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# MOVING OIL BY PIPELINE: EXAMINING THE FACTS

*While this topic is not related to climate science, in the interests of informed discussion and presenting the evidence over ideology, Friends of Science Society offers this informed commentary by Robert Lyman.*

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# MOVING OIL BY PIPELINE: EXAMINING THE FACTS

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A central issue affecting the expansion of crude oil production in Canada concerns the current limitations on the addition of pipeline capacity. Well-organized and funded interest groups oppose the certification of new pipelines that would provide export market access. While these groups often cast their opposition in terms of a desire to stop all greenhouse gas emissions associated with oil production, they rally local communities' support by arguing that the certification of new (and even old, but expanded) pipelines will pose unacceptable risks to water quality through their potential to spill into lakes, rivers, swamplands and underground water reservoirs. "Water is life" has become a favourite rallying cry, as though the construction and operation of a new oil pipeline poses a death threat to human and animal clean water supplies.

The purpose of this paper is to examine the actual safety performance of oil pipeline systems in Canada and the United States, especially as this relates to oil spills. The paper will also describe the measures now being taken by the petroleum industry and governments to prevent oil spills and to ensure that, if they occur, the results are minimized and mitigated. Finally, it will discuss exactly what happens when, despite best efforts, a large spill occurs.

## Some Basic Facts about Oil Pipelines in Canada and the United States

The discovery of large oil fields in Texas in the 1880's began the development of the North American petroleum industry, a development that accelerated early in the 1900's with the invention and mass production of internal combustion automobiles. The first transportation of crude oil to refineries was in wooden barrels and then wooden pipelines. The U.S. oil pipeline industry grew to over 115,000 miles by the 1920's and expanded to almost all parts of the lower 48 states by the 1950's.

The first Canadian oil pipeline was built from Petrolia to Sarnia, Ontario in 1862. With the discovery of large oilfields in Alberta in the 1940's, Canada's pipeline network expanded significantly in the 1950's and 1960's.

Today in Canada, the oil pipeline system is generally divided into the lines that gather crude oil from where it is produced to refineries or storage facilities within the same province; the long interprovincial and international crude oil pipelines that transport crude across Canada and to international markets; and the refined oil product pipelines that transport products like gasoline and diesel fuel to end users. Provincial governments regulate the pipelines that operate exclusively within their borders and the federal government regulates interprovincial and international pipelines. The same is true in the United States, where state governments regulate the pipelines entirely within their jurisdictions and the U.S. federal government regulates interstate pipelines.

In 2015, the federally regulated oil pipeline system in Canada consisted of 38 companies, including 11 that transport both oil and natural gas. In 2015, they transported 1.4 billion barrels of oil along 21,637 kilometres of pipelines.

Source: <http://www.tsb.gc.ca/eng/stats/pipeline/2015/ssep-sspo-2015.asp>

In 2014, the most recent year for which statistics are available, U.S. oil pipelines transported 16.2 billion barrels of oil products, of which 9.3 billion barrels were crude oil. The U.S. oil pipeline system consisted of 199,243 miles of pipe. Over the period 2010 to 2014, U.S. crude oil pipeline mileage increased by 12,018 miles, or 22%.

Source: <http://www.aopl.org/wp-content/uploads/2015/11/AOPL-API-Pipeline-Usage-and-Mileage-Report-2015.pdf>

## What is the Industry's Record Concerning Oil Spills?

In both the Canada and the United States, the oil pipeline industry has a remarkably good record of avoiding spills. Of the total volume of oil moved annually on federally regulated pipelines in Canada in 2015, 99.999% of the oil was delivered safely with no spills. Of the 1.4 billion barrels of oil transported, less than 400 were spilled. In the United States, the same 99.999% record of safe delivery applies.

In Canada, the Transportation Safety Board (TSB) is responsible to monitor federally regulated pipeline safety performance with respect to any damage, injuries and fatalities and spills. The TSB's team of experts has extensive knowledge and experience in the areas of pipeline engineering, metallurgy, welding and control systems, as well as the pipeline regulatory environment. They have access to and use highly trained specialists and state-of-the-art equipment to examine and test pipeline components involved in occurrences in order to identify and confirm safety deficiencies. TSB pipeline investigators also serve on and actively participate in various government and industry committees, activities and forums in order to monitor trends and promote the safety messages resulting from its investigations.

The TSB reports annually on its findings and conducts investigations and audits on an ongoing basis. The TSB generally divides pipeline safety occurrences into two types, accidents and incidents. *Accidents* include a wide range of occurrences of increasing seriousness that result in a rupture, a low-pressure hydrocarbon release, a fire that shuts down a pipeline, a serious injury or a loss of human life. *Incidents* include all other reportable pipeline occurrences, ranging from precautionary shutdowns and any nearby threat to the integrity of the pipeline to a pipeline operated beyond its design limits or an uncontained release of oil or gas.

### Pipeline Occurrences Involving Product Releases in Canada

	Accidents (all Pipelines)	Incidents	
		All Pipelines	Crude Oil Pipelines
2010	8	129	54
2011	4	147	71
2012	3	154	77
2013	7	100	31
2014	2	104	32
2015	0	69	3

Source: <http://www.tsb.gc.ca/eng/stats/pipeline/2015/ssep-sspo-2015-tbls.asp>

Note that no pipeline accidents were reported to the TSB in 2015, down from a total of 2 in 2014 and an average of 4.4 in the previous five-year period (2010-2014). Over the past 10 years (2006 to 2015), 13 occurrences identified as accidents resulted in a release of oil, with 8 releases of less than 1.5 cubic metres (9.44 barrels of oil), one release between 1.5 and 25 cubic metres (between 9.44 and 157 barrels), three releases between 26 and 1000 metres (between 157 and 6290 barrels), and one release over 1000 cubic metres (6,290 barrels).

In 2015, three incidents involved a release of 1.5 to 25 cubic metres of crude oil.

Source: <http://www.tsb.gc.ca/eng/stats/pipeline/2015/ssep-sspo-2015.asp>

The National Energy Board (NEB) is responsible to regulate the design, construction and operation of interprovincial and international oil pipelines in Canada. According to the NEB, these pipelines spilled an average of about 1,084 barrels per year between 2011 and 2014. This is roughly equivalent to two tank cars.

The NEB's [Safety Performance Portal and Environmental Performance Dashboard](#) presents statistics on the number and frequency of various incidents that affect pipeline safety, integrity and the environment.

## Provincially Regulated Crude Oil Pipelines

Under Canada's Constitution, pipelines entirely within the boundaries of a province are regulated by the government of that province. In Alberta, the Energy Resources Conservation Board (ERCB) regulates 886 licensees operating approximately 415,000 km of pipelines within the province. These pipelines carry various gases and fluids and vary in length and size. Crude oil pipelines constitute about 20,000 km of the total. The British Columbia Oil and Gas Commission (OGC) regulates 120 licensees operating approximately 39,000 km of pipeline within the province. Of these, crude oil pipelines constitute about 2,400 km. In Saskatchewan, the Ministry of the Economy regulates 25 licensees operating about 23,000 km of pipelines, of which about 4,200 are crude oil pipelines.

Report 2013-B of the Alberta Energy Regulator provides the best available review concerning pipeline performance in Alberta. It reviews performance over the period 1990 to 2012. The report can be found here:

<https://www.aer.ca/documents/reports/R2013-B.pdf>

Alberta's legislation governing pipeline incidents is very "robust", meaning that it requires licensees to report each and every incident that results in a spill or a release of any volume of pipeline product, any contact or damage to a pipeline, or damage to its corrosion-control exterior coating. As a result, significantly more incidents end up being reported in Alberta than in other jurisdictions.

From 1990 to 2012, 17,605 incidents were reported. Of the total, 15,609 were leaks; 1,116 were hits with no release; and 880 were ruptures. A measure of overall annual pipeline performance is calculated by dividing the number of incidents recorded during each calendar year (excluding pressure-test failures) by the total length of pipeline on record at calendar-end. This measure is reported as incident frequency and is expressed as the number of incidents per 1000 km of pipeline per year. Although the amount of pipeline infrastructure has generally increased every year since 1990, the number of incidents has remained stable or declined. For all pipelines, incidents averaged about 800 per year from 1990 to 2007, and then declined to about 600 per year. Average incident frequency has continually decreased to 1.5 incidents per 1000 km per year.

Crude oil pipelines constitute 4.9 % of the 415,000 km of pipelines in Alberta. The number of oil pipeline incidents has been around 20 per year since 1997.

In terms of pipeline releases, the incidents are divided into four volume classes:

- Less than 100 cubic metres of liquid or 100,000 cubic metres of gas
- 100 to 1000 cubic metres of liquid or 100,000 to one million cubic metres of gas
- 1000 to 10,000 cubic metres of liquid or one million to 10 million cubic metres of gas
- Larger than 10,000 cubic metres of liquid or 10 million cubic metres of gas.

For the smallest volume category (i.e. less than 100 cubic metres), releases of crude oil varied from 230 in 1990 to 231 in 2012, reaching a peak of 334 in 1996. For releases between 100 and 1,000 cubic metres, the highest in one year was five, and since 2000 the number has varied from one to three. For releases between 1000 to 10,000 cubic metres, there were two in 1990 and in 1993, one each in 1992, 2004 and 2006, and none in the other years. There were no larger releases. Of the 6,488 releases from provincially-regulated crude oil pipelines over the 22-year period, 99% were the smallest releases (often a cubic metre or less).

## United States

The Pipeline and Hazardous Materials Safety Administration (PHMSA) of the U.S. Department of Transportation is responsible to regulate pipeline safety in the United States. PHMSA's mission is *“to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives. To do this, the agency establishes national policy, sets and enforces standards, educates, and conducts research to prevent incidents. We also prepare the public and first responders to reduce consequences if an incident does occur.”*

Unfortunately, PHMSA reports do not provide the same level of detail concerning the number and volume of oil spills, as do those of the TSB in Canada. The information is available as a result of the joint American Petroleum Institute (API)-Association of Oil Pipelines Annual Pipeline (AOPL) Safety Performance Report and Strategic Plan. Based on the reports from pipeline operators, in 2013 there were 134 releases from onshore liquids pipelines along pipeline rights of way. The number of barrels released declined from about 90,000 in 2000 to about 30,000 in 2012, before increasing to 110,000 barrels due to one large spill in 2013. Over half (55%) of the barrels released in 2013 were caused by third parties or outside forces, not the operations of the pipeline companies themselves. Of the 397 pipeline incidents reported to PHMSA in 2013, nearly 140, or 35%, were smaller than one barrel, over 260 (two-thirds) were 5 barrels or smaller, and nearly 350 (88%) were 100 barrels or smaller. Only 20 releases were larger than 500 barrels.

Source: <http://www.aopl.org/wp-content/uploads/2015/02/2015-Pipeline-Safety-Perf-Report-Strategic-Plan-s.pdf>

## The Oil Pipeline Safety System

Achieving higher levels of pipeline safety and spill avoidance is one of the highest priorities of both governments and the pipeline industry in North America. There are several inter-related components of the safety system including prevention, preparedness and response, and liability and compensation regimes.

In Canada, the National Energy Board, an independent, expert regulatory body, is the federal agency responsible for regulating pipeline design, construction and operation with the goal of achieving zero incidents. It does this by thoroughly reviewing the design and location of pipelines before they are certificated to be built and attaching any conditions necessary to ensure the safety and integrity of the lines; carrying out thorough environmental assessments and reviews before certification; regularly inspecting pipelines; and reviewing and auditing company performance in safety design, security, emergency response, integrity management and environmental protection programs. Recently, NEB regulations were more closely harmonized with those of the provinces; they set a “prescribed area” where any ground disturbance or building is prohibited without first contacting the company operating the pipeline. The Federal Energy Regulatory Commission performs a similar role in the United States.

Arguably, Alberta’s Energy Resources Conservation Board provides the most thorough overall regulatory regime in North America. The Alberta Pipeline Safety Review, a study prepared by Group 10 Engineering for the ERCB in 2012, confirmed this. The study can be found here:

<http://www.energy.alberta.ca/Org/pdfs/PSRfinalReportNoApp.pdf>

The purpose of the study was to assess the current ERCB regulatory requirements and framework and then to compare them to similar jurisdictions and regulators in Canada and elsewhere, with a special focus on three topics:

- Public safety and response to pipeline incidents
- Pipeline integrity management
- Safety of pipelines near water bodies

The report stresses the importance of pipeline standards, pipeline integrity programs and audits:

*“A common and harmonizing point to all Canadian regulators is the adoption of the Canadian Standards Association document CSA Z662, Oil and Gas Pipeline Systems, as the standard that is in force. This provides consistency with respect to design and construction, and somewhat to operations and maintenance, integrity management*

*and risk management. Each jurisdiction does however have requirements in their respective Acts and regulations that are over and above those required by CSA Z662.”*

*“The requirement for all pipeline companies operating in Canada to have a Pipeline Integrity Program (PIM) became mandatory with its inclusion in the 2003 version of CSA Z662. Guidance on the elements of such programs may be found in Annex N of Z662 as well as API 1160 for liquids pipelines.”*

*“From a regulatory perspective, it is insufficient that companies have merely developed a PIM program; rather, they must also demonstrate its implementation and effectiveness. Gaps in any of these three facets would constitute non-compliance. How compliance is determined varies widely across the various jurisdictions in Canada. For example, in British Columbia, the licensee makes a form of self-declaration/audit; while in Alberta, regular field inspections are the norm. Federally regulated companies are subjected to inspections and detailed audits, albeit on an infrequent basis. (IPC2012-90046 paper entitled Trends on Integrity Management Programs (IMP) and Management Systems (MS) Audit and Incident Findings authored by members of the NEB and B.C. OGC provides current information on audits and the results.”*

Industry bears the primary responsibility to ensure the safe operation of pipelines. Under the leadership of industry associations like the Canadian Energy Pipeline Association (CERA) and the Association of Oil Pipelines in the U.S., industry carefully manages pipeline integrity. This includes:

- Constantly researching and applying new technologies that will promote pipeline integrity and safe operation, such as those for corrosion prevention, inspections, leak detection and damage prevention
- Sensing and preventing: leak detection is done at a distance, using control rooms that are active 24 hours a day, seven days a week, and that collect information about the temperature, flow rate and pressure of the product in the pipeline, using sensors along the pipeline route.
- Investing in pipeline safety; CEPA members invest about \$1.4 billion per year
- Using the most up-to-date inspection technology such as magnetic flux and ultrasonic tools that examine the pipe wall from the inside. These tools, known as “smart pigs,” permit companies to detect potential problems and prevent leaks. In addition, improvements in pipeline coating technologies and the use of cathodic protection have reduced corrosion of pipelines.

## Liability and Compensation

Why do pipeline companies take such measures? Partly, this is because they are aware of the importance of demonstrating to their customers that they are good corporate citizens. However, if there were any companies not so motivated, there is a compelling financial reason. If the operator is at fault, the pipeline company is completely liable for all costs to clean up a pipeline spill. In Canada, there is no limit on the amount a company may be required to pay to clean up a spill. In addition to being financially responsible for clean up, the company may also be fined or be subjected to other enforcement actions such as NEB Orders and Directives or prosecution.

If an incident occurs, the NEB holds the company responsible and accountable for cleanup and site remediation. The federal Pipeline Safety Act sets out absolute liability of \$1 billion for companies operating major oil pipelines (classes and limits for other pipelines are established in regulations). This means that companies will be automatically responsible for up to \$1 billion in damages regardless of who or what caused the incident. It is important to note that where the pipeline company is at fault or negligent, liability will remain unlimited. This extends to damages to the environment beyond the costs of cleanup and other losses. All companies operating a pipeline are required to hold a minimum level of financial resources to ensure they can respond quickly in the event of an incident. If the operator is unwilling or unable to shoulder its responsibilities, the NEB has the authority to take control of spill response, cleanup and remediation, and the NEB is authorized to recover any costs incurred from industry.

Source: <https://www.nrcan.gc.ca/energy/infrastructure/18858>

## What Happens if a Spill Occurs Anyway?

Federal and provincial regulators in Canada, and federal and state regulators in the United States, by law must immediately be notified of spills. A Canadian pipeline company's Emergency Response Plan, which must be pre-approved by the NEB, then guides initial response and containment of a spill with appropriate equipment, such as absorbent booms. Pipeline companies must have spill first-responders under contract. It is also an NEB requirement that companies continually educate all

first responders on practices and procedures to be followed in the event of an emergency.

Once a spill is contained, oil is removed by vacuum truck for recycling. Contaminated soil and water is then removed for treatment. For NEB-regulated pipelines, a Remediation Process Guide requires companies to conduct the appropriate level of Environmental Site Assessment, and to submit a Remedial Action Plan for approval by the NEB. The Guide indicates that the most stringent criteria must be used for remediation of residual soil and groundwater contamination. The spill site is considered clean once the NEB approves a remediation closure report demonstrating all standards have been met. Reclamation of the site to restore the environment is also a part of the clean up.

## What Happens if Everything Goes Wrong?

As indicated in the previous description of oil transport by pipelines in the United States, even the best efforts of governments and industry cannot always prevent spills. Even if 99.999% of oil is transported safely and without a problem, what happens in the worst case?

The answer to that question can possibly be provided by examining the case of the pipeline rupture and release of oil from the Enbridge Line 6B pipeline in a wetland near Marshall, Michigan, in 2010. The rupture occurred during the last stages of a planned shutdown of the pipeline and was not discovered or addressed for over 17 hours. During the time lapse, 844,000 gallons (about 20,000 barrels) of crude oil were released. The oil saturated the surrounding wetlands and flowed into the Talmadge Creek and Kalamazoo River. The U.S. National Transportation Safety Board investigated this accident and issued a report in July 2010. It found that the release was made possible by “pervasive organizational failures at Enbridge Incorporated” including deficient integrity management procedures, inadequate training of control centre personnel, and insufficient public awareness and education.

Source:

<http://www.nts.gov/investigations/AccidentReports/Pages/PAR1201.aspx>

This was one of the worst oil pipeline spills in the last twenty years in North America. What were the effects? There were no injuries as a result of the Marshall release. 330 people experienced temporary headaches and nausea as a result of exposure to the fumes. On August 1 and 3, 2010, the local health departments prohibited the use of surface waters affected by the spill for irrigation and the watering of livestock. The Michigan Department of Community Health advised members of the public not to consume fish from either Talmadge Creek or the Kalamazoo River to the west end of Morrow Lake. The Kalamazoo County Health and Community Services partially lifted the water use ban one month later, on September 3, in response to improved water sampling test results for the affected portion of the Kalamazoo River.

With the cooperation of U.S. Fish and Wildlife Service and the Michigan Department of Natural Resources and Environment, Enbridge established a wildlife response centre in Marshall to accept and treat affected wildlife. The wildlife response centre cared for and released about 3,970 animals, including about 3,650 reptiles and 196 birds. The U.S. Fish and Wildlife Service, in its final report on the spill, noted that 52 birds, 40 mammals (mostly muskrats), 106 turtles and snakes, and 42 fish were found to have died as a result.

Source:

[https://casedocuments.darrp.noaa.gov/greatlakes/enbridge/pdf/FinalDARP\\_EA\\_EnbridgeOct2015.pdf](https://casedocuments.darrp.noaa.gov/greatlakes/enbridge/pdf/FinalDARP_EA_EnbridgeOct2015.pdf)

Enbridge began collecting sediment samples on July 27, 2010 to determine the impact of the spill on the river system. By August 2010, field personnel noticed the presence of submerged oil. Starting in September 2010 and continuing throughout the winter, Enbridge removed the submerged oil by dredging, excavating, and aeration. In spring 2011, an EPA-directed reassessment found a moderate-to-heavy contamination covering over 200 acres of the river bottom. In August 2011, the EPA directed Enbridge to remove the remaining submerged oil. On June 21, 2012, the responding local, state, and Federal agencies announced that impacted areas of Talmadge Creek and the Kalamazoo River, except for Morrow Lake Delta, were open for recreational use.

Enbridge paid dearly. Its estimated costs for emergency response equipment, resources, personnel, and professional and regulatory support were about \$U.S. \$767 million as of October 31, 2011. In addition, PHMSA imposed a \$3.7 million civil penalty. Enbridge subsequently reached a settlement agreement with the U.S. Environmental Protection Agency in which it agreed to pay civil penalties of \$62 million and to spend at least \$110 million on a series of measures to prevent spills and improve operations across its pipeline system in the Great Lakes area.

Enbridge's reputation was damaged, and the accident prompted a major review of the adequacy of PHMSA's oversight that resulted in extensive new regulations in the United States.

Sources:

<http://www.phmsa.dot.gov/portal/site/PHMSA/menuitem.6f23687cf7b00b0f22e4c6962d9c8789/?vgnextoid=0faf7fe7f1a38310VgnVCM1000001ecb7898RCRD&vgnextchannel=d248724dd7d6c010VgnVCM10000080e8a8c0RCRD>

<https://www.justice.gov/opa/pr/united-states-enbridge-reach-177-million-settlement-after-2010-oil-spills-michigan-and>

The Enbridge experience demonstrates that, despite extraordinary efforts by governments and industry and their extreme rarity, oil pipeline spills are still possible. It also demonstrates that, even in the worst cases, the effects on the environment can be substantially moderated by remediation. Companies are careful to reduce their potential liability by using advanced materials and design, and developing the many safety programs they are required to do by law. They have no incentive to cut corners.

## Conclusion

Readers of this paper may be struck by the difference between the message conveyed by pipeline opponents and the facts presented here. The messages of pipeline opponents are stark, cataclysmic, emotional and simple. Reality is far more complex and multi-faceted. The conversation on oil pipelines has become polarized in the media and by opportunistic forces – with only two sides ‘saving the planet’ or ‘exploiting resources and profits.’ The truth is far more complex.

Consequently, informed debate on pipeline safety issues is essential for society.

The reality is that millions of people depend upon the supply of refined oil products for transportation, industrial production, petrochemicals and the thousands of

products and services that people use in our modern industrialized society. Further, as discussed in this document, hundreds of thousands of people work very hard to ensure that the transportation of crude oil and refined oil products moves across our lands with the utmost care given to oil spill prevention, preparedness and response. Comprehensive liability, compensation and governance regimes are in place to make sure that companies have a strong financial incentive to avoid spills and to clean them up as quickly and thoroughly as possible if they do occur. Credit is due to the thousands of people who do their utmost to reduce to a minimum the risks of spills, while ensuring that Canadians' energy needs are met and that jobs, industries and essential products are readily available for you.

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*Robert Lyman is an energy economist and transportation expert with 27 years' experience as a public servant, and ten years' experience as a diplomat.*

*Robert Lyman is a frequent contributor to Friends of Science Society's library of information on the economics of renewable energy, GHG reduction targets and transportation issues. We present this document on oil pipelines in Canada in the interests of encouraging informed debate on public policy.*

## About

Friends of Science has spent a decade reviewing a broad spectrum of literature on climate change and have concluded the sun is the main driver of climate change, not carbon dioxide (CO<sub>2</sub>). Friends of Science is made up of a growing group of earth, atmospheric and solar scientists, engineers, and citizens.

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