

Directive 083

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Hydraulic Fracturing – Subsurface Integrity

Contents

1	Introduction	2
1.1	Purpose of This Directive.....	2
1.2	AER Requirements	3
1.3	What’s New in This Edition	3
2	Well Integrity – Subject Well.....	3
2.1	General Requirements.....	4
2.2	Dual-Barrier System.....	4
2.3	Single-Barrier System	5
3	Interwellbore Communication	6
3.1	General Requirements.....	6
3.2	Hydraulic Fracturing Risk Planning.....	6
3.3	At-Risk Offset Well-Control Plans.....	7
3.4	Notification and Engagement Between Subject Well Licensees and At-risk Well Licensees	7
4	Nonsaline Aquifer Protection	8
4.1	General Requirements.....	8
4.2	Nonsaline Aquifer Risk Assessment.....	8
5	Hydraulic Fracturing Near Water Wells	9
6	Hydraulic Fracturing Near the Bedrock Surface.....	9
7	Special Provisions for Coalbed Methane Fracturing	10
7.1	Coalbed Methane Fracturing Near Water Wells.....	10
7.2	Coalbed Methane Fracturing Near the Bedrock Surface.....	10
7.3	Nitrogen Pumping Volume Limitations in Coals	10

8	AER Notification Requirements	11
9	Continuous Improvement	11
Appendix 1	Definitions	13
Figure 1.	Example of a simplified dual-barrier system.....	4
Figure 2.	Example of a single-barrier system	6
Figure 3.	Hydraulic fracturing exclusion zone near water wells	9
Figure 4.	Hydraulic fracturing exclusion zone relative to the bedrock surface	10

1 Introduction

1.1 Purpose of This Directive

This directive sets out the Alberta Energy Regulator’s (AER’s) requirements for managing subsurface integrity associated with hydraulic fracturing operations, including **geothermal wells**. This directive does not apply to **thermal wells**.

These requirements are intended to

- prevent the loss of **well integrity** at a **subject well** (a well at which a licensee proposes to conduct hydraulic fracturing operations),
- reduce the likelihood of unintentional interwellbore communication between a subject well and an **offset well**¹,
- manage well control at an offset well in the event of interwellbore communication with a subject well,
- prevent **adverse effects** on **nonsaline aquifers**,
- prevent impacts on **water wells**, and
- prevent surface impacts.

This directive includes

- requirements to prevent the loss of well integrity at a subject well (section 2),
- requirements for licensees to assess, plan, and mitigate the risks of interwellbore communication with offset wells (section 3),
- requirements to notify licensees of **at-risk offset wells** related to hydraulic fracturing

¹ An offset well includes any well that has been designated by the AER as an orphan well according to section 70(2)(a) of the *Oil and Gas Conservation Act*.

operations (section 3),

- requirements to protect nonsaline aquifers from hydraulic fracturing operations conducted at depths less than 100 metres (m) below the **base of groundwater protection (BGWP)** (section 4),
- increased vertical depth restriction for hydraulic fracturing operations near water wells (section 5),
- increased vertical depth restriction for hydraulic fracturing operations near the top of the **bedrock** surface (section 6),
- pumping volume restrictions and setback distances for nitrogen fracturing operations for coalbed methane (section 7), and
- requirements to notify the AER about hydraulic fracturing operations (section 8).

In this directive, defined terms are set in **boldface** at first use, and the definitions are provided in appendix 1.

1.2 AER Requirements

In this directive, the term “must” indicates a requirement, while terms such as “should,” “recommends,” and “expects” indicate a recommended practice.

If a requirement applies at both the application stage and later in a development’s life cycle, the requirement may refer to both the applicant and the licensee.

Each AER requirement is numbered in this directive.

Information on compliance and enforcement can be found on the AER website.

Direct any questions about this directive to welloperations@aer.ca.

1.3 What’s New in This Edition

Directive 083 has been rebranded and placed in the AER’s current format for directives.

This directive now also applies to geothermal resource development. References to the [Geothermal Resource Development Rules](#) and other appropriate references to geothermal development have been made.

2 Well Integrity – Subject Well

During hydraulic fracturing operations, subject wells experience significant stresses that might lead to a loss of well integrity. A loss of well integrity may result in subsurface impacts or a release of fluids to the surface, placing the public and the environment at risk.

2.1 General Requirements

- 1) Licensees must design, construct, and operate their wells to provide well integrity during hydraulic fracturing operations.
- 2) Licensees must obtain AER approval if intending to use a **barrier** system other than a **single-barrier system** or **dual-barrier system**.

Licensees are expected to manage well integrity throughout the life of the well, from construction to postabandonment.

2.2 Dual-Barrier System

- 3) A dual-barrier system (see figure 1) must consist of
 - a) a **primary barrier system** capable of containing and isolating the fracture fluids,
 - b) a **secondary barrier system** capable of providing well control in the event of a failure of the primary barrier, and
 - c) a monitoring system to detect and allow for a response to a primary barrier failure.
- 4) To be classified as a dual-barrier system, the cement of the primary barrier system must not extend above the base of the overlying porous interval.

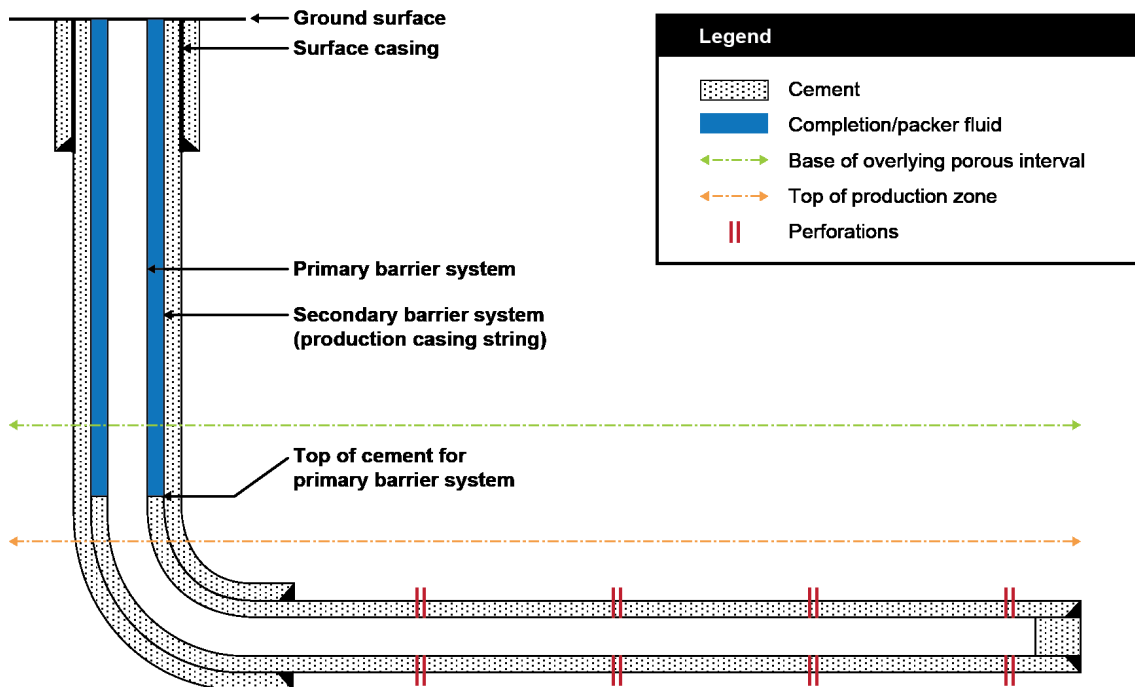


Figure 1. Example of a simplified dual-barrier system

2.3 Single-Barrier System

The AER expects licensees to be diligent in designing a **single-barrier system** (see figure 2).

When using a single-barrier system, surface casing must be set in accordance with the current requirements of [Directive 008: Surface Casing Depth Requirements](#).

- 5) If surface casing is not set to the BGWP, the licensee must
 - a) not use hydraulic fracturing fluids that may cause an adverse effect on nonsaline aquifers and
 - b) cement the next casing string up to the surface.
- 6) If using a single-barrier system, licensees must
 - a) document the load capacity and safety factors used in the casing design relative to the expected loads and the well environment the casing will be exposed to;
 - b) document the **adjusted maximum pressure**;
 - c) use an operating practice, such as the *IRP Volume #25 – Primary Cementing* (Drilling and Completions Committee) or a technically equivalent standard, when planning and executing its cementing program;
 - d) be able to demonstrate the integrity of both the casing and cement before initial fracture operations;
 - e) be able to demonstrate the integrity of the casing during fracture operations;
 - f) be able to demonstrate the integrity of the casing with final completion operations or within 90 days of the fracture operation; and
 - g) conduct a surface casing vent flow/gas migration test or surface casing annulus flow test in accordance with [Directive 087: Well Integrity Management](#)
 - i) before initial fracturing operations and
 - ii) between 60 and 90 days after completing fracturing operations.

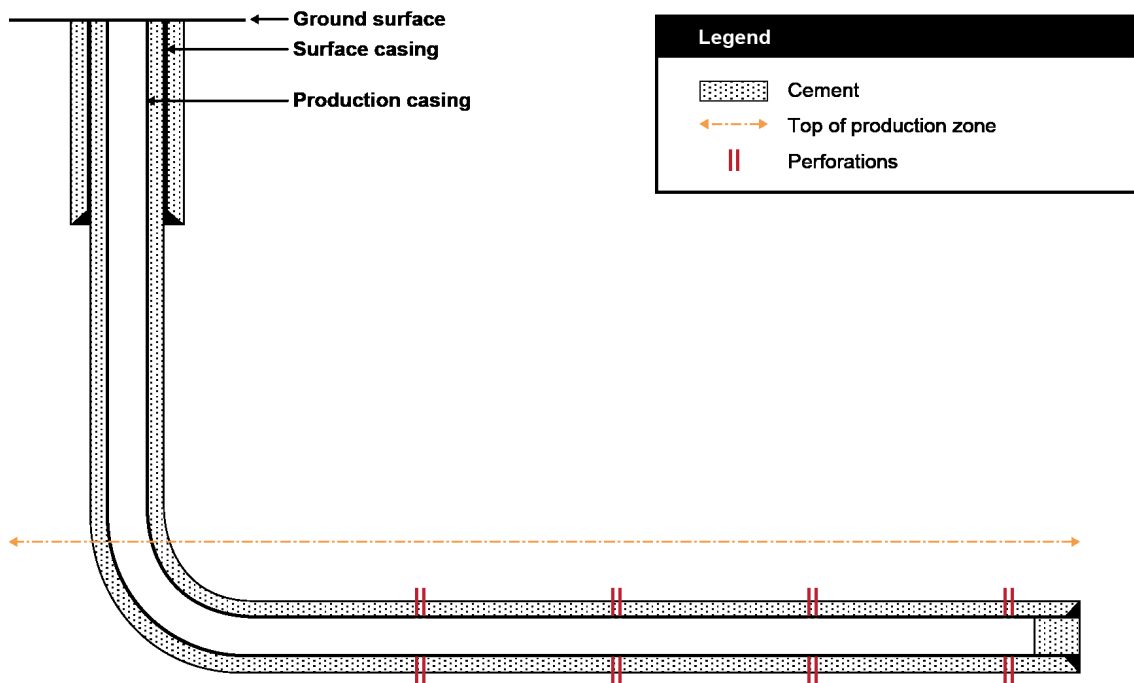


Figure 2. Example of a single-barrier system

3 Interwellbore Communication

Interwellbore communication occurs when a communication pathway has been established between a subject well and an offset well. A communication pathway may cause a **well-control event** at an offset well, which may result in subsurface impacts or a release of fluids to the surface, placing the public and the environment at risk.

3.1 General Requirements

- 7) Licensees must manage the risks of interwellbore communication between the subject well and offset wells.

3.2 Hydraulic Fracturing Risk Planning

- 8) Licensees must have a documented hydraulic fracturing program that includes the following information:
 - a) determination of a **fracture planning zone (FPZ)**
 - b) identification of all offset wells within the FPZ
 - c) an assessment of the well integrity for each offset well
 - d) a **risk assessment** for each offset well, using a methodology such as that described in *IRP Volume #24 – Fracture Stimulation* (Drilling and Completions Committee)
 - e) a determination of at-risk offset wells within the FPZ

- f) identification and assessment of special consideration wells for possible inclusion in the well control plan
 - g) identification of **energizing gases** used in the fracture fluids
- 9) Licensees must maintain a copy of the hydraulic fracturing program at the subject well site for the duration of the operation.

Before fracturing with **high-vapour-pressure hydrocarbons**, the operator requires approval by the AER in accordance with section 8.110(3) of the [Oil and Gas Conservation Rules](#) or section 27(3) of the [Geothermal Resource Development Rules](#), whichever is applicable.

Licensees should be aware of subsurface features such as those described in the *IRP 24 Hazard Register*.

3.3 At-Risk Offset Well-Control Plans

- 10) Licensees must have a documented well-control plan for each at-risk offset well that includes the following information:
- a) the methods of detection of interwellbore communication
 - b) how the information will be relayed from an at-risk offset well to the hydraulic fracturing operations should an interwellbore communication event occur
 - c) the adjusted maximum pressure for each at-risk offset well
 - d) how the licensee will ensure well control at each at-risk offset well
- 11) Licensees must maintain a copy of the well-control plan for each at-risk offset well at the subject well site for the duration of the hydraulic fracturing operation.

3.4 Notification and Engagement Between Subject Well Licensees and At-risk Well Licensees

In this section, if an at-risk offset well is an **orphan well**, “licensee” includes the Orphan Well Association.

- 12) The licensee of the subject well must notify and engage all licensees with at-risk offset wells of its planned hydraulic fracturing program and make all reasonable efforts to develop mutually acceptable well-control plans.

The licensee of the offset well and the licensee of the subject well are responsible for maintaining well control of their licensed wells at all times.

- 13) If the at-risk offset well does not have an active licensee and is not an orphan well, the subject well licensee must contact welloperations@aer.ca.

- 14) Upon becoming aware of any communication event with an offset well, the subject well licensee must immediately notify the licensee of the offset well.

See section 8 for additional AER notification requirements.

4 Nonsaline Aquifer Protection

Communication between the subject well and a nonsaline aquifer because of hydraulic fracturing operations might cause adverse effects.

4.1 General Requirements

- 15) A licensee's hydraulic fracturing operations must not have an adverse effect on a nonsaline aquifer.

4.2 Nonsaline Aquifer Risk Assessment

- 16) The licensee must prepare a risk assessment for any hydraulic fracturing operations above the BGWP or within 100 m below the BGWP and include the following information:
 - a) an evaluation of the potential for direct fracture communication from the subject well to a nonsaline aquifer
 - b) the true vertical depth (TVD) of the top and base of any nonsaline aquifers above the BGWP
 - c) the TVD of the fracture intervals within the wellbore
 - d) the modelled vertical fracture distance (i.e., vertical half-length)
 - e) the minimum distance between vertical fracture propagation and the adjacent nonsaline aquifers along the entire fracture interval
 - f) documentation of the procedure used to determine whether fracture fluid components may cause adverse effects on nonsaline aquifers
 - g) any geological feature or other pathways that might allow or facilitate communication to a nonsaline aquifer
 - h) measures to mitigate the risk of adverse effects on nonsaline aquifers
- 17) If the modelled vertical fracture distance multiplied by a factor of two is within, or would extend above, the BGWP, licensees must not use hydraulic fracturing fluids that cause adverse effects on nonsaline aquifers.

5 Hydraulic Fracturing Near Water Wells

Communication between the subject well and water wells because of hydraulic fracturing operations might cause adverse effects.

- 18) A licensee's hydraulic fracturing operations must not have an adverse effect on a water well's water quality or quantity.
- 19) Licensees must not conduct hydraulic fracturing operations within a 200 m radius from the surface location of a water well and 100 m or less vertically from the total depth of the water well (see figure 3).

See section 7 for the exclusion zone when using nitrogen as the fracturing fluid for coalbed methane completions.

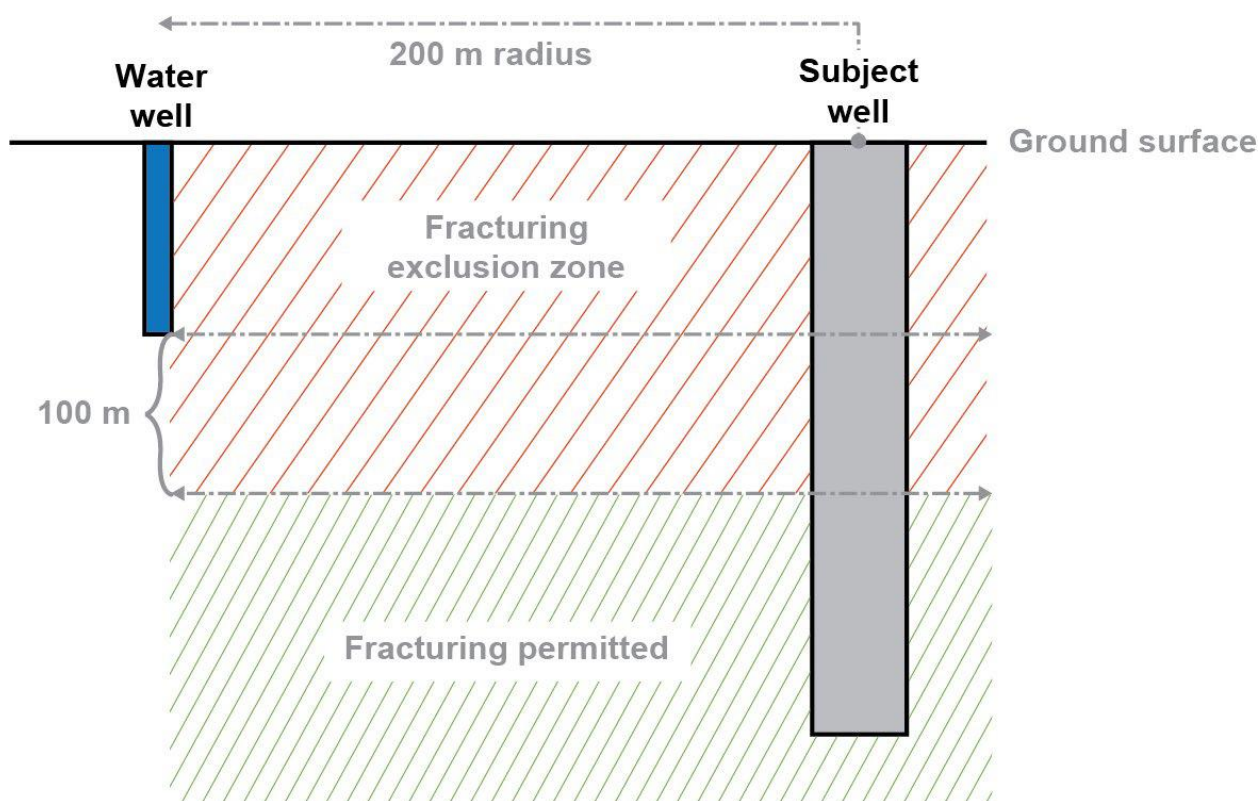


Figure 3. Hydraulic fracturing exclusion zone near water wells

6 Hydraulic Fracturing Near the Bedrock Surface

During hydraulic fracturing operations, fracture propagation may result in a release of fluids to the surface, placing the public and the environment at risk.

- 20) A licensee's hydraulic fracturing operations must not cause surface impacts.
- 21) Licensees must not hydraulically fracture between the ground surface and 100 m TVD below the bedrock surface (see figure 4).

See section 7 for the exclusion zone when using nitrogen as the fracturing fluid for coalbed methane completions.

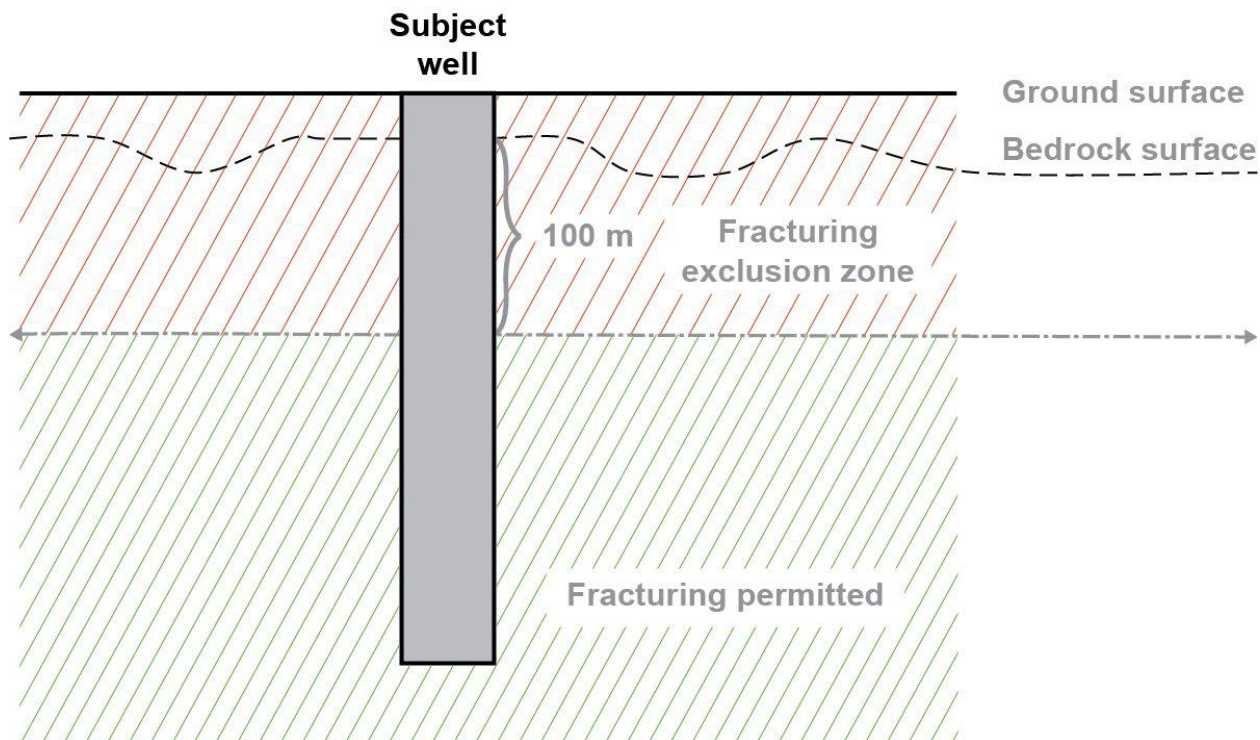


Figure 4. Hydraulic fracturing exclusion zone relative to the bedrock surface

7 Special Provisions for Coalbed Methane Fracturing

The requirements in this section relate to using nitrogen as the fracturing fluid for coalbed methane completions.

7.1 Coalbed Methane Fracturing Near Water Wells

22) Licensees must not conduct nitrogen fracturing operations within a 200 m radius from the surface location of a water well and less than 50 m vertically from the total depth of the water well.

7.2 Coalbed Methane Fracturing Near the Bedrock Surface

23) Licensees must not conduct nitrogen fracturing operations from the ground surface to 50 m TVD below the bedrock surface.

7.3 Nitrogen Pumping Volume Limitations in Coals

24) Licensees must not use more than 15 000 standard cubic metres of nitrogen per vertical metre of coal.

8 AER Notification Requirements

25) Licensees must notify the AER at least five days before pressure testing surface equipment for hydraulic fracturing operations as per the Hydraulic Fracturing Notification Submission form available on the [Directive 083](#) landing page.

26) Licensees must also provide notification of pressure testing in accordance with requirement 25 for any hydraulic fracturing operation that is demobilized and later remobilized.

Notification may be for a single well licence or a multiwell pad with continuous hydraulic fracturing operations.

27) Licensees must notify the appropriate AER field centre immediately if well integrity fails.

28) Licensees must notify the appropriate AER field centre immediately upon becoming aware of any communication event with an offset well, a nonsaline aquifer, or a water well.

9 Continuous Improvement

It is recommended that licensees continuously improve the planning and execution of their hydraulic fracturing operations. Licensees should evaluate how effective their operations are in meeting the regulatory objectives of this directive and revise their planning and execution accordingly.

Licensees are encouraged to document their continuous improvement process using a procedure like that in *IRP 24*.

Appendix 1 Definitions

adjusted maximum pressure	Operating pressure limits at the subject well and offset wells, including a safety margin not to be exceeded.
adverse effect	As defined in the Environmental Protection and Enhancement Act .
at-risk offset well	An offset well that may be adversely affected by hydraulic fracturing operations.
barrier	Individual well components that together comprise a barrier system.
base of groundwater protection	Base of groundwater protection (BGWP) is an estimate of the elevation of the base of the formation in which nonsaline groundwater occurs at that location. Variations in geology and topography are typical, so the actual elevation of the base of the formation will vary from location to location within the formation. The BGWP is set at 600 metres below ground level in the mountainous region and not set for the northeast corner of the province where the Canadian Shield outcrops. For more information, see Base of Groundwater Protection Data .
bedrock	Consolidated rock underlying unconsolidated glacial or drift material.
dual-barrier system	A well system with both primary and secondary barriers.
energizing gas	Gas that improves the effectiveness of the hydraulic fracture.
fracture planning zone	An area that may be affected by hydraulic fracturing operations.
geothermal well	As defined in the <i>Geothermal Resource Development Rules</i> (see open-loop well and closed-loop well).
high-vapour-pressure hydrocarbon	As defined in section 8.110(1) of the <i>Oil and Gas Conservation Rules</i> or section 27(3) of the <i>Geothermal Resource Development Rules</i> , whichever is applicable.
nonsaline aquifer	An aquifer above the BGWP that contains water with a total dissolved solids content of 4000 milligrams per litre or less.
offset well	A well within the fracture planning zone of a subject well, excluding water wells.
orphan well	A well that has been designated by the AER as an orphan well in accordance with section 70(2)(a) of the <i>Oil and Gas Conservation Act</i> .
primary barrier system	A well system designed to contain and isolate fracture fluids within the well.
risk assessment	The systematic analysis of the risks from activities and the rational evaluation of their significance by comparison against predetermined standards, target risk levels, or other risk criteria.

secondary barrier system	The backup well system that provides well control in the event of a failure of the primary barrier system.
single-barrier system	A well system with only a primary barrier.
special consideration well	A well beyond the fracture planning zone that may have characteristics of unique concern justifying further scrutiny.
subject well	A well at which a licensee proposes to conduct hydraulic fracturing operations.
thermal well	A well that is completed in a reservoir that is, was, or has the potential to be artificially heated.
water well	A well used for the production of nonsaline groundwater.
well-control event	The loss of well integrity resulting in a flow of wellbore fluids in the subsurface from one formation to another formation or a flow of wellbore fluids at surface (blowout).
well integrity	Prevention of the escape of fluids (i.e., liquids or gases) to subsurface formations or the surface that can be controlled by the existing wellhead or blowout prevention equipment.