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The Dilbit Disaster: Inside The Biggest Oil Spill You've Never Heard Of, Part 1

A black goo stopped just 10 feet from the metal cap that marked his drinking water well. Walking on the tarry mess was like stepping on chewing gum.

By Elizabeth McGowan and Lisa Song, InsideClimate News

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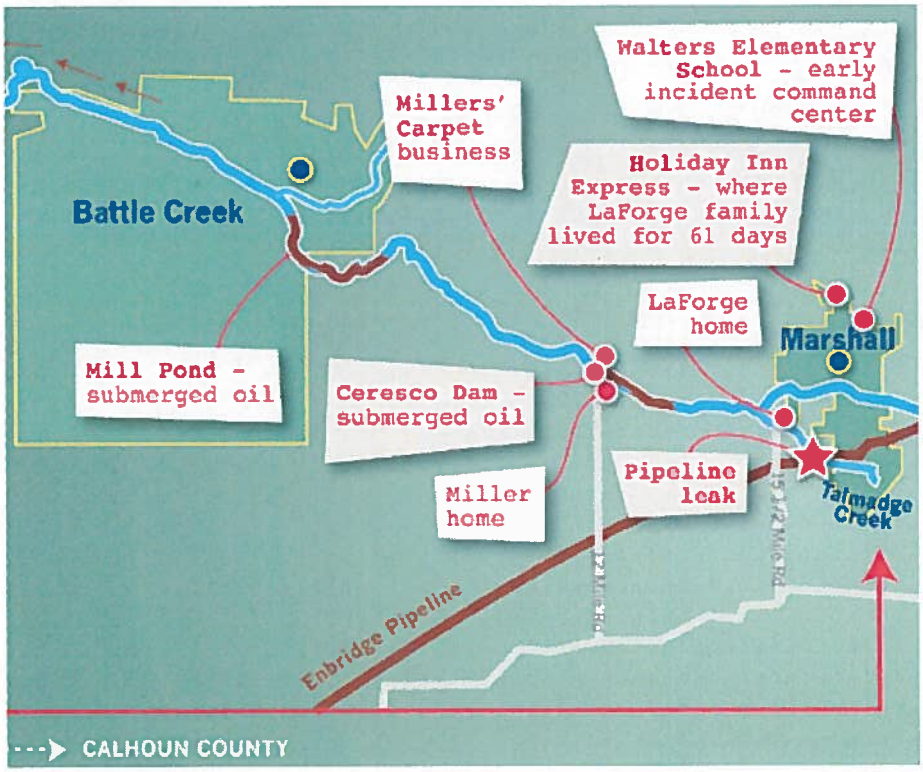


On Sunday, July 25, 2010, Enbridge Line 6B ruptured near Marshall, Mich. and released more than one million gallons of Canadian diluted bitumen into Talmadge Creek and the Kalamazoo River. Illustration by Catherine Mann for InsideClimate News. View the full map on page 2 of this story.

MARSHALL, Mich.—An acrid stench had already enveloped John LaForge's five-bedroom house when he opened the door just after 6 a.m. on July 26, 2010. By the time the building contractor hurried the few feet to the refuge of his Dodge Ram pickup, his throat was stinging and his head was throbbing.

LaForge was at work excavating a basement when his wife called a couple of hours later. The odor had become even more sickening, Lorraine told him. And a fire truck was parked in front of their house, where Talmadge Creek rippled toward the Kalamazoo River.

LaForge headed home. By the time he arrived, the stink was so intense that he could barely keep his breakfast down.

Something else was wrong, too.

Water from the usually tame creek had inundated his yard, the way it often did after heavy rains. But this time a black goo coated swaths of his golf course-green grass. It stopped just 10 feet from the metal cap that marked his drinking water well. Walking on the tarry mess was like stepping on chewing gum.

LaForge said he was stooped over the creek, looking for the source of the gunk, when two men in a white truck marked Enbridge pulled up just before 10 a.m. One rushed to LaForge's open front door and disappeared inside with an air-monitoring instrument.

The man emerged less than a minute later, and uttered the words that still haunt LaForge today: It's not safe to be here. You're going to have to leave your house. Now.

John and Lorraine LaForge, their grown daughter and one of the three grandchildren living with them at the time piled into the pickup and their minivan as fast as they could, given Lorraine's health problems. They didn't pause to grab toys for the baby or extra clothes for the two children at preschool. They didn't even lock up the house.

Within a half hour, they had checked into two rooms at a Holiday Inn Express, which the family of six would call home for the next 61 days.

Their lives had been turned upside down by the first major spill of Canadian diluted bitumen [1] in a U.S. river. Diluted bitumen is the same type of oil that could someday be carried by the much-debated Keystone XL pipeline [2]. If that project is approved, the section that runs through Nebraska will cross the Ogallala aquifer, which supplies drinking water for eight states as well as 30 percent of the nation's irrigation water.

"People don't realize how your life can change overnight," LaForge told an InsideClimate News reporter as they drove slowly past his empty house in November 2011. "It has been devastating."

* * * *

The spill happened in Marshall, a community of 7,400 in southwestern Michigan. At least 1 million gallons of oil blackened more than two miles of Talmadge Creek and almost 36 miles of the Kalamazoo River, and oil is still showing up 23 months later, as the cleanup continues. About 150 families have been permanently relocated and most of the tainted stretch of river between Marshall and Kalamazoo remained closed to the public until June 21 [3].

The accident was triggered by a six-and-a-half foot tear in 6B, a 30-inch carbon steel pipeline operated by Enbridge Energy Partners, the U.S. branch of Enbridge Inc., Canada's largest transporter of crude oil. With Enbridge's costs already totaling more than $765 million [4], it is the most expensive oil pipeline spill since the U.S. government began keeping records in 1968. An independent federal agency, the National Transportation Safety Board, is investigating the accident [5], and the U.S. Environmental Protection Agency has launched criminal and civil probes.

Despite the scope of the damage, the Enbridge spill hasn't attracted much national attention, perhaps because it occurred just 10 days after oil stopped spewing from BP's Macondo well in the Gulf of Mexico, which had ruptured three months earlier. Early reports about the Enbridge spill also downplayed its seriousness. Just about everybody, including the EPA officials who rushed to Marshall, expected the mess to be cleaned up in a couple of months.

What the EPA didn't know then, however, was that 6B was carrying bitumen, the dirtiest, stickiest oil on the market.

Bitumen is so thick—about the consistency of peanut butter—that it doesn't flow from a well like the crude oil found in most of the nation's pipelines. Instead the tarry resin is either steamed or strip-mined from sandy soil. Then it is thinned with large quantities of liquid chemicals so it can be pumped through pipelines. These diluents usually include benzene, a known human carcinogen. At this point it becomes diluted bitumen, or dilbit.

Some environmental organizations say dilbit is so acidic and abrasive that it's more likely to corrode and weaken pipes than conventional oil. The oil industry disputes that hypothesis. It says dilbit is no different from conventional crude.

No independent scientific research has been done to determine who is right. But a seven-month investigation of the Enbridge spill by InsideClimate News has revealed one fact neither side disputes: The cleanup of the Kalamazoo River dilbit spill was unlike any cleanup the EPA had ever tackled before.

Instead of remaining on top of the water, as most conventional crude oil does, the bitumen gradually sank to the river's bottom, where normal cleanup techniques and equipment were of little use. Meanwhile, the benzene and other chemicals that had been added to liquefy the bitumen evaporated into the air.

InsideClimate News also learned that federal and local officials didn't discover until more than a week after the spill that 6B was carrying dilbit, not conventional oil. Federal regulations do not require pipeline operators to disclose that information. And Enbridge officials did not volunteer it.

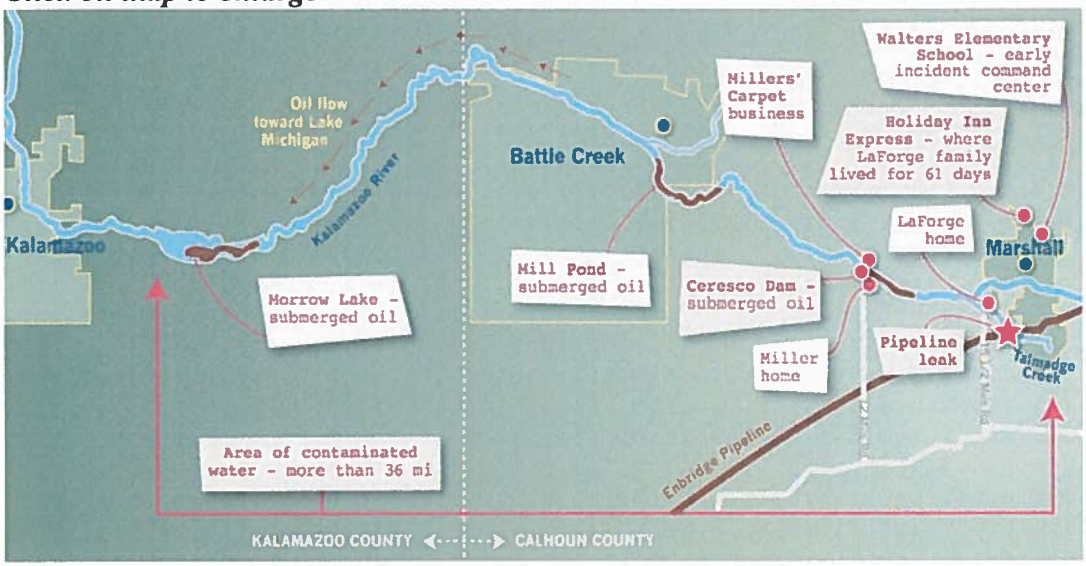
Mark Durno, an EPA deputy incident commander who is still involved in the cleanup in Marshall, is among those who were surprised by what they found.

"Submerged oil is what makes this thing more unique than even the Gulf of Mexico situation," Durno told InsideClimate News. "Yes, that was huge—but they knew the beast they were dealing with. This experience was brand new for us. It would have been brand new for anyone in the United States."

Jim Rutherford, the public health officer for Michigan's Calhoun County, said he had "no idea what I was driving into," when he rushed to Marshall the day 6B ruptured.

"Enbridge was caught off guard initially, much like all of us were," Rutherford said in an interview. "We just weren't ready for anything of this magnitude. ... We didn't even know the nature of the type of crude."

Click on map to enlarge



[6]

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Pipeline 6B was built in 1969 and is 293 miles long. It is part of Enbridge's 1,900-mile Lakehead system, which transports Canadian oil to major refining centers in the Great Lakes region, the Midwest and Ontario.

In 1999 Enbridge was among the first pipeline operators to bring Canadian dilbit into the United States. Every day, more than 11.3 million gallons of Canadian oil is transferred to 6B at Enbridge's terminal in Griffith, Ind., and pumped across southern Michigan, to Sarnia, in the province of Ontario, Canada. From Sarnia, it is transferred to lines that connect to refineries near Detroit and surrounding markets. On the day of the spill, 6B was moving a mixture of two types of dilbit—about one-quarter Western Canadian Select and three-quarters Cold Lake.

[7]

The federal agency responsible for regulating interstate pipelines is the Pipeline and Hazardous Materials Safety Administration [8] (PHMSA), a perennially underfunded and understaffed division [9] of the U.S. Department of Transportation. For the most part the agency relies on pipeline operators to monitor their pipelines and self-report any problems. One of the biggest concerns is corrosion, which can lead to spills or leaks if the corroded areas aren't patched or replaced.

When corrosion rises above a certain threshold, PHMSA requires that it be repaired within 180 days. But the rules are flexible, and companies can easily negotiate for more time.

Records show that 6B had a history of corrosion problems.

In 2008, Enbridge identified [10] 140 corrosion defects on 6B as serious enough to fall into the 180-day category. But the company repaired just 26 of them during that period.

In 2009, Enbridge self-reported a separate set of 250 defects [11] to PHMSA. The company fixed only 35 of them within 180 days.

Instead of immediately addressing the 329 defects that now remained, Enbridge got a one-year extension [12] from PHMSA by exercising its legal option to reduce pumping pressure on 6B while it decided whether to repair or replace the line.

A defect on 6B near John LaForge's house, where the pipeline eventually ruptured, didn't appear on any of the 180-day repair lists.

That defect, at mile marker 608, was detected at least three times [13] before the pipeline ruptured, in 2005, 2007 and 2009, according to documents Enbridge filed with PHMSA over the years. But each time, Enbridge decided it wasn't significant enough to require repairs within 180 days.

Ten days before 6B ruptured, Enbridge applied to PHMSA [14] for another extension. It asked for an additional two and a half years to decide whether 6B should be repaired or replaced.

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On the same day Enbridge applied for that extension, Richard Adams, the company's vice president of U.S. operations, assured a congressional subcommittee on pipeline safety that Enbridge was well prepared for an emergency.

"Our response time from our control center can be almost instantaneous, and our large leaks are typically detected by our control center personnel," Adams told the lawmakers. "They can view that there is a change in the operating system, and there are provisions that, if there is uncertainty, they have to shut down within a period of time, and that would include the closing of automatic valves."

The emergency response plan the company keeps on file with PHMSA is more specific. It says [15] a rupture on the Lakehead system would be detected within five minutes and the damaged segment closed in three minutes.

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The real-world test of Enbridge's emergency plan began at 5:57 p.m. Eastern Daylight Time on July 25, 2010, about the time the LaForge family was eating Sunday dinner. In a control room 1,500 miles away in Edmonton, Alberta, Enbridge was stopping the pumps on 6B as part of a scheduled, 10-hour

shutdown. The company was waiting for more oil to fill storage tanks at the start of 6B in Griffith, Ind., so a full shipment could accumulate before pumping resumed.

One minute later, a high-priority alarm [16] sounded in the control room, indicating that pressure had dropped to zero near Marshall. Another alarm triggered Enbridge's safety system and automatically halted the pumps at Marshall. Over the next five minutes, three more high-priority alarms signaled pressure problems on the line. Then a sixth alarm sounded, signaling a discrepancy between the volume of oil entering and exiting the pipeline.

At first, the control room operators weren't particularly concerned, according to a control room timeline [17] and other documents recently released by the National Transportation Safety Board, or NTSB. They thought a large bubble had formed between batches of crude, a problem that often resolves itself. They figured the bubble would last until they restarted the pipeline early Monday morning.

The operators were so confident of their diagnosis that when their 12-hour shift ended at 8 p.m. they didn't mention the six alarms to their replacements, according to [18] the NTSB documents.

Back in Calhoun County, however, noxious odors were beginning to permeate the summer night. At 9:25 p.m. local residents started dialing 911 [19]. One complained about a "very, very, very strong odor, either natural gas or maybe crude oil." Another described a house "asphyxiated with the gas smell" and asked if it was safe. Firefighters and local utilities checked the area for gas leaks, but found nothing. A Michigan Gas technician reported that he smelled petroleum.

The 911 calls continued as Sunday slipped into Monday.

At 4 a.m., controllers in Edmonton restarted the pipeline as scheduled and pumped oil up the line with the force of a firehose. Over the next hour, six more alarms went off.

At approximately 5 a.m., they shut 6B down again.

A pipeline analyst in the control room said 6B should be started again with more pressure, so oil would fill the line and overcome the bubble they thought was triggering the alarms.

"I guess there's two choices here, either consider it a leak or try it again?" the control center operations supervisor said.

"Just call it a false alarm," the analyst said [20].

As they prepared to restart the line for a second time, one of 6B's operators said he thought there was a leak. But others disagreed, and at 7:10 a.m., 6B's pumps kicked into gear again.

Four more high-priority alarms sounded as pumping continued for at least 45 minutes.

At 7:48 Monday morning—about the time Lorraine LaForge was telephoning John to tell him the smell near their house was even worse—the shift leader called for almost doubling pressure on 6B. But the extra power wasn't available, so they shut down the line again.

Two of the control room operators agreed they had never experienced a situation quite like this.

"Whatever, we're going home and will be off for a few days," one of them said [21]. They left the control room a few minutes later.

The next shift took over, aiming to restart 6B as soon as extra power was available so they could clear what they still thought was a bubble from the line. At 9:49 a.m., they heard some reassuring news from Marshall: The Enbridge electrician who inspected the pump station and general vicinity hadn't detected any leaks or unusual odors [22].

The leak wasn't discovered until 11:17 a.m., when an employee for a Michigan utility company called Enbridge's emergency number with the bad news. Oil was pouring into Talmadge Creek, about three-quarters of a mile from the pump station, he said [23].

At 11:45 a.m., an Enbridge employee arrived at the site and confirmed the leak [24].

InsideClimate News asked Enbridge to answer a question that the NTSB timeline raises: If the company didn't know about the leak until 11:17 a.m., why had its workers gone to the LaForge residence at 10 a.m. and tested the air in the family's home?

A company spokesman said he couldn't answer that question, or any other question about the chronology of events, while the NTSB's investigation is ongoing.

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Pipeline operators are required to report spills to the National Response Center in Washington, D.C. "at the earliest practical moment" following "discovery of a release." This notification is considered crucial to any cleanup response because the NRC alerts state and federal agencies to unfolding disasters.

Enbridge first tried to contact the NRC just after 1 p.m. [25], according to the NTSB documents. The company had already alerted [26] its own public affairs office in Houston about the spill 15 minutes earlier.

Because the NRC line was busy, Enbridge didn't get through until 1:33 p.m.—almost two hours after it had confirmed the spill and more than three hours after Enbridge workers urged the LaForges to leave their home. The company reported a spill of 819,000 gallons of oil.

Three minutes after Enbridge finished talking with the NRC, the center had contacted 16 agencies [27].

By this time, the same oily muck that had darkened the LaForges carefully tended lawn was sloshing over the banks of Talmadge Creek and coating tree trunks, flowers and soil along the Kalamazoo River. Jay Wesley, a fisheries specialist with the Michigan Department of Natural Resources, was already on the scene, trudging along the floodplain and collecting oil-coated muskrats and turtles in cardboard boxes and plastic bins.

Everything reeked of petroleum. Residents were on edge.

Deb Miller was driving home from her event-planning job in Battle Creek that evening when she saw several hundred people clustered on 12 Mile Road bridge. The bridge across the Kalamazoo River is in the village of Ceresco, about five river miles west of John LaForge's home. It offers a dead-on view of the Ceresco Dam, a local landmark.

Miller and her husband, Ken, had raised their two daughters in Ken's childhood home, which sits just 300 feet below the dam. They had built a deck off the back of their nearby flooring and carpeting business so they could enjoy watching fish swimming just under the river's surface.

The crowd parted so Miller could inch her car across the bridge and turn into her driveway. An overpowering odor of boiling hot asphalt assaulted her nostrils before she even opened the car door.

Miller joined the spectators on the bridge. Together, they watched an alarming brown mist rise as river water the shade of a dark chocolate malt tumbled 13 feet over the dam.

"We knew instantly by the smell and the color of the river that something had happened," Miller said, wrinkling her nose at the memory. "And whatever it was, it was huge."

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Enbridge rushed workers to the creek as soon as the spill was confirmed. But even as they positioned absorbent boom on the water's surface and dug culverts to divert the oil, they suspected they wouldn't be able to stop it from surging into the river just a couple of miles away. Flooding from four days of heavy rain made the oil-soaked water almost impossible to contain.

The 175-mile Kalamazoo River is a treasured recreational area. After the federal Clean Water Act was passed in 1972, paper mills, wastewater treatment plants and other polluters had been forced to rein in their once-deadly discharges. Some stretches were so pristine that canoe paddlers could feel transported back to the 18th or 19th century. If rivers had personalities, Wesley, the fish expert, would have classified the pre-spill Kalamazoo as "natural and wild." In 2000, he and a team of scientists had documented it as home to 102 species of fish, 23 species of mussels and clams, 218 species of birds, 40 species of mammals and 40 types of amphibians and reptiles.

Keeping the oil out of this important resource was crucial. But the EPA, which was taking command of the cleanup, was also looking at the bigger picture.

The Kalamazoo is not a drinking water source. But about 115 river miles west of Marshall it empties into Lake Michigan. Together with the other four Great Lakes, Lake Michigan provides drinking water for at least 26 million Americans and close to 10 million Canadians. If the lake became contaminated, a local disaster would escalate into a regional catastrophe.

The EPA and Enbridge also worried about a stretch of the river near the city of Kalamazoo, about 43 river miles west of Marshall.

Polychlorinated biphenyls, better known as PCBs, were embedded in the river where a factory had dumped them years ago. The area had been declared a Superfund site, and nobody was sure what might happen if oil mixed with PCBs, which are known carcinogens.

The cleanup teams had two advantages as they planned their strategy. The break had occurred just minutes from Enbridge's maintenance facility in Marshall, so some cleanup equipment was immediately available. Marshall is also close to Interstates 94 and 69, so more apparatus could be trucked in quickly from Battle Creek, Kalamazoo, Lansing, Detroit and Chicago.

Dozens of federal, state and local officials converged at a makeshift command center in an Enbridge building near the center of town.

Durk Dunham, Calhoun County's emergency management services director, was confident this would be a quick in-and-out operation. He figured vacuum trucks would quickly remove the oil and everybody would be home for dinner that night.

But when Dunham surveyed the devastation from a helicopter later Monday—and saw pure black instead of a ribbon of river—he realized his initial assessment was wrong. His eyes teared up when he saw the extent of the devastation.

"It was heartbreaking," he said. "There wasn't much being said on that helicopter."

By the time Jim Rutherford, Calhoun County's public health officer, arrived that afternoon from his office in Battle Creek, the oil had overwhelmed the creek. Despite the best efforts of the cleanup crews, it was surging into the Kalamazoo River.

Rutherford, just two years into his job, was bewildered by what he saw. He and his staff were prepared to deal with tornadoes and other severe weather but they knew next to nothing about oil spills. Until that afternoon, Rutherford hadn't even known that an oil pipeline passed near Marshall.

"We were pressing Enbridge as to what their plans were," he said about those early chaotic hours at the command center. "They only had a middle manager there and he was like a deer in the headlights. Yes, EPA was there, but we really needed Enbridge to call the shots."

The officials had two questions to answer—fast.

Could a spark ignite a chemical explosion—a major concern at any oil spill? And did the vile-smelling air pose a health risk for nearby residents?

Answering the first question was relatively easy. Using monitors that measured the mixture of oxygen and hydrocarbons in the air, the EPA determined that the likelihood of an explosion was low to non-existent.

Finding a definitive answer to the second question was more daunting.

Every type of crude oil, including diluted bitumen, is made up of hundreds of chemicals, and many of them evaporate into the air after a spill. Scientists don't fully understand how some of these chemicals affect humans. During a congressional hearing on the spill, Scott Masten, a scientist at the National Institute of Environmental Health Sciences, would testify [28] that "the potential for human health effects exist. However, understanding and quantifying these effects requires further study. There has been relatively little long-term research into the human health effects from oil spills."

One chemical commonly found in crude oil—benzene—is of particular concern, because it can cause health effects at low concentrations and over short periods of time. Studies have shown that people regularly exposed to benzene for several years can develop leukemia and other cancers.

The Natural Resources Defense Council and other environmental organizations have long contended that dilbit contains more benzene than conventional oil, but it's hard to know whether that's true. Little research has been done on dilbit, and most of that work was conducted by the industry and is considered proprietary information.

Workers with the EPA and Enbridge joined Michigan health officials in using an assortment of hand-held monitors to check the air for benzene, a standard procedure at any big oil spill. Some types of

monitors, which they usually had access to, weren't available that first day because they were still at the BP oil spill.

The readouts in Marshall fluctuated dramatically. The monitors detected benzene levels that ranged from below 50 parts per billion (ppb) to as high as 200 ppb. Some alarming spikes—6,250 ppb and even 10,000 ppb—showed up over patches of oil on the water and away from homes.

Rutherford huddled with federal and state health experts to try to figure out what these numbers meant. Should they evacuate the hundreds of people who lived near the river?

As Calhoun County's health director, Rutherford was responsible for making that decision. But he felt overwhelmed. Until now, his primary focus had been coordinating food inspections and school nurse programs for the county's 136,000 residents. His health department didn't have access to monitoring equipment. In fact, only one of his 70 employees is dedicated to emergency preparedness.

"People need to understand that at a local level, we're totally dependent on state and federal resources in a situation like this," he said recently. "That's a reality."

For help, Rutherford turned to the federal and state health experts, people he would later describe as his "superheroes." But they couldn't provide any easy answers because no federal benzene guidelines applied specifically to their particular crisis.

The federal Agency for Toxic Substances and Disease Registry calculates [29] that an average person can be exposed to 6 parts per billion of benzene—the rough equivalent of two tablespoons of liquid in an Olympic-size swimming pool—for up to a year without long-term health effects. The agency uses 9 ppb as the benchmark for up to two weeks exposure.

Another set [30] of benzene guidelines, drawn up by a coalition of federal agencies, is usually used for workers dealing with a short-term emergency. Those guidelines say [31] that people can be exposed to up to 200,000 ppb for eight hours without increasing the risk of long-term health effects.

The health experts who gathered in Marshall weren't exactly sure how long the benzene would linger, but their expertise told them it would be longer than eight hours but shorter than two weeks—and definitely less than a year. So what were they to do?

People were already calling Rutherford's office, local hospitals and the Poison Control Center to complain about headaches, sore throats, nausea and vomiting—all symptoms that the Centers for Disease Control and Prevention has linked to benzene exposure. But other, less dangerous chemicals found in oil can also cause those symptoms.

For more accurate data they needed air sampling equipment, which requires more time to produce results but is more sophisticated than hand-held monitors. Mark Durno, an EPA deputy incident commander for the spill, said that the EPA team, veterans of many oil spills, considered this an ordinary spill and saw no need to rush sampling equipment to Marshall on Monday.

Late Monday Enbridge gave the EPA a Material Safety Data Sheet, or MSDS, a federally mandated document required for hazardous substances that are transported or used in a workplace. But the three-page MSDS [32] didn't offer much guidance. Nowhere did it mention "bitumen" or "diluted bitumen" or "dilbit." The only clue that the oil in 6B might be different from conventional oil were references to "diluent" and "condensate," two terms that refer to the chemicals added to dilute the bitumen. But nobody seemed to recognize that the words indicated this was not ordinary crude.

Durno said the MSDS confirmed their assumption that 6B was carrying regular heavy crude oil. The EPA had supervised the cleanup of almost 8,400 spills since 1970, and the Enbridge supervisors at the scene did not hint that this spill might be different.

Rutherford and the other health care experts considered everything they had seen and learned that day. They agreed that an evacuation wasn't needed—at least not yet.

The monitoring was still continuing as Rutherford drove home in the wee hours of Tuesday morning. He pondered how long the oil would dirty the river of his childhood—and how far he would have to travel to outpace the hideous stink that soured the still summer air.

"It was kind of numbing, like being in a dream," he said. "Were we ever going to be able to get a handle on this?"

Researcher Lisa Schwartz and InsideClimate News intern Kathryn Doyle contributed to this report.

Correction: This story has been corrected to reflect that BP's Macondo well was capped on July 15, 2010, ten days before the Enbridge spill occurred.

Links
[1] http://insideclimatenews.org/news/20111101/keystone-xl-oil-sands-pipeline-diluted-bitumen-dilbit-secret-chemicals-corrosion-spill-enbridge?page=show
[2] http://insideclimatenews.com/topic/keystone-xl
[3] http://insideclimatenews.com/news/20120621/enbridge-oil-spill-tar-sands-dilbit-michigan-kalamazoo-river-pipeline-safety-epa-keystone-xl
[4] http://www.documentcloud.org/documents/365744-enbridge-ferc-filing-5-18-12.html
[5] http://www.ntsb.gov/investigations/2010/marshall_mi.html
[6] https://insideclimatenews.org/sites/default/files/assets/2012-06/map_large.jpg
[7] https://insideclimatenews.org/sites/default/files/assets/2012-06/Enbridge%20Line%206B%282%29.jpg
[8] http://www.phmsa.dot.gov/
[9] http://www.nytimes.com/2011/09/10/business/energy-environment/agency-struggles-to-safeguard-pipeline-system.html?_r=1&adxnnl=1&pagewanted=all&adxnnlx=1330632030-mVYbpsRmnypm4yCkJR5YTw
[10] http://www.documentcloud.org/documents/351569-enbridge-cong-test.html#document/p16/a61035
[11] http://www.documentcloud.org/documents/351569-enbridge-cong-test.html#document/p17/a61036
[12] http://www.documentcloud.org/documents/351569-enbridge-cong-test.html#document/p17/a61042
[13] http://www.documentcloud.org/documents/351569-enbridge-cong-test.html#document/p18/a61044
[14] http://www.documentcloud.org/documents/351569-enbridge-cong-test.html#document/p17/a61043
[15] http://www.documentcloud.org/documents/372383-part-3-enbridge-response-plans-chicago-

superior.html#document/p5/a61085
[16] http://www.documentcloud.org/documents/359033-179-control-room-report.html#document/p8/a60946
[17] http://www.documentcloud.org/documents/359033-179-control-room-report.html#document/p9/a60950
[18] http://www.documentcloud.org/documents/359033-179-control-room-report.html#document/p9/a60953
[19] http://www.documentcloud.org/documents/359008-83-transcript-911-calls.html
[20] http://www.documentcloud.org/documents/359033-179-control-room-report.html#document/p12/a60958
[21] http://www.documentcloud.org/documents/359033-179-control-room-report.html#document/p15/a60959
[22] http://www.documentcloud.org/documents/359033-179-control-room-report.html#document/p16/a60962
[23] http://www.documentcloud.org/documents/359033-179-control-room-report.html#document/p17/a60963
[24] http://www.documentcloud.org/documents/360434-025-emergency-environmental-response-group.html#document/p7/a61052
[25] http://www.documentcloud.org/documents/360434-025-emergency-environmental-response-group.html#document/p24/a61055
[26] http://www.documentcloud.org/documents/358979-30-enb-emer-resp-timeline.html#document/p2/a61056
[27] http://www.documentcloud.org/documents/360439-029-nrc-report-948903.html
[28] http://www.documentcloud.org/documents/351569-enbridge-cong-test.html#document/p75/a61057
[29] http://www.documentcloud.org/documents/372295-benzene-atsdr-guide.html
[30] http://www.epa.gov/oppt/aegl/
[31] http://www.epa.gov/oppt/aegl/pubs/results72.htm
[32] http://www.documentcloud.org/documents/371686-christina-lake-msds.html