

Appendix: Research Methods

From the PHMSA website, we downloaded the data files “Hazardous Liquid Accident Data - January 2010 to present (ZIP)” and “Hazardous Liquid Accident Data - January 2002 to December 2009 (ZIP)” [[link to both datasets](#)] on 9/26/18. Full analysis of this data was conducted using pandas in a jupyter notebook, available upon request.

The 2010-present dataset contained 3439 records, of which 52 represented biofuels or CO₂ spills, and were excluded. The remaining 3387 records were comprised of 1725 crude oil spills, 1125 refined petroleum product spills, and 537 HVL spills. The 2002-2009 dataset contained 3030 records, from which we excluded biofuels and CO₂ spills, and any records where the ‘SPILLED’ field was ‘NO.’ Of the remaining 2962 records, 1360 were crude oil spills, 1172 were refined petroleum products spills, and 419 were HVL spills.

Using the PHMSA operator database [[link](#)] and the incidents databases, we identified 28 subsidiaries or joint ventures that were associated with Enbridge. These entities were identified by:

- Searching the incident file for reports submitted via email from the domains enbridge.com or enbridge-us.com.
- Searching the operator database for operator names containing the word “Enbridge.”
- Cross-referencing lists of subsidiaries found in Form 10-K documents against the operator database.

The full list of hazardous liquids subsidiaries included in this report is as follows:

- **Enbridge Energy, Limited Partnership**. PHMSA Operator ID [11169](#). **173 hazardous liquids incidents** reported from 2002-present, all spills were reported from enbridge.com email addresses.
- **Enbridge Pipelines (Ozark) LLC**. Operator ID [31947](#). **39 incidents** reported from 2002-present, all spills were reported from enbridge.com email addresses.
- **North Dakota Pipeline Company LLC**. Operator ID [15774](#). **30 incidents** reported from 2002-present; 28 spills were reported from enbridge.com emails, two spills from enbridge-us.com emails. This company is a joint venture between Enbridge Energy Partners, L.P. and Williston Basin Pipe Line LLC.¹ As of the end of 2017, Enbridge owned 100% of the Class A units and 62.5% of the Class B units for this company.²
- **CCPS Transportation, LLC**. Operator ID [32080](#). **18 incidents** reported from 2002-present, all spills were reported from enbridge.com email addresses. This company is a subsidiary of Enbridge Inc.³ In 2003, Enbridge bought a 90% interest in the Cushing-to-Chicago Pipeline System (now known as the Spearhead Pipeline) and purchased a 100% interest in 2005.⁴ Enbridge reversed the flow of the pipeline so that it now transports Canadian crude from the Mainline System near Chicago south to Cushing, Oklahoma.
- **Olympic Pipeline Company**. Operator ID [30781](#). **8 incidents**. The Olympic Pipeline is a refined petroleum products pipeline in Washington State that is operated by BP. In December 2005, Enbridge acquired a 65% stake in the pipeline,⁵ which it sold in July 2017.⁶ For this analysis we only

¹ Bloomberg. Company Overview of North Dakota Pipeline Company LLC. [[link](#)]

² Enbridge Energy Partners L.P. 2017. Form 10-K. [[link](#)]

³ Bloomberg. Company Overview of CCPS Transportation, LLC. [[link](#)]

⁴ Enbridge. 2005. Enbridge Acquires 100% Interest in Spearhead Pipeline. [[link](#)]

⁵ BP. 2005. BP Partners with Enbridge Inc on Olympic Pipe Line Ownership. [[link](#)]

include 8 incidents between January 2006 and July 2017. All spills reported from bp.com email addresses.

- **Express Holdings (USA) LLC**. Operator ID [31720](#). **8 incidents** reported from 2002-present, all spills were reported from enbridge.com email addresses. The Express Pipeline transports crude oil from Canada to Casper, Wyoming.⁷ It was acquired by Enbridge in its merger with Spectra Energy Partners in 2017.⁸ For this analysis, we include 8 incidents that post-date the merger.
- **Mustang Pipe Line LLC**. Operator ID [31166](#). **4 incidents** reported from 2002-present. The Mustang Pipeline is a crude oil pipeline operated by Exxon Mobil that runs from outside Chicago south to Patoka, Illinois.⁹ Since at least 2003, Enbridge has held a 30% interest in this joint venture.¹⁰ Three incidents were reported from exxonmobil.com emails, and one incident reported from an enbridge.com email.
- **Enbridge Energy Marketing LLC**. Operator ID [31423](#). **3 incidents** reported from 2002-present, all spills were reported from enbridge.com email addresses. This ID is currently listed as inactive.
- **Enbridge Pipelines (Toledo) Inc.** Operator ID [31448](#). **4 incidents** reported from 2002-present, all spills were reported from enbridge.com email addresses.
- **Enbridge Pipelines (East Texas) LP**. Operator ID [31613](#). **2 incidents** reported from 2002-present, all spills were reported from enbridge.com email addresses.
- **Enbridge Pipelines (Louisiana Liquids) LLC**. Operator ID [31884](#). **2 incidents** reported from 2002-present, all spills were reported from enbridge.com email addresses. This ID is currently listed as inactive.
- **Enbridge Pipelines (Southern Lights) LLC**. Operator ID [32502](#). **1 incident** reported from 2002-present; spill reported from an enbridge.com email address.
- **Illinois Extension Pipeline Company LLC**. Operator ID [39347](#). **1 incident** reported from 2002-present; spill reported from an enbridge.com email address. IEPC is a joint venture with Marathon, in which Enbridge has 65% ownership. The entity operates the Southern Access Extension (SAX) pipeline from Flanagan to Patoka, Illinois.¹¹
- **Enbridge Storage (Patoka) LLC**. Operator ID 31948. No PHMSA operator page. **1 incident** reported from 2002-present; spill reported from an enbridge.com email address.
- **Enbridge Storage (Cushing) LLC**. Operator ID 39145. No PHMSA operator page. **13 incidents** reported from 2002-present, all spills were reported from enbridge.com email addresses.

As of February 2017, Enbridge owns a 27.6% interest in the Dakota Access Pipeline and the Energy Transfer Crude Oil Pipeline (together known as the Bakken Pipeline).¹² We do not include incidents from those pipelines in the totals for this report, but we did discuss them in depth in a recent report on the spill record of Energy Transfer Partners.¹³

⁶ Enbridge Energy Partners L.P. 2017. Form 10-K.

⁷ Spectra Energy Partners. Express Pipeline. [\[link\]](#)

⁸ Enbridge. Enbridge and Spectra Merger FAQs. [\[link\]](#)

⁹ Enbridge map

¹⁰ Enbridge. 2003. Enbridge to Acquire U.S. Crude Oil Pipeline and Storage Systems. [\[link\]](#); Enbridge. 2018. Enbridge's Energy Infrastructure Assets. [\[link\]](#)

¹¹ Enbridge Inc. 2017. Form 10-K. [\[link\]](#)

¹² Enbridge Inc. 2017. Form 10-K.

¹³ Donaghy, T. & D. Lisenby. 2018. *Oil and Water: ETP & Sunoco's History of Pipeline Spills*. Greenpeace USA & Waterkeeper Alliance, April. [\[link\]](#)

For each operator, PHMSA reports proposed, assessed and collected penalties dating back to 2006 (Federal Inspection and Enforcement Data page, “Enforcement Actions” tab, and “Detail” sub-tab). Summing over all the operator IDs identified above, find a total of \$6.6 million in assessed penalties.

The following entities were identified as subsidiaries of Enbridge, but reported zero hazardous liquids incidents in the 2002-2009 and 2010-present datasets.

- Enbridge Pipelines (Texas Gathering) LP. Operator ID [31425](#).
- Enbridge Offshore (Gas Gathering) LLC. Operator ID [31485](#).
- Enbridge Pipelines (NE Texas) LP. Operator ID [31614](#). This ID is currently listed as inactive.
- Enbridge Gathering (North Texas) LP. Operator ID [31943](#).
- Aux Sable Liquid Products. Operator ID [32094](#). Enbridge is a 42.7% owner of Aux Sable.¹⁴
- Enbridge Marketing (North Texas) LP. Operator ID [32101](#). This ID is currently listed as inactive.
- Enbridge Offshore Facilities. Operator ID [39354](#).
- Additionally there are six more gas transmission or gas gathering operator IDs associated with Enbridge that are currently listed as inactive by PHMSA (31722, 31615, 18646, 31616, 31944, 31322).

Mapping the Data

An interactive map of the Enbridge and Minnesota spill datasets was created in carto. The 2010-present PHMSA data is standardized with latitude and longitude expressed in decimal degrees. However, the 2002-2009 PHMSA data does not have a standard format for lon-lat data. Latitude and longitude were presented in a variety of formats, including D.d, DM.m and DMS. We converted all of these values to the standard D.d format. For a number of incidents, we changed the reported longitude from positive to negative values, under the assumption that the spills occurred in the western hemisphere. For 9 Enbridge spills, no latitude-longitude was reported, and for 1 additional Enbridge and 2 Minnesota spills, the data was reported in unknown formats. These incidents are not shown on the map.

For comparison purposes, we display U.S. liquids pipelines using shapefiles compiled by the U.S. Energy Information Agency (EIA) [[link](#)]. Where EIA identified Enbridge or one of their corporate entities as the pipeline operator we colored the pipeline red; all other pipelines are colored grey. The shapefiles used were ‘Crude Oil Pipelines’, ‘Petroleum Product Pipelines’ and ‘HGL (hydrocarbon gas liquids) Pipelines.’ EIA describes these files as being based on “publicly available data from a variety of sources with varying scales and levels of accuracy.” This EIA pipeline dataset is likely not a complete set of U.S. liquids pipelines and may not fully reflect Enbridge’s current or past pipeline assets.

For comparison, we include shapefiles from the U.S. Geological Survey showing streams and waterbodies [[link](#)], as well as the route for the existing Line 3 and the proposed Line 3 expansion, from public sources (shown in black).

¹⁴ Enbridge. 2006. Enbridge Announces Agreement Between Aux Sable and BP to Sell Natural Gas Liquids Production. [[link](#)]

Installation Year & Incident Cause

Miles of pipeline for decade installed is taken from PHMSA's annual report data [\[link\]](#). Each operator ID reports miles of pipe by decade installed in Part I. Figure 4 shows miles of pipeline for each decade summed over all the Enbridge hazardous liquids operator IDs identified above, and summed over three different commodity types (crude oil, refined petroleum products, and HVL).

For hazardous liquids incidents, both the 2002-2009 data and the 2010-present data provide information on the cause of the incident (CAUSE and CAUSE_DETAILS fields in the 2010-present data, and GEN_CAUSE_TXT and CAUSE_TXT fields in the 2002-2009 data), the item involved (ITEM_INVOLVED and FAIL_OC_TXT fields, respectively) and the installation year of the item involved (INSTALLATION_YEAR and PRTYR fields, respectively).

IEA's Energy Balance Tables

Figure 8 compares IEA's calculations of Total Primary Energy Demand for oil (TPED, line graphs) against Total Final Consumption for oil (TFC, stacked bar graphs), in different years and scenarios.¹⁵ Typically primary energy does not equal final consumption because some percentage of energy is lost in conversion. However IEA defines the categories it uses in its Energy Balance Tables so as to relate primary energy to final consumption. According to the IEA, TPED is defined as "power generation plus other energy sector excluding electricity and heat, plus total final consumption (TFC) excluding electricity and heat,"¹⁶ while the "Other Energy" sector "covers the use of energy by transformation industries and the energy losses in converting primary energy into a form that can be used in the final consuming sectors."¹⁷

Using these definitions and IEA's Energy Balance Tables, the "Other*" category plotted in Figure 8 includes not just TFC from oil (which includes non-energy uses, such as petrochemical feedstocks), but also power generation from oil (typically small), and "Other Energy" from oil, which includes energy losses. As a result, by incorporating energy losses, we plot final consumption of oil to balance primary energy from oil.

¹⁵ International Energy Agency. World Energy Outlook 2017. Annex A Tables for Scenarios Projections. United States: Current Policies and Sustainable Development Scenarios, p. 657.

¹⁶ International Energy Agency. World Energy Outlook 2017. Definitional note: A.2. Energy demand, electricity and CO2 emissions tables, p. 642.

¹⁷ International Energy Agency. World Energy Outlook 2017. Definitions, p. 746.