MGRA User Guide:

A Guide to Using the "Approved Model" (November, 2016) When Submitting a Modified Generic Risk Assessment (MGRA)

Standards Development Branch
Ministry of the Environment and Climate Change

PIBS # 8450e

Disclaimer:

It should be noted that any description of the legislative and regulatory requirements given in this Guide is for convenience only. A copy of the relevant legislation and regulations should be obtained to determine the exact requirements, and a lawyer should be consulted on questions about the application or interpretation of them.

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Modified Generic Risk Assessment (MGRA) User Guide: A Guide to Using the "Approved Model" When Submitting an MGRA

1 Introduction to Modified Generic Risk Assessment

The Modified Generic Risk Assessment (MGRA; also referred to as "Tier 2") provides a streamlined approach for developing property specific standards (PSS) under Ontario Regulation 153/04 (Records of Site Condition (RSC) – Part XV.1 of the Act), made under the *Environmental Protection Act* (the Regulation). This streamlined process uses the "Approved Model," which is based on the model (a system of interconnected Excel spreadsheets) that was used to develop the generic site condition standards (*Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act* - dated April 15, 2011).

The Approved Model enables a Qualified Person (QP) entitled to prepare or supervise a risk assessment (QP_{RA}, as described in section 6 of the Regulation) to develop PSS quickly and easily. The Approved Model permits users a limited ability to modify physical site characteristics (e.g., distance to surface water body), modify certain pathways (e.g., ½ solubility and S3 for subsurface workers) supported by analytical results/data and opt into risk management measures (RMMs) (e.g., surface capping), which are developed by the Ministry of the Environment and Climate Change (ministry). For these reasons, the ministry provides a streamlined process for acceptance of PSS that are developed in risk assessments (RAs) that rely solely on the Approved Model.

2 Introduction to the User Guide for the Approved Model

The following is a suggested step-by-step guide for using the Approved Model when submitting an MGRA to the ministry for review. The updated Approved Model is available on the ministry's website, and is dated (November 2016).

Although the Approved Model is relatively user friendly, there are some aspects for which guidance may assist the user considerably in generating the appropriate PSSs.

This User Guide assumes that a QP has already conducted or supervised and completed the phase one and two environmental site assessments (ESAs) in accordance with the requirements of the Regulation. Any work needed to modify an assumption within the model must be done in accordance with the Regulation (i.e., sections 41, 42 and Table 4 of Schedule E), and must be completed before the MGRA is submitted. The Approved Model may be used at various stages of an RA for other purposes, such as project planning.

2.1 New Features Introduced in Version 2

The Approved Model was first published for use in RAs in July, 2011. Users could modify 11 site specific parameters (e.g. distance to down-gradient surface water body, depth to highest annual water table, fraction of organic carbon, etc.). Specific phase two ESA work must be carried out (Schedule E, Table 4) to support modifying these parameters from the default values. Users could

also opt into six (6) RMMs [three (3) caps and three (3) building restrictions] in order to develop higher PSSs, which would still provide the same protection for human health and the environment as the generic site condition standards (generic standards). Two (2) pathway modifiers (modified ecological protection and soil vapour screening levels) were also available in the original Approved Model.

In the years since the Approved Model was first published, the ministry has worked closely with a technical advisory body made up of experienced environmental professionals and industry representatives in order to develop new model features to promote more efficient brownfield redevelopment while maintaining the protection of the environment and human health. Version 2 is designed to allow a greater number of sites across the province to qualify for this streamlined RA process. These changes provide a greater number of options for modifying component values, make the model more user friendly, correct errors in the model discovered since the model was first published, and update the model to reflect current science while continuing to provide the same level of environment and human health protection.

For a summary of the effects of all Approved Model options now available, please see the following table.

Name of RMM or Pathway Modifier	Effect of Pathway Modifier/RMM on Component Values	Requirements & Precluding Conditions	Applicability	
			I/C/C	R/P/I (General)
Modified Ecological Protection (MEP) Pathway Modifier	Uses industrial values x 1.9 for plants and soil organisms (PSO) and 1000x for mammals and birds (M&B)	Need to include statement in RSC that MEP is being used.	Yes	Yes
Shallow Soil Cap Barrier RMM (>50cm)	Uses industrial values x 1.9 for PSO and 1000x for M&B; S3 (subsurface contact) replaces S1/S2 (direct contact with surface soil); Eliminates S-Nose	Limited to I/C/C sites only	Yes	No
Fill/Hard Cap Barrier (1.0 metre or specified greater thickness) RMM	Uses industrial values x 1000 for PSO & 1000X M&B; S3 (subsurface contact) replaces S1/S2 (direct contact with surface soil); Eliminates S-Nose	None	Yes	Yes
Modified Subsurface Worker Protection Pathway Modifier	Multiplies S3 by 100x (if leachate comparisons meet criteria for any inorganic contaminant of concern (COCs))	Cap must have a thickness of 1.5m. Complete the relevant part of the MGRA section in the RA Pre-Submission Form; For inorganic COCs: requires leachate testing for some COCs Must have HASP	Yes	Yes
Building with Storage Garage (intermittent 3.9 L/sec/m^2) RMM[1] -	R/P/I Property Use (Developmental COC): Multiplies S-IA and GW2 by 12x for Trichloroethylene (TCE) and by 2x for other developmental COC	Complete the relevant part of the MGRA section in the RA Pre-Submission Form (re: modifying GW2)	No	Yes
	R/P/I Property Use (Non-Developmental COCs):		No	Yes

[1] To see the rationale for the multiplier ceilings shown for the "Building with a Storage Garage" RMM, please see Appendix 7. Please also note that "intermittent ventilation" is the default scenario assumed in the Ontario Building Code. More information is included in Appendix 7.

Name of RMM or Pathway Modifier	Effect of Pathway Modifier/RMM on Component Values	Requirements & Precluding Conditions	Applicability	
			I/C/C	R/P/I (General)
	Multiplies S-IA and GW2 by 200x	If there is a Storage Garage occupying the First Storey of the building, it cannot be double counted as both a "Building with No First Storey R/P/I Use RMM" and a "Storage Garage RMM"		
	I/C/C Property or First Storey Use (Developmental COC): Multiplies S-IA and GW2 by 6x for TCE		Yes	No
	I/C/C Property or First Storey Use (Non-Developmental COC): Multiplies S-IA and GW2 by 50x		Yes	No
Building with Storage Garage (continuous 3.9 L/Sec/m^2) RMM -	R/P/I Property Use (Developmental COC): Multiplies S-IA and GW2 by 200x for TCE and by 30x for other developmental COCs		No	Yes
	R/P/I Property Use (Non-Developmental COCs): Multiplies S-IA and GW2 by 200x		No	Yes
	I/C/C Property or First Storey Use (Developmental COC): Multiplies S-IA and GW2 by 30x for TCE and by 7x for other developmental COCs		Yes	No
	I/C/C Property or First Storey Use (Non-Developmental COC): Multiplies S-IA and GW2 by 100x		Yes	No
Building with Storage Garage (continuous 10 L/sec/m^2) RMM-	R/P/I Property Use (Developmental COC): Multiplies S-IA and GW2 by 200x for TCE and by 70x for other developmental COCs		No	Yes
	R/P/I Property Use (Non-Developmental COCs): Multiplies S-IA and GW2 by 200x		No	Yes
	I/C/C Property or First Storey Use (Developmental COC): Multiplies S-IA and GW2 by 70x for TCE and by 15x for other developmental COCs		Yes	No
	I/C/C Property or First Storey Use (Non-Developmental COC): Multiplies S-IA and GW2 by 200x		Yes	No
Building Prohibition RMM	Effectively S-OA replaces S-IA; Multiplies GW2 by 200x	Cannot be combined with other building related RMMs;	Yes	Yes

Name of RMM or Pathway Modifier	Effect of Pathway Modifier/RMM on Component Values	Requirements & Precluding Conditions	Applicability	
			I/C/C	R/P/I (General)
		Complete the relevant part of the MGRA section in the RA Pre-Submission Form (re: modifying GW2)		
Passive Soil Vapour Intrusion Mitigation System (SVIMS) RMM[2]	Multiplies S-IA and GW2 by 100x	Limited to I/C/C with slab on grade built form; Complete the relevant part of the MGRA section in the RA Pre-Submission Form (re: modifying GW2)	Yes	No
Active Soil Vapour Intrusion Mitigation System (SVIMS) RMM	Multiplies S-IA and GW2 by 200x	Limited to R/P/I (with Property Management Oversight), and to I/C/C; Complete the relevant part of the MGRA section in the RA Pre-Submission Form (re: modifying GW2)	Yes	Only with Property Management Oversight as defined by the CPU
Building with No First Storey Residential, Institutional or Parkland Use RMM	Uses I/C/C S-IA and GW2 values	No R/P/I property use on first storey of building; No Industrial property use at the site; If the building also includes a basement or storage garage, the depth to ground water used in the model should reflect post-development	Yes	Yes

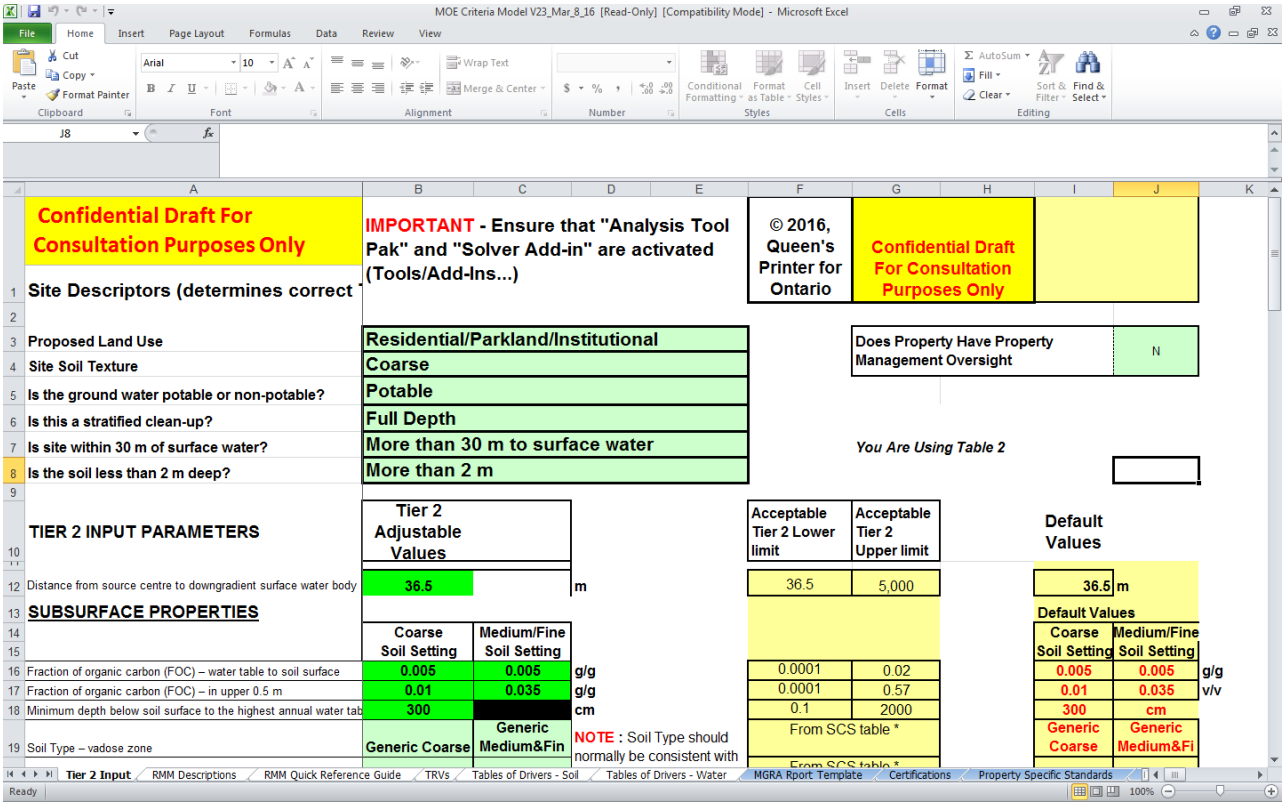
[2] To see the rationale for the multiplier ceilings shown for the SVIMS RMMs, and to see guidance on monitoring performance, please see Appendix 8

Name of RMM or Pathway Modifier	Effect of Pathway Modifier/RMM on Component Values	Requirements & Precluding Conditions	Applicability	
			I/C/C	R/P/I (General)
		conditions; Complete the relevant part of the MGRA section in the RA Pre-Submission Form (re: modifying GW2)		
Soil Vapour Screening Level (met for soil source) Pathway Modifier	Multiplies S-IA by 1000x	Table 4 Sch. E requirements for Environmental Site Assessment (ESA)	Yes	Yes
Soil Vapour Screening Level (met for ground water source) Pathway Modifier	Multiplies GW2 by 200x	Table 4 Sch. E requirements for ESA; Complete the relevant part of the MGRA section in the RA Pre-Submission Form (re: modifying GW2)	Yes	Yes
Building with Minimum First Storey Ceiling Height Requirement RMM	Based on height of first storey, dilution factor for building (proportional to ceiling height); Multiplies S-IA and GW2 up to 2X	Limited to I/C/C	Yes	No
No Ground Water Use RMM	Uses non-potable component values (CVs); Example : Table 3 (non-potable) CVs replace Table 2 (potable) CVs	Complete the relevant part of the MGRA section in the RA Pre-Submission Form (requires pre-consult with District Office)	Yes	Yes
Modify Solubility Pathway Modifier	PHC F2 Solubility CV: 150 µg/L --> 2,500 µg/L PHC F1 Solubility CV: 1,900 µg/L --> 27,000 µg/L.	Complete the relevant part of the MGRA section in the RA Pre-Submission Form; See guidance in Appendix 6	Yes	Yes

Note: Where the RA includes use of the Passive SVIMS or the Active SVIMS RMM, as applicable, the RA should include a statement indicating that a Licenced Professional Engineer knowledgeable in the design and operation of such soil vapour intrusion mitigation systems has reviewed the requirements of these RMMs in the context of the conditions of the Property and agrees that the SVIMS RMM to be used can be properly implemented at the Property.

2.2 New MGRA Report Template Introduced in Version 2

A new MGRA Report Template has been added into the Approved Model (Excel spreadsheet) for Version 2. Adding the template tabs directly into the Approved Model means that many of the tables summarizing model inputs and outputs are now auto-populated by the model, once the QP has selected COCs, inserted site specific characteristics, RMMs and pathway modifiers. This new template was created in order to streamline reporting by the QP and reviewing by the ministry. To visually locate the tabs more easily, the tabs are highlighted blue.



2.2.1 MGRA Report Template Organization

The new MGRA Report Template is broken up into several tabs (identified by blue shading):

1. "MGRA Report Template" tab contains most of the fixed text previously included in the Word version of the template. There are several instances of bright green shaded cells meant for QP input (e.g., Checklist of Mandatory Appendices and Supporting Documents; current property use field). This tab maintains section numbering that corresponds to the headings and requirements contained in Schedule C, Table 1 (Mandatory Requirements for RA Reports).
2. Certifications tab for printing and signing by the QP.
3. Property Specific Standards tab through to RMM tab: these tabs include numbered tables corresponding to the sections in the "MGRA Report Template" tab. Wherever possible, the values in these tables are populated automatically by the model. There are also bright green shaded cells that are for direct user input, and paler green shaded cells that have pull down menus that pop up when the arrow on the right side of the box is clicked.

2.2.2 Printing of the RA Report and Supporting Documentation

Now that the MGRA Report Template has been incorporated into the Approved Model, there is no need to print out the Tier 2 Input tab as part of the MGRA submission.

The proponent should provide, as part of the RA submission, the following items electronically:

- Approved Model (including all site specific inputs and MGRA Report Template tabs completed by the QP).
- RA Pre-Submission Form.

The proponent should provide, as part of the RA submission, the following items in hard copy (4 copies):

- Report cover page.
- Phase two conceptual site model (CSM).
- RA Pre-Submission Form signature page(s).
- MGRA Report Template certifications tab (with QP signatures).

The complete MGRA submission should be mailed to the ministry.

2.3 Amending the Approved Model

The amended version of the Approved Model came into effect November 2016 [method: Decision Notice Posted on the Environmental Registry]. The original version of the model will remain publicly available to view, but not to use.

3 Downloading and Setting up the Model

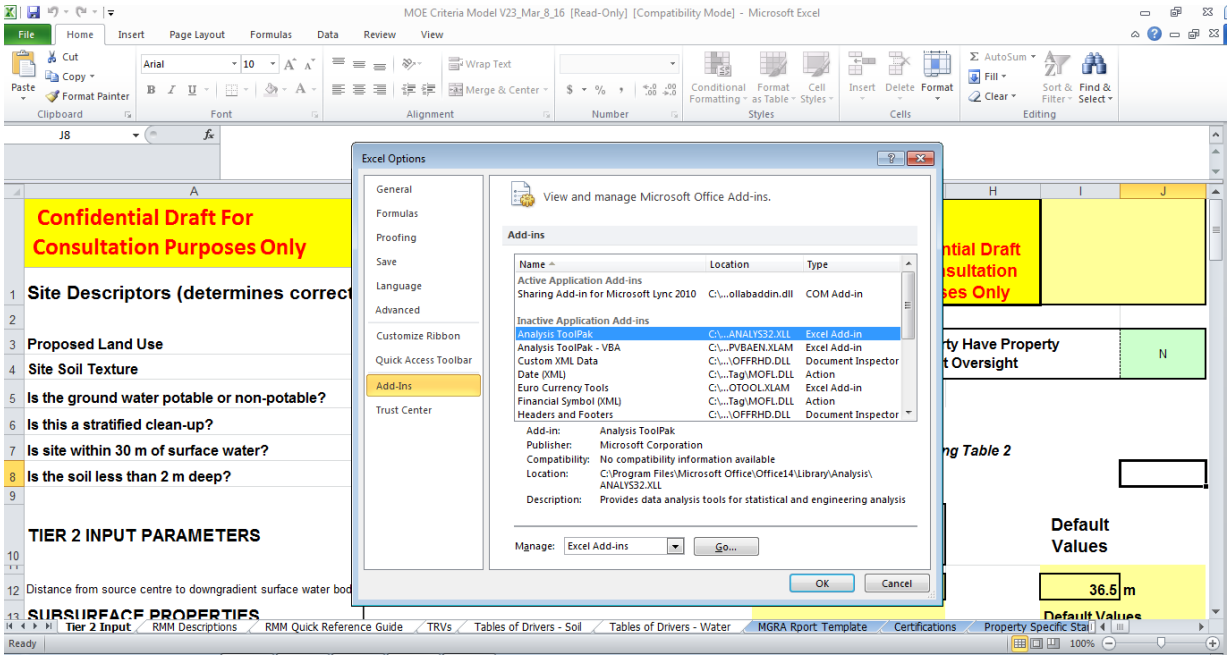
The "Approved Model" can be downloaded from the following website. The model is designed to work on Microsoft Excel 2003 (or later). Note that the print screen from this user guide is based on the Microsoft Excel 2010 version. The ministry cannot assure users that results from its use on other programs will be the same as those produced by Excel.

www.ontario.ca/environment-and-energy/brownfields-redevelopment

** Be sure that "Analysis Tool Pak" and "Solver Add -in" are installed in Excel

- Go to File>Options>Add-Ins (or in earlier versions of Excel: Tools>Add-Ins), then check the appropriate boxes, and click OK

** Also be sure to click the "Enable Content" box in the yellow security warning band at the top of the workbook when it opens.



4 Running the Model and Selecting Model Options

In the following sections you will find a sequence of steps that follows a progression from less to more complex MGRAs. For example, the least complex MGRAs change only measurable parameters such as the distance to the nearest surface water body, and do not require RMMs and are discussed first. More complex MGRAs can combine changes in site specific parameters, RMMs, and additional site investigation to support pathway modifiers. Once you are familiar with the model, you likely wouldn't use the model in this step-wise fashion, but when you are learning the model's features, it's helpful to add layers of complexity in a logical way.

4.1 Entering Site Descriptors for Determining Table of Standards

Step 1. Open "Approved Model" and click on the "Tier 2 Input " tab

The cells that are highlighted in green are cells where the user can input information. The bright green shaded cells are for direct numeric user input, and the paler green shaded cells have pull down menus that pop up when the arrow on the right side of the box is clicked.

Check Site Descriptors in cells B3-B8 to be sure that the descriptions match the RA property. These fields are used to select the applicable table of site condition standards (SCS). To change a description, click on the appropriate cell, then click on the down arrow on the right end of the box and choose the description that is appropriate for the site. Explanations of these site descriptors are available in the document "Records of Site Condition: A Guide on Site Assessment, the Cleanup of Brownfield Sites and the Filing of Records of Site Condition", which can be found at www.ontario.ca/environment-and-energy/brownfields-redevelopment
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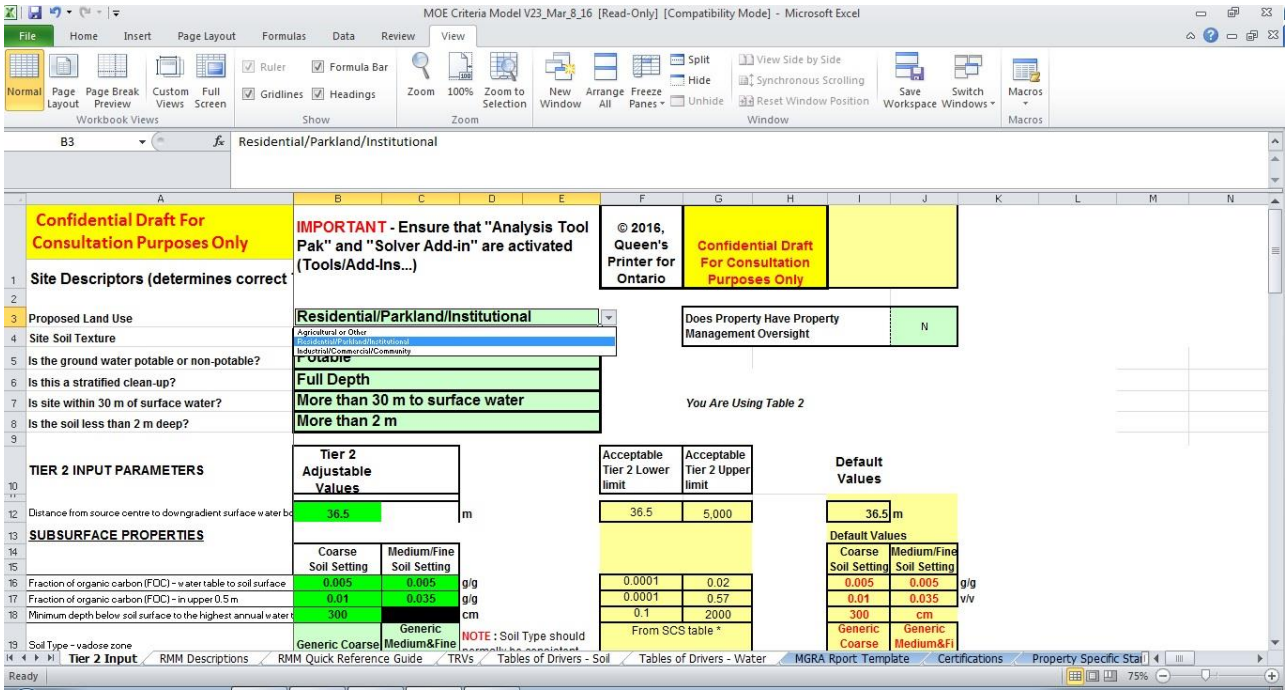


4.2 Entering Site Specific Input Parameters

Step 2. Once the appropriate site descriptors are selected, start entering the relevant site data in cells B12 – B26. If the data entered is outside of the acceptable range (cells in yellow, F12-G26), the warning "INVALID" will be displayed and the cell will be highlighted in red. The Tier 1 (SCS) default values are given in cells I12 to J26 (also in yellow highlight). Once a value changes from the default, so long as it is within the acceptable range, it is displayed in *italics*.

* If there are site properties described in cells A12 –A26 of the Tier 2 Input tab for which no measurements have been conducted, you may wish to check Appendix 3 to determine if you can benefit from measuring them and using them in the Tier 2 process. The possibility of producing a less stringent Tier 2 number exists if there is a check mark in Appendix 3 against the measured parameter for the particular driver that is driving your PSS.

For sites where the overall soil texture is medium/fine, be sure to enter the appropriate data in Cells C16 – C20 (rather than B16 – B17 and B19 – B20, which are for coarse texture soils). Note that cells B19-C20 and B21 are changed using the pull down menus to choose the appropriate soil type or frozen days. For determination of the Soil Type, use the measured sand, silt and clay contents from the site in conjunction with the information in Appendix 1 of this document. If your goal is to develop PSS (as opposed to calculating soil vapour screening levels) be sure to enter the appropriate value for the "Property Soil Type", as opposed to "Area Soil Type". For determination of which value to use for Frozen Ground Days, follow the requirements set out in sections. 41, 42 and Table 4, Schedule E of the Regulation, and round it to the nearest tens or use the maps included in Appendix 2 of

this document. When using Appendix 2, if it is uncertain as to which of two zones your site falls, use the higher (more conservative) of the two numerical values.

*Note that none of the four cells (B19-C20) for Soil Type can include either of the terms "Generic Coarse" or "Generic Medium/Fine" if you want the soil vapour screening levels (SVSLs) to be calculated. These two Soil Types are not options for Tier 2 when SVSLs are being generated. There should be a reasonable correspondence between the Soil Types and the Site Soil Texture, or the QP should have a full understanding and explanation as to the reasons why they do not correspond reasonably well. All Phase Two ESAs upon which MGRA are based should follow sections 41, 42 and Table 4 of Schedule E of the Regulation.

*Note that if the Area Soil Type for the SVSL is considered "fine/medium" textured soil based on grain size analysis, the QP will need to ensure that the "Site Soil Texture" in Cell B4 is changed to correspond to "medium/fine" texture for property SVSL calculations.

4.3 Viewing Modeling Results and Comparing with Site Concentrations

Step 3. After all of the available Tier 2 inputs have been populated, you can review the results that the spreadsheet has generated and compare them with the maximum concentrations measured on the site[3]. To do this, click on Cell A77 and then click on the down arrow at the right end of the cell and choose a chemical identified as a COC at the site. Repeat in cells A78 to A101 for all COCs on site.

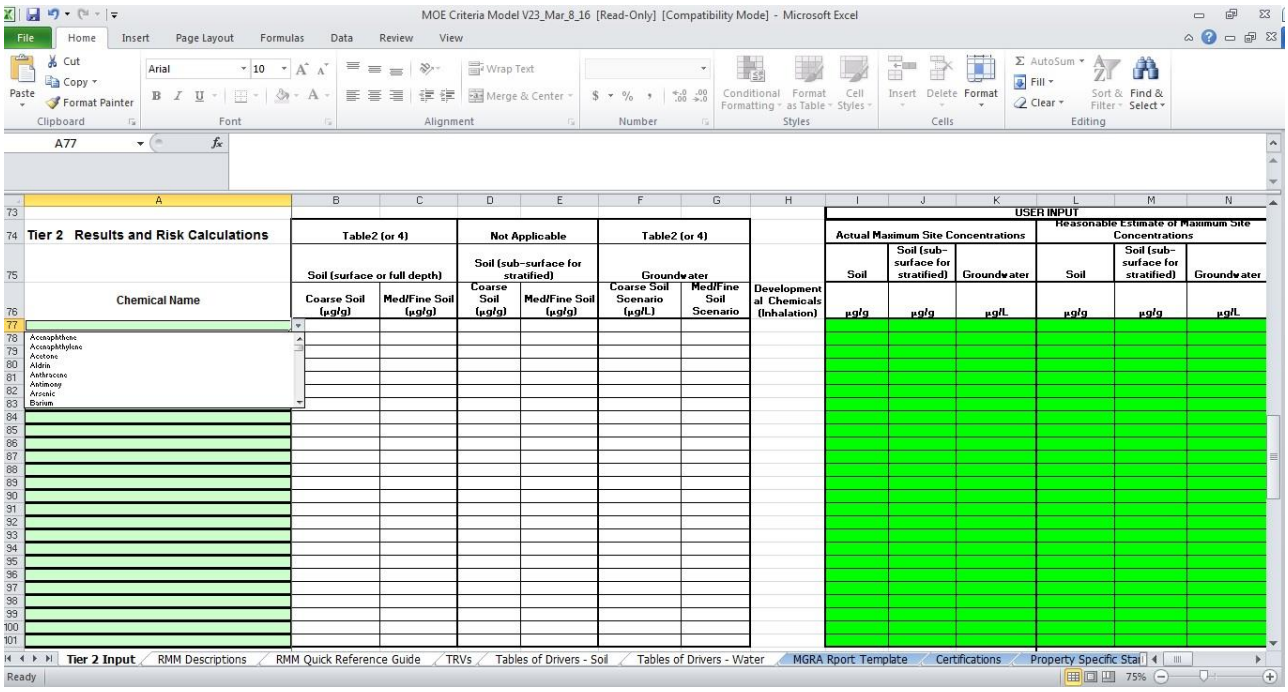
Note 1 – This spreadsheet allows for 25 COCs. If there are more than 25 COCs at the site, you should consider whether an MGRA approach is appropriate given the potential complexity of the site. If needed, you can run the model again for the remainder of the COCs, saving with a different file name.

Note 2 – rather than entering all COCs manually using the drop-down menu, you may prefer to try these tips to help populate your COC list more quickly:

- Tip 1: enter a space before AND after the COC name, e.g. _benzene_, and make sure you type the same name as indicated in the MGRA, e.g. "Dichlorobenzene, 1,2-" NOT "1,2, Dichlorobenzene"
- Tip 2: just copy and paste the COC name from the other tab, e.g. " Phys_chem &Tox"

The initial soil and ground water criteria generated by the spreadsheet will appear in cells B77-G101.

[3] If your property is both shallow soil (typically Table 6/7) *and* within 30 metres of the nearest water body (Table 8/9), you may be wondering how the PSS are calculated. They are based on the lower of the Table 6/7 and 8/9 component values. Please see the tables labelled 10/11 in the "Primary Tables of Standards" tab for a summary of results.



Step 4. Your actual (measured) site concentrations for soil and groundwater are added to the spreadsheet in cells I77-K96, and your calculated reasonable estimate of the site maximum (REM) are inputted into Cells L77-N101. Note that the estimate of the site max cannot exceed 1.2 times the actual measured site max in an MGRA (a warning will pop up if it does). Also note that delineation for all COCs must be complete before the MGRA is submitted. If all COC REM concentrations are numerically lower than the respective values calculated by the spreadsheet (B77-G101), then your site meets the Tier 2 PSSs, and you may submit the RA to the ministry for review. The PSSs that you can use for submitting the RA are displayed in Cells B108-D132. These values account for the REM.

4.4 Adding Risk Management Measures and other Pathway Modifiers

Step 5. If your site doesn't meet the Tier 2 standards, then you may wish to take a look at the Tables of Drivers (see screen shot below) to determine which component value is limiting the PSS value[4]. To do this, at the bottom of the spreadsheet find the appropriate "Table of Drivers" tab (soil or water (meaning ground water)), click on it, and then find the appropriate Table of Standards, Soil Texture, and Land Use (Soils only) in rows 1 and 2. Scroll down to the COC of interest, and determine which component is highlighted. The highlighted cell indicates the driving component (note that if this component is below the reporting limit or the background concentration they are also highlighted, and the criterion is bumped up to the higher value). You may wish to note both the driving component and the next lowest component value (the second driver) and compare both with your COC concentration. Short descriptions of all the components are given at the end of Appendix 3.

[4] For more information about the component values, and how they are used to develop standards, please see the document "Rationale for the Development of Soil and Groundwater Standards for Use at Contaminated Sites in Ontario (MOE 2011)" available at http://www.ontario.ca/environment-and-energy/brownfields-redevelopment

No Possibility of Change in Tier 2:
Solubility (with the exception of PHC F1 and F2, for which there is now site characterization work that the QP can complete to modify this component value. This site characterization work is described in Appendix 6).

Change from Measured Parameters (see Appendix 3)

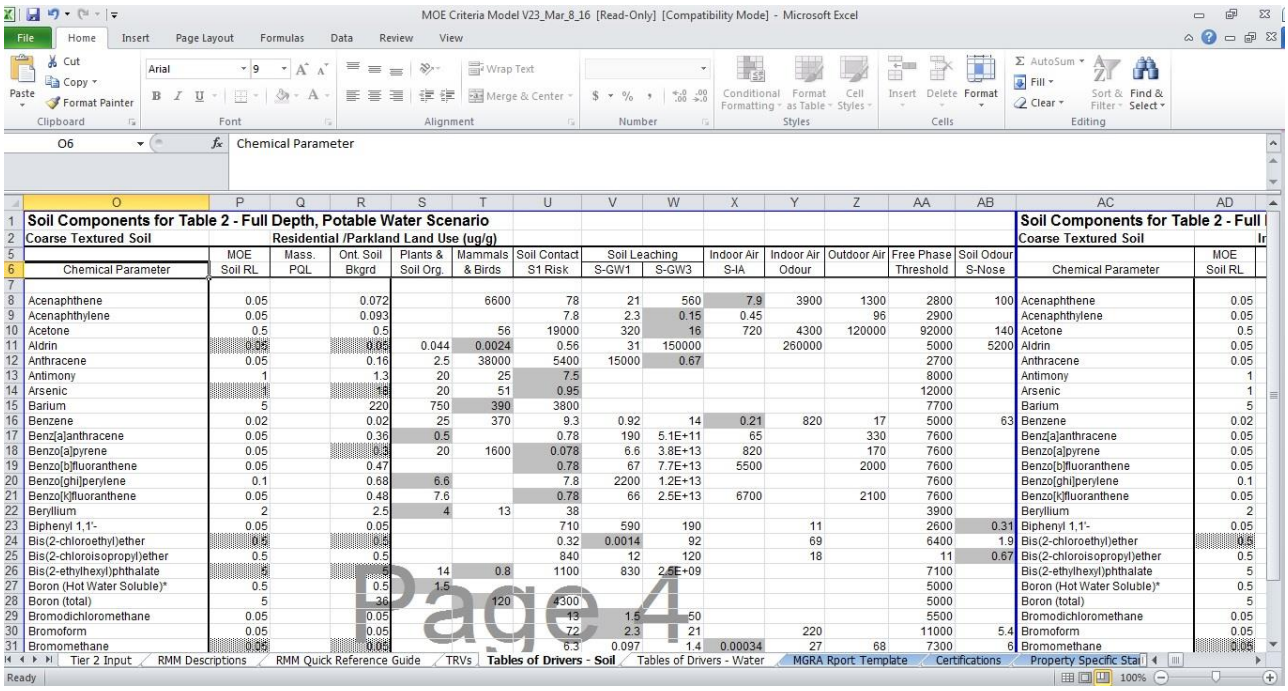
- S-IA, S-Odour, S-GW1, S-GW3, S-OA, GW2, GW2-Odour, GW3, Free Phase Threshold
- Note that meeting the Soil Vapour Screening Level (SVSL) generated for soil and ground water could affect S-IA and GW2

Change from Pathway Modification (step 11)

- Modified Ecological Protection: Plants and Soil Invertebrates, Mammals and Birds
- Modify Solubility Component Values (PHC F1 and F2): solubility
- Soil Vapour Screening Levels: S-IA, GW2 (described below)
- Modified Subsurface Worker Protection: for addressing S3

Change from Risk Management; CPU typically issued (Appendices 5 to 8)

- S-IA, S-IA (Odour), S1, S2, S-Odour, Plants and Soil Invertebrates, Mammals and Birds, S3, GW1, GW2, GW-Odour.



Step 6. If the driving component is "Mammals and Birds" or "Plants and Soil Organisms", then you may wish to consider whether it would be appropriate for your site to use the "Modified Ecological Protection" (MEP) option (by picking "Y" from the pull-down menu in cell B30). This option will generate a higher number for the "Plants and Soil Organisms"

component, and effectively eliminate the "Mammals and Birds" component. An acknowledgement that the option has been chosen must be placed on the RSC. For a full description of this option, read Appendix 4 of this document.

Step 7. If your measured concentrations (for PHC F1 and F2) in ground water still exceed the Tier 2 PSS, and the driver is the solubility component value, then you may wish to opt into the "Modify Solubility Component Values" (cell B40). Note: please see Appendix 6 for guidance to assist proponents in conducting site characterization that is effective in demonstrating that there is no evidence of free product, so that the solubility CV can be modified in the MGRA. You may then answer the questions related to this option that are found in the MGRA section of the RA Pre-Submission Form and provide supporting documentation as part of the MGRA submission.

Note: To this point, none of the options chosen would typically result in the issuance of a Certificate of Property Use (CPU), so if your property meets the Tier 2 PSSs at this stage and the ministry accepts the RA, then a RSC could generally be filed without a CPU. However, all other Tier 2 options (with the exception of Soil Vapour Screening Levels) described from the next step-on would typically be associated with a CPU.

Step 8. If your site soil still doesn't meet the Tier 2 standards and the driving component is any of "Mammals and Birds", "Plants and Soil Organisms", S1, or S2, then you may wish to consider the use of either a "Shallow Soil Cap (Cell B31)" (for industrial/commercial sites) or a "Fill Cap" or "Hard Cap" (Cell B32). These RMMs (RMMs) are described on the "RMM Descriptions" tab of the Approved Model (Excel). In the "Tier 2 Input" spreadsheet, clicking on one of the RMMs hyperlinked in blue (A31-A43) will take you to the appropriate description. Choose the option appropriate for your site by picking "Y" on the pull down menu in Cells B31-B37 & B41- B43 of the Tier 2 Input spreadsheet.

Step 9. If your measured concentrations still exceed the Tier 2 PSS, and the driver is either S-IA or GW2, then you may wish to consider:

- "Building with Storage Garage" (i.e. ventilated parking garage) (cells B33);
- "Building Prohibition" (if no enclosed buildings will be constructed at the site) (choose cell B34 for either);
- "Passive Soil Vapour Intrusion Mitigation System" (cell B35);
- "Active Soil Vapour Intrusion Mitigation System" (cell B36);
- "Building with no First Storey Residential, Institutional or Parkland Use[5]" (cell B37); or
- "Building with Minimum First Storey Height Requirement" (cell B41).
- Soil Vapour Screening Levels (not an RMM; described below)

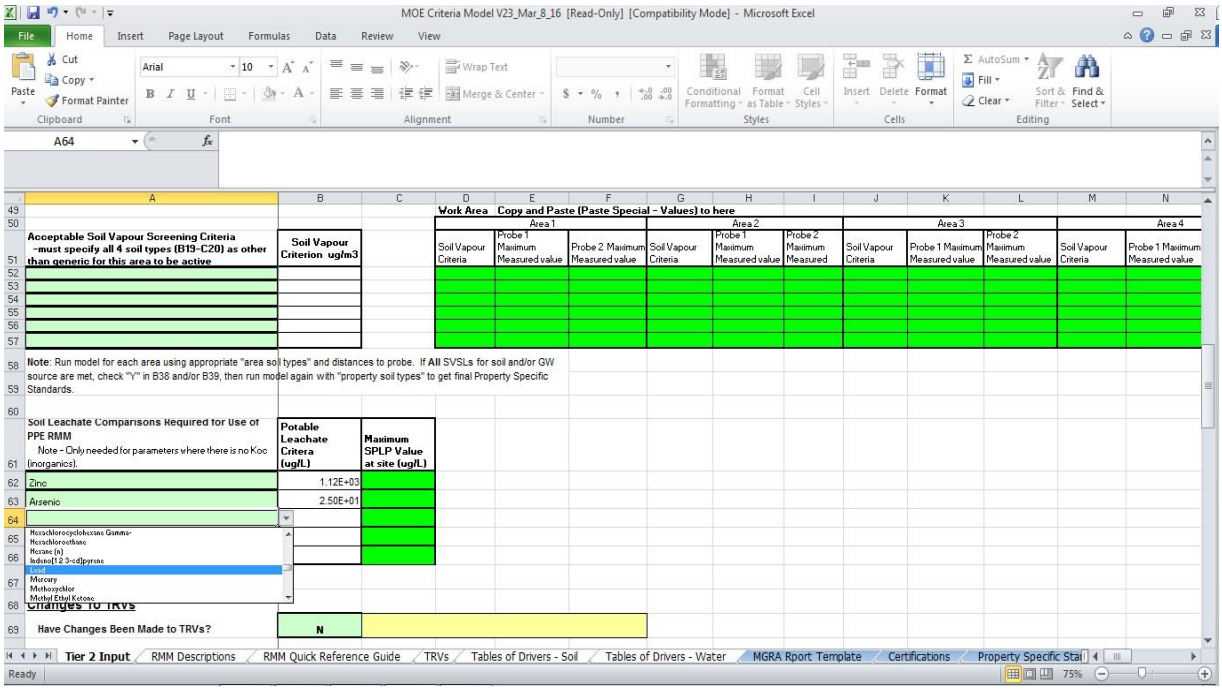
Please see the summary table in Section 2.1 to see requirements and precluding conditions for these options.

[5] If the building also includes a basement or storage garage, the depth to groundwater used in the model should reflect post-development conditions.

Step 10. If your measured concentrations still exceed the Tier 2 PSSs, and the driver is GW1 (for potable ground water site conditions), then you may wish to consider the "No Ground Water Use" RMM (cell B42). Note however, that in order to check the "Y", you must answer the questions related to this RMM that are found in the MGRA section of the RA Pre-Submission Form. Your responses to these questions should be used in pre-consultation with the local District Office. Typically, answers to questions 2, 4 and 5 on Page 26 of the RA Pre-Submission Form must be "yes" in order for this RMM to be used in an MGRA. Note that when you select this option, you must return to cell B5 to change the potability to "Non-potable", which should now be the only option available in the dropdown list. Please also note that one of the outcomes of the ministry's review of the RA may still be the conclusion that groundwater monitoring is warranted for the RA property, and that the RA cannot, therefore, be classified as an MGRA, and may need to proceed as a traditional "Tier 3" RA. The Approved Model can continue to be relied upon to develop PSS, but the Director will review whether any selected RMMs are appropriate for the property, as the RA is no longer considered an MGRA.

Step 11. If your measured concentrations still exceed the Tier 2 PSSs, and the driver is S3, you may wish to opt into the "Modified Subsurface Worker Protection" pathway modifier (cell B43). Note however that for inorganics (COCs without Koc values), in order to check the "Y", you must answer the questions related to this RMM that are found in the MGRA section of the RA Pre-Submission Form, and should provide leachate testing results as part of the MGRA. For details on the use of this pathway modifier, please refer to Appendix 5.

For inorganics, select the COCs from the drop down list in cells A62-A66. The corresponding leachate criteria are generated in row B. Next, enter the leachate analysis results in row C for comparison.



5 Consideration of Off-Site Receptors

If you have used RMMs affecting the ground water for protection of drinking water pathway (GW1 pathway), or the ground water for protection of indoor air pathway (GW2 pathway) or soil vapour screening for a ground water source, you should carefully consider the potential impact of ground water travelling from the RA site to downgradient sites. The following MGRA options modify GW1 and GW2:

- Options that modify GW1:
    - No Ground Water use RMM

- Options that modify GW2:
    - Building with Storage Garage RMMs
    - Building Prohibition RMM
    - Building with No First Storey Residential, Institutional or Parkland Use RMM
    - Soil Vapour Intrusion Mitigation System RMMs
    - Building with Minimum First Storey Ceiling Height Requirement RMM
    - Soil Vapour Screening Level met for ground water source (pathway modifier)

Table 4-5 of the Human Health RA MGRA Report Template (Off-site – HH tab) is provided in accordance with Mandatory Requirements for RA Reports (Schedule C, Table 1 of the Regulation) and this section requires the QP to assess whether the proposed human health standards will likely result in an exceedance of the applicable full depth Site Condition Standard at the nearest off-site human receptor. You must also answer the questions related to options that modify GW1 and GW2 found in the MGRA section of the RA Pre-Submission Form, and should use these questions as a basis to consult with the local District Office about your assessment of the likelihood of off-site impacts.

6 Combining Risk Management Measurements and other Pathway Modifiers Options in the Model: Guidelines and Restrictions

Here are restrictions on how RMMs, Modified Ecological Protection (MEP) and Soil Vapour Screening Levels (SVSLs) can be combined. In general, most options can be combined in the model, but there is not always an advantage to combining them in terms of generating less stringent standards. Please see the bullets and summary table below to see the effects of (and restrictions for) combining options in the Approved Model.

- MEP can be combined with anything, but would provide no extra benefit if a cap is selected
- SVSLs can be combined with anything. There is no numerical advantage in the proposed PSS to doing so; however, the screening level that the measured soil vapour concentration are compared to will be increased if soil vapour RMMs are selected
- “Fill Cap Barrier” & “Hard Cap Barrier” can be combined with one another
- If a “Shallow Soil Cap Barrier” is combined with other caps at a site, only the “Shallow Soil Cap Barrier” multipliers can be used
- “Shallow Soil Cap Barrier” can only be used if the intended and actual property use is industrial/commercial/community

- Caps can generally be combined with other RMMs such as the RMMs affecting the vapour intrusion pathway (subject to the restriction for "Shallow Soil Cap" given above)
- "Active Soil Vapour Intrusion Mitigation Systems (SVIMS)" can only be used if (a) the intended and actual property use is industrial/commercial/community, OR (b) if the intended and actual property use includes residential/parkland/institutional, the Building must be multi-storey and multi-unit, and must have Property Management Oversight. (For more information, please see the description of this RMM and the relevant Definitions).
- "Passive Soil Vapour Intrusion Mitigation System (SVIMS)" can only be used if property use is industrial/commercial/community and the building type is slab on grade.
- "Building Prohibition" cannot be used at sites that will have buildings, so it cannot be combined with other building restrictions (e.g.: "Building with Storage Garage," "Building with no First Storey Residential, Institutional or Parkland Use," "Building with Minimum First Storey Ceiling Height Requirement.")

Abbreviations used in the tables below	
COC	Contaminant of Concern
GW2	Ground water for the protection of Indoor Air
I/C/C	Industrial / Commercial / Community (refers to least sensitive property use category)
M&B	Mammals & Birds
PSF	Pre-Submission Form
PSO	Plants and Soil Organisms
R/P/I	Residential / Parkland / Institutional (refers to a more sensitive property use category)
RSC	Record of Site Condition
S-IA	Soil for the protection of Indoor Air
S-OA	Soil for the protection of Outdoor Air
SVIMS	Soil Vapour Intrusion Mitigation System
SVSL	Soil Vapour Screening Level

Effect on Multiplier Ceilings when MGRA Options are Combined

Options to address Ecological Pathways (PSO, M&B)			
	MEP	Shallow Cap	Hard/Fill Cap
Modified Ecological Protection (MEP)	Uses industrial values x 1.9 for PSO and 1000x M&B; Need to include statement in RSC that MEP option is used.	No value in combining MEP with caps (but CPU typically required for caps)	No value in combining MEP with caps (but CPU typically required for caps)
Shallow Soil Cap Barrier RMM	No value in combining MEP with caps (but CPU typically required for caps)	Uses industrial values x 1.9 for PSO and 1000x M&B; Limited to I/C/C sites	Where shallow and hard/fill caps are present on different areas of a property, the shallow cap multiplier ceilings are applied.
Hard/Fill Cap Barrier RMM	No value in combining MEP with caps (but CPU typically required for caps)	Where shallow and hard/fill caps are present on different areas of the property, the shallow cap multiplier ceilings are applied.	Uses industrial values x 1000 for PSO & 1000 X M&B for R/P/I and I/C/C

Options to address the Soil Contact Pathway (S1, S2, S3)			
	Shallow Cap	Hard/Fill Cap	MSWP
Shallow Soil Cap Barrier RMM	S3 replaces S1/S2 Limited to I/C/C sites	Where shallow and hard/fill caps are present on different areas of the property, the shallow cap multiplier ceilings are applied.	100x S3
Hard/Fill Cap Barrier RMM	Where shallow and hard/fill caps are present on different areas of the property, the shallow cap multiplier ceilings are applied.	S3 replaces S1/S2	100x S3
Modified Subsurface Worker Protection (MSWP)	N/A	1.5 m Fill/hard Cap RMM or stratified standards must be in place in order to use MSWP as well as a HASP	100x S3

Options to address the Vapour Intrusion Pathway (S-IA, GW2)							
	Building Prohibition	Storage Garage	Passive SVIMS	Active SVIMS	No First Storey Residential	Min First Storey Ceiling Height	Soil Vapour Screening Level
Building Prohibition RMM	Effectively S-OA replaces S-IA; 200x GW2	Building Prohibition cannot be combined with any building	Building Prohibition cannot be combined with any building	Building Prohibition cannot be combined with any building	Building Prohibition cannot be combined with any building	Building Prohibition cannot be combined with any building	SVSL would not be used for a site with no buildings
Storage Garage RMMs	Building Prohibition cannot be combined with any building	1-200x S-IA and GW2 (depending on property use and whether any COCs are developmental)	200x S-IA and GW2 (with the exception of developmental COCs for I/C/C Storage Garage (intermittent 3.9 L/sec) RMM	200x S-IA and GW2	1-200x I/C/C S-IA and I/C/C GW2 (depending on property use and whether any COCs are developmental) [6]	1-400x S-IA and GW2 (depending on property use and whether any COCs are developmental)	SVSL is multiplied by 1-200x (depending on property use and whether any COCs are developmental, but S-IA and GW2 remain at 1000x & 200x)
Passive SVIMS RMM	Building Prohibition cannot be combined with any building	200x S-IA and GW2 (with the exception of developmental COCs for I/C/C Storage Garage (intermittent 3.9 L/sec) RMM	100x S-IA and GW2	These would not be combined	100 x I/C/C S-IA and I/C/C GW2	~100-200 x S-IA and GW2	SVSL is multiplied by 100x (but S-IA and GW2 remain at 1000x & 200x)
Active SVIMS RMM	Building Prohibition cannot be combined with any building	200x S-IA and GW2	These would not be combined	200x S-IA and GW2	200 x I/C/C S-IA and I/C/C GW2	~200-400 x S-IA and GW2	SVSL is multiplied by 200x (but S-IA and GW2 remain at 1000x & 200x)
No First Storey Residential, Institutional	Building Prohibition cannot be combined with any	1-200x I/C/C S-IA and I/C/C GW2 (depending on property use and whether any COCs are developmental)	100 x I/C/C S-IA and I/C/C GW2	200 x I/C/C S-IA and I/C/C GW2	I/C/C component values replace R/P/I component values (new baseline)	~1-2 x I/C/C S-IA and I/C/C GW2	I/C/C SVSL

[6] If there is a Storage Garage occupying the First Storey of the building, it cannot be double counted as both a "Building with No First Storey R/P/I Use RMM" and a "Storage Garage RMM"

Options to address the Vapour Intrusion Pathway (S-IA, GW2)							
	Building Prohibition	Storage Garage	Passive SVIMS	Active SVIMS	No First Storey Residential	Min First Storey Ceiling Height	Soil Vapour Screening Level
or Parkland Use RMM	building						
Building with Minimum First Storey Ceiling Height RMM	Building Prohibition cannot be combined with any building	1-200x ~1-2x S-IA and GW2 (depending on property use and whether any COCs are developmental)	~100-200 x S-IA and GW2	~200-400 x S-IA and GW2	~1-2 x I/C/C S-IA and I/C/C GW2	~1-2 x S-IA and GW2 [multiplier is proportional to ceiling height (*new baseline*)]	SVSL is multiplied by ~1-2x; ~1-2 x S-IA and GW2
Soil Vapour Screening Level (SVSL)	Would not be used for a site with no buildings	SVSL is multiplied by 1-200x (depending on property use and whether any COCs are developmental, but S-IA and GW2 remain at 1000x & 200x)	SVSL is multiplied by 100x (but S-IA and GW2 remain at 1000x & 200x)	SVSL is multiplied by 200x (but S-IA and GW2 remain at 1000x & 200x)	I/C/C SVSL	SVSL is multiplied by ~1-2x; ~1-2 x S-IA and GW2	1000 x S-IA 200 x GW2

Options to address the Drinking Water Pathway (GW1)		
	No Ground Water Use	*(There are no other options for this pathway)*
No Ground Water Use RMM	Uses non-potable component values (GW2 or GW3 rather than GW1)	

7 Calculating Soil Vapour Screening Levels

This method offers an alternative approach to address exceedences of the S-IA and GW2 pathways for volatile COCs. If any of the calculated reasonable estimate of the site maximum (REMs) (L77-N101) for volatile chemicals exceed the respective values calculated by the spreadsheet (B77-G101) and the driver is either S-IA or GW2, then you can calculate soil vapour screening levels and compare them to your actual soil vapour measurements. Make sure that you have fulfilled all of the requirements of the Regulation in relation to soil vapour sample collection, including the MGRA-specific requirements found in Schedule E, Table 4. For general guidance on soil vapour assessment, the QP should refer to the draft *Technical Guidance: Soil Vapour Intrusion Assessment*, dated 2013 (or the most recent ministry guidance available).

Step 1. Begin by entering the names of the volatile chemicals for which soil vapour measurements are available into cells A52-A57, and entering the depth to soil vapour measurement (B26) and the corresponding Area Soil Type – vadose zone (B19 or C19) for one of the soil vapour sampling locations on the site where soil vapour measurements were made. The soil vapour screening levels, appropriate for the soil vapour sampling location at a given depth to soil vapour measurement and to the site inputs currently in the spreadsheet, will then appear in row B (that is, if the Area Soil Type cells (B19-C20) do not contain either of the two generic Soil Types). These soil vapour criteria are specific to the particular soil vapour sampling location and depth from which the soil vapour samples were taken, and which is represented by the current Tier 2 input data that you have entered in the spreadsheet. Be sure to separate areas that are ground water source areas from those that are soil source areas such that you can properly later choose the appropriate measures in cells B38 or B39. Repeat this process as many times as needed. You must develop soil vapour screening levels for each sampling location and depth to soil vapour measurement (as specified in Table 4, Schedule E of the Regulation) in which soil vapour measurements were taken at the RA property.

*Note that if the Area Soil Type for the SVSL is considered "fine/medium" textured soil based on grain size analysis, the QP will need to ensure that the "Site Soil Texture" in Cell B4 is changed to correspond to "medium/fine" texture for property SVSL calculations.

Step 2. Check to be sure that the input parameters (especially soil type and depth below soil surface to soil vapour measurement (B26)) are correct for that specific soil vapour sampling location. You can consult Appendix 1 of this guide for determination of soil type. Within the scope of MGRA, the depth below soil surface to soil vapour measurement should meet the following:

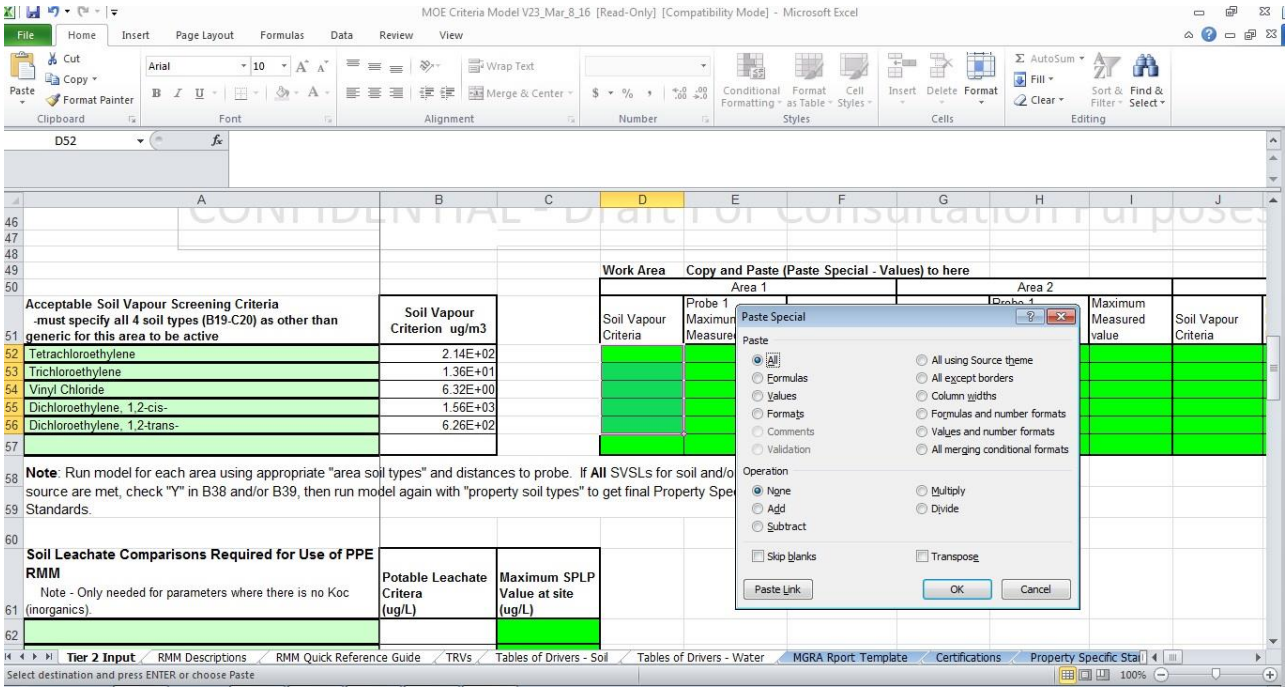
- To minimize the influence of atmospheric short-circuiting, the minimum depth below soil surface to soil vapour measurement is 150 cm, as per Table 4 of Schedule E; and,
- To ensure that the collected soil vapour measurements are appropriate to assess the vapour intrusion pathway for both existing building(s) (if present) and future building(s) (e.g. with respect to vapour accumulation and increased advection near/below the building foundation), soil vapour samples should be collected at least 100 cm below the base of the building foundation. For example, if the depth of the subsurface structure (e.g. basement) is similar to the R/P/I default value (158 cm

below soil surface), soil vapour should be collected at 258 cm below soil surface or deeper.

- For future building(s), if the built form is unknown, it is unlikely that reliance on soil vapour measurements is appropriate to support modification of vapour intrusion component values.

If depths that are shallower than those noted above are entered, the cell (B26) will be shaded red and the message "INVALID" will be shown.

Step 3. For the first sampling location (Area 1), copy the soil vapour screening level (Cells B52-B57) to Cells D52 to D57 (highlight cells to be copied, right click, choose copy, move pointer to D52, right click, choose "Paste Special", then "Values"(this last part is critical, otherwise you will get formulae rather than numbers, or you may alter the formatting).



Step 4. Now enter the maximum soil vapour measurement recorded for that specific soil vapour sampling location and depth for the appropriate chemical in cells E52-E57. If a maximum measured concentration exceeds the soil vapour screening level, it will be highlighted in red.

Step 5. For the next sampling locations (Area 2 to 6), revise the Soil Type – vadose zone and the depth to soil vapour measurement fields to match the identified characteristics at the soil vapour sampling location and depth where soil vapour samples were taken and repeat the previous steps, putting the results in the section of the spreadsheet for appropriate sampling location (e.g., "Area 2"). Then repeat for other sampling locations. (This spreadsheet allows for up to 4 sampling locations at a time)

Step 6. If, for a given COC, all soil vapour measurements, at all the required sampling locations and depths, meet the appropriate calculated soil vapour screening levels, then you

may change the value in cells B38 and/or B39 ("soil vapour screening levels are met"), as appropriate for the source of the soil vapours (soil source or ground water source), to a "Y" (on the pull down menu). In most cases this effectively allows for the removal of the S-IA and the GW2 pathways from the Tier 2 PSSs.

**You will have to keep track as to which COCs meet the soil vapour screening levels, and be sure to use the results from checking "Y" in B38 or B39 only for those COCs that meet all the soil vapour screening levels. You would need to uncheck the "Y" to derive the PSS for those COCs which do NOT meet the soil vapour screening level.

** Before determining your PSSs, you must now go back and re-enter the "Property-wide Soil Types". If at this point all your REMs at the site meet the calculated criteria in cells B77-G101, then your site meets the appropriate Tier 2 PSSs, and you may submit the RA to the ministry for review. The "Proposed Property Specific Standards" that you can use for submitting the RA are displayed in Cells B108-D132.

8 Using Updated TRVs Provided by the Ministry

This option allows QPs to use ministry-provided toxicity reference values (TRVs) in an MGRA, as soon as they are updated and available. Only TRVs provided by the ministry may be used in place of the existing TRV. The ministry will make new TRVs available to QP_{RAs}.

Step 1. Check for the new ministry TRV.

Step 2. Change the TRV and its reference in the appropriate cells in the TRV tab (columns C to V) of the model. The changes will be highlighted in red.

Step 3. Go back to the Tier 2 Input tab, which will be displaying an error that notes the number of changes that have been made in the TRV table. Change cell B69 to "Yes" from the pull down menu to indicate that you have intentionally changed a TRV, at which point the error note disappears.

Step 4. You can now view the updated PSS, which take into account the updated TRV.

9 COCs with Hazard Quotient (HQ) other than 0.2

Source allocation is applied in the derivation of human health component values (HHCVs) in order to account for exposures to the same substance via multiple pathways of exposure. The use of source allocation helps to prevent potential exposure from exceeding a tolerable daily intake (TDI) or tolerable concentration (TC). A default Source Allocation Factor (SAF) of 0.2 is applied in the derivation of most HHCVs for non-cancer. This means that one-fifth of the TDI or TC was allocated for most component values, which translates to a target HQ of 0.2. There are some exceptions, however, for which the target risk levels for HQ are set at different levels or applied in a different way.

9.1 Trichloroethylene (TCE) at Non-Potable Sites

Trichlorethylene (TCE) is now recognized as having developmental effects, as well as carcinogenic effects, and this is reflected in updated TRVs in Version 2 of the Approved Model. PSSs generated based on the updated TRVs are lower than those generated using Version 1 of the Approved Model. For this reason, the ministry undertook a review of assumptions, (specifically the potential for concurrent exposure from multiple pathways) used in calculating CVs for TCE. The review examined multimedia intakes of TCE for an adult and led to the conclusion that TCE intake from ingestion of food, ingestion of ground water, and ingestion and dermal contact with soil are negligible at non-potable sites when compared to TCE exposure via inhalation of indoor air (and possibly also outdoor air). Given that the background indoor air concentration is estimated at approximately half the inhalation TRV (e.g. 2.0 µg/m^3), the use of an HQ of 0.5 is considered appropriate for calculating vapour intrusion CVs for non-potable sites.

The updated HQ of 0.5 applies only at sites where a non-potable ground water condition is applied (i.e. site ground water is not used as drinking water), or for sites using the "No Ground Water Use" RMM. This is because the drinking water pathway is a significant pathway for potable drinking water sites, and an HQ of 0.2 is still applied for S-IA and GW2 at potable drinking water sites.

9.2 Petroleum Hydrocarbons (PHC)

An HQ of 0.5 is used for all PHC fractions. This has not changed since Version 1 of the Approved Model. For more information, please see the ministry's *Rationale for the Development of Soil and Ground Water Standards For Use At Contaminated Sites in Ontario* dated April 2011, Section 2.4.

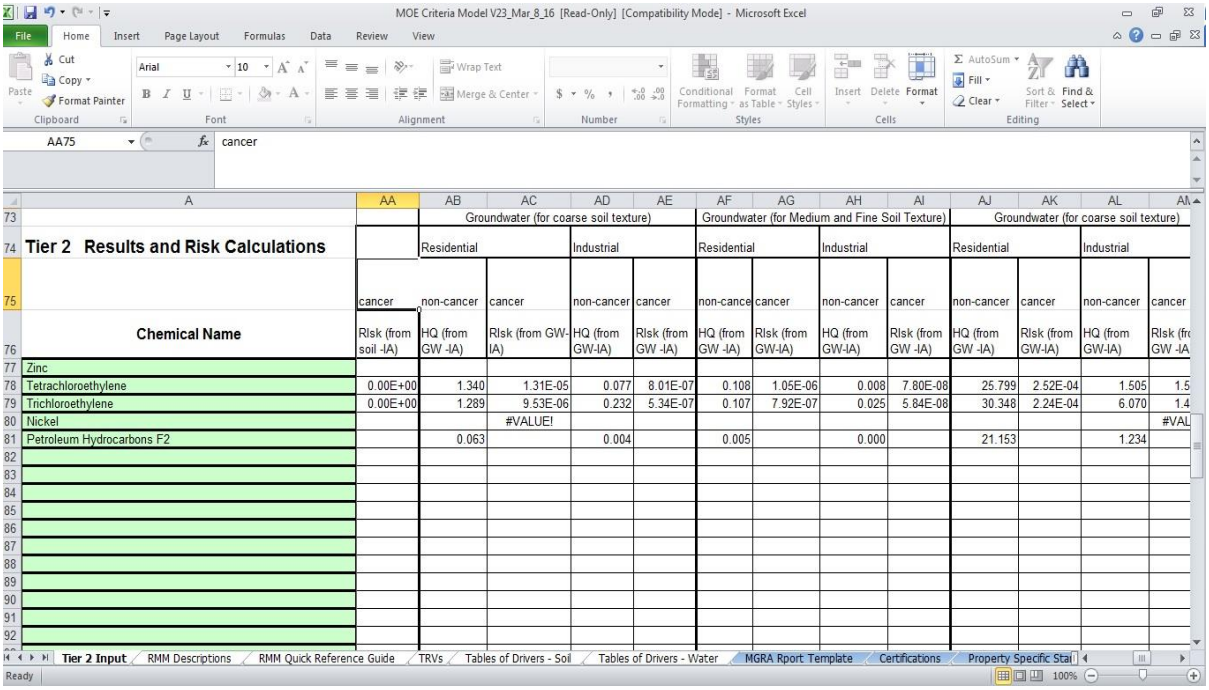
10 Using the Approved Model in a Tier 3 Risk Assessment

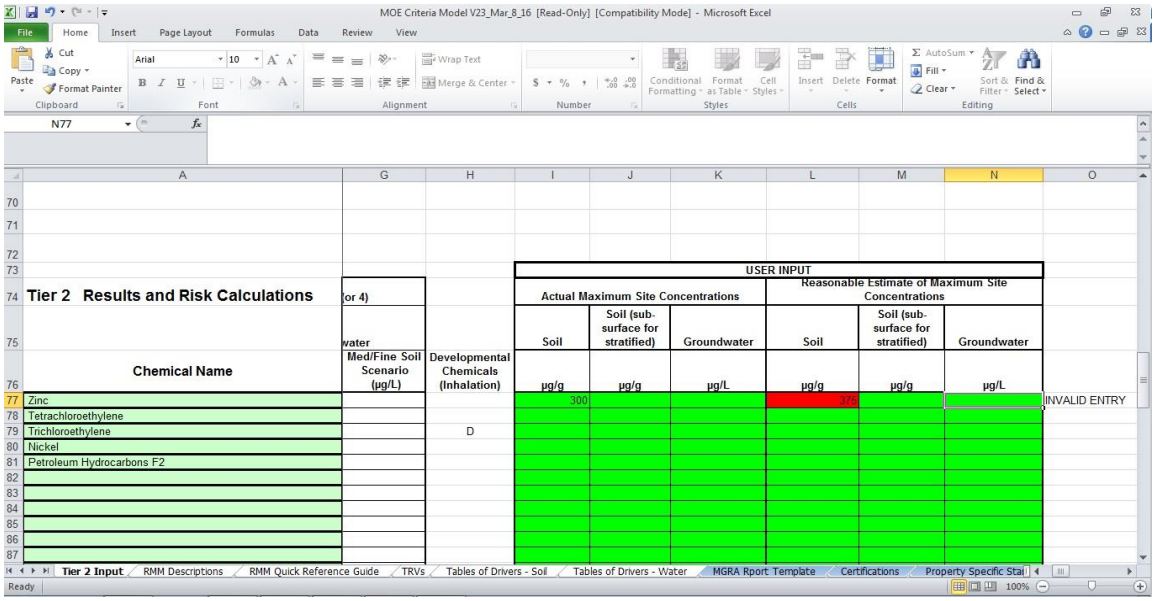
Where there is a need to go beyond the approaches permitted within the Approved Model, a Tier 3 RA approach can be used to supplement the Tier 2 PSS. A proponent will be required to complete and submit a Tier 3 RA to the ministry for review as per the traditional process. The Tier 3 RA can utilize the PSS generated by the Approved Model, including the methodology and/or RMM's relied upon to develop the PSS by appending the Tier 2 RA report to the Tier 3 submission when submitting to the ministry for review.

11 Risk Characterization

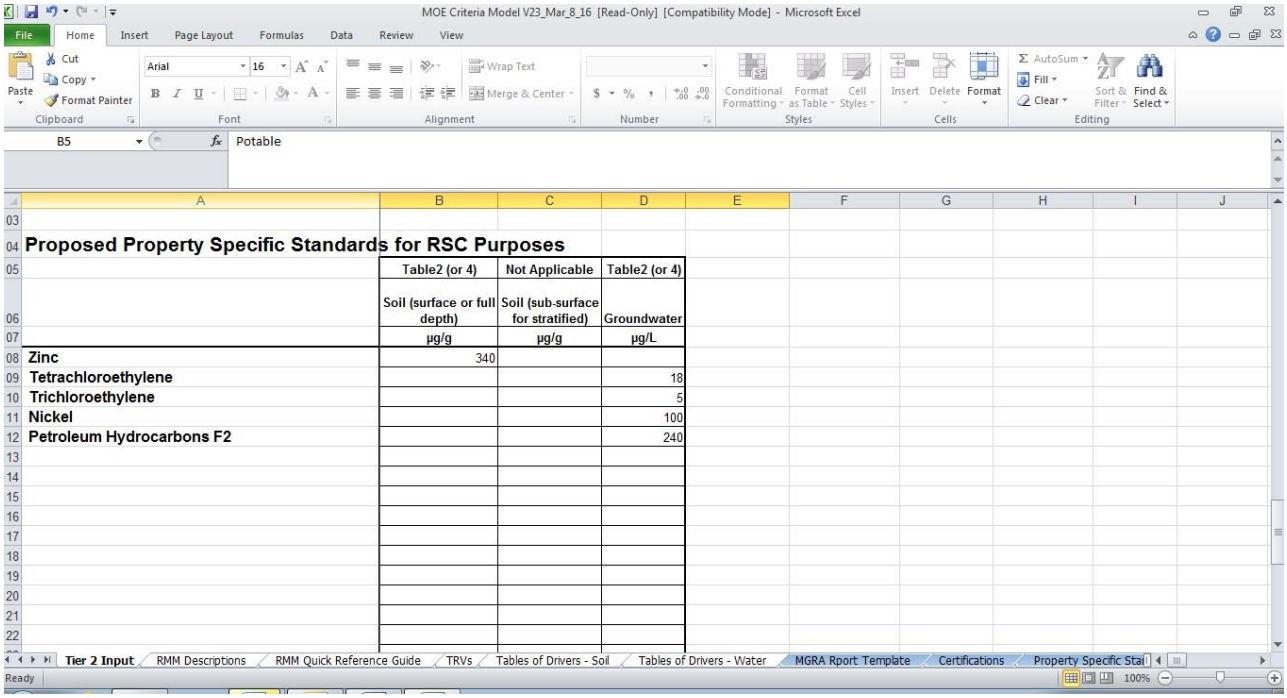
When an RMM has been used, it is necessary to report what the risk level would be if the RMM were to fail. These risk levels are calculated in the Tier 2 spreadsheet in cells P77-BA101. Please note that they no longer need to be calculated with all the RMMs turned off (set at N), unlike in Version 1. Cells B36 and B37 can be set to Y for the risk calculations only if all of the Soil Vapour Screening Levels were met for all soil vapour samples. The screenshot below shows the user input area (note the invalid entry where a reasonable estimate of the site maximum entered is higher than 1.2 times the actual measured value) and the first part of the risk calculations. Determine the risk level by looking under the appropriate risk management measure in Row 72. The cancer risk level

is given for carcinogens and the Hazard Quotient from each particular exposure component (e.g. soil contact) for non-carcinogens.





The next screenshot shows the area of the Tier 2 Input spreadsheet that displays the final Proposed PSSs. There is also an area (cells B108-B132) that gives a quick reference comparison for some common contaminants such that you can quickly see the effects of your Tier 2 changes in comparison to the Generic Table 2 Residential coarse soil standards.


MOE Criteria Model V23_Mar_8_16 [Read-Only] [Compatibility Mode] - Microsoft Excel
File
Home
Insert
Page Layout
Formulas
Data
Review
View
Cut
Copy
Format Painter
Paste
Clipboard
Arial
16
Font
Wrap Text
Merge & Center
Alignment
Number
Conditional Formatting
Format as Table
Cell Styles
Styles
Insert
Delete
Format
Cells
AutoSum
Fill
Clear
Sort & Filter
Find & Select
Editing
B5
Potable
Proposed Property Specific Standards for RSC Purposes
Table2 (or 4)
Not Applicable
Table2 (or 4)
Soil (surface or full depth)
Soil (sub-surface for stratified)
Groundwater
µg/g
µg/g
µg/L
Zinc 340
Tetrachloroethylene 18
Trichloroethylene 5
Nickel 100
Petroleum Hydrocarbons F2 240
Tier 2 Input
RMM Descriptions
RMM Quick Reference Guide
TRVs
Tables of Drivers - Soil
Tables of Drivers - Water
MGRA Rport Template
Certifications
Property Specific Stal
Ready
100%

12 Limitations of the Approved Model

12.1 Limitations Related to Generic Assumptions

Any of the conditions for which the generic assumptions may not hold would result in a violation of the assumptions behind the Approved Model as well. These conditions are reproduced from the introduction to the *Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act*, dated April 15, 2011 below.

Conditions can exist at a site for which the assumptions used to develop the generic criteria may not be valid. The QP must ascertain that the site conditions are appropriate for use of the generic standards such that he/she can be comfortable with signing the certifications on the RSC. To assist the QP in recognizing the types of conditions that may be important in this respect the following examples are given:

a) if the contaminated zone has a volume larger than 340 m^3 or a source length or width greater than 13 metres then all pathways which employ source depletion or ground water transport (Soil to Nose, S-GW1, S-IA, S-GW3 and GW3 components of the standards) may be affected.

b) if a high permeability zone is present in the vadose zone which provides a direct preferential pathway to the building then the soil properties assumed in the generic J&E modelling to determine the S-IA and GW2 components of the standard may change.

c) if the annual average of the capillary fringe of the water table is < 0.8 metres from the outer edge of the gravel crush of the building foundation or when there is less than one (1) meter of between the top of the water table or soil contamination and the gravel crush layer, then the 10 x biodegradation factor assumed in the GW2 pathway for some VOCs may be non-conservative.

d) if the average Organic Carbon content (foc) of soil above the water table is < 0.002 then more contaminant may be in the water and gas phases than assumed in the generic standards.

f) if there is a continuous source of the contaminant then the pathways which assume a depleting source (i.e., S-IA, S-GW1, and Soil to Nose) might be non-conservative.

g) if there is a surface water body that could be affected by the property from contaminant migration via ground water, and the surface water has total hardness less than 70 mg/L (as $CaCO_3$) and/or has pH less than 6.7, the aquatic protection values for some metals and pentachlorophenol may be non-conservative. In such cases, the QP may need to consider whether a site-specific estimate of hardness and pH resulting from mixing of ground water and surface water is needed to estimate an appropriate aquatic protection value for this site.

The existence of any of the above conditions does not necessarily indicate that the Tier 2 PSSs are not valid for a given site. There are many interrelated parameters and factors that were used in the development of the generic standards, and in many cases one factor, such as any of those above, can be outweighed by differences in other factors in a manner that, overall, there is sufficient natural protection provided by the site. In addition, it must also be considered that the component that drives the standard may not be affected by the particular limiting condition described above (e.g. a terrestrial ecological driver, but there are high permeable zones in the

vadose zone). The QP should consider these types of factors in assessing the appropriateness of the use of the Tier 2 PSSs.

12.2 Limitations Related to MGRA Conceptual Site Model (CSM)

1. The Approved Model does not include a "ground water to plants and soil invertebrates" pathway. When you have selected pathway modifiers that multiply ground water component values (GW2 and GW3), consider whether the CSM used to develop the generic SCS is appropriate. The generic GW3 value is a considered to be a reasonable surrogate for protection of plant roots from ground water impacts. At greater distances to the nearest surface water body, the GW3 can increase significantly in relation to the generic GW3 value.

2. The Approved Model does not include a vapour inhalation pathway for ground dwelling mammals (such as groundhogs) or soil dwelling organisms (such as earthworms). When using RMMs with large multipliers for S-IA (such as the "Building Prohibition" RMM), the QP should consider whether or not ground dwelling mammals or soil dwelling organisms could be adversely affected by the concentrations of volatiles substances remaining in the soil. The ecological component values in the CSM used to develop the generic SCS do not have a specific mechanism of protection for this pathway, and the assumption that the human health vapour exposure pathways are adequate for ecological receptors is less likely to be valid at higher multiples of the S-IA and GW2 component values.

13 Submitting the MGRA

Once you have completed the above steps and are satisfied with the RA you can submit it to the ministry. Please see Section 2.2 regarding the MGRA report template.

For more information on Tier 2, contact the Streamlined Risk Assessment Coordinator at Standards Development Branch of the Ontario Ministry of the Environment and Climate Change (E-mail: SDB-Tier2RAReview@ontario.ca; Phone 416-327-5519).

Appendix 1 Determination of Soil Type

Use the results of the soil texture analyses to determine which soil type is appropriate by placing the % sand and % silt (or clay) in the following triangle. . The point of intersection of the two lines gives the Soil Type. The triangle is from Figure 3-16 of the Soil Survey Manual, United States Department of Agriculture, Natural Resources Conservation Service, as published at its website (see the link below for more information and for a calculator):
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167

FIGURE 3-16

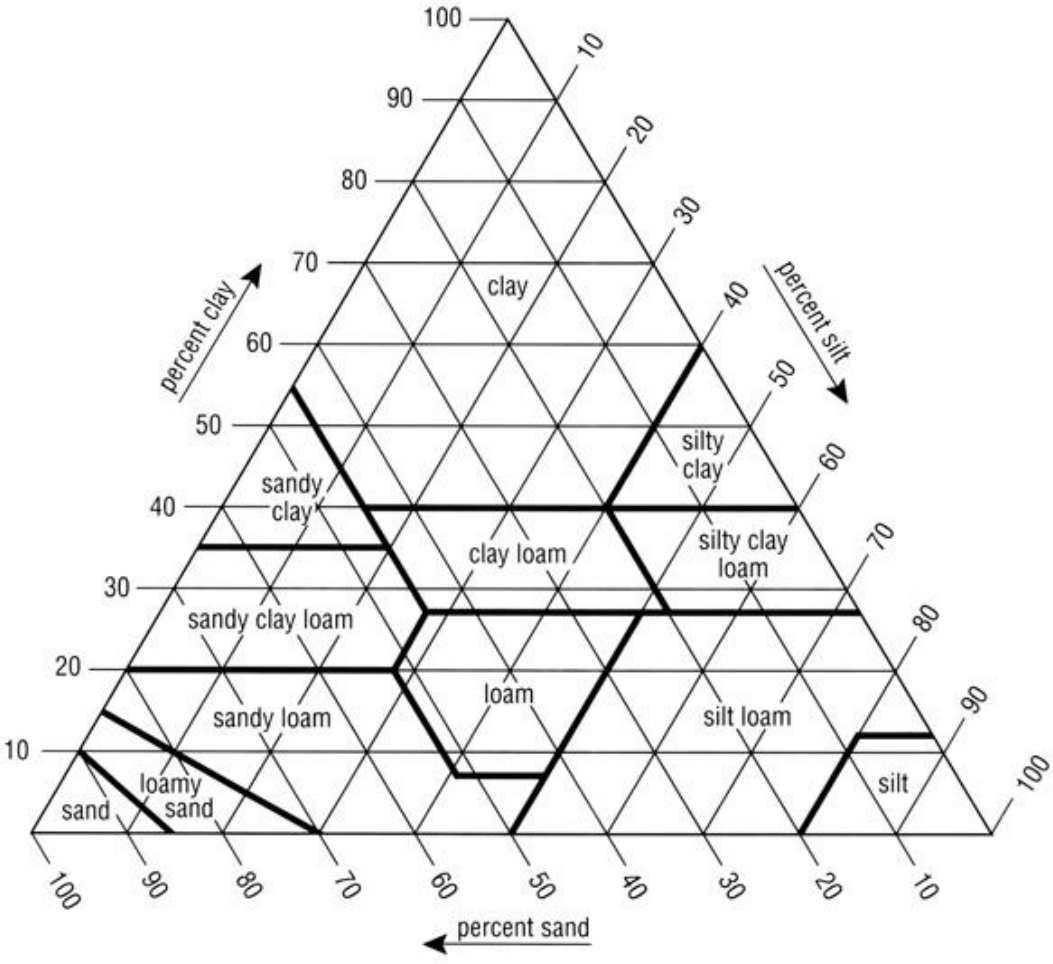
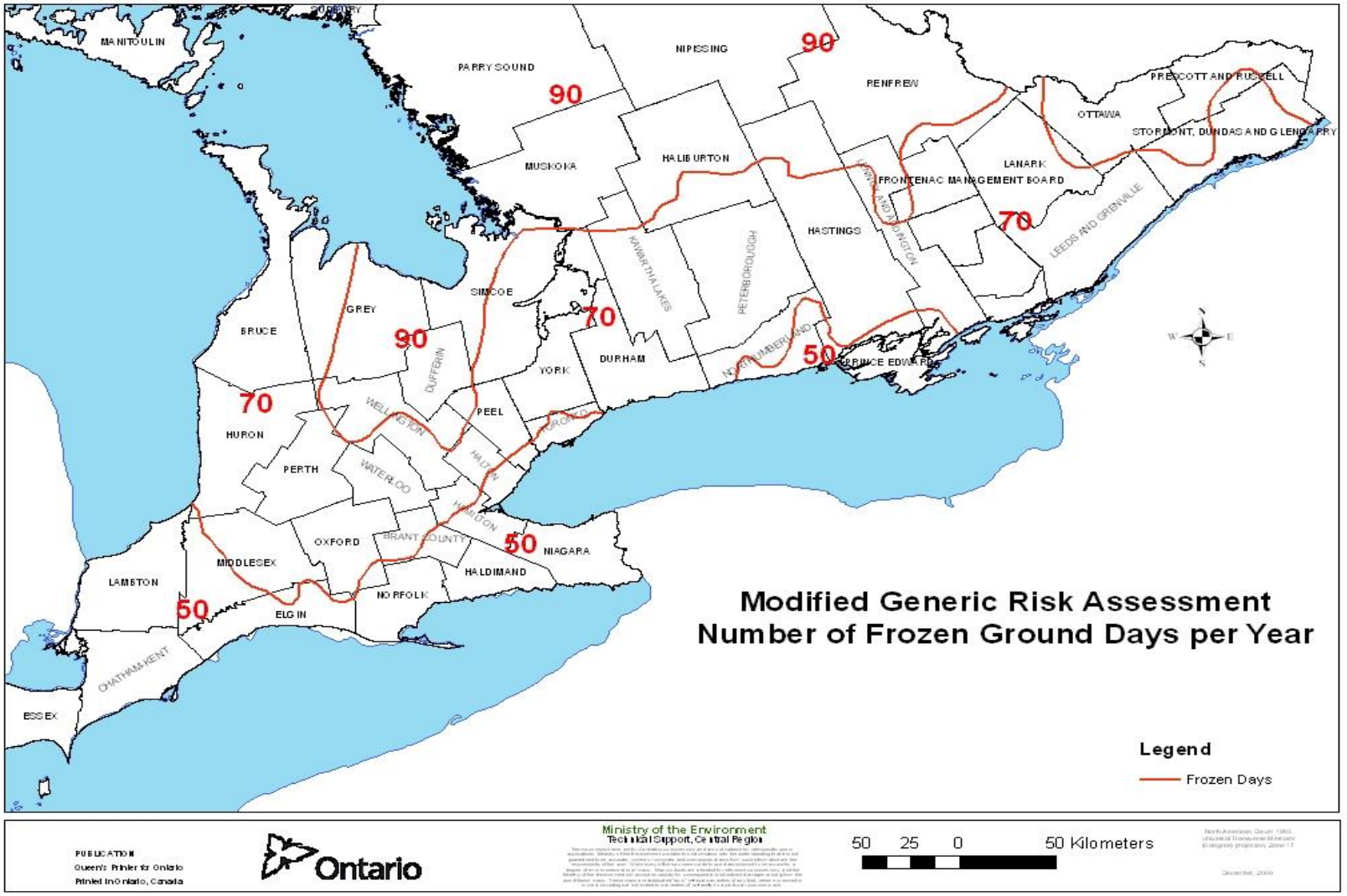


Chart showing the percentages of clay, silt, and sand in the basic textural classes.

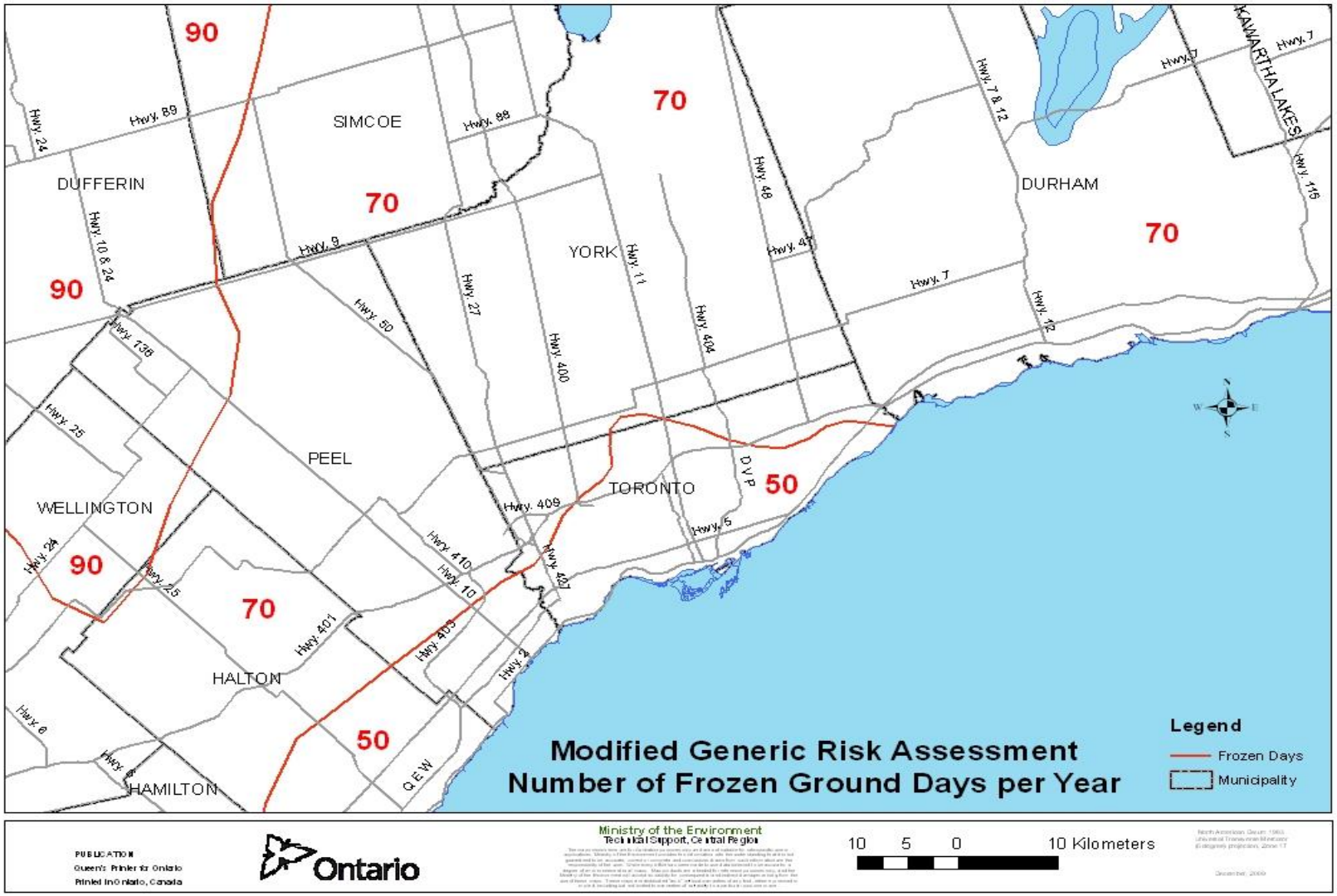
USDA classification
Sand - Soil particles between 0.05 and 2.0 mm in size
Silt - Soil particles between 0.002 mm and 0.05 mm
Clay - Soil particles smaller than 0.002 mm (2 microns) in size

Appendix 2 Maps Showing "Number of Frozen Ground Days Per Year"

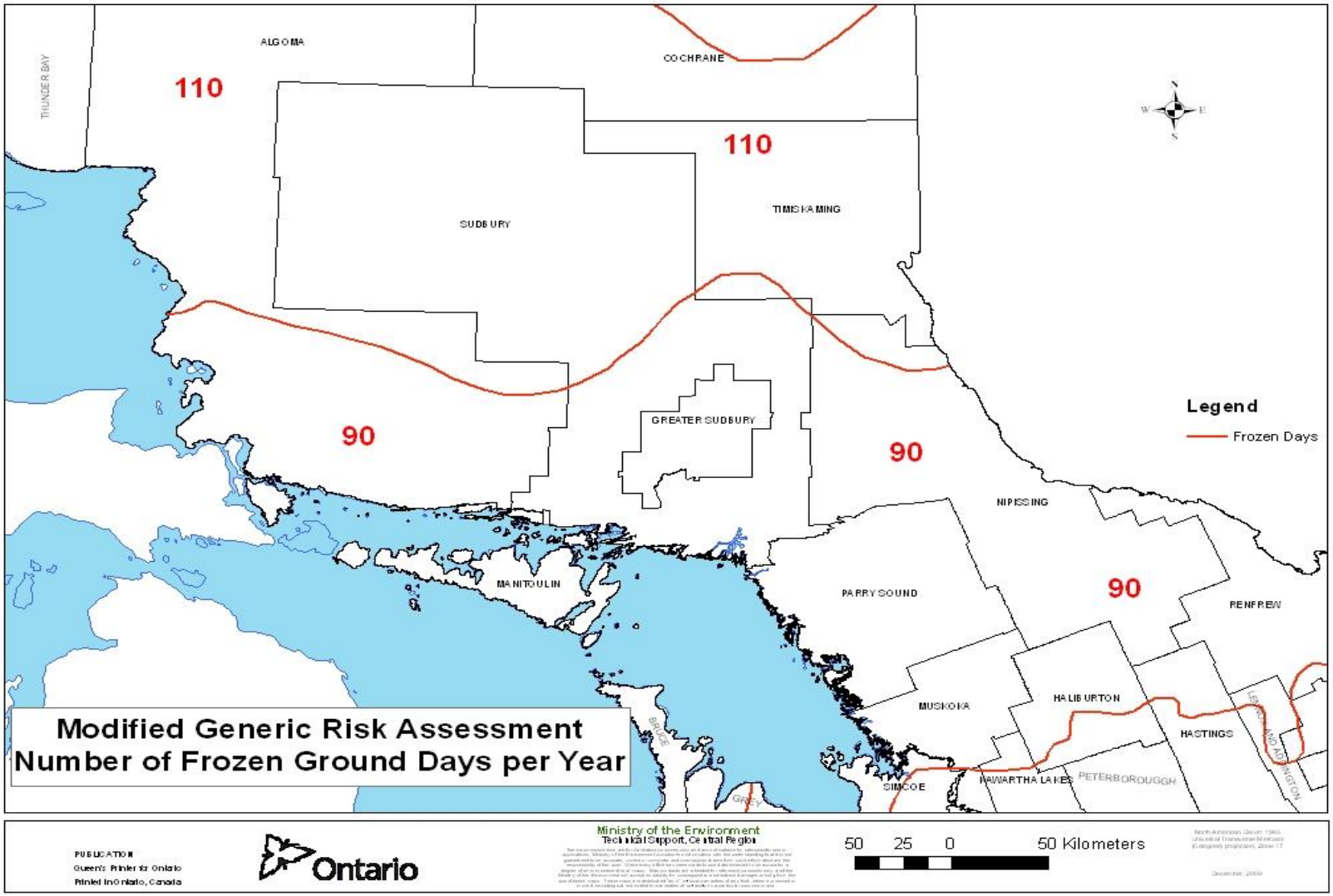
A1 – Southern Ontario



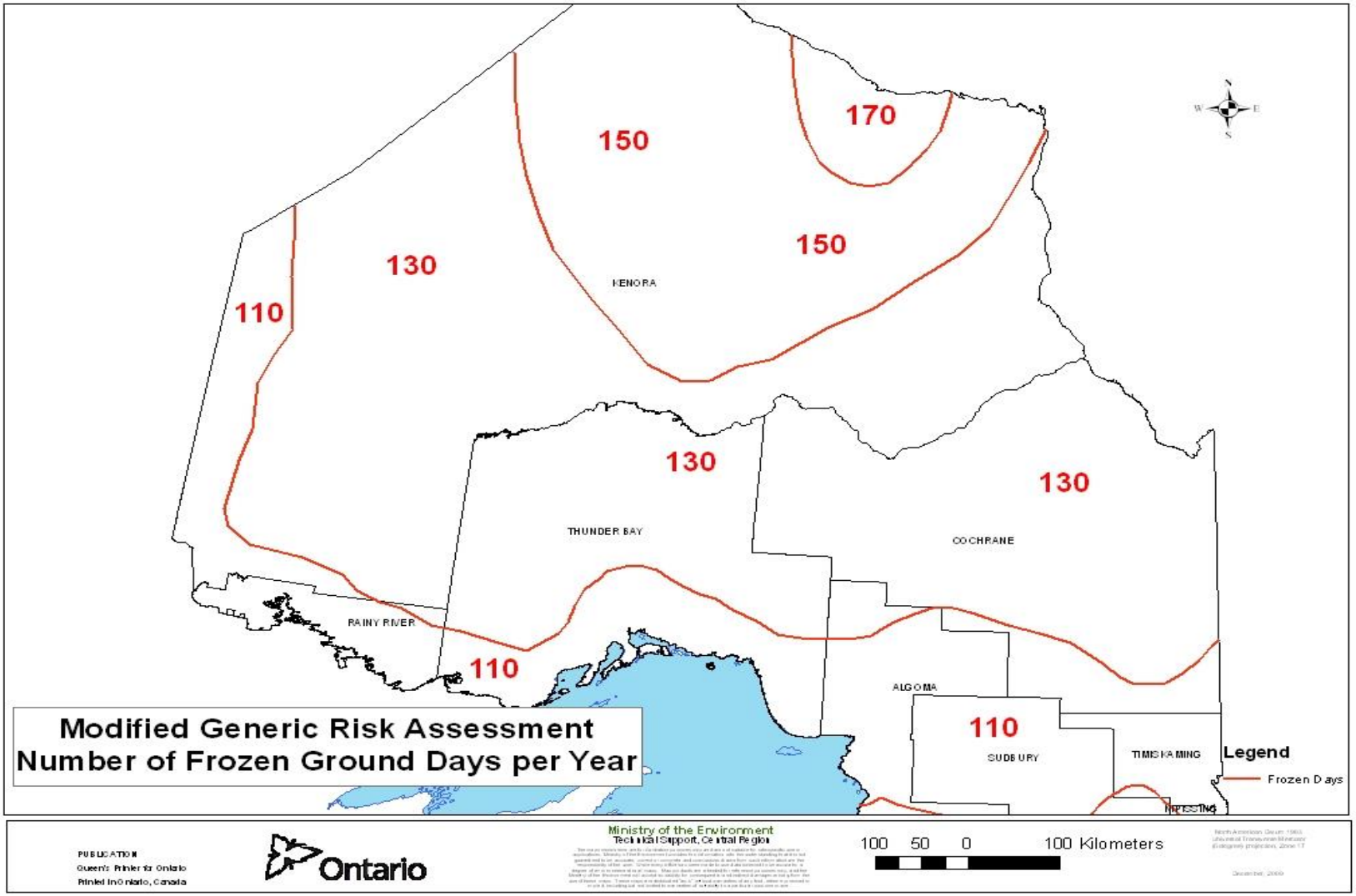
A2 – Greater Toronto Area



B – Central Ontario



C – Northern Ontario



Appendix 3 Chart to identify which Tier 2 input parameters affect which pathways (subsurface transport components)

Pathway\ Tier2 Input Parameters	S-IA*	S-Odour	S-GW1	S-GW3	S-OA	GW1	GW2	GW2-Odour	GW3	Free Phase Threshold
Distance to surface water	NA	NA	NA	✓	NA	NA	NA	NA	✓	NA
Soil FOC – water table to soil surface	✓	NA	✓	✓	✓	NA	NA	NA	NA	✓
Soil FOC – upper 0.5m	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA
Depth to water table	NA	NA	NA	NA	NA	NA	✓	✓	NA	NA
Property Soil Type – vadose zone	✓	✓	✓	✓	✓	NA	✓	✓	NA	✓
Property Soil Type – capillary fringe	NA	NA	NA	NA	NA	NA	✓	✓	NA	NA
# Frozen Days	NA	✓	NA	NA	NA	NA	NA	NA	NA	NA
Aquifer horizontal hydraulic conductivity	NA	NA	NA	✓	NA	NA	NA	NA	✓	NA
Aquifer horizontal hydraulic gradient	NA	NA	NA	✓	NA	NA	NA	NA	✓	NA
Aquifer dry bulk density	NA	NA	NA	✓	NA	NA	NA	NA	✓	NA
Aquifer FOC	NA	NA	NA	✓	NA	NA	NA	NA	✓	NA

* Best method to do Tier 2 on S-IA pathway is using soil vapour screening methods as described in the body of this document or by selection RMMs that mitigate the vapour intrusion pathway.

NA = not applicable for pathway; ✓ = applicable for pathway

Descriptions of all Components

GW1 – Ground water for drinking water purposes

GW2 – Ground water for protection from movement to indoor air

GW2-Odour – Ground water for protection from excessive odours

GW3 – Ground water for protection of aquatic life

S1 – Soil for protection of a residential receptor from direct contact with surface soil

S2 – Soil for protection from direct soil contact for a lower frequency and intensity exposure than residential surface soil, such as for commercial or industrial scenarios where children are not frequently present.

S3 – Soil for direct soil contact for a low-frequency, high-intensity, human health exposure scenario without children present that is protective of a worker digging in the soil.

S-IA –Soil for protection of movement to indoor air and human exposure.

S- OA – Soil for protection of movement to outdoor air and human exposure

S-Odour – Soil for protection from excessive odours

S-GW1 – Soil for protection from movement to ground water for drinking water purposes

S-GW3 – Soil for protection from movement to ground water and then to aquatic life

Plants and Soil Organisms – Soil for protection against adverse effects to plants and soil dwelling organisms

Mammals and Birds – Soil for protection against adverse effects through direct soil and food ingestion to mammals and birds

Appendix 4 Tier 2 Option: Modified Ecological Protection (MEP)

1) What is the Tier 2 modified ecological protection (MEP) option?

In order to allow the development and application of less stringent PSS, current practice in Ontario may be to remove ecological habitat to ensure no ecological species are present or exposed to contamination. This practice results in the removal of habitat which, although degraded, could and often does support a variety of ecological species. While redevelopment needs may drive the removal of habitat, the ministry's intent is to provide another option that will allow for greater preservation of ecological habitat. The ministry has developed a "modified ecological protection (MEP)" option within the Approved Model, which is intended to both promote brownfield redevelopment and preserve existing and potential future ecological habitat. This means getting more brownfield properties developed and providing developers a greener alternative to paving over ecological habitat. The ministry will continue to look at new ways of promoting ecological habitat preservation as part of brownfield redevelopment.

MEP is an option available to risk assessors within the MGRA process in Ontario that uses less stringent ecotoxicity values to develop PSS. The use of the MEP option will allow for the maintenance or establishment of natural habitat; habitat that is not comparable in quality to habitat in an uncontaminated setting, but instead is habitat comprising of assemblages of species that are adapted or less sensitive to the contaminants of concern at the property. Use of the MEP option may result in impacts to some plants, soil organisms and wildlife that might reside in or frequent the site. The MEP option does provide the same degree of protection to humans as the Tier 1 generic standards.

Under the MEP option, ecotoxicity values for mammals and birds are removed from the modified generic model for both residential/parkland and commercial/industrial land uses. Therefore no protection is provided for those ecological receptors under the MEP option. For plants and soil invertebrates under both residential/parkland and commercial/industrial land uses, the Tier 2 MEP option utilizes a multiplier (1.9 x industrial component value) that is equivalent to the 75^{th} percentile value for each dose-response data set (developed for generic model values using the CCME protocol weight-of-evidence procedure where resulting No Observable Effect Concentration (NOEC) and Lowest Observed Effect Concentration (LOEC) data are ranked and ranked percentiles are determined for each data point).

2) What is the purpose of the MEP option?

The ministry recognizes that maintaining natural environments on remediated brownfield sites should be encouraged wherever possible. Soil standards at a brownfield site can often be driven by ecological risks to soil-dwelling invertebrates, plants and wildlife; therefore, "paving" a site as a means of removing potential ecological risks is one option that is exercised by property owners. However, paving a site provides no opportunity for any current or future natural habitat to exist on a property.

The MEP option in MGRA will provide the property owner with a viable alternative to RMMs such as "paving". The MEP option will allow the property owner to use ecotoxicity values

that will yield less stringent PSS values that can support a natural but relatively degraded environment; however it also may result in adverse effects to some plants and soil organisms. As a result, some species may not thrive as they would have at a site that is uncontaminated or which meets the more stringent generic site condition standards. However, more robust species will have the opportunity to populate this habitat which provides a more ecologically sustainable alternative to paving a site and promotes the redevelopment of brownfield properties.

3) Degree of protection provided by the MEP option

It is important to note that unlike other options for modifying the generic assumptions in the Approved Model (i.e. through the input of site-specific parameters into model inputs or the use of standardized RMMs) use of the MEP option does *not* provide the same degree of ecological protection that is provided by the Tier 1 generic standards. Instead a lower degree of ecological protection is permitted under the MEP option and impacts to some portions of ecological receptor populations may be anticipated in many cases. However, the MEP option *does* provide the same degree of protection to humans as the Tier 1 generic standards.

The ministry acknowledges that at some sites the higher soil concentrations allowed under the MEP option might not cause adverse ecological impacts due to ameliorating site-specific conditions (e.g., decreased bioavailability due to soil physicochemical characteristics or due to the site-specific speciation of the contaminant(s), differential sensitivity of species at a site relative to those used to generate ecotoxicity values, plasticity or adaptation of the species at the site, etc.). Therefore, use of the MEP option may not result in adverse ecological impacts. Should a property owner need to demonstrate that no adverse ecological impacts have resulted from leaving concentrations of contaminants using the MEP option a Tier 3 RA could be utilized.

Note on human health exposure pathway through ingestion of plants

The Tier 2 MEP option is available for all land uses except agriculture. The model under the Tier 2 MEP option incorporates all of the same assumptions and exposure pathways for soil contaminants for the protection of human health as the Tier 1 generic model. Therefore, the MEP option provides the same degree of protection to humans as the Tier 1 generic standards. However, the Tier 1 model (and therefore the Tier 2 spreadsheet) does not incorporate the soil-to-plant uptake-to-human ingestion pathway. This is because the current state of the science is very uncertain and excessive conservatism may be required in order to cover all uncertainties, especially with respect to modelling soil-to-plant uptake values in a scientifically defensible manner. There is an enormous amount of variability in the rate of bioaccumulation of individual contaminants in plants in the scientific literature. Uptake factors can vary by orders of magnitude among species and even within subspecies and varieties. Under the Tier 2 MEP option, soil concentrations at the 75^{th} percentile are not in a range anticipated to cause significant phytotoxicity. Therefore, plants grown at these concentrations would likely survive and have the potential to be used as a food item (the same is true for plants grown in soil under generic Tier 1 conditions). Because there is a potential that plants that might be ingested by humans accumulate higher concentrations of contaminants under the Tier 2 MEP option compared to plants grown in soil with contaminant concentrations at the Tier 1 generic standards, the Tier 2 MEP option is not permitted under agricultural land uses. It is also not permitted for agricultural land uses because decreased protection of plant life is incompatible with agricultural land use. The exclusion of the soil-to-plant uptake-to-human ingestion exposure pathway in the generic model is an acknowledged gap and

will be re-evaluated at a future date once the scientific data supporting the development of this pathway into the generic model becomes available.

4) How is the MEP option used within Tier 2?

MEP is an option available to the QP_{RA} in a similar fashion as the Tier 2 adjustable input parameters and RMMs options. If a QP_{RA} wishes to invoke the MEP option for a site, they simply select the "Modified Ecological Protection" option in the Tier 2 spreadsheet. The Tier 2 spreadsheet then recalculates the PSS based on the modified ecological values under the MEP (as well as any other changes in the model if other Tier 2 adjustable parameters have been modified by the QP_{RA}).

5) How is the MEP option reported?

Any RSC that utilizes standards that were developed with the MEP option will state such on the RSC itself, which will be posted on the Brownfields Environmental Site Registry for public viewing.

Appendix 5 Modified Subsurface Worker Protection

This option offers a proponent the ability to modify the subsurface worker exposure scenario. The Approved Model includes protection from direct soil contact for a worker exposed to contaminants in the subsurface (known as the "S3 pathway"). The proponent, as part of the MGRA process, may choose to modify the subsurface worker protection S3 value. Selecting this approach results in S3 being multiplied by 100x, effectively removing the protection provided by the S3 pathway. Selecting this approach will also mean that the Hard/Fill Cap RMM will be included as a requirement at the property, and that hard/fill cap must be a depth of at least 1.5 m (see Hard and Fill Cap RMM descriptions and definitions). Selecting this approach will also mean that a Health and Safety Plan (HASP) will be required for the property (see HASP description). The HASP ensures appropriate protection is in place if a subsurface worker carries out intrusive work in the soil below the 1.5 m cap. The development of the HASP should take into account the presence of the site specific contaminants of concern and consider direct exposure through dermal contact, soil and ground water ingestion, and inhalation of soil particles or vapours. The combination of a hard/fill cap and a HASP, is intended to ensure that subsurface workers are protected where the Modified Subsurface Worker Protection approach has been utilized to develop PSS.

Requirement for a Leachate Test for Inorganics

In order to opt into the Modified Subsurface Worker Protection and get the associated relief for S3 with respect to an inorganic (no Koc value) contaminant of concern in soil that remains at the RA property, an acceptable leachate test result should be submitted as part of the RA. Please see the questions for this option in the MGRA section of the RA Pre-Submission Form.

It is expected that the soil sample(s) collected for the leachate testing will be from the area where the highest concentrations of the contaminant(s) of concern are found. At sites where the distribution of contaminants is across the entire site, the QP should use their best judgement to determine the number of samples that should be collected; the expectation, however, is that in this scenario more than one (1) sample will be collected and sent for leachate testing. To support the use of this pathway modifier, the QP should provide a rationale, in the form of a sampling analysis plan, to justify the number of samples collected and their locations.

Multiplying the S3 component value by up to 100 allows higher soil concentrations to be left at the RA property. For most contaminants, the concentrations remaining at the RA property pose no additional risk to people, plants or animals, due to the RMMs in place. In the case of metals, however, the Approved Model does not model how metals may move from soil into ground water, as this pathway is too site-specific to include in a generic or MGRA. The unmodified S3 value provides an upper bound. If the S3 pathway is to be modified, assurance is needed that the ground water will be protected from contamination by these inorganic contaminant(s) of concern.

A leachate test is carried out to provide this assurance. A leachate test mimics how metals in soil are carried into the ground water through rainfall. The leachate test is to be performed by an accredited laboratory (as defined in Section 47(1)(c)(i) or (ii) of the Regulation), and the results would be entered into the Approved Model for comparison with appropriately protective ground water component values. For sites at which potable ground water site condition standards apply, the leachate results would need to be less than both the GW1 (drinking water protection value) and

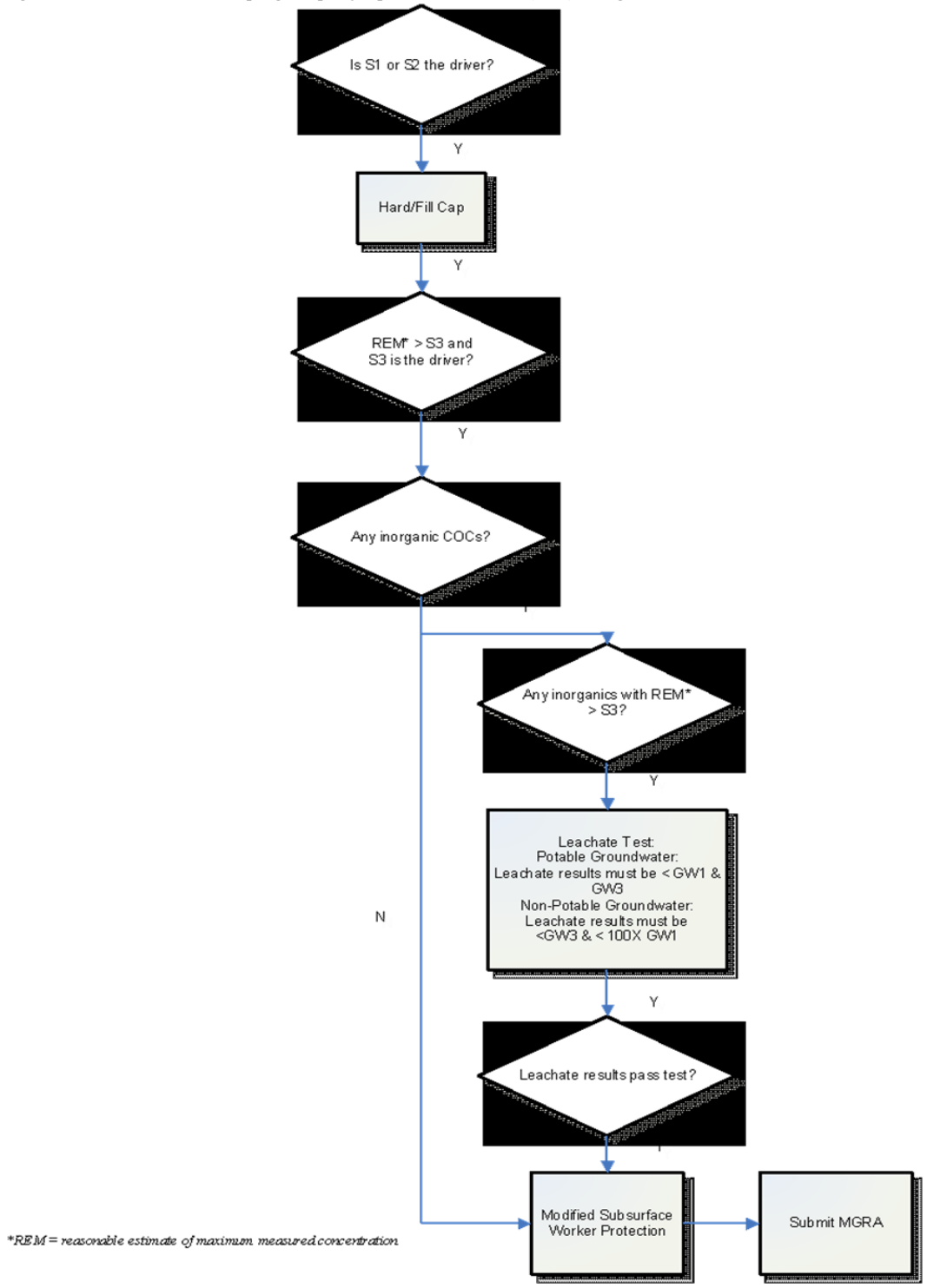
GW3 (aquatic protection value). For sites at which non-potable ground water site condition standards apply, the leachate results would need to be less than both GW3 and 100 x GW1 (as 100 times the Ontario Drinking Water Standards has been used to characterize leachate as being hazardous). If this comparison test is passed, then the Modified Subsurface Protection option could be used to yield relief for metal contaminants of concern in soil at the RA property.

The leachate test to be used for this comparison is the Synthetic Precipitation Leaching Procedure (SPLP; Method 1312 in the United States Environmental Protection Agency (US EPA) publication SW-846 entitled "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods").

Some proponents may already need to carry out a similar test called the Toxicity Characteristic Leaching Procedure (TCLP; Method 1311 in US EPA SW-846) to characterize waste materials. In order to avoid duplication of testing, and since the TCLP is generally more conservative, a proponent may use either the SPLP or the TCLP.

The flow diagram below (Figure 1) is intended to help the reader understand the process for modifying the subsurface component in the Approved Model.

Figure 1 - Process for Developing Property Specific Standards (PSS) using the Modified Subsurface Protection



Appendix 6 Process for Modifying the Solubility Component Value for Petroleum Hydrocarbons (PHCs) F1 and F2 in the Modified Generic Risk Assessment (MGRA) Approved Model

1 Why Modify the Solubility Component Values for PHCs F1 and F2?

The solubility of PHC fractions F1 and F2 is one of the parameters used in the Approved Model to develop ground water standards. These generic solubility component values (CVs) are estimated values and are intended to be an indicator that free product may be present at a RA property. The Approved Model is not appropriate for use at sites where free product is present. In some situations, it is possible that site-specific ground water sampling finds no evidence of free product, even though the solubility CV for PHC F1 and/or F2 is exceeded. In these cases, it may be appropriate to modify the solubility CV within the Approved Model to reflect the fact that site-specific information does not indicate the presence of free product on site. In effect, the absence of evidence of free product on site supersedes the prediction that free product may exist based on the generic solubility estimates.

2 Who is this Guidance for?

This guidance is for proponents of brownfield redevelopment projects at properties with PHC contamination. The ability to modify the solubility CV by demonstrating that there is no evidence of free product on site will permit the development of numerically higher PSS for PHC F1 and F2, thereby offering proponents greater ability to use the streamlined Tier 2 RA process for such properties.

3 When Does this Guidance Apply?

This guidance applies in relation to former gasoline (or associated product) outlets and properties where gasoline and associated products have been stored in fixed tanks. The solubility CV can only be modified when site characterization demonstrates that there is no evidence of free product at the RA property (i.e., no visible petroleum hydrocarbon film or sheen in ground water samples). This guidance contains steps to assist proponents in conducting site characterizations that are effective in demonstrating that there is no evidence of free product, so that the solubility CV can be modified in the MGRA.

4 Prerequisites

1. The RA property is one at which all fixed tanks and associated infrastructure (such as piping and pumps) have been removed, and the site has been decommissioned in accordance with applicable law.

2. A phase one and phase two environmental site assessment (ESA) for the RA property has been completed in accordance with Part XV.1 of the EPA and the Regulation.

3. There must be no evidence of visible petroleum hydrocarbon film or sheen in the ground water at *any* monitoring wells at the RA property. If PHC film/sheen is observed in any of the samples within any of the monitoring wells, the solubility CV cannot be modified in the Approved Model.

5 Modified Solubility CVs

The solubility CVs for PHC F1 and F2 can both be modified in the Approved Model Version 2 (November 2016), up to the maximum values shown in the table below. The maximum modified solubility CVs are based on the effective solubilities of PHC F1 and F2 calculated using Raoult's Law for a range of PHC compositions. However, the recommended PSS must still be based on a reasonable estimate of the maximum concentration found on site after any PHC remediation has been carried out. For example, if the final concentration of PHC F2 is found to be 1,000 µg/L, the recommended PSS would be 1,200 µg/L, so long as other CVs were higher.

Fraction	Generic Solubility CV	Maximum Modified Solubility CV
PHC F1	1,900 µg/L	27,000 µg/L
PHC F2	150 µg/L	2,500 µg/L

6 Demonstrating "No Evidence of Free Product" for an MGRA

Demonstrating "no evidence of free product" for an MGRA is site-specific but needs to consider the following aspects of site investigation:

- Minimum requirements for conducting the investigation as set out in the Regulation (Section 1).
- Additional site investigation activities to be conducted and documented in section 11 of the RA pre-submission form (Section 2).

1. Minimum Regulatory Requirements

The following provisions of the Regulation are highlighted here, as they are particularly relevant to PHC sites and site investigation required to support the modification of solubility CVs.

Reference	Topic	Relationship to this guidance
Parts VII and VIII; Schedules D and E	Phase one environmental site assessments & Phase two environmental site assessments	Must be met for all RA and RSC sites
Part IX, Section 49	Meeting PHC standards	Qualified person's determination that there is no evidence of free product, including any "visible petroleum

		hydrocarbon film or sheen", is a minimum requirement relied on in this guidance.
Schedule E, Part II	Planning site investigation	The selection of sampling locations as documented in the "sampling and analysis plan" is relied on in this guidance.
Schedule E, Sections 7 & 16	Lateral and vertical delineation	This guidance depends on complete delineation of PHCs (*extent* in lateral and vertical directions, as well as identification of areas of *highest* concentrations).
Schedule E, Section 8	Ground water sampling methods	Note that for PHCs, "screened intervals of monitoring wells, shall be positioned to intersect the water table".
Schedule E, Section 9	Requirements where sampling is being undertaken to demonstrate the meeting of standards	Requirements for carrying out ground water sampling
Schedule E, Sections 22 and 23	Variation in ground water level & ground water flow directions	The determination of up-gradient, down-gradient, and cross-gradient directions. Carrying out delineation depends on the assessment of ground water flow direction. In s. 23 (2), testing each monitoring well with an interface probe is required for PHC sites.
Schedule E, Section 25	Monitoring wells and test holes, finalized field logs	This guidance refers to finalized field logs
Schedule E, Sections 37-40	Remediation and confirmatory sampling	These requirements must be met when soil has been excavated at the RA property in order to reduce concentrations of PHC F1 and F2 ("Situation 1", described below).
Schedule E, Table 1, Report Section 9 (b)	Contaminants of concern (COCs) in areas of potential environmental concern (APECs)	Every APEC must be investigated (delineation of the lateral and vertical extent of COCs for each APEC). Note that Schedule D provides details on how to identify APECs. Relevant examples for PHC sites include historical tank nests, pump islands and other site infrastructure which has the potential for PHC releases.
Schedule E, Section 43	Review and evaluation of information	The phase two conceptual site model is relied on in the review of RAs.

2. Additional Activities

2.1 Ground Water Sampling Methods

In addition to the regulatory requirements referenced above, site investigation at every RA property with PHC-impacted soil should include the following elements if the proponent wishes to modify the solubility CV in an MGRA:

- Ground water sampling should be carried out using a low flow sampling technique.
- Ground water samples should be collected ensuring that the intake is placed within the layer where the free product is likely to be found (usually, no deeper than 30 cm below the water table; however, if ground water recovery is slow and insufficient for ground water samples, the QP may lower the low-flow sampling device to obtain the required amount for analysis).

2.2 Ground Water Sampling Locations

The recommended density of ground water sampling locations depends on whether soil has been excavated at the RA property in order to meet the applicable standards for PHC F1 and F2.

Situation 1: PHC Impacted Soil at the RA property has been excavated in order to remediate[7] PHC F1 and F2

Where PHC-impacted soil at the RA property has been excavated following decommissioning and removal of on-property PHC source infrastructure, and phase one and two ESAs (including the required delineation and confirmation sampling) have been completed in accordance with the Regulation, no additional guidance on sampling locations is provided. Please complete Section 11 of the RA pre-submission form.

The following clarification is provided:

1. The excavation of "PHC impacted soil" applies to all soil containing PHCs at concentrations above the PSS developed using the Approved Model. Excavation to generic site condition standards is not required.

2. Confirmatory sampling refers to both soil and ground water, and must be carried out in accordance with regulatory requirements (Schedule E, Section 40 "Requirements for confirmation sampling and analysis"). Documentation of confirmatory sampling (analytical results and figures) is included in the Phase Two CSM that accompanies the MGRA submission. If confirmatory sampling has not been carried out, Situation 2 applies.

[7] "Remediation" is a term commonly used by contaminated site professionals. Please note that the Regulation uses the phrase "actions taken to reduce the concentrations of contaminants."

Situation 2: PHC Impacted Soil at the RA property has NOT been excavated in order to remediate PHC F1 and F2

Where PHC impacted soil at the RA property has not been excavated, proponents wishing to modify the solubility CV in an MGRA should apply the following guidance regarding additional ground water sampling locations (see bold text for activities not specified in Regulation). The reason for this guidance is that the ministry is looking for additional verification that there is no evidence of free product, where concentrations of PHC F1 and F2 in ground water do not meet the applicable site condition standards, and no excavation has been carried out to reduce the concentration of contaminants. The steps are set out below:

1. Undertake ground water monitoring in accordance with the Regulation.

2. Complete delineation as per Sections 7 and 16 of Schedule E of the Regulation (i.e., stepping out both down and cross-gradient of the exceedance, as well as vertically delineating).

3. Install additional monitoring wells down and cross-gradient of ground water exceedences of PHC F1 and F2 to reduce the maximum spacing between wells to approximately three (3) meters. The 3 m spacing is required to protect the vapour intrusion pathway[8].

4. When selecting the locations of additional monitoring wells down and cross-gradient of PHC F1 and F2 exceedences, if ground water flow direction is not supported by at least two (2) years of data collected at least quarterly, or one year of data collected at least monthly, the qualified person (QP) is expected to account for potential variations in ground water flow direction of 30º.

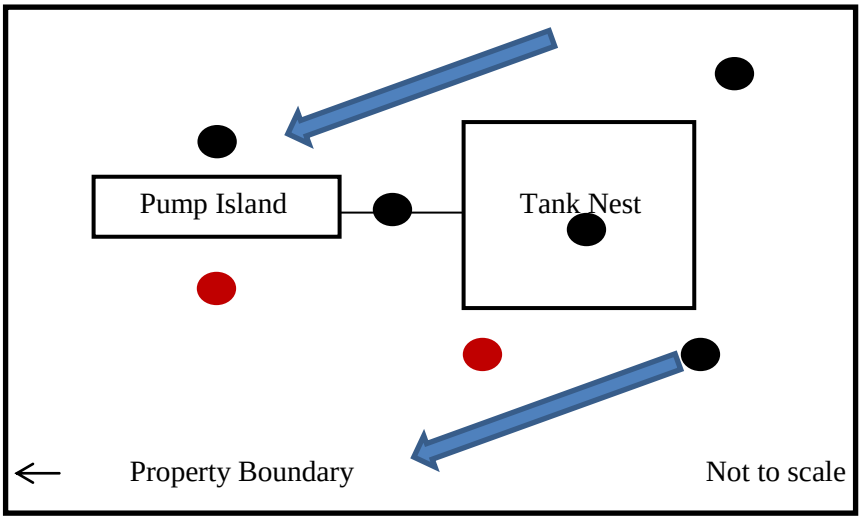
5. Should additional PHC F1 or F2 exceedances above the applicable site condition standard SCS be found after the first set of additional down-gradient/cross-gradient monitoring wells is sampled, an additional step out may be necessary to achieve the 3 m spacing down-gradient of the PHC F1 and F2 exceedences. After the second set of "step outs", the 3 m maximum spacing is no longer recommended (see figures).

6. Once the QP has determined that there is no evidence of visible petroleum hydrocarbon film or sheen in any of the monitoring wells as per Section 2.1 above, the solubility CV can be modified.

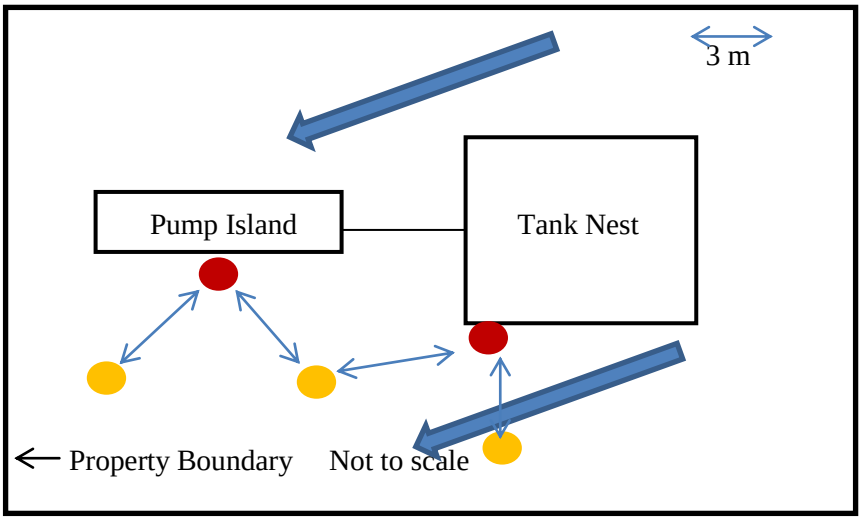
7. Complete Section 11 of the RA pre-submission form.

Figures illustrating recommended monitoring well selection for situations where the PHC-impacted soil at the RA property has NOT been excavated.

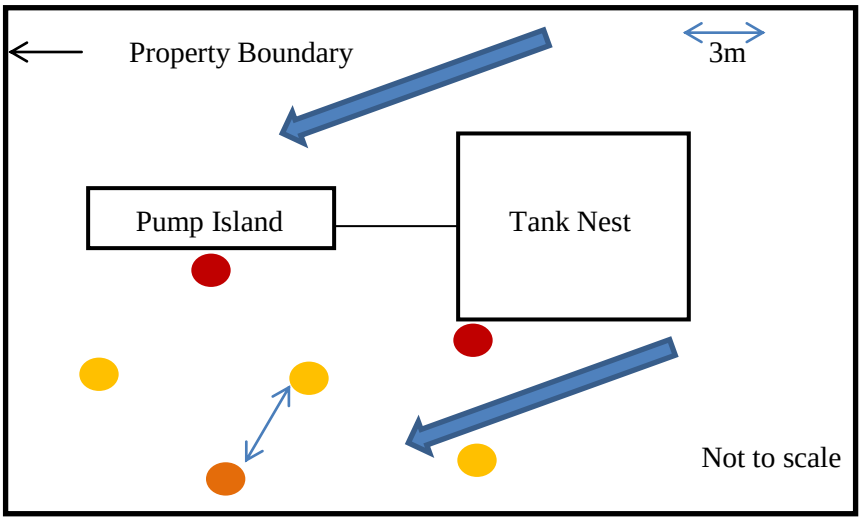
[8] This spacing was selected in order to protect the vapour intrusion pathway. If a PHC non-aqueous phase liquid were present between two adjacent sampling locations, the source size would not pose an unacceptable risk to indoor air.



1. Monitoring wells that are shown in red exceed applicable SCS but no visible petroleum hydrocarbon film or sheen observed.
2. Blue arrows show ground water flow direction based on Phase two ESA
3. In the situation above, additional monitoring wells would be located similar to the figure below.



1. Monitoring wells that are shown in yellow are installed to further investigate the plume.
2. If these wells still show exceedances above SCS, spacing for down-gradient wells would also be approximately three (3) meters. Note: if all the additional monitoring wells installed meet the applicable SCS, then no further wells would be installed. The following figure depicts a scenario where one of the three additional monitoring wells (i.e., the one in the middle) installed still exceeds the applicable SCS.



1. Monitoring wells that are shown in orange are installed to further investigate the plume.
2. If these wells still show exceedances above SCS, and there is sufficient distance to the property boundary to install additional wells, the three (3) meter spacing for down-gradient wells is no longer recommended.

Appendix 7 – Vapour Attenuation Multiplier Ceilings Applied to Storage Garages Considered As Vapour Intrusion Risk Management Measures (RMMs) within the Modified Generic Risk Assessment (MGRA) Approved Model

This appendix provides a summary of the Storage Garage Risk Management Measure (RMM) and the options within that RMM. "Storage Garages" must meet the requirements of O.Reg. 332/12, made under the *Building Code Act, 1992*, S.O. 1992, c.23 (the Ontario Building Code) that specify potentially higher air exchange rates or air change per hour (ACH) than those in residential or commercial units. Storage Garages will often take the form of a typical parking garage under a condominium type development. The existence of lower floor parking garages is a common occurrence in high density urban areas and makes them a logical choice as a vapour intrusion RMM within the MGRA or Tier 2 Approved Model. As a result of the higher ACH, the soil to indoor air (S-IA) and ground water to indoor air (GW2) pathways within the Approved Model can be modified when parking garages are present across the entire footprint of the building. The option of a storage garage can be considered for both residential/parkland/institutional (R/P/I) property use and industrial/commercial/community (I/C/C) property use sites.

For human receptors that live/work in the overlying units, the ventilated storage garage below can provide additional vapour attenuation due to the presence of higher ACH, for example, and the 100x multiplier ceiling in the Approved Model published in 2011, is considered reasonably conservative. However the evaluation of exposure risk to receptors who use the storage garage (even for a short period of time), including the pregnant receptor who spends time inside the storage garage (parking car, shuttling groceries, visiting storage locker, etc.) may be less conservative at 100x. This is especially true at sites impacted with volatile compounds of concern (VCOCs) with developmental toxicity (e.g., trichloroethylene (TCE)), as a single exposure may be sufficient to elicit an adverse developmental effect.

A detailed evaluation of these risks and storage garage scenarios was completed to inform the appropriate level of risk reduction attributed to each storage garage scenario available in the Approved Model. The following provides a summary of evaluated storage garage scenarios and their associated multiplier ceilings

1. Key Assumptions Used for Storage Garage Scenarios

This section presents different storage garage scenarios based on ventilation rates and a summary of key assumptions that deviate from those used in the generic settings presented in the ministry's *Rationale for the Development of Soil and Ground Water Standards For Use At Contaminated Sites in Ontario,* dated April 15, 2011.

1.1. *Storage Garage Scenarios*

Three (3) storage garage scenarios are available in the Approved Model.

- *Intermittent ventilation (at 3.9 L/s/m^2)*: Mechanical ventilation systems should be in conformance with the requirements of Article 6.2.2.3 of Division B of the Ontario Building Code. The systems shall provide, during operating hours, a continuous supply of outdoor air

at a rate of not less than 3.9 L/s or be activated on an as-needed basis by carbon monoxide or nitrogen dioxide monitoring devices, which may result in intermittent ventilation and an estimated ACH of 3.0 with the consideration of a 3.0 m high garage and potential natural ventilation For compounds with developmental effects, continuous ventilation is required to ensure that appropriate indoor air mixing is provided during the entire period of exposure. This is because a single exposure to these compounds may be sufficient to elicit an adverse developmental effect. Given that, within the scope of this scenario, default ACH (1.0 and 0.3 for I/C/C and R/P/I property uses, respectively) are used for the assessment of compounds with developmental effects.

- *Continuous ventilation (at 3.9 L/s/m^2):* Mechanical ventilation systems must meet the requirements of Clause (1)(c) of Article 6.2.2.3 of Division B of the Ontario Building Code. The systems shall provide at all times a continuous supply of outdoor air at a rate of not less than 3.9 L/s, resulting in an estimated ACH of 6.0 with the consideration of a 3.0 m high garage and potential natural ventilation.

- *Continuous ventilation (at 10.0 L/s/m^2):* Mechanical ventilation systems shall provide at all times a continuous supply of outdoor air at a rate of not less than 10 L/s for each square metre of floor area, resulting in an estimated ACH of 13 with the consideration of a 3.0 m high garage and potential natural ventilation

1.2. *Storage Garage Parameters*

A 20 m by 30 m storage garage is assumed along with the vapour mixing height (similar to the ceiling height) of 3.0 m. This is considered to be a relatively small garage (e.g., equivalent to a typical garage that can accommodate approximately 15 to 25 cars), and therefore would provide reasonable but conservative results.

Review of the limited literature available on the potential penetration of volatile compounds from a storage garage to overlying units (e.g., through ceiling, stairwells, or elevator shaft), indicated a 2% to 5% leakage rate into the overlying units from garage. For the purpose of informing the appropriate level of risk reduction attributed to each storage garage scenario, a leakage rate of 2% has been selected.

1.3. *Exposure Frequency in Storage Garage Scenarios*

It is recommended that exposure scenarios involving storage garages use the exposure frequency (EF) of 30 minutes per day. This value is based on the 90^{th} percentile of 30 minutes/day for all combined categories of the U.S. population in the survey reported in *US EPA's Exposure Factors Handbook, dated November 2011.*

It is noted that prorating for exposure frequency is not assumed for compounds with developmental effects (the ministry 2011) with the exception of trichloroethylene (TCE) (see Section 1.4).

1.4. *TCE Exposure Frequency in Storage Garage Scenarios*

The ministry generally does not prorate exposures for contaminants causing developmental effects based on concerns about elevated short-term exposures that may cause an effect. However, on a case-by-case basis, the ministry may consider prorating if sufficient information about the effects of the contaminant is known, and if the prorated value can be confirmed to be protective against the developmental effect.

As TCE is a common VCOC that occurs at many contaminated sites in Ontario, the ministry conducted a closer assessment of some key assumptions behind the multipliers developed for TCE exposure in storage garage scenarios, including the maximum acceptable indoor air concentration in storage garage scenarios for the purpose of calculating vapour intrusion component values (e.g. soil to indoor air (S-IA) and groundwater to indoor air (GW2)). The assessment has led to the conclusion that daily exposures of up to 10 µg/m^3 TCE are considered acceptable for short- term exposures, such as in the 30 minute garage scenario.

Considering an acceptable indoor air concentration of 10 µg/m3 and the use of SAFs of 0.2 and 0.5 for potable and non-potable sites (See Section 9.1), the calculated acceptable indoor air concentrations that are used in deriving the vapour intrusion component values are 2.0 µg/m^3 and 5.0 µg/m^3 respectively

2. Assessment Summary and Multiplier Ceilings

Based on the assessment of different exposure scenarios, a storage garage will provide different reduction levels (multiplier ceilings) depending on whether a COC has developmental or non-developmental effects, land use and ventilation requirements. Higher reduction in levels can be achieved when higher ventilation rates are maintained. While some scenarios evaluated suggested multipliers greater than 200X may be achieved, a multiplier ceiling of 200X was selected within the scope of MGRA. A larger multiplier generally represents a higher potential of risk; therefore it usually requires additional investigation and review and is considered more appropriate outside the MGRA process.

In summary, the use of storage garages as RMM would result in S-IA (soil to indoor air) and GW2 (ground water to indoor air) component values and soil vapour screening levels (SVSLs) being multiplied by different ceiling values, as stipulated in summary table below.

Property Use / Storage Garage Scenarios	Multiplier Ceilings *					
	R/P/I			*I/C/C***		
	VCOC with Non-Developmental Effects	*Trichloroethylene (TCE)*	*VCOC with Developmental Effects****	*VCOC with Non-Developmental Effects*	*Trichloroethylene (TCE)*	*VCOC with Developmental Effects****
Intermittent Ventilation	*200*◊	*12*	*2.0*	*50*	*6*	*1.0*
Continuous Ventilation (3.9 L/s/m^2)	*200*◊	*200*◊	*30*	*100*	*30*	*7.0*
Continuous Ventilation (10 L/s/m^2)	*200*◊	*200*◊	*70*	*200*◊	*70*	*15*

* Values rounded to nearest whole number when value is less than 20 or nearest multiple of 10 when values are greater than 20.

* Several of these multiplier ceilings are less than the 100x published in Version 1 of the Approved model. Where a multiplier ceiling is needed that is greater than the multiplier ceilings available for ventilated storage garages alone, additional RMMs (such as the MGRA "Soil Vapour Intrusion Mitigation System") can be selected.

** I/C/C Property Use sites include sites that have selected the MGRA "No First Storey Residential Use" RMM.

*** For other VCOC with developmental effects other than TCE.

◊*: Capped at 200*

3. Applicability of Multiplier Ceiling for Different Storage Garage Scenarios

The multiplier ceilings were developed based on modelling outcomes, using the Johnson and Ettinger (1991) model (and/or a semi-analytical model) and a number of key assumptions and input parameters. Therefore the application of the above noted multipliers may not be protective for sites with conditions that are not consistent with one or more assumptions that are used in the model (as presented in Section 1 of this Appendix). Additional limitations (or precluding conditions) for using the site condition standards are also listed in Sub-section 7.3.3.1 of the ministry's *Rationale for the Development of Soil and Ground Water Standards For Use At Contaminated Sites in Ontario* dated April 2011.

Some considerations that can be taken into account when assessing and confirming the applicability of model assumptions to site-specific conditions include, but are not limited to, the following:

- Once the Heating, Ventilation and Air Conditioning (HVAC) and/or other air exchange systems are installed and implemented at a storage garage undergoing vapour intrusion mitigation, the air exchange rates can be monitored and evaluated to ensure that the installed system can provide sufficient mixing, considering garage size, traffic patterns, and system layout. If the monitoring results indicate insufficient mixing (e.g. when estimated air exchange rates are lower than the values used in modelling storage garage scenarios (presented in Section 1 of this document), corrective action and/or additional line(s) of evidence may be warranted to ensure the installed system is performing effectively, as intended.
- For the intermittent ventilation scenario, the ventilation system may be activated on an as-needed basis by carbon monoxide or nitrogen dioxide monitoring devices; however, soil vapour intrusion and accumulation can occur at any time. Therefore, the degree of vapour intrusion risk anticipated in the garage following periods when the ventilation system is unlikely to be activated (e.g. overnight and weekends), and the persistence of that risk after the ventilation system is activated, should be assessed to evaluate whether the ventilation system needs to operate continuously.
- For storage garages that are constructed fully or partially below grade, primary entry points for vapors might be through the sidewalls (as opposed to from below the slab), especially, where there is a shallow source, resulting in a higher susceptibility to vapour intrusion. In this case, corrective action and/or additional line(s) of evidence may be warranted to ensure the installed system is performing effectively, as intended.

Appendix 8a – Soil Vapour Intrusion Mitigation Systems (SVIMS) Considered As Vapour Intrusion Risk Management Measures (RMMs) within the Modified Generic Risk Assessment (MGRA) Approved Model

This appendix provides a summary of the Soil Vapour Intrusion Mitigation Systems (SVIMS) Risk Management Measure (RMM) options within the Approved Model. A SVIMS is a venting system combined with a vapour barrier. Both vapour barriers and venting systems are engineered vapour intrusion (VI) RMMs designed to control or eliminate the VI pathway. The overall mitigation performance objective is to control or eliminate the potential for volatile contaminants of concern (VCOC) beneath a structure from entering indoor air.

A detailed evaluation on the effectiveness of both passive and active SVIMS was completed to inform the appropriate level of risk reduction attributed to each SVIMS scenario available in the Approved Model. The following provides a summary of evaluated SVIM scenarios and their associated multiplier ceilings.

Note that where the RA includes use of the passive SVIMS or the active SVIMS risk management measure the RA should include a statement indicating that a Licenced Professional Engineer knowledgeable in the design and operation of such SVIMS has reviewed the requirements of the applicable RMM in the context of the conditions of the Property and agrees that the SVIMS RMM to be used can be properly implemented at the Property

1. SVIMS Scenarios

A SVIMS acts as a pressure relief/reduction, collection, and venting system that dilutes and vents vapours away from the foundation of the building. Soil vapour is collected and conveyed away from the building footprint and vented to the atmosphere primarily as a result of diffusion or pressure-induced vapour flow. The SVIMS can operate in either (1) a passive manner which generally relies on natural phenomena (e.g., thermal and wind effects) to develop suction in the venting stack or (2) an active manner which uses motorized fans to create and maintain a lower pressure underneath the building floor relative to the pressure within the overlying building.

2. Assessment Summary and Multiplier Ceilings and Requirements

Both literature review and modeling results suggest that active systems are a reliable and effective vapour mitigation approach, although a wide range of reduction factors (from 10x up to 1000x) can be expected, depending on the system design and site conditions (e.g. geologic characteristics).

Passive systems are generally not as effective as active ones; however, when combined with (1) a reasonable sealing of significant infiltration points, (2) proper installation of membrane barriers, and (3) a wind-driven or solar powered turbine at the top of the stack, passive systems may be sufficient to mitigate the vapor intrusion pathway to the extent necessary. The uncertainty in potential performance of passive system can be addressed through monitoring and the provision to easily convert to an active system.

Given the above, the use of a SVIMS as an RMM would result in S-IA (soil to indoor air) and GW2 (ground water to indoor air) component values and soil vapour screening levels (SVSLs) being multiplied by different ceiling values, as stipulated in the summary table below.

RMM	Multiplier Ceilings	Additional Requirements & Limitations I/C/C	Additional Requirements & Limitations R/P/I
Passive SVIMS	100x	Buildings must be slab on grade.	Not permitted
Active SVIMS	200x	No restrictions on building form or management.	Building must be a multi-storey, multi-unit building with separately owned or occupied units on different storeys of the building and there is ongoing Property Management Oversight of the Property and Building.

3. Applicability of Multiplier Ceilings for Different SVIMS and Property Use

The applicability of above noted multipliers is based on the type of SVIMS to be implemented at the RA property and the property use. A summary of building restrictions, if present, is presented in the above table. Details on the system design and maintenance, inspection, and monitoring programs are available in RMM 5.1 and RMM 5.2 (presented in Tab "RMM Descriptions" of the Approved Model). Additional guidance on SVIMS Performance Verification and Monitoring is provided in Appendix 8b.

It should be also noted that since a high water table will significantly decrease the efficiency of passive/active depressurization systems, these systems may not be appropriate for sites with shallow ground water. The Qualified Person (QP) should ensure that there is sufficient separation distance between ground water and the venting layer for the proposed system to be effective.

Appendix 8b – Guide to Performance Verification and Monitoring of Soil Vapour Intrusion Mitigation Systems (SVIMS)

A Soil Vapour Intrusion Mitigation System (SVIMS) is an engineered vapour intrusion (VI) risk management measure (RMM) designed to control the vapour intrusion pathway. Once a SVIMS is installed and implemented, performance verification/monitoring is required to confirm that the system is operating effectively as intended (for example meeting performance objectives). Monitoring of on-going system effectiveness is also required along with routine maintenance and inspection, for as long as the system is operational. Requirements for preparing and implementing maintenance, inspection, and monitoring (MIM) programs are available in RMM 5.1 and RMM 5.2 (presented in Tab "RMM Descriptions" of the Approved Model).

The SVIMS RMM requires a monitoring program prepared by a Licenced Professional Engineer in consultation with a Qualified Person (QP) and to be retained by the Property Owner. In general, design of the monitoring program should be commensurate with the level of risk being mitigated.

Following a review of similar guidance and supporting documents (from other jurisdictions) and considering the ministry current experience, the following guidance was developed to assist the QP in designing a monitoring plan that will help to enhance confidence that the SVIMS, within the scope of a MGRA, is achieving the desired risk reduction and will provide recommendations on (1) performance objectives and monitoring of a SVIMS and (2) additional lines of evidence to be considered when the performance objective(s) cannot be achieved and trigger a reassessment and/or system modification(s).

1. *Performance Objective and Verification*

As part of the Approved Model, a SVIMS is considered an engineered VI RMM that can operate in either (1) a passive manner which generally relies on natural phenomena to develop suction in the stack with the aid of a wind turbine or solar powered wind turbine on each vent riser or (2) an active manner which uses motorized fan(s), to create and maintain a lower pressure underneath a building floor relative to the pressure within the overlying building. Within the scope of MGRA, the overall performance objective is to reduce the potential for volatile contaminants of concern (VCOC) beneath a structure from entering indoor air by a factor (or a multiplier to component values) of up to 200x, depending on the type of SVIMS employed as specified in Appendix 8a.

Generally, a SVIMS should decrease pressures in the sub-slab layer and generate a negative pressure field beneath the slab which should reduce the entry of soil vapour into the building, thereby reducing VCOC concentrations in indoor air. To confirm the negative pressure condition across the slab, sub-slab deferential pressure and/or vacuum measurements are obtained from the monitoring devices advanced in the target areas and/or suction points, where appropriate.

The number and locations of the monitoring devices installed below the foundation floor slab for measurement of the sub-slab differential pressure, relative to the indoor air pressure within the building should be determined by the Licenced Professional Engineer in consultation with the QP, taking into account site-specific factors, such as the building area and the design and configuration of the building foundation.

Vacuum testing should be completed prior to building occupancy to demonstrate the pressure integrity of the soil vapour venting layer and system and to measure the potential extent of the suction field. These tests can indicate whether the SVIMS is viable and may also support the selection of an appropriate number and locations of suction points and/or monitoring devices. Vacuum testing should also be conducted as considered appropriate by the Licenced Professional Engineer after occupancy has commenced.

Generally, to indicate that a passive SVIMS is operating as intended within the scope of MGRA, collecting pressure data to demonstrate the presence of a negative pressure field across the foundation slab (e.g., the air pressure below the slab is lower than the indoor air pressure within the building) is considered adequate. For an active SVIMS, the objective is to achieve a pressure differential of at least - 6 Pascal across at least 90% of the building footprint during all seasons. Not achieving this objective at all times or locations; however, does not mean the active SVIMS is not operating effectively, but the Licenced Professional Engineer should assess the SVIMS further and make improvements or repairs of any deficiencies as appropriate or consider collecting additional lines of evidence (see Section 2 of this Appendix). It is recommended that sub-slab differential pressure monitoring be implemented under normal building operating conditions (e.g. ventilation). Also, while measurement of sub-slab differential pressure is generally considered an adequate performance measure of satisfactory system operation, the QP should, based on professional judgement and the best knowledge of site conditions at the time of assessment, consider whether additional performance measures (e.g., vapour sampling) are warranted.

Requirements on the minimum frequency and timing of monitoring events to demonstrate continued effectiveness will depend on the type of SVIMS, and are specified in RMM 5.1 and RMM 5.2. It is recommended that site-specific considerations be taken into account when developing the actual monitoring program. Considerations that may indicate the need for additional monitoring (e.g., beyond the required minimum) include, but are not limited to: (1) the degree of vapour intrusion risk being mitigated, (2) initial/previous post-installation monitoring results indicating wide variations in system performance (e.g., wind turbine(s) or solar powered wind turbine(s) not working due to accumulation of snow or ice or lack of wind) and/or marginal effectiveness, (3) the nature and extent of subsurface contamination, and (4) future site work that may alter subsurface conditions and/or enhance the vapour intrusion pathway. For example, in the event that future activities (e.g. change in building use or intrusive work) are undertaken at the site, it is necessary to confirm whether the post-activity site conditions are likely to have an impact on vapour intrusion and the system performance and whether additional corrective action(s) are required to ensure the intended effectiveness. Cautions about intrusive work are included in RMM 5.1 and RMM 5.2.

2. *Considerations for Re-Assessment of System Performance*

If pressure monitoring results indicate that the performance objectives referred to in Section 1 are not being achieved, additional operational testing and inspections should be done, and if appropriate, additional lines of evidence, (e.g. vapour sampling) can be used to assess whether the observed pressure deferential is adequate to reduce concentrations of VCOCs in indoor air to below the Health Based Indoor Air Criteria (HBIAC). The following provides general guidance on vapour sampling as an additional line of evidence to re-evaluate system performance. Vapour sampling refers herein to collecting either sub-slab soil vapour or indoor air samples (or both).

The QP is referred to RMM 5.1 and RMM 5.2 for requirements for preparing and implementing a contingency plan, in the event the system modification is necessary (e.g. a passive SVIMS needs to be converted to operation as an active SVIMS) and/or deficiencies related to system performances cannot be repaired promptly.

2.1. Collection of Vapour Samples

In cases where vapour sampling appears to be necessary to re-evaluate the performance of the SVIMS, it should be conducted in conjunction with sub-slab differential pressure monitoring. Confirmatory indoor air and/or sub-slab soil vapour samples below the selected target levels, coupled with the measured pressure differentials across the slab, can be used to confirm that the SVIMS is operating as intended. When a consistent correlation between the pressure differentials and vapour concentrations in indoor air and/or sub-slab soil vapour can be established, the pressure differential observed at the time it was demonstrated that the vapour concentrations are acceptable can be set as a new pressure differential performance objective and used to monitor the SVIMS effectiveness.

Collection of sub-slab soil vapour samples is generally selected over the collection of indoor air samples when sources other than sub-surface soil vapour may be contributing to indoor air concentrations (e.g. background sources). The concentrations of VCOC in sub-slab samples can be compared to the sub-slab soil vapour screening levels (SVSLs) provided in the Approved Model. However, indoor air samples are still often collected as they can provide direct confirmation that concentrations of VCOCs in indoor air are below the HBIAC. HBIAC can be found under the "Human Health" Tab of the Approved Model.

Indoor air sampling is recommended as part of the monitoring program if (1) pre-mitigation indoor air and/or sub-slab soil vapour samples exceeded the selected target levels, (2) post-mitigation sub-slab soil vapour samples, exceeded the selected target levels, and (3) site conditions (e.g., preferential pathways) are present that may potentially negate or limit the use of sub-slab soil vapour data. If background sources are of concern, indoor air sampling events should be completed in conjunction with collection of sub-slab soil vapour samples and/or other lines of evidence to support the evaluation of background sources.

While detailed steps and key considerations for the design of sub-slab soil vapour and indoor air sampling programs can be found in the draft *Technical Guidance: Soil Vapour Intrusion Assessment*, and dated 2013 (or updated version once available), the recommended minimum

number of samples to be collected based on the building footprint area when evaluating sub-slab soil vapour and indoor air are presented in Tables 8b.1 and 8b.2, respectively. It is recommended that samples be collected biased towards worst case locations identified during previous sampling events and/or using professional judgment (for example, collecting indoor air samples within the lowest levels of buildings). In addition, the vapour sampling program should be developed and implemented on a case by case basis to reflect site specific considerations. Considerations that may warrant additional monitoring include, but are not limited to, the following:

- Internal building partitions;
- Heating, Ventilation and Air Conditioning (HVAC) layout (e.g., different zones or systems);
- Contaminant distribution in the subsurface;
- Potential soil gas entry points (e.g., sumps or drains, utilities, etc.); and,
- Any other conditions that may impact the vapour intrusion pathway.

Table 8b.1: Recommended Minimum Number of Sub-slab Soil Vapour Samples

Building Area (m^2)	Density over Building Area	Minimum number of samples*
up to 500	one per 100 m^2	3
> 500 to 2,000	one additional per every 500 m^2 over 500	5
> 2,000 to 5,000	one additional per every 1,000 m^2 over 2000	8
> 5,000	one additional per every 2,000 m^2 over 5,000	11

* The number of samples calculated by density is rounded to the nearest whole number.

Table 8b.2: Recommended Minimum Number of Indoor Air Samples

Square Meter of Open Space (m^2)	Minimum Number of Samples*
Up to 500	2
> 500 to 1000	3
> 1000	1 additional sample for every 1000 m^2 over 1000*

* The number of samples calculated by density is rounded to the nearest whole number.

2.2. Supporting Lines of Evidence

If the results of any monitoring event indicate that the measured concentrations VCOC in indoor air and/or sub-slab soil vapour potentially exceed the selected target levels, collection of additional lines of evidence may be warranted, based on professional judgement and the best knowledge of site conditions at the time of assessment. Examples include further evaluation of vapour sampling with additional operational measurements to reconfirm the effectiveness of the implemented system and/or implementation of corrective action(s). For example, if measured indoor air data exceed the selected HBIAC, the data can be further evaluated with other lines of evidence that are collected within the same event (e.g., sub-slab vacuum readings, ambient air data and sub-slab soil vapour data, if available) to determine whether indoor air exceedances are solely attributed to background sources. If the further evaluation does not clearly demonstrate that the exceedances come from a source other than sub-surface contamination, it is recommended that the installed system be modified, or another corrective action implemented as specified in the contingency plan, followed by a re-evaluation of the effectiveness of the corrected system, as appropriate.

APPENDIX 9 - MGRA Risk Management Measures

The following are the Risk Management Measures that are housed within the Approved Model, and are provided here for information purposes.

DEFINITIONS FOR USE IN RISK MANAGEMENT MEASURES AND CERTIFICATE OF PROPERTY USE FOR MODIFIED GENERIC RISK ASSESSMENTS

The definitions for use in risk management measures and a Certificate of Property Use for a Modified Generic Risk Assessment are set out below.

The bracketed portions in the definitions apply for purposes of issuing a Certificate of Property Use.

DEFINITIONS

"Act" means the Environmental Protection Act, R.S.O. 1990, c. E.19.

"Active SVIMS" means a soil vapour intrusion mitigation system designed and operated to collect and remove soil vapour from below a Building and convey the soil vapour through vent risers to the outside air by means of one or more electrical fan powered vents drawing air from below the Building.

"Approved Model" has the same meaning as in subsection 1 (1) of Schedule C of O. Reg. 153/04, namely, the data file entitled "Modified Generic Risk Assessment Model" and dated October 19, 2009 as amended from time to time, that is maintained by the Ministry as part of its Brownfield initiative and is available on the Internet and may be available in such other manner as the Minister considers appropriate.

"ASTM" means the American Society for Testing and Materials.

"Barrier" means a Fill Cap Barrier, Hard Cap Barrier or Shallow Soil Cap Barrier.

"Building" means an enclosed structure occupying an area greater than ten square metres consisting of a wall or walls, roof and floor.

"Building Area" means the horizontal area of a Building at Grade within the outside surface of the exterior wall or walls.

"Building Code" means Ontario Regulation 332/12 (Building Code) as amended to January 1, 2015, made under the Building Code Act, 1992, S.O. 1992, c. 23.

"Capping Soil" means,

(a) soil found on, in or under the Property in which no Property Specific Contaminants of Concern are present, or

(b) soil that meets the applicable site condition standards for the Property, and does not contain any contaminant for which no applicable site condition standard for soil is prescribed under Part IX (Site Condition Standards and Risk Assessment) and which is associated with any potentially contaminating activity described in the Risk Assessment.

"Certificate of Property Use" or "CPU" means the certificate of property use [*FOR PURPOSES OF THE MGRA CPU, INSERT* "bearing the number {INSERT DOCUMENT NUMBER}"] issued for the Property by the Director under section 168.6 of the Act, as it may be amended from time to time.

"Competent Person" has the same meaning as in the Occupational Health and Safety Act, R.S.O. 1990, c. O.1.

"Contaminants of Concern" has the same meaning as in O. Reg. 153/04, which, for the Property, means one or more contaminants found on, in or under the Property at a concentration that exceeds the applicable site condition standards for the Property, as specified in section 3 of the Risk Assessment report [*FOR PURPOSES OF THE MGRA CPU, INSERT* "and in Table 1 of the CPU"].

"Director" means a person in the Ministry appointed as a director for the purpose of issuing a Certificate Of Property Use under section 168.6 of the Act.

"Fill Cap Barrier" means cover, above the Property Specific Contaminants of Concern, that,

(a) is at least,

(i) 1.0 metre thick, or any greater thickness than 1.0 metre, as specified in section 7 of the Risk Assessment report, or

(ii) 1.5 metres thick, where the option to modify the S3 component value in the Approved Model for protection of subsurface workers from direct soil contact has been used in the Risk Assessment, as specified in section 7 of the Risk Assessment report,

whichever is applicable, and,

(b) consists of at least 0.5 metres thickness of Capping Soil, and above this, cover consisting of additional Capping Soil or non-soil surface treatment such as asphalt, concrete or concrete pavers, stone pavers, brick or aggregate.

"First Storey" has the same meaning as in the Building Code.

"Grade" has the same meaning as in the Building Code.

"Hard Cap Barrier" means an asphalt or concrete cover layer, above the Property Specific Contaminants of Concern, that is at least 225 millimetres thick, and consists of at least 75 millimetres thickness of hot mix asphalt or poured concrete underlain by Granular "A"

aggregate or equivalent material, and includes a building slab or building foundation and floor slab meeting these specifications.

"Intrusive Activities" means any intrusive activity undertaken at the Property, such as excavating or drilling into soil or ground water, which may disturb or expose Property Specific Contaminants of Concern at the Property.

"Licenced Professional Engineer" means a person who holds a licence, limited licence or temporary licence under the Professional Engineers Act, R.S.O. 1990, c. P.28.

"Minister" means the Minister of the Ministry.

"Ministry" means the Ministry of the Environment and Climate Change.

"O. Reg. 153/04" means Ontario Regulation 153/04 (Record of Site Condition – Part XV.1 of the Act), as amended, made under the Act.

"Owner" means the owner(s) of the Property, beginning with the person(s) to whom the Certificate of Property Use for the Property is first issued by the Director under section 168.6 of the Act based on the Risk Assessment, and any subsequent owner of the Property.

"Passive SVIMS" means a soil vapour intrusion mitigation system designed and operated to collect and remove soil vapour from below a Building and convey the soil vapour through vent risers to the outside air by means of natural forces and one or more wind turbine, or solar powered wind turbine operated vents drawing air from below the Building.

"Property" means the property that is the subject of the Risk Assessment.

"Property Management Oversight" means management, on an ongoing basis, of all structural, mechanical, electrical, ventilation and other Building and Property services that relate to an installed Passive SVIMS or Active SVIMS, [*FOR PURPOSES OF THE MGRA CPU, REPLACE* "an installed Passive SVIMS or Active SVIMS," *WITH* "the installed Passive SVIMS," OR "the installed Active SVIMS," *AS APPLICABLE FOR THE PROPERTY, AS SET OUT IN SECTION 7 OF THE RISK ASSESSMENT REPORT*] including oversight of operation, inspection, monitoring, maintenance and repair activities, and of operational and reserve funding for these activities, by a property manager or management company engaged by the Owner or, in the case of collective ownership, by an authorized representative or representatives of the collective ownership of the Building and Property, such as a condominium board.

"Property Specific Contaminants of Concern" means one or more contaminants found on, in or under the Property at a concentration that exceeds the applicable site condition standards for the Property and any higher standards for the contaminant or contaminants as generated by the Approved Model without incorporation of risk management measures, and as specified in section 3 of the Risk Assessment report [*FOR PURPOSES OF THE MGRA CPU, INSERT* "and in Table 1 of the CPU"].

"Property Specific Standards" means the standards established as the maximum allowable concentrations for the Property Specific Contaminants of Concern at the Property, as generated by the Approved Model with incorporation of risk management measures, as specified in section 6 of the Risk Assessment report [*FOR PURPOSES OF THE MGRA CPU, INSERT* "and in Table 1 of the CPU"].

"Provincial Officer" has the same meaning as in the Act, namely, a person who is designated by the Minister as a provincial officer for the purposes of the Act and the regulations.

"Qualified Person" means a person who meets the qualifications set out in subsection 5. (2) of O. Reg. 153/04.

"MGRA Director" means a person in the Ministry appointed as a director for the purpose of responding to a risk assessment submitted under section 168.5 of the Act.

"Risk Assessment" and "MGRA" means the modified generic risk assessment [*FOR PURPOSES OF THE MGRA CPU, INSERT "number {INSERT MGRA DOCUMENT NUMBER}"*] submitted with respect to the Property and accepted by the MGRA Director [*FOR PURPOSES OF THE MGRA CPU, INSERT* "on {INSERT DATE ACCEPTED} and set out in the following documents: {*INSERT DOCUMENT TITLE(S), AND DATES AND COMPANY/PERSON NAMES PREPARED BY}"*].

"Storage Garage" has the same meaning as in the Building Code.

"Shallow Soil Cap Barrier" means cover, above the Property Specific Contaminants of Concern, that is at least 0.5 metres thick, and consists of Capping Soil.

1. SHALLOW SOIL CAP BARRIER RISK MANAGEMENT MEASURE

The Shallow Soil Cap Barrier risk assessment measure may be used where the intended and actual use of the Property is industrial use, commercial use, or community use, as defined in O. Reg. 153/04, or a combination thereof.

The Shallow Soil Cap Barrier risk management measure is set out below.

SHALLOW SOIL CAP BARRIER RISK MANAGEMENT MEASURE (RMM)

a. Covering of all areas of the Property where Property Specific Contaminants of Concern are present at or within 0.5 metres below the soil surface, such that a Shallow Soil Cap Barrier, or Hard Cap Barrier or Fill Cap Barrier, is in place in these areas, so as to prevent exposure to the Property Specific Contaminants of Concern at the Property, in conjunction with any existing Barriers in any other areas of the Property where Property Specific Contaminants of Concern are present below the soil surface;

b. Before commencing development of all or any part of the Property, installing fencing and implementing dust control measures for any part of the Property requiring covering but which has not been covered, so as to restrict access to the part fenced and prevent exposure to the Property Specific Contaminants of Concern at the Property, with the fencing and dust control measures to be maintained until covering of the part fenced is complete;

c. Preparing and implementing a written inspection and maintenance program, prepared by a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, so as to ensure the continuing integrity of each Barrier at the Property so long as the Property Specific Contaminants of Concern are present at the Property, including, at a minimum:

    i. procedures and timing for implementing the program;

    ii. semi-annual inspections, in spring and fall, of the Barrier;

    iii. noting any deficiencies in the Barrier observed during the inspections, or at any other time;

    iv. repairing promptly any such deficiencies, to the original design specifications, with written confirmation by a Licenced Professional Engineer that the Barrier has been properly repaired, to be retained by the Owner and be available for inspection upon request by a Provincial Officer;

    v. contingency measures, such as fencing, to be implemented if cracks, breaches or any loss of integrity of the Barrier cannot be repaired or addressed in a timely

manner, to prevent exposure to the Property Specific Contaminants of Concern in that area of the Property; and

vi. recording, in writing, all inspections, deficiencies, repairs and implementation of contingency measures, to be retained by the Owner and be available for inspection upon request by a Provincial Officer;

and which is,

vii. delivered to the Owner before use of all or any part of the Property begins, or within 90 days following completion of covering of all or any part of the Property, whichever is earlier; and

viii. updated and delivered to the Owner within 30 days following making any alteration to the program;

d. Preparing a site plan of the entire Property, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, showing the Property, any fencing, and the location, type and design of each Barrier at the Property, including cross-sectional drawings of the Barrier showing its design and vertical and lateral extent;

and which is,

i. delivered to the Owner before use of all or any part of the Property begins, or within 90 days following completion of covering of all or any part of the Property, whichever is earlier; and

ii. updated and delivered to the Owner within 30 days following making any alteration to the location, design or extent of the Barrier, or other relevant feature shown on the site plan; and

e. Preparing and implementing written procedures, prepared by a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, for written and oral communication to all persons who may be involved in Intrusive Activities at the Property that may disturb a Barrier at the Property, so as to ensure the persons are made aware of the presence and significance of the Barrier and the Property Specific Contaminants of Concern at the Property and the precautions to be taken to ensure the continued integrity of the Barrier when undertaking the Intrusive Activities, and if damaged, to ensure that the Barrier is repaired promptly to the original design specifications, or, if it cannot be repaired promptly, to ensure that the contingency measures are implemented, and records kept, as specified in the inspection and maintenance program;

and which are,

i. delivered to the Owner before any Intrusive Activities are undertaken at the Property; and

ii. updated and delivered to the Owner within 30 days following making any alteration to the procedures.

2.1 HARD CAP OR FILL CAP BARRIER (1.0 METRE OR SPECIFIED GREATER THICKNESS) RISK MANAGEMENT MEASURE (RMM)

The Hard Cap or Fill Cap Barrier (1.0 Metre or Specified Greater Thickness) risk management measure is set out below.

HARD CAP OR FILL CAP BARRIER (1.0 METRE OR SPECIFIED GREATER THICKNESS) RISK MANAGEMENT MEASURE (RMM)

a. Covering of all areas of the Property where Property Specific Contaminants of Concern are present at or within [INSERT {NUMBER} WHICH IS "1.0", OR THE SPECIFIED GREATER FILL CAP BARRIER THICKNESS AND DEPTH BELOW THE SOIL SURFACE, THAN 1.0 METRE, IF CHOSEN BY THE OWNER, AS SPECIFIED IN SECTION 7 OF THE RISK ASSESSMENT REPORT] metre(s) below the soil surface such that a Hard Cap Barrier or Fill Cap Barrier is in place in these areas, so as to prevent exposure to the Property Specific Contaminants of Concern at the Property, in conjunction with any existing Barriers in any other areas of the Property where Property Specific Contaminants of Concern are present below the soil surface;

b. Before commencing development of all or any part of the Property, installing fencing and implementing dust control measures for any part of the Property requiring covering but which has not been covered, so as to restrict access to the part fenced and prevent exposure to the Property Specific Contaminants of Concern at the Property, with the fencing and dust control measures to be maintained until covering of the part fenced is complete;

c. Preparing and implementing a written inspection and maintenance program, prepared by a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, so as to ensure the continuing integrity of each Barrier at the Property so long as the Property Specific Contaminants of Concern are present at the Property, including, at a minimum:

    i. procedures and timing for implementing the program;

    ii. semi-annual inspections, in spring and fall, of the Barrier;

    iii. noting any deficiencies in the Barrier observed during the inspections, or at any other time;

    iv. repairing promptly any such deficiencies, to the original design specifications, with written confirmation by a Licenced Professional Engineer that the Barrier has been properly repaired, to be retained by the Owner and be available for inspection upon request by a Provincial Officer;

v. contingency measures, such as fencing, to be implemented if cracks, breaches or any loss of integrity of the Barrier cannot be repaired or addressed in a timely manner, to prevent exposure to the Property Specific Contaminants of Concern in that area of the Property; and

vi. recording, in writing, all inspections, deficiencies, repairs and implementation of contingency measures, to be retained by the Owner and be available for inspection upon request by a Provincial Officer;

and which is,

vii. delivered to the Owner before use of all or any part of the Property begins, or within 90 days following completion of covering of all or any part of the Property, whichever is earlier; and

viii. updated and delivered to the Owner within 30 days following making any alteration to the program;

d. Preparing a site plan of the entire Property, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, showing the Property, any fencing, and the location, type and design of each Barrier at the Property, including cross-sectional drawings of the Barrier showing its design and vertical and lateral extent;

and which is,

i. delivered to the Owner before use of all or any part of the Property begins, or within 90 days following completion of covering of all or any part of the Property, whichever is earlier; and

ii. updated and delivered to the Owner within 30 days following making any alteration to the location, design or extent of the Barrier, or other relevant feature shown on the site plan; and

e. Preparing and implementing written procedures, prepared by Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, for written and oral communication to all persons who may be involved in Intrusive Activities at the Property that may disturb a Barrier at the Property, so as to ensure the persons are made aware of the presence and significance of the Barrier and the Property Specific Contaminants of Concern at the Property and the precautions to be taken to ensure the continued integrity of the Barrier when undertaking the Intrusive Activities, and if damaged, to ensure that the Barrier is repaired promptly to the original

design specifications, or, if it cannot be repaired promptly, to ensure that the contingency measures are implemented, and records kept, as specified in the inspection and maintenance program;

and which are,

i. delivered to the Owner before any Intrusive Activities are undertaken at the Property; and
ii. updated and delivered to the Owner within 30 days following making any alteration to the procedures.

2.2 HARD CAP OR FILL CAP BARRIER (MODIFIED S3 SOIL COMPONENT VALUE) RISK MANAGEMENT MEASURE (RMM)

The Hard Cap or Fill Cap Barrier (Modified S3 Soil Component Value) risk management measure must be used where the Risk Assessment uses the modified S3 component value associated with protection of subsurface workers from direct soil contact in the Approved Model. The Hard Cap or Fill Cap Barrier (Modified S3 Soil Component Value) risk management measure is set out below.

HARD CAP OR FILL CAP BARRIER (MODIFIED S3 SOIL COMPONENT VALUE) RISK MANAGEMENT MEASURE (RMM)

a. Covering of all areas of the Property where Property Specific Contaminants of Concern are present at or within 1.5 metres below the soil surface such that a Hard Cap Barrier or Fill Cap Barrier is in place in these areas, so as to prevent exposure to the Property Specific Contaminants of Concern at the Property, in conjunction with any existing Barriers in any other areas of the Property where Property Specific Contaminants of Concern are present below the soil surface;

b. Before commencing development of all or any part of the Property, installing fencing and implementing dust control measures for any part of the Property requiring covering but which has not been covered, so as to restrict access to the part fenced and prevent exposure to the Property Specific Contaminants of Concern at the Property, with the fencing and dust control measures to be maintained until covering of the part fenced is complete;

c. Preparing and implementing a written inspection and maintenance program, prepared by a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, so as to ensure the continuing integrity of each Barrier at the Property so long as the Property Specific Contaminants of Concern are present at the Property, including, at a minimum:

    i. procedures and timing for implementing the program;

    ii. semi-annual inspections, in spring and fall, of the Barrier;

    iii. noting any deficiencies in the Barrier observed during the inspections, or at any other time;

    iv. repairing promptly any such deficiencies, to the original design specifications, with written confirmation by a Licenced Professional Engineer that the Barrier has been properly repaired, to be retained by the Owner and be available for inspection upon request by a Provincial Officer;

v. contingency measures, such as fencing, to be implemented if cracks, breaches or any loss of integrity of the Barrier cannot be repaired or addressed in a timely manner, to prevent exposure to the Property Specific Contaminants of Concern in that area of the Property; and

vi. recording, in writing, all inspections, deficiencies, repairs and implementation of contingency measures, to be retained by the Owner and be available for inspection upon request by a Provincial Officer;

and which is,

vii. delivered to the Owner before use of all or any part of the Property begins, or within 90 days following completion of covering of all or any part of the Property, whichever is earlier; and

viii. updated and delivered to the Owner within 30 days following making any alteration to the program;

d. Preparing a site plan of the entire Property, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, showing the Property, any fencing, and the location, type and design of each Barrier at the Property, including cross-sectional drawings of the Barrier showing its design and vertical and lateral extent;

and which is,

i. delivered to the Owner before use of all or any part of the Property begins, or within 90 days following completion of covering of all or any part of the Property, whichever is earlier; and

ii. updated and delivered to the Owner within 30 days following making any alteration to the location, design or extent of the Barrier, or other relevant feature shown on the site plan; and

e. Preparing and implementing written procedures, prepared by Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, for written and oral communication to all persons who may be involved in Intrusive Activities at the Property that may disturb a Barrier at the Property, so as to ensure the persons are made aware of the presence and significance of the Barrier and the Property Specific Contaminants of Concern at the Property and the precautions to be taken to ensure the continued integrity of the Barrier when undertaking the Intrusive Activities, and if damaged, to ensure that the Barrier is repaired promptly to the original

design specifications, or if it cannot be repaired promptly, to ensure that the contingency measures are implemented, and records kept, as specified in the inspection and maintenance program;

and which are:

i. delivered to the Owner before any Intrusive Activities are undertaken at the Property; and

ii. updated and delivered to the Owner within 30 days following making any alteration to the procedures.

3.1 BUILDING WITH STORAGE GARAGE (INTERMITTENT 3.9 L/SEC) RISK MANAGEMENT MEASURE (RMM)

The Building with Storage Garage (Intermittent 3.9 L/sec) risk management measure may be used where the Risk Assessment uses component values associated with soil vapour in the Approved Model that are based on the Storage Garage meeting, but not being required to exceed, the mechanical ventilation requirements and all other applicable requirements of the Building Code.

The Building with Storage Garage (Intermittent 3.9 L/sec) risk management measure is set out below.

BUILDING WITH STORAGE GARAGE (INTERMITTENT 3.9 L/SEC) RISK MANAGEMENT MEASURE (RMM)

Not constructing any Building on the Property unless the Building includes a Storage Garage, and:

a. The Storage Garage is constructed at or below the Grade of the Building;

b. The Storage Garage area covers the entire Building Area at Grade; and

c. The Storage Garage complies with all applicable requirements of the Building Code, such as the provisions governing:

    i. design of a mechanical ventilation system as set out in Division B, Article 6.2.2.3. (Ventilation of Storage and Repair Garages) of the Building Code;

    ii. interconnection of air duct systems as set out in Division B, Sentence (2) of Article 6.2.3.9. (Interconnection of Systems) of the Building Code; and

    iii. air leakage as set out in Division B, Section 5.4. (Air Leakage) of the Building Code.

3.2 BUILDING WITH STORAGE GARAGE (CONTINUOUS 3.9 L/SEC) RISK MANAGEMENT MEASURE (RMM)

The Building with Storage Garage (Continuous 3.9 L/sec) risk management measure may be used where the Risk Assessment uses component values associated with soil vapour in the Approved Model that are based on enhanced mechanical ventilation of the Storage Garage which provides at all times a continuous supply of outdoor air at a rate of not less than 3.9 litres per second for each square metre of floor area, in addition to the Storage Garage meeting the mechanical ventilation requirements and all other applicable requirements of the Building Code.

The Building with Storage Garage (Continuous 3.9 L/sec) risk management measure is set out below.

BUILDING WITH STORAGE GARAGE (CONTINUOUS 3.9 L/SEC) RISK MANAGEMENT MEASURE (RMM)

Not constructing any Building on the Property unless the Building includes a Storage Garage, and:

a. The Storage Garage is constructed at or below the Grade of the Building;

b. The Storage Garage area covers the entire Building Area at Grade;

c. The Storage Garage complies with all applicable requirements of the Building Code, such as the provisions governing:

    i. design of a mechanical ventilation system as set out in Division B, Article 6.2.2.3. (Ventilation of Storage and Repair Garages) of the Building Code;

    ii. interconnection of air duct systems as set out in Division B, Sentence (2) of Article 6.2.3.9. (Interconnection of Systems) of the Building Code; and

    iii. air leakage as set out in Division B, Section 5.4. (Air Leakage) of the Building Code; and

d. The mechanical ventilation system for the Storage Garage is designed to provide, and provides at all times, a continuous supply of outdoor air at a rate of not less than 3.9 litres per second for each square metre of floor area, as set out in section 7 of the Risk Assessment report.

3.3 BUILDING WITH STORAGE GARAGE (CONTINUOUS 10.0 L/SEC) RISK MANAGEMENT MEASURE (RMM)

The Building with Storage Garage (Continuous 10.0 L/sec) risk management measure may be used where the Risk Assessment uses component values associated with soil vapour in the Approved Model that are based on enhanced mechanical ventilation of the Storage Garage which provides at all times a continuous supply of outdoor air at a rate of not less than 10.0 litres per second for each square metre of floor area, in addition to the Storage Garage meeting the mechanical ventilation requirements and all other applicable requirements of the Building Code.

The Building with Storage Garage (Continuous 10.0 L/sec) risk management measure is set out below.

BUILDING WITH STORAGE GARAGE (CONTINUOUS 10.0 L/SEC) RISK MANAGEMENT MEASURE (RMM)

Not constructing any Building on the Property unless the Building includes a Storage Garage, and:

a. The Storage Garage is constructed at or below the Grade of the Building;

b. The Storage Garage area covers the entire Building Area at Grade;

c. The Storage Garage complies with all applicable requirements of the Building Code, such as the provisions governing:

    i. design of a mechanical ventilation system as set out in Division B, Article 6.2.2.3. (Ventilation of Storage and Repair Garages) of the Building Code;

    ii. interconnection of air duct systems as set out in Division B, Sentence (2) of Article 6.2.3.9. (Interconnection of Systems) of the Building Code; and

    iii. air leakage as set out in Division B, Section 5.4. (Air Leakage) of the Building Code; and

d. The mechanical ventilation system for the Storage Garage is designed to provide, and provides at all times, a continuous supply of outdoor air at a rate of not less than 10.0 litres per second for each square metre of floor area, as set out in section 7 of the Risk Assessment report.

4. BUILDING PROHIBITION RISK MANAGEMENT MEASURE (RMM)

The Building Prohibition risk management measure is set out below.

BUILDING PROHIBITION RISK MANAGEMENT MEASURE (RMM)

Not constructing any Building on the Property.

5.1 PASSIVE SOIL VAPOUR INTRUSION MITIGATION SYSTEM (SVIMS) RISK MANAGEMENT MEASURE (RMM)

The Passive Soil Vapour Intrusion Mitigation System risk management measure may be used where,

INDUSTRIAL, COMMERCIAL OR COMMUNITY USE

i. the intended and actual use of the Property is industrial use, commercial use or community use, as defined in O. Reg. 153/04, or a combination thereof, and

ii. all Buildings on the Property are constructed as slab-on-grade.

The Passive Soil Vapour Intrusion Mitigation System risk management measure is set out below.

PASSIVE SOIL VAPOUR INTRUSION MITIGATION SYSTEM (SVIMS) RISK MANAGEMENT MEASURE (RMM)

Not constructing any Building on the Property unless the Building is constructed as slab-on-grade and includes a Passive SVIMS, and the Passive SVIMS meets the following requirements:

DESIGN, INSTALLATION AND OPERATION

a. Designing, installing and operating a Passive SVIMS for the Building, designed by a Licenced Professional Engineer in consultation with a Qualified Person and installed by a person acceptable to and under the supervision of a Licenced Professional Engineer, so as to remove soil vapour from below the Building and prevent soil vapour containing the Property Specific Contaminants of Concern from entering the Building air, including the following requirements and components for the Passive SVIMS:

SYSTEM REQUIREMENTS

i. the Passive SVIMS is to:

(a) be designed, installed and operated with the objective of achieving during all seasons a lower air pressure differential below the foundation floor slab, relative to the indoor air pressure within the Building, across at least 90% of the Building Area;

(b) be able to be readily converted to operation as an Active SVIMS, if necessary, to ensure soil vapour is being sufficiently removed from below the Building, including making provision to readily allow installation and operation of an electrical powered fan on each vent riser, with the objective of achieving during all seasons at least a 6 Pascal lower air

pressure differential below the foundation floor slab, relative to the indoor air pressure within the Building, across at least 90% of the Building Area, and making provision for an automated monitoring system of electrical fan operation which remotely detects and indicates system malfunctions; and

(c) have in place or be able to easily put in place, measures, as appropriate based on an assessment carried out in accordance with ASTM E1998, to prevent potential depressurization induced back drafting and spillage of combustion products from vented combustion appliances that may be in the Building, in the event conversion to operation as an Active SVIMS is necessary;

SUB-SLAB FOUNDATION LAYER

ii. throughout the Building Area below the foundation floor slab, a sub-slab foundation layer, above soil containing the Property Specific Contaminants of Concern, designed by a Licenced Professional Engineer for the Building constructor in consultation with the Licenced Professional Engineer for the Passive SVIMS;

SOIL VAPOUR VENTING LAYER

iii. throughout the Building Area below the foundation floor slab and above the sub-slab foundation layer, a soil vapour venting layer designed for collection and venting of soil vapour from below the floor slab to vent risers for venting to the outdoor air, with the soil vapour venting layer consisting of:

(a) perforated collection pipes or geocomposite strips of sufficient size or diameter, frequency and locations to promote efficient collection and venting, embedded in granular materials of sufficient air permeability and depth;

or,
other soil vapour collection and venting products used to construct a soil vapour venting layer with continuous open void space, such as an aerated sub-floor below the floor slab and around the exterior walls, which provides similar or greater air permeability and collection and venting efficiency;

(b) for a Building with isolated soil vapour venting layer areas caused by interior grade beams or areas of thickened slabs, ventilation pipes to connect the isolated areas or a soil vapour venting layer that extends below these elements of the Building foundation; and

(c) clean-outs, drains or openings to ensure drainage and removal of condensate or water, including any entrained dust, that may enter

collection pipes, geocomposite strips or vent risers, and, if required, to ensure drainage or dewatering of the soil vapour venting layer in Property areas with a shallow ground water table;

SOIL VAPOUR BARRIER MEMBRANE

iv. throughout the Building Area, a continuous leak free soil vapour barrier membrane, such as a sheet geomembrane or spray applied membrane, below the foundation floor slab and above the soil vapour venting layer, and below and along the walls of any subsurface structures such as a sump, and which:

(a) is of appropriate thickness and meets the appropriate gas permeability and chemical resistance specifications to be considered substantially impermeable to the soil vapour, in accordance with the appropriate ASTM standards such as D412 and D543, as applicable; and

(b) has a suitable protective geotextile, or other suitable protective material, such as a sand layer, immediately below or above the soil vapour barrier membrane, as considered appropriate by the Licenced Professional Engineer;

VENT RISERS

v. vent risers of sufficient size or diameter, frequency and locations to promote efficient venting and that terminate above the roof of the Building, to convey soil vapour from the soil vapour venting layer to the outdoor air above the roof of the Building and that discharge at an appropriate distance, consistent with the separation provisions in ASTM E2121 but modified as appropriate for the characteristics of the soil vapour and Building, from Building air intakes and openable windows, doors and other openings through which exhausted vapours could be entrained in Building air, including:

(a) at least one vent riser per isolated section of the soil vapour venting layer caused by interior grade beams or thickened slabs, unless analysis or testing indicates a lesser number of vent risers is required;

(b) vent pipe riser diameter that is greater than the collection pipe diameter, to promote efficient venting;

(c) vent risers located within the Building, where appropriate, to promote temperature induced convective venting during colder weather; and

(d) a wind turbine or solar powered wind turbine on each vent riser;

MONITORING DEVICES

vi. monitoring devices installed below the foundation floor slab across the Building Area for measurement of the (lower) air pressure differential, relative to the indoor air pressure within the Building, being achieved by the soil vapour venting layer, with the number and locations of the monitoring devices installed being as considered appropriate by the Licenced Professional Engineer in consultation with the Qualified Person, taking into account factors such as the Building Area and the design and configuration of the Building foundation;

LABELING OF EQUIPMENT

vii. labeling of equipment for the Passive SVIMS, including information such as the installer's name, date of installation and identification of all visible piping, consistent with the labeling provisions in ASTM E1465 but modified as appropriate for the characteristics of the soil vapour and Building; and

UTILITY SEALING

viii. where utilities or subsurface Building penetrations are a potential conduit for soil vapour migration,

(a) utility trench dams, consisting of a soil-bentonite mixture, sand-cement slurry or other appropriate material, installed as a precautionary measure to reduce the potential for soil vapour to migrate beneath the Building through relatively permeable trench backfill; and

(b) conduit seals constructed of closed cell polyurethane foam~~,~~ or other inert gas-impermeable material at the termination of all utility conduits and at subsurface Building penetrations, such as sumps, to reduce the potential for vapour migration along the conduit to the interior of the Building;

QUALITY ASSURANCE / QUALITY CONTROL

b. Preparing and implementing a quality assurance and quality control program, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, so as to ensure that the Passive SVIMS is being and has been properly installed and the installation documented, including inspections, verification testing and documenting of the installation as it is carried out, including at a minimum:

i. procedures and timing for implementing the program, by a person acceptable to and under the supervision of a Licenced Professional Engineer;

ii. daily inspections of the installation of the Passive SVIMS, including of the quality assurance and quality control measures and procedures undertaken by the installer;

iii. undertaking, at a minimum, the following quality control measures and verification testing of the soil vapour barrier membrane:

(a) daily inspection reports noting any deficiencies and corrective actions taken;

(b) smoke testing of the soil vapour barrier membrane, or equivalent alternative testing method that provides comparable results;

(c) verification of the type and thickness of the soil vapour barrier membrane through testing of representative samples of materials used, including destructive testing and repair of portions of the membranes to be conducted in a manner and at a frequency that meets or exceeds manufacturer's recommendations;

(d) verification of field seams of sheet geomembranes as being continuous and leak free through vacuum or pressure testing, geophysical testing or other appropriate means; and

(e) verification that appropriate measures to prevent post-construction damage or degradation to the soil vapour barrier membrane have been taken, including at a minimum, appropriate preparation of the sub-slab foundation layer, placement of a protective geotextile, or other suitable protective material, below or above the soil vapour barrier membrane, if included in the design, and work practices to prevent post-construction damage;

iv. noting any deficiencies in the materials or installation of the Passive SVIMS;

v. ensuring the prompt repair of any deficiencies, to the design specifications;

vi. preparing a written report of all inspections, quality control measures and verification testing undertaken, and any deficiencies and repairs, prepared by the Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer;

and which is,

vii. delivered to the Owner before installation of the Passive SVIMS begins; and

viii. updated and delivered to the Owner within 30 days of making any alteration to the program;

AS CONSTRUCTED PLANS

c. Preparing as constructed plans of the Passive SVIMS, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, showing the location of the Building and the location and specifications of the installed Passive SVIMS, including cross-sectional drawings specifying the design and the vertical and lateral extent of the Passive SVIMS relative to the Building and the ground surface, and which is:

i. delivered to the Owner before use of all or any part of the Building begins, or within 90 days following completion of installation of the Passive SVIMS, whichever is earlier; and

ii. updated, and delivered to the Owner within 30 days following making any alteration to the Passive SVIMS, or other relevant feature shown on the plans;

INSPECTION AND MAINTENANCE

d. Preparing and implementing a written inspection and maintenance program, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, to ensure the continued integrity and effectiveness of the Passive SVIMS, including, at a minimum:

i. procedures and timing for implementing the program, by a person meeting the qualifications as set out in the program;

ii. maintenance and calibration of operational, monitoring and other equipment, as appropriate;

iii. inspections of the Passive SVIMS, including:

(a) semi-annual inspections, in spring and fall, of the visible areas of the foundation floor slab or subsurface walls in contact with soil to identify any cracks, breaches or other deficiencies that may allow soil vapour to enter the Building;

(b) semi-annual inspections, in spring and fall, of the visible components of the Passive SVIMS to identify any cracks, breaches or other deficiencies that may hinder the collection or venting of soil vapour from below the Building;

(c) additional inspections, on a more frequent basis as appropriate, of the wind turbine(s) or solar powered wind turbine(s) to determine whether they turn freely, and

(d) additional inspections, during winter, as appropriate, to identify any significant accumulation of snow or ice requiring removal;

iv. noting any deficiencies or concerns with the floor slab and Passive SVIMS identified during any inspection, or at any other time;

v. repairing promptly any deficiencies, including under the supervision of a Licenced Professional Engineer for a deficiency referred to in part iii. (b) above;

vi. factors and considerations for determining if additional inspections or monitoring should be undertaken;

vii. a contingency plan to be implemented in the event the deficiencies cannot be repaired promptly, including factors and considerations for determining if the Passive SVIMS needs to be converted to operation as an Active SVIMS, and including prompt notification of the Ministry if such deficiencies, along with operational monitoring results and any additional lines of evidence suggest that soil vapour intrusion into the Building may occur, as determined by a Licenced Professional Engineer; and

viii. preparing a written report of all inspections, deficiencies, repairs and maintenance, and of implementation of the contingency plan if necessary, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer;

and which is,

ix. delivered to the Owner before use of all or any part of the Building begins, or within 90 days following completion of installation of the Passive SVIMS, whichever is earlier; and

x. updated and delivered to the Owner within 30 days following making any alteration to the program; and

OPERATIONAL MONITORING

e. Preparing and implementing a written program for monitoring of the operation of the Passive SVIMS, prepared by a Licenced Professional Engineer in consultation with a Qualified Person and to be retained by the Owner, and be available for inspection upon

request by a Provincial Officer, to ensure the continued integrity and effectiveness of the Passive SVIMS, including, at a minimum:

ii. procedures and timing for implementing the program, by a person meeting the qualifications as set out in the program;

iii. locations and description of the devices and equipment used, or tested, for each monitoring event;

iv. procedures for undertaking the testing, measurement and evaluation during a monitoring event, including calibration of operational, monitoring and other equipment, as appropriate;

v. undertaking operational monitoring, including the recording of the monitoring results, in accordance with the following:

(a) at least once before occupancy and as considered appropriate by the Licenced Professional Engineer after occupancy has commenced, vacuum testing of the soil vapour venting system by conducting pilot testing using temporary electrically powered fan(s), including with respect to the soil vapour venting layer being able to achieve, in the event conversion to operation as an Active SVIMS is necessary, a 6 Pascal lower air pressure differential objective below the foundation floor slab across the Building Area, relative to the indoor air pressure within the Building; and

(b) at least once before occupancy, quarterly during the first two years after occupancy has commenced and semi-annually thereafter, measuring of the (lower) air pressure differential below the foundation floor slab across the Building Area, relative to the indoor air pressure within the Building, being achieved by the soil vapour venting layer, using all of the monitoring devices, including those referred to in part vi. of section a. above;

v. for each year, undertaking an assessment and preparing a written monitoring report, by a Licenced Professional Engineer in consultation with a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, on the operational monitoring undertaken and its results and findings with respect to the integrity and effectiveness of the installed Passive SVIMS, including taking into account previous monitoring undertaken, and with recommendations and any follow-up actions to be taken, such as:

(a) the need to repeat or undertake additional or follow-up operational monitoring~~,~~ and assessment, or additional inspections;

(b) changes to the frequency or nature of the monitoring;

(c) the need to make repairs or changes to the design or operation of the Passive SVIMS; and

(d) if necessary, implementation of the contingency plan, including if the Passive SVIMS needs to be converted to operation as an Active SVIMS, in the event needed repairs or changes to the Passive SVIMS cannot be made promptly, including notification of the Ministry if the operational monitoring results, inspections and any additional lines of evidence suggest that soil vapour intrusion into the Building may occur, as determined by a Licenced Professional Engineer;

and which is,

vi. delivered to the Owner before use of all or any part of the Building begins, or within 90 days following completion of installation of the Passive SVIMS, whichever is earlier; and

vii. updated and delivered to the Owner within 30 days of following making any alteration to the program;

INTRUSIVE ACTIVITIES CAUTION

f. Preparing and implementing written procedures, prepared by a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, for written and oral communication to all persons who may be involved in Intrusive Activities at the Property that may disturb an installed Passive SVIMS, so as to ensure the persons are made aware of the presence and significance of the Passive SVIMS and the Property Specific Contaminants of Concern at the Property and the precautions to be taken to ensure the continued integrity of the Passive SVIMS when undertaking the Intrusive Activities, and if damaged, to ensure the Passive SVIMS is repaired promptly to the original design specifications, or if it cannot be repaired promptly, to ensure the contingency measures are implemented, and records kept, as specified in the inspection and maintenance program;

and which are,

i. delivered to the Owner before any Intrusive Activities are undertaken at the Property; and

ii. updated and delivered to the Owner within 30 days following making any alteration to the procedures; and

g. The Building complies with all applicable requirements of the Building Code, such as the provisions governing the following:

    i. soil gas control as set out in Division B, subsection 9.13.4. (Soil Gas Control) of the Building Code;

    ii. protection against depressurization as set out in Division B, Article 9.32.3.8. (Protection Against Depressurization) of the Building Code; and

    iii. separation of air intakes and exhaust outlet openings and protection against contamination of the ventilation air by the exhaust air as set out in Division B, Article 9.32.3.12. (Outdoor Intake and Exhaust Openings) of the Building Code.

5.2 ACTIVE SOIL VAPOUR INTRUSION MITIGATION SYSTEM (SVIMS) RISK MANAGEMENT MEASURE (RMM)

The Active Soil Vapour Intrusion Mitigation System risk management measure may be used where,

INDUSTRIAL, COMMERCIAL OR COMMUNITY USE

i. the intended and actual use of the Property is industrial use, commercial use or community use, as defined in O. Reg. 153/04, or a combination thereof,

or,

RESIDENTIAL, PARKLAND OR INSTITUTIONAL USE

ii. the intended and actual use of the Property is commercial use, community use, residential use, parkland use or institutional use, as defined in O. Reg. 153/04, or a combination thereof, and

iii. if the intended and actual use of the Property includes residential use, parkland use or institutional use, or a combination thereof, the Building is a multi-storey, multi-unit Building with separately owned or occupied units on different storeys of the Building, and there is ongoing Property Management Oversight of the Property and Building.

The Active Soil Vapour Intrusion Mitigation System risk management measure is set out below.

ACTIVE SOIL VAPOUR INTRUSION MITIGATION SYSTEM (SVIMS) RISK MANAGEMENT MEASURE (RMM)

Not constructing any Building on the Property unless the Building includes an Active SVIMS and the Active SVIMS meets the following requirements:

DESIGN, INSTALLATION AND OPERATION

a. Designing, installing and operating an Active SVIMS for the Building, designed by a Licenced Professional Engineer in consultation with a Qualified Person and installed by a person acceptable to and under the supervision of a Licenced Professional Engineer, so as to remove soil vapour from below the Building and prevent soil vapour containing the Property Specific Contaminants of Concern from entering the Building air, including the following requirements and components for the Active SVIMS:

SYSTEM REQUIREMENTS

i. the Active SVIMS is to:

(a) be designed, installed and operated with the objective of achieving during all seasons at least a 6 Pascal lower air pressure differential below the foundation floor slab, relative to the indoor air pressure within the Building, across at least 90% of the Building Area; and

(b) have in place, measures, as appropriate based on an assessment carried out in accordance with ASTM E1998, to prevent potential depressurization induced back drafting and spillage of combustion products from vented combustion appliances that may be in the Building, due to the use of electrical fan powered vents;

SUB-SLAB FOUNDATION LAYER

ii. throughout the Building Area below the foundation floor slab, a sub-slab foundation layer, above soil containing the Property Specific Contaminants of Concern, designed by a Licenced Professional Engineer for the Building constructor in consultation with the Licenced Professional Engineer for the Active SVIMS;

SOIL VAPOUR VENTING LAYER

iii. throughout the Building Area below the foundation floor slab and above the sub-slab foundation layer, a soil vapour venting layer designed for collection and venting of soil vapour from below the floor slab to vent risers for venting to the outdoor air, with the soil vapour venting layer consisting of:

(a) perforated collection pipes or geocomposite strips of sufficient size or diameter, frequency and locations to promote efficient collection and venting , embedded in granular materials of sufficient air permeability and depth;

or,
other soil vapour collection and venting products used to construct a soil vapour venting layer with continuous open void space, such as an aerated sub-floor below the floor slab and around the exterior walls, which provides similar or greater air permeability and collection and venting efficiency;

(b) for a Building with isolated soil vapour venting layer areas caused by interior grade beams or areas of thickened slabs, ventilation pipes to connect the isolated areas or a soil vapour venting layer that extends below these elements of the Building foundation; and

(c) clean-outs, drains or openings to ensure drainage and removal of condensate or water, including any entrained dust, that may enter

collection pipes, geocomposite strips or vent risers and, if required, to ensure drainage or dewatering of the soil vapour venting layer in Property areas with a shallow ground water table;

SOIL VAPOUR BARRIER MEMBRANE

iv. throughout the Building Area, a continuous leak free soil vapour barrier membrane, such as a sheet geomembrane or spray applied membrane, below the foundation floor slab and above the soil vapour venting layer, and below and along the walls of any subsurface structures such as a sump, and which:

(a) is of appropriate thickness and meets the appropriate gas permeability and chemical resistance specifications to be considered substantially impermeable to the soil vapour, in accordance with the appropriate ASTM standards such as D412 and D543, as applicable; and

(d) has a suitable protective geotextile, or other suitable protective material, such as a sand layer, immediately below or above the soil vapour barrier membrane, as considered appropriate by the Licenced Professional Engineer;

VENT RISERS

v. vent risers of sufficient size or diameter, frequency and locations to promote efficient venting and that terminate above the roof of the Building, to convey soil vapour from the soil vapour venting layer to the outdoor air above the roof of the Building and that discharge at an appropriate distance, consistent with the separation provisions in ASTM E2121 but modified as appropriate for the characteristics of the soil vapour and Building, from Building air intakes and openable windows, doors and other openings through which exhausted vapours could be entrained in Building air, including:

(a) at least one vent riser per isolated section of the soil vapour venting layer caused by interior grade beams or thickened slabs, unless analysis or testing indicates a lesser number of vent risers is required;

(b) vent pipe riser diameter that is greater than the collection pipe diameter, to promote efficient venting;

(c) vent risers located within the Building, where appropriate, to promote temperature induced convective venting during colder weather; and

(d) an electrical powered fan on each vent riser, and an automated monitoring system of fan operation which remotely detects and indicates system malfunctions;

MONITORING DEVICES

vi. monitoring devices installed below the foundation floor slab across the Building Area for measurement of the (lower) air pressure differential, relative to the indoor air pressure within the Building, being achieved by the soil vapour venting layer, with the number and locations of the monitoring devices installed being as considered appropriate by the Licenced Professional Engineer in consultation with the Qualified Person, taking into account factors such as the Building Area and the design and configuration of the Building foundation;

LABELING OF EQUIPMENT

vii. labeling of equipment for the Active SVIMS, including information such as the installer's name, date of installation and identification of all visible piping, consistent with the labeling provisions in ASTM E1465 but modified as appropriate for the characteristics of the soil vapour and Building; and

UTILITY SEALING

viii. where utilities or subsurface Building penetrations are a potential conduit for soil vapour migration,

(a) utility trench dams consisting of soil-bentonite mixture, sand-cement slurry or other appropriate material, installed as a precautionary measure to reduce the potential for soil vapour to migrate beneath the Building through relatively permeable trench backfill; and

(b) conduit seals constructed of closed cell polyurethane foam, or other inert gas-impermeable material at the termination of all utility conduits and at subsurface Building penetrations, such as sumps, to reduce the potential for vapour migration along the conduit to the interior of the Building;

QUALITY ASSURANCE / QUALITY CONTROL

b. Preparing and implementing a quality assurance and quality control program, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, so as to ensure that the Active SVIMS is being, and has been, properly installed and the installation documented, including inspections, verification testing and documenting of the installation as it is carried out, including at a minimum:

i. procedures and timing for implementing the program, by a person acceptable to and under the supervision of a Licenced Professional Engineer;

ii. daily inspections of the installation of the Active SVIMS, including of the quality assurance and quality control measures and procedures undertaken by the installer;

iii. undertaking, at a minimum, the following quality control measures and verification testing of the soil vapour barrier membrane:

(a) daily inspection reports noting any deficiencies and corrective actions taken;

(b) smoke testing of the soil vapour barrier membrane, or equivalent alternative testing method that provides comparable results;

(c) verification of the type and thickness of the soil vapour barrier membrane through testing of representative samples of materials used, including destructive testing and repair of portions of the membranes to be conducted in a manner and at a frequency that meets or exceeds manufacturer's recommendations;

(d) verification of field seams of sheet geomembranes as being continuous and leak free, through vacuum or pressure testing, geophysical testing or other appropriate means; and

(e) verification that appropriate measures to prevent post-construction damage or degradation to the soil vapour barrier membrane have been taken, including at a minimum, appropriate preparation of the sub-slab foundation layer, placement of a protective geotextile, or other suitable protective material, below or above the soil vapour barrier membrane, if included in the design, and work practices to prevent post-construction damage;

iv. noting any deficiencies in the materials or installation of the Active SVIMS;

v. ensuring the prompt repair of any deficiencies, to the design specifications;

vi. preparing a written report of all inspections, quality control measures and verification testing undertaken, and any deficiencies and repairs, prepared by the Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer;

and which is,

vii. delivered to the Owner before installation of the Active SVIMS begins; and

viii. updated and delivered to the Owner within 30 days of making any alteration to the program;

AS CONSTRUCTED PLANS

c. Preparing as constructed plans of the Active SVIMS, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, showing the location of the Building and the location and specifications of the installed Active SVIMS, including cross-sectional drawings specifying the design and the vertical and lateral extent of the Active SVIMS relative to the Building and the ground surface, and which is:

    i. delivered to the Owner before use of all or any part of the Building begins, or within 90 days following completion of installation of the Active SVIMS, whichever is earlier; and

    ii. updated and delivered to the Owner within 30 days following making any alteration to the Active SVIMS, or other relevant feature shown on the plans;

INSPECTION AND MAINTENANCE

d. Preparing and implementing a written inspection and maintenance program, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, to ensure the continued integrity and effectiveness of the Active SVIMS, including, at a minimum:

    i. procedures and timing for implementing the program, by a person meeting the qualifications as set out in the program;

    ii. maintenance and calibration of operational, monitoring and other equipment, as appropriate;

    iii. inspections of the Active SVIMS, including:

        (a) semi-annual inspections, in spring and fall, of the visible areas of the foundation floor slab or subsurface walls in contact with soil, to identify any cracks, breaches or other deficiencies that may allow soil vapour to enter the Building;

        (b) semi-annual inspections, in spring and fall, the visible components of the Active SVIMS, to identify any cracks, breaches or other deficiencies that may hinder the collection or venting of soil vapour from below the Building;

        (c) additional inspections, on a more frequent basis as appropriate, of the electrical powered fans to confirm they turn freely, to confirm the

automated monitoring system of fan operation is operational and to confirm operational parameters such as amperage levels are within appropriate ranges; and

(d) additional inspections during winter, as appropriate, to identify any significant accumulation of snow or ice requiring removal;

iv. noting any deficiencies with the floor slab and Active SVIMS identified during any inspection, or at any other time;

v. repairing promptly any deficiencies, including under the supervision of a Licenced Professional Engineer for a deficiency referred to in part iii. (b);

vi. factors and considerations for determining if additional inspections or monitoring should be undertaken;

vii. a contingency plan to be implemented in the event the deficiencies cannot be repaired promptly, including prompt notification of the Ministry if such deficiencies, along with operational monitoring results and any additional lines of evidence suggest that soil vapour intrusion into the Building may occur, as determined by a Licenced Professional Engineer; and

viii. preparing a written report of all inspections, deficiencies, repairs and maintenance, and of implementation of the contingency plan if necessary, prepared by a Licenced Professional Engineer and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer;

and which is,

ix. delivered to the Owner before use of all or any part of the Building begins, or within 90 days following completion of installation of the Active SVIMS, whichever is earlier; and

x. updated and delivered to the Owner within 30 days following making any alteration to the program;

OPERATIONAL MONITORING

e. Preparing and implementing a written program for monitoring of the operation of the installed Active SVIMS, prepared by a Licenced Professional Engineer in consultation with a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, to ensure the continued integrity and effectiveness of the Active SVIMS, including, at a minimum:

i. procedures and timing for implementing the program, by a person-meeting the qualifications as set out in the program;

ii. locations and description of the devices and equipment used, or tested, for each monitoring event;

iii. procedures for undertaking the testing, measurement and evaluation during a monitoring event, including calibration of operational, monitoring and other equipment, as appropriate;

iv. undertaking operational monitoring, including recording of the monitoring results, in accordance with the following:

(a) at least once before occupancy and as considered appropriate by a Licenced Professional Engineer after occupancy has commenced, vacuum testing of the soil vapour venting system by conducting pilot testing using the powered fan(s), including with respect to the soil vapour venting layer being able to achieve a 6 Pascal lower air pressure differential objective below the foundation floor slab across the Building Area, relative to the indoor air pressure within the Building; and

(b) at least once before occupancy and semi-annually after occupancy has commenced, measuring of the (lower) air pressure differential below the foundation floor slab across the Building Area, relative to the indoor air pressure within the Building, being achieved by the soil vapour venting layer, using all of the monitoring devices, including those referred to in part vi. of section a. above;

v. for each year, undertaking an assessment and preparing a written monitoring report, by a Licenced Professional Engineer in consultation with a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, on the operational monitoring undertaken and its results and findings with respect to the integrity and effectiveness of the installed Active SVIMS, including taking into account previous monitoring undertaken, and with recommendations and any follow-up actions to be taken, such as:

(a) the need to repeat or undertake additional or follow-up operational monitoring and assessment, or additional inspections;

(b) changes to the frequency or nature of the monitoring;

(c) the need to make repairs or changes to the design or operation of the Active SVIMS; and

(d) if necessary, implementation of the contingency plan in the event needed repairs or changes to the Active SVIMS cannot be made promptly, including notification of the Ministry if the operational monitoring results and any additional lines of evidence suggest that soil vapour intrusion into the Building may occur, as determined by a Licenced Professional Engineer;

and which is,

vi. delivered to the Owner before use of all or any part of the Building begins, or within 90 days following completion of installation of the Active SVIMS, whichever is earlier; and

vii. updated and delivered to the Owner within 30 days of following making any alteration to the program;

INTRUSIVE ACTIVITIES CAUTION

f. Preparing and implementing written procedures, prepared by a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, for written and oral communication to all persons who may be involved in Intrusive Activities at the Property that may disturb an installed Active SVIMS, so as to ensure the persons are made aware of the presence and significance of the Active SVIMS and the Property Specific Contaminants of Concern at the Property and the precautions to be taken to ensure the continued integrity of the Active SVIMS when undertaking the Intrusive Activities, and if damaged, to ensure the Active SVIMS is repaired promptly to the original design specifications, or if it cannot be repaired promptly, to ensure the contingency measures are implemented, and records kept, as specified in the inspection and maintenance program;

and which are,

i. delivered to the Owner before any Intrusive Activities are undertaken at the Property; and

ii. updated and delivered to the Owner within 30 days following making any alteration to the procedures; and

g. The Building complies with all applicable requirements of the Building Code, such as the provisions governing the following:

    i. soil gas control as set out in Division B, subsection 9.13.4. (Soil Gas Control) of the Building Code;

    ii. protection against depressurization as set out in Division B, Article 9.32.3.8. (Protection Against Depressurization) of the Building Code; and

    iii. separation of air intakes and exhaust outlet openings and protection against contamination of the ventilation air by the exhaust air as set out in Division B, Article 9.32.3.12. (Outdoor Intake and Exhaust Openings) of the Building Code.

6. BUILDING WITH NO FIRST STOREY RESIDENTIAL, INSTITUTIONAL OR PARKLAND USE RISK MANAGEMENT MEASURE (RMM)

The Building with No First Storey Residential, Institutional or Parkland Use risk management measure is set out below.

BUILDING WITH NO FIRST STOREY RESIDENTIAL, INSTITUTIONAL OR PARKLAND USE RISK MANAGEMENT MEASURE (RMM)

Not constructing any Building on the Property, unless:

a. The intended and actual use of the Property is commercial use, community use, residential use, parkland use or institutional use, as defined in O. Reg. 153/04, or a combination thereof;

b. The intended and actual use of the Building on its First Storey and below Grade is not residential use, parkland use or institutional use, or a combination thereof;

c. The ventilation and air duct systems serving the First Storey of the Building and any area below this are separate systems from the ones serving all stories above the First Storey; and

d. The Building complies with all applicable requirements of the Building Code, such as the provisions governing:

    i. interconnection of air duct systems as set out in Division B, Sentence (2) of Article 6.2.3.9. (Interconnection of Systems) of the Building Code; and

    ii. air leakage as set out in Division B, Section 5.4. (Air Leakage) of the Building Code.

7. BUILDING WITH MINIMUM FIRST STOREY CEILING HEIGHT REQUIREMENT RISK MANAGEMENT MEASURE (RMM)

The Building with Minimum First Storey Ceiling Height Requirement risk management measure is set out below.

The bracketed portion in the risk management measure applies for purposes of issuing a Certificate of Property Use.

BUILDING WITH MINIMUM FIRST STOREY CEILING HEIGHT REQUIREMENT RISK MANAGEMENT MEASURE (RMM)

Not constructing any Building on the Property, unless:

a. The intended and actual use of the Property is industrial use, commercial use or community use, as defined in O. Reg. 153/04, or a combination thereof;

b. A minimum First Storey ceiling height in centimetres has been specified for the Building in section 7 of the Risk Assessment;

c. The Building is constructed with the minimum First Storey ceiling height [FOR PURPOSES OF THE MGRA CPU, INSERT "of {INSERT NUMBER} centimetres,"] as specified in section 7 of the Risk Assessment report; and

d. The Building is designed, constructed and operated with a ventilation system for the First Storey that provides an air exchange rate of a minimum of 1 air exchange per hour.

8. NO GROUND WATER USE RISK MANAGEMENT MEASURE (RMM)

The No Ground Water Use risk management measure is set out below:

NO GROUND WATER USE RISK MANAGEMENT MEASURE (RMM)

a. Not using ground water in or under the Property as a source of water;

b. Properly abandoning any wells on the Property, as defined in section 35. (1) of O. Reg. 153/04, according to R.R.O. 1990, Regulation 903 (Wells), as amended, made under the Ontario Water Resources Act, R.S.O. 1990, c. O.40; and

c. Not constructing on the Property any wells as defined in section 35. (1) of O. Reg. 153/04.

9. HEALTH AND SAFETY PLAN REQUIREMENT

The Health and Safety Plan requirement is set out below.

HEALTH AND SAFETY PLAN REQUIREMENT

a. In addition to any requirements under the Occupational Health and Safety Act, R.S.O. 1990, c. O.1, preparing and implementing a written health and safety plan for the Property, prepared by a Competent Person in consultation with a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, that includes information concerning the potential hazards and safe work measures and procedures with respect to the Property Specific Contaminants of Concern at the Property and the communication of this information to all persons who may be involved in Intrusive Activities at the Property, including, at a minimum:

    i. the procedures and timing for implementing the plan, including the supervision of persons implementing the plan;

    ii. all relevant information concerning the presence of, human exposure to, and risk posed by, the Property Specific Contaminants of Concern through dermal contact, soil or ground water ingestion and inhalation of soil particles or vapour, and concerning any biogenic gases such as methane that may be present at the Property including information in the Risk Assessment,

    iii. all relevant information, measures and procedures concerning protection of the persons from exposure to the Property Specific Contaminants of Concern and the precautions to be taken when undertaking Intrusive Activities, including the supervision of workers, occupational hygiene requirements, use of personal protective equipment, provision of air flow augmentation in excavations or other areas or situations of minimal air ventilation, and other protective measures and procedures as appropriate;

    iv. all relevant information concerning the presence and significance of the risk management measures and requirements which are being, or have been, implemented at the Property,

    v. the procedures and timing for implementing emergency response and contingency measures and procedures, including contact information, in the event of a health and safety incident; and

    vi. the recording, in writing, of the implementation of the plan and any health and safety incidents that occur, to be retained by the Owner and be available for inspection upon request by a Provincial Officer;

and which is,

vii. delivered to the Owner before any Intrusive Activities are undertaken at the Property; and

viii. updated and delivered to the Owner within 30 days following making any alteration to the plan.

10. SOIL AND GROUND WATER MANAGEMENT PLAN REQUIREMENT

The Soil and Ground Water Management Plan requirement is set out below.

SOIL AND GROUND WATER MANAGEMENT PLAN REQUIREMENT

a. Preparing and implementing a written soil and ground water management plan for the Property, prepared by a Qualified Person and to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, for managing excavated soil or soil brought to the Property, and, if any, ground water from dewatering during Intrusive Activities at the Property, so as to prevent exposure to or uncontrolled movement or discharge of the Property Specific Contaminants of Concern in soil or ground water at the Property, including, at a minimum:

    i. procedures and timing for implementing the plan, including the supervision of persons implementing the plan;

    ii. measures to control dust and prevent tracking of soil by vehicles and persons from the Property, including the cleaning of equipment and vehicles;

    iii. measures, in addition to any applicable measures specified in O. Reg. 153/04, to manage soil excavated at the Property and any soil brought to or removed from the Property, including:

        (a) characterizing for contaminant quality all excavated soil and any soil brought to the Property, including determining whether the soil:

            1. is Capping Soil;

            2. meets the Property Specific Standards; or

            3. exceeds the Property Specific Standards;

        (b) managing excavated soil separately from any soil brought to the Property, including any excavated soil that is to be:

            1. used as Capping Soil at the Property;

            2. otherwise used as fill at the Property;

            3. removed from the Property for off-site storage or processing but is to be returned for use as fill at the Property; or

            4. removed from the Property for off-site use as fill or disposal; and

(c) stockpiling of excavated soil and any soil brought to the Property in separate designated areas that:

1. reflect the distinctions described in parts iii. (a) and (b);

2. have been lined and covered, as appropriate, to prevent uncontrolled movement or discharge of the Property Specific Contaminants of Concern;

3. have been bermed or fenced, as appropriate, to restrict access by persons; and

4. have storm water runoff controls in place to minimize storm water runoff contacting stockpiled soil, with provision for discharge of storm water runoff to a sanitary sewer or to other approved treatment if needed;

iv. measures to manage storm water and any ground water from dewatering at the Property to prevent the movement of entrained soil and Property Specific Contaminants of Concern within and away from the Property, including, in addition to any applicable measures specified pursuant to other applicable law or other instruments, measures such as silt fences, filter socks for catch-basins and utility covers, and provision for discharge to a sanitary sewer or to other approved treatment if needed; and

v. recording, in writing, the soil, storm water and any ground water management measures undertaken, in addition to any applicable record keeping requirements specified in O. Reg. 153/04 or pursuant to other applicable law or other instruments, to be retained by the Owner, and be available for inspection upon request by a Provincial Officer, including:

(a) dates and duration of the Intrusive Activities being undertaken;

(b) weather and site conditions during the Intrusive Activities;

(c) the location and depth of excavation activities, and dewatering activities, if any;

(d) dust control and soil tracking control measures;

(e) characterization results for excavated soil and any soil brought to or removed from the Property, and for any ground water from dewatering;

(f) soil management activities including soil quantities excavated and brought to and removed from the Property, and stockpile management and storm water runoff control;

(g) management activities for any ground water from dewatering;

(h) names and contact information for the Qualified Persons and on-site contractors involved in the Intrusive Activities;

(i) names and contact information for any haulers and receiving sites for soil and any ground water removed from the Property, and for haulers and source sites of any soil brought to the Property; and

(j) any complaints received relating to the Intrusive Activities, including the soil, storm water and any ground water management activities;

and which is,

vi. delivered to the Owner before any Intrusive Activities are undertaken at the Property; and

vii. updated and delivered to the Owner within 30 days following making any alteration to the plan.