An oil refining chemical has infiltrated the water of a small Alaskan town, but families—many worried about health issues—are left with more questions than answers.

Lois Parshley

NORTH POLE, Alaska—Linda Brown would one day look back with regret on her family's optimism as they dug into the cold, hard soil.

The Browns live in North Pole, Alaska, about 1,700 miles south of the actual geographic pole; the town was named in the 1950s by a real-estate company hoping to attract a toy manufacturer. That factory never materialized, but Santa's sleigh still sits proudly outside of city hall.

Like many in North Pole who live without running water, the Browns saved up for a well. It cost $5,000 dollars, though they did the work themselves. Four days after they finished in 2009, Linda turned on the evening news to see images of an oil refinery a mile from their trailer. A chemical solvent called sulfolane had spilled, contaminating the groundwater. She recalled, "I told my husband we can't drink the well water. And he said 'What!? We just drilled it.'"

A week later, representatives from Flint Hills Resources Alaska, the refinery owners, showed up to test the Browns' new well. Their water had 283 parts per billion (ppb) of sulfolane, well above the Environmental Protection Agency's (EPA) regional screening level of 20 ppb. The company capped off the Browns' well, offering them a holding tank and money for six months of water delivery. Linda accepted the tank, but put the cash toward her dogs' medical bills—since they'd moved onto the property, all four had gotten cancer.

As the Browns learned more, they were shocked to discover that the chemical might have been in the groundwater for decades. As far back as 1986, the original owner, Williams Alaska Petroleum, knew that one of its wastewater ponds leaked. But it wasn't until 2009 that North Pole learned the sulfolane plume had traveled off the refinery. Reporters at the Fairbanks Daily News Miner covered the scandal as the chemical was belatedly found in the city's drinking water, as well as hundreds of private wells.

"It should have been stopped, within the first moment they found out," Linda told EHN. "I'm so frustrated with them—and so scared."
The Santa Claus House features prominently along the Richardson Highway, and is a fixture for visitors to the area. (Credit: Sean McDermott for Environmental Health News)

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A widely-used industrial solvent, sulfolane is used in more than 150 locations around the world, including refineries in California, Texas, and Puerto Rico. The chemical is in everything from insecticides to lithium batteries, pharmaceuticals, and printer ink.

"There are estimated to be thousands of tons of this product generated annually worldwide," Mary Beth Leigh, a microbiologist at the University of Alaska Fairbanks who's studied how slowly the solvent breaks down in the water table, told EHN. "Unfortunately, like a lot of chemical products, a fair amount of it ends up in the environment."

The Environmental Protection Agency has considered sulfolane hazardous waste since 1995, following groundwater contamination near a Chevron refinery in Puerto Rico. But despite being used for 50 years, its human health impacts are not well-studied. If it causes cancer, we wouldn't know; it hasn't been tested. In limited animal studies, high exposures cause many negative effects, including hyperactivity and convulsions, developmental and reproductive problems, and death.

Now, Linda's daughter and grandchildren, who also live on the property, haul drinking water in for the family every week. The Browns would like to move, but lack the means to do so. Linda said, "I would feel really guilty selling this property to anybody else."

It's not an isolated problem. Sulfolane is just one of 86,000 chemicals approved for commercial use in the U.S. today, but only a fraction of these are regularly monitored in the environment. Nor is sulfolane the only chemical released from the refinery: A persistent and toxic group of chemicals called PFAS have formed a second groundwater plume spreading under North Pole.

Unlike Canada or the European Union, which place the burden of proof on companies to demonstrate their chemicals are safe, the U.S. has a very high bar for proof of harm before regulatory action is taken.

"If there's no accountability," Linda asked, "who's to say it's not going to happen again?"

**Contamination spreads for decades**

Mary Beth Leigh, a microbiologist who has studied the North Pole sulfolane plume, on the University of Alaska Fairbanks campus. (Credit: Sean McDermott for Environmental Health News)
The North Pole refinery was built in 1977 to tap crude oil from the new trans-Alaska pipeline, refining it into jet fuel for the nearby Eielson Air Force Base, and producing heating fuel and gasoline. The refinery used sulfolane to remove aromatics like benzene from oil, so that specific concentrations could be added later for each type of gasoline it produced. "It’s considered a quick and dirty refining process," Leigh explained, because it's less expensive to build and operate than other types of extraction.

The contaminated wastewater from these extraction units went into holding ponds. Sulfolane wasn’t explicitly regulated by the state, but Alaskan law prohibits the release of hazardous substances, even if there isn’t a clean up level established. The Alaska Department of Environmental Conservation (DEC) said despite subsequent legal posturing, Williams recognized they needed to report when sulfolane spilled, filing several such notices with the state. (Williams did not respond to requests for comment.) But investigations in the 1980s determined Williams’ wastewater system violated federal regulations for other hazardous waste, and the EPA fined the company twice.

The company did report spilling 150,000 gallons of petroleum, which contained the chemical, in its first decade of operation; in 1990, the company spilled another 275,000 gallons of petroleum. In 1988, the refinery hooked up to piped city utility water because of contamination of its own drinking water wells. Yet for the next 15 years, waste oil—and its residual sulfolane—continued to leak onto the soil and into the groundwater.

One of the primary sources was an oily wastewater pond called Lagoon B. Williams employee Ben Britten described the company’s haphazard approach to its maintenance in courtroom testimony. By 1995, the pond’s liner had bubbled above the water level, pushed up by gases rising from the thawing permafrost beneath. The employees thought the big, round bulges looked like breaching whales, and nicknamed them belugas. Britten recounted watching the superintendent of operations use a .458 Colt 15 Sauer rifle—an elephant gun, used for big game—to shoot at the belugas. When asked what effect this target practice had on Lagoon B, Britten replied, "Well, it wouldn't have helped the integrity of the liner." With additional leaks from underground sumps, by 1996, Williams’ own records show that monitoring wells on the property contained as much as 2.7 million parts per billion of sulfolane.

Sulfolane is highly soluble; it’s a clear, colorless liquid that's heavier than water. It doesn't like to evaporate or stick to soils, but it’s very good at dissolving. This means that in water, it quickly spreads out and travels easily, creating one of the largest groundwater plumes in Alaska.

In 2004, Williams sold the refinery to Flint Hills Resources Alaska, a wholly owned subsidiary of Koch Industries. Flint Hills agreed to assume responsibility for "all existing, known contamination," including a document that listed sulfolane concentrations at various monitoring wells on the site. What wasn't included in the sale agreement was the fact that the plume already extended off the property.
Shortly after the sale, the DEC warned Flint Hills that it needed to find out the extent of the problem. (Flint Hills declined to comment, citing involvement in ongoing litigation.) A consulting firm, Shannon & Wilson, told Flint Hills in 2006 that new wells were required to ensure the plume hadn’t escaped the monitoring network. When Flint Hills drilled these, they discovered the contamination had left the property. It took until 2009 for Flint Hills to test wells in North Pole, confirming the plume had migrated into the town’s drinking water.

Oil storage tanks sit along the front of the refinery property. (Credit: Sean McDermott for Environmental Health News)

By then, the plume had grown to 3.5 miles long and 2 miles wide; in some places, it’s 300 feet deep. More than 7,000 people unknowingly drank that contaminated water, possibly for as long as 20 years.

Flint Hills agreed to pay to connect affected families to city water, although first, two city wells had to be moved outside of the plume. For those living beyond city connections, like the Browns, Flint Hills initially paid for bottled water, and later, for water tanks and delivery service, or treatment systems. In exchange, some residents signed non-disclosure agreements and accepted one-time payments, waiving their right to sue in the future.

In a 2017 lawsuit, the state, North Pole, and Flint Hills reached a $100 million dollar settlement to expand the city’s piped water system to all properties within the plume that had a well and water sample that tested positive for sulfolane, or had a structure or dwelling on the property that was valued at over $1,000. The agreement extended to properties in the plumes’ anticipated path as well. The expansion bid at $52 million and was completed in 2020, approximately doubling the water utility's customers to a total of 1,200. As part of the agreement, Flint Hills turned off a groundwater treatment system on the refinery that had been reducing how much sulfolane traveled off the property. (DEC says the majority of the plume had already traveled off the refinery property when Flint Hills purchased it in 2004, and that the money was better spent installing a piped water system.) As you read this, the plume continues its northwest migration.

"The immediate need of getting people safe water was met," Bryce Ward, who was mayor of North Pole from 2012 to 2018, told EHN. But the long-term question of how to clean up the groundwater remains. Neither the state nor the federal government have currently set a cleanup level. According to the DEC, sulfolane and petroleum contamination are expected to "remain in soil and groundwater for many years."

David Barnes, a professor of civil and environmental engineering at the University of Alaska Fairbanks, studies the transport of contaminants in aquifers located in permafrost zones. Sulfolane breaks down very slowly without oxygen, he explained, and there’s not much dissolved oxygen in the aquifer. "With other plumes, like gasoline, you can blow air into the groundwater to create degradation, but that won't work with a large plume like this," he told EHN, as it's too large and complex to be practical. To make things worse, when the DEC
hired Leigh to research the plume, she found that unlike petroleum, which can be broken down by many microbial organisms, only one bacterial species in the aquifer was eating sulfolane.

The plume is unlikely to "undergo biodegradation under ambient aquifer conditions," Leigh said—while it might get diluted as it spreads, it's not going to go away on its own.

**Illness and uncertainty**

Bryce Ward, the former Mayor of North Pole, including during much of the sulfolane saga, poses for a portrait outside of North Pole City Hall. (Credit: Sean McDermott for Environmental Health News)

Elizabeth Smith—who needs to use a pseudonym as she signed a Flint Hills waiver, and isn't sure what rights she gave up—was home alone when company representatives knocked on her door in 2011. "They reiterated over and over the preliminary studies said it wasn't harmful, but in an abundance of caution, they wanted us to sign paperwork so they could get us clean drinking water," she recalled to EHN. She asked about bathing, noting she was several months pregnant. They told her that was fine. Elizabeth left the conversation reluctant to sign, but she and her husband decided they needed the water.

The Smiths had relied on their well since they moved to North Pole in 2006; despite being deep, it turned out to have high levels of sulfolane. Elizabeth went on to have a difficult pregnancy. Her daughter Mary (also a pseudonym) was born six weeks early, needing a full resuscitation at birth. Coming home from the hospital, Elizabeth said, "I was really paranoid about our water—I didn't even bathe her at our house." She started going to her parents' house in Fairbanks to shower and do laundry.

When Mary was 6 months old, she had a severe seizure, and had to be medevacked to Anchorage. "She almost died again," Elizabeth said. Mary was diagnosed with rare seizure disorder. Their neurologist offhandedly mentioned this was an unusual condition, but he'd recently seen it in multiple children from the North Pole area. (Dr. Roderic Smith, a neurologist with Providence Medical Group, declined to be interviewed, citing patient confidentiality.) "After he said that, we were like, that's it—we're moving," Elizabeth said.

They borrowed money from her parents, "scraped together every last cent," to purchase a small property in nearby Fairbanks, fleeing their old house without trying to sell it.

Things quickly improved. Her husband had suffered persistent skin lesions, right where water would hit his back in the shower. Within two months of moving, they disappeared. Most importantly, Mary's seizures stopped.

Elizabeth acknowledges it's hard to draw a clear connection between her daughter's medical conditions and her prenatal sulfolane exposure. "But you don't know," she said. That uncertainty is devastating.
Teasing out health impacts

The DEC determined in 2011 that there were sufficient questions about North Pole’s plume to request that the federal National Toxicology Program (NTP) study the long-term chronic effects of sulfolane. The state also worked with the federal Agency for Toxic Substances and Disease Registry to establish a "public health action level" for sulfolane, with the lowest limit set at 20 parts per billion for infants, and 70 for adults. (The Smiths' well had concentrations orders of magnitude higher.)

Because no studies have directly looked for sulfolane’s effects in people, toxicologists are relying on animal data and computer modeling. Laboratory animals given high doses of sulfolane showed damage to their central nervous system, leading to seizures and hyperactivity. Other studies found that sulfolane affects the immune system, lowers white blood cell counts, and subtly changes organs like the liver, kidneys, and spleen. In mice, high doses were found to cause reproductive and developmental problems.

The sulfolane levels North Pole residents were exposed to are lower than those used in these animal studies. To more accurately mimic chronic exposures in the community, scientists at the NTP are now wrapping up a two-year study where they gave rats and mice lower doses in their drinking water. A decade after the DEC's request, the results are pending.

In 2012, the Alaska Department of Health and Social Services (DHSS) put together a report comparing North Pole’s rates of cancer and birth defects to the rest of the state. They found 8.4 percent more cancer cases in the census tract than expected, but because of the confidence intervals, they wrote, "we cannot conclude with enough confidence that the observed number of cases is not due to chance." They also found statistically significant increases in two types of birth defects—cardiovascular anomalies and chromosomal anomalies—but identified other possible explanations. For example, maternal age is the only known risk factor for chromosomal anomalies; after adjusting for age, North Pole's rates were also outside of confidence intervals.

This illustrates a common problem in communities like North Pole, where small populations make it hard for studies to have enough statistical power to find health effects. Further muddling the situation is the fact that doses of sulfolane varied widely, based on both behavior and differing concentrations within the plume. The DHSS report concludes sulfolane is unlikely to have caused harm, but added, "We cannot say with absolute certainty that there would not be any health effects from long-term exposure to low levels of sulfolane in drinking water."
In the meantime, state agencies have had to craft guidelines in the absence of conclusive science. In 2010, for example, DHSS acknowledged they didn't know if it was safe to use contaminated water in gardens, writing, "Our advice for now is to water your gardens using your well." Later that summer, they studied 27 plant parts from seven North Pole gardens, finding sulfolane in all parts of the plants. From this limited sample, the agency reversed course. They now suggest avoiding sulfolane-contaminated water for gardening.

Ward, who's advocated for expanding the city's water system, said these kinds of changes have added to a pervasive distrust of both the refinery companies and the government agencies.

"You know, I will say that it's not the first time that government agencies had been wrong about groundwater contamination," he said in 2019 courtroom testimony about the DHSS's findings, "or been wrong about concentrations of what's acceptable and not acceptable."

A new plume of PFAS

"I raised kids out there, and they don't have two heads or anything," said James Bradley. (Credit: Sean McDermott for Environmental Health News)

Small planes covered in snow at the Bradley Sky-Ranch Airport. Bradley's hangar is the blue building, with the orange windsock in the background. (Credit: Sean McDermott for Environmental Health News)

A handful of snow-covered single-prop airplanes line the road to James Bradley's hangar on the Bradley Sky-Ranch airport in North Pole. Down the runway, bare birches partially obscure the jagged teeth of the Alaska Range. To the southeast, smoke rises above the refinery. Bradley's well, which was used for washing planes as well as drinking water, is in the sulfolane plume. Flint Hills paid for a holding tank, and then for his property to be connected to city water. "I raised kids out there, and they don't have two heads or anything," he said.

Though Bradley's happy with how Flint Hills responded to the sulfolane plume, he now has a new concern: per- and polyfluoroalkyl substances, or PFAS, a group of substances called "forever chemicals" because they don't break down in the environment. Bradley has been trying to get the agency or Flint Hills to test his float pond, where people also regularly fish, to no avail. "Every time we see them fishing, we tell them you probably shouldn't eat that," he told EHN. In 2018, Flint Hills discovered PFAS from firefighting foams on the refinery had also entered the groundwater—forming a new plume under North Pole. Unlike sulfolane, PFAS have a long list of well-established health impacts, including cancer, reproductive problems, and disrupting endocrine and immune systems.

The DEC says the city's piped water expansion, built for the sulfolane plume, appears to protect residents from PFAS. But the plume's full extent hasn't been determined yet. The DEC is not aware of any studies of how these chemicals may interact, but the next steps are
complicated by the two plumes overlapping: Some clean up actions that may be effective for
sulfolane, like air sparging, may create more PFAS compounds from precursor molecules in
the groundwater.

These double plumes highlight the failures in the U.S. approach to chemical management.
Numerous lawsuits after scandals in West Virginia and Minnesota found that DuPont, the
inventor of PFAS, knew the chemicals were toxic as early as 1961. In 2005, the EPA accused
DuPont of concealing its knowledge in violation of the Toxic Substances Control Act (TSCA).
The company settled.

Forty years ago, TSCA granted the EPA the responsibility to ensure the safety of chemicals.
But loopholes made the law difficult to enforce: Chemicals already in use before 1976 were
exempt. Even though new chemicals had to be approved before being sold, the EPA wasn't
allowed to request specific toxicity data. Instead, the law allowed companies to decide what
information they provided.

After discovering in 2018 that PFAS from the former refinery had entered local groundwater,
spreading northwest of the property, the Alaska Department of Environmental Conservation
closed Kimberly Lake to fishing in 2019. (Credit: Sean McDermott for Environmental Health
News)

In practice, the federal government had little oversight over chemical usage—allowing
dangerous substances, like PFAS and asbestos, to remain on the market for decades after
detrimental effects were identified. After an update to TSCA in 2016, the EPA can now at
least require toxicity testing before chemicals are approved, and ban chemicals without
considering the economic impacts to the company. But a 2021 National Academies of
Sciences, Engineering, and Medicine report finds that TSCA is still failing. The blistering
report criticizes the EPA for their piecemeal approach to evidence, saying they "lack
objectivity at each step."

Jon Samet, one of the authors of the paper, as well as a physician and epidemiologist and
dean of the Colorado School of Public Health, explains, "What we're saying is look, your
processes need to be changed."

In North Pole, these failures have put state agencies in a difficult position. DEC
Contaminated Sites Program senior project manager Ann Farris, who coordinated the
sulfolane response, told EHN that when DEC first found sulfolane in the groundwater, the
available toxicity information was "pretty limited." Though she had dealt with many complex
projects before, the responsibility for handling the largest contaminant plume in the state
without clear regulatory guidelines weighed on her.

"You have to be the person who goes into the public meetings and tells people actually being
exposed that you don't have good answers," she said. Farris was so troubled by the process
and the politics that she quit. "I didn't feel like the Department or the refinery was doing
enough to address the issue," she said.

Once people have been exposed to a chemical, it may be too late to prevent health impacts. But Farris said that's why it's so important to change how emerging contaminants are regulated—to have toxicity data before chemicals go into use, in order to keep these kinds of exposures from happening. Because many potentially hazardous chemicals are not regulated, they don't have state-mandated clean up levels, which can prevent the state from enforcing remediation efforts.

"Every state could have a North Pole refinery," she said. "We need clear regulatory lines in the sand."

**Legal limbo over the pollution plume**

A column of smoke rises above the refinery in the distance. The refinery formerly owned by Williams Alaska Petroleum, and then Flint Hills Resources Alaska, LLC, shares a property line with Petro Star Inc, an active oil refining company not implicated in the sulfolane contamination. (Credit: Sean McDermott for Environmental Health News)

In North Pole, this ongoing scientific and regulatory ambiguity has made accountability difficult. A few people living in the plume have successfully sued: After drinking contaminated well water every day for two years, North Pole resident James West took Flint Hills to court in 2011. He argued sulfolane exposure could have contributed to his prostate cancer. The court threw out part of his case, saying he proved only a possibility, not a probability, that the exposure increased his risk of disease. But Flint Hills still settled his property damage claims for an unspecified sum. (West was unable to comment, citing a non-disclosure clause in the settlement.)

West's partial success is an anomaly. Jason Weiner, West's lawyer, explained he also tried to pull together a personal injury class-action lawsuit for North Pole residents, but the court declared each individual would have different damages, making it impossible to pursue as a class action process. "It was hard to gauge how long people had been exposed, or how much," Weiner admitted.

Peter Ehrhardt, one of the lawyers that successfully tried the Exxon Valdez case in 1992, also tried to organize a class-action lawsuit based on property damage, which is easier to prove. As Bradley has discovered, being in the groundwater plumes makes it more difficult to sell. "We're trying to sell the airport," Bradley said, "and the contamination is a problem." The state requires disclosing the water contamination to potential buyers, though former mayor Ward said from personal experience this doesn't always occur. Ward himself has purchased property he was aware was within the plume, although the sellers never mentioned it.

Ehrhardt's efforts never got off the ground, in part because many of the potential plaintiffs had relinquished their rights to sue in exchange for drinking water. "Flint Hills was really smart," Ehrhardt said. "People often take the deal. The business model here is to dump this
stuff and run away."

Weiner, for his part, said, "I thought that Flint Hills was very responsive." He points to the $130 million the company has spent—and then notes that Flint Hills is currently in a years-long legal battle with Williams to determine who will ultimately be responsible for paying the bills. In 2020, the Superior Court in Fairbanks issued a decision holding Williams liable for 75 percent of the spill, announcing $29.4 million in costs and damages. The decision also orders Williams, which has not participated in the cleanup, to partially reimburse Flint Hills, and to pay future response costs. Williams immediately appealed the decision, and the case is ongoing.

Flint Hills closed the refinery in 2014, citing high operating costs. The company sold the refinery to Marathon Petroleum Corporation in 2019, who now use the property for fuel storage. The duration of litigation over who should pay—outlasting both corporations' involvement with the property—illustrates just how daunting legal action can feel for the people living with the consequences.

Credit: Sean McDermott for Environmental Health News

Credit: Sean McDermott for Environmental Health News

"You gotta let it go"

Elizabeth Smith admits that her family regrets signing away their rights. Mary was diagnosed with a chronic neurological disability when she was two, leading to significant medical expenses. But even if the Smiths could sue, she's realistic about their vanishingly small chance of prevailing. "It's a hard choice. You want them to take responsibility for what they did to people. But at the same time, we may never see a resolution—[Mary] may never see a resolution in her lifetime."

The Smiths have decided that instead of fighting Flint Hills, their focus will be on their daughter, and what she needs now. "It's like sometimes, you just gotta let it go."

*Lois Parshley is a freelance investigative journalist. Follow her on Twitter @loisparshley.*

Banner photo credit: At his small-plane hangar at the Bradley Sky-Ranch Airport in North Pole, James Bradley says that in addition to sulfolane contamination in the groundwater, he is now concerned about the potential presence of PFAS in his float pond. (Credit: Sean McDermott for Environmental Health News)