EC3003

Petroleum Pipelines—Facts and Safety

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Introduction

Since 2005, increased United States oil and natural gas production and increased oil output from Canadian oil sands has outpaced existing transportation infrastructure. As a result, there are plans to increase both natural gas and oil pipelines in the U.S. Although increased production of hydrocarbons has economic benefit, there are concerns about leaks and spills from petroleum pipelines and their potential environmental impacts. There has been particular concern about protecting Nebraska's water resources from possible leaks of the proposed Keystone XL pipeline extension, the permit application for which was denied by the U.S. Department of State on November 6, 2015. TransCanada responded to this action by initiating an international arbitration case in January 2016, under the North American Free Trade Agreement.

Regardless of one's viewpoint of the Keystone XL project proposal, petroleum pipelines are an undeniably important part of our transportation infrastructure. They provide heat for homes, fuel for transportation, and chemicals used to produce products ranging from fertilizer to plastics.

According to the Nebraska Pipeline Association, there are more than 2.0 million miles (3.2 million kilometers) of petroleum pipelines in the United States, and these pipelines are operated by more than 3,000 companies. Nebraska Pipeline Association member companies alone operate more than 102,000 miles (164,000 kilometers) of transmission pipelines

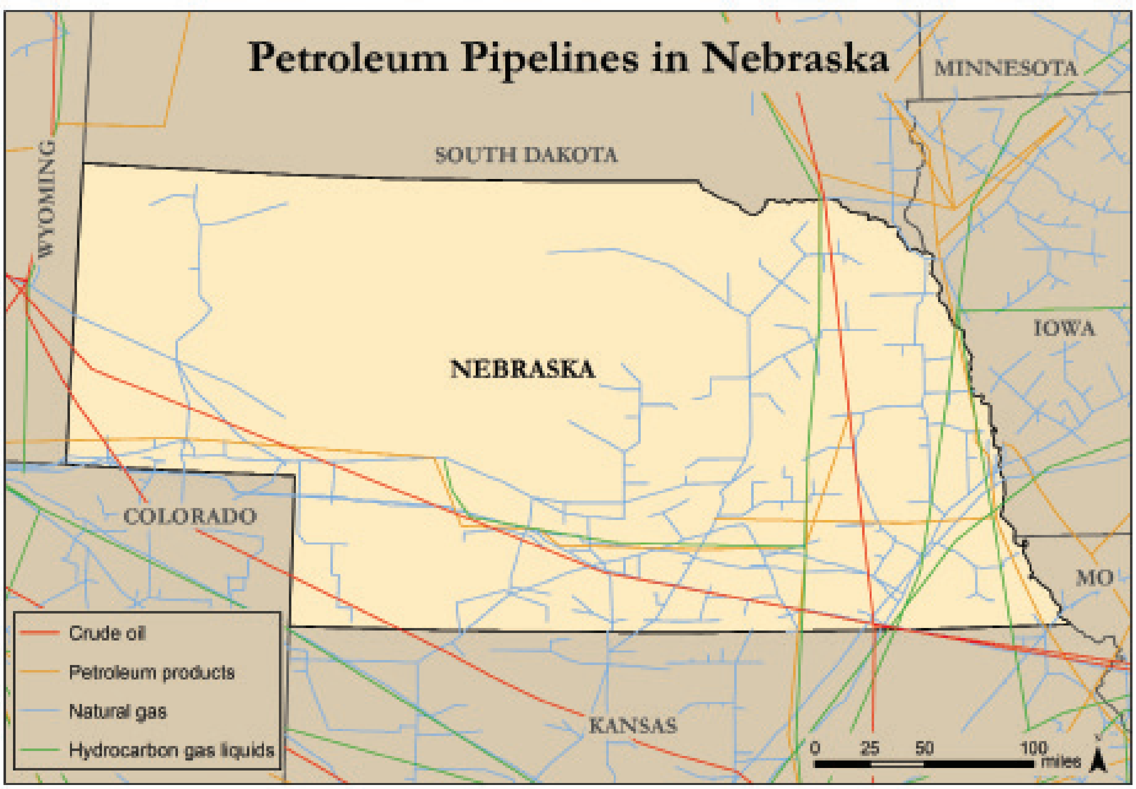


Fig. 1. Map showing various types of interstate distribution pipelines traversing Nebraska.

and transport petroleum or natural gas in 80 0f 93 of Nebraska's 93 counties. Residential natural gas distribution pipelines are ever-present in much of the U.S. and distribute natural gas to customers in 79 counties in Nebraska. Large interstate petroleum transmission lines cross under large parts of Nebraska and surrounding states *(Figure 1)*.

At the date of this publication, the proposed Keystone XL pipeline project was on hold pending the results of the legal action initiated by TransCanada. This guide, however, provides widely applicable information regarding potential environmental and human impacts from petroleum pipelines in general, and it reviews how pipelines are constructed to minimize adverse impacts. Although leaks in modern pipelines are rare and small relative to the immense volumes of products transported within them, the identification of pipeline leaks improves safety and protects the natural environment.

Carbon Footprint

A measure of the total amount of carbon dioxide (CO2) and methane (CH4) emissions of a defined population, system, or activity, considering all relevant sources, sinks, and storage within the spatial and temporal boundary of the population, system, or activity of interest. Calculated as carbon dioxide equivalent (CO2e) using the relevant 100-year global warming potential (GWP100). From Wright, Kemp, and Williams, in the journal *Carbon Management*

History and Development of Petroleum Pipelines

The first commercial natural gas well in the United States was drilled in 1821 in Fredonia, New York. Due to a lack of pipeline infrastructure and technology, natural gas usage was largely limited to lighting municipal street lamps in areas close to gas fields in the 19th century. In 1891, a 120 mile (193 kilometer) pipeline was laid between natural gas fields in Indiana and Chicago. After WWII, improvements in welding and pipe making technology led to a natural gas pipeline building boom that greatly increased natural gas usage. Currently, 22 percent of all energy use in the United States is dependent on natural gas and natural gas pipelines.

The development of horizontal drilling combined with hydraulic fracturing has greatly increased U.S. reserves of natural gas to the point where it is now competing with coal in generating electricity. As reported by the Institute for Energy Research in March 2014, burning natural gas releases less carbon per BTU than coal and is considered by many to be the "bridge" fuel between an economy fueled by fossil fuels and an economy in which energy is supplied by renewable sources. According to Scott Tinker, director of the Bureau of Economic Geology at the University of Texas at Austin, the use of natural gas in generating electricity has allowed the United States to substantially reduce its carbon footprint. More information regarding the scale and trends of human energy use is available through Tinker's "Switch Energy Film and Energy Project" at http://www.switchenergyproject.com/.

In 1859, "Colonel" Edwin Drake drilled the first commercial oil well in Titusville, Pennsylvania. Transportation of crude oil from fields to railroads was by wagon and horse until the first 9-mile-long wooden pipeline was built in 1862.

Fig. 2. Natural gas street lamp.

Pipelines began to compete with railroads when the 109-mile-long wrought iron Tidewater Pipeline in Pennsylvania was completed in 1879. Now, pipelines not only carry crude oil and natural gas, they also transport refined products and chemicals *(Table 1)*.

Fig. 3. Edwin Drake drilled the first oil well in 1859.

Pipeline Engineering and Preventative Safety Measures

Modern petroleum pipeline construction has advanced considerably beyond the 19th century's crude wood and cast iron versions. Modern steel pipelines include sophisticated leak-detection systems that help minimize the size of potential spills. Modern pipelines are constructed of steel and are coated with fusion bonded epoxy to minimize corrosion. Pipelines are often installed belowground, but can also be installed aboveground if necessary. Pipelines installed belowground in marshes and wetlands are coated not only with epoxy but also reinforced concrete. River and stream crossings may be constructed by boring or excavating beneath the streambed *(Figure 4),* or by building bridging and elevating the pipeline.

Fusion Bonded Epoxy

A powdered polymer coating that is melted and set with heat, resulting in the chemical linking that prevents it from re-melting when heated further. It is commonly used to prevent corrosion in industrial applications.

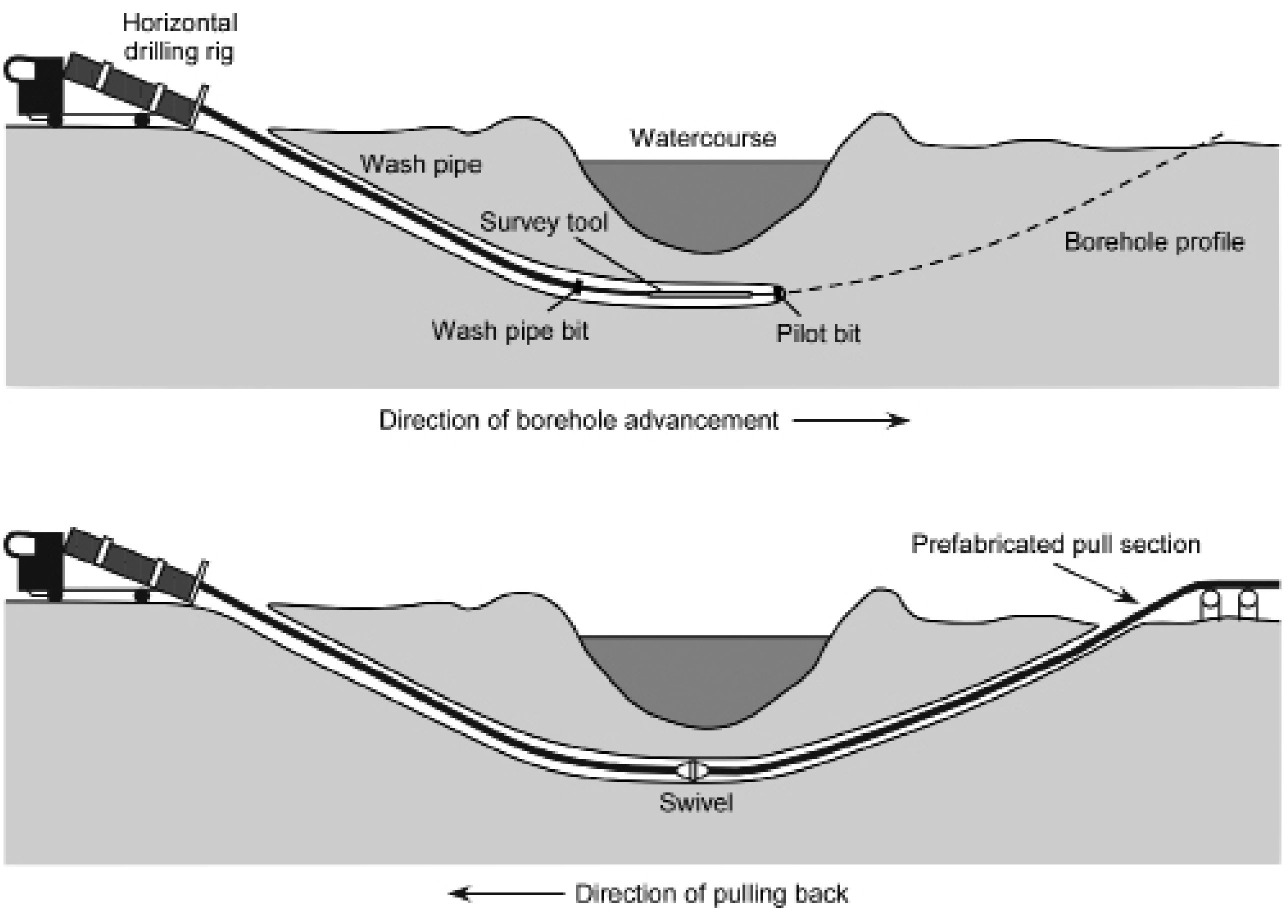


Fig. 4. Schematic diagram illustrating pipeline installation beneath a waterway or wetland.

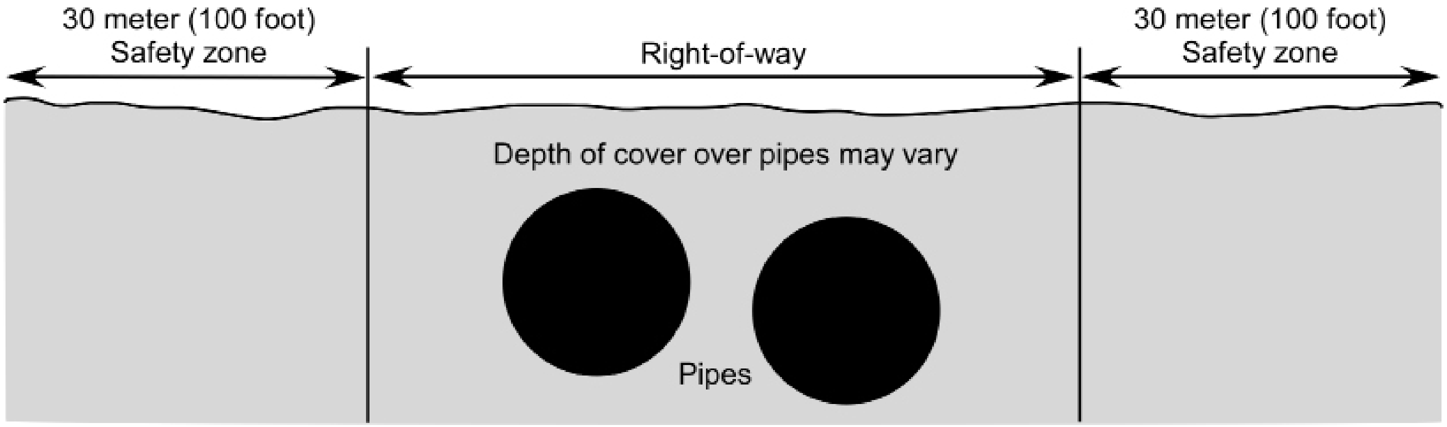


Fig. 5. Schematic diagram of typical pipeline right-of-way, including safety zone buffers.

When a belowground installation is desired, thick-walled pipe and directional drilling are often used for larger river crossings like the Platte River. Automated isolation valves are installed within a few miles of river crossings, depending on the local geography. Despite all the modern construction techniques, leaks and spills will occur. The key to minimizing the detrimental effects of leaks and spills is leak detection. One of the primary methods of modern leak detection is a system of software, sensors, and modern communications called SCADA (supervisory control and data acquisition) that uses pipeline pressures and flow rates to calculate flow balances. When SCADA detects a difference between what is put into one section of pipeline and what is flowing in the next section, an alert is issued at a remote control center. Remote control centers are often located somewhere along the pipeline route, but could be stationed anywhere in the world.

Once an alert is issued, operators in the remote control center will shut down pump stations, close isolation valves, and dispatch emergency response. Emergency responders include both local emergency responders and pipeline company employees who are stationed and employed near the pipeline to facilitate a rapid response to any emergency.

In addition to monitoring flow rates with computer software, physical methods of detecting petroleum pipeline leaks exist. The Nebraska Pipeline Association emphasizes physical inspection techniques such as inspection by air, visual inspection by routine patrol of pipeline right-of-way (Figure 5), and regular internal inspections and integrity tests.

Remote leak systems such as SCADA have a good track record when it comes to detecting large, sudden spills of pipeline products. The Wall Street Journal reported in 2014 that remote monitoring detected nearly two-thirds of the 37 releases of more than 1,000 barrels recorded since 2010. These 37 releases accounted for nearly 90 percent of the total barrels of product accidentally released.

Even with advanced leak detection technology, the human role in pipeline monitoring is vital. A review of more than 1,400 accident reports collected by the federal Pipeline and Hazardous Materials Safety Administration found that on-site employees and local residents were usually the first to detect and report a leak, whereas only 19.5 percent of reported spills were first detected in a control room.

Because remote monitoring does not always detect every small leak or slow leaks, responsible neighbors need to be aware of the signs of a pipeline release. Releases can be detected by individuals through visual, audible, and olfactory signs (Figure 6). These include petroleum on the ground, fire and explosion, mist or cloud of vapor, dying vegetation in a green vegetative area, a sheen or film on water, and water bubbling or liquid in unusual areas. In addition, the sound of hissing, whistling, or roaring noise is also a sign of a pipeline release. Strange and unusual chemical odors could also be a sign of a pipeline release.

Natural gas pipeline companies and utilities add mercaptan to their distribution lines and some of their transmission lines. Mercaptan adds an unpleasant odor to odorless natural gas to aid in the detection of leaking natural gas. It is particularly effective in detecting small leaks in distribution lines in residential areas.

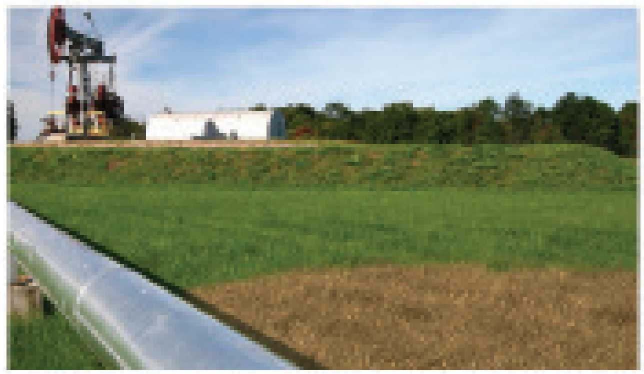
Table 1. Products transported by pipelines (adapted from: https://primis.phmsa.dot.gov/comm/FactSheets/FSProductList.htm).

Product	Chemical Formula	Use
Aviation Gasoline	variable; $C_{4-19}H_{10-40}N_nS_nONPb_n$	Fuel prepared especially for use in reciprocating piston aircraft engines.
Anhydrous Ammonia	NH_3	Used as a fertilizer and as an industrial refrigerant.
Bitumen	variable; e.g. $C_{200}H_{240}N_2S_7O_4$	Blended with condensates and refined by heavy oil refineries. Preferred feedstock for producing asphalt.
Carbon Dioxide	CO_2	Naturally occurring gas used in the petroleum industry.
Compressed Natural Gas	CH_4	Used as fuel for automobiles and industrial motors.
Condensates	variable; $C_{4-6}H_{10-14}N_nS_nO_n$	Occurs with natural gas and petroleum. Used to dilute and blend heavy oils.
Crude Oil (low sulfur)	variable; $CHN_nS_nO_n$+/-metals	Unrefined petroleum that is extracted through oil wells. Low sulfur is referred to as sweet crude.
Crude Oil (high sulfur)	variable; $CHN_nS_nO_n$+/-metals	Unrefined petroleum that is extracted through oil wells. High sulfur is referred to as sour crude.
Distillate Fuel Oils	variable; $C_{10-20}H_{20-42}$+/-$N_nS_nO_n$	Diesel fuel and fuel oils used for heating and transportation.
Ethane	C_2H_6	Simple hydrocarbon used as petrochemical feedstock.
Ethylene	C_2H_4	Simple hydrocarbon used as petrochemical feedstock for chemicals used to produce plastic products.
Gasoline	mixture; average of C_8H_{18}	The most commonly recognized refined petroleum product.
Gas Oil		Intermediate refinery product used as feedstock by specific refineries.
Hydrogen	H_2	Simple gas used as a petrochemical feedstock.
Hydrogen Sulfide	H_2S	Oil contaminant extracted to produce elemental sulfur.
Jet Fuels	variable mixture; $C_{10-16}H_nN_nS_nO_n$	Highly refined kerosene petroleum distillates used for transportation.
Liquefied Natural Gas	CH_4	Natural gas in liquid form, which requires less space (1/600th) to store and transport.
Liquefied Petroleum Gas	mixture; C_3H_8 and C_4H_{10}	Mixture of gaseous hydrocarbons, liquefied under pressure and used for heating and cooking.
Methane Gas	CH_4	Heat-producing fuel used like natural gas. (Natural gas is composed of 94% methane.)
Natural Gas	mixture; mostly CH_4	Widely used as a fuel for residential, commercial, and industrial purposes.
Natural Gas Liquid	mixture; $C_{2-5}H_{6-12}$	Byproduct of natural gas processing, useful as petrochemical feedstock or energy source.
Naphtha	mixture; $C_{4-12}H_{10-26}$	Intermediate refinery product used in paint thinners and solvents.
Nitrogen	N_2	Simple gas used in several forms for fertilizer, manufacturing plastics, and agricultural feed supplements.
Oxygen	O_2	Reactive elemental gas used in medical and petrochemical industries.
Paraxylene	C_8H_{10}	Aromatic hydrocarbon used in production of polyester and polyester products.
Produced Water	H_2O	Water separated from crude oil and liquid natural gas from production wells.
Propylene	C_3H_6	Feedstock used for antifreeze, deicers, polyester, solvents, medicine, cosmetics, and food products.
Synthetic Crude Oils	variable; $CHN_nS_nO_n$	Upgraded crude used as refinery feedstock.
Tertiary Butyl Alcohol	$(CH_3)_3COH$	Denaturant for ethanol, manufacturing feedstock, solvent, octane booster.
Xylene	C_8H_{10}	Naturally occurring petrochemical used as solvent, feedstock for polyester manufacturing, and in paints.

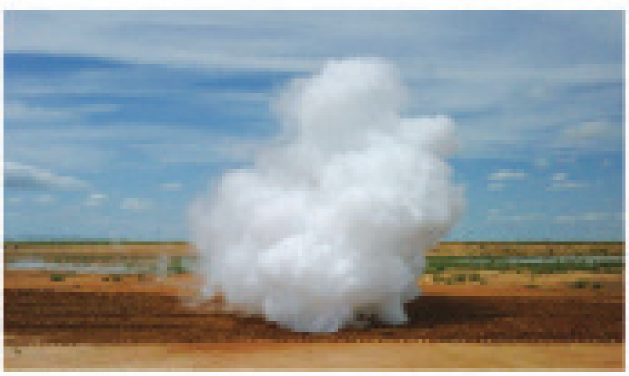
Petroleum on the ground

Fire or explosion

Mist or cloud of vapor

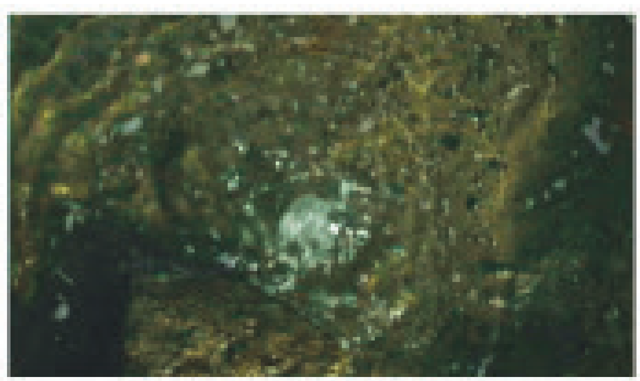


Dying vegetation on green corridor



CO2 vapor cloud

Sheen or film on water



Water bubbling or liquid standing in unusual areas

Fig. 6. Examples of possible pipeline leaks. (Images from the Nebraska Pipeline Association at http://nebraskapipeline.com/pipeline_safety/)

Table 2. Selected petroleum pipeline incidents and consequences.

Year	Location	Type	Consequences
1950	Newtown Creek, New York	Oil Tank, Refinery	Undetected until 1978, underground petroleum still discharging to Creek.
1954	Goldsboro, North Carolina	LP Gas Distribution Line	Leaking distribution line caused explosion that demolished 3 buildings, injured 15, and killed 5 people.
1958	Blue Creek, Idaho	Jet Fuel Pipeline	Jet fuel flowed from the ruptured pipeline into Blue Creek and ignited, destroying 6 bridges and damaging a home.
1962	Kansas City, Kansas	Natural Gas Transmission Line	Two pipelines ruptured, flowed for 10 minutes, and ignited; 11 houses were destroyed, 23 were damaged, and 1 person was injured.
1966	Norfolk, Nebraska	Natural Gas Transmission Line	A pipeline ruptured, interrupting service to 20,000 people in 10 communities.
1968	Yutan, Nebraska	LPG Pipeline	A pipeline ruptured, repair crews ignited the vapor, 5 repairmen were killed.
1976	Fremont, Nebraska	Natural Gas Distribution Line	A gas leak at the Pathfinder Hotel exploded, killing 23 people.
1978	Grand Island, Nebraska	Natural Gas Distribution Line	Gas from a polyethylene main migrated beneath a home, exploded and burned, damaging 3 homes, destroying 1, and injuring 1 person.
1979	Bemidji, Minnesota	Oil Pipeline	10,000 barrels of oil spilled from pipeline rupture onto land surface, site converted to National Crude Oil Spill Research Site, research ongoing.
1981	Yutan, Nebraska	LPG Pipeline	Hunters fired rifle at a pipeline thinking it was a log in a creek bed, several families were temporarily evacuated; there was no fire.
1985	Kaycee, Wyoming	Aircraft Turbine Fuel Pipeline	A weld on a pipeline failed during maintenance and ignited, destroying construction equipment, burning 6 people, and killing 1 person.
1988	Vienna, Missouri	Crude Oil Pipeline	A pipeline ruptured and spilled 20,500 barrels into the Gasconade River, a brewery was idle for 3 days with contaminated water.
1994	Waterloo, Iowa	Natural Gas Distribution Line	Leaking gas ignited, causing a building to explode, damaging adjacent buildings and autos, injuring 5 people and killing 6 people.
1999	Pleasant Hill, Iowa	Crude Oil Pipeline	A pipeline ruptured when struck by excavating equipment and released 3,700 barrels of crude oil.
2004	Blair, Nebraska	Anhydrous Ammonia Pipeline	Pipeline failed, releasing 193,213 pounds of ammonia, resulting in the hospitalization of one individual and emergency responders evacuated houses within a one-mile circumference of the break.
2004	Renton, Washington	Gasoline pipeline	Physical wear created pinhole leak, resulting in leak of thousands of gallons and fire, with firefighter injuries.
2006	Prudhoe Bay, Alaska	Oil Pipeline	6,500 barrels of oil spilled from 6mm hole in pipeline; BP pled guilty to negligence, conducted remediation and paid fine.
2010	Kalamazoo, Michigan	Crude Oil Pipeline	20,000 barrels of diluted bitumen spilled from rupture and flowed into Talmadge Creek, resulting in costly spill cleanup.
2011	Yellowstone River, Montana	Crude oil pipeline	1,500 barrels of oil spilled from pipeline damaged by high water, pipeline rebuilt below riverbeds at crossings.
2011	Nemaha County, Nebraska	Gasoline/Jet Fuel Pipeline	2,200 barrels of gasoline and jet fuel spilled when pipeline struck by excavator, dams and trenches prevented flow into surface water.
2014	Fremont, Nebraska	Natural Gas Transmission Line	A pipeline ruptured and burned in a corn field north of Fremont, Nebraska.
2015	Yellowstone River, Montana	Crude Oil Pipeline	950 barrels of oil spilled from pipeline into the Yellowstone River, temporarily contaminating the municipal water supply of Glendive, Montana.

Pipeline Spills and Leaks and Their Environmental and Human Impacts

Incidental or accidental releases of hydrocarbons are bound to occur, even though modern pipelines are safer in construction and have highly sophisticated integrated leak detection systems. There are also natural springs and seeps of hydrocarbons into the surface from subsurface hydrocarbon accumulations. The most well-known natural hydrocarbon seeps are the La Brea tar pits in Los Angeles, California, but there are many other examples of such seeps around the world. At the U.S. Environmental Protection Agency's 2004 Freshwater Spills Symposium, Dagmar Schmidt Etkin reported that natural releases of hydrocarbons are estimated to be nine times the volume of all human-caused releases.

Natural gas and refined products are highly flammable and leaks in pipelines that carry these products often result in explosion and fire. Natural gas contains a very high percentage of methane, a potent greenhouse gas that could contribute to global warming. Crude oil is much less flammable than natural gas. Consequently, oil pipeline leaks rarely cause loss of life, fires, or explosions but can impact the local environment to a greater extent than natural gas leaks. Oil pipelines move more oil with fewer incidents than any other form of transportation. When oil pipeline spills go undetected, a large spill can occur.

As pipeline technology has improved, the overall volume of oil spilled has declined significantly. An example is the 80% reduction in coastal and inland spillage between 1969 and 2007 reported by Dr. Etkin in her "Analysis of U.S. Oil Spillage" (2009). *Table 2* lists selected pipeline leaks and spills with a range of consequences that vary depending on the size of the leak and the type of product involved. As the table indicates, natural gas and refined product leaks tend to have a greater risk for structural damage and loss of life when compared with crude oil pipelines.

Crude oil and bitumen share common chemical *(Table 1)* and toxicological characteristics, and have their own set of public safety risks. They are mixtures of hydrocarbon compounds that range from smaller volatile compounds to larger nonvolatile compounds. Hydrocarbons are compounds whose chemistry consists primarily of carbon and hydrogen.

According to the Handbook of Oil Spill Science and Technology, the mixture of compounds can be highly variable depending on the geological formation in which it is found. Many of the compounds in crude oil are somewhat toxic depending on the compound and dosage.

Benzene (C_6H_6) is one of the lighter hydrocarbons that are carcinogenetic. Benzene is found in higher concentrations in lighter crude oil and refined products such as gasoline. Bitumen is a high viscosity crude oil with high density similar to the tar found in asphalt. According to U.S. Geological Survey researchers Richard F. Meyer and Emil D. Attanasi, bitumen is found at the margins of geologic basins and is thought to be the residue of formerly light oil that has lost its light-molecular-weight components through degradation by bacteria, water-washing, and evaporation.

Selected Case Studies

The following selected case studies of accidental releases of hydrocarbons from pipelines include a relatively large release of crude oil derived from Canadian tar sands and two smaller releases of lighter hydrocarbons.

Kalamazoo River Spill

In 2010, a 30-inch pipeline owned and operated by Enbridge Incorporated ruptured in a wetland near Marshall, Michigan. The rupture was not recognized or addressed for over 17 hours due to human error in interpreting monitoring equipment during a planned shutdown and subsequent restart procedure. An estimated 843,000 gallons (3.2 million liters) of diluted bitumen (dilbit) were released into the wetland, resulting in flow into Tallmadge Creek and the Kalamazoo River. Dilbit is bitumen mixed with a light hydrocarbon to facilitate its transportation by pipeline. Upon release in the stream, the light oil in the dilbit volatilized and the heavy bitumen sank to the streambed of the Kalamazoo River.

Although volumetrically small compared with other oil spills, the cleanup costs of $1 billion make it one of the most expensive spill cleanups in history. Initially there was public concern that dilbit might be more hazardous to transport by pipeline than conventional crude oil, implying that the corrosivity of dilbit may have played a role in causing the spill.

In 2012, a detailed study by the Battelle Memorial Institute, a nonprofit research firm, found that dilbit is no more corrosive than conventional crude oil and therefore did not present any additional risk for pipeline transport. Similarly, the National Transportation Safety Board (NTSB) spill investigation concluded that defects on the coating of the pipe and microbial corrosion on the exterior of the pipe resulted in the rupture. NTSB also found that improper follow-up from physical inspections (indicating corrosion), combined with misinterpretation of SCADA alarms during the shutdown/restart procedure, contributed to the severity of the spill.

Yellowstone River Spill

On January 17, 2015, the 12-inch (305 millimeter) Bridger Polar Pipeline ruptured and spilled about 30,000 gallons (115,000 liters) of light Bakken crude oil into the Yellowstone River upstream of Glendive, Montana. The rupture was detected by the SCADA monitoring system indicating a pressure drop in the 6,800-foot (2,072 meter) section of pipeline that extended under the river. The pipeline was shut down and the pipeline section isolated after the system alarm sounded, and the Montana Department of Environmental Quality was notified of a possible release. The river was ice-covered at the time of the spill, and physical signs of the spill were not discovered until the following day, when oil sheen was found on an area of open water a short distance downstream from the pipeline crossing.

During the incident response, prior inspection reports were reviewed in detail to determine if there was indication of any anomalies in that section of pipe. There were no anomalies apparent in the previous inspections, so the ruptured pipeline was removed and sent to a lab for analysis and metallurgical testing to help determine why the pipe failed. The municipal water supply plant in Glendive was shut down temporarily because customers complained of an odor in their tap water, and benzene was detected in the municipal supply. Since benzene is volatile, the ice on the river probably influenced the amount of the dissolved chemical that reached the municipal intakes, which are about 14 feet (4 meters) below the river surface. Slots were cut in the ice for oil capture and water testing. Water quality at the municipal intake was monitored daily, and permanent monitoring equipment was installed at the municipal supply facility. Contaminant levels dissipated quickly and the facility was back online within a week. Long-term remediation of the spill is ongoing.

Nemaha County, Nebraska Spill

On December 10, 2011, about 120,000 gallons (450,000 liters) of gasoline, diesel, and jet fuel spilled when a bulldozer struck 8- and 12-inch (203 and 305 millimeter) Magellan Midstream Partners' refined products pipelines in a terraced field about 0.3 miles (480 meters) from a small, unnamed tributary of Jarvis Creek in Nemaha County, Nebraska. The pipeline control room in Tulsa, Oklahoma, noticed a drop in pressure in the lines and began shut down procedures around the same time that the bulldozer operator was notifying local authorities. Two interception trenches and seven temporary dams were used to contain the spilled fuel. Surface water samples collected from the streams below the spill location did not contain detectable contamination.

The damaged pipeline was shut down, excavated, repaired, and placed back in service within three days. Testing showed that spilled fuel was absorbed by the soil at the site to depths up to 20 feet (6 meters). A few fish were killed in the immediate spill area, but additional impacts to wildlife were not noted. A long-term remediation plan was approved by the Nebraska Department of Environmental Quality in April of 2013, and long-term remediation of the spill continues.

Environmental Impacts

The environmental impacts of oil pipeline leaks tend to be areally limited because of the slow movement of groundwater and the physical and chemical properties of oil. Oil is immiscible in water and exists as a separate phase, which limits its flow through fine-grained sediments. Long-term studies of a crude oil spill near Bemidji, Minnesota, indicated that the crude oil spill, 290 thousand gallons (about 7,000 barrels, or 1.1 million liters), had limited migration [less than 300 feet (90 meters) in 25 years] that stabilized with time due to natural attenuation and biodegradation.

Although biodegradation and other reactions had transformed the hydrocarbons to less toxic compounds, a considerable volume of oil remained in the subsurface after 25 years in an area of less than 20 acres. Research at the Bemidji site continues and findings are kept up to date on the web at http://mn.water.usgs.gov/projects/bemidji/.

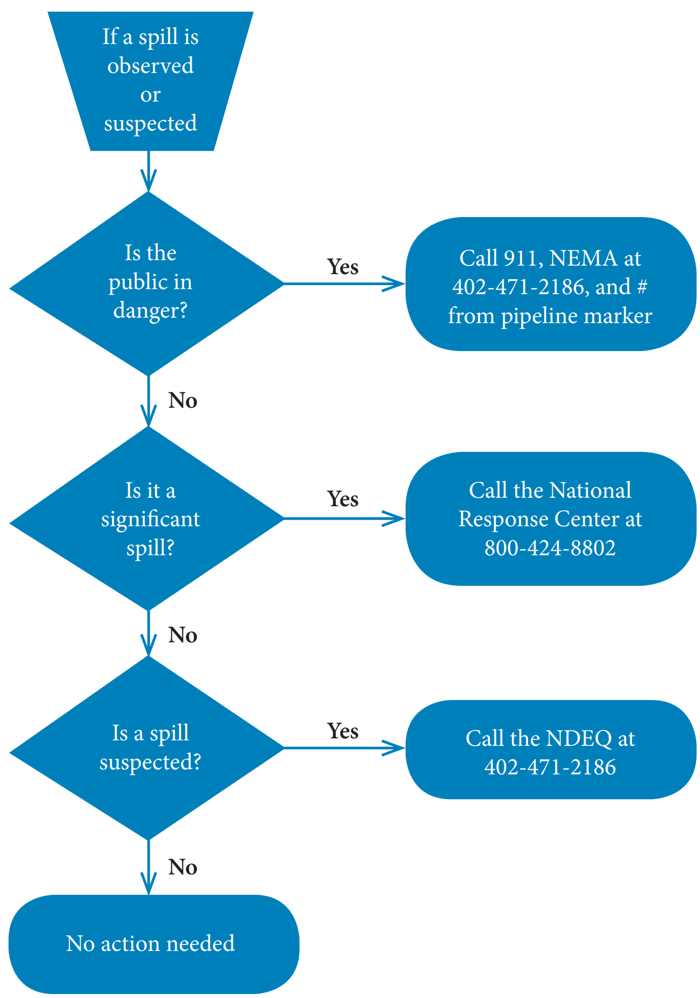


Fig. 7

In the cases of both the Bemidji and Kalamazoo spills, hydrocarbons tended to be trapped in the fine-grained sediments such as silt and clay. Since stream flow is much faster than groundwater flow, the immediate environmental impacts are greater with a spill onto surface water. Pipeline companies recognize these potential impacts and increase monitoring sensors and shut-off valves closer to stream crossings.

How to Deal With a Spill

The transportation of oil and natural gas will continue to be essential to the maintenance of our modern lifestyles. Therefore, it is important that we recognize the signs of pipeline spills and know what to do in case of an emergency to protect the public and the environment. There are many avenues to report a spill or leak. To help determine an appropriate number to contact, several are included in figure 7 on the previous page.

The first key is prevention; before digging, any homeowner or contractor involved in excavating should contact Nebraska811 at 811-331-5656 or www.ne1call.com. Even if only planting a tree or driving a T post, a homeowner could encounter a gas line or other utility. Major transmission and distribution lines are often marked with signs that show the approximate location and the name of the company with an emergency phone number.

In the event of a leak or spill, call the number on the marker as well as your local emergency number (911) to shut down the pipeline to minimize damaging impacts. The Nebraska Emergency Response Agency is the lead Nebraska agency for various emergency responses. The National Response Center, Environmental Protection Agency, and Nebraska Department of Environmental Quality (NDEQ) have various responsibilities relating to spill response and remediation, and may be useful contacts in some instances.

Selected Resources

NEBRASKA811, "KNOW WHAT'S **BELOW**, **CALL** BEFORE YOU DIG," http://www.ne1call.com/

Nebraska Pipeline Association, http://nebraskapipeline.com/home/

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Fact Sheet: Products Transported in Pipelines. PHMSA [Pipeline and Hazardous Materials Safety Administration]

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