



Ethyl Ether and Badger Army Ammunition Plant

Wisconsin Department of Natural Resources South Central Region

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Update: Ethyl Ether and Badger Army Ammunition Plant

The purpose of this update is to respond to questions we've received from the public in regard to the presence of the compound ethyl ether at and around the former Badger Army Ammunition Plant.

This update communicates basic information regarding the characteristics of ethyl ether, evaluation of site conditions and the next steps concerning ethyl ether and the groundwater monitoring program at Badger.

The most current round of questions came from groundwater sampling results collected in the fall of 2013. These results indicated five monitoring wells had elevated levels of ethyl ether (see attached map). The monitoring wells are located in the southern area of Badger; some affected wells are on-site and others are directly off-site.

All of these wells are monitoring groundwater quality just above the bedrock, approximately 200 feet below the surface. The ethyl ether concentrations for four of the five wells exceed the health-based standard set by the Wisconsin Department of Natural Resources. This standard is often referred to as the regulatory Enforcement Standard or, ES and is found in ch. NR140, Wis. Admin. Code. The ethyl ether plume is not adjacent to any private drinking water wells and given the direction of groundwater flows, no private drinking water wells are in imminent threat of being impacted.

Characteristics of Ethyl Ether

Ethyl ether ($C_2H_5OC_2H_5$), also known as diethyl ether, is an organic compound comprised of two carbon groups, ethyl, separated by an oxygen atom.

Ethyl ether has a relatively low boiling point at 94.3°F. This is the temperature at which ethyl ether changes from a liquid to a gas. It also has a very low vapor pressure at room temperature, which means it starts to change from a liquid to a gas at a temperature lower than its boiling point.

A compound with a low vapor pressure is said to evaporate easily. Alcohol used for household purposes such as rubbing alcohol is a good example of this characteristic. The alcohol evaporates so easily from your hand that it has a cooling sensation.

Ethyl ether has been used as an organic solvent and as a fuel, and has a long history of use in the field of medicine. It is flammable, having a flash point of 113°F and an auto-ignition temperature of 320°F.

The following counties are in the South Central Region: Columbia, Dane, Dodge, Green, Grant, Iowa, Jefferson, Lafayette, Richland, Rock, Sauk.

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Ethyl ether is soluble in water and has a density less than one gram per cubic centimeter (g/cm^3). It is less dense than water and will float on top of a body of water.

The ES for ethyl ether is 1,000 micrograms per liter ($\mu\text{g/L}$) which is the equivalent of 1,000 parts per billion (ppb). This is the maximum allowable concentration of ethyl ether in drinking water believed safe for human consumption.

Ethyl ether is one of many compounds that are measured as part of the volatile organic compounds (VOC) laboratory analysis for groundwater samples collected at Badger over the years. Ethyl ether is known to be naturally occurring in only a few environments and is only known to be a potential break-down product of some alcohols.

Because of the characteristics of ethyl ether, it acts very differently in soil and groundwater than other chemicals. Because it evaporates so easily, it is rarely found in high permeability surface soils such as the sands and gravels typical of Badger soils long after it is released.

The exception to this would be for significant or catastrophic releases. Ethyl ether can be trapped in low permeability soils such as clay, but because of its solubility in water, it will not be trapped for long periods if there is a high level of infiltration of precipitation or the clay is in contact with ground water. Ethyl ether dissolved in water will remain, but it diffuses quickly in the water mass and, because of the low vapor pressure, ethyl ether will evaporate from water when it comes into contact with air.

The application of this science to Badger

During the fall 2013 scheduled groundwater monitoring event, five wells near the southern boundary of Badger had elevated detections of ethyl ether. In four of these wells the concentration of ethyl ether exceeded the ES found in ch. NR 140, Wis. Admin. Code.

The department has defined a groundwater plume, based on detection of ethyl ether, at the monitoring wells. This plume has not been detected in the past and there is no evidence that the plume has migrated from another location.

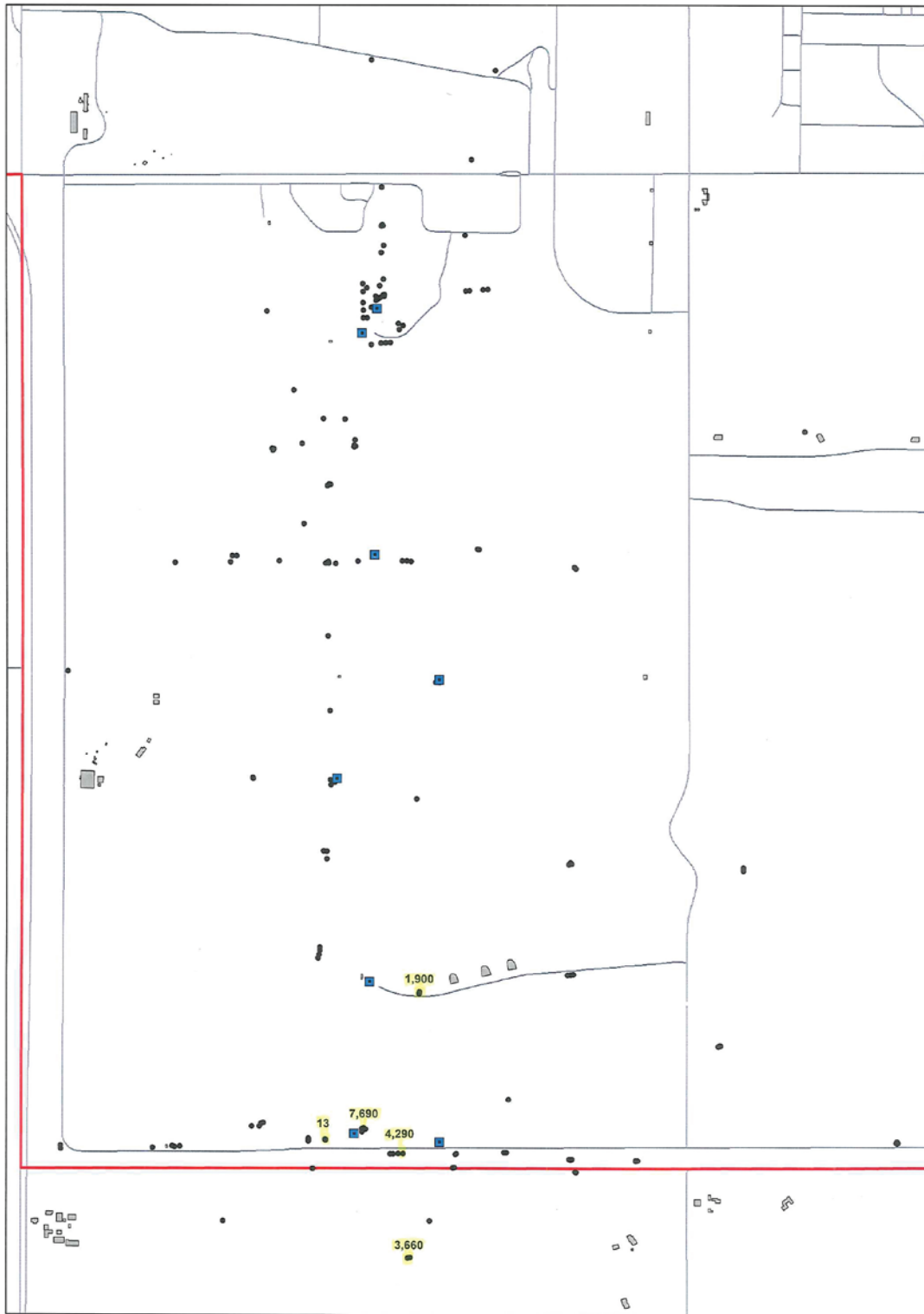
Given the history of known groundwater flow direction in this area it is anticipated that the newly detected plume of ethyl ether will follow this known plume flow direction. If this is the case, there are no private drinking water wells in the immediate path of the plume. However, the department and the Army will continue to monitor its location closely.

The Army and DNR have put significant effort into examining possible sources and explanations as to how ethyl ether got to this location in such a high concentration. We have found no conclusive evidence that would completely support or rule out any of these explanations.

What can be concluded is, given the concentration of ethyl ether found in the monitoring wells near the southern boundary of Badger, there was likely a significant or catastrophic release of ethyl ether.

While there is no direct link between the observed ethyl ether in groundwater and a known source at the site, the department will continue to look for possible sources. But more importantly, the department will continue to monitor the situation so that actions can be taken in the future, as necessary, to prevent the plume of ethyl ether from impacting a private drinking water well.

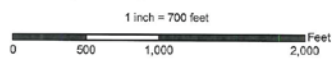
Monitoring wells detecting ethyl ether with observed concentrations of ether at each well



Legend
 ● Monitoring Well
 ■ Extraction Well
 4,290 Ethyl Ether Concentration (ug/l)

Figure 1

Ethyl Ether Fall 2013
 Badger Army Ammunition Plant



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