



Ministry of
Environment and
Climate Change Strategy

PROTOCOL 16 **FOR CONTAMINATED SITES**

Determining the Presence and Mobility of
Nonaqueous Phase Liquids and Odorous Substances

Version 3.0

Prepared pursuant to Section 64 of the
Environmental Management Act

Approved: _____

Director of Waste Management

_____ Date

Effective date: **XXX**

1.0 Definitions

Terms defined in the *Environmental Management Act* (EMA) and Contaminated Sites Regulation (CSR) apply to this protocol in addition to the following:

“contaminant” means a substance causing “contamination” as such term is defined in section 39 of EMA.

“contaminant migration” means the spreading of a contaminant within or between soil, sediment, water or vapour.

“dense nonaqueous phase liquid” [DNAPL] means a nonaqueous phase liquid having a specific gravity greater than 1.0.

“fractured bedrock” means a rock mass that contains fractures of hydrogeological significance as determined by the presence of any of the following conditions:

- (a) the rock mass is composed of crystalline rocks including most plutonic and metamorphic rocks, non-pyroclastic volcanic rocks, and highly cemented sedimentary rocks,
- (b) the rock mass is brittle and deforms by fracturing,
- (c) the rock mass contains fractures that are visible in surface exposures, core, or well-image logs, or
- (d) the bulk hydraulic conductivity of the rock mass exceeds 10⁻⁶ m/s.

“free phase liquid” means a nonaqueous liquid that has not been absorbed onto soil, retains its original state and is free to move under prevailing site conditions.

“high water mark” means:

- (a) for freshwater: the visible high water mark of a stream where the presence and action of the water is so common and usual, and typically enduring, as to mark on the soil of the bed of the stream a character distinct from that of its banks, in vegetation, as well as in the nature of the soil itself, and includes the active floodplain associated with a site;
- (b) for marine water: the high water mark as defined by the most elevated High Water Mean Tide by Fisheries and Oceans Canada and as mapped on Canadian Hydrographic Services navigational charts; and
- (c) for estuarine water: the high water mark is whichever of the freshwater or marine water high water mark is further inland.

“light nonaqueous phase liquid” [LNAPL] means a nonaqueous phase liquid having a specific gravity less than 1.0.

“migrating NAPL” means a nonaqueous phase liquid that is spreading or expanding laterally or vertically

“mobile NAPL” means that either or both LNAPL and DNAPL are present at a site and that one or more of the conditions described in section 3.2 of this protocol has occurred.

“nonaqueous phase liquid” [NAPL] means a liquid that does not dissolve in water and forms a separate physical density phase from water.

“soil surface” means the upper surface of the soil layer below open air or constructed surface covers other than buildings.

“theoretical solubility limit” means the maximum [i.e. saturation] concentration of a chemical compound in water at 25 degrees Celsius and 1 atmosphere of pressure.

2.0 Introduction

Consistent with EMA and the CSR, this protocol:

1. establishes substantive and procedural requirements for persons planning, conducting or reporting on the remediation of a contaminated site; and
2. evaluates site conditions for classifying sites as high risk sites based on an evaluation of risk to human health and the environment.

Schedule 3.1 – Part 2 and Schedule 3.1 - Part 3 of the CSR contain environmental quality standards for nonaqueous phase liquids and odorous substances. For all land uses, the Schedules list those standards as “not present” and in footnotes 15 and 16 of Schedule 3.1 Part 2 and footnotes 10 and 12 of Schedule 3.1 Part 3 further explain that soil must be remediated so that these substances are not present in quantities in excess of those acceptable to a director.

This protocol provides the director’s requirements in the context of these footnotes and the standard “not present”. In addition, it describes the circumstances when two types of NAPL (i.e. DNAPLs and LNAPLs) are considered present, mobile and migrating.

3.0 Present, mobile and migrating nonaqueous phase liquids (NAPLs)

For any of the eight land uses (i.e. wildlands natural, wildlands reverted, agricultural, urban park, residential low density, residential high density, commercial and industrial) provided in the CSR, pursuant to section 11(1) and Schedules 3.1 and 3.2 of the CSR, a site is contaminated if NAPL is present at the site. The site would be considered remediated under section 17(1) of the CSR if the NAPL is removed so that NAPL is considered not present. The following subsections indicate when the director considers LNAPL and DNAPL present or not present.

3.1 Presence of NAPL

3.1.1 When LNAPL is present

LNAPL is considered present when either of the following occurs at a site:

- a) free phase liquid is found in soil or on the soil surface; or
- b) free phase liquid is found in monitoring wells at a thickness greater than 2 mm.

3.1.2 When DNAPL is present

DNAPL is considered present when any of the following occur at a site:

- a) free phase liquid is found in soil or on the soil surface;
- b) free phase liquid is found in monitoring wells at a thickness greater than 2 mm; or
- c) individual DNAPL substances are detected in water at concentrations exceeding 1% of their theoretical solubility limit.

3.2 Mobile NAPL

Mobile NAPL represents a contaminant source with potential to cause contaminant migration, undetermined future risks as well as increased complexity, cost, and effort in site remediation. Mobile NAPL is therefore a factor which is considered in classifying the risks a site poses to human health and the environment.

NAPL is considered mobile when present at a site, as determined using the criteria specified in section 3.1 of this protocol, and one or more of the following conditions occur.

3.2.1 When LNAPL is mobile

Under this protocol, LNAPL is defined as mobile when any of following conditions occurs:

- a) LNAPL is present over an area greater than 10 m² on the land surface;
- b) LNAPL is present in fractured bedrock;
- c) LNAPL is measured in the subsurface over an area greater than 50 m² and at least one of the following apply:
 - Seasonal water table fluctuations exceed 1 m (unless monitoring data is available to determine maximum LNAPL thickness at both high water and low water levels);
 - Hydraulic gradients exceed 0.01 m/m for soil compositions listed in Table 1;
 - Preferential pathways intersect zones containing LNAPL with a thickness exceeding 0.3 m;
 - LNAPL thicknesses exceed values indicated in Table 1;
- d) quarterly groundwater monitoring events indicate increasing thickness of LNAPL in monitoring wells; and

- e) quarterly groundwater monitoring events indicate advancement of LNAPL across a monitoring well network.

Table 1. LNAPL thickness considered mobile as a function of soil composition^{1,2}

Soil Type	Characteristic Fraction	Percent Fines (silt and clay)	LNAPL Thickness (m)
Coarse sand or gravel	> 20% Coarse sand	< 3	0.03
Coarse sand or gravel	> 20% Coarse sand	3-10	0.05
Medium sand	Medium sand	< 10	0.1
Fine sand	Fine sand	< 10	0.2
Silty sand	Sand	> 10	0.3

Notes:

1. Soil compositions are based on the Unified Soil Classification System.
2. Soil compositions falling outside listed soil types must be assigned the soil type that most closely approximates the permeability characteristics of the soil. In the event of uncertainty, a coarser grained soil type must be assigned.

3.2.2 When DNAPL is mobile

DNAPL is considered mobile when any of the following conditions occur at a site:

- a) DNAPL is present in fractured bedrock;
- b) DNAPL is present over an area greater than 10 m² on the land surface;
- c) quarterly groundwater monitoring events indicate advancement of DNAPL across a monitoring well network;
- d) free phase liquid is found in monitoring wells at a thickness greater than 2 mm; and
- e) individual DNAPL substances are detected in water at concentrations exceeding 10% of their theoretical solubility limit.

3.2.3 Potential for NAPL migration

Mobile NAPL sources have the potential to migrate resulting in the NAPL body spreading or expanding laterally or vertically. Under this protocol, all mobile NAPL sources, as determined under the criteria specified in section 3.2 of this protocol, are considered to have potential to migrate until any of the following conditions is met:

- a) Quarterly groundwater monitoring events for one year with at least one of them in low water table season provides evidence that the NAPL conditions at a site have not changed over time.
- b) Historical monitoring data with at least two years of groundwater monitoring results for a site has provided evidence that the NAPL plume is stable and not migrating.
- c) Multiple lines of evidence evaluation showing reduced potential for NAPL migration following current science based approaches.

4.0 Odorous substances presence

Schedule 3.1 Parts 2 and 3 of the CSR provide “not present” standards for odorous substances for all eight land uses specified in section 12(3).

Under section 11(1) of the CSR a site is contaminated with respect to odorous substances if a substance is present at the site where concentrations exceed any of environmental quality standards in Schedule 3.3 for the applicable land use. As well, the site would be considered remediated under section 17(1) of the CSR with respect to odorous substances if the substances exceeding the generic numerical vapour standards in Schedule 3.3 for the applicable land use are remediated to concentrations less than those standards or if the exposure is managed to meet risk-based standards.

Revision history

Approved Date	Effective Date	Document Version	Notes
May 31, 2010	June 1, 2010	1.0	
August, 2017	November 1, 2017	2.0	Updated for CSR Stage 10 amendment
DRAFT		3.0	<ul style="list-style-type: none">• Added new definitions for migrating NAPL• Added definition for contaminant migration• Added introductory paragraph• Added one new condition for determining potential for NAPL migration