By Ken Kopp, PG, Source Water Specialist

This photo shows the remediation building at Hanover, Kansas on September 26, 2017. Nine residences are located on or adjacent to the former CCC/USDA property.

Groundwater Remediation at Hanover, Kansas

A unique groundwater remediation project has recently commenced in Hanover, a small community of 700 residents, in Washington County, Kansas. The culprit is a plume of contaminated groundwater in the northeast corner of town, left behind as the result of a USDA grain storage facility that operated there from the 1950s through the 1970s. As was common during that time frame, a pesticide composed of carbon tetrachloride and carbon disulfide was applied as a fumigant to stored grain, which in some cases would be kept at such facilities for several years. Carbon tetrachloride has also been used for other purposes, such as the production of refrigerants, aerosol propellants, cleaning and degreasing agents and used in fire extinguishers. According to the Agency for Toxic Substances and Disease Registry ToxFAQs™ fact sheets, exposure to these chemicals can damage the liver, kidneys and nervous system. Carbon tetrachloride has been deemed to be a probable human carcinogen. It can contaminate groundwater, soil and air. Use of carbon tetrachloride as a grain fumigant and most other uses was banned by the U.S. Environmental Protection Agency (EPA) in 1985.

According to the USDA Final Corrective Action Study for the Hanover site, completed under contract by Argonne National Laboratories, the USDA Commodity Credit Corporation (CCC) initiated a large-scale temporary grain storage program in the United States, beginning in the 1940s. During its peak, the USDA-CCC operated grain storage facilities at several thousand locations nationwide. In Kansas, the Kansas Department of Health and Environment (KDHE) has sampled 273 former USDA grain storage facilities, and found 38 locations that had detectable levels of carbon tetrachloride. Of those 38 sites, 22 sites, including Hanover, were found to have groundwater samples that exceed the EPA's established drinking water limit, an MCL of 0.005 mg/L or five parts per billion (ppb).

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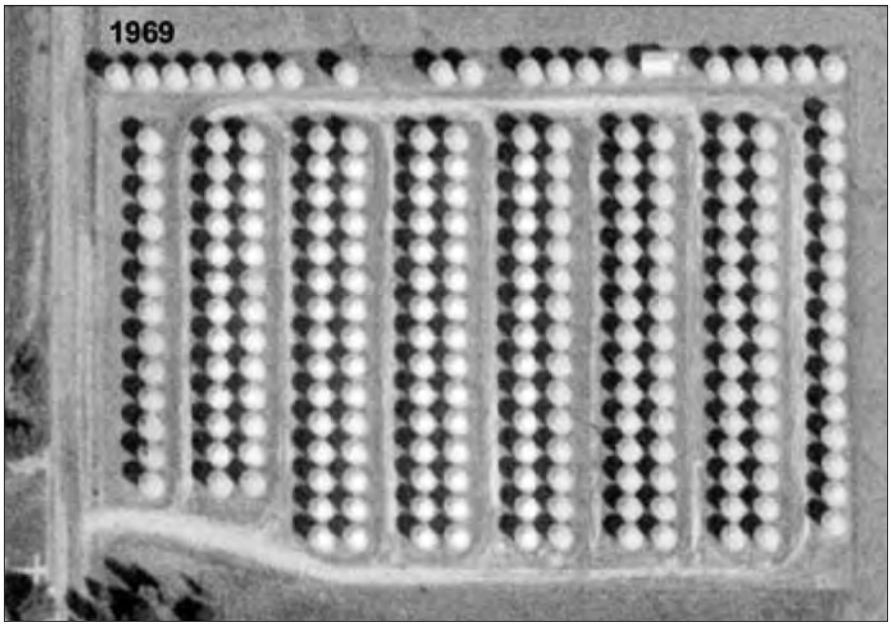
The report states that after the Hanover site was decommissioned in the 1970s, the land was sold at auction and there have been nine homes constructed on top of or adjacent to the former storage facility. By 1998, low levels of carbon tetrachloride were being detected in samples from nearby private domestic wells that were being used for lawn and garden irrigation. Soil and air sampling were later conducted in 2007, and based on the results of those tests, KDHE requested a full site



This 1969 aerial photo of grain storage bins in Hanover, Kansas is from the USDA-Argonne National Laboratory Report of Final Corrective Action.

evaluation to understand the magnitude of contamination at the Hanover site. While no significant contamination of soil was noted, the tests revealed some indoor air quality impacts and significant groundwater impacts that were above federal drinking water standards, in groundwater at the former storage site, with a plume of contaminated groundwater migrating away from the original site toward the west and southwest. There are 4 water producing layers directly underneath the Hanover USDA-CCC site. The upper layers contain detectable levels of carbon tetrachloride, while the lower layers appear to have been protected from contamination by impermeable geologic layers. Carbon tetrachloride contamination was identified in the groundwater at concentrations of up to 617 micrograms per liter in a monitoring well drilled into the upper layer on the former site. Chloroform, a byproduct from the breakdown of carbon tetrachloride, was also found in groundwater samples in these upper layers.

It should be noted that since 1974, Hanover residents have been served by Washington County RWD No. 1, which obtains its water from wells located several miles north of the former grain storage facility. Those public water supply wells have not been affected by the carbon tetrachloride contamination plume. Prior to that, the city operated their own municipal wells in the Little Blue River valley on the west edge of town, which were not in close proximity to the former USDA-CCC facility, but also not believed to have been affected by contamination.

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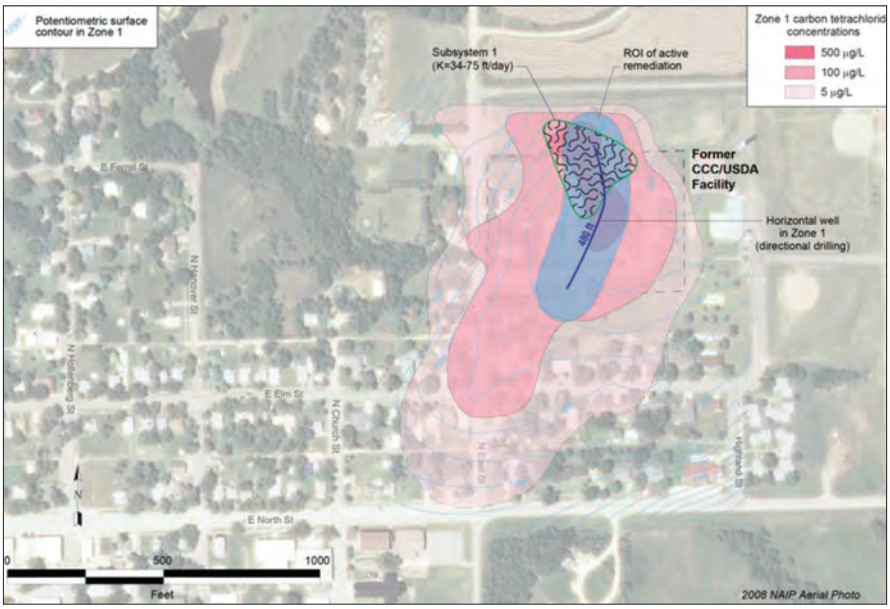
Alternatives for the project

Several remediation alternatives were proposed in the Argonne report for dealing with the groundwater contamination, from a "no action" alternative, to simply plugging affected domestic wells and controlling land use at the site with long-term groundwater monitoring. Phytotechnology, or the use of plants to carry out remediation processes, specifically natural or hybrid tree species with effective deep root systems, was also considered. Such a phytoremediation program is being utilized at a former USDA-CCC grain storage facility in Murdock, Nebraska, where 2,000 trees representing six species (Niobe willow, black willow, eastern cottonwood, hybrid poplar, green ash, and northern catalpa) cover an area of approximately 4.5 acres. Naturally occurring processes could be expected to reduce carbon tetrachloride concentrations in time. However, it was determined that none of these options would be acceptable over the long-term, since contaminated groundwater would continue to migrate and discharge as surface water, creating a potential risk to area ecology before such a stand of trees could reach maturity. Instead, a groundwater extraction option was determined to be preferable in order to provide a more immediate and increased level of protection for the local community and to protect human health. The report suggests that the preferred method would be the installation and operation of a groundwater extraction system consisting of a well or wells installed in the more permeable, highly contaminated portion of the aquifer, treatment of the extracted groundwater through a tray aerator



Extent of Hanover, Kansas carbon-tetrachloride contamination plume and proposed horizontal well placement from USDA-Argonne National Laboratory Report of Final Corrective Action.

(air stripping) system and discharge to surface waters. Once treated, water may also be used by the city or school district to irrigate the football field and other area ball fields.

A typical remediation site might utilize several conventional vertical wells to remove and treat contaminated groundwater and to control the contamination plume. What makes the Hanover remediation project unique is that the Argonne plan calls for a single angled or horizontal well to be drilled under the former site and neighboring property to collect groundwater for treatment. While angled or horizontal drilling is not a new concept in the utility world, especially to install waterlines and cabling, technological advances in the utilities and oil and gas industries have also made these drilling capabilities more economical for use in the world of water wells. Instead of several wells interfacing just a few feet of the aquifer at each well site, a single horizontal well can be used to more effectively interface (in this case) with approximately 500 feet of aquifer allowing more contaminated groundwater to be withdrawn at a much higher rate.

The Argonne plan calls for a horizontal well at a depth of 25 to 30 feet below ground surface, trending roughly from North to South-Southwest, through nearly 700 feet of the contamination plume to intersect the maximum concentrations of carbon tetrachloride in the aquifer's uppermost layer. Water will be extracted at vertical wells on each end of the horizontal portion. It is hoped that extraction of water from this uppermost layer will prevent downward migration of water into the next lower contaminated layer. Using this method, it is estimated that the contamination may be removed within approximately five years. As a protective measure, a handful of domestic lawn and garden wells that intersect the various water producing layers in the area will be abandoned and plugged to prevent movement of contaminated water between the four layers. The project is estimated to cost $1.69 million, including capital, operations and maintenance. The site will continue to be monitored for at least 30 years and reviewed at least every five years.

More information about the contamination remediation project, including the full USDA report, can be found on the Kansas Department of Health and Environment's website at http://www.kdheks.gov/remedial/site_restoration/hanover.html

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