Sulfolane Investigation Update

Provided by the Technical Project Team to inform the North Pole community on recent developments in the investigation and remediation of soil and groundwater contamination related to the North Pole refinery.

June 2013

Frequently Asked Questions

Background

Why is sulfolane a problem in North Pole?

The discovery and investigation of sulfolane contamination has been unprecedented in Alaska due to the distance that sulfolane has traveled in groundwater, and the number of properties affected with private drinking water wells. All residents with sulfolane detections in their water currently have been offered an alternate drinking water source. Most now have a permanent solution. Sulfolane is a "contaminant of emerging concern" because the risk it presents to human health and the environment is not completely known.

Leaks and spills of petroleum and industrial wastewater have occurred ever since the refinery's start-up in 1977. Since the 1980s DEC has required the successive owners to conduct increasingly more investigation and cleanup of petroleum-contaminated groundwater in the subsurface of the refinery property. In 2001 ongoing monitoring results also revealed sulfolane within the plume of petroleum contamination. At the time, the solvent was

Open House on Sulfolane

Meet with State of Alaska Staff

Tuesday, June 25
11 a.m. – 2 p.m. and 4 p.m. – 7 p.m.
in the North Pole City Offices

Come meet with representatives of the Department of Environmental Conservation and the Department of Health and Social Services involved in the investigation of the sulfolane groundwater plume in North Pole. Only State agencies will be present at the event to will update the community on the project to:

- Listen to concerns and answer questions
- Provide the most up-to-date information, including maps.

not regulated by the state or federal government. DEC listed sulfolane as a "contaminant of interest" for the site, established a cleanup level, and required that it be monitored under the assumption that by removing petroleum from groundwater, sulfolane would be sufficiently contained and eventually break down.

In 2009, then-owner Flint Hills began testing groundwater off its property, near private homes with drinking water wells. Sulfolane concentrations in the test wells were significantly higher than expected, although under the cleanup level. The company then sampled some nearby private wells, also finding sulfolane.

Flint Hills, as the responsible party, notified DEC with the results and with a plan to immediately supply alternate water and begin testing residential wells. Both DEC and Flint Hills have been in direct communication with homeowners since the contaminant's discovery and have regularly provided information updates to the community.

The discovery and investigation of sulfolane contamination has been unprecedented in Alaska due to the distance that sulfolane has traveled and the number of properties affected with private drinking water wells.

Meanwhile DEC reviewed the sulfolane cleanup level for its protectiveness of human health.

How is the investigation proceeding?

Flint Hills has assured DEC that they have contacted virtually every homeowner in the plume area, and all have been offered alternative water. Most have permanent solutions. Several, so far, are not reachable despite attempts. Several have chosen not to talk to Flint Hills.

Since then efforts have had centered in these areas:

- Prevent further exposure to the contamination by providing alternate water sources for people with sulfolane in well-water.
- Identify all the sources of sulfolane releases and do inspections to ensure that there are no ongoing releases.
- Understand the toxicity of sulfolane and all potential risks to human health and the environment from all of the contaminants of concern. The risk assessment, as this process is called, evaluates the risks from all of the chemicals of concern in order to set protective site-specific cleanup levels for sulfolane and the other chemicals of concern.
- Thoroughly identifying the three-dimensional shape of contamination and its potential for further movement or degradation. This is done by establishing an extensive monitoring network and doing work to more completely understand the characteristics of the chemical sulfolane.
- Evaluate alternatives to stop migration and cleanup the contamination, including a pump and treat system, an air sparging pilot study, and carbon filtration on the drinking water wells.
- Pursue aggressive remediation (cleanup) in source areas and hot spots to reduce the mass of contamination in the aquifer and prevent further migration.

Who is responsible?

Under Alaska law the responsible or liable party must investigate and clean up the spill at the direction of DEC and in compliance with Alaska State regulations. Potentially responsible parties under Alaska law include current and past landowners as well as anyone who may have helped cause the contamination. MAPCO purchased the plant in 1980, merged with The Williams Companies in 1998 and sold the facility to Flint Hills Resources in 2004. The response so far has been led by Flint Hills, and Williams has begun to take part in plans for further investigation and cleanup.

At the time of the initial discovery of sulfolane outside of the refinery property, Flint Hills began testing of drinking water wells. Although the testing showed sulfolane was present, the concentrations did not exceed the interim cleanup level existing at the time. Flint Hills responded immediately with caution, providing individual notifications and an alternative clean water supply to all residents whose drinking water wells were or were likely to be contaminated. DEC contacted the state health department and EPA for assistance in reevaluating the cleanup level in light of the presence of the compound in drinking water wells. This effort resulted in DEC lowering the sulfolane level based on additional review of the research. DEC has done research on sulfolane, completed risk analysis, updated the cleanup level, and provided oversight of the investigation and cleanup effort to protect people from exposure and ensure compliance with all legal requirements.

DEC also established a Technical Project Team to provide the highest level of oversight of Flint Hills's work. The team consists of experts in every aspect of environmental investigation and cleanup, including members from the University of Alaska, federal and state health and regulatory agencies, and private sector consultants.

The U.S. Environmental Protection Agency can also exercise oversight over cleanup. In 1986 DEC issued a Compliance Order by Consent and in 1989 the U.S. Environmental Protection Agency (EPA) issued two Administrative Orders on Consent to then-owner MAPCO. These orders outlined a cleanup and monitoring strategy for the petroleum contamination and RCRA hazardous waste violations. EPA conducted a Preliminary Assessment in 2012 of the refinery's contamination, and has not yet made a jurisdiction decision. DEC and EPA continue to discuss the federal agency's role in the oversight of the investigation and cleanup.

Health

What do we know about the health effects of sulfolane?

Right now there is little information on the health effects of sulfolane on humans. What we currently know about the toxicity (health effects) of sulfolane comes from laboratory studies where test animals were exposed to relatively high levels of sulfolane for short periods of time (up to six months). We hope to gain a better understanding of sulfolane toxicity in the next 4-5 years, when the federal National Toxicity Program conducts animal studies to evaluate the short and longer term health effects of sulfolane.

North Pole residents who consumed water with detectable levels of sulfolane from their private wells are not likely to experience negative health effects. The levels of sulfolane in North Pole wells are low, and below those that caused subtle health effects in test animals. However, we cannot say with absolute certainty… because no studies have looked at long-term exposure to low levels in drinking water in animals or humans.

In January 2012 the Alaska Department of Health and Social Services (DHSS) published a health consultation report evaluating community concerns about sulfolane in private water wells. The agency concluded that "North Pole residents who consumed water with detectable levels of sulfolane from their private wells are not likely to experience negative health effects. The levels of sulfolane in North Pole wells are low, and below those that caused subtle health effects in test animals. However, 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, because no studies have looked at this in animals or humans."

DHSS also reviewed the rates of cancer and birth defects in the North Pole area and did not find any unusually high rates of either. This information is based on statistical analysis of reported cases of cancer and birth defects from the State of Alaska Cancer Registry and Birth Defects Registry.

In the absence of human health data, scientists commonly use animal studies and computer modeling to determine what is a "safe level" of exposure to a chemical for people. The less we know, the lower this level is set, to be more protective.

Do you still recommend that impacted well water should not be used for gardening?

Yes, state health officials continue to recommend using water with no detectable level of sulfolane for growing fruits and vegetables, until more is known. Some scientific studies have indicated that plants can absorb sulfolane from water; however, no published studies are currently available on sulfolane uptake in edible garden plants.

In the summer of 2010, the Technical Project Team, helping guide the investigation of sulfolane contamination in North Pole, conducted a garden sampling project. Only seven local gardens participated, thus very few samples of each plant were available during one single growing season. With these limitations and other factors (e.g., amount of rainfall and level of sulfolane in the water) that could affect the final levels of sulfolane in the plants, we cannot draw broad conclusions about the safe use of sulfolane-impacted water for growing fruits and vegetables for all North Pole gardeners.

Nonetheless, the sampling results provide valuable information for North Pole residents:

1. Edible garden plants can take up sulfolane present in water, so people can be exposed to sulfolane by eating those foods.

2. Sulfolane was found at low levels in all parts of plants sampled (leaves, fruits, flowers, stems and roots). The highest levels were found in the leafy part of the plant.

3. Based upon what we know about sulfolane, the levels of sulfolane found in edible plants from the North Pole gardens we tested were low and not likely to harm health. To be on the safe side, however, state health officials continue to recommend using water with no detectable level of sulfolane for growing those foods, until more is known.

Flint Hills has been offering all homes within the plume area and not on city water an alternate source of water for gardening. You can read more in these fact sheets found on our website's documents page, "Final Results of the North Pole Sampling Project, Jan. 18, 2011," and the "DHSS Health Consultation - Sulfolane Plume in Groundwater."

Why are no health studies being done with people in North Pole?

Some North Pole residents have asked why the Alaska Department of Health and Social Services (DHSS) is not conducting a more extensive health study to collect information about medical conditions and monitor disease outcomes potentially related to sulfolane exposure. There are many factors to consider when deciding whether to do such a study. Briefly, performing an extensive health study often takes years to successfully implement and considerable resources to complete. One of the major factors to consider is how successful the study might be in identifying a specific exposure-outcome association. When the health outcome for a particular exposure is known and is related to the exposure, the chance for success is good. Unfortunately, this is not the case with sulfolane. The historical exposure data are lacking and the health effects of sulfolane are not known. Without this information, a health study cannot currently be designed to adequately evaluate potential associations.

Tests on water from North Pole's new city water wells have never shown detections of sulfolane. The two new wells for the City's water system are located outside of the contaminant plume.

Due to the considerable limitations of performing an extensive health study in this situation, some stakeholders have suggested that a health registry of some sort should be established to look for unusual patterns of disease. Health registries can be useful if past exposures are well understood, specific disease endpoints are reasonably expected, and the exposed population is large enough that one could reasonably expect to detect a sufficient number of cases of a particular health endpoint over time (typically years) to identify a potential association with the exposure of interest. None of these conditions are present with sulfolane exposure in North Pole. That said, if some stakeholders feel as though a health registry is still warranted despite these substantial limitations, EPHP staff are dedicated to listening to their rationale for this point of view.

As has always been the case, DHSS's Environmental Public Health Program staff members are committed to continue working with the North Pole community on this issue by listening to community member concerns, staying abreast of new information as it becomes available, and responding appropriately using the best available evidence-based practices.

Is the North Pole city water safe?

Tests on water from North Pole's new city water wells have never shown detections of sulfolane. The two new wells for the City's water system are located outside of the contaminant plume and are screened at depths starting at 122 and 145 feet below ground surface. DEC issued its final operational approval for these new wells on April 30th, 2012, however an interim operational approval was granted in December 2010. The wells are now fully approved to operate without restrictions or caveats but follow a prescribed testing schedule for sulfolane, as required by DEC.

Also, tests on water <u>treated</u> by the City of North Pole's public water system have never shown a detection of sulfolane. The former North Pole drinking water wells were replaced in 2010 due to trace detections of sulfolane in the raw water in both wells. Former Well #1 had detections of up to 6 parts per billion (ppb). Former Well #2 had detections of up to 9.3 ppb. Please note that the highest detections in the untreated water were still below the recently established site-specific cleanup level of 14 ppb.

Why isn't' Flint Hills testing people's well water for benzene from past petroleum spills in addition to sulfolane?

DEC has no reason to believe that benzene has moved off of the refinery property. DEC has overseen monitoring of benzene and other compounds in groundwater at the refinery since 1986 and will continue to do so into the future. We know from examining these many years of monitoring data that benzene has not left the refinery property. If private water wells north of the property were sampled and benzene or other petroleum compounds were detected, their origin would not be from the refinery and therefore not the responsibility of Flint Hills. If you suspect that your well contains contamination other than sulfolane we encourage you to have your well tested independently.

Cleanup

Is the plume size growing or shrinking?

Investigating the three-dimensional shape and the behavior of the plume is a key objective of the site

characterization process Flint Hills is currently conducting, with DEC oversight and Technical Project Team participation. Additional monitoring wells will be installed in the summer of 2013 to improve our understanding of the plume. Sulfolane trends cannot yet be determined for some of the monitoring wells, especially those installed most recently, because there is not enough data. Therefore, definitive statements about the plume's behavior are premature at this point. There will likely be seasonal fluctuations in sulfolane concentrations, but eventually we expect the data will reflect the results of Flint Hills Resources' ongoing cleanup efforts to reduce the amount of contamination leaving the refinery.

In general, the plume concentrations do decrease in groundwater further from the refinery, but some areas have higher concentrations than others, and the contamination flow paths are not yet fully understood.

There are currently 192 monitoring and observation wells on the refinery, and 126 monitoring wells located off the refinery. Many of these locations are "nests" of monitoring wells at different depths that provide information about the vertical plume behavior. Monitoring wells have been installed to the top of permafrost or up to 150 feet deep, although none of the monitoring wells have been drilled through permafrost. More well installations are planned for targeted locations in 2013. While the horizontal or lateral extent of the plume is now fairly well understood, less is known about its vertical movement, in particular, how and where sulfolane migrates below the permafrost.

Sulfolane has been detected in private wells below permafrost as deep as 300 feet. It is extremely unusual to see contamination at that depth in the Fairbanks area. Understanding how permafrost is affecting the flow of contaminants within the plume is important so we can be sure the treatment systems are designed properly and we don't miss any movement, should it occur. Currently, Flint Hills is performing periodic sampling of selected private wells known to have depths below the permafrost. In addition, the University of Alaska, Fairbanks (UAF) is conducting research focused on acquiring additional knowledge about the effect of permafrost on groundwater flow.

Sulfolane is the only contaminant detected in groundwater off the refinery property. Other contaminants such as fuel and fuel constituents (benzene, etc.) are present in groundwater and soils at the facility. Extensive monitoring for contaminants of potential concern, however, has shown those chemicals are not leaving the property.

What are the future plans regarding monitoring and sampling the groundwater?

Sampling and monitoring the plume of sulfolane-contaminated groundwater serves to supply new data where information gaps now exist and to track plume movement or seasonal variation. Flint Hills Resources continues to collect groundwater samples four times a year from monitoring wells located both on and off of the refinery. In addition to Flint Hills' monitoring efforts, UAF researchers are studying the plume to learn more about biodegradation of sulfolane within the plume. Biodegradation is a process in which naturally-occurring microbial organisms transform or alter the structure of chemicals introduced into the environment, thus removing it from the environment by breaking it down into different simpler components.

What is DEC's cleanup level, how was it set, and how is it used?

Early in 2013,after 3 years of an extensive review of sulfolane's toxicity by close to 30 toxicologists from health and regulatory agencies, DEC announced a groundwater cleanup level of 14 parts per billion (ppb) for sulfolane at the Flint Hills Resources North Pole Refinery site. This level is protective of human health, both in terms of drinking water and water use for gardening and other general purposes. A cleanup level is the highest concentration of a hazardous substance that may be left in groundwater. This is a level that will not pose a threat to the health and safety of people in contact with the contamination or to the environment itself.

The U.S. Environmental Protection Agency (EPA) sets toxicity values for known toxic substances. The agency had never set a value for sulfolane, so DEC formally requested that EPA develop one: a Provisional Peer Reviewed Toxicity Value (PPRTV). After considering the health consults done by ATSDR in 2010 and 2011 and more than a year of their own research into previously published data, EPA established a PPRTV for sulfolane in 2012. DEC set the new cleanup level for the North Pole Refinery site based on the EPA toxicity value and a site-specific risk assessment for the North Pole Refinery.

Setting a sulfolane cleanup level for the North Pole Refinery based on EPA's analysis provides a defensible, legal basis for DEC's oversight of the cleanup at the site. After EPA established the PPRTV, the laboratory techniques for sulfolane were evaluated to ensure the detection limits were low enough to meet the new cleanup level.

Are there any other contaminants from the refinery?

While DEC and Flint Hills Resources continue their efforts to investigate and clean up sulfolane-contaminated groundwater, they're also running a parallel testing regimen for other "contaminants of potential concern." It's standard procedure that once contamination has been identified at a site, additional testing is done to ensure other types of contamination related to site operations aren't present as well.

Sulfolane is the only contaminant detected in groundwater off the refinery property. Other contaminants such as fuel, fuel constituents, including benzene, toluene, ethylbenzene, and xylenes (also known as BTEX); and perfluorinated compounds, or PFCs (man-made chemical compounds used in fire-fighting foams) are present in groundwater and/or soils at the facility. Extensive monitoring work, however, has shown those chemicals are not leaving the refinery property boundaries. Work will continue at an aggressive pace to confirm these findings and ensure nothing has been missed.

What is Flint Hills doing to clean up the contamination on the property?

DEC has given Flint Hills the goal of zero contaminant migration offsite and aggressive treatment of onsite contamination. The company has done rigorous inspections to find all potential sources of leaks and repaired them, they have enhanced the pump and treat system in an effort to minimize migration offsite through greater hydraulic control, and they are evaluating alternatives to clean up the main source areas. This evaluation of alternatives will be completed following EPA CERCLA guidelines to determine the most aggressive and appropriate system. In addition, Flint Hills will be preparing a feasibility study next year to compare potential cleanup options. A final cleanup plan will be established from the feasibility study results.

When sulfolane was discovered in the groundwater, Flint Hills already had an active groundwater extraction and treatment system for petroleum contamination on the refinery. The existing system includes a series of wells that pump contaminated groundwater out of the ground and into a treatment system that removes petroleum and sulfolane. The groundwater recovery system was upgraded in 2011 by adding a new recovery well and rehabilitating some of the existing wells. Planned upgrades for 2013 include replacement of two underperforming recovery wells and the addition of two new recovery wells. The addition in June 2011 of sand filters and granular activated carbon vessels enabled the treatment system to successfully remove sulfolane from contaminated groundwater.

Since 2009, aggressive efforts to identify and eliminate sulfolane discharges have taken place. These efforts, which consist primarily of improvements such as stopping leak points and associated procedural changes, are critical to preventing further contamination.

For more information:

www.dec.alaska.gov/spar/csp/sites/north-pole-refinery/

Get updates by email: **www.dec.alaska.gov/spar/csp/sites/north-pole-refinery/email_sulfo.htm**

Project Contacts

DEC, Spill Prevention and Response Division, Contaminated Sites Program
Tamara Cardona, Project Manager, (907) 451-2192, tamara.cardona@alaska.gov

DHSS, Division of Public Health, Epidemiology Section
Nim Ha, health educator (907) 269-8028, nim.ha@alaska.gov

DEC, Division of Environmental Health, Drinking Water Program
Cindy Christian, Compliance Program manager (907) 451-2138, cindy.christian@alaska.gov

Flint Hills Resources
Marisa Sharrah, Koch Companies Public Affairs (907) 488-5103, marisa.sharrah@kochps.com

City of North Pole
Mayor Bryce Ward (907) 488-2281, mayor@northpolealaska.com

Fairbanks North Star Borough
Mayor Luke Hopkins (907) 459-1300, mayor@co.fairbanks.ak.us