

OPI



ONTARIO OIL AND NATURAL GAS PRODUCTION

Safely Harvesting Energy

An Overview of Hydraulic Fracturing in Ontario

A Briefing Note prepared by the:
Ontario Petroleum Institute

Executive Summary

The Ontario Petroleum Institute (OPI), an industry association founded in 1963, represents companies and individuals involved in oil and natural gas production, hydrocarbon storage, and salt/solution mining. The OPI's primary objective is to encourage the responsible exploration and development of oil and natural gas. Ontario producers have been safely harvesting energy for 150 years.

The oil and natural gas industry is a significant part of the Ontario economy. In Southwestern Ontario 140 companies are in the oil and natural gas business, one of North America's largest underground natural gas storage hubs is located in Dawn Township, underground salt caverns in the Sarnia area are used to store many of the refined hydrocarbon products produced at refineries and petrochemical plants in the Sarnia area, and a thriving salt and solution mining industry operates in Goderich and Windsor.

Hydraulic fracture treatment of oil and natural gas wells to improve production rates was first employed in 1949 and is now routinely used around the world, including Ontario. Economic production rates could not be attained for most wells without this technology. In Ontario hydraulic fracturing for conventional vertical wells has been used safely in the oil and natural gas industry for 60 years. Higher volume multi-staged hydraulic fracturing is a recent technical innovation and up-scaling of "conventional" hydraulic fracture treatment technology and has been in widespread use in the United States and Canada only since the early 2000's.

For exploration and production the Ontario industry needs the ability to continue to pump conventional hydraulic fracturing stimulations to develop oil and natural gas reservoirs in the province.

In a very short period of time oil and natural gas production has taken off to the point that predictions are that North America will be oil self-sufficient by 2020. Much of this increased production is due to the widespread development of unconventional formations such as shale gas and tight light oil reservoirs. This has been primarily as a result of accelerating exploration and development using innovative drilling and well stimulation technologies – notably horizontal drilling and higher volume multi-stage hydraulic fracturing or often referred to as "fracing".

Fracing has received considerable public attention in recent years. It's viewed positively in some areas. In Western Canada and in the Mid-Western United States higher volume multi-stage hydraulic fracturing is widely used to develop unconventional formations. In Eastern Canada and parts of the United States higher volume multi-stage hydraulic fracturing has yet to take hold. It has become an emotional and controversial subject with moratoriums on shale gas development in Quebec and New York.

No unconventional shale gas or tight oil drilling has occurred to date in Ontario. Does this potential exist in Ontario? Quite possibly, the potential for development is under evaluation. There are new challenges associated with hydraulic fracturing treatments that require higher fluid volumes used during stimulation treatments and disposal of those recovered fluids.

In Ontario higher volume multi-staged hydraulic fracturing receives media coverage as “fracing” on a fairly regular basis. Often the stories contain errors or do not provide balanced reporting. What concerns Ontario producers is that the Government of Ontario may respond to the emotional appeals about higher volume multi-stage hydraulic fracturing with measures that could be damaging to future exploration and development.

The Ontario Ministry of Natural Resources (MNR) regulates the oil and natural gas industry in Ontario through the Ontario Oil, Gas, and Salt Resources Act and associated regulations and standards, which are designed to ensure safe operations, protect the environment and the general public. (workers , health and safety, standard operating produceers) It’s important that future policy development will start with a mutually acceptable mandate by government and industry – the safe extraction of Ontario’s natural resources – that will focus on looking ahead to determine what regulations and operating standards are necessary for the oil and natural gas industry operating in 2013 and beyond.

Viabale Contributor to the Ontario Economy

The Ontario oil and natural gas industry has made a significant contribution to Ontario’s economy, especially in southwestern Ontario. Since the beginning an estimated 50,000 oil and natural gas wells have been safely drilled on land as well as offshore in Lake Erie.

Today the impact of this contribution to the energy needs of a significant number of Canadian consumers can be seen in many ways:

- Oil exploration and production
- World class oil refinery operations
- Natural gas exploration and production
- Natural gas underground storage
- Salt solution mining
- Hydrocarbon underground storage associated with the petrochemical industry

Presently, about 140 companies of differing size produce, store and distribute oil and natural gas. These companies are supported by drilling contractors, well and oilfield services, geologists and engineers as well as a range of professional consulting services. Exploration has resulted in the discovery of many producing oil and natural gas fields and storage pools.

An estimate of the oil and natural gas industry's contribution to the Ontario economy:

- Approximately 700 plus people directly employed in exploration, production, storage and salt solution mining in Ontario
- Industry assets = \$650 million
- Personal total taxable income = \$55 million
- Services and goods purchased by the industry = \$90 million
- Lease payments and royalties paid to land owners and the crown = \$10.4 million
- Municipal taxes = \$4 million per year

The value of production and storage in Ontario in 2014:

- 1,183 wells produced 66,365 m³ (417,000 barrels) of oil= \$38.31million
- 1,221 wells produced 159,000 thousand m³ (5.6 bcf ¹) of natural gas = \$22.1 million
- 6,900 million m³ (244 bcf) of natural gas storage capacity = \$1 billion in value
- 3.5 million m³ of hydrocarbon storage capacity = ± \$2 billion in value

Overall annual value of oil and gas sector to the Ontario is \$4 billion.

These activities provide Ontario consumers with the following:

- A percentage of Ontario's supply of oil and related products
- A percentage of Ontario's supply of natural gas
- Storage of natural gas imported to Ontario by pipeline from Western Canada and the United States held in reserve to supplement times of peak demand, especially for space heating in winter. This becomes very important with the switch from coal to natural gas generation of electricity.
- Table salt and industrial salt – Ontario is a net exporter of mined salt
- Underground storage caverns of product necessary for Ontario's petrochemical refining industry

Source: Ontario Oil, Gas and Salt Resources Library

Supporting Ontario's Energy Needs

Ontario's oil and natural gas industry supplies electricity, heat and gasoline for Ontario families, businesses and the economy that is reliable, efficient, dependable and environmentally sustainable. In 2012 this oil and natural gas production fuelled over 40,000 vehicles, and heated over 100,000 residences.

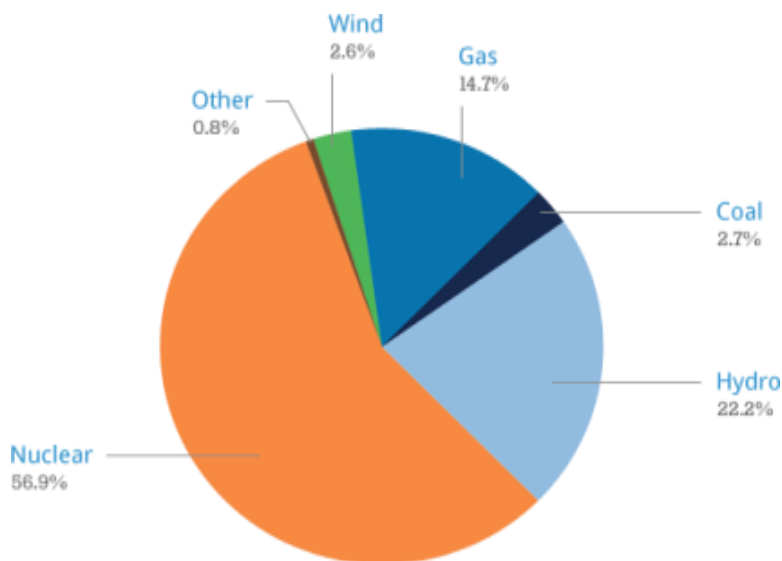
Ontario's Long-Term Energy Plan – Building Our Clean Energy Future is the Provincial Government's energy strategy to 2030. Its main thrust is to build a clean energy future in Ontario by maintaining a balanced approach to providing energy without jeopardizing a commitment to clean air.

¹ billion cubic feet

The following are excerpts from the Plan:

- Natural gas plants have the flexibility to respond well to changes in demand, making them an important cushion for Ontario’s electricity system – particularly for peak periods.
- Natural gas will support the increase in renewable sources over time and supplement the modernization of nuclear generators.
- By replacing coal with natural gas and renewable energy sources, Ontario has greatly reduced greenhouse gas emissions from its electricity supply mix. This policy has prepared Ontario for the possibility of greenhouse gas regulation in the North American market.
- The Ontario government and the Ontario Power Authority have launched a number of clean natural gas and cogeneration projects since 2003 to help with local reliability and peak demand.

Currently natural gas provides close to 15% of the province power source.



Source: Ontario Ministry of Energy

Exploration and Production

Ontario oil and natural gas producers have supplied energy safely for 150 years. It’s generally understood that 50% of the potentially recoverable oil and natural gas in Ontario remains to be developed. Ontario currently imports the majority of its energy supply for power and transportation. Increasing this supply from the province’s own natural resources enhances the security of that supply and contributes to the economic well-being through the jobs created and the services and supplies purchased in towns, cities and municipalities across Ontario.

Whether it's oil from new "plays" or natural gas from "shale" formations, the technologies that are commonly practiced around the world have come from Canadian innovators. These technologies are widely used in most of North American oil and natural gas basins with a few exceptions.

The Ontario MNR oversees the oil and natural gas industry through the Ontario Oil, Gas, and Salt Resources Act supported by Regulation 245/97 and Provincial Operating Standards to ensure safe operations protect the environment.

One of the common technologies, hydraulic fracturing, has been safely used to enhance or stimulate the natural flow potential of conventional oil and natural gas formations since the late 1940's. Hydraulic fracture treatments have been successfully used to enhance natural gas and oil reservoirs in Ontario since the late 1950's.

Hydraulic Fracturing

Hydraulic fracturing is the forcing open of fissures in subterranean rocks by introducing fluid at high pressure to extract oil or natural gas.

Water mixed with sand and chemicals (water 95%, sand 4%, chemicals 1%) are pumped into the formation to create cracks. The sand particles are then "lodged" in the tiny cracks to prop them open creating a path by which oil and natural gas can flow into the well bore and up to the surface (inside several strings of casing). The majority of the fluids used during the fracturing process flow back out of the well and are gathered and disposed of by the well operator in accordance with the strict regulations that have existed in Ontario for decades.

Hydraulic fracturing in conventional well drilling in Ontario has been in use since the 1950's in cooperation with landowners.

Vertical Well Drilling

Is the process of vertically drilling a well from the surface to a subsurface oil and natural gas bearing formation. (Diagrams 1 and 2).

Horizontal Well Drilling

The process of drilling a well from the surface to a subsurface location just above the oil or natural gas reservoir called the "kickoff point", then directing the well bore from the vertical plane horizontally to expose more reservoir rock to the well bore (Diagram 3 & 4).

Conventional Reservoirs

Exploration for conventional oil and natural gas has been the sole focus of the industry since it began nearly 150 years ago. Conventional oil and natural gas is typically "free oil and gas" trapped in multiple, relatively small, porous zones in various naturally occurring rock

formations such as carbonates, sandstones, and siltstones. Conventional oil and natural gas reservoirs can be either developed using vertical wells (Diagram 1 & 3) or horizontal wells (Diagram 2).

Unconventional Reservoirs

Most of the growth in supply from today’s recoverable oil and natural gas resources is found in unconventional formations. Unconventional oil and natural gas reservoirs include tight coal bed methane, gas hydrates, tight sandstone and shale. The technological breakthroughs in horizontal drilling combined with multi-stage hydraulic fracturing have made shale and other unconventional oil and natural gas supplies commercially viable and have revolutionized Canada’s oil and natural gas supply picture (Diagram 4).

Why is Hydraulic Fracturing Important?

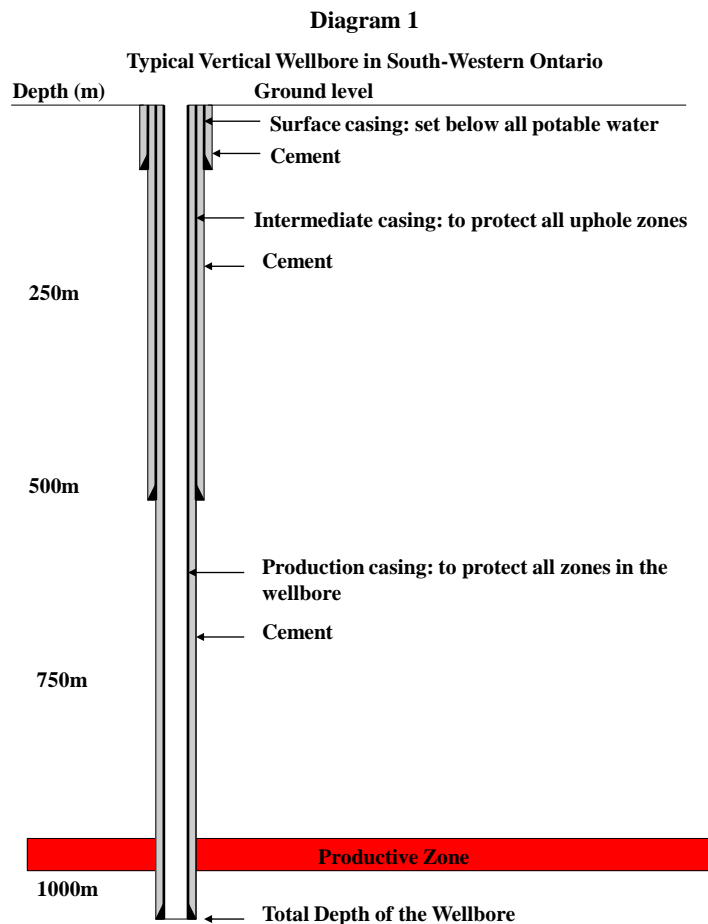
Hydraulic Fracturing has been performed as a means of improving production rates from Ontario oil and natural gas fields for over 60 years. Without these stimulation treatments many of the oil and natural gas pools in Ontario would not be economical to produce. Recent innovations in the use of high volume multi-stage hydraulic fracturing in horizontal wells has resulted in increases in oil and natural gas production such that North America is projected to be energy self-sufficient by 2020.

The Need for Hydraulic Fracturing

Future exploration and development of Ontario natural gas and oil reservoirs will require hydraulic fracturing to make the production economic.

In most wells drilled in Ontario to depths below 500m, a surface casing string is installed and cemented to surface to protect potable water, and a second, intermediate casing string is set and cemented to protect the shallower sedimentary formations from the higher pressures anticipated while drilling, completing, or producing the deeper, target formations (Diagram 1).

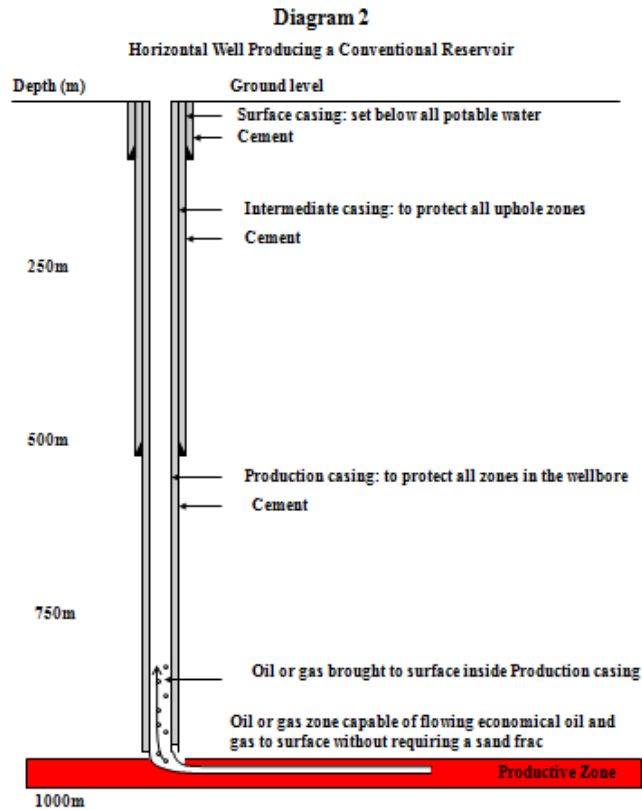
An operator may choose to intersect the target conventional oil or natural gas zone using a horizontal wellbore to expose more reservoir rock. To date in Ontario, no high volume hydraulic



fracturing has been used to stimulate these conventional horizontal wells (Diagram 2).

Prior to pumping a hydraulic fracture treatment to stimulate the target formation, the annulus between the drilled hole and steel well casing (the production casing) is cemented to surface to isolate all oil, natural gas or water zones from other zones in the well. Before completing and fracing the productive zone, this steel well casing is pressure-tested to confirm the integrity of the casing and the cement job.

The oil or natural gas zone is then perforated by “shooting” small holes through the casing and is stimulated through the perforations to allow the fracture fluids and particles to enter only in the desired area (see Diagram 3). This practice is standard oilfield activity in Ontario.



In Ontario, fracturing stimulations are necessary for the economical production of oil and natural as from Paleozoic-age (525 to 360 million years old) conventional reservoir rocks that have low porosity and permeability, low natural flow, compared to very porous and permeable young rocks (120 to 60 million years old, e.g., Gulf Coast USA) with high natural flow characteristics.

Conventional versus Unconventional Reservoir Development using Hydraulic Fracturing

There is only one means to create a hydraulic fracture: by pumping fluid at high pressure into a formation to initiate a fracture. However there is a difference as to the degree - the volume of fluids used for conventional hydraulic fracturing compared to unconventional hydraulic fracturing. Most conventional reservoirs are fractured with lower volume, single-staged hydraulic fracture treatments pumped through vertical wells (Figure 3).

Higher volume multi-staged hydraulic fracture treatments are used for unconventional well drilling in shale rock formations for example. Multi-staged hydraulic fracture stimulations have been used primarily to develop shale gas and low permeability (tight) oil reservoirs in conjunction with long reach horizontal wells. A higher volume of fluids is used for these types

of stimulations. The amount of fluid pumped to qualify as a high volume hydraulic fracture treatment varies by jurisdiction throughout North America.

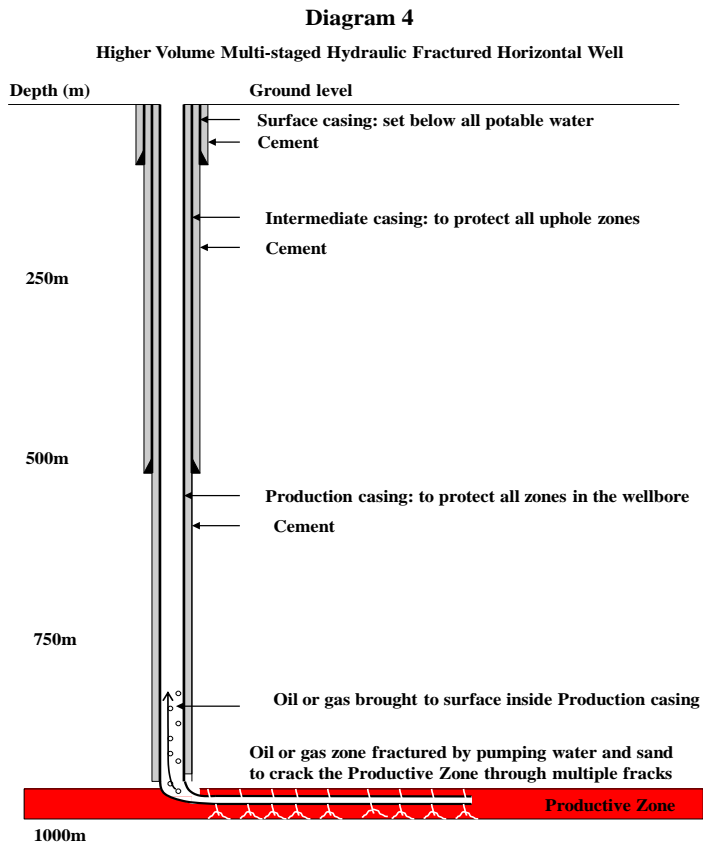
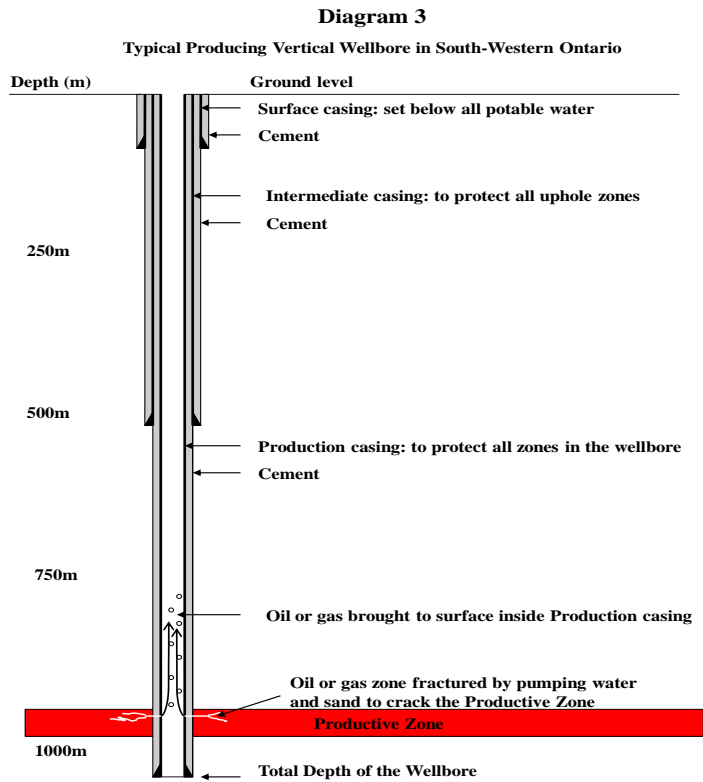
In Ontario a defined fluid volume necessary to qualify as a high volume hydraulic fracture treatment has not been established as it has yet to be determined if production from shale formations can be done economically. The fluid volumes that may be required will depend on the depth of the shale zones and the number and size of each hydraulic fracture treatment pumped along the multi-staged horizontal length of the well in Ontario.

Currently, wells drilled in Ontario use less than 5% of the water volume used in other jurisdictions for higher volume multi-stage hydraulic fracture treatments.

Conventional Hydraulic Fracturing

Hydraulic fracturing for conventional vertical well stimulation was developed in the late 1940's and has been used commercially in Ontario since the 1950's. Many currently producing zones in Ontario would have been uneconomical to develop without conventional hydraulic fracture stimulations.

The Ontario oil and natural gas industry is dependent on hydraulic fracture stimulations to continue the exploration and development of conventional oil and natural gas reservoirs.



Approximately 3,500 hydraulic fracture treatments have been performed in Ontario since the 1950's without incident or any impact to the environment. In Ontario the volume of fluids used in hydraulic fracture treatments has ranged up to 360m³ (79,000 gallons). (Diagram 3)

Unconventional Hydraulic Fracturing

In contrast, higher volume multi-staged hydraulic fracturing for unconventional well development in shale rock formations, for example, is a fairly recent phenomenon and has only been commercially used on a large scale since the early to mid-2000's and has become increasingly prevalent since 2008-2009. Multi-staged hydraulic fracturing stimulations have been used primarily to develop shale gas and low permeability (tight) oil reservoirs in conjunction with long reach horizontal wells. (Diagram 4)

Although horizontal well drilling has been used in Ontario very successfully to increase oil and natural gas production from conventional reservoirs there has been no high volume hydraulic fracture treatments on any horizontal wells drilled.

In Ontario, the Ministry of Environment (MOE) regulates fresh water usage through the Permit to Take Water process. The MOE also regulates the disposal of stimulation fluids through their deep well disposal regulations. The MNR regulates the set-back requirements for oil and natural gas facilities from all other activities. Ontario's current regulatory framework would ensure the safety of hydraulic fracturing treatments.

The Ontario oil and natural gas industry through the OPI wants to work with the MNR, MOE and other Government agencies to review and modify, if necessary, current regulations.

What are other jurisdictions doing?

	Conventional HF	Higher volume multi-staged HF
Ontario	√	N/A
Manitoba	√	√
Saskatchewan	√	√
Alberta	√	√
British Columbia	√	√
Quebec	Unclear	Moratorium
New Brunswick	√	N/A
New York	√	Moratorium
Michigan	√	√
Ohio	√	√
Pennsylvania	√	√

In Conclusion

The first heartbeat of oil production in North America dates back to 1858 in Ontario. Historical fields in Oil Springs and Petrolia produce oil today with jerker rods reaching out to each well just as it was in the 1850s. Oil Springs is the home the Canadian Oil Museum that superbly displays how those early steps of production literally set the stage for oil and natural gas exploration and development worldwide.

It was this early commercial development that led to the oil refining industry and the establishment of one of the most recognizable names in Canadian business – Imperial Oil which continues to operate one of the world’s largest petroleum refinery complexes in Sarnia, Ontario. Imperial Oil has purchased and refined all of Ontario’s oil production since day one.

Ontario oil and natural gas producers have been supplying oil since 1858 and natural gas to heat and provide electricity to homes and business since the early 1900’s. In 2012, Ontario well production fuelled over 40,000 vehicles, and heated over 100,000 residences - all the homes in the county of Chatham/Kent, and cities of Leamington and Sarnia.

Ontario producers want to continue to contribute to the energy needs of Ontarians for – heat, electricity, industrial use, and transportation. For the industry to provide this energy it needs the ability to continue to use hydraulic fracturing.

For the past 150 years and into the future the Ontario oil and natural gas industry has been and will continue - Safely Harvesting Energy.

The OPI’s Producers Committee has prepared this Briefing Note to state the industry’s commitment to the following objectives:

- 1. To continue the safe, responsible and sustainable exploration and development of oil and natural gas as it has for 155 years.**
- 2. To work with the Government of Ontario to study higher volume multi-staged hydraulic fracturing, develop policies and implement any regulatory measures deemed necessary to ensure the safe, responsible and sustainable exploration and development of oil and natural gas in Ontario.**

SOURCES

ONTARIO OIL, GAS AND SALT RESOURCES LIBRARY, [WWW.OGSRLIBRARY.COM](http://www.ogsrlibrary.com)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REPORT FROM NOVEMBER 2011, PLAN TO STUDY THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING ON DRINKING WATER RESOURCES

[WWW.FRACFOCUS.CA](http://www.fracfocus.ca) (GOVERNMENT SITE)

MINISTERE DES RESSOURCES, QUEBEC - [HTTP://WWW.MRN.GOUV.QC.CA/ENGLISH/HOME.JSP](http://www.mrn.gouv.qc.ca/english/home.jsp)

STATE OF NEW YORK EXECUTIVE CHAMBER EXECUTIVE ORDER NO. 41: REQUIRING FURTHER ENVIRONMENTAL REVIEW

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ).



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