OUT OF CONTROL:
Nova Scotia’s Experience with Fracking for Shale Gas

Nova Scotia Fracking Resource and Action Coalition
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Nova Scotia Fracking Resource and Action Coalition (NOFRAC) | April 2013

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This issue paper is based on information obtained through Freedom of Information and Protection of Privacy (FOIPOP) requests to the Nova Scotia Departments of Energy and Environment, as well as public documents, media reports and peer-reviewed studies.

Where an endnote refers to a FOIPOP document, we have made the document available in pdf form. Each endnote source document is titled with the number of the endnote to which it refers. FOIPOP documents on-line at http://nofrac.wordpress.com/issue-paper-2/

Additional FOIPOP documents not referenced in the report are available on the NOFRAC website under Public Documents, Hants County.


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NOFRAC, the Nova Scotia Fracking Resource and Action Coalition, is a group comprising almost 100 members and representing more than 15 environmental and community organizations. The coalition was formed in December 2010 to share information about the risks of hydraulic fracturing and the development of shale gas in Nova Scotia, and to raise public awareness about the risks of these practices.

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Introduction

Nova Scotia has had only one experience with hydraulic fracturing (fracking)* for shale gas. That experience was minimal – just five exploration wells drilled vertically. Three of these vertical wells were fracked. The operations which took place represent a small fraction of the activities and resulting impacts which would be generated by a producing shale gas field.

Yet four years after Triangle Petroleum** drilled its last well in Hants County, new issues continue to emerge and old questions remain unresolved. Millions of litres of fracking wastewater*** remain in ponds on two sites in Kennetcook, open to the elements and susceptible to leaching and spillovers. The wastewater is highly saline (3-4 times saltier than seawater) and contaminated with fracking chemicals and with toxins and radioactive elements released from the drilled and fracked rock. Questions about how to dispose of the wastewater remain unresolved after years of wrangling between the company and government departments.

Nova Scotia Environment (NSE) records show that at least one of the wastewater ponds has leaked. In addition, the company was given permission to remove frozen wastewater from the ponds and allow it to melt on the ground on-site. Until November 2012, no soil testing had been done on either site.

Triangle has announced its intention to leave Nova Scotia,¹ but the unconventional gas story is not over. Other companies presently hold licences to explore for shale gas and other unconventional gas or oil resources in the province. Out of Control: Nova Scotia’s Experience with Fracking for Shale Gas documents what actually happened in

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* Fracking: for the purposes of this paper, we use the term “fracking” when referring to the new combination of techniques used for the extraction of unconventional oil and gas, in this case shale gas. The full term for this combination of techniques is high volume slickwater hydraulic fracturing with multi-well pads and long laterals (horizontal drilling.)

** Triangle Petroleum and Elmworth Energy: Triangle Petroleum is the parent company of Elmworth Energy, a wholly owned subsidiary. Documents and permits referenced in this paper are often in the name of Elmworth Energy. Correspondence is generally between government departments and Triangle Petroleum. For clarity, we refer to Triangle Petroleum throughout.

*** Fracking wastewater is an overview term used to cover several different types of wastewater generated by fracking operations, including formation water, also referred to as brine, which is released from shale beds, produced water and flowback. Each of these terms appears in various documents from Nova Scotia Environment and Triangle Petroleum. The term fracking wastewater as used in this report covers all three types.
Hants County, what the company did, what government regulators did, how decisions were made, and the lessons which can be learned. The report is based on information from documents obtained through Freedom of Information requests, as well as public documents, peer-reviewed studies and media reports.

Taking a clear look at Nova Scotia’s experience with exploration for shale gas can provide a glimpse of the issues the province could face if it decides to allow shale gas, or other unconventional gas or oil development, to proceed in the future.

**Triangle's project plan for Nova Scotia**

Denver-based Triangle Petroleum, with subsidiary Elmworth Energy, holds rights to explore for and extract shale gas or other petrochemicals in the 1,920 square kilometer Windsor Block. The area lies mainly in East and West Hants, and includes a smaller area in eastern Kings County near Wolfville.

The area is bounded on the north by the Cobequid Bay and Minas Basin, and runs from Maitland in the east to Wolfville in the west. It includes the Avon River Estuary and the towns of Windsor and Hantsport. Extending inland, it takes in the communities of Greenfield, Windsor Forks, East Uniacke, Kennetcook, Georgefield and a number of smaller communities.

Some parts of the area leased to Triangle lie merely 40 km from downtown Halifax, and 20 km from Lower Sackville. *See Appendix A map.*

The company hoped to exploit shale gas using the new technique of horizontal drilling with high-pressure hydraulic fracturing from multi-well pads. In June 2008, Triangle’s Development Application Plan stated:

> fractured horizontal wells used successfully in other North American shale gas fields had not yet been employed in the Windsor Block. However, Elmworth believes this set of technologies to be the most likely development model for the Block."}2 (emphasis added)
The plan outlined a project to explore and develop shale gas in four areas: Kennetcook, Stanley, Avon and Wolfville. It called for 680 wells to be developed from 2009 to 2018, at a rate of 80 wells per year, after an initial development phase. The gas was destined for the Maritimes Northeast pipeline. To make this connection, the project included a plan to drill horizontally under the Shubenacadie River to bring the gas via pipes to the main pipeline.

The first phase of the development was to cover 70 square kilometers close to Kennetcook and Noel, with 210 wells, grouped on 35 well pads, and 5 compressor stations. This seven by ten kilometer block formed only a small section of Triangle’s lease area. See Appendix B map.

The Kennetcook - Noel communities

The communities of Noel and Kennetcook, located along the southern shore of the Minas Basin, have populations of 1200 and 1400 respectively. Approximately 250 homes, and 3 schools with a combined enrollment of 400 students lie within 2 km of the sites that were drilled, some as close as 1 km. As in most rural areas, residents rely on domestic wells from surface and groundwater resources for drinking water and other water uses, including the needs of farm animals. Many residents draw income from family farms and woodlots. See Appendix C map of well sites and nearby homes.

Burns Brook, which lies 100 meters from one of the well sites, runs into the Kennetcook River, while another well site lies 500 meters from Noel Bay. The drilling sites are also within five km of two areas presently being considered for protected area designation. A loon conservation area and several types of natural wetlands are close to the sites. The wetlands are sensitive ecosystems, providing natural water filtration and flooding mitigation.

What happened and what didn’t?

In 2007 and 2008, Triangle Petroleum applied for and received permits from Nova Scotia Environment (NSE) to drill and frack five wells, four in East Hants and one in West Hants. Three of the wells, labeled KC #1, KC #2, and Noel Lake (N-14-A), were drilled vertically, and fractured over one vertical section. Two other wells, Noel and Walton, were drilled in Fall 2008 but were never fractured. All five were exploration wells, not production wells. No horizontal drilling or horizontal fracking was done on any of the wells. Triangle did not get to the stage of developing dense, multi-well clusters or building compressor stations or pipelines. Very little gas flaring was done. Only preliminary exploration took place.
Fresh water withdrawals

In Hants County, Nova Scotia Environment gave permission for Triangle to withdraw fresh water for fracking operations from the Kennetcook River, the Noel River, and Noel Lake. The largest amount was to be taken from the Kennetcook River. NSE permitted the withdrawal of up to 1,334,000 litres of fresh water per day from the Kennetcook River. These permits were granted for two one-year periods, from Sept 2007-September 2008, and from September 2008-September 2009.  

An additional permit to withdraw up to 600,000 litres of water per day from the Noel River was given in September 2008, and extended until June 2009.

Seven million litres of fresh water were used to frack each of the two Kennetcook wells, a total of 14 million litres. The company estimated they would require an additional 6 million litres for the Noel Lake well. There is no documentation to confirm the amount of fresh water finally used for this well. It appears that some of the water used to frack the Noel Lake well was taken from the KC #1 wastewater pond, and some came from the Town of Truro.

The Kennetcook River, Noel River and Noel Lake are all relatively small bodies of water. Water withdrawal approvals were given on a permit-by-permit basis by NSE. In Hants County, government records do not indicate that any stream gauging was carried out to monitor the impacts on the rivers when water was withdrawn, although the company was required to do stream gauging as part of the terms and conditions of water withdrawal.

The federal Department of Fisheries and Oceans Fish Habitat Management Program also reviewed and approved the application for withdrawal of up to 6 million litres of water from the Noel River over a ten to 14 day period, stating “provided that the plans are implemented as described… the proposal is not likely to result in impacts to fish or fish habitats.”
No department, provincial or federal, appears to have evaluated the cumulative long-term impacts of withdrawing the amount of water required for a project of 680 or more wells from these bodies of water and others in the area.

Water withdrawal from surface resources can pose major risks to an aquatic ecosystem. Withdrawal of extremely large quantities of water is a recognized risk associated with hydraulic fracturing for unconventional oil and gas. Withdrawing these high volumes of water from rivers over long periods of time can have a number of negative impacts, including on fisheries.14

Dominic Baccante, a fisheries biologist with the BC Ministry of Forests, Lands and Natural Resources Operations in Fort St. John notes:

we need to be aware of the potential impacts of [fracking] on the aquatic ecosystem… because it uses large and significant amounts of water, and because water is increasingly becoming a more precious resource globally … The scale of gas extraction and the required amounts of water, and to a lesser extent sand, can be quite significant …

The questions are many, including the impacts of water withdrawals at a local and watershed scale; recharge rates; ground water flow; management and disposal of used water; and many others. The scale and magnitude of these operations in many ways are beyond any one individual or organization’s ability to comprehend, predict, and manage impacts.15 (emphasis added)

Fresh water gone forever

Generally, between 20% and 85% of the millions of litres of water and chemicals used for hydraulic fracturing remain underground.16 The contaminated water that does return above ground is no longer suitable for drinking or agricultural purposes. The result is a net loss of freshwater and drinking water.

At the Noel Lake (N-14-A) well in Hants County, only 15% of the injected fluid was recovered, with the remaining fluid left deep underground.

Completion operations commenced on the N-14-A well at the end of October 2008, with a four-stage perforation and fracture treatment taking place in early December 2008 …. After recovering about 15% of the injected frac fluid and CO2, but measuring negligible burnable gas, frac flowback operations were suspended.17
There is no documentation available as to the amount of the water-chemical mixture that remains underground in the KC #1 and KC #2 wells.

One recognized consequence of hydraulic fracturing for shale gas is that large quantities of water are removed from the fresh water supply available to local residents and from the water cycle. The long-term effects of withdrawing fresh water in large quantities from a non-renewable water supply remain unknown, whether in Hants County, other parts of Nova Scotia, or on a global scale. NS has not mapped its groundwater resources in a number of areas where shale gas exploration is taking place. This makes it even more difficult to evaluate the consequences of allowing massive water withdrawals. In a world where fresh water is described as "the new oil," it is crucial that governments make prudent long-term decisions about water.

### Fracking chemicals used

Large quantities of chemicals, many of which are kept secret, are added to even larger quantities of fresh water in order to drill and frack for unconventional gas. The use of slickwater, the chemical laden fluid mixture, is one of the new techniques of shale gas development. The chemicals, many of which have identified health risks, have the potential to contaminate drinking water wells and aquifers below ground, and streams, creeks and soil above ground.

Some of the chemicals used in Hants County were disclosed in documents obtained through Freedom of Information requests. Others were not made public, nor were the quantities and proportions of chemicals used. This is common practice for the shale gas industry and was not challenged by NSE. The identified chemicals used in Hants County include potential carcinogens, mutagens, and reproductive toxins, as well as chemicals that can adversely affect ecosystems. Some of the identified chemicals are water soluble, while others are volatile and were released into the air.

The peer-reviewed article *Natural Gas Operations from a Public Health Perspective,* by Dr. Theo Colborn, provides a detailed analysis of chemicals and chemical mixtures commonly used in hydraulic fracturing for shale gas and their health risks.

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The long-term effects of withdrawing fresh water in large quantities from a non-renewable water supply remain unknown.
Of the 22 identified chemicals used in Hants County, 14 are listed in the Colborn article, including:

- 2 known to adversely affect reproduction
- 8 potential mutagens
- 8 potential carcinogens
- 11 with potential to cause adverse effects on ecological integrity.

Of the 31 identified products (chemical mixtures) used in Hants County, 17 are cited by Colborn including:

- 5 associated with adverse effects on reproduction
- 5 containing potential mutagens
- 8 containing potential carcinogens
- 8 with potential to cause adverse effects on ecological integrity.

Some chemicals and chemical mixtures in this list have more than one known adverse health or environmental effect. See Appendix D and Appendix E for additional information.

Most companies keep many of the ingredients in fracking fluids from public disclosure, by claiming they are "trade secrets." Even when new regulations requiring disclosure are adopted, many chemicals still remain secret. In Texas, a new law was passed in
late 2011, requiring disclosure of chemicals used in fracking. In the following year, 19,000 chemicals were exempted from disclosure. Texas state representative Lon Burnam, co-author of the original bill, described the law which was passed as having “a hole big enough to drive a Mack truck though.”

The organization Sky Truth has researched industry information to determine actual disclosure rates. Their analysis shows that in Pennsylvania, only 43% of chemicals used in fracking operations were disclosed, and in West Virginia, less than 33% of chemicals were disclosed. In Alberta and British Columbia, similar patterns of exemption of chemicals from disclosure are current practice. Fracfocus.ca, a petroleum industry website, provides information to companies about how to gain exemption of materials from disclosure by filing a claim for exemption using the Hazardous Material Information Review Act.

Small percentages add up

Drilling companies point out that fracking chemicals make up only a small percentage of the fracking mixture, from 0.5% to 2%. But given the immense quantities of fluid mixtures required for horizontal drilling and fracking, even a small percentage results in the use of large quantities of chemicals.

If fracking chemicals comprised only 1% of the fluids used to frack the two Kennetcook wells, roughly 140,000 litres of chemicals would have been used (1% of 14 million litres). Some would remain underground, while the rest would return with the wastewater. As noted above, some of these chemicals are volatile and evaporate into the surrounding air, while others are water-soluble. Even diluted, the chemicals used for fracking can impact the health of humans, wildlife, farm animals and eco-systems, immediately or in the long term. Exposure can occur via water, air or soil. Some identified fracking chemicals are endocrine disruptors which can cause long-term harm from exposures in minute quantities, even in quantities of parts per billion or parts per trillion.
Ponds without permits

Ponds were built at the two Kennetcook sites to store fresh water for use in the fracking process -- or so the government believed. In reality, Triangle used the ponds for wastewater storage, although permits for this usage had not been issued. Triangle applied to use the ponds for wastewater long after the fact.

“As approval was given after the produced water was stored within ponds that were intended for the storage of fresh water, Nova Scotia Environment (NSE) considers the initial design of the ponds did not take into account the storage of the high saline content production water,” NSE wrote to Triangle CEO Peter Hill in August 2011. NSE granted short term, two-year permission for Triangle to use the ponds for wastewater in 2009, and a one year extension in 2011. However, most of the wastewater remains on site in the two ponds as of March 2013.

KC #2 wastewater pond with overflow chute.
What’s in the wastewater ponds?

Even the limited vertical fracks that were conducted generated considerable contamination. Water quality data submitted by Triangle to Nova Scotia Environment in 2008 show that the level of contaminants in two of the wells and ponds far exceeded levels found in the nearby Kennetcook River.26

But the information submitted does not tell the whole story. It does not include levels for all classes of chemicals used in fracking fluids, or for the full range of contaminants commonly released from shale by the fracking process itself. Bromide, one of the common contaminants in fracking wastewater was not included in the sampling. Testing for radioactive elements was also omitted, as detailed below.

Water quality report submitted by Triangle Petroleum to Nova Scotia Environment for 2007-200827

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<td></td>
<td>well KC#1</td>
<td>KC#2 Pond</td>
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<td>KC#2 Pond</td>
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Comparisons of Kennetcook River with water from KC #1 and KC #2 wells and KC #1 and KC #2 waste ponds and with Canadian Drinking Water Quality (GCDWQ) and Aquatic Protection Guidelines (CEQG) in mg/L.

ng= no guideline, na= analysis not provided, nd = non detect

1 Three versions of this table show these values using the wrong units (44 and 32 instead of 44000 and 32000)
2 Four PAH parameters had concentrations above detectable limits
3 Two PAH parameters had concentrations above detectable limits
4 One PAH parameter had concentration above detectable limits
5 Six PAH parameters had concentrations above detectable limits.
After receiving water analyses from Triangle dated 2007-2008 and supplementary information dated 2009, Nova Scotia Environment did not receive updated or supplementary water quality information from Triangle until 2011. In October 2011, Nova Scotia Environment was still attempting to get additional information from Triangle as to the contents of the wastewater. The department wrote to Triangle CEO Peter Hill:

NSE reminds Triangle to submit all analytical data, **AND** to also begin sampling for the additional parameters outlined in the October 4th correspondence. It is suggested that you begin conducting this sampling immediately as it may further influence where this wastewater may be able to be disposed.\(^{29}\)

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**Radioactive elements unaccounted for**

A 2008 in-house NSE document, *Environmental Best Management Practices for Formation Water from Exploration and Production Activities*\(^ {30}\) states, “Formation water has been found to contain high levels of chlorides, arsenic, barium, manganese, TPH, PAHs and may even contain naturally occurring radioactive materials (NORMS).\(^ {31}\) Nova Scotia government maps available in 2008 clearly indicate Hants County is likely or highly likely to contain radionuclides. In November 2009, *Scientific American* published an article documenting that “Wastewater from natural gas drilling in New York State is radioactive, as high as 267 times the limit safe for discharge into the environment and thousands of times the limit safe for people to drink.”\(^ {32}\)

However, Nova Scotia Environment did not require Triangle to test for, or report on levels of radionuclides in wastewater until 2011, four years after drilling took place. By the time this information was received by NSE, decisions as to the disposal of millions of litres of wastewater had already been made, without considering the presence of radioactive elements. Waste drilling mud and sand appear to also have been disposed of without testing for the presence of radioactive contaminants.

Laboratory test results obtained in November 2011 for the Kennetcook waste ponds documented levels of naturally occurring radioactive materials (NORMS) in wastewater high enough to require special handling for disposal. Analyses documented a range of naturally occurring radioactive elements in the wastewater,\(^ {33}\) including radium 226 and uranium, both of which have long half-lives and known health risks. *See Appendix F for full analytical information.*

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**Analyses documented a range of naturally occurring radioactive elements in the wastewater, including radium 226 and uranium, both of which have long half-lives and known health risks.**
Wasterponds – More than just salt

Both Triangle and Nova Scotia Environment appear to have focused almost exclusively on the high salinity of the waste ponds, and less on the potential harmful impacts of other contaminants. In approving Triangle’s application for a “brine storage pond,” NSE stated, “The main environmental impacts associated with the proposed operation are the potential inadvertent discharge of high salinity wastewater into receiving watercourses, wetlands or groundwater.”

While high salinity was an issue of concern, it was not the only - or the most significant - risk factor, as the earlier noted NSE document indicates. Nova Scotia Environment appears not to have fully considered the wide range of contaminants normally contained in fracking wastewater. This information would have been common knowledge to the industry.

“Brine” is a term used to describe the highly salty, chemical-laden and often radioactive water coming from the shale formation. It is also referred to as “formation water.” Fracking wastewater ponds contain both formation water and returned fracking fluid chemicals. Referring to these ponds as “brine ponds” creates a false impression that high salinity is the only issue of concern, and can be misleading to people who are unfamiliar with technical terms.

Pond leaking

One of the two ponds in Hants County is known to have leaked. A letter dated August 2, 2011 from Nova Scotia Environment to Triangle CEO Peter Hill, NSE states:

In a site visit on May 5, 2011, a seepage was found to be occurring at the KC-1 site, at the side of the berm... as a result of further investigation by your consultant, your conclusion is that the seepage is most likely to be arising from the brine pond.35

NSE issued an Environment Act Directive notifying the company that they “shall ensure the level of liquid within the brine pond at Kennetcook KC-1... is lowered so that it is held below that of the height of the seepage identified in the berm of the brine pond in May 2011 by August 10, 2011.”36

No soil tests or clean-up measures were ordered as of late 2012.

A punctured liner at the KC #1 wastewater pond.
Missing wastewater

Not all the wastewater that was generated in Hants County is accounted for. The waste pond at KC #2 was mostly drained in June 2008 of approximately 3.5 million litres of wastewater. There is no record of where this wastewater went.

“The company was not obligated to inform the Department as to the disposition of these waters,” stated a Nova Scotia Environment official in an email dated November 2012 in response to the inquiry of a private citizen. “As the Department did not attribute a significant risk associated with these ponds and the water contained in them, the Department had no reason to verify where the water was ultimately disposed of,” the email explained. Now no one, apparently including the government, knows where this waste went.

The well at the Noel Lake site (N-14-A) was fracked in April 2009, but there was never a waste storage pond at this site. There are no indications of where the waste from the Noel Lake site went either.
Wastewater to Windsor

In October 2012, evidence emerged that over seven million litres of fracking wastewater had been disposed of through the Windsor Sewage Treatment Plant between March 2010 and August 2011. While Atlantic Industrial Services (AIS) of Debert, NS arranged for the disposal, Nova Scotia Environment gave special approval for this disposal.

The Town of Windsor was only informed about levels of salinity and iron, but received no information about the presence of other hazardous chemicals or radioactive elements. Windsor’s Director of Public Works, Don Beatty, told CBC news:

> The town received a report from a consulting firm stating that our plant was capable of treating the brine water in question. As we were not aware that the wastewater contained radioactive components, this aspect of treatment was never considered.\(^{40}\)

In an interview reported in The Hants Journal, Windsor Mayor Paul Beazley stated:

> Certainly anything that was done was done under the direction of the Nova Scotia Department of Environment... it was the department that said this... brine water should be treated as normal wastewater and there was no information to suggest it was anything different than normal wastewater ... From all the information that we have had going back to before we even accepted the water, all the way through and up until this minute, we have not been advised of any safety concerns related to the water that went through our system.\(^{41}\)

Fracking wastewater is not “normal” sewage, nor is it merely highly salty wastewater. Sewage treatment plants such as the Windsor plant are not set up to remove either the chemicals, heavy metals or radioactive materials commonly found in fracking wastewater. After treatment at the Windsor wastewater facility, water flows into Lebreau Creek, which empties into the Avon River and then into the Minas Basin.

When the province gave approval in 2009 for this discharge of 7.3 million litres of untreated fracking wastewater it did not yet have full information about the contaminants in the wastewater, including the presence of radioactive elements. Questioned by CBC about this omission, Minister of Environment Sterling Belliveau explained that the water was analyzed by a consultant and deemed safe, but it wasn’t tested for radioactivity. Belliveau added that the consultant was not aware of Nova Scotia’s geology.\(^{42}\)

The Minister’s explanation raises more questions than it answers. It does not address why a consultant did not take into account Nova Scotia’s geology. It does not address how NSE overlooked this omission. And it does not explain why testing for radionuclides was not required earlier by NSE. Given information that NSE had in hand, as well as the general knowledge that shales and clays are recognized as responsible for most natural
radioactivity, requiring the company to provide information as to levels of radioactivity before approving disposal of fracking wastewater would have been a reasonable step to take.

But even without information relating to radioactivity, NSE had enough information to know that discharging fracking wastewater through the Windsor sewage treatment plant was risky. The 2008 NSE document, *Environmental Best Management Practices for Formation Water from Exploration and Production Activities*,\(^{43}\) notes the potential presence of numbers of toxic contaminants including radioactive elements, and points out:

As previously stated, Nova Scotia requires wastewater effluent discharges meet, at a minimum, the CCME FWAL [Fresh Water Aquatic Life] Guidelines or CCME CDWQ [Canadian Drinking Water Quality] Guidelines. Formation waters in Nova Scotia typically can not meet these requirements without prior treatment before discharge.\(^{44}\)

**Frozen wastewater melted on site**

In April 2009, Nova Scotia Environment gave permission for Triangle to remove 2500 cubic meters (2.5 million litres) of frozen wastewater from the KC #1 waste pond and allow it to thaw and melt into the ground, outside the pond berms. “The ice will be placed in the center of the site where it will thaw and infiltrate into the surface. Presumably, the water will undergo significant dilution as it makes it way through the upper aquifer,” the approval document stated.\(^{45}\) Similar approval was given for the KC #2 pond.

The approvals for melting and disposal on site were a change to the original approvals for wastewater handling, which required trucking all wastewater from the ponds to an approved disposal facility as “waste dangerous goods.”\(^{46}\) According to department notes agreeing to allow on-site melting, “this procedure is primarily a cost cutting measure associated with disposal of wastewater.” The revised approval was based on information provided to NSE by Triangle stating “sodium chloride and iron ... are expected to be the primary contaminants of concern.”\(^{47}\) Testing for a full range of contaminants in the ice was not required by NSE. “I do not expect ice melt to be any worse than roadside salt in snow melt, typically approx 4000mgk,”\(^{48}\) a NSE official wrote in April 2009. Approval for on-site melting of frozen wastewater was renewed in 2011.\(^{49}\)
The Colchester connection

The wastewater issue has also involved Colchester County, site of the Atlantic Industrial Services industrial waste treatment facility in Debert. AIS specializes in industrial waste management, and treats and disposes of industrial waste from Nova Scotia and New Brunswick. It is not licensed to remove radioactive materials from waste.

In December 2011, lab analysis of samples from the Kennetcook waste ponds found the wastewater contained radioactive materials above levels considered safe by Health Canada. This raised new issues for how the waste could be disposed of. At the end of 2012, 15.5 million litres of wastewater still remained in open-air ponds on site at the two Kennetcook well sites and in barrels at AIS’s Debert facility.

In September 2012, Atlantic Industrial Services, with the prior approval of NSE, asked Colchester Municipal Council to permit them to release 4.5 million litres of fracking wastewater through the Colchester Sewage Treatment Plant, after it had undergone treatment at AIS. AIS planned to use an experimental process to remove the radioactive components of the waste. If the process was successful, AIS hoped to dispose of an additional 11 million litres of fracking wastewater the same way. No specifics were given to Colchester Council about the range or level of contaminants that would remain in the water destined for the sewage plant. At the Council meeting in early October, councilors were uneasy with the request, but found that by-laws blocked them from refusing. They decided to amend their sewage by-laws to allow them to refuse any materials that might put their sewage treatment plant at risk.

In January 2013, Colchester Council met again to discuss a new sewage by-law, granting them increased powers to refuse material that could cause problems to health or safety. At this meeting, councilors were informed of a new issue - previously undisclosed contaminants in the wastewater. “They alerted us to something else. It’s something that could destroy our system. We feel it’s in the wastewater, it’s above acceptable limits and we’ll have to deal with that,” Mayor Bob Taylor told the Truro Daily News. The “mystery contaminant” was not revealed to the public. If Council had accepted the original proposal to allow the wastewater to be released through their sewage system, the presence of additional contaminants might never have come to light.
Experimental on-site option to remove radioactive materials

As Colchester Council discussed the issue, another option for dealing with the fracking wastewater was being investigated. In August 2012, NSE approved a pilot project allowing AIS to use an experimental process that AIS claimed would be able to remove naturally occurring radioactive materials (NORMS) from the fracking wastewater. If the pilot project was considered successful, AIS hoped to bring a mobile processor to the wastewater sites to reduce radioactive elements and other contaminants in the wastewater to acceptable levels, after which it would be sent for further processing at AIS. There is no additional information at the date of writing this report about the results of this experimental process.

Removing radioactive materials is recognized as a specialized, complex and costly process, and is one of the unsolved problems of fracking.\textsuperscript{51} There is no facility in the Atlantic Provinces licensed to do this at the present time.

Approvals based on incomplete information

Recommendations and approvals about disposal of the contaminated wastewater in Windsor (2009) and Colchester (2012), as well as approvals for melting frozen fracking wastewater on open ground (2009 and 2011) were made before NSE had possession of full information about the wastewater’s composition, including the presence of radioactive elements.

Without knowing the full range and levels of all contaminants in the wastewater, it is unclear how AIS would have known what contaminants needed to be removed, and to what degree, in their treatment process. It is also unclear how the province would have verified that the water released by AIS no longer contained toxic substances.

Pressure to allow disposal via deep injection wells

Triangle Petroleum made repeated attempts over several years to get permission to dispose of the fracking wastewater by leaving it on site in deep injection wells. Nova Scotia Environment’s approvals for Brine Pond Operations had specified, from the beginning, that “Wastewater (i.e. brine) and wastewater sludge shall be removed from the pond and directed to a facility approved to handle the waste.” NSE repeatedly turned down Triangle’s requests to allow deep injection, restating NSE’s position that waste had to be disposed of at an approved facility.
Nova Scotia Environment’s refusal to allow deep-well injection was prudent and admirable. While there is no detailed explanation provided in communications between NSE and the company, an in-house NSE document sums up some of the arguments against deep well injection.

The arguments against this form of disposal are also persuasive. Injection is a form of dumping since no treatment has occurred or is likely to occur at depth. This results in an area that is permanently impacted and withdrawn from potential beneficial use. There is also additional risk if the underlying geology is not perfectly understood, since leakage may occur and monitoring is difficult and expensive to install.

Since Nova Scotia does not have an extensive history of land-based petroleum exploration and therefore does not have preexisting wells or land areas that are impacted by drilling fluids, it does not appear reasonable at this time to establish deep well injection as a disposal option for formation waters. There are currently no approved deep well injection facilities in Nova Scotia.

**Note:** Many jurisdictions are now reviewing environmental impacts of existing onshore deep well injection sites with the stated goal of phasing out these operations.\(^5^2\)

Triangle CEO Peter Hill saw things differently. “This method [deep injection] is considered best practice in much of the world,” Hill wrote to NSE. “There can be no unconventional gas development of scale unless there is re-injection of produced brines, and you will lose all momentum for any appraisal and development of the large onshore gas resources of the Province of Nova Scotia.” Hill’s statement is not accurate. Pennsylvania, which has extensive shale gas development, does not allow disposal of fracking waste by deep injection wells.

In May 2010, Triangle requested that NSE approve a “pilot project” to inject the Kennetcook waste on site.\(^5^3\) This option was turned down by NSE.

In August 2011, Hill again proposed a re-injectivity pilot. If that was still not acceptable, Hill proposed that Triangle leave the wastewater on site and wait for a decision of the Nova Scotia Hydraulic Fracturing Review.

Should the Review fail to support deep re-injectivity of formation water back to their formation of origin, or ban, restrict or delay shale gas activity for a long period, then we will drain the ponds by the then best method available.
remEDIATE all sites, return our licenses back to the Nova Scotia Department of Energy and cease any further investment in the Province of Nova Scotia.\textsuperscript{54}

Hill stated that hauling wastewater by truck to AIS facilities in Debert and Dartmouth would require “5-6 trucks PER DAY for the next 5-6 months in the Kennetcook area and the AIS site in Dartmouth. The damage to the environment, townships, roads, sites, traffic density and most importantly road safety would be too dangerous,” Hill said.\textsuperscript{55}

“It’s far too expensive and dangerous,” Hill told the Chronicle Herald.\textsuperscript{56}

Hill’s concern about danger and damage to the environment is confusing, given that up to 2400 heavy industrial truck trips are required per frack for a shale gas production well\textsuperscript{57}—considerably more than the number of trucks needed to haul the Kennetcook waste.

Triangle did propose an alternative method for disposing of the highly saline wastewater — spread it on winter roads for de-icing. The use of fracking wastewater for road de-icing is a practice in some parts of the US. It reduces costs to the company, but can lead to environmental contamination.\textsuperscript{58}

NSE replied to Triangle President Peter Hill on October 18, 2011, “it continues to be the position of the province of Nova Scotia that re-injection of this wastewater is currently not an acceptable method of disposal.”\textsuperscript{59}

\textbf{Fracking wastewater: A problem without a solution}

The issue of toxic wastewater and its disposal is the most significant problem that can be verified arising from Hants County’s limited experience with shale gas development. Nova Scotia is not alone in its fracking wastewater disposal problems. Disposal of immense amounts of highly contaminated wastewater generated by fracking is an unresolved problem everywhere that fracking for unconventional gas and oil is taking place.

No method of disposal has been determined to be safe.\textsuperscript{60} All methods of disposal have problems, some more obvious than others.\textsuperscript{61} The immense volumes of fracking wastewater generated multiply the impacts of any form of disposal.

The problem becomes even more complex when considering a number of emerging issues:

- While federal standards define acceptable levels at which some contaminants may be released into the environment, many of these standards have not been revised
for decades, even though information about human and environmental impacts has changed over time.

- No water quality standards exist for numerous chemicals present in fracking wastewater. One example is endocrine disruptors, which can be harmful in minute quantities.\(^{62}\)

- Some contaminants in fracking wastewater persist in the environment for long periods of time. Radium 226, present in the Kennetcook waste ponds, has a half-life of 1600 years. Because these long-lasting elements persist in the environment, they build up over time. Even if released wastewater meets present standards, over time accumulated levels may have greater impacts than expected.

- Some contaminants create new problems after their release. Bromide is a contaminant commonly found in fracking wastewater, although it is not measured in Triangle’s water sample analysis. Bromide can serve as a precursor for the creation of trihalomethanes, which can form when water is chlorinated. Trihalomethanes are carcinogenic, and high levels have been measured in Pennsylvania rivers where fracking wastewater has been disposed of.

- There is a need to consider the size and use of water bodies into which treated fracking wastewater may be discharged. The smaller the water body, the greater the impact that released fracking wastewater can have.\(^{63,64}\)

An opinion paper by four scientists from the University of New Brunswick concludes that “hydro-fracking should not go ahead unless there’s an environmentally-responsible plan to dispose of the waste water.”\(^{65}\) So far, New Brunswick has disposed of its fracking wastewater by sending it to Nova Scotia. Recently, a Newfoundland company announced that they planned to do the same.\(^{66}\)

### Site contamination and reclamation

Potential for contamination of well sites and the need for stringent site clean-up appear to have been underestimated, much as the potential hazards of fracking wastewater were.

An inspection report of the Noel well site on December 12, 2008 notes the site “appears to have a pile of drill cuttings, no oil or sheen present... capped wellhead was at centre of the site, No odor evident.”\(^{67}\) Visual evidence of oil or sheen or noticeable smell, however, are not a sufficient basis to determine whether soil testing or cleanup is required.

Nova Scotia Environment was aware of pond leakage at the KC #1 site and had approved melting of frozen fracking wastewater into the ground at both KC #1 and KC #2, yet requirements for site reclamation appear to have been minimal. In granting approval for the operation and reclamation of the KC #1 Brine Storage Pond in
August 2010, Nova Scotia Environment required only “The Approval Holder plans to immediately restore all disturbed areas via grading and vegetation once works are completed or prior to expiry of the approval.”68 NSE’s 2010 approval did not require soil or water testing prior to grading the disturbed areas. Triangle’s reclamation plan also makes no mention of any soil or water testing to determine if there is any contamination before grading and re-vegetation. The reclamation plan for the brine pond at KC#1 submitted on behalf of Triangle in August 2011 states, “The pond berms will be removed and along with the stockpiled material will be used to infill the ponds.”69

In “Natural Gas Operations from a Public Health Perspective, Colborn notes:

While much attention is being given to chemicals used in fracking, our findings indicate that drilling chemicals can be equally, if not more dangerous. … Our data reveal that extremely toxic chemicals are found in evaporation pits and indeed, these and other similar sites may need to be nominated for Superfund [extremely hazardous waste] cleanup.70

In December 2011, NSE notified Triangle that “we have become concerned about NORM as a new issue for wastewater disposal.”71 At this time, NSE specified that Triangle’s site remediation plan must provide specific details as to “how the liner will be disposed of, as well as handling and possible treatment of surface and subsurface soils that may be potentially impacted due to liner failure.”72 That plan was to have been submitted to NSE by January 16, 2012. It is unclear whether the required testing was only for radioactive elements, or for a full range of contaminants.

However, it was only after residents at a community meeting in Kennetcook in October 2012 insisted that the NSE test soil samples from the sites that government officials agreed to conduct soil tests.73 Test results have now been released, but were not available in time to be analyzed for this report.

There do not appear to be records documenting what was done with the waste from the three Hants County wells, including drilling mud and sand that returned to the surface in fracking wastewater. There did not appear to be any testing for levels of contamination in waste materials prior to disposal. With radioactivity documented in the Hants County wastewater, it is likely that solid waste materials from the three sites contained both radioactive elements and other contaminants.

Contaminated solid waste from fracking sites is an emerging problem in landfills in communities with shale gas and oil development. The assistant director of North Dakota’s solid waste management program notes, “A serious problem of poorly managed radioactive waste [from shale oil production] is only going to get worse.”74

Only after residents at a community meeting insisted that NSE test soil samples from the site did government officials agree to do so.
Air quality and human health

There was little requirement to monitor or limit discharge of air pollutants in Hants County. The only reporting required was for the six air pollutants specified under the Nova Scotia Environment Act. There was no requirement to track additional pollutants commonly generated by gas field operations. Although the Hants County operations were minimal, volatile organic compounds would have been released during the fracking process as well as from wastewater stored on site and from flaring of the two wells.

In areas with producing gas fields and compressor stations, hazardous air pollutants have been measured at levels high enough to be serious health hazards. The tiny community of Dish, Texas lies close to several recently built gas compression stations. Many residents began reporting a range of symptoms including nosebleeds, headaches, and dizziness. Independent laboratory air sampling and analysis documented high levels of 15 chemicals, including benzene, xylene, naphthalene and carbon disulfide at five of seven test sites. At some test sites, the levels were 10 times the recommended safe level for short-term exposure. Some sites registered levels high enough to be classified as “disaster potential” according to the final report.\(^75\)

Hazardous levels of ozone have been documented in several rural states after gas fields were developed.\(^76\) Ozone can travel up to 300 km from gas production areas.\(^77\) If Triangle’s 680 well project had proceeded as planned in Hants County, industry-generated air pollutants could have affected the immediate and long-term health of thousands of people, in surrounding rural areas and in Halifax Regional Municipality.

Health is a growing concern in areas with shale gas development, and there is increasing evidence of significant potential health risks. Three major scientific health studies have recently been undertaken and will take a number of years to complete.\(^78\) In late February 2013, New York State extended its moratorium on fracking in order to allow a fuller review of potential health impacts.\(^79\)

Health issues highlight the need to understand the potential risks of all aspects of the unconventional gas industry. Unfortunately, health has been excluded from Nova Scotia’s narrowly defined review of hydraulic fracturing.
Municipal impacts

As the experiences of Windsor and of Colchester County illustrate, municipalities may be on the front lines in a variety of ways if shale gas development is allowed in Nova Scotia. Potential impacts on municipalities go beyond disposal of wastewater and other fracking waste.

Municipalities may face:

- Requests to purchase large amounts water from municipal supplies, which can lead to conflicts with residential uses.
- Deteriorated roads from thousands of heavy truck trips.
- Decreased tax bases from declines in property values.
- Potential contamination of municipal water supplies and damage to infrastructure.
- Increased demand on emergency services, including policing, emergency response and hospital care, and
- Destruction of community life as they know it.\(^80\) \(^81\)

These issues are not covered in Nova Scotia’s current review of fracking.

In New Brunswick a number of municipalities as well as the Association of Francophone Municipalities of New Brunswick have adopted resolutions calling for a moratorium on fracking in the province. The Town of Sackville declared their municipality off-limits for fracking. Similar resolutions have been adopted in Nova Scotia in Cumberland County and Inverness County.

New industry, emerging science

Unconventional gas and oil extraction, including shale gas, is a very new industry. The combinations of techniques used to extract shale gas have been in use for less than a decade. Until very recently, what was believed to be true about shale gas came from only one source - industry.

The first independent peer-reviewed scientific study into the impacts of shale gas development was published only two years ago. Since that time, scientific studies have documented a number of unexpected consequences. Growing numbers of peer-reviewed studies indicate that the risks associated with shale gas could be much greater and more wide-ranging than previously recognized.
In the past two years, peer-reviewed studies have found:

- Aquifer contamination in Pavillion, Wyoming linked to fracking (US Environmental Protection Agency study presently in peer-review process.)\(^8^2\)
- Levels of methane 17 times higher in drinking water wells within ½ mile (800 metres) of active shale gas wells, compared to methane levels in water wells farther away. Methane found in drinking wells was identified as associated with shale gas extraction.\(^8^3\)
- Potential pathways from hydraulically fractured shale to aquifers exist,\(^8^4\)\(^8^5\) and multiple hydraulic fractures could lead to aquifer contamination in as little as 10 years.\(^8^6\)
- Cancer risks 66% higher for families living within ½ mile (800 metres) of gas wells.\(^8^7\)
- Links between fracking wastewater disposal wells and earthquakes.\(^8^8\)
- Climate impacts of shale gas equal to, or greater than, the impacts of coal over a 20-year time frame,\(^8^9\) and eroded claims that shale gas is “green energy.”\(^9^0\)

On the other hand, no peer-reviewed evidence has indicated that any of the methods for disposal of fracking wastewater is safe.\(^9^1\)

In many fields, the science relating to unconventional gas and oil extraction is new and unfolding. Without valid scientific information, there is no way to know the actual risks involved in shale gas extraction. Without knowing the actual risks, it is not possible to weigh risks against potential benefits to determine whether this industry will be of overall benefit to the province. At this point in time, decisions about how to regulate shale gas can only be made based on extremely limited scientific information.

“Industry best practices” cannot be assumed to prevent harm. In most cases, best practices are simply the best practices the industry is willing to employ. “Best practices” are not necessarily safe practices.

Will new regulations solve the problems?

The most frequent government response to the problems that arose in Hants County, and to problems coming to light in other shale gas production areas, is “That’s why we have a review in Nova Scotia. New regulations will make sure it is done safely here.”

Unfortunately, there are no real life examples to illustrate that new regulations result in shale gas development being carried out safely.

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New regulations requiring full disclosure of fracking chemicals in Texas still allowed 19,000 chemicals to remain secret in 2012.
• Texas adopted new regulations requiring full disclosure of fracking chemicals in late 2011. In 2012, 19,000 chemicals were exempted and remain secret.92

• Regulations do not stop well contamination being hidden from public knowledge through secrecy clauses in compensation settlements.93 94 This allows companies to claim that there are no proven incidents of water contamination.

• Regulators are swamped and can’t keep up with reported problems.95 In North Dakota, 19 regulators look after 7,000 wells. In Oklahoma, 58 inspectors are responsible to monitor 90,000 wells. The New York Times analyzed more than 50,000 inspection reports and found that “as the number of drilling rigs rose by more than 22 percent in 2011 from the prior year, the number of inspections at such work sites fell by 12 percent.”96

• Regulations don’t prevent illegal dumping of fracking wastewater.97

• Pennsylvania’s promised health registry to track health problems in gas producing areas disappeared when the state cut all funding. The state still has no measures to record or measure health impacts of the fast-growing new industry.98

• A study by the US National Institute for Occupational Safety and Health (NIOSH) found that 47% of all oil and natural gas workers breathe air exceeding established safe limits for silica dust, a carcinogen.99

• Of the 2,200 oil and gas industry trucks inspected between 2009 and February 2012, 40% had to be removed from the road because they were too unsafe to drive, according to Pennsylvania State Police reports.100

Canadian experience with regulatory control is no more reassuring.

• British Columbia issued detailed regulations in 2010 that limit where and when companies can drill, and set new environmental standards. However, the province then gave its Oil and Gas Commission the authority to exempt drillers from virtually all of these provisions.101

• A major well blow out near Innisfield Alberta in January 2012 exposed the underside of Alberta’s claim to have “model regulations” and “no incidents.” After the blowout, information emerged that no reporting of incidents of this type had been required. Because no reporting was required, the province could claim to have “no incidents.” A committee formed after the blowout found 21 incidents in the past year, of which five resulted in releases to the surface.102

• “Regulation of this industry is mostly targeted at meeting operational requirements,” according to BC Fisheries officer Baccante.103

• In New Brunswick, Windsor Energy knowingly ignored a provincial law requiring that the company obtain municipal permission before carrying out seismic testing in Sussex.104 The premier asked the company to apologize.
Looking at the big picture

The Hants County experience gives an indication of what could happen when government is not looking at the big picture. Approvals were given on a step-by-step, well-by-well, permit-by-permit basis as is normal department practice.

No one seems to have had the responsibility to consider the overall impacts of the Hants County project. There does not appear to have been any evaluation of the potential impact of withdrawing the vast quantities of water that would have been used if the 680 well project had proceeded as planned. Wastewater disposal was treated with a "we’ll cross that bridge when we come to it" approach. No one evaluated the potential impacts on air quality and health, or on agriculture, tourism, wineries or fisheries - foundations of the region’s economy.

Nova Scotia’s present review of hydraulic fracturing continues to avoid looking at the big picture. The review’s objectives are limited to determining “best practices” for hydraulic fracturing. Significant issues are specifically excluded from the review, including impacts on human health, potential negative economic impacts on existing industries, and socio-economic impacts on communities.105 The review’s narrow scope does not provide an opportunity to weigh risks and costs against benefits to determine whether this industry will actually benefit Nova Scotia.

Quebec is taking a different approach. Quebec imposed a moratorium on hydraulic fracturing for shale gas in 2011. The moratorium followed a “significant” well leak near St. Hyacinthe and the discovery that 19 of 31 shale gas wells in the province were already leaking. Quebec then undertook an in-depth strategic environmental assessment process, including public hearings and a range of studies designed to address the question – can shale gas be safely developed without posing a threat to residents of the province? In February 2013, the new PQ government announced their intention to table legislation that will ban the awarding of exploration licenses for shale gas and suspend licenses already granted until studies are completed.106

Tip of the iceberg...

The real lesson of fracking in Hants County is what could have happened if the project had gone ahead, and what could still happen if shale gas development is allowed in Nova Scotia. A shale gas production field has substantially greater impacts than the three exploratory wells drilled and fracked in Hants County.

- **Shale gas production wells are drilled vertically and then horizontally** for a distance of up to 3 kilometers, increasing the chance of intersecting with existing geological faults.

- **The horizontally drilled shale layer is fracked over its entire length** to release gas.

- **Each frack uses substantially more water** - between 7.4 and 37 million litres - drawn from local water sources.
• More chemicals are needed in order to drill long distances through dense shale. A 15 million litre frack requires from 80 to 330 tons of chemicals.\textsuperscript{107}

• Wells are usually grouped six per well pad, with pads spaced at one kilometer intervals. Unconventional gas extraction requires many closely spaced wells to maintain production, as each well’s production drops 80% after 2 years.

• Thousands of truck trips (up to 2400 per well per frack) generate diesel fumes, linked to respiratory problems and lung cancer, and damage local roads and bridges.

• Toxins, including radioactive elements, are released from the shale as it is fractured, resulting in greater contamination in wastewater and air.

• Tons of contaminated drilling mud and sand are generated, and many millions of litres of wastewater is produced.\textsuperscript{108}

• Production wells flare-off gas, compressor stations emit volatile organic compounds, and pipelines are built to transport the gas. Air pollutants are released at each step, and continue to be released over time from waste products.

• Large numbers of wells means an increased likelihood of well leakage, potentially resulting in risks to drinking water, surface water, health and climate. Industry statistics show that 5-7% of wells leak in the first year, with up to 60% leakage after 30 years. Shale gas wells in Pennsylvania drilled in the last two years have similar or higher rates of leakage.\textsuperscript{109}

Every stage of shale gas exploration and extraction has its impact on eco-systems and on health. Full scale shale gas development would multiply the problems and risks both quantitatively and qualitatively.

This story is far from over. Triangle has announced its intention to leave Nova Scotia\textsuperscript{110} but rising gas prices could renew industry interest in the Windsor Block. Other areas of the province could face the same issues soon. St. Brendan’s Exploration has begun exploration for shale gas on 335,000 hectares stretching from New Glasgow to Amherst. The Calgary-based subsidiary of US Triana Energy has been clear that they will use hydraulic fracturing if they find shale gas. In Cape Breton, close to Lake Ainslie, Petroworth is prepared to drill an exploration well to look for conventional oil and natural gas and has not ruled out fracking.\textsuperscript{111} Forent Energy is assessing the results from their first exploration well near Truro, and Eastrock Resources has two exploration agreements in Cumberland County.

Triangle’s Hants County operations represent the barest tip of the fracking iceberg. The Hants County experience suggests that neither the industry or the Province is ready to address the range of problems inherent in shale gas development and fracking, even at the lowest conceivable levels of exploratory operations.
Lessons to be learned

Although the Hants County experience with drilling and fracking for shale gas was minimal, valuable lessons can still be learned. The problems that Nova Scotia experienced with this small project are very similar to the problems being experienced on a much larger scale where shale gas extraction is taking place.

- In the relatively new unconventional gas industry, industry is far ahead of regulators. Governments lag behind and have difficulty responding effectively as unexpected issues and problems emerge.
- When regulators base decisions on information provided by industry, the results can be unexpected problems that are difficult or impossible to resolve satisfactorily.
- If industry does not want to comply with local rules or regulations, it is difficult to make them do so, especially in a timely way.
- Even the exploratory stages of unconventional gas development can have significant impacts.
It is essential to understand the specific conditions of Nova Scotia, including geology, land use, water resources, infrastructure and other factors, in evaluating the potential impacts of shale gas development.

Many of the effects of hydraulic fracturing and shale gas production may appear only over time. This was true in Hants County, where the presence of radioactive materials in wastewater was identified only several years after drilling and disposal of some of the waste, and it is true with well leakage. The magnitude of the industry increases both risks and cumulative impacts. Some harm may not become apparent until long after operations have finished and the company responsible has moved on.

It is crucial to look at the big picture of shale gas extraction, and evaluate the combined impacts of all aspects of this new type of natural gas production, including but not limited to hydraulic fracturing. A permit-by-permit, well-by-well approach is not sufficient to avoid problems. The Nova Scotia government’s current review of hydraulic fracturing needs to evaluate the risks and impacts of shale gas development as a whole, including issues which are currently excluded, such as health, local economies, communities, and global climate.

At this time, there is no scientific evidence indicating that any method of disposal of fracking wastewater is environmentally safe, considering cumulative and long-term impacts. Until a proven solution to the wastewater problem can be found, it would be wise not to allow fracking in Nova Scotia, nor to allow Nova Scotia to become the fracking wastewater disposal centre for other provinces.

Emerging science is exposing unexpected and serious risks. The first independent peer-reviewed scientific studies into the impacts of shale gas development were published only two years ago. Many aspects are only now being researched and documented. When risks are high and damage can be long lasting, as with fresh water contamination, massive land use change and multiple health impacts, it is common sense to wait until there is sufficient valid evidence on which to base decisions.

The risks of shale gas were not as evident in 2007, when Triangle began work, as they are today. In 2013, no government can move ahead with shale gas development and later say, “we didn’t know there would be problems.”
Conclusion: Two possible roads ahead

**Industry proposes:** “Let’s push ahead. How can we learn to do better if you don’t let us try? Those problems in other places are exaggerated, and it will be different here. Trust us and let’s develop shale gas together, with new regulations.” Cash-strapped governments are desperate to believe this is possible.

**Other voices say:** “Slow down. Risks are significant and when things go wrong, there may be no way to fix them. Let’s take an honest look at all the risks and benefits, and see whether this industry will be good for Nova Scotia – economically, environmentally and socially – now and in the long-term. Decisions need to be based on independent scientific evidence, not industry hype, and the science is not yet in.”

The road ahead is still a choice. A small province like Nova Scotia does not have a lot of room to make costly mistakes.

Nova Scotia does not need to jump onto the shale gas bandwagon. The gas is not going away, and current prices are very low. Unconventional gas, including shale gas, is an industry with only a ten-year history. There is a lot still to learn, a lot of truths yet to uncover. Nova Scotia would be wise to take a long time out, and wait to learn from independent science, including studies based on the experiences of other areas.

**The Nova Scotia Fracking Resource and Action Coalition recommends either:**

**A 10-year legislated moratorium on shale gas and fracking** exploration and development. After 10 years, the province will be in a better position to evaluate, based on scientific evidence, whether shale gas can be extracted safely. Or,

**Ban shale gas and fracking now.** Some jurisdictions have decided that there is enough evidence already to ban shale gas development. Nova Scotia could do the same.
Appendices

Report appendices can be found online:

- Appendix A – Map of Windsor block, from Triangle Petroleum’s Development Program Application
- Appendix B – Map of plan for first phase, from Triangle Petroleum’s Development Program Application
- Appendix C – Map of homes and well sites from Triangle Petroleum’s Development Program Application
- Appendix D – Chemicals used in Hants County: FOIPOP documentation
- Appendix E – Chemicals in Natural Gas Operations: Health Effects Spreadsheet and Summary - Hants County, Nova Scotia
- Appendix F – Lab analysis of levels of radioactive elements, Kennetcook wastewater ponds

Notes

3. Ibid., p. 17, Table 1-2
5. Ibid, Appendix D, See our Appendix B attached
10. Rushton, T. A. [2010, May 20] [Correspondence from Theresa Rushton, Dillon Consulting, to Melanie Haggart, Nova Scotia Environment, p.1]. “Approximately 7,000 cubic meters of fresh water was used to frac each well.” Conversion of cubic meters to litres is 1000 litres per cubic meter.

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18. See Appendix D


23. Ibid


31. Ibid., p.2


33. Appendix E


35. Westhaver, S. (2011, August 2). [Correspondence from Stephen Westhaver, Nova Scotia Environment, to Peter Hill, Triangle Petroleum CEO, p. 2]


44. Ibid., p. 4


47. Ibid


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71. DeGrass, D. J. (2011, December 2). [Correspondence from Derek J. DeGrass, Nova Scotia Environment, to Peter Hill, Triangle Petroleum CEO].


86. Ibid.


108. Conventional oil and gas wells use, on average, 300,000 pounds of proppant, coalbed fracture treatments use anywhere from 75,000 to 320,000 pounds of proppant and shale gas wells can use more than 4 million pounds of proppant per well. Hydraulic fracturing 101. Retrieved from http://www.earthworksaction.org/issues/detail/hydraulic_fracturing_101#.UTP6qJ6RxkI

