FACT SHEET

Protecting Water Producing Gas

THE IMPACT OF NATURAL GAS & COALBED METHANE ON GROUNDWATER IN ALBERTA

Protecting Water, Producing Gas

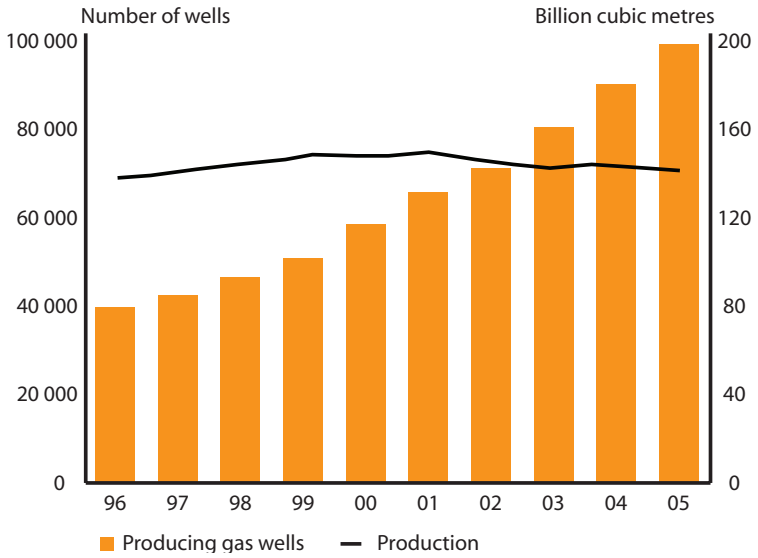
How the production of natural gas, including coalbed methane, might impact groundwater in Alberta and what is being done to minimize the risks

More than 350,000 oil and gas wells have been drilled in Alberta since production started, which is about one well for every ten people living in the province.

In 2005 more than 13,000 conventional natural gas wells were drilled in the province and about 4,000 were drilled or completed for coalbed methane (CBM). Each of these wells and the pipelines associated with them can impact water in various ways.

The sources of gas in Alberta are changing and so are the potential impacts. As conventional natural gas production in Alberta declines and prices increase, companies are developing unconventional gas sources such as CBM, tight gas and shale gas.

Landowners are concerned that the aquifers supplying their water wells will be affected by such development, especially the drilling of wells into shallow formations where the water is fresh. Some of this worry stems from the fact that many CBM wells had already been drilled before the government had sufficient information about groundwater. Some landowners believe that groundwater quality is being affected as a result as this activity.



▲ *Figure 1: Marketable Gas Production in Alberta and Producing Wells, 1996–2005.*

SOURCE: ALBERTA ENERGY AND UTILITIES BOARD, EUB 2005 YEAR IN REVIEW

Differences between conventional and unconventional gas

Conventional natural gas is found in pore spaces in porous formations such as sandstone or limestone and is mainly composed of methane. It is usually produced from deep rock formations where the water is salty. Some new unconventional gas sources are also very deep (over 1,000 metres) but an increasing number are shallow and may be less than 200 metres below the surface. The annual output from an unconventional gas well is, on average, much lower than that from a conventional well, as the gas does not flow as freely through the formation. As a result, a higher density of wells is often required to produce an economic volume of gas.

Rapid increase in gas wells

As can be seen from Figure 1, the number of producing gas wells has increased two-and-a-half times over the past decade, even though natural gas production began declining in 2001. This upward trend in the number of wells being constructed is likely to continue, as an increasing proportion of gas is produced from unconventional sources.

The importance of groundwater protection

Within Alberta, 90 per cent of rural residents rely on groundwater for their water supply. The Paskapoo aquifer, which overlies the Ardley coals, supplies 100,000 water wells. Water wells for domestic and agricultural use are generally shallower than gas wells (see Figure 2), but there may be connections between fresh water aquifers and gas-bearing formations.

Alberta Environment and the Alberta Energy and Utilities Board (EUB) have rules designed to protect shallow groundwater – that is, water that is above the base of groundwater protection. For example, the EUB requirements for the cementing of casings on oil and gas wells are intended to prevent gas from getting into groundwater. New rules have been developed to address unconventional gas production. As can be seen in Figure 2, the base of groundwater protection is generally deeper in the west of the province than in the east.

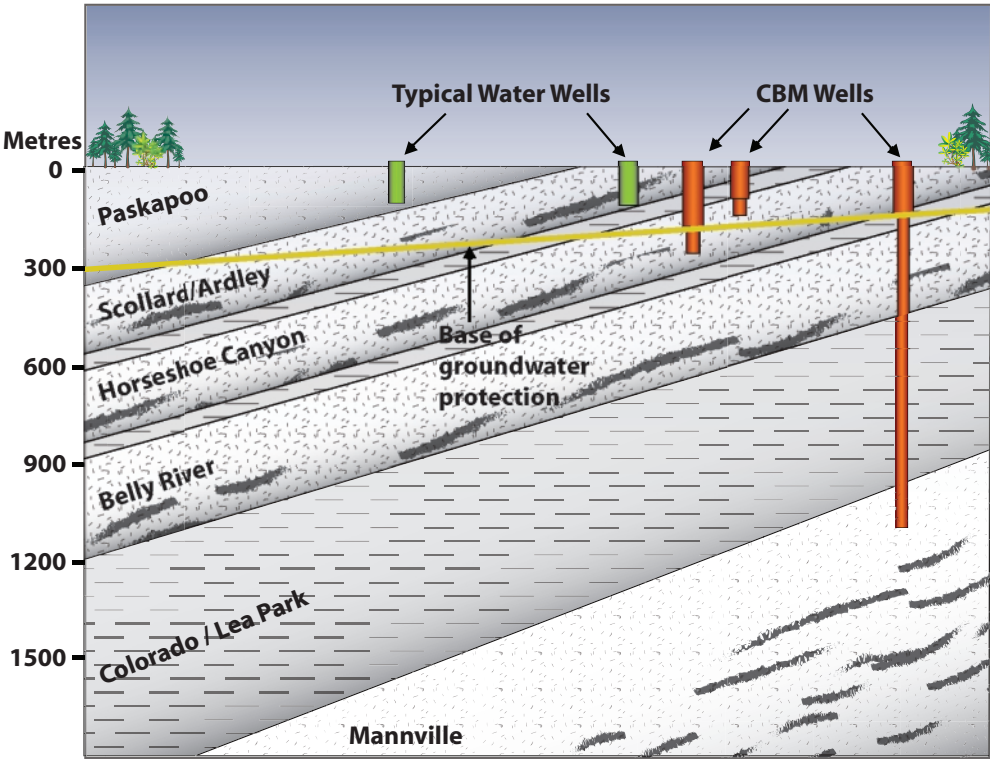
More information is needed on fresh groundwater

While the number of oil and gas wells has grown rapidly, the size of Alberta Environment's groundwater monitoring network was reduced in the 1990s. It now has about 200 observation wells (half the number it monitored 15 years ago) and one-third the number of monitoring wells currently found in Manitoba. Alberta has not invested enough over the last decade in collecting information about the condition of the province's fresh groundwater, to ensure that water is not withdrawn faster than it is flowing back into the aquifers. Studies of the Paskapoo and Ardley formations are currently underway to reveal more about shallow aquifers that might be impacted by CBM development.

The EUB now requires companies to take measurements of (or log) the upper part of new oil and gas wells and to submit this information so that the EUB can learn more about the extent of shallow strata, including aquifers (EUB Directive 43). New requirements in place for CBM production are described below.

Base of groundwater protection

An important term to understand when dealing with government and gas development is the "base of groundwater protection." It describes the boundary between fresh (non-saline) and salty (saline) water. In Alberta it is usually between 150 and 600 metres deep where saline water is defined as having more than 4,000 milligrams per litre of total dissolved solids. The term "dissolved solids" describes the level of salts in the water. Shallow groundwater often has less than 500 milligrams per litre of total dissolved solids,which is the recommended maximum level for drinking water.



Note: Exaggerated vertical scale; dip on strata 1-2°

Figure 2: Cross-Section Showing Central Alberta's Main Coal-Bearing Formations and the Base of Groundwater Protection

SOURCE: THE PEMBINA INSTITUTE. 2007. BASED ON FIGURES FROM ALBERTA ENERGY AND UTILITIES BOARD. COAL SEAMS ARE FOUND IN THE SCOLLARD/ARDLEY, HORSESHOE CANYON, BELLY RIVER AND MANNVILLE FORMATIONS.

Potential impacts of gas production

The production of different gas sources may impact water differently.

Conventional natural gas

Production of conventional natural gas from deep formations may lead to the production of saline water as the well is depleted (this can happen right from the start of production, or a year or more later in the case of more prolific gas wells). This "produced water" is piped or trucked to an injection well, which returns the water deep underground well below the base of groundwater protection. If a produced water pipeline leaks the soil will be contaminated with salt water, which will damage the soil structure and prevent plant growth. The company responsible must thus clean up all spills and leaks. In 2005 there were 179 incidents associated with water being piped from oil and gas pipelines in the province; that is one incident for every 117 km of produced water pipeline.

Some conventional gas wells are above the base of groundwater protection and may produce some water as the wells age. At present, Alberta Environment does not regulate the production of fresh water from shallow conventional gas wells, but has stated that, in the future, the rules that apply to the diversion of fresh water from CBM wells will also apply to shallow conventional wells.

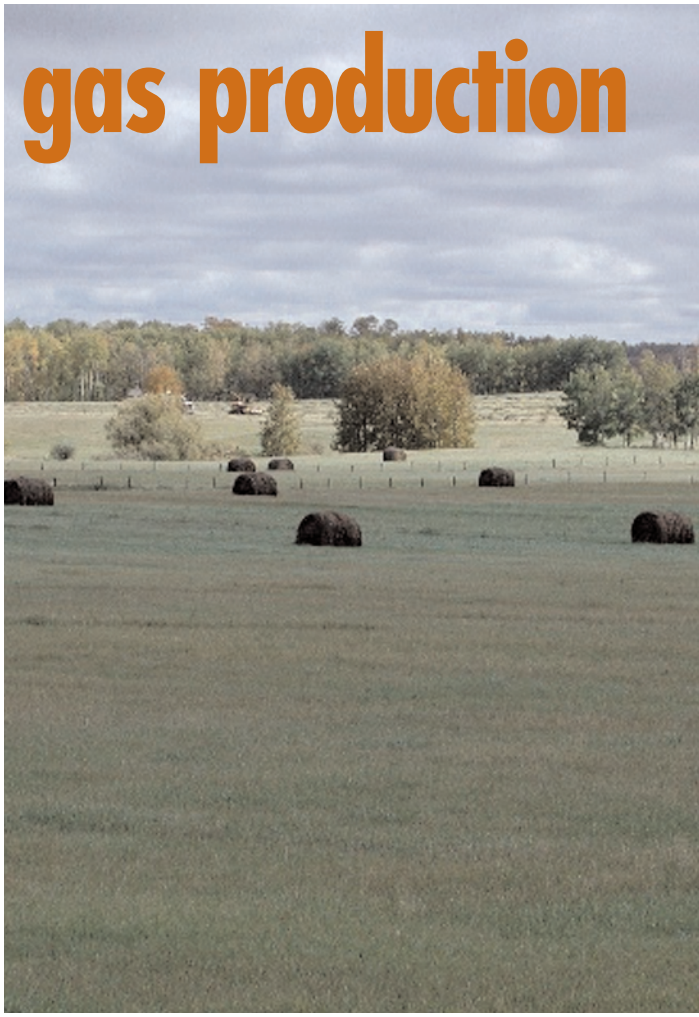
Coalbed methane

With the expansion of CBM development, much of the attention has been focused on the potential for impacts on fresh groundwater.

One-third of the recommendations of the government's Coalbed Methane/ Natural Gas in Coal Multi-Stakeholder Advisory Committee relate to the protection of groundwater and are being implemented by the government. The potential impacts of CBM development depend on whether the coal seams are shallow or deep and whether they contain water or are dry. The majority of coal seams in the Horseshoe Canyon formation are dry (except at the northeast corner of the formation, southeast of Wetaskiwin); those in the Mannville formation are deep and contain saline water; the shallow Ardley coals (which partly underlie the Paskapoo aquifer referred to above) are sometimes dry, but may contain fresh or saline water. Figure 3 shows the main coal-producing formations.

If coal seams contain water, this water must be pumped out to reduce the pressure in the coal so that the gas can flow to the surface. At present all produced water must be sent for deep well disposal. If too much water were pumped from coals above the base of groundwater protection, it might draw water from shallow aquifers that are used for water wells. Landowners also worry that gas may migrate from the coal into groundwater as a result of such activity.

Government rules to protect fresh groundwater include the 2006 requirement for baseline water well testing before a company drills a CBM well that will be above the base of groundwater protection, and limiting the volume of non-saline water that any oil or gas well can produce without a licence. Special rules apply to the fracturing of shallow coals and to the diversion of fresh water from a CBM well.



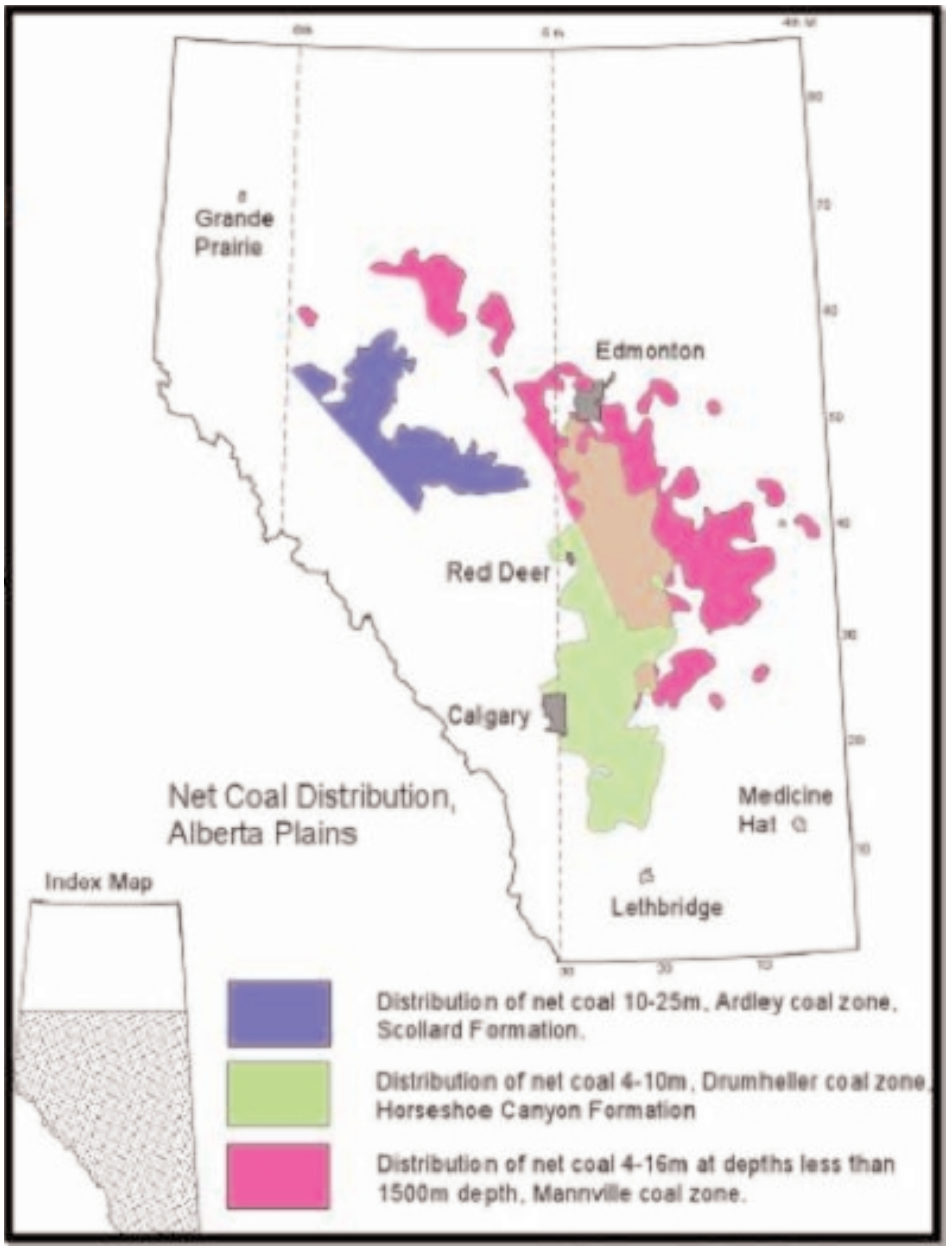
▲ *Salty water being piped from wells for underground storage may leak causing damage to crops.* SOURCE: THE PEMBINA INSTITUTE

Importance of baseline water well testing

In case shallow groundwater is later impacted by the production of CBM, it is important to have information about the baseline conditions of the water before CBM wells are drilled. Since May 2006 Alberta Environment has required companies drilling for CBM above the base of groundwater protection to offer to test all water wells within 600 metres of a proposed gas well, in the manner set out in their protocol. Wells at a greater distance from a proposed gas well may also be tested in some situations. The water well must be tested for yield, and water samples sent to a laboratory to be tested for bacteria, certain minerals and salinity (as measured in total dissolved solids). If there is any free gas in the water well, a gas sample must be taken and analyzed for composition and the isotopic characteristics of the gases. The company must give a copy of the laboratory analysis to the landowner; the landowner should carefully store this record of baseline conditions in case there are later problems with the water well. The EUB enforces baseline water well testing (see Directive 35). Alberta Environment set up a scientific panel to review the baseline testing results and intends to report before the end of 2007 on whether the standard for testing needs to be improved.

Concerns about fracturing of coal seams

If the coal seams contain water, this must be pumped off to allow the gas to flow. Even if the seams do not contain water, they must usually be fractured. Fracturing involves pumping a fluid or an inert gas (usually nitrogen in the case of dry CBM wells) down the well at extremely high pressures for a few minutes to create or extend natural fractures in the coal so that the gas can flow more easily to the well bore (the hole drilled to reach the gas). Some landowners fear that substances used for fracturing might enter shallow groundwater and that the fractures might make it easier for gas to migrate from the coals into groundwater.



▲ *Figure 3: Coalbed Methane Target Zones in Alberta.*

SOURCE: ALBERTA ENERGY AND UTILITIES BOARD

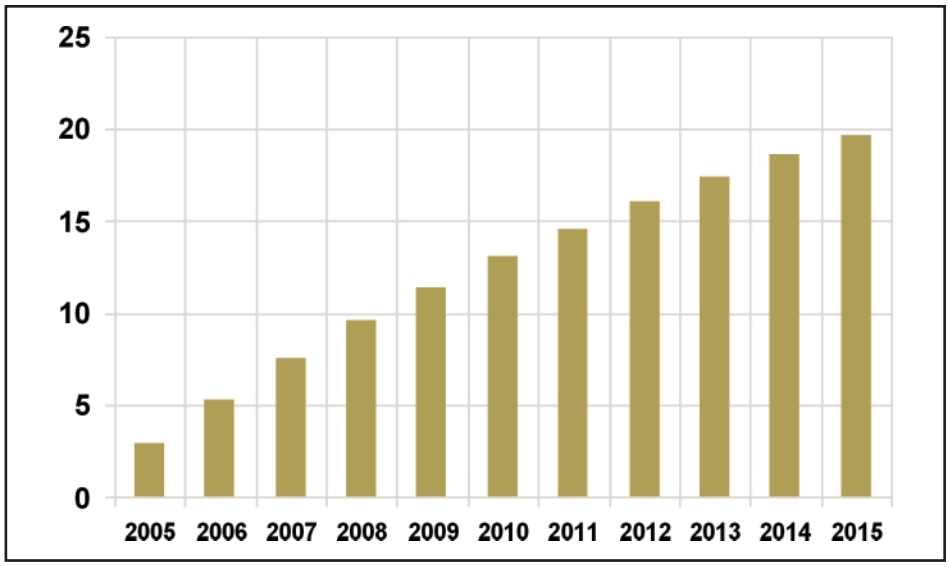
The EUB does not allow any toxic substances to be used for fracturing wells drilled above the base of groundwater protection. It is known that shallow fractures tend to extend horizontally in shallow zones (whereas they extend vertically at depth) but companies are still learning how shallow fractures propagate. Thus, the EUB has set limits on fracturing of formations shallower than 200 metres, and set up a technical review committee to examine shallow fracturing (see Directive 27).

Diverting fresh groundwater

If a company wants to produce gas from a coal seam that contains water above the base of groundwater protection, it must apply to Alberta Environment for a licence to divert the water. Before a company can obtain a licence, it must conduct a technical review of groundwater resources in the area and submit it with their application. Alberta Environment is developing plans to allow a company to withdraw a limited amount of water (probably less than 30 m^3/month per well or 100 m^3/month per section) by following a code of practice instead of applying for a licence. This volume would allow the withdrawal of up to 1,200 m^3/year per section under the code. For comparison, any water well drilled for household purposes is allowed to withdraw up to 1,250 m^3/year without a licence.

Complaints related to water wells and coalbed methane

Sometimes landowners think that changes in the yield or quality of the water in their water well are due to CBM development, but it is difficult to prove. From January 2004 to November 2006, Alberta Environment's Central and Southern Regions received 55 complaints about water wells where there was mention that the problem might be due to CBM production. In the majority of cases no linkage to CBM could be found, but ten cases are still under investigation.



▲ *Figure 4: Production of coalbed methane is expected to rapidly increase.*

SOURCE: ALBERTA ENERGY AND UTILITIES BOARD

Some Key Recommendations

The government introduced some new measures to protect shallow water in 2006 but more needs to be done. Some key recommendations are listed below. A detailed list can be found in the full report ***Protecting Water, Producing Gas****.*

The Pembina Institute calls on the government to:

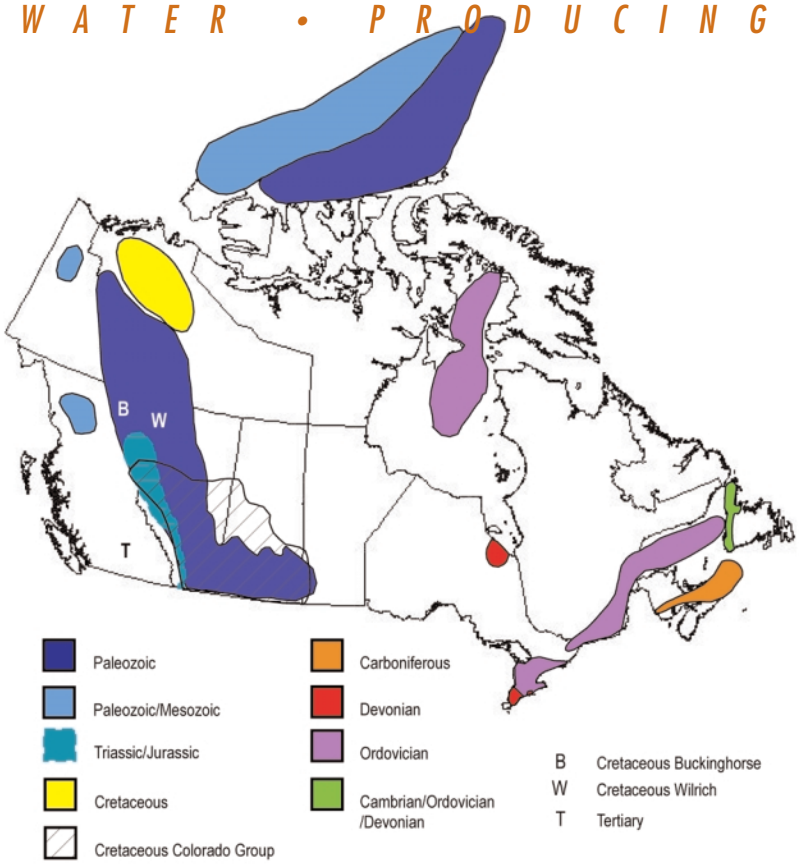
1) *Extend the protection of groundwater to include somewhat saline aquifers that could be used in times of drought.*
2) *Greatly expand the province-wide groundwater monitoring system.*
3) *Increase the requirements on industry to conduct water well testing prior to drilling gas wells.*
4) *Improve the system for handling and reporting on water well complaints.*
5) *Ensure long-term funding to enable sustainable, integrated management of the province's groundwater.*

Issues related to using produced water

At present produced water is normally re-injected deep underground to ensure that the salts in the water do not harm the environment. However, Alberta Environment is considering whether to allow non-saline water to be used, if it meets certain standards and will not contaminate soils, shallow groundwater or surface water. The level of salinity that is acceptable partly depends on how the water is to be used. For example, if water is used for irrigation, it is important to evaluate not only the salinity of the water but also the sodium adsorption ratio of the soil and the salt tolerance of the crop.

Shale gas

Shale gas is probably at the same stage of development in Alberta as CBM was five years ago, and production of gas from shale is likely to increase in the future. There are many zones containing shale in the formations that underlie Alberta, and the industry is looking for "sweet spots" (areas that will be economic to produce). As the EUB does not currently have a separate code for shale gas, it is not possible to identify where shale gas is being produced. In the U.S., where three to four per cent of total gas production comes from shale, some formations produce water (fresh or saline) while others are dry. Shale needs fracturing to release the gas. As with CBM, this may be done with water or other substances. Also like CBM, if the shale formations contain water, this water must be pumped out to reduce pressure so that the gas can flow to the well bore. A high well density may be required to access the gas, but where the shale formations are deep, pad drilling (with several wells on one site) may be possible, as is done with deep CBM. If the pressures are suitable, shale gas may be commingled in the well bore with gas from other formations, so a company may not always need to drill new wells to develop shale gas. The rules for conventional natural gas production apply to shale gas.



▲ *Figure 5: There are many zones containing shale in the formations that underlie Alberta and the industry is looking for areas that will be economic to produce.* SOURCE: ALBERTA GEOLOGICAL SURVEY AND GEOLOGICAL SURVEY OF CANADA

Want more information?

In addition to this document, the Pembina Institute has also published ***Protecting Water, Producing Gas – Frequently Asked Questions*** *(4 pages) and a detailed report,* ***Protecting Water, Producing Gas: Minimizing the Impact of Coalbed Methane and Other Natural Gas Production on Alberta's Groundwater*** *(122 pages), which examines the many ways gas production may affect fresh water. It includes recommendations on how industry, government and landowners can help protect fresh water aquifers. The report, which includes references for all the information in this summary, can be found on the Pembina Institute website. This report was made possible by grants from the Alberta Ecotrust Foundation and the Walter and Duncan Gordon Foundation. Support our work. For more information or to make a donation to the Pembina Institute please visit www.pembina.org.*

See also the Alberta Environment website for information on CBM at www.waterforlife.gov.ab.ca/coal/index.html and the EUB website at www.eub.ca/portal/server.pt.

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