protection Associated with Land Use as provided in CSST, 1996 [1], Landis et. Al., 1998 [7], British Columbia, 1998 [8], CCME, 2006 [3], SABCS, 2009 [4, 5], the CSR Stage 6 Amendment, 2006 [9] and now proposed in this document for the Stage 10 Amendment to the Regulation

Table A1. Various Levels of Ecological Protection Associated with Land Use as provided in CSST, 1996 [1], Landis et. al., 1998 [7], British Columbia, 1998 [8], CCME, 2006 [3], SABCS, 2009 [4, 5], the CSR Stage 6 Amendment, 2006 [9] and Now Proposed in this Document for the Stage 10 Amendment to the Regulation.

Land use	CSR STD (CSST 1996) [1]	Tier I 1998 [7]	CSST Policy 1998 [8]	CCME 2006 [3]	SAB 2009 [4,5]	Stage 6 CSR [9]	Recommended 2015
Industrial (CSR)	> of EC50-NL or LC20	EC50	EC50	50th percentile of compiled IC25, EC25	lowest MER (lowest EC50 or LC50)		Method 1: EC/LC50 Method 2: MER (EC50 and LC50)
Commercial (CSR)	> of EC50-NL or LC20	EC50	EC50	50th percentile of compiled IC25, EC25	lowest MER (lowest EC50 or LC50)		Method 1: EC/LC50 Method 2: MER (EC50 and LC50)
Residential (CSR)	< of EC50-NL or LC20	EC20	EC20	25th percentile of compiled IC25, EC25			
Residential - HD					lowest LER (lowest EC25 or LC25)		Method 1: EC/LC25 Method 2: LER (EC25 and LC25)
Residential - LD					lowest LER (lowest EC25 or LC25)		Method 1: EC/LC25 Method 2: LER (EC25 and LC25)
Urban Parkland (CSR)	< of EC50-NL or LC20	EC20	EC10	25th percentile of compiled IC25, EC25	lowest LER (lowest EC25 or LC25)		Method 1: EC/LC25 Method 2: LER (EC25 and LC25)
Agricultural (CSR)	< of EC50-NL or LC20	EC20	EC10	25th percentile of compiled IC25, EC25	[Lowest LER/ (Lowest MER/Lowest LER)] (EC10?)		Method 1: EC/LC25 Method 2: LER (EC25 and LC25)
Wildlands (CSR)					[Lowest LER/ (Lowest MER/Lowest LER)] (EC10?)	< 3m deep Urban Park (< of EC50-NL or LC20)	Method 1: EC/LC15 Method 2: Use of protection factor (1.5 or 2.0)
						> 3m deep Commercial (> of EC50-NL or LC20)	

Appendix B,

Various Ecological Receptors and Direct and Indirect Exposure Pathways Considered Relevant to the Various CSR Land Uses - Including the Proposed New RL_{HDR} and WL Land Uses.

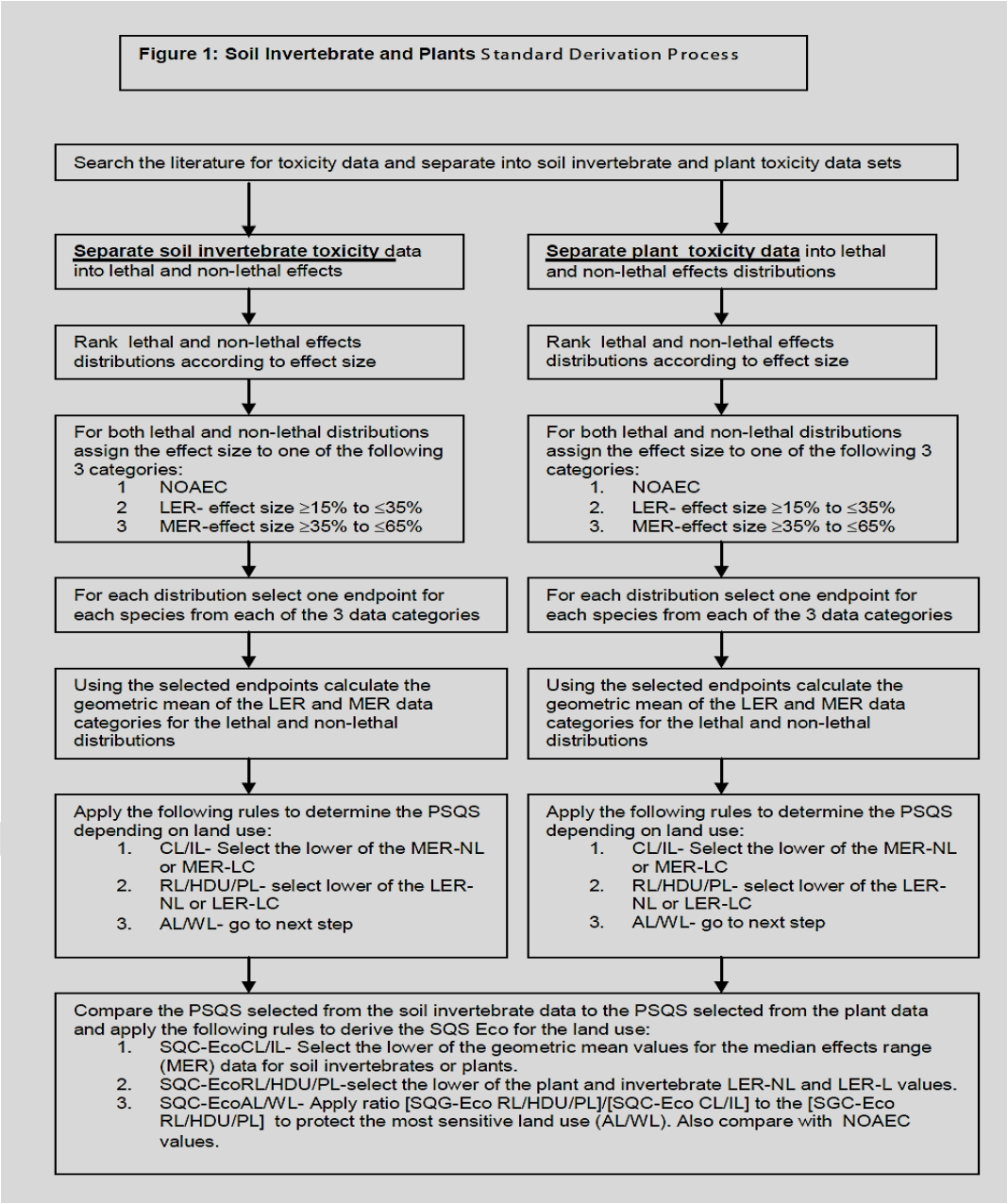
Table B1. Various Ecological Receptors and Direct and Indirect Exposure Pathways Considered Relevant to the Various CSR Land Uses - Including the Proposed New RL_{HDR} and WL Land Uses.

Land Use	Receptors	Direct Exposure Pathways	Indirect Exposure Pathways
Wildlands (WL)	- soil nutrient cycling processes (microbes) - plants - soil invertebrates	- direct soil contact	- Contaminant transfer to groundwater affecting: 1. aquatic life 2. plants
Agricultural (AL)	- soil nutrient cycling processes (microbes) - crops/plants - soil invertebrates - livestock	- direct soil contact - soil and fodder ingestion by livestock	- contaminant transfer to groundwater affecting: 1. aquatic life 2. livestock 3. Plants
Low Density Residential RL_{LDR})	- plants - soil invertebrates	- direct soil contact	- contaminant transfer to groundwater affecting: 1. aquatic life 2. plants
High Density Residential (RL_{HDL})	- plants - soil invertebrates	- direct soil contact	- contaminant transfer to groundwater affecting: 1. aquatic life 2. Plants
Urban Park (PL)	- plants - soil invertebrates	- direct soil contact	- contaminant transfer to groundwater affecting: 1. aquatic life 2. Plants
Commercial (CL)	- plants - soil invertebrates	- direct soil contact	- contaminant transfer to groundwater affecting: 1. aquatic life
Industrial (IL)	- plants - soil invertebrates	- direct soil contact	- contaminant transfer to groundwater affecting: 1. aquatic life

Appendix C

SABCS, 2009 [4, 5] recommended geometric mean based derivation process for soil invertebrate and plant, environmental protection matrix soil standards

Figure C1. SABCS, 2009 [4, 5] Recommended Geometric Mean Based Derivation for Soil Invertebrate and Plant, Environmental Protection Matrix Soil Standards



Appendix D

CCME, 2006 [3] Protocol – Summary of the Methods Used to Derive the Soil Invertebrate and Plants Protective Soil Quality Guideline

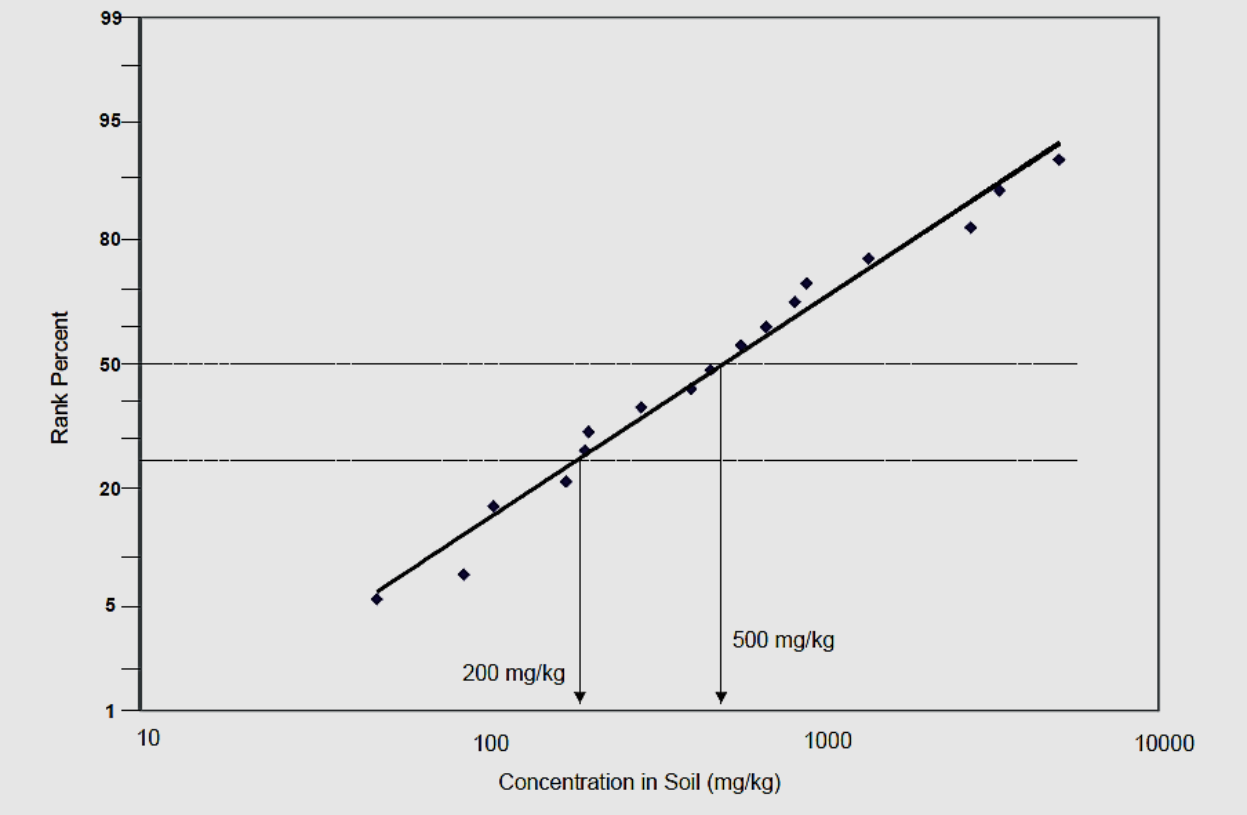
CCME 2006 soil quality protocol:

The 2006 CCME soil quality protocol considers four routes of exposure for the protection of environmental health: soil contact; soil and food ingestion; ingestion of contaminated water (livestock); and contact with contaminated water (freshwater life and crop irrigation). The CCME guideline derivation for the first two soil pathways (contact and ingestion) will be summarized here.

CCME Method of Soil Contact Guideline Derivation

The first step in deriving the soil contact guideline is to screen the toxicological data to ensure they meet data quality criteria. The "selected" data are compiled and, depending on the quantity and quality of the toxicity information, one of three methods of deriving soil contact guidelines is chosen: weight of evidence; LOEC method or median effects method. The plant and soil invertebrate data are evaluated separately and separate guidelines are derived if sufficient data is available. The most stringent of the plant or soil invertebrate guidelines are then used as the soil contact guideline. If insufficient data is available, the plant and soil invertebrate data are combined

The preferred method for deriving soil contact guidelines is the weight of evidence method. The essential step in this process is to derive an "estimated species sensitivity distribution" (ESSD). This distribution is obtained by compiling the IC_{25} and EC_{25} data from the verified toxicity database. Typically this toxicity data would encompass the 20% to 30% effects data. The data is graphed as the rank percentile versus concentration of the chemical. The 25^{th} percentile of the ranked ESSD distribution is used as the basis for soil contact guidelines for the agricultural and residential/parkland land uses and is considered the Threshold Effects Concentration (TEC). The 50^{th} percentile of the ESSD distribution is used as the basis for the soil contact guidelines for the commercial and industrial land uses and is considered the Effects Concentration – Low (ECL). The 25^{th} and 50^{th} percentile values of the ESSD distribution are estimated from the rank percentile graph or calculated from a regression line fit to the rank percentile graph. The figure below is from the CCME 2006 [3] soil protocol document and depicts the estimation of $ESSD_{25}$ and $ESSD_{50}$ from the rank percent graph. The application of an uncertainty factor to the ESSD percentile value is recommended if the data do not meet all of the data uncertainty criteria (e.g. more than 50% of the data are based on toxicity studies with low bioavailability conditions).



Example of a Rank Probability Plot of Bioassay Data

If the weight of evidence method for deriving soil contact guidelines cannot be use due to data limitations, the next preferred method is to use the LOEC method. In this method, the TEC for agricultural and residential/parkland land use is derived by taking the lowest available LOEC value from the selected data and dividing this value by an uncertainty factor (if necessary). The ECL for commercial and industrial land use is derived by taking the geometric mean of the available LOEC data.

If there is insufficient data for the LOEC method the median effects method can be used to derive the TEC value, but not the ECL value. The TEC is derived by applying an uncertainty factor of 5 to 10 to the EC5 or EC50 value. The median effects method is not recommended for deriving ECL values because uncertainty factors are not applied at the point of departure from the effects distribution and the ECL would be estimated at a level of median effects, which is contrary to the level of protection (i.e. 25%) desired for ECL.

CCME Method of Soil and Food Ingestion Guideline Derivation

The CCME procedure for deriving soil guidelines for soil and food ingestion by grazing livestock and wildlife is used for agricultural land use, and if the contaminant may biomagnify, for residential land use.

The first step in deriving the soil and food ingestion guideline is to determine the daily threshold effect dose (DTED) for each applicable trophic level. The most threatened species for this

pathway is identified by finding the species with the lowest ratio of reported LOAEL to dry matter ingestion rate (as food ingested per kg body weight per day). An uncertainty factor is applied to the LOAEL in order to calculate the DTED. Information on the bioavailability and bioconcentration of the contaminant is then applied in trophic level specific equations to calculate the soil guideline for soil and food ingestion. The primary consumer guideline is calculated from the following formula:

$$SQG_{1C} = \frac{0.75 \times DTED_{1C} \times BW_{1C}}{(SIR_{1C} \times BF) + (FIR_{1C} \times BCF_1)}$$

Where:
$DTED_{1C}$ = daily threshold effects dose for primary consumer ($mg \cdot kg^{-1} \cdot d^{-1}$)
BW_{1C} = body weight of primary consumer (kg)
SIR_{1C} = soil ingestion rate for primary consumer ($kg \cdot d^{-1}$)
FIR_{1C} = food ingestion rate for primary consumer ($kg \cdot d^{-1}$)
BF = bioavailability factor for soil
BCF_1 = bioconcentration factor in food of primary consumer (unitless)

Similar formulas are used to calculate soil and food ingestion guidelines for secondary and tertiary consumers.

Appendix E

Tables of Substances for Which Proposed New Soil Invertebrate and Plants Standards Will, or May, Be Derived for the Stage 10 Amendment to the CSR.

Table E1. Listing of Existing Schedule 5 Substances for Which New Soil Invertebrate and Plants Matrix Standards are Expected to be Derived for the Stage 10 Amendment to the CSR.

Substance	Substance
Arsenic	Lead
Barium	Mercury (inorganic)
Benzene	Pentachlorophenol
Benzo (a) pyrene	PCB
Cadmium	PCDD and PCDF
Chloride ion	Sodium ion
Chromium	Tetrachloroethylene
Copper	Toluene
DDT	Trichloroethylene
Ethyl benzene	Xylene
Ethylene glycol	Zinc

Table E2. Listing of Existing Schedule 4 Substances for Which New Soil Invertebrate and Plants Matrix Standards may be Derived for the Stage 10 Amendment to the CSR.

Substance	Substance
Beryllium	Selenium
Cyanide	Thallium
Naphthalene	Uranium
Nickel	Vanadium
PAHs	DIPA : di-isopropanolamine
Phenols (as phenol)	n-Hexane
Propylene glycol	Sulfolane

Table E3. Listing of Substances Currently Undergoing Soil Quality Guideline Development by CCME, and for some of which, Proposed New Soil Invertebrate and Plant Matrix Standards may be Derived for the Stage 10 Amendment to the CSR.

Substance	Status
Nickel	HH and Eco draft guideline public review has been completed.
Lead	Health Canada is revising their draft guideline document to address comments received from Ontario. Eco values remain circa 1999.
Zinc	Health Canada has completed a draft guideline document. Environment Canada is in the process of developing Eco guidelines for zinc
Methanol	Eco and HH draft guidelines are in preparation by Alberta MOE
Amines	Eco and HH draft guidelines are in preparation by Alberta MOE
Glycols	Eco and HH draft guidelines are in preparation by Alberta MOE
PFOS	Eco draft guideline is in preparation by Environment Canada.
Molybdenum	Eco and HH guidelines being developed to CCME standards by Ian Mitchell funded by Petroleum Technology Alliance Canada
Cobalt	Eco and HH guidelines being developed to CCME standards by Ian Mitchell funded by Petroleum Technology Alliance Canada