The UNIVERSITY of VERMONT

James M. Jeffords Center's
Vermont Legislative Research Service

Tar Sands Oil

Tar sands, also referred to as oil sands, are a mixture of bitumen, clay, water, and sand. Bitumen, an asphalt-like hydrocarbon that is black and viscous, can be extracted and processed to generate crude oil that can be further refined to develop asphalt, gasoline, and other products.[1] "The bitumen in tar sands cannot be pumped from the ground in its natural state; instead tar sand deposits are mined, usually using strip mining or open pit techniques, or the oil is extracted by underground heating with additional upgrading."[2]

The world's largest deposits of tar sands are in Canada, primarily in Alberta, and Venezuela, along with several Middle Eastern countries. In the United States, tar sands are mostly found in Utah. Canada currently is the only country to use tar sands on a large-scale commercial level with 40% of their oil production comprised of tar sands. With the demand and prices for crude oil rising, the tar sands industry has become "commercially attractive, and both government and industry are interested in pursuing the development of tar sands oil resources as an alternative to conventional oil."[3]

This report examines how tar sands oil is extracted and transported from Canada to the U.S., while focusing on their environmental impacts and safety concerns. We then look at the current progress of the Keystone XL Pipeline Project.

Extraction

When the deposit of tar sands is close to the surface, open pit mining techniques can be used for extraction. This method uses "large hydraulic and electrically powered shovels to dig up tar sands and load them into enormous trucks that can carry up to 320 tons of tar sands per load."[4]

---

[1] David Silawsky, "Fact Sheet: U.S. Tar Sands Potential," U.S. Department of Energy, February 17, 2011, accessed on February 4, 2013, http://fossil.energy.gov/programs/reserves/npr/Tar_Sands_Fact_Sheet.pdf.
[2] Bureau of Land Management, "About Tar Sands," U.S. Department of the Interior, accessed on February 4, 2013, http://ostseis.anl.gov/guide/tarsands/index.cfm.
[3] Bureau of Land Management, "About Tar Sands," U.S. Department of the Interior, accessed on February 4, 2013, http://ostseis.anl.gov/guide/tarsands/index.cfm.
[4] Bureau of Land Management, "About Tar Sands."

Once the tar sands are mined, they are transported to an extraction plant, put into separation cells and processed with hot water, and then agitated to separate the bitumen from the sand, water, and clay. From this point, the bitumen can be collected and eventually processed into synthetic crude oil.[5]

If the deposits are too deep for mining, in situ methods are used for recovery. This process involves steam injection, which heats the bitumen making it less viscous and easier to retrieve.[6] This method generally reduces land disturbance and water consumption.[7]

Environmental Effects of Extraction

There are various manners in which the technologies, mining, and processing of tar sands impact the environment: global warming, greenhouse gas emissions, disturbance of mined land, impacts on wildlife, and air and water quality.[8] A significant amount of water is required in extraction and production and this could affect regional water supplies along with the release of treated water.[9] Mining and surface methods of extraction cause considerable land disturbance. In Alberta, Canada, "about two tons of oil sands must be mined, moved and processed to produce one barrel of synthetic crude oil (SCO)," along with two to 5.4 barrels of water "are required to produce one barrel of SCO."[10] Further detail can be found in the 2012 Oil Shale and Tar Sands Programmatic Environmental Impact Statement, prepared by the Bureau of Land Management.[11]

Transportation of Tar Sands

After extraction, bitumen must be treated with diluents to reduce viscosity and make it transportable by pipeline. Diluted bitumen is commonly referred to as dilbit.[12] Tar sands crude oil, or dilbit, is transported in the same manner of other crude oils through a vast underground pipeline system that extends across international borders and throughout the United States.

---

[5] Bureau of Land Management, "About Tar Sands."

[6] Joule Bergonson et al, "Life Cycle Greenhouse Gas Emissions of Current Oil Sands Technologies: Surface Mining and In Situ Applications," *Environmental Science and Technology* 46 (2012): 7865-7874, accessed on February 8, 2013, http://www.iseee2.ca/projects/lcaost/sites/default/files/pdf/LC-GHG-Emissions-Current-Oil-Sands-Technologies-Surface-Mining-and-In-Situ-Applications.pdf.

[7] Utah Heavy Oil Program, " A Technical, Economic, and Legal Assessment of North American Heavy Oil, Oils Sands, and Oil Shale Resources," the University of Utah, September 2007, accessed on February 11, 2013, http://www.fossil.energy.gov/programs/oilgas/publications/oilshale/HeavyOilLowRes.pdf, p. 7.1.

[8] Bureau of Land Management, "About Tar Sands."

[9] David Silawsky, "Fact Sheet: U.S. Tar Sands Potential."

[10] Utah Heavy Oil Program, " A Technical, Economic, and Legal Assessment of North American Heavy Oil, Oils Sands, and Oil Shale Resources," p. 7.1.

[11] Bureau of Land Management, " Proposed Land Use Plan Amendments for Allocation of Oil Shale and Tar Sands Resources on Lands Administered by the Bureau of Land Management in Colorado, Utah, and Wyoming and Final Programmatic Environmental Impact Statement," November 2012, accessed on February 6, 2013, http://ostseis.anl.gov/documents/peis2012/index.cfm.

[12] US Department of State, "Final EIS Keystone XL Project," August 26, 2011, accessed February 2, 2013, http://keystonepipeline-xl.state.gov/archive/dos_docs/feis/vol1/index.htm, p. ES-2.

The US energy transportation grid includes 175,000 miles of pipelines that transport hazardous liquid in the form of crude oil or refined oil products.[13] The Pipeline and Hazardous Materials Safety Administration (PHMSA), a regulatory arm of the US Department of Transportation, oversees all pipelines including those that transport tar sands crude oil. The PHMSA established regulatory requirements for the "construction, operation, maintenance, monitoring, inspection, and repair of hazardous liquid pipeline systems."[14]

Oil Spills

According to the US Department of State's (DOS) Final Environmental Impact Statement (EIS), "spills are likely to occur during operation over the lifetime of the proposed [Keystone] Project."[15] There have been 14 recorded oil spills along the existing Keystone pipeline since operation began in June 2010. "Of those spills, 7 were 10 gallons or less, 4 were 100 gallons or less, 2 were between 400 and 500 gallons, and 1 was 21,000 gallons."[16] The largest of these spills, which released 21,000 gallons of oil in total, occurred on May 7, 2011 at the Ludden, North Dakota pump station.[17] The PHMSA issued TransCanada a Corrective Action Order on June 3, 2011, after finding this failure to be of particular concern. The PHMSA Assistant Administrator of Pipeline Safety explains in their notification letter to TransCanada:

> The proximity of the pipeline to populated areas, water bodies, public roadways and high consequence areas, the hazardous nature of the product the pipeline transports, the ongoing investigation to determine the cause of the failures, and the potential for the conditions causing the failures to be present elsewhere on the pipeline… a failure to issue this Order expeditiously to require immediate corrective action would result in likely serious harm to life, property, and the environment.[18]

The Final EIS posits that "weather, time of year, water level, soil, local wildlife, and human activity" at the time of a spill would determine impact, and the extent of any damage would depend on "the response time and capabilities of the emergency response team."[19] Additionally, the FEIS notes that a spill in environmentally sensitive areas would be of great concern. These areas include:

- wetlands,

---

[13] Pipeline & Hazardous Materials Safety Administration, "Pipeline Basics," US Department of Transportation, accessed February 8, 2013, http://primis.phmsa.dot.gov/comm/PipelineBasics.htm?nocache=6098.
[14] US Department of State, "Final EIS Keystone XL Project," August 26, 2011, accessed February 2, 2013, http://keystonepipeline-xl.state.gov/archive/dos_docs/feis/vol1/index.htm, p. ES-6.
[15] US Department of State, "Final EIS Keystone XL Project," p. ES-8.
[16] US Department of State, "Final Environmental Impact Statement: Keystone XL Project," August 26, 2011, accessed February 25, 2013, http://keystonepipeline-xl.state.gov/documents/organization/182010.pdf, p. ES-8.
[17] US Department of State, "Final EIS Keystone XL Project," p. ES-8.
[18] Jeffrey D. Wiese, "Corrective Action Order," U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration Office of Pipeline Safety, June 3, 2011, accessed on February 2, 2013, http://primis.phmsa.dot.gov/comm/reports/enforce/documents/320115006H/320115006H_CAO_06032011.pdf, p. 3.
[19] US Department of State, "Final EIS Keystone XL Project," p. ES-8.

- flowing streams and rivers,
- shallow groundwater areas,
- areas near water intakes for drinking water or for commercial/industrial uses,
- and, areas with populations of sensitive wildlife or plant species.[20]

In 2010, the largest tar sands crude oil spill took place in Marshall, Michigan along a pipeline owned by Enbridge Energy Partners. It was first estimated to have spilled 800,000 gallons of dilbit into a tributary along the Kalamazoo River.[21] As of November 12, 2012, however, 1,149,120 gallons of oil have been collected along the river and 180,205 cubic yards soil/debris have been disposed.[22] Because tar sands crude oil are much heavier than other forms of crude oil, the spill clean up has proven particularly arduous and is expected to take two more years to complete. After the spill, nearly 40 miles of the Kalamazoo River were closed to the public and it "resulted in over 220 areas of moderate-to-heavy contamination, including over 200 acres of submerged oil on the river bottom and over 300 solidified oil deposits."[23] Toxic diluents, such as the hazardous chemical benzene, are added to bitumen and pose serious health risks if released into the environment, particularly given the levels of toxicity released in the event of a spill are often unknown and not immediately detected.[24]

In response to public health concerns, the Michigan Department of Community Health, Calhoun County Public Health Department, and the Kalamazoo County Health and Community Services Department collaborated in developing a public health surveillance system to "describe the magnitude and distribution of human health impacts due to exposure to the spilled oil."[25] The researchers found that between July 26 and September 4, 2010, 147 health care visits by individuals living near the affected waterways or working on the pipeline, were reported by health care providers, one-third of whom where found to have medical outcomes classified as minor, and two-thirds of whom were found to have medical outcomes classified as moderate.[26] However, a year after the Kalamazoo River oil spill, the Final EIS states, "[Tar sands crude oil] spills are not likely to have toxic effects on the general public because of the many restrictions that local, state and federal agencies impose to avoid environmental exposure after a spill."[27]

The Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011 (P.L. 112-90, enacted January 16, 2012) requires the Secretary of Transportation to "conduct an analysis to determine whether there is any increased risk of a release for pipeline facilities transporting [tar sands

[20] US Department of State, "Final EIS Keystone XL Project," p. ES-8.
[21] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues," Congressional Research Service, January 24, 2013, accessed on February 8, 2013, http://www.fas.org/sgp/crs/misc/R41668.pdf, p. 30.
[22] US Environmental Protection Agency, "EPA's Response to the Enbridge Oil Spill," accessed February 8, 2013, http://www.epa.gov/enbridgespill/index.html.
[23] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues," p. 31.
[24] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues," p. 31.
[25] Stanbury et al, "Acute Health Effects of the Enbridge Oil Spill," Michigan Department of Health, November 2010, http://www.battlecreekenquirer.com/assets/pdf/A5167647127.PDF.
[26] Stanbury et al, "Acute Health Effects of the Enbridge Oil Spill," p. 6-7.
[27] US Department of State, "Final EIS Keystone XL Project," p. ES-10.

crude oil].”[28] The PHMSA responded by contracting the National Academy of Sciences to carry out a complete, independent study of these concerns and should release their findings in the coming months.[29]

Keystone XL Pipeline Project

“In September 2008, TransCanada (a Canadian company) applied to the U.S. Department of State for a permit to cross the U.S.-Canada international border with the Keystone XL pipeline project.”[30] As seen in Figure 1, the pipeline project would consist of two extensions, the Keystone XL and the Gulf Coast Project, of the already existing Keystone pipeline, which currently delivers oil across the U.S.-Canada border from Alberta to refineries in Oklahoma and Illinois. Currently, the existing Keystone pipeline has the capacity to deliver 591,000 bpd. With both extensions, TransCanada anticipates a total capacity of 1.3 million bpd; however, this pipeline proposal was denied by the U.S. Department of State due to a section of the Nebraska route as indicated in Figure 1. Nonetheless, TransCanada announced on February 27, 2012, that it would continue with the development of the Gulf Coast Project, since that extension does not cross international borders, and therefore does not require a Presidential Permit.[31]

Figure 1: The TransCanada Keystone Pipeline System: Keystone and Keystone XL
Source: Paul W. Parfomak et al., “Keystone XL Pipeline Project: Key Issues,” Congressional Research Service, January 24, 2013, accessed on February 8, 2013, http://www.fas.org/sgp/crs/misc/R41668.pdf, p. 4.

[28] Paul W. Parfomak et al., “Keystone XL Pipeline Project: Key Issues,” p. 31.
[29] Paul W. Parfomak et al., “Keystone XL Pipeline Project: Key Issues.”
[30] Paul W. Parfomak et al., “Keystone XL Pipeline Project: Key Issues,” p. 1.
[31] Paul W. Parfomak et al., “Keystone XL Pipeline Project: Key Issues.”

Gulf Coast Project

As seen in Figure 1, the proposed pipeline extension labeled "Gulf Coast Project" would continue the flow of crude oil from Cushing, OK into Nederland and Houston, TX. The Gulf Coast Project, anticipated to be in service by mid-to-late 2013, will require the construction of 435 miles of 36-inch pipeline, as well as a receipt facility in Cushing and delivery facilities in both Cushing and Nederland.[32]

Keystone XL

On May 4th, 2012, "TransCanada reapplied to the U.S. Department of State for a Presidential Permit to build the Keystone XL pipeline."[33] Similar to the first proposal, this proposed pipeline extension, labeled "Keystone XL" in Figure 1, would run through Montana, South Dakota, and Nebraska connecting to the already existing Keystone Cushing Pipeline in Steele City, NE. The Keystone XL Project will require the construction of 1,179 miles of 36-inch pipeline, as well as receipt facilities in Baker, MT, and is expected to be in service by late 2015. The total project cost for the pipeline was originally estimated to be $5.3 billion for the United States portion. However, with the new route in Nebraska, projects costs are expected to be even higher.[34]

Bakken Marketlink

Currently, crude shale oil is produced in two U.S. states: North Dakota and Montana. Shale oil is oil embedded in shale rock, making extraction particularly expensive. With minimal production, transportation of shale oil to refineries has been limited to rail and truck. In March 2012, Bakken productions exceeded 500,000 bpd due to new rock fracturing technology, calling the need for a more economical way of transporting the crude oil. With receipt facilities built in Baker, MT, the Keystone XL pipeline will be able to deliver approximately 150,000 bpd of Bakken shale crude oil to Gulf Coast refineries. This project with TransCanada aids in meeting the anticipated quota of 1.3 million bpd and assists in the investment and support for Bakken shale oil production.[35]

Montana

"Montana requires a certificate from the state's Department of Environmental Quality (DEQ)" in order for the construction of oil pipelines to run through the state. [36] On December 22, 2008, TransCanada submitted an application for approval of the Keystone XL pipeline project to Montana's DEQ. On March 30, 2012, the DEQ issued a certificate of Compliance for the pipeline

[32] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues," p. 4.
[33] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues."
[34] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues."
[35] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues."
[36] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues," p. 15.

project.[37]

South Dakota

South Dakota requires a permit to be issued from the state Public Utility Commission (PUC) in order for the construction of oil pipelines to run through the state.[38] On March 12 2009, TransCanada applied for a permit to South Dakota's PUC for the construction of the Keystone XL pipeline. In February 2010, the PUC granted TransCanada the permit, and in June 2010, the PUC released their Amended Final Decision and Order.[39]

Nebraska

The original 2008 proposal was denied because the Keystone XL route would cross over the Sand Hills and Ogallala Aquifer in Nebraska.

> The Sand Hills region is a 19,600 square mile sand dune formation stabilized by native grasslands that cover 95% of its surface. The surface is highly susceptible to wind erosion if the grassland is disturbed. Below its surface lie hundreds of feet of coarse sand and gravel. Essentially, the porous soil acts like a giant sponge that quickly absorbs precipitation, allowing very little to run off. In some areas, the water table reaches the land surface—a characteristic that creates lakes that dot the region as well as 1.3 million acres of wetlands. The loose, porous soil and sensitivity to wind erosion have been factors contributing to a lack of development on the Sand Hills. As a result, the region contains the most intact natural habitat of the Great Plains of the United States. The porosity of the soil is also relevant because the Sand Hills sits atop the Ogallala Aquifer—one of the largest freshwater aquifer systems in the world.[40]

With such porous soil in the Sand Hills, any oil spill on the surface water can easily enter the aquifer contaminating it drastically. The Ogallala Aquifer accounts for "78% of the regions public water, 83% of irrigation water in Nebraska and 30% of water used in the United State for irrigation and agriculture."[41] Figure 2 represents the revised route TransCanada submitted to the Nebraska Department of Environmental Quality on September 5, 2012. This alternate route for the Keystone XL pipeline completely avoids the Sand Hills, but still crosses part of the Ogallala Aquifer. On January 22, 2013, the Governor of Nebraska approved the revised route through the state.[42]

---

[37] Montana Department of Environmental Quality, "In the Matter of the Application of TransCanada Keystone Pipeline, LP (Keystone) for a Certificate of Compliance under the Major Facility Siting Act," March 30, 2012, accessed on February 15, 2013, http://deq.mt.gov/mfs/keystonexl/keystonecertificate.mcpx.
[38] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues."
[39] Public Utilities Commission of the State of South Dakota, *Amended Final Decision and Order*, HP09-001, June 29, 2010, http://puc.sd.gov/commission/orders/hydrocarbonpipeline/2010/hp09-001c.pdf.
[40] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues," p. 18-19.
[41] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues," p. 19.
[42] Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues."

Figure 2: Keystone XL Preferred Alternative Route in Nebraska
Source: Paul W. Parfomak et al., "Keystone XL Pipeline Project: Key Issues," Congressional Research Service, January 24, 2013, accessed on February 8, 2013, http://www.fas.org/sgp/crs/misc/R41668.pdf, p. 20.

Vermont

Vermont's Act 250 was established in 1970 to monitor and review "environmental, social and fiscal consequences of major subdivisions and development in Vermont through issuance of land permits."[43] On January 25, 2013, Senate Bill 58 (S.58) was introduced to the Committee on Natural Resources and Energy, seeking to amend Act 250. S.58 would "require an Act 250 permit for a new oil pipeline or for an existing oil pipeline if a physical change is made to the existing pipeline that is not solely for the purpose of repair."[44] S.58 is in its 3rd reading in the Senate.[45]

[43] State of Vermont, "Permit and License Information: Act 250," October 2010, accessed on March 25, 2013, http://www.anr.state.vt.us/dec/permit_hb/sheet47.pdf, p. 1.
[44] Vermont Legislative, *"S.58; An Act Relating to Act 250 and Oil Pipelines,"* access on March 25, 2013, http://www.leg.state.vt.us/docs/2014/bills/Intro/S-058.pdf, p. 1.
[45] The Vermont Legislative Bill Tracking System, "S.58," accessed on March 25, 2013, http://www.leg.state.vt.us/database/status/summary.cfm?Bill=S.0058.

Currently, Vermont's liquid pipelines do not transport tar sands crude oil. The Portland Pipeline Corporation (PPC), a subsidiary of The Portland-Montreal Pipe Line Corporation (PMPL), "operates all 175 miles of hazardous liquid pipelines in Vermont, 117 of which are in service. The remaining pipelines are retired."[46] The pipeline in service cuts through the Northeast corner of Vermont, carrying crude oil from Portland, Maine to Montreal, Canada for refinement.[47] In a December 2012 statement posted on the PMPL website, the company responds to concerns over the possibility of transporting tar sands from Alberta, Canada through their pipelines to Portland, Maine. Doing so would require PMPL to reverse the flow of the pipeline used for that purpose. The company affirms that "while [they] do not have an active project to reverse the flow in either of [their] pipelines, if there is a demand for doing so in the future, [they] will consider it."[48]

When examining alternative routes for the Keystone XL pipeline, the proposed Enbridge Trailbreaker Project was considered. The proposed pipeline would have used the Northeast pipeline owned by PMPL that cuts through the Northeast Kingdom of Vermont. A lack of "firm volume commitments" to proceed left the project dormant, and in 2010 Enbridge made the decision to let go of the proposal. Therefore, this route was not further discussed as an alternative to the current Keystone XL proposed route.[49]

Conclusion

Bitumen, a hydrocarbon that can be extracted from tar sands, can be processed to generate crude oil. Depending on depth and viscosity, either mining or in situ methods can be used to extract tar sands. Tar sands extraction and processing into crude oil can affect the environment in several ways including land disturbance, greenhouse gas emissions, and water and air quality.

Tar sands oil is transported through pipeline routes, however, oil spills around fittings and valves have been common. The density of bitumen makes the risk of oil spills of particular concern. The Enbridge spill in 2010 provided a glimpse of the challenges transportation poses on the health of both people and the environment in affected communities. Despite strong pipeline regulations, the Department of State admits that spills will likely occur along oil pipelines, including the proposed Keystone XL Pipeline.

In May 2012, TransCanada reapplied for a Presidential Permit for the Keystone XL Project after the U.S. Department of State denied their 2008 proposal. After Nebraska's Governor and the

[46] Jason Kleps, GIS Analyst, National Pipeline Mapping System, e-mail correspondence, February 27, 2013.
[47] Molly Walsh, "A Vermont Pipeline intersects tar sands debate," Burlington Free Press, February 24, 2013, http://www.burlingtonfreepress.com/article/20130224/GREEN01/302240001/A-Vermont-pipeline-intersects-tar-sands-debate.
[48] Portland-Maine Pipe Line, "Current Events," December 2012, accessed on February 25, 2013, http://www.pmpl.com/current_events.php.
[49] US Department of State, "Final EIS Keystone XL Project," pp. 4-32.

state approved the revised route submitted by TransCanada, all states in which the Keystone XL extension would pass through approved the pipeline in their respective state committees. With new shale rock fracturing technology, Bakken shale oil producers have partnered with TransCanada to allow approximately 150,000 bpd of their oil be transported through the Keystone XL pipeline, expanding domestic oil markets.

Although there is no project currently in motion, the potential to have tar sands crude oil transported through Vermont has been discussed.

This report was completed on April 22, 2013 by Jon-Paul Scordio, Carolina Resende and Tess Knowles-Thompson, under the supervision of Assistant Director Kate Fournier and Professor Anthony Gierzynski in response to a request from Representative David Deen.

Contact: Professor Anthony Gierzynski, 513 Old Mill, The University of Vermont, Burlington, VT 05405, phone 802-656-7973, email agierzyn@uvm.edu.