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GUIDANCE MANUAL FOR ENVIRONMENTAL SITE CHARACTERIZATION IN SUPPORT OF ENVIRONMENTAL AND HUMAN HEALTH RISK ASSESSMENT

VOLUME 2 CHECKLISTS

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PREFACE

This manual is one of a series of volumes dedicated to providing guidance on environmental site characterization in support of environmental and human health risk assessment at contaminated sites. The goal of the environmental site characterization guidance is to provide Canadians with a consistent approach to sampling and analyzing complex environmental matrices, such that the data obtained will be representative and of known quality.

The environmental site characterization guidance consists of four volumes:

Volume 1: Guidance Manual
Volume 2: Checklists [this document]
Volume 3: Suggested Operating Procedures
Volume 4: Analytical Methods

The intent of Volume 2, *Checklists*, is to help users develop a concise compilation of key information on the site, and to facilitate a review of the key elements of an Environmental Site Assessment to assess the completeness and to identify data gaps that may exist.

There are four checklists in Volume 2:

CHECKLIST NO. 1

SUMMARY OF SITE CONDITIONS AND REVIEW[1]

Summary author:

_____

Date prepared:

_____

INTENDED PURPOSE: The intent of the "Summary of Site Conditions and Review" is to facilitate a concise compilation of key information on the site, which may be used by both practitioners assessing sites and regulators reviewing reports. The context is environmental site characterizations performed in support of human health and environmental risk assessments. Checklist 1 is intended to be used in conjunction with Checklists 2 to 4, which provide a more detailed review. This summary should not be used as the sole basis for decisions about the site. Instead, the available reports for the site should be consulted to develop a more detailed understanding of the site. Firms, agencies and individuals that rely on the information contained herein do so entirely at their own risk.

1.0 Reason for Report

This Summary Report is prepared in support of:

_____

_____

2.0 Site Location (Attach site location figure and if available, the legal plan)

Subject Site:	
Civic Address:	
Code identifier: *(*e.g., *FCSI 8-digit identifier)*	
Site Common Name : *(if applicable)*	
Legal description *or* metes and bounds:	
Property identifier number (e.g., PID, PIN or DFRP number) *(if applicable)*	
Centre of site: *(using NAD 83 convention)*	Latitude: ____ degrees ____ min ____ secs
	Longitude: ____ degrees ____ min ____ secs

[1] Adapted from checklist developed for BC Environment Contaminated Sites Regulations Schedule 1.1 (Summary of Site Condition) and Technical Guidance 10 (Checklist for Reviewing a Preliminary Site Investigation) and Technical Guidance 11 (Checklist for Reviewing a Detailed Site Investigation).

Offsite impacted properties	☐ Offsite impacted properties present; ☐ Not Applicable.
Civic Address:	
Site Common Name*:* *(if applicable)*	
Legal description *or* metes and bounds:	
Property identifier number (e.g., PID, PIN or DFRP number) *(if applicable)*	
Centre of site:	Latitude: ____ degrees ____ min ____ secs
	Longitude: ____ degrees ____ min ____ secs

3.0 Investigations Completed

		Yes	No
Phase 1 ESA	Completed?	☐	☐
Phase 2 ESA (preliminary)	Completed?	☐	☐
Phase 3 ESA (detailed)	Completed?	☐	☐
Other Reports	Completed?	☐	☐

4.0 Document Summary

(List all known site investigation, assessment and remediation reports completed and supporting correspondence for subject site and offsite impacted sites)

#	Document Title	Author / Company	Date

5.0 Site Conditions

Topography
Describe steepness and direction of slope and position of site in relation to surrounding land

_____
_____
_____

Stratigraphy
Describe depth and grain size of typical stratigraphic components and note depth to cemented or very compact materials, bedrock / refusal, etc.

_____

_____

_____

Hydrogeology
Describe groundwater levels, confining / semi-confining layers, flow direction and velocity

_____

_____

_____

Surface water features
List name, direction and distance to nearest surface water bodies and the characteristics (e.g., relative size / flow, lentic/lotic, depth, area) of the water body

Fresh water:

_____

_____

Marine:

_____

_____

6.0 Land Use

Location		**Description of Current Land Use(s) / Activities**
Onsite	Subject site	
Offsite (within 1 km)	North	
	East	
	South	
	West	

Proposed future land use of subject site: ☐ same as above or ☐ other (*please specify*)

_____

7.0 Applicable Numerical Concentration Standards and/or Criteria

Soil: (check all that apply)

Property		**Land Use**					
		Residential	Commercial	Industrial	Parkland	Agricultural	Other
Subject site	Current	☐	☐	☐	☐	☐	☐
	Proposed	☐	☐	☐	☐	☐	☐
Offsite impacted property / management area		☐	☐	☐	☐	☐	☐

If other is specified above, please explain:_____

Water: (check all that apply)

	Freshwater Aquatic Life*	Marine Aquatic Life*	Drinking Water	Livestock Water	Irrigation Water	No Water Use
Groundwater	☐	☐	☐	☐	☐	☐
	Freshwater Aquatic Life	Marine Aquatic Life	Drinking Water	Livestock Water	Irrigation Water	
Surface Water	☐	☐	☐	☐	☐	

*Downgradient (surface) receptor

Sediment: (check all that apply)

☐ Freshwater ☐ Marine/Estuarine ☐ Sensitive ☐ Typical ☐ Not applicable

Biological Tissue: (check all that apply)

☐ Fish tissue (human consumption) ☐ Fish tissue (wildlife consumption)
☐ Other biological tissue ☐ Not applicable

8.0 Areas of Potential Environmental Concern (APEC) and Contaminants of Potential Concern (COPC) Summary (attach figure(s) showing on and off-site APECs)

Area of Potential Environmental Concern (APEC)		**Contaminants of Potential Concern (COPCs)** *(indicate products, chemicals, waste type, etc. and / or analytical parameter)*	**Check where analyses completed** *(or n/a if not applicable)*					
APEC #	**Description** *(describe location and historical or current site use or activity that has led to the environmental concern(s), and whether soil, groundwater, soil, vapour contamination, surface water and/or sediment is a concern*		Soil	Sediment	Ground water	Surface Water	Vapour	Other (explain)
			☐	☐	☐	☐	☐	☐
			☐	☐	☐	☐	☐	☐
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			☐	☐	☐	☐	☐	☐

Other (please explain): _____
_____
_____
_____

Areas of Environmental Concern and Contaminant Summary

(attach figure(s) showing on and off-site AECs)

AEC # (*Use same #s as for APECs*)	**Contaminant of Concern**	**Medium** *(e.g., soil, groundwater, sediment, vapour, surface water, sediment, other)*	**Maximum Measured Concentration** (indicate units)	**Extent of Contamination**	
				Approximate Area (m^2)	**Approximate Depth Range** (m)

Notes:_____
_____

10.0 Offsite Migration

Is there evidence that one or more substances has migrated, or may migrate, to a neighbouring property or water body and is likely causing contamination of the neighbouring property or water body?
☐ Yes ☐No

Has any sampling occurred offsite for COPCs in any media? ☐ Yes ☐No

Have preferential pathways been assessed? ☐ Yes ☐No

If yes to the first question, complete the following:

The off-site migration, or likely off-site migration, is occurring in: ☐ dissolved plume in groundwater; ☐ free-phase non-aqueous phase liquid (NAPL); ☐ surface water; ☐ soil vapour; ☐ sediment; and/or ☐other.

Briefly describe the nature of and evidence for offsite migration (either known, suspected or potential) and whether is likely currently occurring, has potential to occur in future, or has occurred historically.

Have owners of impacted offsite properties been formally notified? ☐ Yes ☐ No
Have applicable regulatory agencies been formally notified? ☐ Yes ☐ No

The impacted offsite lands are categorized as:

- ☐ having a potable groundwater source;
- ☐ aquatic habitat;
- ☐ agricultural lands
- ☐ residential or urban parklands
- ☐ commercial land
- ☐ industrial land

11.0 Key Element Review

When completing this table, consider providing a brief reasoning for answering "Yes" to the stated question with reference to guidance used, standards used, or specific site information. Likewise, if the answer to the stated question is "No", identify the additional information required.

Issue (# in bracket refers to corresponding section in Checklist No. 2 - Phase 2/3 ESA)		**Summary of Review (summarize key aspects of review)**
Purpose and Objectives (1)	Are they clearly stated?	
Review and Initial CSM (2)	Has existing information been reviewed and an initial CSM developed, which is used to guide development of work plan?	
	Is the CSM complete in its identification of potential sources, migration pathways, and receptors?	
	Has the extent to which existing data has been relied upon been indicated in report?	
Site Information and Description (3-5)	Site information provided?	
	Climatic information provided?	
	Site description provided?	
Site Characterization Design and Methods (6-12)	Has representative data been obtained through appropriate sampling design and has there been sufficient sampling to characterize spatial and temporal variability?	
Soil	Key issues include: was an appropriate statistical sampling design followed, was contamination delineated, has there been appropriate use of discrete and composite samples and appropriate sampling methods for volatiles?	

Issue (# in bracket refers to corresponding section in Checklist No. 2 - Phase 2/3 ESA)		**Summary of Review (summarize key aspects of review)**
Groundwater	Key issues include: were there sufficient wells to characterize ground water flow and delineate plume, when estimating groundwater travel times, were appropriate estimates/assumptions made with respect to hydrogeologic parameters (conductivity, gradients), were screen lengths less than or equal to 1.5 m (and preferably less than 0.3 m), were appropriate sampling methods used (e.g., low-flow sampling)?	
Soil Vapour	Key issues include: did sampling design consider spatial and temporal variability, were minimum depth requirements for external probes met, was sampling density sufficient including minimum of two probes per APEC and two per building (when screening building), was seasonal (temporal) sampling conducted. Were key quality control requirements met including soil gas probes sealed, appropriate materials used, were flow and vacuum and leak tracer test results acceptable, and probes properly purged?	
Indoor Air	Key issues include: were potential background sources considered and were concurrent subslab/soil vapour and outdoor air samples obtained, does sampling design consider weather and building conditions and was temporal data obtained?	
Surface Water	Is sampling design spatially and temporally representative, and relevant to receptors of concern? Were reference areas appropriately selected and sampled?	
Sediment	Were sample depths defined appropriately, considering the biologically active zone? Were samples collected for purposes of chemical characterization, benthic community structure analysis, and toxicity testing co-located and collected concurrently? Were reference areas appropriately selected and sampled? Is characterization complete with respect to both chemical and	

Issue (# in bracket refers to corresponding section in Checklist No. 2 - Phase 2/3 ESA)		**Summary of Review (summarize key aspects of review)**
	habitat variables (e.g., grain size, total organic carbon)? Is sampling design spatially representative?	
Biological Tissue	Are the sampled species and life stage representative of the dietary preferences of relevant receptors? Were relevant feeding guilds targeted? Were samples prepared in a manner consistent with risk assessment needs (e.g., fillet skin on, fillet skin off, whole body)? Is the sampling design spatially and temporally representative? Was the method for and rationale for any sample compositing clearly stated?	
All media	Have all COPCs, transformation products and complementary parameters been tested?	
Maps and Figures (6-13)	Are there maps (with north arrow and scale) showing sampling locations, APECs, AECs and relevant site features and site uses?	
	Are there plans and cross-sections providing stratigraphic and hydrogeologic information?	
	Are the chemical concentrations posted on plans and cross-sections (or shown in table)?	
Quality Assurance/ Quality Control (QA/QC) (14)	Is there an adequately comprehensive description of QA/QC program and results of data quality indicators relative to targets?	
	Conclusions provided on the reliability of data based on QA/QC program?	
Data Validation & Interpretation (15)	Have all APECs been adequately investigated for all COPCs?	
	Have the investigation and sampling design objectives been met?	
	Is further assessment required to delineate the horizontal and vertical extent of contamination?	
CSM and Comparison to Regulatory Criteria (16) also see Sections 8 and 9 in Checklist No. 1 above)	Has an updated CSM that integrates available information on contamination sources, migration pathways, receptors and exposure mechanisms been developed?	
	Have correct federal and provincial criteria and/or standards been used for current and future site use?	

Issue (# in bracket refers to corresponding section in Checklist No. 2 - Phase 2/3 ESA)		**Summary of Review (summarize key aspects of review)**
	Are all APECs, AECs, and COPCs clearly identified in report?	
Conclusions and Recommendations (17)	Are conclusions and recommendations clear, unambiguous, and complete?	
Documentation (18)	Is documentation complete (e.g., logs, sampling sheets, laboratory reports including QA/QC)?	
References (19)	Primary authors and qualifications listed and references provided?	

12.0 Conclusions of Review (if answer "Yes", explain why in Section 13.0)

		Yes	**No**	**n/a**
Phase 1 ESA	Any outstanding issues for Phase 1 ESA?	☐	☐	☐
Phase 2 ESA (preliminary)	Any outstanding issues for Phase 2 ESA?	☐	☐	☐
Phase 3 ESA (detailed)	Any outstanding issues for Phase 3 ESA?	☐	☐	☐
Other Reports	Any outstanding issues?	☐	☐	☐

13.0 Summary of Review, Data Gaps, and Investigation Issues

CHECKLIST NO. 2

REVIEW OF ENVIRONMENTAL SITE CHARACTERIZATION REPORT

Report title:

Report author:

Report date:

Reviewed by:

Date reviewed:

INTENDED PURPOSE: The "Checklist for Review of Environmental Site Characterization Report" is intended to facilitate a review of the key elements of an Environmental Site Assessment (ESA) by a custodial department project manager. The focus of the review is to assess the ***completeness*** of the ESA, and to ***identify data gaps*** that may exist. Key technical requirements for ESAs are also itemized in the checklist, which will allow the reviewer to identify potential deficiencies in the report and/or in the methods used to conduct the ESA. The checklist does not address location of utilities and health and safety considerations (beyond the scope of this guidance).

Issue	Query	Yes	No	N/A	Report Section & Comments
Phase 1 Environmental Site Assessment					
1. Purpose and Objectives	1. Are the purposes (or goals) and objectives of the investigation clearly stated?				
2. Review	1. Have existing environmental, geotechnical or other relevant reports been reviewed?				
	2. Does the report indicate whether there are any federal or provincial orders or charges, or court or administrative actions that apply to the site?				
3. Site Information	**Does the report provide:**				
	1. Legal address of the property				
	2. Legal plan of the property				
	3. Civic address of the property				
	4. UTM coordinates for the centre of the property				
	5. If available, property identifier number (e.g., PID or PIN or DFRP or FCSAP number)				
	6. Dimensions and area of the property				
	7. Current owners				
	8. Municipal zoning of property				
	9. Municipal services and utility plans				
	10. Surface water and groundwater use				
	11. Distance to nearby surface water bodies and characteristics of those water bodies				
	12. Building plans and dimensions				

Issue	Query	Yes	No	N/A	Report Section & Comments
	13. Current and historic sources of building heat				
	14. Information on historic and current septic fields				
4. Regional Information	**Does the report provide:**				
	1. Search of databases and other sources for information on groundwater use (e.g., drinking water, irrigation) and monitoring wells for site and surrounding areas[2]				
	2. Search of databases on contaminated sites for site and surrounding areas[3]				
	3. Description of regional hydrogeology and aquifer classification from available reports and maps				
	4. Description of surficial geology from available reports and maps (e.g., Geological Survey of Canada)				
	5. Summary of climatic information from nearby weather station (temperature and precipitation)				
5. Historical Review	**Does the report provide:**				
	1. Site plans and diagrams				
	2. Aerial photographs				
	3. Provincial and municipal environmental records concerning the site				
	4. Historical property title search				
	5. City business directories				
	6. Fire insurance maps or records				
	7. Information provided by individuals knowledgeable about site				
6. Site Description & Reconnaissance	**Does the report provide description of:**				
	1. Site uses for property and surrounding areas				
	2. Topography and surface water drainage				
	3. Surface cover type and estimate of percentage of site occupied by buildings, landscaped areas, paved or non-paved parking lots, fields, parklands, forests, *etc.*				
	4. Surface water bodies (rivers, streams, lakes, ponds, *etc*), marshes and wetlands for site and surrounding areas; distance from site to these features				
	5. Potential for flooding of the site				
	6. Identification of potential environmentally sensitive habitats				
	7. Debris, waste disposal, lagoons, drums, chemical storage, burn sites or other indicators of potential contamination sources				

[2] The appropriate search radius is typically 0.5 to 1.5 kilometres, but may depend on inferred direction for groundwater flow (i.e., upgradient, sidegradient or downgradient direction).
[3] The appropriate search radius is typically a minimum of 0.5 kilometres.

Issue	Query	Yes	No	N/A	Report Section & Comments
	8. Visible signs or sources of pollutants on the surface of soil or water				
	9. Visibly distressed or dead vegetation				
	10. Photographs of site and adjoining properties				
	11. Date reconnaissance was conducted				
7. Industrial or Commercial Sites	**For industrial or commercial sites currently operating, does the report:**				
	1. Identify manufacturing processes, raw materials, chemicals and/or fuels used				
	2. Identify potential waste streams				
	3. Determine each waste stream's chemical characteristics, volume, and method of treatment and disposal				
	4. Identify the presence of electrical transformers or capacitors				
8. Maps and Figures	**Are there site map(s) that include:**				
	1. Property dimensions, north arrow and scale				
	2. Relevant buildings				
	3. Relevant land use				
	4. Natural features such as lakes, streams, marshes, wetlands, parklands, and forests				
	5. Constructed features such as ditches, buried utility corridors, above-ground and underground storage tanks, waste storage areas, landfills and lagoons				
	6. Topographic data (1:20,000 scale or larger)				
	7. Plan map showing all identified APECs and COPCs[4]				
	8. Map showing the site in context of local area (e.g., site location plan)				
9. Data Interpretation & Preliminary Conceptual Site Model (CSM)	**Does the report:**				
	1. Identify possible contamination associated with each site activity (past/present) for property and relevant off-site areas and approximate age of contamination, if known?				
	2. Are all APECs and COPCs clearly identified?				
	3. Present a preliminary CSM for contamination sources, contaminant migration pathways, receptors and exposure mechanisms?				
	4. Identify whether there is the potential for soil contamination?				
	5. Identify whether there is the potential for groundwater contamination?				
	6. Identify whether there is the potential for vapour intrusion?				
	7. Identify whether there is the potential for site-related surface water contamination?				

[4] APEC = Area of Potential Environmental Concern; COPC = Contaminant of Potential Concern

Issue	Query	Yes	No	N/A	Report Section & Comments
	8. Identify whether there is the potential for site-related sediment contamination?				
	9. Identify whether there is the potential for site-related biological tissue contamination?				
10. Conclusions & Recommendations	1. Are the conclusions clear and unambiguous, and supported by the investigation results?				
	2. Are uncertainties clearly stated and fully discussed?				
	3. Are the recommendations supported by the findings of the investigations and are they complete?				
11. References	**Does the report identify or reference:**				
	1. Who the primary participants and authors are and his or her qualifications				
	2. All data sources (including interviews) and previous studies that contributed information to the study				
	3. Technical literature that provides additional detail on procedures used in the study				
Phase 2 and 3 Environmental Site Assessments					
1. Purpose and Objectives	1. Are the purposes (or goals) and objectives of the investigation clearly stated?				
2. Review and Development of Initial CSM	1. Have existing environmental, geotechnical or other relevant reports been reviewed?				
	2. Were the findings of previous assessments (e.g., Phase 1 ESAs) used to develop initial CSM and guide development of work plan?				
	3. Does the report indicate the extent to which previous investigations and data were or were not relied upon; is the rationale for data exclusion provided if data not considered?				
	4. Does the report indicate whether there are any federal or provincial orders or charges, or court or administrative actions that apply to the site?				
3. Site Information	**Does the report provide (or reference previous reports for):**				
	1. Legal address of property, UTM coordinates, and other identifiers (e.g., PID, PIN, FCSI or DFRP)				
	2. Civic address of the property				
	3. Dimensions and area of the property				
	4. Municipal zoning of property				
	5. Municipal services and utility plans				
	6. Distance to nearby surface water bodies and characteristics of those water bodies				
	7. Surface water and groundwater use				
	8. Building plans and dimensions				
	9. Information on septic fields				

Issue	Query	Yes	No	N/A	Report Section & Comments
4. Climatic Information	**Does the report provide:**				
	1. Climatic information from nearby weather station providing the: a. Annual range in monthly temperature b. Annual range in monthly precipitation c. Seasonal variation in precipitation				
	2. An estimate of the infiltration rate, where warranted				
5. Site Description	**Does the report provide description of (or reference previous reports for):**				
	1. Site uses for property and surrounding areas				
	2. Topography and surface water drainage				
	3. Surface cover type and estimate of the percentage of site occupied by buildings, landscaped areas, paved or non-paved parking lots, fields, parklands, forests, *etc.*				
	4. Surface water bodies (rivers, streams, lakes, ponds, *etc*), marshes and wetlands for site and surrounding areas; distance from site to these features				
	5. Potential for flooding of the site				
	6. Identification of potential environmentally sensitive habitats				
	7. Debris, waste disposal, lagoons, drums, chemical storage, burn sites or other indicators of potential contamination sources				
	8. Visible signs or sources of pollutants on the surface of soil or water				
	9. Visibly distressed or dead vegetation				
	10. Photographs of site and adjoining properties				
	11. Date(s) of site reconnaissance				
6. Soil	**Does the report address the following:**				
	1. Are the objectives of the soil characterization program clearly stated?				
	2. Has available information from earlier investigative phases (contamination sources, soil type, topography, wind, utilities) integrated in the work plan?				
	3. Given the objectives and each APEC identified, is soil characterization appropriate with respect to: a. Collection of representative data through appropriate sampling design (e.g., judgemental, systematic, random) and use of statistical techniques (e.g., hypothesis testing)?				

Issue	Query	Yes	No	N/A	Report Section & Comments
	b. Appropriate sample type, which for most investigations are discrete samples; if composite samples have been used, have the results been qualified? c. For initial investigations (i.e., Phase 2 ESA), has a maximum spacing of 25 to 50 m been used to investigate larger areas of suspected contamination? d. For follow-up investigations (i.e., Phase 3 ESA), has a maximum spacing of 10 to 20 m been used to investigate known contamination through systematic sampling? e. Have all localized contamination hot-spots been delineated through appropriate step-out sampling (typically 3 to 4 step-outs at 5 to 10 m spacing)? f. Have soil samples been analyzed for all COPCs? g. Do sampling locations consider variability in NAPL source zones and possible NAPL migration pathways?				
	4. Was an assessment of background soil quality conducted? If not, briefly explain why a background study is or is not warranted?				
	5. Were appropriate field screening and sampling methods used to obtain soil data?				
	6. Were methods adequately documented?				
	7. Were soil samples obtained for volatile analyses preserved in the field or obtained using specialized sampling devices that minimize losses through volatilization or biodegradation?				
	8. Are the soil characteristics and stratigraphy described in sufficient detail on logs?				
	9. Does soil characterization data analysis and interpretation include: a. Summary of sampling strategy and design and whether representative data was obtained b. Integration of historical information and investigation results to identify potential sources of contamination and different contaminant populations that may exist c. Exploratory and interpretive data views to aid interpretation and delineation such as data posting, contouring, histograms, cumulative frequency plots and correlation plots				

Issue	Query	Yes	No	N/A	Report Section & Comments
	d. Where single populations are defined, calculation of summary statistics (e.g., minimum, maximum, arithmetic mean, standard deviation, median, coefficient of variation, upper confidence limit of the mean, percentiles) for each population Calculation method for each statistic should be provided (e.g., parametric, non-parametric methods) e. Evaluation of data distributions through analysis of summary statistics, histograms, fitting of different distributions to data, goodness-of-fit testing and probability plots f. Use of statistical methods for lognormal distributions, if data distributions are skewed and approximately log-normal g. Appropriate method to address non-detect values, when > 10% non-detects; if > 50% non-detects statistical parameters should generally not be calculated h. The rationale for identifying data point as an outlier and for excluding data point from analysis i. Possible influence of background levels in the surrounding area for contaminants that occur naturally or that may have been deposited by non-point sources				
	10. Figures providing the following: a. Chemical concentrations in soil posted beside measurement locations on plans and cross-sections (or shown in table on plans or sections) with reference to applicable criteria, and concentration contours, where appropriate b. Cross-sections to include stratigraphic information				
7. Groundwater	**Does the report address the following:**				
	1. Are the objectives of the groundwater characterization program clearly stated?				
	2. Has available information from earlier investigative phases (e.g., groundwater well data, regional hydrogeology, surficial geology, utilities) been integrated in the work plan?				
	3. Given the objectives and each APEC identified, is the groundwater characterization appropriate with respect to: a. ***Vertical spatial scale***: Maximum well screen length 1.5 m or less.				

Issue	Query	Yes	No	N/A	Report Section & Comments
	b. ***Horizontal spatial scale***: Maximum well separations for suspected or known plumes of 20 m to 50 m in longitudinal and 10 m to 20 m in transverse direction c. ***Temporal scale***: At least two samples obtained from each well on different dates, and sufficient monitoring to characterize temporal variability d. ***Chemicals***: All COPCs and transformation products; inorganic constituents and geochemical parameters, where warranted. e. ***NAPL zones:*** Do sampling locations consider variability in NAPL source zones and possible NAPL migration pathways?				
	4. Was an assessment of background groundwater quality conducted? If not, is a background study warranted?				
	5. Has complementary data been obtained on soil stratigraphy or hydrostratigraphic units where warranted (e.g., through deep boreholes or collection of soil cores)?				
	6. Were appropriate methods utilized to obtain groundwater data? Were methods adequately documented?				
	7. Does the groundwater data analysis and interpretation include: a. Summary of sampling strategy and design and whether representative data was obtained b. Integration of historical information and investigation results to identify potential contamination sources and different contaminant plumes that may exist c. Depths to water table d. Seasonal variation in water table e. Physical extent of and likely boundaries to aquifer(s) of interest (thickness of each unit and lateral extent) f. Hydraulic properties of each aquifer and aquitard g. Regional and local groundwater flow directions; seasonal variation in flow direction h. Seasonal variation of groundwater flow rates i. Groundwater recharge and discharge zones j. Dissolved plume extent and mobility k. Free-phase NAPL and residual NAPL extent and potential mobility				

Issue	Query	Yes	No	N/A	Report Section & Comments
	l. Possible influence of background levels in the surrounding area for contaminants that occur naturally or that may have been deposited by non-point sources				
	8. Figures providing the following: a. Piezometric heads in each aquifer of interest posted on plan and head contours and groundwater flow direction, where appropriate b. Stratigraphic cross-sections longitudinal and transverse to groundwater flow direction that include interpolated extent of identified strata, physical hydrogeologic data, water levels, soil sample locations, and well completion intervals c. Chemical concentrations in groundwater posted beside measurement locations on plans and cross-sections (or shown in table on plans and sections) with reference to applicable criteria, and concentration contours, where appropriate				
8. Soil Vapour	**Does the report address the following:**				
	1. Are the objectives of the soil vapour characterization program clearly stated?				
	2. Has available information from earlier investigative phases (e.g., groundwater data, surficial geology, building information, utilities) been integrated in work plan?				
	3. Is a CSM developed that identifies APECs and volatile COPCs, sources of vapour including NAPL zones and/or dissolved substances in groundwater, biogenic gases, major soil zones or hydrostratigraphic units with volatile contaminants and migration pathways, current and future buildings, and preferential pathways? Are relevant details included on buildings and pathways including building foundation type, condition and size, heating and ventilation system, and potential pathways including utilities and sumps? Is information shown on scaled plans?				
	4. Given the objectives and each APEC identified, is soil vapour characterization appropriate with respect to: a. ***Vertical spatial scale***: Generally begin with near contamination source characterization; for risk assessment the depth of external (beside building) soil vapour probes should be at least ½ way between lowest point of building foundation and contamination				

Issue	Query	Yes	No	N/A	Report Section & Comments
	source (with minimum depth of 1 m unless pre-cautions are taken to construct surface seal around probe); vertical sampling profiles maybe warranted at selected locations b. ***Horizontal spatial scale***: Minimum of two probes per APEC, where delineation is warranted probe spacing of 10-20 m for smaller sources or where there are steep concentration gradients; larger spacing may be justified for some sites; when assessing building the probes should be installed close (preferably 2-3 m with maximum of 10 m) to building on at least two sides c. ***Temporal scale***: Sufficient monitoring to characterize temporal variability; typically a minimum of two sampling rounds obtained on a seasonal basis d. ***Chemicals***: COPCs and transformation products; plus fixed/biogenic gases such as O_2, CO_2 CH_4 and H_2S where warranted. e. ***NAPL zones***: Do sampling locations consider variability in NAPL source zones and possible NAPL migration pathways?				
	5. Were subslab vapour samples obtained where there is shallow contamination below buildings or where there are other characteristics that would lead to non-representative data for external soil vapour samples?				
	6. Was an assessment of background soil vapour quality conducted? If not, is a background study warranted?				
	7. Were complementary data obtained on soil properties (e.g., moisture content, fraction organic carbon, grain size), groundwater quality and weather data?				
	8. Were appropriate methods utilized to obtain soil gas data? Were methods adequately documented? See Checklist #3 for supplemental soil vapour checklist.				
	9. Does the soil vapour data analysis and interpretation include consideration of the following for assessing soil vapour migration: a. Summary of sampling design for obtaining representative data b. Integration of historical information and investigation results to identify potential contamination sources and different contaminant populations that may exist				

Issue	Query	Yes	No	N/A	Report Section & Comments
	c. Groundwater flow direction, depths to water table and short-term (e.g., tidal) and seasonal variations in water table d. Vadose zone properties, including soil layering e. Biogeochemical conditions including oxygen levels and possible aerobic biodegradation of petroleum hydrocarbon vapours and anaerobic or aerobic biodegradation of chlorinated solvent vapours (and implications for daughter product formation) f. Preferential pathways such as utilities g. Properties of buildings and surface cover beside buildings h. Weather conditions including rainfall and snowmelt for at least 24 hours prior to sampling and estimates of infiltration rates, snow and frost, and longer-term seasonal fluctuations with respect to wet and dry periods i. Discussion of temporal data and trends (if sufficient data) and whether data represents time periods when higher soil vapour concentrations would be expected? j. For vapour assessments conducted following contamination source removal, were possible non steady state vapour conditions considered? k. Exploratory data views such as data posting, vertical and lateral concentration plots, cumulative frequency plots, correlation plots and contouring, as appropriate l. Comparison of field and laboratory test data m. Comparison of soil vapour concentrations to concentrations in other media (groundwater, soil, indoor air)[5] n. Possible influence of background levels in the surrounding area for contaminants that occur naturally or that may have been deposited by non-point sources				

[5] When making comparisons between different media take into account different chemical properties that influence partitioning (e.g., Henry's law constant).

Issue	Query	Yes	No	N/A	Report Section & Comments
	10. Figures providing the following: a. Chemical concentrations in soil vapour posted beside measurement locations on plan and section (or shown in table on plan or section) with reference to applicable criteria, and concentration contours, where appropriate b. Cross-sections should include stratigraphic information				
9. Indoor Air	**Does the report address the following:**				
	1. Are the objectives of the indoor air characterization program clearly stated?				
	2. Has available information from earlier investigative characterization phases (e.g., groundwater and soil vapour) been integrated in the work plan?				
	3. Was a CSM developed incorporating factors described under 8.3 but including additional discussion on building factors including whether building is potentially pressurized or depressurized?				
	4. Has a communications plan been developed for the work and were appropriate authorizations for indoor air and subslab vapour sampling obtained?				
	5. Was a pre-sampling questionnaire and survey of the building and subsurface utilities below and adjacent to building completed; did survey include use of field detectors for measuring organic vapours and potentially explosive gases?				
	6. Were any immediate health and safety concerns identified for building, subsurface utilities or other possible confined spaces?				
	7. Were there chemicals present within the building that could represent a background source of the subsurface COPCs, if so, were these chemicals removed from the building at least 48 hours prior to sampling?				
	8. Was a survey conducted to identify potential external emission sources such as gasoline stations, major highways, paving operations and remediation systems?				

Issue	Query	Yes	No	N/A	Report Section & Comments
	9. Given the objectives and each APEC identified, is indoor air characterization appropriate with respect to: a. Types of samples, which depending on objectives may consist of (i) exposure samples from approximate breathing zone and (ii) pathway samples from possible entry points for soil vapour intrusion (e.g., sumps, cracks) b. Number of samples, which will depend on the size and characteristics of the building, but should generally be a minimum of two samples c. Location of samples, which will typically consist as a minimum samples from the first occupied floor of the building and possibly higher building levels d. Building conditions during sampling, which generally should be those under normal occupancy excluding certain activities such as use of paints, glues or solvents, high use of fans, and use of fireplace. Any unusual conditions should be noted e. Sampling duration, which should be a minimum of eight hours for commercial buildings, and 24 hours for residential buildings f. Sampling frequency, which typically will involve a minimum of two sampling rounds (often on a seasonal basis) to evaluate temporal variability g. Chemicals, which should consist of COPCs, but may also include other chemicals to facilitate evaluation of potential background sources through evaluation of concentration ratios h. Collection of subslab soil vapour samples, which should be obtained concurrently or close to the time when indoor air samples are obtained; for residential single family houses, a minimum of two subslab samples should be obtained; for larger buildings, additional samples are warranted				

Issue	Query	Yes	No	N/A	Report Section & Comments
	i. Because installation and sampling of subslab probes could potentially contaminate indoor air, appropriate pre-cautions should be taken including venting subslab gases outdoors when purging, waiting a minimum of 24 hours before collecting indoor air samples after installing subslab probes, and keeping subslab probe valves closed unless sampling j. Collection of outdoor air samples, which should be obtained concurrently with indoor air samples				
	10. Were complementary data obtained such as weather data, differential pressure between building and subslab or outdoor air and building ventilation rate or air exchange rate? Was the use of natural tracers, such as testing of radon, considered?				
	11. Were appropriate methods utilized to obtain indoor air data? Were methods adequately documented?				
	12. Does the indoor air data analysis and interpretation include consideration of the following for assessing soil vapour intrusion: a. Summary of sampling design for obtaining representative data b. Integration of data for different media (soil, groundwater, soil vapour, subslab vapour, indoor air, outdoor air) and complementary data c. Properties of unsaturated zone soil, particularly soil conditions near to the building foundation d. Preferential pathways such as utilities e. Properties of buildings and surface cover beside buildings f. Weather conditions including barometric pressure, temperature and precipitation during, and 3 days prior to and after samplings, and longer-term seasonal fluctuations g. Exploratory data views and statistical techniques to aid in interpretation h. Comparison of field and laboratory test data i. Comparison of indoor air concentrations to concentrations in other media (groundwater, soil, indoor air)[6]				

[6] When making comparisons between different media take into account different chemical properties that influence partitioning (*e.g.*, Henry's law constant).

Issue	Query	Yes	No	N/A	Report Section & Comments
	j. Multiple line of evidence evaluation of potential influence of background sources on indoor air quality including (i) evaluation of concentration ratios between different chemicals and between different media as supported by data visualization techniques (e.g., multi linear plots), (ii) comparison of measured indoor and outdoor concentrations (iii) comparison to published literature background values for indoor air, (iv) project specific background control study involving testing of similar buildings to study buildings but in an area known not to be contaminated, (v) testing of indoor air for different building conditions (e.g., pressurized, depressurized), (vi) comparison of indoor air concentrations to model predictions, and (vii) consideration of tracers				
	13. Figures providing the following: Chemical concentrations in indoor air and subslab soil vapour, with data either posted beside measurement locations and/or shown in table on plan with reference to applicable criteria.				
10. Surface Water	**Does the report address the following:**				
	1. Are the objectives of the surface water characterization program clearly stated?				
	2. Has available information from earlier investigative phases been integrated in the work plan?				
	3. Has a communications plan been developed for the work and were appropriate authorizations for surface water sampling obtained?				
	4. Has a site reconnaissance been conducted and did it identify field conditions relevant to the surface water sampling program (e.g., water body depth, width and area, access points, safety concerns)?				
	5. Have appropriate reference water bodies been identified and was the method for their selection fully documented?				
	6. Are reference water bodies well matched to the site, with respect to flow, size, hardness, pH, temperature, salinity, presence of nonpoint source inputs, absence of point source inputs?				

Issue	Query	Yes	No	N/A	Report Section & Comments
	7. Given the objectives and each APEC identified, is surface water characterization appropriate with respect to: a. Types of samples b. Number of samples c. Locations of samples d. Sampling depth e. Frequency of sampling f. Target analyte				
	8. Were complementary data obtained, such as pH, temperature, turbidity, hardness, salinity?				
	9. Were sampling locations recorded or surveyed to within 1 m accuracy?				
	10. Were sampling methods adequately documented?				
	11. Does the surface water data analysis and interpretation include: a. Summary of sampling strategy and design and whether representative data were obtained, confirmation that QA/QC goals were met b. Integration of data for different media (groundwater-to-surface water discharge, sediment, porewater, biological tissue) and complementary data c. Exploratory data views and statistical techniques to aid in interpretation, as appropriate d. Comparison of site and reference area results				
	12. Figures providing the following: Chemical concentrations in surface water, with data either posted beside measurement locations and/or shown in table on plan with reference to applicable criteria.				
11. Sediment	**Does the report address the following:**				
	1. Are the objectives of the sediment characterization program clearly stated?				
	2. Has available information from earlier investigative phases been integrated in the work plan?				
	3. Has a communications plan been developed for the work and were appropriate authorizations for sediment sampling obtained?				
	4. Has a site reconnaissance been conducted and did it identify field conditions relevant to the sediment sampling program (e.g., depositional areas, access points, safety concerns)?				

Issue	Query	Yes	No	N/A	Report Section & Comments
	5. Have appropriate reference water bodies been identified and was the method for their selection fully documented?				
	6. Are reference water bodies well matched to the site, with respect to depositional areas, grain size, total organic carbon, presence of nonpoint source inputs, absence of point source inputs?				
	7. Given the objectives and each APEC identified, is sediment characterization appropriate with respect to: a. Types of samples b. Number of samples c. Locations of samples d. Sampling depth e. Handling of samples f. Frequency of sampling g. Target analytes.				
	8. Was complementary data obtained, such as total organic carbon and grain size?				
	9. Were sampling locations recorded or surveyed to within 1 m accuracy?				
	10. Were sampling methods adequately documented?				
	11. Does the sediment data analysis and interpretation include: a. Summary of sampling strategy and design and whether representative data were obtained b. Integration of data for different media (groundwater-to-surface water discharge, surface water, porewater, biological tissue) and complementary data c. Exploratory data views and statistical techniques to aid in interpretation, as appropriate d. Comparison of site and reference area results with respect to chemical concentrations and complementary data				
	12. Figures providing the following: Chemical concentrations in sediment, with data either posted beside measurement locations and/or shown in table on plan with reference to applicable criteria				
12. Biological Tissue	**Does the report address the following:**				
	1. Are the objectives of the biological tissue characterization program clearly stated?				
	2. Has available information from earlier investigative phases been integrated in the work plan?				

Issue	Query	Yes	No	N/A	Report Section & Comments
	3. Has a communications plan been developed for the work and were appropriate authorizations for biological sampling obtained (e.g., scientific collection permits)?				
	4. Has a site reconnaissance been conducted and did it identify field conditions relevant to the biological sampling program (e.g., habitat types, preferred trapping locations, access points, safety concerns)?				
	5. Have appropriate reference areas been identified and was the method for their selection fully documented?				
	6. Are reference areas well matched to the site, with respect to habitat quality, type and extent, proximity to human development, potential for human disturbance, harvesting, surrounding land use?				
	7. Given the objectives and each APEC identified, is biological tissue characterization appropriate with respect to: a. Species and age classes sampled b. Organisms' sex c. Compositing practices d. Number of samples e. Locations of samples f. Frequency of sampling g. Sample preparation and preservation methods h. Target analytes				
	8. Was complementary data obtained, such as allometric measurements, lipids, moisture?				
	9. Were sampling locations recorded or surveyed to within 1 m accuracy?				
	10. Were sampling methods adequately documented?				
	11. Does the biological tissue data analysis and interpretation include: a. Summary of sampling strategy and design and whether representative data were obtained b. Integration of data for different media (surface water, soil, sediment, other biological tissue) and complementary data c. Exploratory data views and statistical techniques to aid in interpretation, as appropriate d. Comparison of site and reference area results with respect to chemical concentrations and complementary data				

Issue	Query	Yes	No	N/A	Report Section & Comments
	12. Figures providing the following: Chemical concentrations in biological tissue, with data either posted beside measurement locations and/or shown in table on plan with reference to applicable criteria				
13. Maps and Figures	**Are there site map(s) that include:**				
	1. Property dimensions, north arrow and scale, clear, concise, and of appropriate scale and detail				
	2. Relevant buildings				
	3. Relevant land use				
	4. Natural features such as lakes, streams, marshes, wetlands, forests				
	5. Constructed features such as ditches, buried utility corridors, above ground and underground storage tanks, landfills, waste storage areas and lagoons				
	6. Scaled map showing all sampling locations, including test pits, borehole monitoring wells, soil vapour, subslab and air monitoring locations, and biological sample or transect locations, preferably with survey (e.g., UTM) coordinates provided				
	7. Estimated lateral and vertical extent of all APECs and AECs, shown in plan and in cross section				
	8. Topographic map (1:20,000 scale or larger)				
14. Quality Assurance/ Quality Control	**Does the report:**				
	1. Identify laboratory that conducted chemical and ancillary analyses, and whether it was certified for parameters analyzed?				
	2. Describe sampling equipment and decontamination procedures followed during sampling?				
	3. Describe sampling containers and field preservatives used?				
	4. Describe sample preparation, storage, transportation procedures and chain-of-custody procedures?				
	5. Describe analytical methods and indicate whether they conform with applicable federal or provincial guidance or standard methods?				
	6. Document whether analytical holding times were met?				

Issue	Query	Yes	No	N/A	Report Section & Comments
	7. Indicate whether appropriate field quality control checks and samples were analyzed: a. Field duplicates submitted blind to the laboratory, for samples from areas suspected to have higher concentrations b. Trip blanks c. Field blanks d. Equipment blanks				
	8. Indicate whether appropriate laboratory control checks and samples were analyzed: a. Laboratory duplicates b. Method blanks c. Surrogate and matrix spikes d. Standard or certified reference materials.				
	9. Describe whether data quality indicators, including detection limits, relative percent difference for duplicates, and % recoveries for spikes and certified reference materials, are within acceptable limits when compared to data quality targets?				
	10. Use control charts to monitor and control the accuracy and precision of the analyses for large studies with more than 100 samples?				
	11. Describe whether data is complete, based on the sampling and analysis plan?				
	12. Describe any departures from the sampling plan, and rationale and anticipated impact on results?				
	13. Indicate whether data has been checked for possible transcription and manipulation errors?				
	14. Provide conclusions on the reliability of the data based on the results of the QA/QC program?				
	15. Indicate whether any corrective action was taken and/or whether re-tests or verification tests are required?				
15. Data Validation and Interpretation	**Does the report address the following:**				
	1. Have all APECs been adequately assessed for all COPCs?				
	2. Have investigation objectives been met, including all data required for risk assessment purposes?				
	3. Have apparent outliers been evaluated and addressed?				
	4. Based on the updated CSM, has sufficient sampling been completed at the site based on APECs and populations identified?				
	5. Do the results make sense relative to the CSM and hypothesis for site contamination?				

Issue	Query	Yes	No	N/A	Report Section & Comments
	6. Is further assessment required to delineate the horizontal and vertical extent of contamination at the site?				
16. Conceptual Site Model (CSM) and Comparison to Regulatory Criteria	**Does the report:**				
	1. Provide an updated CSM that integrates available information on stratigraphy, hydrogeology, contamination sources, contaminant migration pathways, receptors and exposure mechanisms (see Checklist #4 for additional guidance for soil vapour intrusion)?				
	2. Use the correct federal and provincial criteria or standards, as applicable, for current and future use of the site for soil, groundwater, surface water and/or soil vapour?				
	3. Are all APECs and COPCs clearly identified?				
	4. Is there soil contamination. If so, what are the COPCs?				
	5. Is there groundwater contamination. If so, what are the COPCs?				
	6. Is there soil vapour contamination. If so, what are the COPCs?				
	7. Is there indoor air contamination. If so, what are the COPCs?				
	8. Is there surface water contamination. If so, what are the COPCs?				
	9. Is there sediment contamination. If so, what are the COPCs?				
	10. Is there biological tissue contamination. If so, what are the COPCs?				
	11. What is the potential for human or ecological receptors to be exposed to contamination in shallow soil, surface water, sediment, biological tissue, groundwater, and/or indoor air?				
	12. Is off-site migration of contamination probable or likely to have occurred?				
17. Conclusions & Recommendations	1. Are the conclusions clear and unambiguous and supported by the investigation results?				
	2. Are uncertainties clearly stated and fully discussed?				
	3. Are the recommendations supported by the findings of the investigations and are they complete?				
18. Documentation	**Does the report provide:**				
	1. Test pit, borehole and monitoring well logs				
	2. Groundwater, soil vapour, surface water, sediment, and biological tissue field sampling and data sheets				
	3. Analytical laboratory reports including QA/QC data				

Issue	Query	Yes	No	N/A	Report Section & Comments
19. References	**Does the report identify or reference:**				
	1. Who the primary participants and authors are and his or her qualifications				
	2. All data sources (including interviews) and previous studies that contributed information to the study				
	3. Technical literature that provides additional detail on procedures used in the study				
	4. The name and version of any computer software used. For software that is not commercially available is a brief description and reference provided.				

CHECKLIST NO. 3

REVIEW OF ENVIRONMENTAL SITE CHARACTERIZATION REPORT – SUPPLEMENTAL INFORMATION FOR SOIL VAPOUR STUDIES

Report title:

Report author:

Report date:

Reviewed by:

Date reviewed:

INTENDED PURPOSE: The "Checklist for Review of Environmental Site Characterization Report" is intended to facilitate a review of the key elements of an Environmental Site Assessment (ESA). Since soil vapour characterization is an emerging science, a supplemental checklist is provided for soil vapour sampling and analysis. The technical requirements for soil vapour itemized in this checklist are designed to allow the reviewer to identify potential deficiencies in the report and/or in the methods used. (The checklist does not address location of utilities and health and safety considerations since they are beyond the scope of this guidance).

Issue	Query	Yes	No	N/A	Report Section & Comments
1. Probe Construction	**Does the report address the following**:				
	1. Provide adequate description of probe?				
	2. Were appropriate materials used for the probe (e.g., steel, rigid PVC, Teflon)?				
	3. Was probe constructed with an appropriate annular and surface seal?				
	4. Was a leak tracer test completed to verify that no significant leakage occurred with respect to atmospheric air migrating along the outside of the probe or through leaks at connection of sampling train to probe?				
	5. Was probe sealed to atmosphere when not sampled or pneumatically tested (e.g., through closed valve)?				
	6. Were probes that were re-used first checked for possible contamination through testing of equipment blank?				
2. Leak Testing	**Does the report address the following:**				
	1. Was a leak tracer test completed to verify that no significant leakage occurred with respect to atmospheric air migrating along the outside of the probe or through leaks at connection of sampling train to probe?				

Issue	Query	Yes	No	N/A	Report Section & Comments
	2. Was a leak pressure test (pressure shut-in test) or leak tracer test of the sampling train performed?				
3. Sampling	**Does the report address the following:**				
	1. Provide adequate description of sampling procedures?				
	2. After installation, were probes developed (minimum 3 probe volumes) and then allowed to equilibrate for a sufficient time prior to sampling? If the drilling method used air, was the additional uncertainty introduced discussed?				
	3. Was weather data prior to and during sampling obtained and implications for soil vapour sampling discussed (i.e., especially precipitation and wait time of at least 1 day after heavier rainfall events (> 0.5 cm) for coarse-grained soil and longer for fine-grained soil)?				
	4. Were appropriate materials used for sampling train (Teflon is acceptable for all chemicals and Nylaflow is acceptable except when naphthalene or similar chemicals are COPCs)?				
	5. Were new materials appropriately stored and handled to avoid cross-contamination?				
	6. Were sampling train materials that were re-used first checked for possible contamination through testing of equipment blanks?				
	7. Were gas-tight fittings and connections used?				
	8. Were the flow and vacuum measured during sampling? Were the flow rate < 200 ml/min and the vacuum < 10 inches of water during sampling (note collection of samples at greater than 10 inches water is acceptable)? Excessive purging and vacuums should be avoided. If vacuum was elevated, were the potential implications on sample quality discussed?				
	9. After purging, were conditions allowed to stabilize and vacuum dissipate (with the probe remaining sealed) prior to sampling?				
	10. Was an appropriate sampling device or container used for sample collection?				
	11. For gas-bags samples used for field screening, was a vacuum chamber (lung box) used to obtain samples to avoid collection through a pump (note: gas-bags should not be used for laboratory analysis)?				

Issue	Query	Yes	No	N/A	Report Section & Comments
	12. For sorbent tubes, were the tubes placed upstream of the pump and was the flow rate and sampling duration measured during sampling?				
	13. Were appropriate handling and storage procedures used; place in samples in non-chilled container after collection (except for sorbent tubes which may be placed in chilled container)?				
	14. Were appropriate pre-cautions taken for cold weathering sampling?				
4. Analysis	**Does the report address the following:**				
	1. Provide adequate description of analytical methods?				
	2. Were field detectors calibrated to appropriate gas? Was calibration checked on a daily basis and possible interferences noted?				
	3. Were detection limits acceptable based on project objectives?				
	4. Were holding times met?				
	5. For Summa or Silco canisters: a. Were field trip blanks analyzed (i.e., canister filled with laboratory certified high purity gas) (optional)? b. Were field duplicates analyzed? How were duplicates obtained (e.g., splitter)? c. Were laboratory duplicates analyzed? d. Were canisters (and flow controllers) batch or individually certified? e. Was the vacuum prior to and after sampling measured and within acceptable limits?				
	6. For sorbent tubes: a. Were field trip blanks analyzed? b. Were field duplicates analyzed? How were the duplicates obtained (e.g., splitter)? c. Were laboratory duplicates analyzed? d. Were laboratory blanks analyzed? e. Were fronts and backs of tubes (or two tubes in series analyzed) analyzed to evaluate possible breakthrough?				

CHECKLIST NO. 4

SOIL VAPOUR INTRUSION CONCEPTUAL SITE MODEL

Project:

Prepared by:

Date prepared:

INTENDED PURPOSE: This checklist is intended to address conceptual model development for soil vapour intrusion studies, but does not include considerations relating to characterization of indoor air quality. It is recognized that some of the information on buildings may not be available in the absence of indoor air sampling.

Information Sources and Status

- ☐ Summarize the information sources that have been used to develop the conceptual site model
- ☐ Summarize the status of investigations completed at the site
- ☐ Summarize the status of remediation completed at the site including contamination source zone, groundwater or vapour remediation.

Contamination Source Characteristics

- ☐ Describe the type, source and history of the contamination release
- ☐ Describe the presence, distribution and composition of LNAPL and/or DNAPL, if present at the site, describe whether LNAPL and/or DNAPL is potentially mobile
- ☐ Describe the distribution and extent of dissolved organic chemicals in groundwater
- ☐ Describe whether there could be transformations to daughter products of potential concern (e.g., chlorinated solvents)
- ☐ Describe the migration characteristics of the dissolved plume, and whether the plume is expanding, stable or shrinking,
- ☐ Describe possible evidence for natural attenuation and bioattenuation in both saturated and unsaturated zones.

Geology/Hydrogeology

- ☐ Describe the physical properties of soil in the unsaturated zone and shallow saturated zone (grain size, moisture content, porosity, density, permeability)

- ☐ Describe the natural organic carbon (or organic matter) content in soil
- ☐ Describe the soil lithology (i.e., type of soil) with particular attenuation to soil layering
- ☐ Describe the bedrock with particular attenuation to fracture occurrence and orientation, if bedrock is present
- ☐ Describe the depth to groundwater and fluctuations in the water table (e.g., seasonal, tidal, long-term due to pumping)
- ☐ Describe the hydrostratigraphic units and shallow groundwater flow system, and perched water table, if present
- ☐ Describe hydrogeological parameters (e.g., groundwater flow direction, hydraulic conductivity, vertical and horizontal hydraulic gradients)
- ☐ Describe foundation subsoils.

Utilities

- ☐ Identify the location of subsurface utilities; indicate the type of utility, the plan location, depth, and backfill properties, as available
- ☐ Identify the location of any utilities that intersect the vapour contamination zone and directly connect to buildings.

Site Characteristics and Anthropogenic Features

- ☐ Describe the surface cover in the area of the vapour contamination source(s) and nearby buildings
- ☐ Estimate the vertical and lateral distances from the vapour contamination source(s) to nearby buildings. Estimate distances for soil, groundwater (dissolved) and NAPL contamination sources.
- ☐ Describe potential future changes to land use and implications for surface cover.

Buildings

- ☐ Identify location of existing buildings
- ☐ Identify potential future buildings
- ☐ Describe the occupancy and use of the buildings (residential, institutional, recreational, commercial, industrial)
- ☐ Approximate age of building
- ☐ Describe characteristics of the building
    - Size of building
    - Number of storeys

- Height of storeys
- Foundation type (e.g,. basement, crawlspace, slab-at-grade); if combination of foundations, indicate percentage for each type
- Depth below grade to base of foundation
- Foundation construction for both floor and subsurface walls (e.g., poured concrete, concrete block, brick, wood)
- General condition of foundation (cracks, openings)
- Building construction (e.g., wood frame, concrete, brick)
- Elevator shafts
- Moisture vapour barrier below building
- Sumps or drains
- Monitoring wells inside the building
- Attached garage (i.e., single family residential)
- Below building parking (i.e., apartment, commercial building)
- Chemical use and storage.

☐ Describe the HVAC system in the building including:

- Type of heating system (natural gas, oil, radiant, steam, electrical)
- Type of air conditioning system
- Location of heating and air conditioning units
- For commercial buildings, air intake and exhaust units
- For residential buildings with forced air furnace systems, return air ducting, does furnace have source of combustion air
- Describe sub-slab ventilation systems or moisture barriers present on existing buildings, or identify building- and fire-code requirements for sub-slab ventilation systems (e.g., for methane) or moisture barriers below foundations.