Ministry of Environment and Climate Change Strategy

# PROTOCOL 21
## FOR CONTAMINATED SITES

# Water Use Determination

Version 2.0

Prepared pursuant to Section 64 of the
*Environmental Management Act*

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| Approved: | Cameron Lewis | October 31, 2017 |
| | Director of Waste Management | Date |

**Effective Date: November 1, 2017**

## 1.0 Definitions

The following words, acronyms and expressions used in this document are defined in ministry Procedure 8, "Definitions and Acronyms for Contaminated Sites":

aquatic receiving environment
dense nonaqueous phase liquid
drinking water use
groundwater contamination source
muskeg
natural confining barrier
numerical water standards
organic soil
preferential flow pathway
qualified professional
receiving environment
Regulation

## 2.0 Introduction

This protocol provides criteria for determining groundwater uses at a site.

Section 12 (4) of the Contaminated Sites Regulation (the Regulation) specifies that groundwater may be used for drinking, aquatic life, irrigation and livestock watering. The Regulation contains requirements to ensure that groundwater at a site is suitable for current and future uses and is of adequate quality to protect adjacent water uses. Relevant provisions in the Regulation include sections 12 (2) and (5).

This document supersedes former Technical Guidance 6 "Water Use Determination" dated July 2010. Technical guidance supporting the application of this protocol is provided in revised Technical Guidance 6, "Assessment of Hydraulic Properties for Water Use Determinations" and Technical Guidance 8, "Groundwater Investigation and Characterization".

## 3.0 Drinking water use

Site-specific information is required to determine the applicability of current and future drinking water use at a site. In some circumstances, site-specific information may be augmented by adjacent site data (see Technical Guidance 6 for further information).

The flowchart in Figure 1 is provided to assist with navigation of the drinking water use evaluation process.

### 3.1 Current drinking water use

Drinking water use applies where the groundwater or surface water at or near a site is currently used for drinking water. For site investigation purposes, nearby drinking

water wells or surface water intakes are those located within a radial distance of 500 metres from the site property boundary or, where the groundwater contamination source extends beyond the property boundary, a radial distance of 500 metres from the groundwater contamination source. If the groundwater flow direction has been reliably determined using approved methods (see Technical Guidance 8), nearby current uses may be limited to include drinking water wells or surface water intakes located 100 metres upgradient and 500 metres cross-gradient and downgradient of the site property boundary or outer extent of the groundwater contamination source where it extends beyond the property boundary.

The presence of current drinking water wells or surface water intakes can be determined using the following methods:

(a) A search of the Ministry of Environment's WELLS Database.

(b) Performing a door to door survey.

(c) A search of B.C.'s Water License Database.

(d) Contacting local municipalities, water utility owners, Medical Health Officers and local Drinking Water Officers.

The use of all the search methods listed above may not be required in every circumstance, provided the locations of current drinking water wells and surface water intakes can be demonstrated to be accurate.

At some sites, there may be potential for adverse impacts on current drinking water uses located greater than 500 metres, or 100 metres upgradient of a site property boundary or groundwater contamination source. This could include sites where preferential flow pathways are present, where there are high volume groundwater extraction wells or where contaminant plumes are large and expanding. At such sites, additional evaluation of the groundwater flow pathway may be required to rule out current drinking water use.

If current drinking water wells are limited to a deeper aquifer that is protected from shallow groundwater contamination sources by a natural confining barrier, current drinking water use does not apply to geological units above the confining barrier. Section 7.0 of this protocol describes procedures for assessing the presence of natural confining barriers.

Where applicable and scientifically defensible, well capture zone analysis may be carried out by a qualified professional on drinking water wells located within 500 metres or 100 metres upgradient of the site property boundary or groundwater contamination source. Where it can be shown that site groundwater will not enter the capture zone of all nearby drinking water wells, current drinking water use does not apply.

If it is determined that groundwater and surface water at or nearby a site are not currently used for drinking water purposes, future drinking water use may apply and must also be evaluated.

### 3.2 Future drinking water use

Future drinking water use applies to all drinking water aquifers below a site whether or not current drinking water use applies. Drinking water aquifers are saturated geological units that have suitable hydraulic properties and natural water quality to support a single family domestic water supply. Where information is unavailable or inadequate to demonstrate an absence of drinking water aquifers below a site, drinking water aquifers are considered to exist.

Where drinking water aquifers below a site are protected from shallow groundwater contamination sources by a natural confining barrier and no shallow drinking water aquifers exist, future drinking water use does not apply to geological units above the confining barrier. Where drinking water aquifers are not protected by a natural confining barrier, future drinking water use will apply to all geological units below the site.

#### 3.2.1 Aquifer hydraulic properties

Saturated geological units with yields greater than or equal to 1.3 L/min are capable of supporting a single family domestic water supply (B.C. provincial allocation for domestic surface water licenses) and are considered drinking water aquifers. Future drinking water use applies to these aquifers.

Unconsolidated geological units with aquifer yields greater than or equal to 1.3 L/min typically have bulk hydraulic conductivities greater than $1 \times 10^{-6}$ m/s. Therefore, saturated unconsolidated geological units with hydraulic conductivities greater than or equal to $1 \times 10^{-6}$ m/s are considered drinking water aquifers, unless aquifer yield has been measured and is found to be less than 1.3 L/min. Future drinking water use does not apply to saturated unconsolidated geological units with hydraulic conductivities less than $1 \times 10^{-6}$ m/s. Guidance for assessing aquifer yield for purposes of determining water use can be found in Technical Guidance 6.

Bedrock units show a poorer correlation between yield and hydraulic conductivity. Therefore, hydraulic conductivity alone cannot be used to rule out drinking water use in bedrock. Section 6.0 of this protocol describes procedures for assessing bedrock aquifers.

Site-specific measurements of hydraulic conductivity and calculation of bulk hydraulic

conductivity as described below are required to evaluate whether a geological unit below a site qualifies as a drinking water use aquifer. Bulk hydraulic conductivity is calculated as follows:

- the geometric mean of hydraulic conductivity measurements obtained from six or more wells, spatially distributed across a site and located within the same geological unit; or
- the maximum hydraulic conductivity where measurements are obtained from five or fewer wells.

Confined aquifers that:

- have an average saturated thickness of 1 metre or less; and
- are situated within a predominantly confined unit;

are not considered sustainable sources of domestic water supply. Future drinking water use does not apply to these aquifers.

Unconfined aquifers that:

- are present only seasonally or have an average saturated thickness of 2 metres or less; or
- are comprised only of imported fill;

are not considered sustainable sources of domestic water supply. Future drinking water use does not apply to these aquifers.

#### 3.2.2 Aquifer natural water quality

Saturated geological units containing naturally occurring total dissolved solids concentrations of 4,000 mg/L or greater or groundwater flow systems contained within organic soils or muskeg (see Procedure 8, "Definitions and Acronyms for Contaminated Sites") are considered to have unsuitable water quality for domestic water supply. Therefore, future drinking water use does not apply to these units.

Saturated geological units that:

- are located within and below filled former marine and estuarine foreshore; or
- are located within 500 metres of a marine and estuarine foreshore; and
- contain naturally occurring chloride and sodium concentrations greater than the drinking water standards measured in wells spatially distributed across the site and located within the same geological unit;

are considered to have unsuitable water quality for domestic water supply. Future drinking water use does not apply to these geological units.

## 4.0 Irrigation and livestock water use

Irrigation or livestock water use applies where the groundwater or surface water at or nearby a site is currently used for irrigation or livestock watering. Nearby irrigation or livestock watering wells or surface water intakes are those located within a radial distance of 500 metres from the site property boundary or, where the groundwater contamination source extends beyond the property boundary, a radial distance of 500 metres from the groundwater contamination source. If the groundwater flow direction has been reliably determined using approved methods (see Technical Guidance 8), nearby current uses may be limited to include irrigation and livestock watering wells or surface water intakes located within 100 metres upgradient and 500 metres cross gradient or downgradient of the site property boundary or outer extent of the groundwater contamination source where it extends beyond the property boundary.

If current irrigation or livestock watering wells are limited to a deeper aquifer that is protected from shallow groundwater contamination sources by a natural confining barrier, current irrigation or livestock water uses do not apply to geological units above the confining barrier.

Well capture zone analysis may be carried out on current irrigation or livestock watering wells within 500 metres distance or 100 metres upgradient of the site property boundary or groundwater contamination source. Where it can be shown that site groundwater will not enter the capture zone of any nearby irrigation or livestock watering wells, current irrigation or livestock water uses do not apply.

The flowchart in Figure 2 is provided to assist with navigation of the irrigation and livestock water use evaluation.

## 5.0 Aquatic life water use

Aquatic life water use applies to all groundwater located within 500 metres of an aquatic receiving environment unless it can be demonstrated that the groundwater does not flow to that receiving environment (e.g., groundwater in confined aquifers below shallow ponds or creeks).

Aquatic life water use applies to groundwater located beyond 500 metres of an aquatic receiving environment if the groundwater contains substances with concentrations above the aquatic life water use standards and has the potential to migrate within 500 metres of the aquatic receiving environment. Examples include groundwater plumes that cross or continue to migrate towards the 500 metre setback boundary or plumes

that are conveyed along preferential flow pathways such as buried creek channels or underground utility corridors.

The flowchart in Figure 3 is provided to assist with navigation of the aquatic life water use evaluation.

## 6.0 Bedrock aquifers

The assessment of bedrock aquifers for current drinking water, irrigation or livestock water use should be evaluated as described under Section 3.1 and 4.0. If current drinking water, irrigation or livestock watering wells are located in a bedrock aquifer below or nearby a site, the corresponding water use applies to the bedrock aquifer and to overlying geological units. If current drinking water, irrigation or livestock watering wells are limited to a bedrock aquifer that is protected from shallow groundwater contamination sources by a natural confining barrier as defined under Section 7.0 below, current drinking, irrigation or livestock water uses do not apply to geological units above the confining barrier.

Future drinking water use applies to bedrock aquifers mapped in the BC Water Resource Atlas. Where bedrock investigations indicate that part of the bedrock unit at a site would operate as a natural confining barrier protecting a deeper more permeable bedrock unit, site owners may seek a site-specific decision of water use from the Director under Section 9.0 of this protocol.

Bedrock aquifers must be assessed for future drinking water use when:

- no bedrock aquifers are mapped in the BC Water Resource Atlas and;
- soil or groundwater containing substances at concentrations above standards protective of drinking water extend to the bedrock surface.

Where bedrock assessment is required, hydraulic properties and yield must be assessed on the basis of *in situ* field investigations conducted at the site or within a 500 metre radial distance of the site property boundary where the bedrock can be shown to be of the same geological formation.

The flowchart in Figure 4 is provided to assist with navigation of the current and future drinking water use evaluation in bedrock.

The assessment of bedrock aquifers for aquatic life water use should be evaluated as described under Section 5, "Aquatic life water use", above.

## 7.0 Natural confining barriers

Natural confining barriers are unconsolidated geological units that protect underlying aquifers from shallow groundwater contamination. For a geological unit or part of a geological unit to qualify as a natural confining barrier, it must satisfy the criteria for either Type A or Type B listed below.

**Type A**

A Type A natural confining barrier is a geological unit or part of geological unit that:

- has a bulk hydraulic conductivity less than $1 \times 10^{-7}$ m/s;
- has a minimum thickness of 5 metres;
- is reasonably uniform in composition and is unfractured;
- is continuous across the extent and predicted migration pathway of contaminant plumes; and
- is demonstrated free of contamination based on substance concentrations in soil or water that are:
    - less than or equal to the commercial land use soil standards listed in Schedule 3.1 Part 2 and 3 of the Regulation;
    - less than or equal to the commercial land use soil standards for the site-specific factor of groundwater used for drinking water, irrigation water or livestock water listed in Schedule 3.1 Part 1 of the Regulation, depending on the applicable water use of the deeper aquifer; or
    - less than or equal to the drinking, irrigation or livestock water standards in Schedule 3.2 of the Regulation, depending on the applicable water use of the deeper aquifer, where no soil standards protective of the applicable water use are listed in Schedule 3.1 Part 1.

**Type B**

A Type B natural confining barrier is a geological unit or part of geological unit that:

- has a bulk hydraulic conductivity between $1 \times 10^{-7}$ m/s and $1 \times 10^{-6}$ m/s;
- has a ratio of thickness to hydraulic conductivity greater than $5 \times 10^{7}$ s;
- is reasonably uniform in composition and is unfractured;
- is continuous across the extent and predicted migration pathway of contaminant plumes; and
- is demonstrated free of contamination based on substance concentrations in soil and water that are less than or equal to the applicable regulatory standards.

Where dense nonaqueous phase liquids are present, contamination of natural confining barriers for both Type A and Type B must be determined on the basis of substance concentrations in both soil and groundwater.

Site-specific measurements of hydraulic conductivity are required to evaluate whether a geological unit below a site qualifies as a natural confining barrier. Bulk hydraulic conductivity is calculated as follows:

- the 90th percentile of hydraulic conductivity measurements obtained from six or more wells, spatially distributed across a site and located within the same geological unit; or
- the maximum hydraulic conductivity obtained from five or fewer wells.

## 8.0 Applicable water use standards

Numerical water standards for investigating the presence of contamination in surface water (non-aquatic life receiving environment) and groundwater at sites in BC are provided in Schedule 3.2 of the Regulation. The numerical standards are provided for each of the water uses described in this protocol. Where multiple water uses apply at a site, the presence of contamination must be determined using the most stringent of all of the applicable numerical water standards. Different water uses might apply to different sections of a site.

## 9.0 Requesting a Director's decision of water use

Where water uses determined to apply at a site under this protocol are considered unlikely or unreasonable, site owners and operators may request a Director to make a site-specific decision of water use. Such requests must be accompanied by a completed Contaminated Sites Services Application form and a supporting technical report prepared by a qualified professional. For applications requesting a decision of no drinking water use, Appendix 1 provides the Director's decision framework for making such decisions.

*For more information, please direct inquiries to site@gov.bc.ca.*

### Revision history

| Approved Date | Effective Date | Document Version | Notes |
|---|---|---|---|
| December 15, 2015 | February 1, 2016 | 1.0 | |
| August, 2017 | November 1, 2017 | 2.0 | Updated to reflect CSR Stage 10 amendments |
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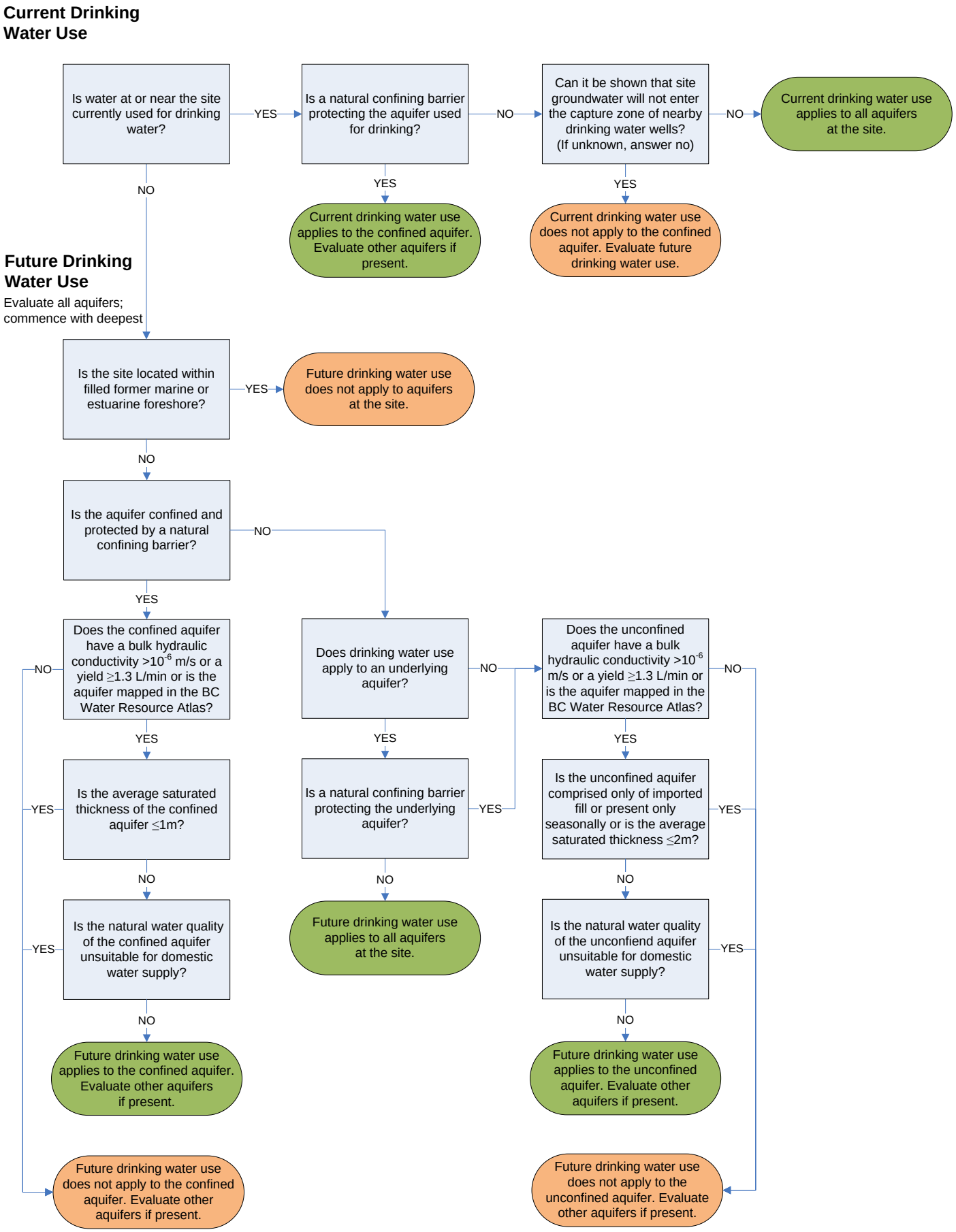


**Figure 1. Current and future drinking water use evaluation for unconsolidated aquifers.**

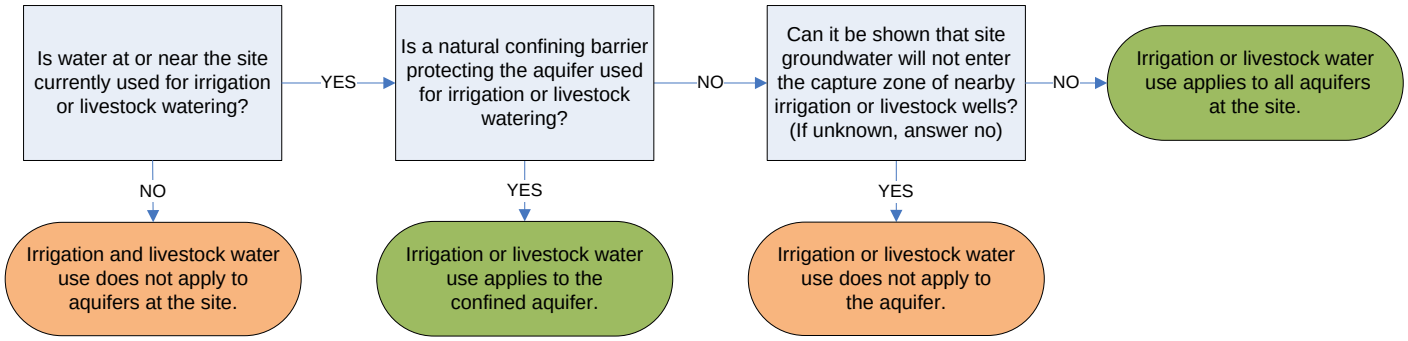


**Figure 2. Irrigation and livestock water use evaluation.**

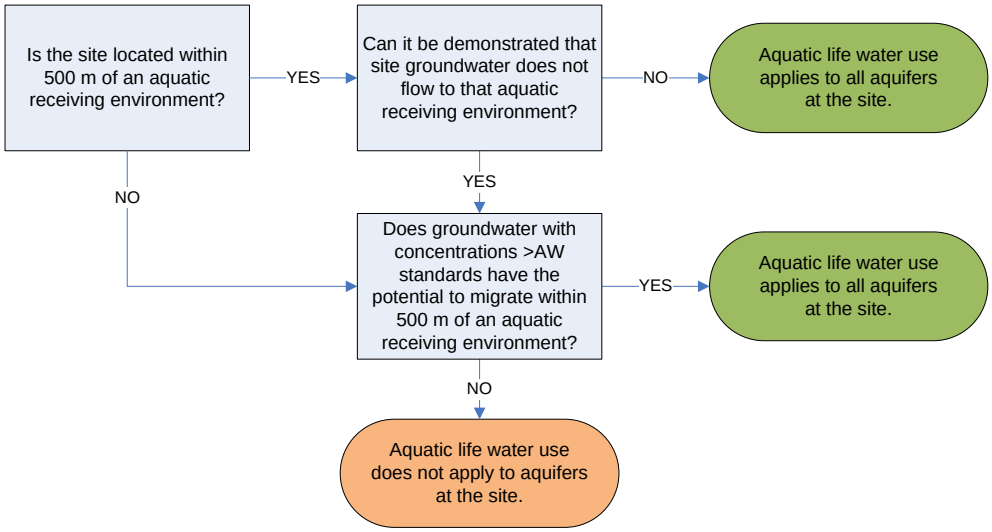


**Figure 3. Aquatic water use evaluation.**

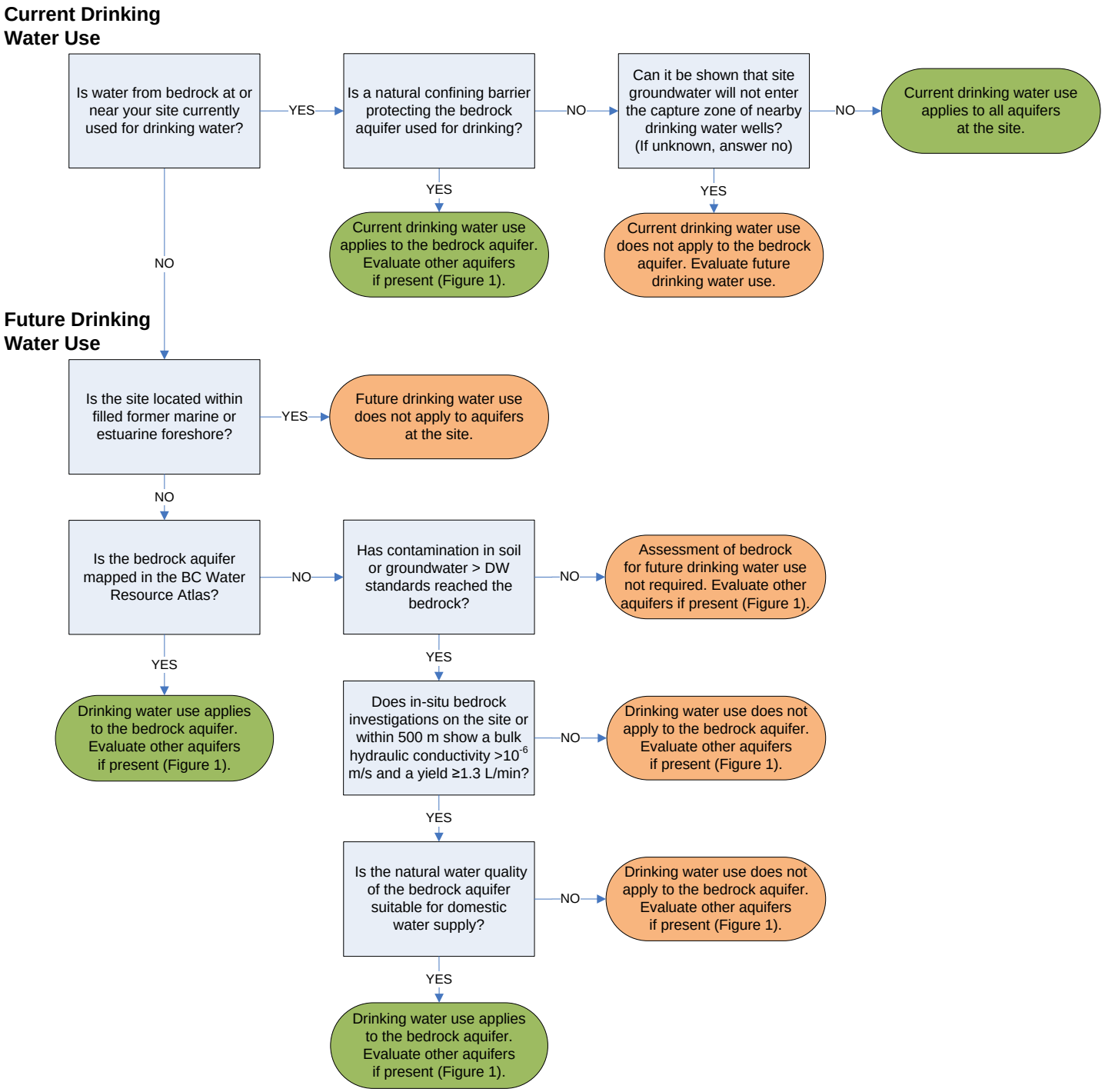


**Figure 4. Current and future drinking water use evaluation for bedrock aquifers.**

## Appendix 1

### Director's Decision Framework for Site-Specific Decisions of Water Use

Where drinking water use has been determined to apply at a site under Protocol 21 and site circumstances indicate that it is unlikely or unreasonable to anticipate that water from the site or nearby the site would be used for drinking, site owners and operators may apply to the Director for a site-specific decision of no drinking water use. Applications for a decision of no drinking water use must be accompanied by a completed Contaminated Sites Services Application form and a supporting technical report prepared by a qualified professional.

This decision framework describes a multiple-lines-of-evidence approach for demonstrating that water use for drinking water purposes would be unlikely or unreasonable to anticipate at a site.

Site-specific conditions considered valid lines of evidence for supporting a decision of no drinking water use are listed below. The conditions listed are not exhaustive and may be augmented by other relevant information on a site-by-site basis. However, multiple site-specific conditions should be demonstrated to apply. Satisfying a single listed condition or two or more conditions that fall under a single category (e.g., groundwater demand) is unlikely to provide sufficient justification for a decision of no drinking water use. In addition, some of the listed conditions are relevant to shallow aquifers only and may, in combination with other demonstrated conditions, be sufficient to support a determination of no drinking water use in a shallow aquifer but not be sufficient for a decision of no drinking water use in a deeper aquifer. Where deep drinking water aquifers are present below a site, applications for a Director's decision of no drinking water use in a shallow aquifer must be accompanied by evidence of a natural confining barrier above the drinking water aquifer.

Water quality

- The site is located in an area of long industrial use with multiple landowners, multiple sources, and widespread contamination which has not been attributed to particular responsible person(s).
- The site is located adjacent to the marine receiving environment and groundwater pumping for drinking water use would result in seawater intrusion. Under this condition groundwater flow and contaminant migration must be toward the marine environment and not to neighbouring parcels.

Aquifer productivity

- The sustainable yield in the shallow aquifer cannot support a single family dwelling at 1.3 L/min for more than a limited number of years.

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Groundwater demand

- A municipal water supply is in place that does not rely on groundwater.
- The aquifer underlying the site is not classified as a high demand aquifer according to the Ministry of Environment's Aquifer Classification System
- The site is not located in an area of known limited water resources.
- Groundwater at the site is not restricted for drinking water use under a Local Government Water Management Plan.
- The future use of the site and surrounding area is industrial.