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SUMMARY PAPER ON BRITISH COLUMBIA MINISTRY OF ENVIRONMENT ON THE DERIVATION OF HIGH DENSITY RESIDENTIAL SOIL STANDARDS

Dear Mr. Kickham:

Golder Associates Ltd. (Golder) was retained by the British Columbia Ministry of Environment (Land Remediation Section; BC MoE) to prepare a summary paper on the Derivation of High Density Residential Soil Standards previously prepared[1] by Golder for the BC MoE. Golder understands that the summary paper will be utilized as part of the consultation process for the BC MoE Contaminated Sites Regulation standards update.

1.0 INTRODUCTION

As part of the planned omnibus updating of the environmental quality standards of the Contaminated Sites Regulation (CSR), the BC MoE intends to establish a new high density residential land use and derive appropriate soil numerical standards for use in high density urban areas. Currently, residential lands are assessed and managed under the numerical standards of the CSR using a single type of residential scenario. The current residential scenario was primarily developed in consideration of human and ecological receptors and contaminant exposures believed representative of a single family dwelling. However, the majority of residents within high density urban areas in major urban centres in BC do not reside in single family dwellings; rather the majority reside in higher density, multi-unit complexes. A 2011 report by Golder and the Science Advisory Board for Contaminated Sites in British Columbia (SABCS) recommended a protocol to derive high density land use residential soil and vapour quality standards for use under the CSR. The study involved review of similar protocols in other jurisdictions, consideration of the nature of urban development, and the potential for exposure of human and ecological receptors to subsurface contamination for a defined high density land use scenario. The work built upon and was consistent with the framework for soil standards derivation prepared by the Contaminated Sites Soil Task Group (CSST) as documented in BC MoE (1996) and the CSST review completed by SABCS (2009a and 2009b). BC MoE has developed several types of soils standards as part of the CSR (BC MoE 2010). Matrix numerical soil standards are found under Schedule 5 of the CSR, for which there are two mandatory site specific exposure pathways that are applied: intake of contaminated soil, and toxicity to soil invertebrates and plants. Generic numerical soil standards, found in Schedule 4, were developed for substances for which in 1996, there was not sufficient toxicological information to develop matrix standards.

[1] Golder Associates Ltd. (Golder). 2011. Derivation of High Density Residential Soil and Soil Vapour Quality Standards for Use under Contaminated Sites Regulation. Prepared for the BC MoE, May 24, 2011.

This summary paper provides the derivation, assessment, and recommendations for the proposed high density residential land use soil standards for human health intake of soil and ecological health through direct soil contact, as described in the 2011 Golder report.

2.0 OVERVIEW OF EXISTING CSST DERIVATION

In 1996, the BC MoE prepared a document entitled "*Overview of CSST Procedures for the Derivation of Soil Quality Matrix Standards for Contaminated Sites*" which outlined the procedures used by the BC MoE to derive soil quality standards for protection of human and ecological health. The soil standards developed using these procedures comprise Schedule 5 (matrix numerical soil standards) of the BC CSR and are applied at contaminated sites throughout BC. The BC MoE 1996 document was based closely on the following methods used by the Canada Council of Ministers of the Environment (CCME) in the development of the Canadian Soil Quality Guidelines (1997, updated in 2006) at that time:

- CCME. 1994a. "*A Protocol for the Derivation of Ecological Effects-Based and Human Health-Based Soil Quality Criteria for Contaminated Sites*".
- CCME. 1994b. "*Guidance Manual for Developing Site Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada*".

The BC MoE 1996 document adopted many of the features of the above documents, but some areas were modified based on BC MoE policy. The modifications made included:

- Not including background checks for volatiles in indoor air, produce, off-site dust or grazing herbivores;
- Use of the ministry's slightly different hydrogeological model to derive soil standards for protection of groundwater; and
- Adjustment of toxicologically-derived soil ingestion standards for arsenic, cadmium and lead to reflect the results of empirical studies on human health outcomes (clinical study factors) for these particular substances.

3.0 RECOMMENDED ALTERATIONS TO THE EXISTING PROTOCOL FOR HIGH DENSITY RESIDENTIAL LAND USE

3.1 Human Health - Intake of Contaminated Soil

The BC MoE has defined "high density residential" land use in Procedure 8, version 2.1 (BC MoE 2014). That definition includes specific land use examples. These specific land uses as well as supporting information from the literature were considered in the development of a conceptual exposure model, which was used to simplify the number of exposure scenarios considered for the development of the high density residential standards. The apartment and condominium scenario was considered the primary focus for the standards development for high density residential land use.

The characteristics of apartment developments vary widely with respect to the potential for soil exposure, but generally the landscaping at high density residential developments is limited to small grass-covered strips or ornamental landscaping. However, some apartment developments include children's playgrounds and in less dense urban areas may include small park-like and landscaped grass-covered areas. A key consideration for development of high density residential standards is the frequency of use of children's playgrounds and small park-like areas by children and toddlers.

Many health agencies (e.g., Health Canada, 2009) have endorsed policies which assume a maximal daily rate of soil ingestion occurs at a site regardless of the amount of time spent in areas where ingestion could occur. However, this approach while admittedly conservative and protective does not consider that the amount of soil ingested, and certainly the likelihood that soil ingestion would actually occur, would be time-dependent to some degree. A review of the literature did not find any soil ingestion rate studies that are specific to high density residential sites and there are very limited data available on child activity patterns for children's play areas and frequency of use for high density land use. Nevertheless, an argument can be made that lower soil ingestion rates should apply to soils that are less likely to be contacted on an "hours per day" and/or "days per week" basis, such as those found in common areas of apartment developments.

The following concepts were considered to be reasonable for time spent in contact with soil:

- Based on professional judgment, it would seem that the areas within high density residential sites where play is encouraged (e.g., backyards of townhomes, playgrounds) could be used at roughly the same intensity as typical low density residential and parkland sites. As a result, there seems to be little justification for altering the assumed time spent and/or soil ingestion rates for these areas.
- For other areas of high density residential sites where soil is present and play is not specifically encouraged (e.g., ornamental gardens, common areas with grass and landscaping), it would seem that the opportunity to come into direct contact with outdoor soils would be lower than at typical low density residential and parkland sites. At such areas, there seems to be a lower likelihood of a toddler specifically playing in the soil and having as much hand-to-mouth activity as in areas where play activities are encouraged. As a result, there does seem to be justification for reducing either the assumed exposure time or the soil ingestion rates for these areas.

Consequently, it was concluded that for high density residential sites where play areas do not exist, the net contaminant exposure for the human health soil intake pathway could reasonably be considered to be lower than at typical low density residential or parkland sites.

Although mathematically similar to reducing soil ingestion rates, it was determined that adjustment of the exposure term (ET) was the more straightforward approach for addressing this issue. For the purposes of development of high density residential soil standards for intake of contaminated soil, the Golder 2011 report recommended that an ET of 0.5 be utilized. Currently, at residential and parkland sites, CSST procedures employ an ET of 1 while for commercial sites, a value of 0.33 is used. This effectively means that year-round soil ingestion rates from residential/parkland sites are assumed to be 80 mg/day for toddlers and 20 mg/day for adults, while values of 26 and 6.6 mg/day could be assumed for commercial sites. Thus, the ET value of 0.5 recommended for a high density residential land use scenario is positioned between the current CSST commercial and low density residential/parkland values.

It was stressed that standards developed using the ET of 0.5 would apply to soils that are not used for play purposes, such as common areas that include landscaped grass areas, ornamental gardens and walking paths. This is based on the presumption of a lower likelihood that children would play in these areas as compared to typical residential or parkland settings. However, this does not mean that it was assumed such play activities would never occur, but that such play activities would occur at a rate of about 50% of typical residential and parkland sites.

3.2 Ecological Health - Toxicity to Soil Invertebrates and Plants

Modification of the CSST protocol to derive new standards for the protection of soil invertebrates and plants was not recommended. Instead, the existing commercial standards for the protection of soil invertebrates and plants were proposed for the high density residential land use, based on the similarity between these land uses in terms of utilization by soil invertebrates and plants:

- **Consideration of exposure pathway based on size of undeveloped area**: CSR Protocol 13 and the MoE Procedure 8 "Definitions and Acronyms for Contaminated Sites" define "potential terrestrial habitat" as land that "contains over 50 m^2 (where residential land use applies at the site) and over 1,000 m^2 (where commercial or industrial land use applies at the site) of contiguous undeveloped land." High density sites are considered likely to have between 50 m^2 and 1,000 m^2 of contiguous undeveloped land and therefore, terrestrial ecological receptors require some level of protection from soil contamination. Protection of soil invertebrates and plants is also a mandatory applicable standard at all sites, irrespective of land use.
- **Consideration of level of protection based on nature of receptors:** Vegetation at most high density residential land use sites is considered likely to be maintained (*e.g.*, ornamental gardens, sidewalks, hedges, planter boxes and lawns). Non-maintained, natural vegetation is likely limited in spatial extent because high density sites will tend to exist in a landscape dominated by human influences. The types of soil invertebrates and plants likely present at a high density site was considered by Golder and the SABCS in the Golder 2011 report, to be similar to the ecological community present at commercial sites, and therefore, the level of protection afforded by the commercial standards was believed likely to be adequate for high density sites as well.

Two exceptions to the proposed adoption of commercial standards for high density residential sites would be: (i) a high density site used for growing plants for human consumption (with certain possible exclusions), and (ii) a high density residential site that contains a land parcel of special ecological value.

4.0 COMPARISON TO OTHER JURISDICTIONS

Guidance documents on soil standards development from Canada, New Zealand, Australia, the Netherlands and the United Kingdom were reviewed. Jurisdictions with generic soil standards addressing a high density residential land use scenario were limited to New Zealand and Australia, and these only considered human health.

The New Zealand Ministry for the Environment (NZ MfE) recently published a background document (NZ MfE, 2010) to soil standard development that includes a high density scenario for townhouse multi-unit dwellings and high-rise apartments. The protocol indicates there are little or no data available for deriving exposure parameters for residential scenarios other than the standard low density single family residence scenario (i.e. 10% produce grown on site), and therefore professional judgment must be resorted to for the high density scenario. The differences between the standard low density and high density residential scenarios are limited to different assumptions for soil ingestion and soil adherence factors. For both factors, the standard residential assumptions are divided by approximately a factor of two.

Federal management of contaminated sites in Australia is provided by the National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) (NEPC,1999a,b,c,d) and includes a high density scenario for residences "*with minimal soil contact (includes dwellings with fully and permanently paved yard space,* e.g., *high-rise apartments and flats)".* The Australian soil standards for standard residential use is based on a two-year old child receptor and soil ingestion rate of 100 mg/day and body weight of 13.2 kg. The soil standards for the high density residential scenario follow a simple factor approach based on judgment, where the residential standard is divided by a default exposure ratio (DER) of 0.25 to calculate the high density standard.

The Commonwealth of Australia (2001) recommended ET values between 0.25 for residential sites with minimal opportunity of contact with soils and 0.5 for parks. Thus, the recommended ET of 0.5 for high density residential land use in the 2011 report is on the conservative side of the Commonwealth of Australia (2001) recommendations.

5.0 CONCLUSIONS

The following definition for the high density residential land use for the apartment and condominium scenario, which was the primary focus of the Golder 2011 high density residential standards report, has been proposed:

- Three-storey or higher apartment or condominium;
- Site does not contain a children's playground, unless it is constructed on top of a parking garage, concrete slab or other impervious barrier to soil; and
- Land is not used for growing plants for human consumption, unless such plants are grown in uncontaminated soil on roof-top gardens or in planters with concrete bottoms.

A playground is defined as an area that is primarily used for children's play (e.g., containing play equipment, picnic area or other attributes that encourage frequent use by children). For high density urban areas use with a playground or garden, the low density residential standards would apply to the entire site, unless the play area and garden can be considered separately from the remaining site area through subdivision or other administrative tool.

For the purposes of development of high density residential soil standards for intake of contaminated soil, it was recommended that an ET of 0.5 be utilized. This recommended value is between the ET values for commercial (0.33) and residential/parkland (1) sites currently employed in BC MoE procedures. The high density standards developed using this ET would apply to common areas that include landscaped grass areas, ornamental gardens and walking paths soils that are not used for play purposes. An ET of 0.5 suggests that such play activities would occur at a rate of about 50% of typical residential sites.

Modification of the CSST protocol to derive new standards for the protection of soil invertebrates and plants was not recommended due the close similarity between high density residential and commercial land uses in terms of utilization by soil invertebrates and plants. Instead, adoption of the existing commercial standards for the protection of soil invertebrates and plants are proposed for the high density residential land use.

6.0 CLOSURE

We trust the information contained in this summary paper is sufficient for your present needs. Should you have any additional questions regarding this work, please do not hesitate to contact the undersigned at 604-296-4200.

Yours very truly,

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