Appendix 4:
BEST PRACTICES FOR ENVIRONMENTAL SITE ASSESSMENT IN THE NWT

INTRODUCTION

This document presents the best management practices (BMPs) for conducting an Environmental Site Assessment (ESA) at a contaminated site in the Northwest Territories (NWT). The contents of this guidance have been adapted from the Atlantic Partnership in RBCA implementation User Guidance (Appendix 1 – Best Management Practices for Environmental Site Assessment of Impacted Sites in Atlantic Canada) (APIRI, 2021). Additional guidance is provided in the Canadian Standards Association (CSA) Standard for Phase II Environmental Site Assessment (CAN/CSA-Z769-00 [R2018]) (CSA, 2018), the Canadian Council of Ministers of the Environment (CCME) Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment (CCME, 2016a), and the Alberta Environmental Site Assessment Standard (AEP, 2016).

It is understood that ESAs are typically conducted in various phases, and should be consistent with the Government of the Northwest Territories (GNWT) Guideline Process. ESAs are required to assess and delineate the limits of contamination to ensure a proper Remedial Action Plan (RAP) or Risk Management Plan (RMP) can be developed to ensure the protection of human health and ecological receptors both on-site and offsite. This may require assessment and delineation of contaminant impacts across property lines onto third party properties. Notification of contamination to third party property owners for impacts to their property is required under this Guideline.

The design of the testing program must reflect the fate and transport properties of the contaminants of potential concern (COPCs). It is also beneficial to consider potential remedial options and discuss the options with the Department of Environment and Climate Change (ECC) during the early stages of an investigation to determine what data should be collected to support the design of the RAP. During any ESA, measures should be taken to avoid potential spreading of contamination to other areas of the site or other media.

The physical properties of some COPCs make them extremely difficult to assess and remediate (i.e., some chlorinated volatile organic compounds [CVOCs]). This is particularly the case if free phase product (non-aqueous phase liquid or NAPL) is present. Petroleum hydrocarbons (PHCs) and most volatile organic compounds (VOCs) are lighter than water, allowing free phase product to float on the surface of the groundwater (light non-aqueous phase liquid or LNAPL). However, some VOCs are heavier than water (i.e., dense non-aqueous phase liquid or DNAPL); therefore, if free phase product is present, it would tend to sink, spreading until it reaches confining layers (e.g., clay lenses, aquitards, permafrost, bedrock). Due to the complex nature of DNAPLs, they often can be undetected

when using conventional tools and investigative strategies. Understanding LNAPL/DNAPL flow and behavior allows an adequate conceptual site model (CSM) to be developed that helps guide characterization efforts of the LNAPL/DNAPL and dissolved phase impacts.

When assessing most PHC and VOC impacted sites, monitoring wells would be screened across the water table to confirm presence/absence of free product and to assess dissolved groundwater plumes. Because PHCs aerobically degrade, the extent of dissolved plumes and vapour plumes would be more limited than CVOC plumes. Because some VOCs can act as DNAPLs, free product can sink and deeper aquifers could become contaminated. Vertical movement of DNAPLs is generally controlled by soil stratigraphy, permafrost or bedrock fractures. Also, since biodegradation of certain VOCs is anaerobic and proceeds much more slowly, dissolved plumes and vapour plumes tend to be much more extensive, with some dissolved plumes extending several kilometers or more from the point of release. During assessment of CVOCs, it is important to assess both the source and degradation products as some degradation products may be more toxic than the original COPC. During drilling, caution must be used to avoid puncturing an aquitard, which could cause further plum emigration vertically and/or horizontally.

The extent of all COPC impacts in soil, groundwater (dissolved or LNAPL) is expected to be delineated to the applicable Tier 1 Criteria.

Where there is a potential for indoor air exposure, soil vapour, sub-slab or indoor air quality testing may be required to assess potential risk. In this case, the extent of VOC impacts may be delineated through soil vapour and groundwater data or other means deemed appropriate by the Qualified Professional (QPro) and acceptable to ECC.

PURPOSE

The purpose of this Appendix is to describe the recommended BMPs for assessing contamination in the NWT. It provides guidance for assessment data to apply Tier 1 Criteria or Tier 2 Pathway Specific Criteria, and to complete a Site-Specific Risk Assessment (SSRA).

The objectives of collecting assessment data are to characterize: 1) the nature and extent of soil and groundwater contamination in three dimensions; 2) potential migration pathways; and 3) potential receptors. It is expected that these characterizations will be achieved with an acceptable level of certainty.

The BMPs presented herein are intended to establish the **minimum requirements** for collection of such data at typical sites, unless otherwise agreed upon between the QPro and ECC. **For more complicated or sensitive sites it may be necessary to increase the scope of the investigation to achieve an acceptable level of certainty. Note that for CVOC sites, a large amount of data may be required to fully characterize the impacts.**

BEST MANAGEMENT PRACTICES – SITE CHARACTERIZATION

It is acknowledged that assessment report formats may vary between individual companies. However, regardless of format, certain minimum information is expected.

Each ESA report should commence with a detailed executive summary. The body of the report will present the assessment information and should typically contain the following details.

Basic Site Information

The following background site information is to be included in a typical Phase II/III ESA report:

Site Location:

- ❑ City/Town/Hamlet.
- ❑ Civic Address.
- ❑ Property Identification Number, where available.

Current Land Use (i.e., best fit based on site activities; refer to Section 7.3.1 of the Guideline for definitions):

- ❑ Agricultural
- ❑ Residential/Parkland
- ❑ Commercial
- ❑ Industrial

Building & Underground Service Locations (obtained through non-intrusive site inspection and available site information) to support assessment of potential exposure and preferential pathways:

- ❑ On-Site (source site).
- ❑ Off-Site (potential/known impacted third-party properties).
    - For most COPCs, within 200 m unless sensitive human or ecological features exist at greater distance.
    - For VOCs, the off-site assessment is dependent on the extents of the plume, therefore, on-going assessment of land uses, buildings and underground services may have to expand throughout the delineation process including assessment of third-party properties.
- ❑ Location, depth and type of underground services (e.g., natural gas, sewer, water, telephone, cable TV, fiber optic cables).
- ❑ Reasonable foreseeable future land use (on-site).

Historical Information (obtained from available information i.e., Phase I ESA). This would typically include:

- ❑ Previous owners and uses of the source property.
- ❑ Historical summary of chemical handling practices at the site.
- ❑ Details on chemical products (e.g., gasoline, diesel, furnace oil, used oil), CVOCs (dry cleaning fluids, degreasers), and other COPCs handled at the site.
- ❑ Age, type and construction of chemical storage and distribution systems (e.g., single/double wall, steel/fiberglass, monitoring equipment).
- ❑ Location of previous storage and distribution equipment (aboveground and underground).
- ❑ Operational history of storage and distribution equipment including previous reported spills or leaks.
- ❑ Previous assessment or remedial activities, including regulatory status.

Regional Drainage, Geology, Hydrogeology (obtained from site investigations or available regional information sources):

- ❑ Surface drainage pattern.
- ❑ Surficial and bedrock geology.
- ❑ Groundwater flow direction.
- ❑ Groundwater recharge/discharge zones.
- ❑ Aquifer types (e.g., bedrock, sand & gravel, confined, unconfined).
- ❑ Regional groundwater and surface water use and location (within 100 m upgradient and 300 m downgradient).

Local Drainage, Geology and Hydrogeology and Water Use (obtained through non-intrusive site inspection, intrusive site investigation and available site information):

- ❑ Surface drainage patterns.
- ❑ Surficial and bedrock geology (specific physical characteristics that may affect contaminant migration to be included, including orientation of bedrock fractures if impacts suspected in bedrock).
- ❑ Permafrost conditions.
- ❑ Groundwater flow direction.
- ❑ Groundwater recharge/discharge zones.
- ❑ Aquifer types (such as bedrock, sand and gravel, confined, unconfined to a sufficient depth to which COPCs may extend).
- ❑ Groundwater classification (potable or non-potable, subject to ECC guidance/policy).
- ❑ Local surface water use and location.

- ❑ Grain size analyses (if proposing alternate criteria based on soil texture (i.e., fine grained)).
- ❑ Water table depth and elevations (relative to local datum).
- ❑ Groundwater hydraulic gradient.
- ❑ Presence of aquitards.

Known or Potential Receptors (obtained through on-site and off-site investigation):

- ❑ On-Site.
- ❑ Off-Site.
    - For most COPCs, within 200 m unless sensitive human or ecological features exist at greater distance.
    - For CVOCs, on-going assessment of receptors must continue throughout the delineation process (i.e., subject to confirmation of plume extent(s)) because of the nature of the COPC and degradation products.
- ❑ Sensitive receptors (e.g., private and municipal drinking water/industrial supply wells, buildings with sumps, sensitive surface waters, sensitive ecological habitat, Species at Risk (SAR)).

Contaminant Characterization:

- ❑ Free product (LNAPL/DNAPL) assessment.
- ❑ Representative soil and groundwater chemistry.
- ❑ Lateral and vertical extent of impacts exceeding Tier I Criteria. As a default for chlorinated solvent assessment, shallow and deep monitoring wells will be required as most CVOCs are dense and if DNAPL is present, it will sink until it reaches a confining layer such as an aquitard or clay layer.
- ❑ Soil vapour or sub-slab vapour chemistry (if measured or otherwise reported). For CVOCs in soil, vapour sampling will likely be required to delineate impacts where there is a potential indoor air exposure pathway.
- ❑ Sediment chemistry (where potentially impacted aquatic receptors have been identified).
- ❑ Surface water chemistry (where potentially impacted aquatic receptors have been identified).

BEST MANAGEMENT PRACTICES – TESTING PROTOCOLS

Intrusive Testing Locations and Information:

- ❑ Testing methods and techniques are expected to be consistent with current-day industry standards. Regardless of the method/techniques used, all efforts should be made to minimize the spread of contamination as a result of assessment activities.
- ❑ Field screening techniques may be used to guide the initial focus of the investigation. However, laboratory results must be used to demonstrate the requirements of the Guideline. Confirmatory samples and samples used to characterize materials for relocation must be submitted for laboratory analysis.

- Sample locations should provide an adequately detailed understanding of the nature, extent and fate of COPCs in three dimensions. They should also provide information on potential subsurface migration pathways. The following are considered minimum requirements:
  - Initial assessment phase: Minimum of one (1) borehole or test pit per potential source area - typically at least 3-5 locations except for very small sites. Potential source areas may include, but are not limited to tanks, lines, drains, loading areas, fuel handling areas or any areas with visible impacts (i.e., stained areas). Soil vapour or other vapour assessments may be considered based on the judgment of the QPro.
  - Once areas of contamination are identified, horizontal delineation samples should be collected. Horizontal delineation samples must be collected at the same depth as the original sample. Horizontal delineation samples should be collected in all directions where possible. Locations of horizontal delineation samples may be adjusted based on information gathered during a site investigation or previous analytical data.
  - When contamination is identified, the area of contamination will be presumed to extend to the nearest sample location and depth found not to be contaminated. When the horizontal delineation samples are found not to be contaminated, the contamination will be presumed to exist in an area centred between the original contaminated sample and the uncontaminated horizontal delineation samples. If no horizontal delineation samples are collected, the contaminated area may be presumed to be unlimited in size.
  - Vertical delineation samples should also be collected in conjunction with horizontal delineation samples. The zone of contamination will be presumed to extend to the depth of the shallowest uncontaminated vertical delineation sample at each sampling location where contamination has been detected.
  - Any soil and groundwater COPC plume(s) should be delineated to criteria that are protective of the health of identified receptors (human and ecological) considering current land uses or reasonablyforeseeable future land uses. Contamination is expected to be delineated to the Tier I Criteria or background (where applicable) for all impacted media.
  - Sufficient test locations to determine the direction of groundwater flow on-site. **A *minimum of three (3) groundwater monitoring wells or piezometers installed in drilled boreholes.*** Shallow wells are to be screened across the water table to intercept LNAPL. Bedrock monitoring wells may be required to assess potable water sources and multilevel installation of piezometers to assess vertical groundwater gradient may be advisable in some circumstances. **For DNAPLs, a minimum of three groundwater monitoring wells or piezometers *perhydrogeological unit* (i.e., shallow and deep wells)** is recommended to allow for shallow and deep groundwater sampling, as well as description of potential confining layers (as noted above, care must be taken during drilling to ensure that confining layers are not breached in a manner that will create pathways for additional migration).
  - Monitoring well construction standards are to follow current-day industry standards. For CVOC assessments, generally the screen lengths are shorter.
  - Monitoring wells should not be installed in test pits, unless drill rigs are not available due to remote location or exorbitant cost. Also, in conditions with shallow permafrost, borehole drilling may not be effective. Monitoring wells installed in test pits will require significantly more purging than those installed in drilled boreholes to remove the water collected in the disturbed material used to backfill the test pit.

- ❑ All soil test locations should extend to the bottom of the contaminated zone, to the seasonal low water table level, or to bedrock, whichever is shallower with considerations for permafrost. Samples must represent the dominant type of soil or fill at each location and depth. Samples must be collected at consistent depth intervals (usually 0.5, 0.75, or 1.0m intervals), unless site specific conditions warrant a different approach.
- ❑ Ex situ sampling of stockpiles may be conducted for initial characterization purposes in situations where emergency response has been carried out (i.e., recent spills). Stockpile sampling results may not be used to override in situ characterization sampling results as inadvertent dilution during excavation and soil handling may have occurred and therefore may no longer be representative of on-site conditions.
- ❑ When conducting characterization sampling on stockpiles created in emergency response situations, stockpiles must be divided into portions or "cells" representing 50 m^3 for non-highly contaminated soils or 10 m^3 for soils suspected to be highly contaminated. One composite sample made up of several grab samples must be collected throughout the cell with a focus on suspected "hot spots".
- ❑ All monitoring wells should be monitored for the presence of free product. Note that if DNAPL is present, this may prove to be difficult given that free product would sink until it reaches a confining layer making it hard to identify.
- ❑ In the instance of VOCs, sufficient soil vapour samples should be collected to characterize potential indoor air inhalation concerns and to provide delineation of VOCs. The number of soil vapour samples is highly dependent on the size of the plume, site conditions and the number and size of buildings where soil vapour intrusion is of potential concern (within 30 m of occupied buildings).
- ❑ Check on-site and off-site manholes and interceptors (or other similar pathways) for the presence of COPCs (NAPL and/or vapours).

Sample Analysis

- ❑ All soil samples will be screened in the field for soil VOC measurements. Visual and olfactory observation information shall be recorded on borehole/test pit records, which are to be included in the report(s).
- ❑ Analysis for all suspected COPCs as determined by the product released or historical information from a Phase I ESA.
- ❑ One sample per borehole or test pit must be submitted for analysis. If contamination is identified, additional samples would be submitted for analysis to attempt to vertically delineate the contamination. The QPro will be responsible for determining the number of additional samples requested.
- ❑ Chemical analyses are to be conducted on at least one groundwater sample from each monitoring well and on-site water supply wells. Note: sampling may also be required for off-site downgradient water supply wells if possible.
- ❑ For petroleum impacted sites, CCME Petroleum Hydrocarbon Methods (also known as TPH fractionation which allows for the hydrocarbon concentrations to be divided into aliphatic and aromatic groups) may be necessary in those instances where an SSRA is proposed. In those cases, one sample (highest total PHC concentration) per release event or source, if different

type, should be submitted for fractionation analysis.

- ❑ Grain size analyses are to be conducted on at least one sample per hydrogeologic unit if the fine-grained or other soil texture values are to be applied.

Laboratory Requirements

- ❑ Laboratories performing analysis must be accredited to ISO/IEC 17025 standards (and subsequent revisions) by the Standards Council of Canada (SCC) or the Canadian Association of Laboratory Accreditation (CALA). All routinely required analyses must appear on the laboratory's certificate.
- ❑ All sampling and analysis must be in accordance with laboratory approved recommendations concerning sample containers, storage, and preservation.
- ❑ Appropriate selection of laboratory analytical methods to ensure adequate conformance to data quality objectives, assessment endpoints (ecological or human health), and method/reportable detection limits.
- ❑ For all COPCs, the analytical methods recommended are those in the latest guidance from the CCME Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment, Volume 4 Analytical Methods:

https://ccme.ca/en/res/guidancemanual-environmentalsitecharacterization_vol_4_epn1557.pdf

QUALITY ASSURANCE / QUALITY CONTROL

- ❑ At least one blind duplicate should be analyzed per batch of samples submitted for quality assurance/qualitycontrol (QA/QC) purposes. For larger batches (greater than 10 samples), 10% duplicates should be analyzed. The QA/QC results should be presented/interpreted in the report.
- ❑ For groundwater, a blind field duplicate sample, a field blank sample and a trip blank sample should be collected and analyzed with each batch of samples, regardless of the number of samples tested.
- ❑ For soil vapour samples, a blind duplicate should be collected and analyzed with each batch of samples, regardless of the number of samples tested.
- ❑ Sampling and sample handling protocols must be consistent with accepted practices. In particular, samples for VOCs must be collected such that there is no headspace in water samples and a minimum headspace in soil samples. Samples should be collectedin a manner to reduce potential loss of volatiles. Samples should be kept cool until they are delivered to the laboratory. ***Sample handling procedures should be verified with the receiving laboratory.***
- ❑ Ensure appropriate decontamination procedures are applied between sampling locations (including, but not limited to, decontamination of monitoring well sampling equipment, hand sampling tools, drilling augers/core barrels) to limit potential cross contamination.

OCCUPATIONAL HEALTH AND SAFETY

Safety practices should be consistent with the requirements of the Responsible Party (e.g., Site owner) and/or Workers' Safety & Compensation Commission (WSCC). As a minimum, the following is expected:

- ❑ Field personnel must have adequate protective clothing such as hard hat, safety vest, steel toe boots and gloves.
- ❑ Field personnel must have a working knowledge of the physical and chemical properties of the chemical hazards expected to be present.
- ❑ Electrical hazards such as electrical wires, buried cables; natural gas lines must be identified by a utility locator or the owner of the buried utility before any assessment activities.

Be aware that intrusive testing for COPCs has intrinsic risk to personal Health and Safety. As such, intrusive testing should only be undertaken by those with the appropriate training.

DATA TO SUPPORT CHANGES TO TIER 1 MODELLING PARAMETERS

For sites where the Tier I or Tier II Criteria are exceeded, the Responsible Party may elect to generate Tier II Site Specific Target Levels (SSTLs). Site-specific data must replace default modelling parameter values to support this approach. Replacement of any default modeling values will require technical justification. Following are some examples of parameters that may be considered for replacement of default parameters.

In general, data used to describe the specific fate and transport characteristics of the site and data used to characterize the natural attenuation processes will be required. Specific parameters are listed within the CCME, Health Canada and other risk assessment protocols.

- ❑ A minimum of one hydraulic conductivity test must be conducted for **each hydrogeologic unit** to support changes to hydrogeological default parameters.
- ❑ Meteorological data collected at the site or the closest meteorological station to the site must be used to support changes to default climate parameters.
- ❑ Actual site measurements/knowledge must be provided to support changes to building or receptor characteristics and exposure parameters.

MONITORING WELL DECOMMISSIONING

Groundwater monitoring wells should be decommissioned if they are no longer required for the following reasons;

- the site is closed and no longer monitored;
- the monitoring wells are no longer required for site investigation or remedial purposes; and/or
- the monitoring wells have been compromised or damaged.

Several Canadian jurisdictions have established guidelines or regulations regarding the decommissioning of groundwater monitoring wells. Most of the guidelines and procedures reflect the procedures outlined in the American Society for Testing and Materials International document Standard Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and other Devices for Environmental Activities (ASTM D5299/D5299M-18 (ASTM 2018).

Decommissioning of groundwater monitoring wells should be an integral part of the overall site restoration plan, and it is recommended that QPros follow the guidelines in the ASTM D5299/D5299M-18 document.

Additional information is available from the following guidance:

Decommissioning a groundwater monitoring well: federal contaminated sites advisory bulletin: How, when and why do I decommission a groundwater monitoring well?

ADDITIONAL RESOURCES

Additional resources can be found at the following web sites:

CSA 2018 Canadian Standards Association Standard for Phase II Environmental Site Assessment (CAN/CSA-Z769-00 (R2018)). https://www.csagroup.org/store/product/2701035/

CCME 2016*. Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment.*

i. Volume 1 Guidance Manual
ii. Volume 2 Checklists
iii. Volume 3 Suggested Operating Procedures

AEP 2016. Alberta Environment and Parks - Alberta Environmental Site Assessment Standard