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.

September 2012

Current work seeks better understanding of plume

When the Technical Project Team for the North Pole sulfolane project evaluated questions and comments it received from the public at its recent open house, one thing was clear – North Pole residents want a clearer understanding of the current status of the sulfolane contamination plume.

"Investigating the three-dimensional shape and behavior of the plume is a key objective of the site characterization process we are currently carrying out," said Ann Farris, the TPT's project manager.

"This year, we've installed more than 100 new monitoring wells within known affected areas," she continued. "All are beginning to provide the data we need to better understand the plume."

Mapping the plume

So far, the data has enabled TPT scientists to begin mapping out the horizontal and vertical extent of the plume.

Farris said while the horizontal or lateral extent of the plume is now fairly well understood, less is known about its vertical movement.

"Shannon and Wilson (a Flint Hills contractor) has done a lot of testing from the water table down to about 60 to 80 feet, so the extent at those depths is more easily understood. However, sulfolane has also been detected in wells as deep as 300 feet," she said. "It is extremely unusual to see contamination at that depth in the Fairbanks area. It's unclear how sulfolane reached that depth or the exact extent of contamination at that depth."

Testing is now underway to determine whether faulty drinking water well casings might be responsible for localized downward contaminant migration.

If those tests prove negative, the TPT is evaluating the best methodology for drilling deeper, through permafrost, for more detailed study.

The discontinuous permafrost found throughout the plume area is playing a role in the flow of contamination, making it a bigger challenge to predict the potential for future movement, Farris said.

"Permafrost can significantly impact the flow of groundwater, both vertically and horizontally," she said. "We need to understand on a larger scale, how it's affecting the flow of contaminants within the plume so we can be sure the treatment systems are designed properly and we don't miss any movement, should it occur."

TPT members Ann Farris (top) and Nim Ha (bottom) discuss sulfolane contamination issues with affected North Pole residents at the May 1 open house.

Currently, two DEC-sponsored UAF research efforts are focused on acquiring that knowledge. Dr. David Barnes is studying hydraulic forces and groundwater flow within the plume. Dr. Yuri Shur, an internationally recognized permafrost expert, also recently joined the studies.

Understanding plume behavior

Farris said once the plume has been mapped and the physical and chemical forces affecting it well understood, scientists will be in a better position to make informed observations about its behavior.

"Trend data are not yet available for every monitoring well, so definitive statements about the plume's behavior are premature at this point," Farris said. "There will likely be seasonal fluctuations in sulfolane concentrations, but eventually we expect the data will reflect the results of ongoing cleanup efforts by Flint Hills Resources to reduce the amount of contamination leaving the refinery."

TPT's goal remains on track

Farris said the goal of this summer's ongoing site characterization work – the process of learning as much detail as possible about all aspects of a contaminated site – is to gather enough data to enable selection of the most appropriate and aggressive remediation options.

"The TPT's goal remains to have a comprehensive, aggressive cleanup plan in place by the end of 2012 that is legally binding."

See related Project Timeline on Page 4.

FHR's air sparging pilot test shows promise

Flint Hills Resources is conducting a pilot test on-site at the refinery to investigate the potential benefits of injecting air (oxygen) into the groundwater, a technique known as "air sparging."

Previous work – including monitoring of sulfolane removal across the existing on-site groundwater treatment system and supplementary bench tests – suggested that sulfolane may be removed through processes that begin with the introduction of air to the groundwater.

The air sparge pilot system uses eight air injection points installed roughly 20 feet below the water table and a blower that delivers atmospheric air to the injection points. The system also has eight groundwater monitoring wells to measure the effectiveness of sulfolane removal and 10 monitoring points to measure the distribution of air and dissolved oxygen in the groundwater.

Groundwater monitoring has been completed weekly since the startup of the test to measure the response to air injection.

The results have shown a decrease in the sulfolane concentration in every monitoring well in the pilot test area. Initial concentrations of sulfolane in the center of the test area varied from 125 to 146 parts per billion, and currently there are no detectable levels of sulfolane at those locations.

Additional analysis is being done to determine if any unintended impacts to the overall water quality may be occurring as a result of the air injection. If testing continues to show good results, additional analysis would also be necessary to determine whether air sparging can be implemented beyond the scale used for the pilot test.

The pilot test is continuing so that FHR can investigate ways to optimize the system to promote sulfolane removal. So far, the results have shown successful sulfolane removal under all conditions tested. Further testing will determine the extent of the treatment area, the necessary air injection rate to achieve sulfolane removal, and whether operational changes, such as continuous or intermittent air injection, will optimize sulfolane removal.

From the PM's Desk

Thank you to all of you who attended our May open house and shared your questions and concerns. I appreciate getting to talk to you one-on-one and hearing the concerns you bring. Many, of course, we share, but it's your direct feedback that provides the grist for each issue of this newsletter. The Technical Project Team strives for transparency on the difficult issue of sulfolane contamination, and this newsletter serves as a key outlet for reaching all of you with new information.

While the summer field season finds our scientists and researchers busy gathering data and testing solutions, it's understandable that the primary concern of affected residents is knowing the current status of the plume. In response, our top story provides an update on the knowledge the TPT has gathered to date on the plume and what remains to be accomplished. Work continues on all fronts at an accelerated pace to deepen our understanding of the sulfolane extent and viable cleanup options.

I remain optimistic we'll have a cleanup plan for addressing all aspects of the contamination by the end of the year. You will hear about the plan and have an opportunity to comment on it in early 2013, before the plan is implemented next spring and summer.

We've picked two ongoing work efforts – from among the many – to highlight. First is an article on Flint Hills Resources' testing of air sparging as a means to remediate sulfolane. Air sparging involves the injection of oxygen into the ground in a controlled way. Preliminary results show the oxygen promotes both chemical and biological degradation of sulfolane without creating any harmful side effects. This technology has been highly effective on petroleum, so if these preliminary results are confirmed, this is an exciting development.

Second, we have been very fortunate to be able to partner with the University of Alaska Fairbanks, specifically Dr. David Barnes and Dr. Mary Beth Leigh, to solve the complex problems resulting from the discontinuous permafrost and a chemical like sulfolane, whose degradation processes are not well understood, particularly in cold climates. The article on their efforts at the University of Alaska Fairbanks underlies the fact that we still have a lot to know about this site and this chemical, but substantial progress is being made.

Finally, I know how difficult it must be for some to follow the technical process and timing of this large-scale project. To help put it in perspective, we've included a fairly comprehensive timeline showing where we've been, where we are right now, and where we are going in this long-term process.

Our goal for the newsletter is always to help bring clarity to this complex issue. On behalf of the entire Technical Project Team, please be assured we are working as hard and as fast as possible to remedy this unfortunate situation. In the meantime, I hope you are working with Flint Hills to get or maintain your alternative water supply, or to get a treatment system installed.

As always, please contact me with questions or concerns.

Sincerely,
Ann Farris
TPT project manager

UAF team studies biodegradation value in cleaning up sulfolane contamination

Robert Burgess, a UAF student studying for his master's degree (left), and Jacob Howell, a high school student in the Rural Alaska Honors Institute-2 (RAHI-2) program, analyze water samples taken from within the sulfolane plume for Dr. Mary Beth Leigh.

As part of a two-year grant funded this year by DEC, University of Alaska Fairbanks researchers are studying the North Pole sulfolane contamination plume to learn more about natural attenuation. Attenuation is the process where chemicals are degraded or removed from the environment via naturally occurring processes.

One of those processes is known as biodegradation. The U.S. Environmental Protection Agency defines biodegradation as, "A process by which microbial organisms transform or alter the structure of chemicals introduced into the environment."

Scientists have found biodegradation useful in cleaning up environmental contamination – a process they call bioremediation.

"Not all microbes are bad or pathogenic," says Dr. Mary Beth Leigh, a UAF microbiologist. "In fact, most bacteria can be considered good, since they perform useful functions necessary for the effective operation of nature's processes. The entire spectrum of bacterial types coexists in varying, mixed communities throughout our environment."

Leigh said her team's challenges are to:

- Identify the potential for natural attenuation of sulfolane via bioremediation in North Pole.
- Determine whether it is already occurring and, if so, at what pace.
- Investigate ways to accelerate that process.

Ultimately, Leigh hopes to understand and encourage the growth of "good bacteria" with an appetite for sulfolane.

Confirmation and observations

In the early 1990s, scientists in Canada discovered that certain microbes found in soil and groundwater effectively degrade sulfolane over time by breaking down the molecule and using it for food and energy.

Leigh said her team's first task was to determine whether similar bacteria existed in North Pole. Little is currently known about natural attenuation in the Arctic, and whether cold, permafrost or available nutrients act to limit the growth of "good bacteria" that degrade sulfolane.

The team began by collecting and analyzing numerous soil and groundwater samples from throughout the contamination plume area. Testing soon indicated that the samples contained sulfolane-degrading bacteria.

The microbes were then cultured in the laboratory and are now undergoing DNA analysis for more detailed identification. Leigh expects the results in the next few weeks.

Leigh said the laboratory analyses have also identified differences in the composition of bacterial communities sampled from different locations in the plume area. Most notable were samples taken from within the Flint Hills Resources air sparging treatability test area (see related article, Page 2). Although definitive data is not yet available for this aerobic enhancement, Leigh said she is encouraged by the initial indications.

Outlook

Leigh's team stayed busy in the laboratory and in the field during Alaska's short summer season.

"By the end of the year, we hope to have identified many of the naturally occurring sulfolane degraders that exist within the plume area, quantified them, and gained an initial understanding of the factors that affect their activity," she said. "This information will form the basis for determining the direction of next year's research."

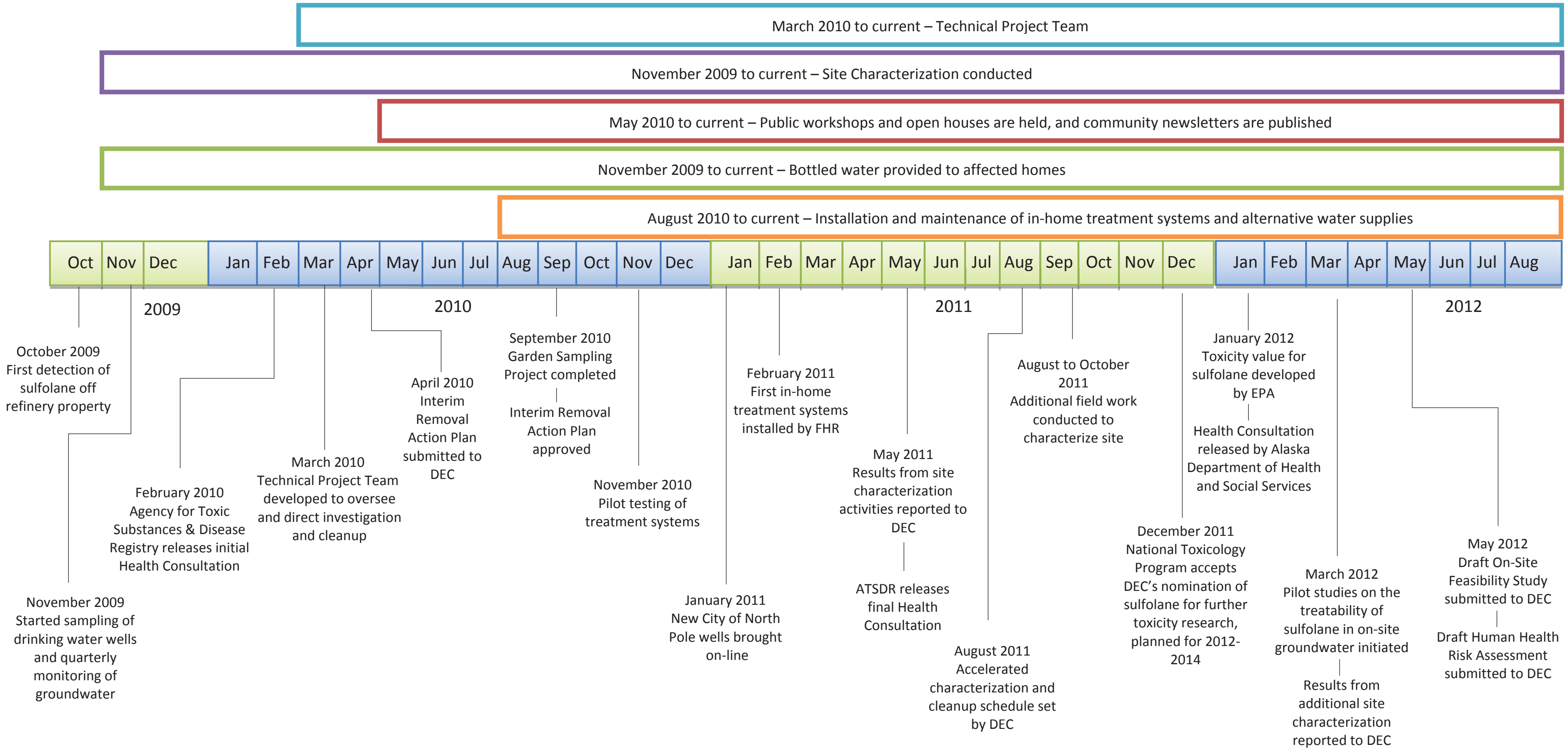
Other UAF researchers are conducting other plume studies in parallel with Leigh.

Dr. David Barnes, professor and department chair for the Civil and Environmental Engineering at the College of Engineering and Mines, is examining hydraulic forces and groundwater flow within the plume. He has also evaluated the plume model developed by a Flint Hills Resources' subcontractor, Geomega, and provided feedback.

Another UAF civil engineering professor, Dr. Yuri Shur, is studying the plume as an internationally recognized permafrost expert.

According to Ann Farris, DEC's TPT project manager, "UAF's scientific contributions are key to gaining a fuller understanding of the contaminant plume and its behavior – knowledge that will enable development of the most appropriate cleanup plan and aid DEC in effective oversight of the overall remediation effort."

Project Timeline



Project Contacts

DEC, Spill Prevention and Response Division, Contaminated Sites Program
Ann Farris, environmental engineer and TPT coordinator
(907) 451-2104, ann.farris@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

The Project Website:
dec.alaska.gov/spar/csp/sites/north-pole-refinery/

Flint Hills Resources (Continued)
Jeff Cook, Koch Companies External Affairs
(907) 488-5104, jeff.cook@kochps.com

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

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