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CSR OMNIBUS UPDATING: Proposed Amendments to Schedule 11

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

A summary of the proposed updates to Schedule 11 follows:

1. Updating standards to be consistent with TRV selection hierarchy presented in MOE risk assessment policy (e.g., Technical Guidance Document 7 [1]). This will also update standards with the most recent TRVs from the various agencies.
2. Derivation of a new set of Schedule 11 standards for parkade exposures.
3. Derivation of a new set of Schedule 11 standards for wildlands exposures.

1.0 Introduction

British Columbia Contaminated Sites Regulation (CSR) Schedule 11 contains the Generic Numerical Vapour Standards for CSR land uses (AL, PL, RL, CL and IL) for chemicals determined to have adequate volatility to present a vapour risk.

Part 1 of the CSR defines "vapour" as "gaseous emissions from soil, sediment or water", and the ministry's position is that only a volatile substance can give rise to gaseous emissions. The definition of volatility was provided to MOE by BCELQAAC [2] as follows:

Those substances exhibiting:

- Henry's Law Constant > 1.0 x 10^{-5} atm-m^3/mol, and
- Vapour Pressure > 0.05 Torr (@ 1 atm, 25^oC)

Pursuant to CSR Section 11(1) (c.1) a site may be defined as contaminated if "*the concentration of any substance in vapour at the site is greater than the applicable generic numerical vapour standard*". Vapour assessment has the added clarification that as footnote 4 in Schedule 11 indicates, "*vapour standards applied to soil may be adjusted for depth dependent attenuation*".

Application of depth dependent attenuation factors is the mechanism by which sub-surface soil vapour concentrations are used to predict chemical concentrations in indoor and outdoor air (called "breathing zone" in Technical Guidance 4 [3]) arising from sub-surface contamination.

Ministry policy for application of depth dependent attenuation is contained in Technical Guidance Document 4 [3]; and is beyond the scope of this review. The update will be limited to the methodologies to determine the Schedule 11 standards indicative of

acceptable breathing zone concentrations of volatile contaminants under CSR land use scenarios.

2.0 Current Protocol

British Columbia's current Schedule 11 standards were originally derived in 2007 and presented as Directors Interim Criteria [4] (Air Concentration Criteria). The criteria were calculated using modified equations originally recommended by the Science Advisory Board for Contaminated Sites in British Columbia [5] which relied primarily on Health Canada documents [6,7] to determine target reference concentrations (RfCs) for air. These targets were then tailored for use in various CSR land use scenarios, which culminated in combined CSR Schedule 11 standards for AL, PL and RL land uses, and discreet standards for CL and IL land uses using the following exposure terms.

ET	Exposure Term: land-use specific	
AL/RL/PL	ET = 1.0	(24hr/24hr x 7d/7d x 52 wk/52wk x 70 yr/70yr)
CL	ET = 0.33	(12hr/24hr x 5d/7d x 48 wk/52wk x 70 yr/70yr)
IL	ET = 0.11	(8hr/24hr x 5d/7d x 48 wk/52wk x 35 yr/70yr)

For threshold contaminants, the following equation was used in the derivation of Schedule 11 standards:

$$ACC = (HQ^T \times RfC) / ET$$

where: ACC Air Concentration Criteria (mg/m^3)
HQ^T Target Hazard Quotient for substance = 1.0
RfC Reference Concentration (mg/m^3): if RfC unavailable for substance,
RfC = RfCcalc (see below)

RfCcalc Reference Concentration calculated (mg/m^3): substance specific

$$RfCcalc = (RfD \times BW) / IR$$

where: RfD Reference Dose (mg/kg/d): substance specific
BW Body weight (kg): age specific, adult = 70 kg, child = 13 kg
IR Inhalation Rate (m^3/d): age specific, adult =23 m^3/d, child = 5 m^3/d

For non-threshold contaminants (Carcinogenic substances), the following equation was used in the derivation:

$$ACC = ICLR^T / (UR \times ET)$$

Where: ACC Air Concentration Criteria (mg/m^3)
$ICLR^T$ Target Incremental Lifetime Cancer Risk = 1.0×10^{-5}
UR Cancer Unit Risk $(mg/m^3)^{-1}$: if UR unavailable for substance,

UR = URcalc (see below)

URcalc = (SF x IR) / BW

where: SF Cancer Slope Factor $(mg/kg/d)^{-1}$: substance specific
IR Inhalation Rate (m^3/d): age specific, adult =23 m^3/d, child = 5 m^3/d
BW Body weight (kg): age specific, adult = 70 kg, child = 13 kg

3.0 Jurisdictional Review

This section outlines the key similarities and differences between the derivation protocol for British Columbia compared to several other North America Jurisdictions. It is not intended as an exhaustive comparison, but rather to provide a general comparison of methodologies to stimulate discussion regarding additions or alternatives to aspects of the BC derivation protocol.

3.1 CCME

Canadian Council of Ministers of the Environment (CCME) recently finalized the derivation protocol for federal vapour quality guideline [8]. Part C of the document contains the details of guideline derivation, which included the following key similarities:

a) Default exposure assumptions – The CCME residential/agricultural exposure term is identical to that for British Columbia AL/RL/PL land uses; while the CCME commercial/industrial exposure term is very similar to that for CL land use in British Columbia. A comparison of exposure terms is presented below in Table 1.
b) TRV selection process – The CCME protocol recommends using RfCs from various agencies in the following order of preference: Health Canada, USEPA, followed by the World Health Organization (WHO).

Key differences include:

a) The CCME derivation incorporates inclusion of background vapour levels and includes cumulative exposure across the various exposure pathways (e.g., oral, dermal, inhalation).
b) Industrial land use is combined with commercial.

3.2 USEPA

The United States Environmental Protection Agency Regions 3, 6 and 9 have recently harmonized their regional screening level (RSL) tables [9] for a wide variety of substances. Among these were soil vapour RSLs that showed the following similarities:

a) TRV selection hierarchy – TRV Selection for the USEPA RSLs is generally from Agencies in the United States (USEPA IRIS, ATSDR).
b) Default exposure assumptions – The USEPA residential/agricultural exposure term is nearly identical to that for British Columbia AL/RL/PL land uses; while

the USEPA worker (e.g., commercial/industrial) exposure term falls between those for BC CL and IL land uses.

Key differences include:

a) Level of protection for carcinogens set at an increase of incremental lifetime cancer risk of 1 in 1 x 10^{-6}.

3.2 Interstate Technology and Regulatory Council (ITRC)

The ITRC released a practical guidance document for evaluation of the vapour intrusion pathway in 2007 [10]. The guideline did not contain a listing of toxicity reference values (although there is a general reference to USEPA IRIS). The ITRC document, however, does provide advice with respect to selection of appropriate exposure assumptions for various receptor groups (e.g., residential, commercial). The assumptions are generally consistent with other jurisdictions (see Table 1).

3.3 Washington / Oregon DEQ

Pacific northwestern states rely heavily on the USEPA for derivation of screening levels for the vapour pathway. Oregon DEQ documentation [11] references the USEPA Region 3, 6 and 9 RSLs directly, whereas the Washington guidance [12] references a variety of US federal agencies (e.g., USEPA, ITRC, and ATSDR).

3.4 Alberta Environment

Alberta Environment Tier 1 soil and groundwater remediation guidelines were published in 2010 [13]. The guidelines include consideration of exposures to vapours by back-calculating soil and groundwater concentrations to ensure guidelines are protective of vapour intrusion pathway.
Key similarities:

a) TRVs are (generally) selected from Health Canada and USEPA,
b) Exposure assumptions for are taken from CCME which are similar to BC's assumptions as described above.

3.5 New South Wales Australia

The New South Wales Department of Environment Climate Change and Water released vapour guidance in 2010 [14]. Toxicity reference values are generally taken from the World Health Organization and the USEPA IRIS database. The exposure assumptions are adopted from ITRC guidance.

4.0 Exposure Assumptions

The various jurisdictions use slightly different assumptions for differing exposure types (e.g., residential vs. industrial). For residential exposures, parameters are considered for multiple age ranges (e.g., children and adults) and are summarized in the table below.

Table 1. Exposure Term Comparison Table – Soil Vapour Standard Derivation

Parameter	BC MOE	Health Canada	CCME	USEPA	ITRC
Residential[a]					
hours per day	24	24	24	24	24
days per week	7	7	7	7	7
weeks per year	52	52	52	50	50
Commercial					
hours per day	12	8	10	8	10
days per week	5	5	5	5	5
weeks per year	48	52	48	50	50
RL Exposure Term	1.0	1.0	1.0	0.96	0.96
CL Exposure Term	0.33/0.11[b]	0.24	0.27	0.23	0.29

a. Includes agricultural or parkland land uses
b. CSR Industrial land use exposure term

It is apparent that there is a large degree of similarity among North American Jurisdictions, and even in Jurisdictions as far away as Australia. While there are minor differences among the jurisdictions reviewed, they would not generally result in derivation of a significantly different standard.

5.0 Proposed Updates for Stage 10 Amendment

1. Updating standards to be consistent with the Technical Guidance 7 [1] TRV selection hierarchy, using recent TRVs derived by various agencies. No changes proposed for exposure terms for the various CSR land uses.
2. Derivation of a new set of Schedule 11 standards for parkade exposures.
3. Derivation of a new set of Schedule 11 standards for wildlands exposures.

5.1 Standards Update:

The ministry will conduct a detailed review the most recent versions of the available toxicological reviews from other jurisdictions. It is proposed that this occur in a manner consistent with the TRV selection hierarchy presented in MOE Technical Guidance 7 - *Supplementary Guidance for Risk Assessments* [1]; as follows:

- *USEPA Integrated Risk Information System,*

- *Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0- 2010,*
- *US Agency for Toxic Substances and Disease Registry: ATSDR Toxic Substances Portal,*
- *California Environmental Protection Agency: Toxic Criteria Database,*
- *Netherlands National Institute of Public Health and the Environment: Re-evaluation of Human Toxicological Maximum Permissible Risk Levels,*
- *US EPA, Region 9: Regional Screening Levels (Formerly PRGs),*
- *UN World Health Organization: International Programme on Chemical Safety, INCHEM.*

5.2 Consideration for derivation of a new set of Schedule 11 standards for parkade exposures.

In 2011 Golder Associates in conjunction of the Science Advisory Board for Contaminated Sites in BC provided a report titled "Derivation of High Density Residential Soil and Vapour Quality Standards for Use under Contaminated Sites Regulation" [15]. Contained within the document were protocols for deriving CSR soil and vapour standards for a new land use (High Density Residential) under the Regulation. The document could not identify a rationale for modification of the exposure assumptions for the various land uses based on density of residents / workers at a site. However exposure assumptions specific to parkades were identified as a component of high density developments that merit consideration.

Land use under the CSR is determined by the primary site use at ground surface. Therefore currently, for residential sites, the applicable Schedule 11 standard in a parkade is residential. The exposure assumptions related to vapour standard derivation for residential land use were considered to be overly conservative for the scenario by the SABCS. The SABCS document [15] recommends the following exposure scenario for parkade receptors irrespective of the surface land use.

Potential vapour exposure in a parkade includes:

- Parking vehicles,
- Using storage lockers,
- Using laundry rooms located at parkade level,
- Conducting vehicle maintenance

A white paper prepared following the Science Advisory Board risk forum in 2009 (Todoruk *et al*., 2009 [16]) made the following recommendations related to vapour exposure in parkades:

a) During weekdays (5 days/week 52 weeks/year) – a total of 1 hour per day based on four 15 minute exposures to parkade air,
b) During weekends (2 days/week, 52 weeks/year) – a total of 8 hours per day.

The above exposure assumptions result in an exposure term of 0.125, which is very similar to 0.11, the current exposure term used for the industrial land use schedule 11 standard. Options to address the parkade scenario would be to create a new column in schedule 11 for parkade exposures (ministry preferred option), or to indicate the IL standards are appropriate for application in parkade scenarios.

5.3 Consideration for derivation of a new set of Schedule 11 standards for wildlands land use.

As part of the Stage 10 amendments the ministry is considering adopting or deriving soil standards protective of wildlands land use. The standards would be intended to be protective of human receptors using wildlands with greater frequency than the average British Columbian (e.g., First Nations, recreational camp users). As part of the Schedule 5 human health standards update, the ministry has proposed an exposure term (ET) for Wildlands of WL ET=24hr/24hr x 7d/7d x 26wk/52wkx x80yr/80yr). This would have the effect of reducing the Schedule 11 AL/PL/RL vapour standard by a factor of 2.

6.0 Considerations for future updates

6.1 Addition of vapour contaminants to Schedule 11

Mercury - Mercury has a low vapor pressure at standard temperature and pressure, so the liquid vaporizes slowly at room temperatures. Despite this, the primary route of exposure to metallic mercury is inhalation of its colorless and odorless vapors. For a developing fetus or young child, the most sensitive endpoint is considered to be the developing central nervous system (CNS). Therefore, development of appropriate vapour standards for mercury should be considered in the next cycle of standards revisions.

Semi Volatiles – In 2008 the British Columbia Environmental Laboratory Quality Assurance Advisory Committee (BCELQAAC) provided detailed recommendations regarding Schedule 11 vapour standards [2]. One topic of significant discussion was the definition of a volatile substance, and whether semi volatiles with vapour pressures of 0.001 Torr – 0.05 Torr (at 25^{o}C and 1atm) should merit inclusion in schedule 11. The report provided a listing of the relative importance of substances in the 0.001 – 0.05 Torr range, and determined the following:

- Key drivers of remediation are likely to be BTEX, VPHv, hexane, decane, naphthalene, tetrachloroethylene and degradation products,
- On average the total contribution of the nC13-nC16 fraction was approximately 2-4% of the Total Volatile Organic Compounds (TVOC) detected in these samples,
- In the worst case situation (samples contaminated only with heavy diesel or fuel oil) the relative contribution of the nC13-nC16 fraction was approximately 25% of the TVOC.
- At site where biphenyl or PAHs heavier than methyl-naphthalene (acenaphthalene, acenaphthene, fluorine), were detected they were usually found at levels less than 2.5% of the naphthalene concentrations present.

Based on the above, BCELQAAC [2] concluded that while semi volatiles are expected to be present at contaminated sites, higher concentrations of volatile substances listed in Schedule 11 would be also (most likely) be present. Therefore, evaluation and remediation based on the presence of volatile substances should also result in adequate protection from vapours arising from semi-volatile substances.

Potential actions for the next cycle of standards revisions (post Stage 10) include:

- Compare the substance lists between CSR Schedule 11 and the USEPA Region 9 RSL, and determine if there are substances where the above rationale may not apply,
- Request comment from BCELQAAC as to whether the arguments presented in 2008 still hold with respect to semi-volatile substances.

6.2 Soil and groundwater standards protective of vapour pathway.

Several Canadian jurisdictions (e.g., Ontario, Alberta) have developed soil and groundwater standards protective of the vapour inhalation pathway rather than formally adopting numerical vapour standards. These standards serve as a conservative screening tool to determine whether contamination is present at a site. Generally, the soil and groundwater standards are derived by back-calculating from an acceptable inhalation TRV using the vapour partitioning equations available from Health Canada.
In general the back-calculation produces very stringent standards for soil and groundwater. Often the standards are so conservative that the must be reconciled with detection limits for a variety of substances.

There is precedence in the CSR for implementation of soil standards that are protective of other media (e.g., schedule 5 soil to groundwater standards for protection of aquatic life). In view of the current CSR regulatory approach to require direct evaluation of vapours to the Schedule 11 vapour quality standards; there would be very limited, if any, benefit to deriving and implementing soil and groundwater standards protective of the vapour pathway. However, there is a potential benefit to deriving such vapour protective soil and groundwater standards+ with respect to issuance of Determinations under CSR.

Currently, determinations are available to applicants following application of CSR depth dependent attenuation factors specific to the scenario for their site. If the configuration of the site were changed, the site may in fact be considered to be contaminated.
If this approach is pursued as part of the next cycle of standards revision, it will be important to craft language that allows proponents to collect soil vapour data that would supersede concentrations predicted from soil and groundwater concentrations for use in determination of a contaminated site.

6.3 Consideration for adoption of CCME CWS for petroleum hydrocarbon fractions to replace the VPHv standard.

Currently, British Columbia is one of the only Provinces/Territories that has not adopted the CCME fractionation for petroleum hydrocarbons (PHCs), choosing rather to continue with British Columbia specific fractions for PHC evaluation. CCME has recently updated their PHC guidelines and it may be a duplication of effort for BC to maintain their own fractions. As part of the next cycle of standards revision, consideration for adopting the CCME Canada Wide standards should be made, furthermore, when the issue is considered, the decision should be consistent across all relevant media.

7.0 References

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