

L.U.S.T.LINE



A Report On Federal & State Programs To Control Leaking Underground Storage Tanks

GHOSTS ARE STAKEHOLDERS TOO!

Remediation Activities at a Historic Woonsocket, RI, Mill Are Delayed by Unexpected Events

by Sofia M. Kaczor

*I*n my wildest dreams I could not have imagined that I would receive notification that paranormal complications were delaying cleanup activities at a 130,000-gallon leaking UST removal. I have been a staff member with the Rhode Island Department of Environmental Management (RIDEM) Leaking Underground Storage Tank (LUST) Program for 20 years, and just when I'd thought I'd seen it all, surprise surprise! Jason Proulx of Proulx Environmental, the consulting firm overseeing the petroleum remediation at this LUST site, informed me of this ghostly anomaly. He told me that all demolition and contaminated soil removal activities had to stop temporarily. It had become too dangerous for the construction crew to work at the site after one of the crane operators was almost killed.



The former French Worsted Company. Demolition of the building was abruptly halted in June 2012 due to a series of unusual events.

Tank Removals in Rhode Island

The RIDEM LUST Program has been involved in overseeing and managing tank removals for almost three decades. The process for properly closing a tank involves submitting a "Permanent Closure Application for USTs," scheduling the tank removal with a Project Manager from the LUST Program, and then submitting an UST Closure Assessment Report, when necessary, documenting the tank removal activities and physical background of the site.

Once the Permanent Closure Application is reviewed and approved, we pride ourselves on being one of the few states that can easily visit and inspect every tank removal in the state (including Block Island), due to our small size.

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During these removals we have witnessed an assortment of UST permutations—tank size, contents, material of construction, settings. We've also dealt with many complications related to the physical constraints of the site, weather conditions, contractual agreements, and other factors related to the proper closing of a tank in Rhode Island.

We document each tank removal with an official inspection report that becomes a permanent record in the UST facility file, which in turn is subject to public review. Except for non-leaking heating oil USTs and certain motor fuels at farms and residences, all UST facilities must submit an UST Closure Assessment Report to document background conditions at the facility and determine if a petroleum or hazardous substance leak did occur. If a tank removal shows evidence that a release into the environment has occurred, the UST facility owner must take appropriate steps to clean up the release.



L.U.S.T.Line

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In spring 2012, the RIDEM received a "Permanent Closure Application for USTs" to remove a concrete 130,000-gallon No. 6 heating oil UST from a historic textile mill—the French Worsted Company Mill Historic District in Woonsocket, Rhode Island.

The Blackstone River Valley National Heritage Corridor

The French Worsted Company Mill Historic District is located on the banks of the Blackstone River and is part of the John H. Chafee Blackstone River Valley National Heritage Corridor, which is considered to be the "Birthplace of the American Industrial Revolution"—the place where the U.S. made the transformation from farm to factory.

The Corridor was created by an Act of Congress on November 10, 1986, to preserve and interpret the significant historic and cultural lands, waterways, and structures within the valley. It includes cities, towns, and villages along the Blackstone River, and it stretches from Worcester County in Massachusetts to Providence County in Rhode Island.

America's first water-powered cotton textile mill was Slater Mill, built along the Blackstone River about 11 miles to the south of our subject site. Samuel Slater was the first to bring (smuggle) British classified textile technology to America. The firm of Almy, Brown, and Slater began spinning cotton on December 20, 1790. The new Slater Mill, which is now a museum, was built in 1793 and continued to spin cotton for three decades.

The success of these extremely profitable textile mill ventures was due in large part to the cheap labor, consisting of male immigrants and women and children in descending order of salary expectations. The workweek at these textile mills was typically 14-hour days, six days a week. Conditions were notoriously dangerous; workers were killed and maimed routinely (a fitting environment for unsettled spirits). However, in spite of the meager salaries, long hours, and dangerous conditions, these jobs were sought after over farm work.

The success of Slater Mill inspired other entrepreneurs to build their own mills in the Blackstone

Valley and later throughout New England. Woonsocket was on the road to becoming the home for the so-called "French Mills," largely due to the work of Aram J. Pothier, who became the first French-Canadian governor of Rhode Island. In 1889, as an official Rhode Island delegate to the Paris Trade Exposition, Pothier took the opportunity to meet and visit European textile manufacturers, particularly the old manufacturing families of Northern France and Belgium.

Pothier felt that Woonsocket needed foreign capital investment to grow, and he persuaded some of these companies to come to Woonsocket. He noted that Woonsocket had an abundant supply of skilled labor that could be easily trained and, moreover, that spoke French. By producing goods in Woonsocket, these companies could sell in the American market without having to pay high U.S. tariffs.

The French Worsted Company Mill complex was constructed between 1906 and 1939 and was added to the National Register of Historic Places on May 21, 2008. It was established as the American Branch of Charles Tiberghien and Sons of Tourcoing, France. They already had textile plants in Austria and Czechoslovakia when they started in Woonsocket. Aided by a 15-year tax exemption obtained in 1906 through the offices of Adam Pothier, the investors built a five-story building at 153 Hamlet Avenue (the site of our 130,000-gallon UST) across the street from the Lafayette Worsted Company (the first French spinning mill in Woonsocket).

By 1910, more than 400 persons were employed at the French Worsted Company Mill. By 1930, 600 workers operated 24 worsted carding machines, 50 worsted combs, and 50 spinning mules with 28,000 spindles. It is important to note that children were still a significant part of the textile labor force in the early 1900s. Particularly in the large French-Canadian families, children left school as soon as they were old enough to hold a job and contribute to the support of the family unit. In 1904 a state inspection found 568 children among the 8,099 mill hands in Woonsocket.

Removing the 130,000-Gallon No. 6 Fuel-Oil UST

The tank removal was scheduled as part of a larger development project. It had to be scheduled simultaneously with other active demolition activities taking place at the French Worsted Company Mill Historic District. The removal activities began in April 2012 and included the removal of the concrete tank structure. Prior to the removal activities, the 5,000 gallons of virgin No. 6 fuel oil still in the UST were properly disposed of. The tank was rinsed and cleaned; oily water generated during this process was also properly disposed of.

During the first RIDEM visit to this site, I met with Jason Proulx, who updated me on the location and

During the demolition period, a series of unexpected events brought the whole operation to a halt! The main actor in the drama was a very large crane-wrecker used to remove structural columns and beams, an operation that required systematic removal. For several days when the crane-wrecker would approach the mill building attached to the boiler room, specifically near the third floor, it would unexpectedly malfunction or shut down.

condition of the UST system. The UST, constructed of 12-inch thick concrete reinforced with steel rebar, was approximately 50 feet in length, 50 feet in width, and approximately 8 feet in depth. The UST consisted of three sections, two of 60,000-gallon capacity and one central section of 10,000-gallon capacity. The age of the tank was unknown, since evidence of coal in the tank grave indicated that coal was initially used for heating purposes.

Fuel delivery to the concrete UST was accomplished using a cargo train located on an elevated track in the immediate vicinity of the UST. The fuel oil was emptied into a five-foot steel funnel connected by trough



Jason Proulx (second from left) standing with RIDEM staff over the soon to be excavated contaminated-petroleum soils area. In the background, a crane is gingerly wrecking accessible areas of the main mill building of the former French Worsted Company. The right side of the building, however, could not be accessed at the time that this photo was taken.

product lines to the UST. Three adjacent boilers were fueled by the concrete UST units, which were used to heat the 6.5-acre mill complex. Just north of the boiler room, was a 150-foot high smokestack.

Petroleum-impacted soils were identified during the UST closure activities. While identifying the nature and extent of the petroleum release, it was apparent that the No. 6 fuel oil had migrated from multiple sources such as the steel funnel, lines between the UST and the boilers, and the drains beneath the boilers, which were constructed of bricks. Petroleum contamination was attributed to at least the three identified sources. Once the release was characterized, the extent of petroleum-impacted soil had to be defined and then removed over a period of several months. One of the main obstacles during the soil removal activities was the demolition of one of the mill buildings attached to the boiler room.

The Obstacles

During the demolition period, a series of unexpected events brought the whole operation to a halt! The main actor in the drama was a very large crane-wrecker used to remove

structural columns and beams, an operation that required systematic removal. For several days when the crane-wrecker would approach the mill building attached to the boiler room, specifically near the third floor, it would unexpectedly malfunction or shut down. The crew witnessed these malfunctions and removed the crane-wrecker from the demolition site. The crane-wrecker was taken apart by the crew at their yard; they could not find any problems with it.

Determined to work through these obstacles, the wrecking company continued with demolition. The last straw, however, was when the crane operator saw a large wooden beam from the floor of the mill building, bounce onto the ground in an almost "guided manner" and then fly directly at him while he was inside the cab. Something made him flinch and move away at the last minute. The protective glass in the excavator cab saved him from being impaled!

The Solution

At this point, the LUST Program received notification that the wreck-

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View of the front main mill building of the former French Worsted Company. Demolition activities were halted near the left side of the building, where the windows are boarded up (see circled area), due to unexplained equipment breakdowns and dangerous work incidents. The two mediums climbed up to this area and conducted a "clearing."

ing company was extremely troubled by this sequence of events and was forced to look into the possibility that something a bit, um, ghostly was taking place. Andrew Lake, a paranormal researcher and investigator of Greenville Paranormal in Rhode Island, was asked to come to the site to determine if there was, in fact, paranormal activity. Lake described his first visit to the site as a somber one, where the demolition crew appeared quite grave.

On his second visit, Lake arrived accompanied by two fellow paranormal "medium" researchers who climbed up to the building's third-floor area of concern. They quickly found that there was indeed paranormal activity related to specific people, including a young boy, who had worked and possibly died at the mill. The two mediums then conducted a "clearing" that involved contacting the troubled spirits and letting them "move on."

Since this event may well be the first time such unusual events delayed remediation progress at a LUST case in Rhode Island, we could only note the results and determine that appropriate actions were taken to solve this "ghost" issue. The para-

normal investigators/researchers claimed that they were able to pacify the troubled spirits and averted further construction and remediation delays. After that intervention, work proceeded calmly and according to schedule.

After demolition of the building took place, the remedial activities were finalized by the consultant and contractor hired by the property owner. An UST Closure Report was submitted by Proulx Environmental and reviewed by the LUST Program. Based on the results of the report, remediation was deemed successful

and environmental compliance was achieved. A letter of "No Further Action" was issued and the LUST case was subsequently closed. In the end, all stakeholders, living and dead, were satisfied. ■

Sofia Kaczor is a Principal Environmental Scientist with the LUST Program of the Rhode Island Department of Environmental Management. She can be reached at sofia.kaczor@dem.ri.gov. Sofia acknowledges contributions from Jason Proulx, who provided additional details of the UST removal activities not included in the UST Closure Report.

FYI: RIDEM's offices are located at the Former Brown & Sharpe Manufacturing Company (1876–1916), a famous mill in Providence, Rhode Island.

DISCLAIMER: This is a factual account of the events that took place during the closure of the subject UST.

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What's the Deal with Methane at LUST Spill Sites?

Part 2: Vapor Intrusion

by John T. Wilson, Mark Toso, Doug Mackay, Nick de Sieyes, and George E. DeVaul

In Part 1 of this two-part series we discussed methane produced from releases of ethanol and gasoline-ethanol mixtures (LUSTLine #71). In Part 2 we discuss methane gas specifically with regard to petroleum vapor intrusion at LUST sites.

Vapor intrusion is a process whereby vapors of hazardous substances move through unsaturated soil and enter buildings. Occupants of the buildings are exposed to the hazardous substances as vapors in indoor air. Motor fuel from a leaking UST system may generate petroleum hydrocarbon vapors, creating a petroleum vapor intrusion (PVI) situation. The vapors may originate from contaminated groundwater or from non-aqueous phase liquids (NAPLs).

Vapor Intrusion and Petroleum Hydrocarbons

The default conceptual model for vapor intrusion is built around experiences with chlorinated solvents such as TCE and PCE (USEPA, 2012). The vapors of chlorinated solvents are not biologically degraded in soil gas. As a result, the rate of intrusion is controlled by the diffusion of the vapors from the source of contamination to the receptor. However, the behavior of petroleum vapors is more complex. When oxygen is available in the soil gas, the vapors of petroleum hydrocarbons are biologically degraded.

Under typical conditions, hydrocarbon vapors diffuse upward in the unsaturated zone from their source and oxygen from the atmosphere diffuses downward into the unsaturated zone. Most of the hydrocarbon vapors are aerobically degraded where the two diffusion paths meet. This relationship is illustrated in Figure 1. The data are from an aviation gasoline spill in fine sand at a site in central Michigan (Table 5 of Ostendorf and Kampbell, 1991). The maximum concentration of hydrocarbon vapors was associated with LNAP at a depth of five meters (Panel A of Figure 1). There was a linear decrease in the concentrations of hydrocarbon vapors with decrease in depth until an inflection point was

reached at a depth of three meters. Starting at a depth of one meter, there was a linear decrease in the concentrations of oxygen with increase in depth, until the same inflection point at a depth of three meters.

Panel A of Figure 1 plots the data in conventional units. Panel B replots the data on hydrocarbon vapors in terms of the theoretical oxygen demand of the vapors. Notice that the concentration gradient of oxygen is the inverse of the concentration gradient of oxygen demand. The behavior of the petroleum hydrocarbon vapors can be described mathematically by assuming that the oxygen demand of the hydrocarbon vapors that diffuse upward from the source is balanced by

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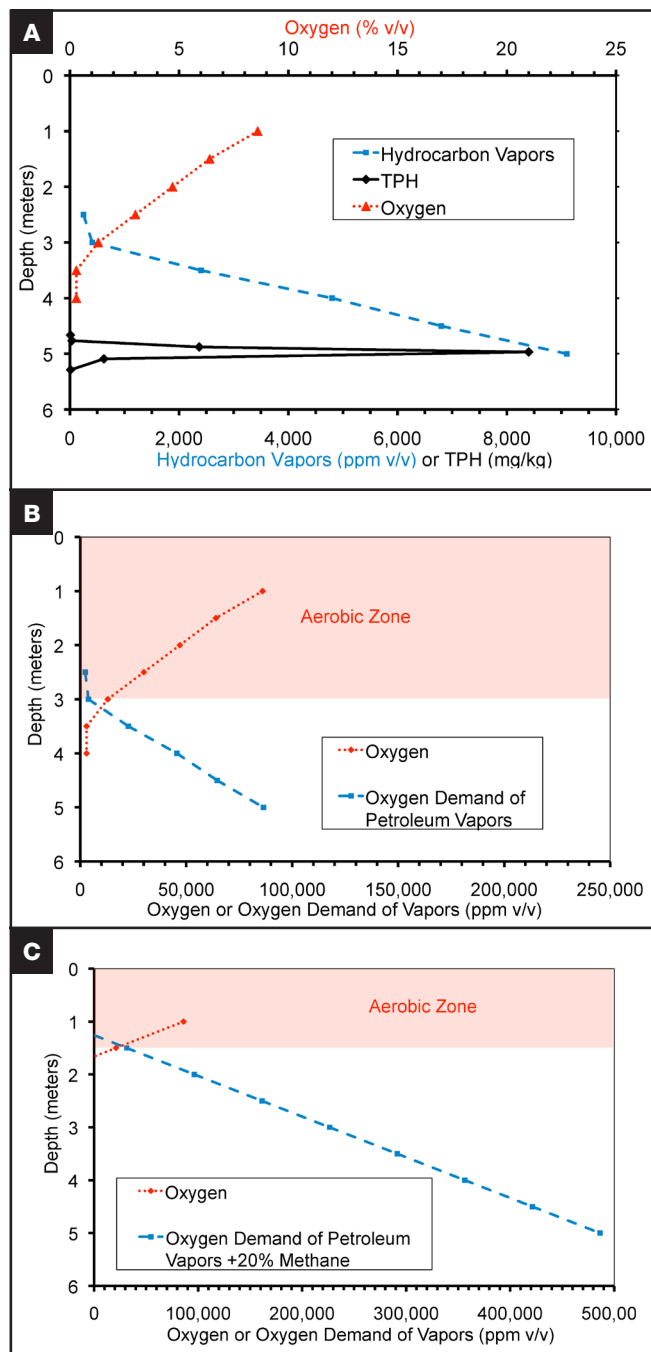


FIGURE 1. Interaction between the concentrations of oxygen and the concentrations of hydrocarbon vapors during aerobic biodegradation of the hydrocarbons in soil gas.

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the supply of oxygen that is diffusing downward into the soil from the soil surface or from the receptor (Ostendorf and Kampbell, 1991; DeVaul, 2007; Abreu et al., 2009).

Whenever the concentration of oxygen is adequate to allow aerobic biodegradation, the biodegradation of individual hydrocarbons in the aerobic zone is modeled by applying a pseudo first order rate constant for biodegradation. The thicker the aerobic zone, the more time spent by hydrocarbon vapors as they diffuse upward to a receptor, the more opportunity for biodegradation, and the lower the final concentration of hydrocarbon vapors when they reach the receptor.

The biodegradation of methane produced from releases of ethanol and gasoline-ethanol mixtures in the subsurface consumes oxygen that would otherwise be available for benzene biodegradation. This is illustrated in Panel C of Figure 1. The panel depicts the depth of the aerobic zone that would be expected if the petroleum hydrocarbons were accompanied by 20 percent methane in the soil gas. The thickness of the aerobic zone would be reduced by half. This can have a profound effect on the concentration of an individual petroleum hydrocarbon (e.g., benzene) that reaches the receptor. Assume that concentration of benzene is reduced tenfold whenever it diffuses across a meter of the aerobic zone. In Figure 1 (B), the concentration would be reduced 1,000-fold by biodegradation. In Figure 1 (C), the concentration would only be reduced 30-fold.

DeVaul et al. (2009) used this conceptual model of vapor biodegradation in soil to create a computer application that can be used to screen sites for PVI. The BioVapor model is available from the API at www.api.org/pvi. Ma et al. (2012) used the BioVapor model to forecast the interactions between the concentration of methane in soil gas and the expected concentrations of benzene in indoor air. Their simulations are reproduced in Figure 2. In their simulation, the vertical separation distance between the source of contamination and the building was five meters (16 feet).

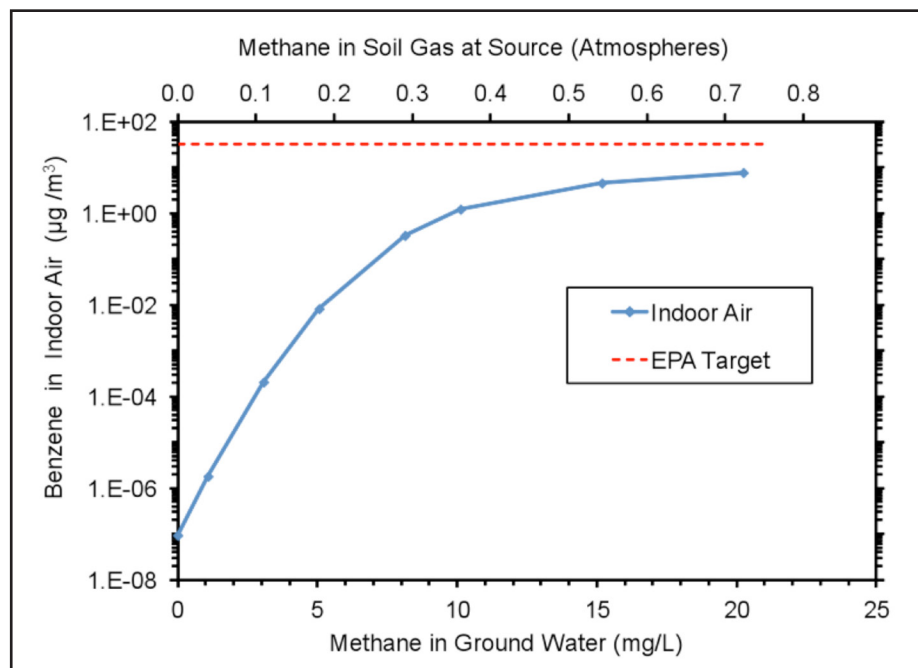


FIGURE 2. Effects of methane in soil gas on the possibility of the intrusion of benzene vapors into a building that is 16 feet above the source of the vapors. Adapted with permission from Figure 6 of Ma et al. (2012). © 2012 American Chemical Society. Note that the USEPA target air concentration corresponds to a 10^{-4} lifetime risk.

At low concentrations of methane, the predicted concentrations of benzene in indoor air were very low. When concentrations of methane in soil gas exceeded approximately 300,000 ppmv (corresponding to about 10 mg/L in groundwater) the predicted concentration of benzene in indoor air approached the USEPA target concentration for indoor air (USEPA, 2002, Table 2a). The forecast in Figure 2 applies for the assumptions specified in Ma et al. (2012), and for a separation distance of 16 feet. If you wish to calibrate BioVapor to the particular conditions that pertain at your site, the model is available at www.api.org/pvi. However, the simulations indicate that when the separation distance at a site is less than ten feet, and the concentrations of methane in soil gas are high, there is a possibility that methane will increase the risk for petroleum vapor intrusion.

How much methane is out there at LUST sites? Jewell and Wilson (2011) surveyed the concentrations of methane in soil gas at service stations in Oklahoma that had experienced a recent release of gasoline. They used a simple screening approach provided by Abreu et al. (2009) to determine whether the presence or absence of methane in the soil gas had an effect on the possibility of

petroleum vapor intrusion. At three of eleven sites, the methane in the soil could have caused unacceptable concentrations of benzene at a hypothetical receptor.

At one site, the methane came from a leak of natural gas. At the other two sites, the methane was produced by biodegradation of the fuel spill. At one of the two sites, the receptor was more than hypothetical. The Petroleum Storage Tank Division of the Oklahoma Corporation Commission responded and required the installation of sub-slab monitoring points. As it turned out, the concentrations of methane and gasoline hydrocarbons in soil gas below the slab were low. There was no risk of petroleum vapor intrusion.

What's the Impact of Methane Production on Petroleum Vapor Intrusion?

The BioVapor model assumes that the soil gas in contact with the capillary fringe is in equilibrium with groundwater sampled by monitoring wells. The diffusion coefficient of oxygen in soil gas is much higher than the diffusion coefficient of methane in water. If there is adequate transport of oxygen to support the biodegradation of methane in the capillary fringe, this assumption is very conservative. The achieved con-

centrations of methane in soil gas are much less than would be expected from concentrations in the groundwater.

This proved to be the case in the sand tank study reported by Ma et al. (2012). Methane concentrations in groundwater were 20 mg/L or more. The concentration of methane in soil

concentration measured in soil gas in the vicinity of gasoline LNAPL (Lahvis et al., 2012). In the simulation, the concentrations of toluene, ethylbenzene, mixed xylenes, and 2,2,4-trimethylpentane were set at 8.3×10^5 , 3.5×10^5 , 8.5×10^5 , and $6.7 \times 10^7 \mu\text{g}/\text{m}^3$ respectively. To model vapor in contact with groundwater we omitted

bon level of $f_{oc} = 0.005 \text{ g/g-soil}$. The scenarios include both a concrete basement (or slab-on-grade) and a dirt-floor crawlspace for comparison. The results of the model simulations are plotted in Figure 3.

The maximum tolerated concentrations of benzene should be higher when the competing oxygen

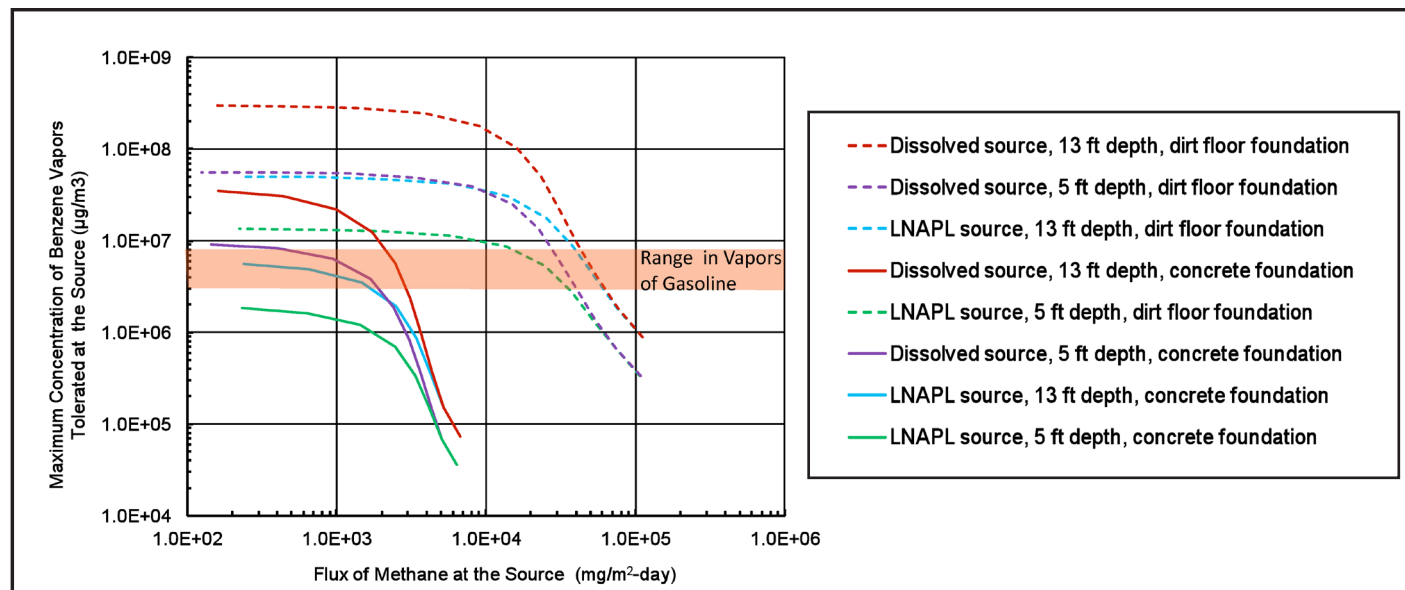


FIGURE 3. Interaction between the rate of production of methane and the calculated acceptable concentration of benzene in soil gas at the source of contamination. Source depth is specified at 5 and 13 feet. Indoor air benzene criteria is specified at $31 \mu\text{g}/\text{m}^3$, corresponding to a 10^{-4} lifetime risk. Oxygen below the concrete foundation is limited by an effective airflow through the foundation of 5 L/min. Oxygen at depth in soils below the dirt floor foundation is limited by diffusion through the soil layer. The filled shape is a plausible range for concentrations of benzene in soil gas in contact with NAPL-phase gasoline. The order in the legend corresponds to the position in the chart extending from top to bottom on the left-hand side of the chart.

gas predicted from the Henry's Law Constant (at 50°F) is near 700,000 ppm_v (compare the upper and lower axis of Figure 2). The measured concentration of methane in the soil gas just above the capillary fringe was only 4,900 ppm_v .

If the methane were to leave the groundwater in bubbles and move directly into the soil gas, the impact would be a combination of the concentration of methane in the bubble and the rate of transfer of the bubbles into the soil gas. We used BioVapor to evaluate the impact. The overall model assumptions were the same as described in Ma et al. (2012). We compared two sources of vapors: (1) vapors from residual LNAPL gasoline hydrocarbon and (2) vapors originating from dissolution of BTEX water-soluble gasoline hydrocarbon constituents into groundwater.

To model vapor in contact with LNAPL we used concentrations of hydrocarbons that correspond to the approximate upper bound on the

2,2,4-trimethylpentane because it has a low solubility in water. However, we used the same concentrations of the TEX compounds.

The simulations were set up to estimate the maximum concentration of benzene that can be tolerated in the soil gas at the source if the concentration of benzene in indoor air is to be less than the USEPA Target Concentration ($31 \mu\text{g}/\text{m}^3$, see Table 2a of USEPA, 2002). That concentration of benzene in indoor air corresponds to a 10^{-4} lifetime risk. This means that if a person were to breathe that concentration of benzene for a lifetime, the chance that he or she would die of a disease related to breathing the benzene is 1 in 10,000.

The maximum concentration was estimated for various combinations of the efflux of methane and the separation between the source and receptor. The oxygen demand due to baseline soil respiration is included, with an assumed soil organic car-

bon demands of methane and the other gasoline hydrocarbons are lower. Because the simulations of a LNAPL source had 2,2,4-trimethylpentane as a representative volatile alkane, there was extra oxygen demand associated with the volatile alkanes compared to the simulations for a dissolved source. As a result, the maximum tolerated concentrations of benzene in the simulations of the LNAPL sources were lower than for the dissolved sources.

As would be expected, the maximum tolerated concentrations of benzene when the source is at a depth of 13 feet are greater than when the source is at 5 feet. The additional depth provides more opportunity for degradation of hydrocarbons before benzene vapors reach the soil surface.

For the concrete basement, if the efflux of methane is less than approximately 300 to 400 $\text{mg}/\text{m}^2\text{-day}$, there was minimal effect on benzene

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concentrations in indoor air in any of the simulations. At much higher values for the efflux of methane at the source, the effect on benzene attenuation can be substantial. For the dirt-floor crawlspace, minimal effects are evident for methane flux values of approximately 3,000 to 4,000 mg/m²-day, or about one order of magnitude higher than for the concrete basement.

As the methane flux from the source increases, the curves for the dissolved source and the LNAPL source converge. At the point where the lines converge, methane totally dominates the oxygen demand and the demand associated with 6.7x10⁷ µg/m³ of 2,2,4-trimethylpentane is trivial.

In our concrete basement (or slab-on-grade) simulations the availability of oxygen is limited by an assumed nominal flow of air through cracks in the foundation of the building. We assumed the air flow was 83 cm³ per sec (Qs in the model), that the relative surface area occupied by cracks in the foundation was 0.000377 m²/m², and that the surface area of the foundation was 106 m². Flow of air through the cracks would deliver oxygen at the rate of 11,300 mg/m²-day. Four parts oxygen are required to degrade one part of methane.

This flux of air into the subsurface can support the aerobic degradation of 2,800 mg/m²-day of methane. Notice that the tolerated concentration of benzene in our simulations plummets when the efflux of methane is greater than 2,000 mg/m²-day. If the cracks are larger, or if the airflow is larger, then more methane and gasoline hydrocarbons can be degraded and the impact to indoor air will be less.

For the dirt-floor crawlspace scenario, oxygen flow into the subsurface is limited by diffusion into the subsurface soil layer. Substantial decreases in the tolerable concentration of benzene in the source occur but at much higher values of methane flux than for the concrete basement scenario.

The filled shape in Figure 3 compares the tolerated concentrations of benzene in soil gas to the concen-

trations that might reasonably be expected. Harley et al. (2000) found that benzene comprised 0.4 percent of hydrocarbon vapors in air above gasoline. If the vapor pressure of the gasoline was one half of an atmosphere, this would correspond to a vapor concentration of benzene of 8.3·10⁶ µg/m³. Lahvis et al. (2012) measured the concentrations of benzene in soil gas in the vicinity of gasoline LNAPL. The upper bound on the measured concentrations was near 3·10⁶ µg/m³. The filled shape corresponds to the range between these two estimates.

In instances where the building had a concrete foundation, the separation distance was five feet, and the source was NAPL, it didn't matter what the flux of methane was. The tolerated concentration of benzene in soil gas was far below the plausible concentrations. PVI might be a problem. If the separation distance was 13 feet with a NAPL source and a concrete foundation, the tolerated concentrations were greater than the plausible concentrations whenever the methane flux was less than about 2,000 mg/m²-day.

If the contamination was in groundwater, the tolerated concentrations with a concrete foundation were also greater than the plausible concentrations whenever the methane flux was less than about 2,000 mg/m²-day. If the building had a dirt floor, the tolerated concentrations of benzene were greater than the plausible concentrations whenever the methane flux was less than about 10,000 mg/m²-day.

The BioVapor model presumes that diffusion in soil gas is dominant over flow by advection. Numerical modeling results that include the effect of advective soil gas flow are presented by Jourabchi et al. (2012) in similar modeled scenarios, and are reasonably consistent with the results presented here. The effects of advection become significant in these scenarios at higher methane source flux values (on the order of 10,000 mg/m²-day and greater). Remember these model scenarios do not apply to all soils under all conditions. Advective effects can also be more significant relative to diffusion in wetter soils when air-filled porosity is not connected (air-filled porosity less than approximately 0.1 to 0.2

m³/m³), principally because of lower diffusion rates of gases and vapors in the wetter soils.

How Much Methane Can You Expect from Ethanol Biodegradation?

What is the chance that methane from a spill of E85 or denatured fuel-grade ethanol (E95) would produce so much methane that it would exceed the supply of oxygen and overwhelm the natural capacity for methane aerobic biodegradation in the soil gas? The answer depends in part on how fast the ethanol is degraded to acetate, which then can be degraded to methane. Table 1 presents zero-order rate constants for ethanol degradation at four sites in the U.S., one site in Brazil, and two different experiments at one site in Canada. The highest rate of biodegradation was on Vandenberg AFB, California (500 mg/L-day). Although methane was produced at this site, the groundwater was sulfate-reducing and the rates may not be typical. The other sites ranged from 1.4 mg/L-day to 55 mg/L-day with a median of 14 mg/L-day. It is reasonable to expect a LUST site to fall into this range.

The production of methane also depends on the stoichiometry of ethanol to methane degradation, and the thickness of the water column that is contaminated with ethanol and is methanogenic. Figure 4 estimates the production and potential release of methane as a function of the thickness of the water column. The calculation assumes that two molecules of ethanol degraded to make three molecules of methane (reaction 8 on page 10) and that the porosity of the aquifer was 0.25.

Over the known range in rates of ethanol degradation and the typical thickness for plumes at LUST sites, the rate of methane production should vary from 100 to 100,000 mg/m²-day. Compare the methane production to the methane flux that can be tolerated before methane increases the possibility of methane intrusion in a structure with either a basement or a slab-on-grade foundation (Figure 3). For most conditions, the production of methane will exceed the flux that can be tolerated before there is an impact on indoor air.

Site	Spill	Initial Conc.	Final Conc.	Travel Distance	Estimated Travel Time	Ethanol Degradation	Reference
		mg/L	mg/L	Feet		mg/L-day	
Ontario, Canada	50 L Gasoline with 10% Ethanol	1390	560	51	1.6 years	1.4*	Mocanu et al. (2006)
Florianopolis, Brazil	100 L Gasoline 24% Ethanol	2503	ND	28	3 years	2.3*	Corseuil et al. (2000)
Florianopolis, Brazil	100 L Gasoline 24% Ethanol	2503	Half life 1.5 years or first order rate constant of 0.00127 per day			3.2**	Corseuil et al. (2011)
Florida	Ethanol solution in water	10,000	Half life 0.33 years or first order rate constant of 0.000903 per day			9.0**	Mravik et al. (2003)
Platte Valley, Nebraska	Ethanol solution in water	190	4.4	20	13 days	14*	Zhang et al. (2006)
Platte Valley, Nebraska	Ethanol solution in water	190	Half life 2.2 days or first order rate constant of 0.32 per day			61**	Zhang et al. (2006)
Ontario, Canada	50 L of Ethanol with 5% Gasoline	15700	5030	51	1.6 years	18*	Mocanu et al. (2006)
Tigard, Oregon	72,000 L Denatured Ethanol	16,000	<50 mg/L	260	0.8 years	55*	McDowell et al. (2003) Buscheck et al. (2001)
Vandenberg AFB, California	Ethanol solution in water	~500	<1 mg/L	1.5	1 day	500*	Mackay et al. (2006)

* Calculated by subtracting the final concentration from the initial concentration, then dividing by the estimated travel time.

** Calculated by multiplying the initial concentration by the first order rate constant.

TABLE 1. Rates of ethanol degradation in groundwater.

■ Use Equation (1) to estimate the rate of production of methane at your LUST site.

Equation 1

$$P = 0.3048 \cdot D \cdot 0.232 \cdot R \cdot \Theta$$

In Equation (1):

P is the rate of methane production in mg/m²-day.

R is the rate of ethanol degradation in mg/L-day.

D is the thickness of the plume in feet.

Θ is the water-filled porosity as a fraction.

The coefficient of 0.3048 in Equation (1) converts feet to meters and the coefficient of 0.232 converts the mass of ethanol degraded to the mass of methane produced.

Select an estimate of *R* that is appropriate to your site. If your site is nutrient-poor or if the water is cold, use a lower value. If the temperature is above 60° F, and the soils above the aquifer are fertile, select the median rate. If the aquifer is warm and nutrient rich, and the spill is more than five years old, you might select the highest rate. If you have information on the distribution of the plume of ethanol in groundwater, calibrate the FOOTPRINT model to your site (Ahsanuzzaman

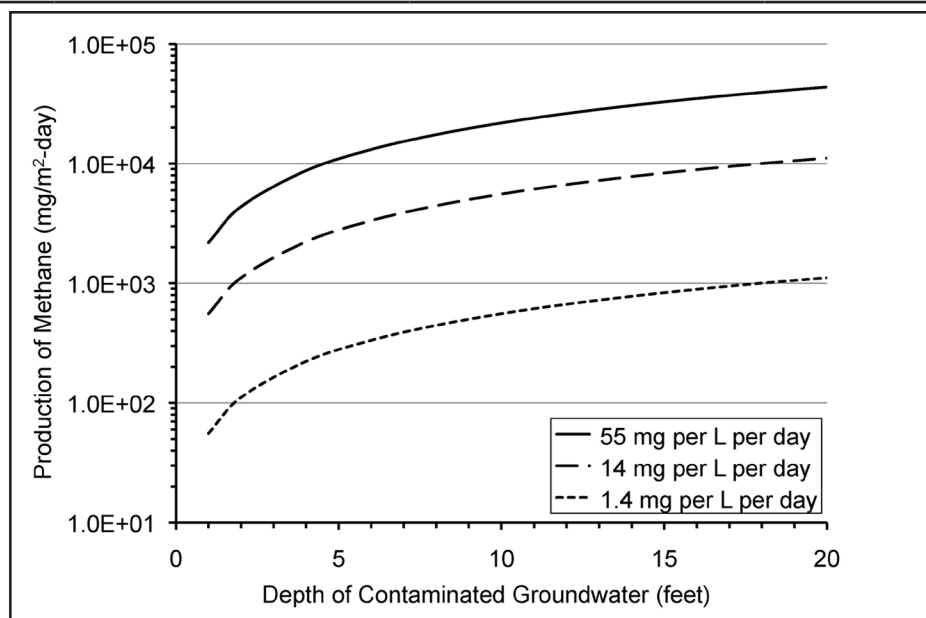


FIGURE 4. The production and efflux of methane that can be expected based on the rate of degradation of ethanol and the depth interval in the aquifer containing ethanol.

et al., 2008). Enter values for the zero-order rate constant into FOOTPRINT until the model matches the true disposition of the plume. Then use that value for *R*.

Acetate is a metabolic intermediate in the degradation of ethanol to methane. Equation (1) assumes that acetate does not accumulate. In other words, Equation (1) assumes that acetate is degraded to methane as fast as acetate is produced from degradation of ethanol. Equation (1) also assumes that groundwater is

saturated with methane and that the methane leaves the groundwater as soon as it is produced.

Recent studies show that ethanol tends to accumulate in the capillary fringe (Stafford et al., 2009). If you have information on the texture of the geological material and can use that knowledge to estimate the thickness of the capillary fringe, then add that value to the depth interval of contaminated groundwater to get a value for *D* in Equation (1).

■ continued on page 10

■ Methane at LUST Spill Sites *from page 9***Details on Methane Production from Ethanol Biodegradation**

The biodegradation of ethanol to form methane is a two-step process. In the first step, bacteria ferment ethanol to produce acetate and molecular hydrogen (reaction 1).



In the second step, the acetate and hydrogen are metabolized to make methane. One group of methanogenic bacteria ferments the acetate to make methane and bicarbonate ion (reaction 2).



The yield of methane and carbon dioxide from ethanol depends on what happens to the molecular hydrogen in reaction 1. In one possibility, another group of methanogenic bacteria directly metabolize hydrogen and bicarbonate to make methane (reaction 3).



In a second possibility yet another group of bacteria can use the hydrogen and bicarbonate to make even more acetate (reaction 4). These organisms are called acetogenic bacteria. They are not tolerant of oxygen, and they grow slowly.



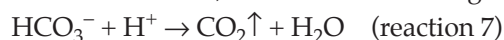
If all of the molecular hydrogen is used to make acetate, there will be a total of three molecules of acetate produced for each two molecules of ethanol consumed (reaction 5 = reaction 1 plus 4).



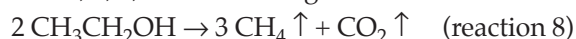
Fermentation of the three molecules of acetate will produce three molecules of methane (reaction 6).



Bicarbonate ion is produced by reaction 2. As the concentrations increase, the bicarbonate can accept a hydrogen ion to form carbon dioxide, which can leave the groundwater as a gas (reaction 7).



Reactions 1, 2, 3, and 7 sum to give reaction 8. Reactions 1, 4, 6, and 7 also sum to give reaction 8.

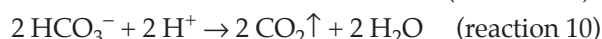


At equilibrium, any bubble that is produced following reaction 8 would be 75% methane and 25% carbon dioxide. Organisms that ferment acetate or hydrogen to form methane are not tolerant of oxygen, and they grow slowly.

Another group of bacteria, the sulfate-reducing bacteria, can use the molecular hydrogen to reduce sulfate to sulfide (reaction 9).



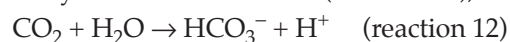
These organisms grow rapidly. If sulfate is available, most of the molecular hydrogen may be consumed by the sulfate-reducing bacteria and it will not be available to the methanogenic bacteria or the acetogenic bacteria. More bicarbonate will be left to make carbon dioxide (reaction 10).



As a result, degradation of ethanol will follow reactions 1, 2, 9, and 10, and only two molecules of methane will be produced from each molecule of ethanol consumed (reaction 11). At equilibrium, any bubble that is produced would be 50% methane and 50% carbon dioxide.



The actual percent composition of constituents in soil gas can be more complicated than indicated by reactions 1 through 9. Unless and until the geochemistry of the subsurface comes to equilibrium with the carbon dioxide that is produced through biodegradation of the ethanol, some portion of the carbon dioxide will be removed by geochemical reactions and will not find its way into the soil gas. Until the system comes to equilibrium, carbon dioxide can be retained by dissolution in water (reaction 12), or by reaction with carbonate minerals (reaction 13).



Actual Production of Methane from Biodegradation of Ethanol in E10

Table 2 presents monitoring data from three wells at an E10 spill in Oklahoma. Soil gas was sampled using permanent groundwater monitoring wells following the procedure in Jewell and Wilson (2011). The samples were analyzed by gas chromatography using a thermal conductivity detector. This analysis is cheap and readily available.

The actual composition of the soil gas is in general agreement with the hypothetical predictions above, but the correspondence is far from perfect. Notice that there is very little hydrogen in the soil gas. If all the hydrogen had been used to make methane, the ratio of methane produced to carbon dioxide produced would be near three to one (reaction 8 on page 10). The actual ratio is somewhat higher. It is likely that some portion of the carbon dioxide was removed by reaction 12 or 13; however, the ratios of methane and carbon dioxide are reasonably close to the ratio that would be expected from the fermentation of ethanol.

Is the methane coming out of groundwater pushing the soil gas out of the way? All the samples had very low concentrations of nitrogen compared to the atmosphere. The vapors of unweathered gasoline can displace roughly one third to one half of the air. The concentration of gasoline vapors was much lower in the actual samples (Table 2); something else must have displaced the air. There is only one explanation for the low concentrations of nitrogen. Methane and carbon dioxide produced by biodegradation of ethanol (and fuel hydrocarbons) pushed the air out of the soil gas. It was easy to recognize and document this phenomenon by comparing concentrations of nitrogen in the soil gas samples.

Notice that the ratio of oxygen to nitrogen in samples from MW-2 and MW-1 are close to the ratio of oxygen and nitrogen in the atmosphere. It is likely that the oxygen and nitrogen in the samples did not represent the true conditions at the water table. The soil gas samples were collected through the screen of a conventional groundwater monitoring well. The oxygen and nitrogen may have come from soil gas higher in the soil pro-

		Atmosphere	MW-2	MW-9	MW-1
Nitrogen	% (v/v)	78.0	6.6	19.9	24.1
Methane	% (v/v)	0.0002	71.0	61.2	60.1
Carbon Dioxide	% (v/v)	0.04	19.6	18.4	11.7
Oxygen	% (v/v)	21.0	1.23	1.02	3.92
Gasoline Hydrocarbons	% (v/v)	NA	1.90	0.16	0.59
Hydrogen	% (v/v)	0.00006	0.05	<0.001	<0.001
Sum	% (v/v)	99.04	100.40	100.68	100.41
Ratio methane to carbon dioxide			3.6	3.3	5.1
Ratio oxygen to nitrogen		0.27	0.19	0.05	0.16
Size of leak based on nitrogen	% Sample		8.5	25.5	30.9
Size of leak based on oxygen	% Sample		5.9	4.9	18.7

TABLE 2. Measured concentrations in soil gas at an E10 spill site in Oklahoma.

file, or more likely resulted from a leak in the system. Table 2 estimates the fraction of the sample that was a leak if all the nitrogen in the sample came from the leak.

The samples also had low but detectable concentrations of oxygen in the soil gas. Where did the oxygen come from? G.B. Davis et al. (2009) compared the concentrations of oxygen and vapors and hydrocarbons at seven sites in Australia. They measured concentrations using dedicated in-situ devices as well as conventional gas samples. When measurements were made with in-situ probes, oxygen was not detected when hydrocarbons were present, and vice versa. Conventional samples had low concentrations of oxygen in the presence of hydrocarbons.

G.B. Davis et al. (2009) concluded that the oxygen from the atmosphere contaminated the conventional samples during the act of sampling. If we assume that biodegradation of methane and gasoline hydrocarbons had consumed essentially all the oxygen in soil gas at the site in Oklahoma, we can use the measured concentration of oxygen to provide a second line of evidence for the size of the leak. That estimate is also provided in Table 2.

Taken together, the data indicate that the soil gas samples were a reasonably representative sample of gas just above the water table at this site,

and that methane and carbon dioxide produced by biodegradation of the fuel spill had pushed the atmospheric gases out of the air-filled porosity.

Summary

The survey of Jewell and Wilson (2011) suggests that methane from biodegradation of spills of conventional petroleum gasoline or E10 at LUST sites may contribute to petroleum vapor intrusion. However, the impact of methane on vapor intrusion is already considered in current approaches to manage the risk of petroleum vapor intrusion. In recent years, Robin Davis with the Utah Department of Environmental Quality, and her colleagues and collaborators have gathered empirical information on the vertical separation distances between sources and receptors and the measured impacts to indoor air in the receptors.

The vertical separation distance between a source and a receptor can be used to distinguish sites with a plausible risk of petroleum vapor intrusion from sites without a plausible risk. This data set (R.V. Davis, 2009; Lahvis et al., 2012) includes many sites in the midwestern United States that have used E10 for decades. At the time of this writing, USEPA is in the process of reviewing the data set collected by Robin Davis, with

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Tank -nically Speaking

by Marcel Moreau

Marcel Moreau is a nationally recognized petroleum storage specialist whose column, *Tank-nically Speaking*, is a regular feature of LUSTLine.

As always, we welcome your comments and questions. If there are technical issues that you would like to have Marcel discuss, let him know at marcel.moreau@juno.com.

Why Are Releases Rarely Discovered at the Time They Occur?

In recent years I've had occasion to review scads of documents relating to releases of petroleum products at many dozens of gas stations. In the great majority of cases, the release is only discovered when some type of excavation activity is conducted such as a tank or piping upgrade or replacement. Although leak detection equipment is in place, and the existing records indicate "passing" results, significant contamination is more often than not present.

My observations are consistent with several studies that have shown that leaks are most often discovered via excavation rather than leak detection:

- A study conducted by the Florida Department of Environmental Protection found that only 51 percent of releases were detected using standard leak detection methods.¹
- A California survey of 313 release incidents determined that only 15 (4.8%) of these releases were correctly identified by a leak detection method. The dominant method of discovering releases was tank closure.²
- A separate California study determined that out of 16,318 reported releases where the method of discovering the release was known, releases were discovered during field activities such as tank removal or piping replacement 92 percent of the time, while release detection activities discovered only 8 percent of the releases.³
- A study conducted by the New York State Department of Environmental Conservation investigated 52 facilities on Long Island with UST systems. The study uncovered 33 previously unreported releases of petroleum product into the environment.⁴ The study concluded that "it is evident that repairs (to storage system equipment) are routinely conducted and spills are not reported."⁵

How does this happen? Doesn't leak detection work? I suspect that the details of why releases go unreported are many and varied, but here is my armchair overview of the broad principles that might be behind many of these "undetected" releases.

■ In most cases we are looking for a needle in a haystack.

Sales volumes at the majority of active facilities today are measured in thousands of gallons per day. Leaks are likely to be in the range of a few gallons per day or even less. The volume of product lost relative to the volume of product handled at the facility is a small fraction of a percent. Because accurately measuring large amounts of fuel is challenging, small discrepancies in accounting for the fuel are ignored. Because of

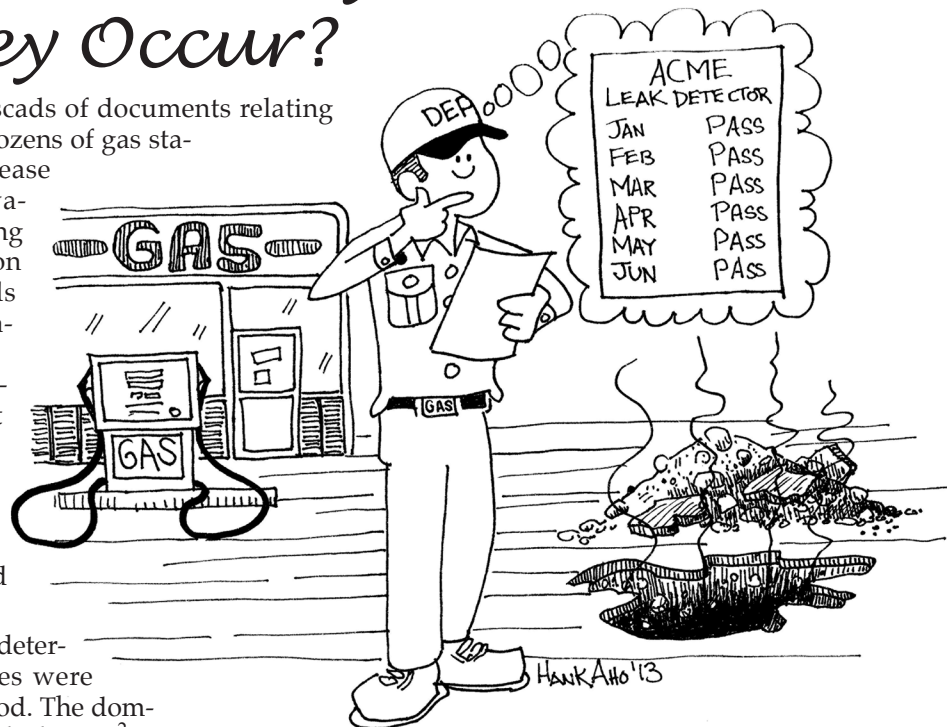
this, the loss may persist for weeks to many months before it is noticed (often by accident) and corrected. While the leak rate is small, the cumulative volume of product released may be large—in the hundreds or thousands of gallons.

■ Most releases today are easily repaired.

Piping releases have always been a substantial portion of the leaking "tank" problem, and as tank corrosion issues have been addressed, I

believe the proportion of releases originating in piping has increased. I include leaks from submersible pumps (e.g., functional elements) and leaks from dispenser components (e.g., filters, meters, shear valves, unions) in the broad category of "piping leaks." Some industry data indicate that leaks are more likely to occur near the pump and the dispenser rather than in the piping itself.

Fixing corrosion holes in tanks was a major operation, involving



replacing the tank, or at a minimum, lining the tank. Releases from piping components are much more easily repaired, especially when they occur inside the dispenser or at the submersible pump where they can be readily observed and accessed without excavation.

Consider the following scenario. A technician opens a dispenser cabinet to replace the filters and sees that one of the union fittings connecting the below-grade piping to the dispenser piping is dripping fuel. He tightens the union with a wrench and the drip is stopped. He proceeds to replace the filters and notes that the outside surface of one of them is wet with fuel. He replaces the leaking filter along with the others, perhaps being a little more careful to be sure the new filter seals properly. The work order he completes to document his work notes only that he replaced the filters. The fact that he has discovered and repaired two leaks is not recorded.

Such a scenario is likely quite common. A survey of Petroleum Equipment Institute members, who service many of the nation's UST systems, estimated that for every 100 dispensers inspected, 47 leaks would be detected, and for every 100 submersible pumps inspected, 44 leaks would be identified.⁶

■ There is a widespread “don’t ask, don’t tell” policy regarding releases.

As I have just described, while performing a routine task a technician may note that a component is wet with fuel and simply tighten or replace it. Seldom is any effort made to determine how badly the component was leaking when the pump was on and the piping was under pressure or how long the leak may have been occurring. How much fuel may have been released is not investigated. The operator may not even be told that a release has been repaired.

Many such releases may occur over time. The person conducting the repair is not inclined to call attention to the release because he does not want to get the person who hired him in trouble. The presence of contamination is not documented until months or years later when renovation work is undertaken and con-

taminated soil and/or groundwater is discovered.

■ ATG test results are misunderstood.

Most tank owners live in a fairyland where automatic tank gauge (ATG) test results (whether for tanks or, when equipped with an electronic line-leak detector, the piping) can never bring bad news: a passing test result means that absolutely no leak is present, and a failing test result must be wrong. The truth resembles a nightmare much more than a fairy-tale. But first, let's be clear about the terminology. Table 1 defines the terms relevant to this discussion.

TERM	DEFINITION
Performance criterion	A requirement stated in regulations that specifies the size leak that must be reliably detected. For example, rules state that a monthly ATG test must be able to detect a leak rate of 0.2 gallons per hour (gph) with a probability of detection of at least 95% and a probability of false alarm of no more than 5%.
Probability of detection	The odds of detecting a leak of a <i>given size</i> when a test is conducted. A probability of detection of 95% for a leak rate of 0.2 gph means that if I were to test 100 tanks, <i>each of which was leaking at exactly 0.2 gph</i> , I would correctly identify 95 of these tanks as leakers and incorrectly pass 5 of the tanks as “tight.” The probability of detection is tied to a specified leak rate. If a leak of greater than 0.2 gph is present, the probability of detecting the leak will be greater than 95%. <i>If a leak of less than 0.2 gph is present, the probability of detecting the leak will be less than 95%.</i>
Probability of false alarm	The odds of failing a tank test when the tank is absolutely tight and not leaking a drop. The rules specify a probability of false alarm of no more than 5%. This means that if I were to test 100 tanks, <i>each of which was absolutely tight</i> , I would incorrectly fail five of these tanks and call them leakers.
Threshold	The leak rate that a test method uses as the boundary between a passing and failing test is called the threshold leak rate. In order to be 95% sure of correctly identifying leaks of 0.2 gph, a test method must fail the tank when the leak rate measured during a test is somewhat less than the performance criterion. The threshold leak rate is typically about half the performance criterion. So an ATG monthly test with a performance criterion of 0.2 gph will typically have a threshold leak rate of 0.1 gph. This means that if the measured leak rate during a test is 0.1 gph or greater, the tank fails the test and is presumed to be leaking.

TABLE 1. To understand any discussion of the effectiveness of leak detection, the terms used must be thoroughly understood. This table presents definitions of the terms commonly used when discussing leak detection in UST systems.

Most tank owners and many regulators have a poor understanding of the behavior of ATGs when leaks significantly smaller than the performance criterion (0.2 gallons per hour for monthly testing) are present. The key fact to remember is that the probability of detection is only valid for a specified leak rate (see Table 1). It is true that leaks smaller than the performance criterion can be detected by many methods of leak detection. The issue is that the probability of detecting such a leak will decrease as the leak rate decreases.

For example, let's say I have a leak detection method with a prob-

ability of detection of 95 percent for a leak of 0.2 gph. My threshold for declaring a leak for this method is 0.1 gph. For the case where the actual leak rate is equal to the threshold, the probability of detection is 50 percent. This means that with my leak detection method there is a 50/50 chance that I will correctly identify a leak of 0.1 gph.

Consider what happens when a 0.1 gph leak is present in an UST system that is tested with my method. Half the tests that are run will identify the leak and half will not. What does the tank owner do? The standard response to a failed test (other than ignoring the test com-

pletely) is to run the test again. There is almost a universal belief among tank owners when faced with one passing result and one failing result that the passing result is the correct one and the failing result is in error.

The probability of detecting leaks smaller than 0.1 gph is even less than 50 percent. For example, the probability of detecting a leak of .025 gph might be only 10 percent. This means that out of each hundred tests that are run on the leaking tank or pipe, odds are that 10 tests will detect the leak and 90 tests will not. Faced with such results, the typical tank

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■ Tank-nically Speaking

from page 13

owner will conclude that his tank is tight and not leaking a drop, when in fact, the test results indicate that a small leak is present. This “small” leak will add up to 0.6 gallons a day, 18 gallons a month, and 216 gallons a year, more than enough to have had serious consequences when MtBE was present in gasoline.

This is how small leaks remain undetected. Because the probability of detection for these small leaks is quite low, most of the test results will be passing, and the few failing tests that do occur are considered to be erroneous. While there is no “allowable leak rate” as far as USEPA is concerned, the fact is that many small leaks go undetected because tank owners do not grasp the significance of failed test results interspersed with passing test results.

That said, it is also true that some tests may produce failing results for reasons that are not related to a leak, so that *every* failed test result is not necessarily an indication of a small leak. But determining the difference between an aberrant test and a small leak could cause a lot of hair loss among tank owners and tank technicians.

■ Tightness testing does not prove that a storage system is tight.

Tightness test documents are often produced to “prove” that a storage system did not leak. However, there are a number of ways that a *leaking* storage system can produce a *passing* tightness test result. Here are five of them:

- a) **Piping tightness tests most often do not test the entire piping system.** The dispenser is most often isolated by closing the shear valve at the base of the dispenser; as a result, leaks inside the dispenser will not be detected. Likewise, the submersible pump is often isolated by closing a ball valve in the product piping; as a result, leaks in the submersible pump itself will not be detected by the test.
- b) **The test documentation generally represents the condition of the system when the techni-**

cian left the site, not the condition of the system when he arrived at the site. For example, a test technician may begin to increase the pressure in a piping run and notice an immediate drop in pressure. He investigates and finds a dripping union at the submersible pump. He tightens the union, and pumps up the pressure in the piping again. If the pressure now holds and the test passes, the formal written record will show that the piping is tight.

This is a true description of the leak status of the piping at the end of the test, but it is NOT the true condition of the piping when the tester arrived at the site. This type of repair activity is sometimes documented in the handwritten paperwork that the tester completes in the field, but such repair activity rarely shows up in the formal paperwork sent to the owner and presented to the regulator.

This scenario is especially prevalent with vapor leaks. While the results of pressure-decay testing are most often “pass,” the test results typically include a list of parts that were replaced. It is the list of replacement parts, not the “passing” test results, that is important in determining whether the storage system may have had a vapor leak when the tester first arrived at the site.

- c) **The test may not be properly conducted.** Occasionally errors in the test procedure are obvious, such as failing to follow procedures required when the water table is above the bottom of the tank. More often a careful study of the test documentation is required to confidently state that the test results were falsified. Most often, the issue is that the test results are “too good to be true.”

This is most frequently seen in piping test results where the measured leak rate for multiple piping tests is consistently zero. While zero volume change during a piping test is not an impossible event, it should be quite a rare event when normal test

procedures are followed. Thus such results are suspicious, and I am reluctant to accept them as “proof” that a piping run has not leaked.

- d) **The test methodology is defective.** Some tank testing methods apply a vacuum to the tank and rely on the detection of water entering the bottom of the tank to detect a leak when the water table elevation is above the bottom of the tank. The length of these types of tank tests is generally calculated to be the amount of time that it would theoretically take for a leak of 0.1 gallons-per-hour (gph) to produce a water depth sufficient to register on a water sensor positioned at the bottom of the tank.

This calculation is made assuming that the tank is a perfectly round cylinder that is perfectly horizontal in the ground, neither of which are reliable assumptions. The calculation also often ignores the presence of striker plates positioned at the bottom of the tank that typically cause the water sensor to be at least a 1/4 inch off the bottom of the tank. Such tests are unlikely to detect water ingress because the length of the test is too short to allow enough water to enter the tank and be detected by the sensor.

Another issue when the gasoline contains ethanol is that the water entering the tank may be absorbed into the fuel and not be present as a separate phase that can be detected by the sensor. Standard third-party evaluations, usually cited as “proof” that a test method is effective in indentifying leaks, do NOT evaluate the test method’s ability to detect water. The equipment manufacturer’s claim that the method works when water is present is the only evidence we have of the test method’s effectiveness.

Test methods that use this water ingress approach for leak detection are also vulnerable to another error when free product resulting from a large leak in the tank is present in the excava-

tion. If the free product is outside the perforation in the tank, product will be drawn into the tank rather than water when the vacuum is applied during the test. Since these test methods generally do not look for ingress of product, the test result will be “pass” even though a substantial leak may be present.

- e) Tightness testing does not establish that there is no leak, only that the leak is likely to be less than 0.1 gph.** As with the ATG test results discussed above, small leaks may be present, but if they are significantly less than the test method’s threshold, the probability of detecting the leak will be quite small. Tightness testing only establishes that a storage system is tight enough to pass the test, not that it is absolutely tight.

■ **Inventory records do not prove that a storage system is tight.**

Occasionally inventory records will be produced to “prove” that a storage system did not leak. There are a number of ways a storage system can leak, however, and still produce acceptable inventory records. In addition, there are a number of factors that complicate the review of inventory records.⁷

- a) Inventory records are typically evaluated using the regulatory standard that allows a loss of one percent of the sales volume plus 130 gallons over a period of a month.** This standard is very crude, and is only designed to detect leaks of about a gallon per hour.⁸ Inventory records could have abundant evidence of a small release but still successfully pass this regulatory criterion.
- b) Inventory data by themselves will only reveal that there is a certain amount of product that is unaccounted for.** The possible causes for the loss are varied and include temperature effects, evaporation, theft, and leakage. The most useful technique to identify a leak in the inventory records is to have service records available so the timing of the loss in the inventory data can be

correlated to the timing of work done at a facility.

For example, a significant loss rate in the inventory records that ends on the day when the repair records indicate a flexible connector was replaced would provide a reasonably clear indication of a leaking flexible connector. A loss rate in the inventory records accompanied by an increase in contamination in monitor wells adjacent to the storage system may be another avenue for concluding that the unaccounted for inventory variance was due to a release. Without corroborating information, however, a loss trend in inventory data by itself is not conclusive evidence of a release.

- c) Relevant inventory records may not be produced.** Because releases are most often discovered long after they have occurred, the inventory records that document the release may be many months or years in the past. A regulatory agency may request inventory records for the previous several months or even a year, but if the release occurred two years ago, the inventory records produced will not provide evidence of the release.

- d) Inventory records may be altered.** Sometimes the alteration can be detected. A typical example is when the volume of fuel in the tank recorded on the first day of the month is not the same as the volume of fuel recorded on the last day of the previous month. This is often an indication that records for the entire month have been fabricated. This type of falsification is not unusual at facilities where company policy or regulatory requirements specify that inventory variances must be kept small. Frustrated at not being able to meet the strict requirements using actual inventory data, operators simply create inventory records that will meet the requirements.

Some modifications of inventory records cannot be detected. For example, there would be no way to tell if the daily sales num-

bers were routinely adjusted to reduce the daily variance unless there was some independent record of the daily sales volume.

- e) Inventory recordkeeping is not done carefully.** When daily variances average many tens of gallons, with frequent variances of hundreds of gallons, the inventory records are unlikely to be able to reveal anything but massive leaks. Even when carelessly conducted, inventory records may still pass the regulatory criterion of having a monthly variance of less than one percent of the sales volume plus 130 gallons, and so be considered evidence of a “tight” storage system.

What’s to Be Done?

As a result of the Energy Policy Act of 2005, most states are heading down the road of secondary containment for new storage systems. Properly installed and maintained secondary containment addresses many of the issues discussed here, but it will be a long time in most states before today’s single-walled storage systems are replaced. In the meantime, keep a critical eye on leak detection records of all stripes and colors, and be on the lookout for contamination whenever you see an excavation at an UST site. ■

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1. Florida Leak Autopsy Study, as of February 2005. Unpublished data based on survey of 889 releases between 1995 and 2005.
2. “Are Leak Detection Methods Effective in Finding Leaks in Underground Storage Tank Systems?” by Shahla Dargahi Farahnak, P.E., and Mary M. Drewry, California State Water Resources Control Board, January 1998.
3. *Analysis of California UST & LUST Programs and the Impacts of MtBE and Ethanol to California*, prepared by Anne Happel for the U.S. Department of State, Office of the Legal Adviser, December 2003, p. 27.
4. *USEPA MTBE Pilot Project – Objective 2 Investigate Potential Sources of MTBE Contamination on Long Island That Could Impact Water Supplies or Environmentally Sensitive Areas*, New York State Department of Environmental Conservation, February 2008, p. 5.
5. *Ibid.*, Appendix D, p. 3.
6. “PEI Members Weigh in on UST System Performance,” *LUSTLine Bulletin* #41, June 2002, p. 5.
7. For a more detailed discussion of how to look at inventory records, see “Baffled by a Leak? Check the Inventory Records,” *LUSTLine Bulletin* #44, July 2003.
8. *Analysis of Manual Inventory Reconciliation*, Entropy Limited, EPA 510-S-92-802, March 18, 1988.

Nassau County, NY, Small Tank Abandonment/Removal Program

An Innovative Approach to Preventing Leaks from Residential Tanks

by Robin Putnam

Nassau County, New York, population 1.4 million people, relies on the USEPA-designated "Long Island Sole Source Aquifer" as its only source of potable water. As a result of the heightened responsibility to protect this resource, the county sought and received delegation in 1986 to administrate the New York State (NYS) Petroleum Bulk Storage program locally through the County Health Department (NCHD) and the Fire Marshal's Office.

By 1989, it became apparent to the Health Department that in addition to regulating facilities storing over 1,100 gallons of petroleum products, it needed to amend its ordinance to give specific guidance to owners of small heating oil tanks on decommissioning their tanks prior to having a known leak condition or catastrophic loss of product. In 1990 Article XI of the Nassau County Public Health Ordinance was amended to provide requirements for small-tank closures at facilities not regulated by NYS petroleum Bulk Storage regulations.

In 1989, based on information from the Oil Heat Institute (OHI), it was estimated that approximately 63,000 small single-walled steel underground heating oil tanks were located in Nassau County at residences and small businesses, and that a large percentage of these tanks were over 30 years of age.

In one area of the county, Levittown, it was determined that there were approximately 17,400 homes in a 6.9 square-mile area. These homes were constructed from 1947 through 1951, and each home was built with an underground 275-gallon heating oil tank. Based on field inspections of tanks voluntarily removed from the ground in this town from 1987 to 1990, the NCDH documented a perforation rate of 33 to 50 percent.

Assuming a 33 percent perforation rate and a conservative estimate of 30 gallons per spill it was estimated that over 172,000 gallons of oil could discharge into the environment each year from tanks in this one area of the county! The potential for groundwater contamination from these sources motivated the county to implement a Small Heating Oil Tank Abandonment/Removal Program.

The Small Heating Oil Tank Abandonment/Removal Program

In 1990, the Nassau County Department of Health (NCDH) initiated a multifaceted program to inform and educate the public about groundwater protection and spill prevention. Initially, a public information package was produced that included general information about protecting Nassau County's groundwater, a letter outlining the proper procedure for abandonment of an underground heating oil tank, and the two forms required to be filed with NCDH to record the abandonment or removal of a tank. These forms were distributed to local libraries, homeowner organizations, and contractors involved in tank closures.

They were also mailed to residents in target areas of concern. In addition, Department staff attended public meetings in an effort to educate various community and civic groups on the environmental and financial benefits of spill prevention, as well as the requirements for tank closure. NCDH staff also served as guest speakers at meetings organized by the Oil Heat Institute, Long Island Power Authority, Long Island Board of Realtors, and the National Association of Home Inspectors.

All of these efforts to educate the public and industry representatives have resulted in an increase in the number of voluntary small UST removals and abandonments from approximately 100 per year to as many as 2,600 per year.

Since 1990, the county has educated over 50,000 small tank owners, including 7,736 homeowners in Levittown, about the benefits of decommissioning their aging small heating oil tanks prior to developing a known leak condition. Figure 1 represents the towns with the most abandonment/removals on record compared to the number of residential homes in each town.

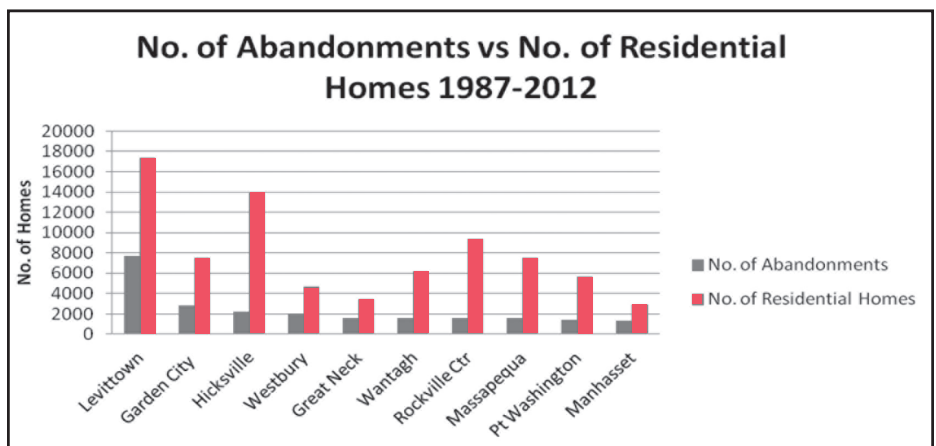


FIGURE 1. Towns with the most abandonment/removals on record compared to the number of residential homes in each town.

In 2005, the National Association of County and City Health Officials recognized this innovative, proactive program as a Model Practice, and the database that the county maintains now serves as a standard information resource for real estate transfers. In 2011, the Department was able to respond to 1,925 Freedom of Information inquiries regarding the disposition of small heating oil tanks within the county.

Over the past 22 years, real estate professionals, local contractors, and informed residents have become the greatest assets in assuring that old tanks are properly abandoned in place or removed. Now, oil companies compete for new customers by offering tank replacement to gain new customers; real estate attorneys demand closure of old tanks as a condition of property transfer; and home inspectors routinely check for improper tank abandonments and request records from the Department's database of tank closures.

Since the local ordinance was amended in 1990, the Department has moved steadily toward its goal of upgrading all of the aging small USTs in the county, thereby preventing thousands of gallons of petroleum products from discharging to the environment each year. As of June 2012, the NCHD has recorded 50,096 small UST closures. This represents 80 percent of the small UST population initially identified by the Oil Heat Institute (OHI) (Figure 2).

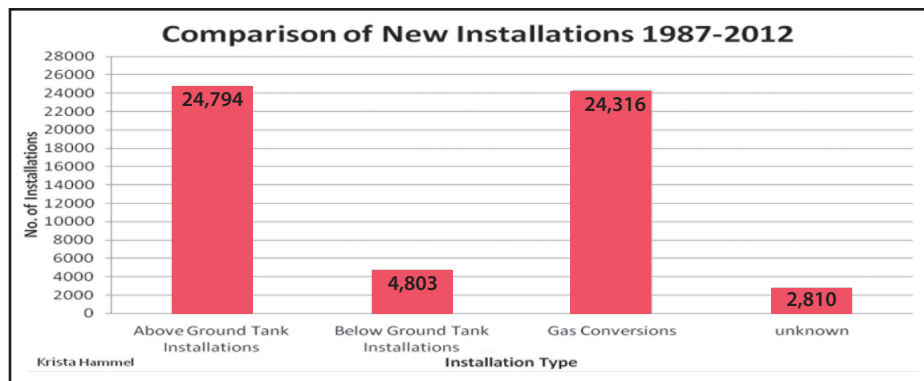


FIGURE 3. Homeowners are now choosing to convert to gas heat or use ASTs.

In addition to maintaining a record of UST closures, the Department must also be notified of small aboveground tank removals. Inspections of these removals are conducted to ensure that the piping for these tanks is removed or permanently sealed to prevent accidental oil deliveries to basements. All of the small tank removals and abandonments are recorded in a database along with information on the type of tank installed as a replacement or the site's conversion to gas heat (see Figure 3).

Water Quality Is the Winner

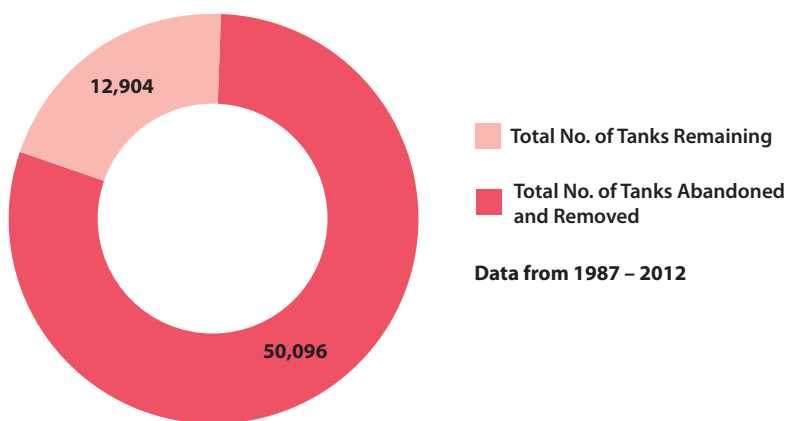
The Nassau County Department of Health has created a procedure that allows the owners of small heating oil tanks to be proactive in their approach to spill prevention instead of just reacting to a spill event. The voluntary closure of thousands of old small heating oil tanks has sub-

stantially reduced the amount of petroleum being released to the environment and will therefore reduce the amount of pre-treatment necessary to provide water to the residents of the county that meets New York State Drinking Water Standards. ■

Robin Putnam is Program Director for the Nassau County Department of Health's Toxic and Hazardous Materials Storage Program.

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Tanks Abandoned or Removed Compared to 1990 OHI Estimate of 63,000 USTs



Krista Hammel

FIGURE 2. Eighty percent of the county's residential USTs have been replaced as of 2012.

Next Issue of LUSTLine:

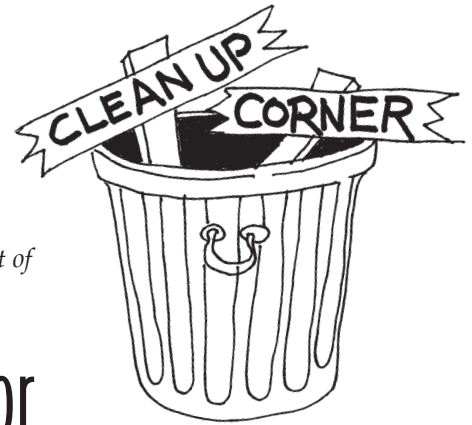
Long Island's Home Heating Oil Cleanup in the Wake of Superstorm Sandy

As a result of late October's Superstorm Sandy more than 4,600 oil spills were reported in New York State. The Department of Environmental Conservation responded and pumped out more than 500,000 gallons of oil and water from tanks, crawlspaces and basements, yards, storm drains, and canals. Long Island accounted for more than half of these spills—2,446 spills were reported of which more than 80 percent involved releases from residential home heating oil tanks. Tune in to the next issue of *LUSTLine* for the details. ■

Cleanup Corner

A Neat Little Column by Gary Lynn

Gary Lynn is Petroleum Remediation Manager for the State of New Hampshire Department of Environmental Services (NHDES). He can be reached at glynn@des.state.nh.us.



"Make a Difference Day" in the Crud Corridor

I still think of the former heavy industry portion of Concord, New Hampshire, as the Crud Corridor rather than the newer upbeat name, "The Opportunity Corridor." Although I strongly support the city's effort to change entrenched ideas and perspectives by renaming the corridor, it is easy for me to slip into old perceptions that are heavily influenced by my involvement with cleanups undertaken prior to 1997, when Concord optimistically renamed the corridor as part of its USEPA brownfields grant application.

The Crud Corridor has a colorful and interesting industrial past. The southern portion once housed a massive B&M Railroad maintenance complex, a coal gasification facility, and the Concord Stage Coach manufacturing complex (yes, stage coaches were manufactured here in the East and shipped West by train). The northern portion includes Page Belting, a manufacturer of extraordinarily long, continuous belts for industry, and the burnt out Concord Lumber property. Nearly all of the brownfields properties in the Corridor have some or are predominately petroleum contaminated.

In late October of each year the *USA Weekend* magazine and the Points of Light volunteer organization co-sponsor Make a Difference Day, a national day of community service (<http://www.pointsoflight.org/signature-events/make-difference-day>). As our contribution to the 2012 Make a Difference Day, volunteers from the New Hampshire Department of Environmental Services (NHDES) Petroleum Remediation Program and WESTON Solutions, a sustainability innovation company, got together and constructed six raised beds at the most recent undertaking of the Crud Corridor renaissance, the new Friendly Kitchen building.



Volunteers from the NHDES Petroleum Remediation Program and WESTON Solutions constructed six raised beds at the new Friendly Kitchen building.

WESTON Solutions supplied the labor, funding, and a complete complement of gardening tools. The Petroleum Remediation Program provided the design, additional labor, and hot soup for everyone. The raised bed design addressed gardening and public acceptance concerns. The site contained urban fill with a higher asphalt content than organic content.

Constructing raised beds, filling them with high quality imported loam, and placing a weed-stop fabric below the bed created a safe and ready-for-growing reuse spot. The Friendly Kitchen's mission for over 30 years has been to make sure that no one goes hungry in the Concord

area. Our goal on that day was to assist the Friendly Kitchen with their dream of growing produce and herbs for use in their kitchen.

The construction of the raised beds started me thinking on multiple levels about Concord's successful 15-year-old brownfields corridor project. Making a difference in this portion of Concord certainly involved more than half a day of hard work. To tell part of the story, however, we can start with the Friendly Kitchen project.

The Friendly Kitchen Project

The saga for the folks at the Friendly Kitchen started with a catastrophic fire at their former location near

downtown Concord. After the fire, the Friendly Kitchen sought approval for an onsite rebuilding project. The local property owner's reactions were quick, intense, and negative. Sensitive to this response, the City of Concord and the Friendly Kitchen worked together to find a location that would obtain public acceptance and could be accessed by transportation-challenged homeless people. Attention turned to the former Rumford Energy property that was just blocks off of Main Street.

The Rumford Energy property was initially a gas station and later a bulk fuel-oil facility. When the property transitioned from a gas station to bulk fuel-oil storage in the 1990s,

■ Cleanup Corner *from page 9*

five gasoline USTs were removed and replaced with four fuel-oil USTs with 30,000 gallons of aggregate capacity. NHDES involvement at the site began shortly thereafter when contamination was discovered during the UST removals. At this point, state petroleum reimbursement fund-financed cleanup activities at this highly contaminated site included removal of nearly 3,000 tons of petroleum contaminated soil and the installation of an SVE system.

Rumford Energy declared bankruptcy in 2007, leaving more than 450 pre-pay oil customers and 1,000 creditors in the lurch. The shutdown was so abrupt that drums and containers full of waste were left scattered throughout the property. The property was eventually rescued from bankruptcy by one of the creditors. NHDES worked with them to remove the fuel oil tanks, the drums, and finish remediation at the property.

By the time that the Friendly Kitchen was looking seriously at the property, the remedial actions were essentially complete, other than some questions regarding the remaining underground piping and potential hazardous material issues with the building. To fill the data gaps, NHDES completed a Phase II investigation using brownfields funding (our USEPA 128(a) grant cost recovery account). The Phase II report and pro bono work by area environmental attorneys and professionals helped the Friendly Kitchen develop sufficient comfort with the property to purchase it.

Rising from the Ashes

The Friendly Kitchen's Capital Campaign to rebuild, *Rising from the Ashes*, was launched in August 2012 and successfully raised enough money to pull this project off. They broke ground on July 12, 2012 and work progressed rapidly.

The new building is about 5,800 square feet and can feed up to 120 people (Friendly Kitchen serves about 50,000 meals a year). The redevelopment project cost approximately \$1.8 million and received substantial funding from the Lincoln Foundation (\$100,000) and a Community Development Block Grant

(CDBG) (\$500,000) from the NH Community Development Finance Authority through the City of Concord. The rest of the funding was obtained from borrowing and fundraising.

The new Friendly Kitchen has both indoor and outdoor seating and is completely accessible for people with disabilities. The one-floor building features an up-to-date commercial kitchen and has ample storage area for donated foods. The first meal was served from the kitchen before Christmas and the first crop in the raised beds will be planted this spring.

Seize the Opportunities

Before ending it is important to credit Concord for making good on their promise to find and take advantage of opportunities in their Crud Corridor. The City of Concord and their frequent partner, the Capital Region Development Corporation, have used a variety of tools including tax increment financing districts, CDBG grants, Petroleum Reimbursement Funds, USEPA cleanup grants, and a host of other tools to fund cleanups as well as infrastructure and road upgrades.

Smart use of these funding options has facilitated redevelopment projects. For example, Concord/CRDC cleaned up the Concord Lumber property and obtained a Covenant Not to Sue from the state for their efforts. Now, the burnt out Concord Lumber property has been redeveloped into a high-end Marriott hotel and multiple high-rise office buildings. The coal gasification plant-created tar pond has been drained of nearly 200,000 gallons of coal tar and is part of a new park. The rest of the former B&M railroad maintenance complex is slated for redevelopment into the Concord Steam Corporation's replacement steam plant.

NHDES is working with Concord to prepare for the potential next



The new Friendly Kitchen risen from the ashes in Concord, New Hampshire's "Crud Corridor."

phase of the rebirth in the corridor. Next to the Friendly Kitchen building, Concord demolished the burnt out former Agway building, and the state Petroleum Reimbursement Fund will pay for the removal of the property's fuel-oil contaminated soil. Nearby, the state is reimbursing for floating product recovery at another former bulk petroleum storage facility (over 4,500 gallons of LNAPL removed to date).

This general area also houses the state highway shed complex, which is a petroleum-contaminated site. The highway shed is on the top of Concord's list of underutilized eyesores that it would like to redevelop. The area being worked on will be opened up for redevelopment when Concord completes its Storrs Street extension project. Based on our strong working relationship with Concord, the extension of Storrs Street and the redevelopment of this next section of the corridor should go smoothly. Given the progress made to date, NHDES is confident that with our partnerships with Concord, property owners, and companies we will be able to finish removing the crud from the Crud Corridor, leaving only the opportunities behind.

To achieve successes like this, every day has to be and should be a Make a Difference Day. That's what petroleum cleanup programs are doing throughout the United States. I believe that we need to document and share our successes with the public as we protect our nation's water supplies, facilitate the redevelopment of contaminated properties, and keep companies in business via our financial assurance funds. ■

A Message from Carolyn Hoskinson

Director, USEPA's Office of Underground Storage Tanks

Increased Prevention: The Energy Policy Act's Legacy to the UST Program

I think prevention is the gift that keeps on giving. By anticipating and taking precautions, preventative actions can help keep negative things from happening. Going to the dentist for checkups twice a year helps prevent cavities. Using our seatbelts while driving or riding in cars prevents serious injuries during car accidents. I could go on. But you get the gist, and you probably have a pretty good idea of where I'm going with this.

My dictionary defines prevention as keeping something from happening, especially by taking precautionary action. And when I read that definition, I thought of how aptly it applies to our work in the national underground storage tank (UST) program.

As those of us who deal with UST releases on a daily basis know all too well, UST rules require tank owners and operators to take precautionary actions to prevent product stored in USTs from being released into the surrounding environment, contaminating our soil and groundwater, and having negative impacts on human health. Taking precautionary action to prevent UST releases also helps avoid potential significant costs associated with cleaning up UST releases.

Energy Policy Act Keeps on Giving

Seven years ago Title XV, Subtitle B of the Energy Policy Act of 2005 gave the national UST program additional ways to ramp up UST prevention efforts. And gear up prevention, we have.

Over the last six years, we have seen confirmed releases steadily decrease (from 8,361 in 2006 to 5,674 in 2012) and compliance rates steadily increase (from 62 percent in 2006 to 71.4 percent in 2012) (see Figure 1). We believe the trend of decreasing confirmed releases is likely attributed to mul-

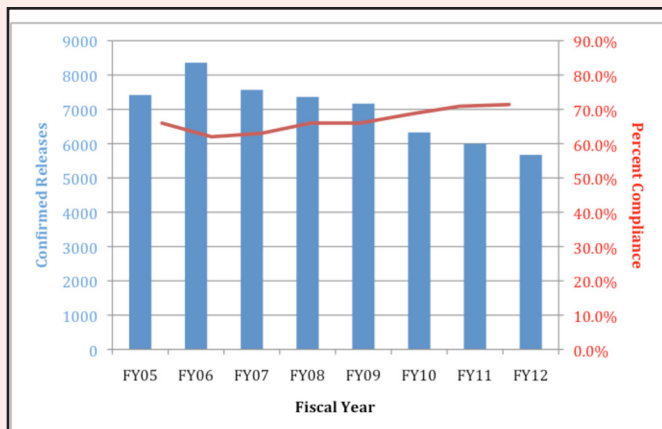


FIGURE 1. The data show that confirmed releases from UST systems in recent years have been decreasing, while compliance with the regulations has been increasing.



iple factors—increased compliance, secondary containment, increased operator knowledge—that the Energy Policy Act prevention requirements support. And I expect compliance will continue to improve as even more UST operators become trained on the UST requirements.

The UST program achieved two significant UST prevention milestones in 2012: the final operator training deadline from the Energy Policy Act and delivery prohibition guidance for federal UST inspectors.

Final Operator Training Deadline

August 2012 marked the deadline for state UST programs to require that all designated operators are trained on operating and maintaining their UST systems. Although operator training is the final deadline in the Energy Policy Act, many requirements, such as three-year inspections and public records, are ongoing. Forty-four states meet the operator training requirement as described in USEPA's operator training grant guidelines (see www.epa.gov/oust/fedlaws/optraing.htm), and five additional states are close to finalizing their requirements. USEPA is working with the remaining states to ensure their compliance.

Several states are showing great progress as they implement this operator training requirement. For example, South Carolina, Colorado, and Utah recently reported 98 percent, 90 percent, and 82 percent compliance, respectively, in having trained designated operators. Going forward, USEPA, state, territorial, and tribal partners are discussing how to track compliance of facility owners and operators in meeting operator training requirements.

Some states, such as Utah, are seeing an impact during inspections at those facilities where operators are already trained. For example, trained operators are better prepared for facility inspections compared to facilities without trained operators. Trained operators have been more likely to prevent and repair small problems, leading to fewer issues for inspectors to find. I believe we will continue to see additional positive impacts at facilities where operators are already trained.

In states without final operator training requirements, UST system owners and operators do not need to meet training requirements until their states issue final requirements. Owners and operators should check with the state where their USTs are located to determine the date of compliance.

Prohibiting Delivery to Noncompliance USTs

Also in summer 2012, we issued the *EPA Policy on Underground Storage Tanks Delivery Prohibition*, which allows USEPA, after appropriate notice and due process, to prohibit

Message From Carolyn Hoskinson, continued

delivery to significantly or chronically noncompliant USTs. The policy, jointly issued by USEPA's Office of Underground Storage Tanks and Office of Civil Enforcement, implements a key provision of the Energy Policy Act. The policy uses access to fuel as a vehicle for helping ensure UST compliance. Delivery prohibition makes it unlawful to deliver, deposit, or accept a regulated substance into an UST that USEPA identified as ineligible for delivery, deposit, or acceptance. (See www.epa.gov/oust/fedlaws/ust_delv_proh_guid_6-25-12.pdf to view the policy.)

Based on states' experiences with delivery prohibition, we expect USEPA will find delivery prohibition to be an efficient mechanism for improving compliance by getting UST owners to address problems quickly when inspectors encounter serious or repeated noncompliance.

Energy Policy Act's Legacy to the UST Program

In recent years, the UST program has seen an increasing rate of significant operational compliance and a continuing

decrease in UST releases—that is a win-win scenario! I believe the Energy Policy Act is part of the reason we are seeing those results.

The Energy Policy Act's final deadline does not mean our prevention authority goes away. The UST program will continue to reap the benefits of that prevention legislation for many years.

We owe gratitude to all our UST partners—states, territories, tribes, USEPA, tank owners, service providers, and other industry—for the UST program's continued prevention successes. Many stakeholders have devoted considerable resources and efforts to meeting all of the Energy Policy Act's requirements.

I believe our increased emphasis on prevention and compliance is keeping our nation's groundwater and land safe, as well as reducing the number of UST releases that threaten our environment. Now that is a gift I will gladly accept. ■

■ Methane at LUST Spill Sites
from page 11

the intention of using those data to establish vertical separation criteria in a guidance document (USEPA, 2013).

The situation is different for spills of E85 and E95. There is much less field experience to serve as a basis of evaluation; however, at one spill site the concentration of methane that accumulated under an inverted tub approached the explosive range (Toso, 2008). At a spill of denatured fuel alcohol (E95) at Cambria, Minnesota, rates of methane efflux as high as 540,000 mg/m²-day have been measured (Mark Toso, personal communication). The site has shallow groundwater and wet soils.

If spills of E85 or E95 produce enough methane to force the methane out of solution in groundwater at rates greater than about 2,000 mg/m²-day, methane can greatly increase the chances for petroleum vapor intrusion in a building with a concrete floor. If the building has a crawl space or basement with a dirt floor, methane can greatly increase the chances for petroleum vapor intrusion when the efflux of methane is greater than approximately 20,000 mg/m²-day. These rates of methane production are feasible based on typical rates of ethanol degradation in groundwater. ■

Notice

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for publication.

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■ Methane at LUST Spill Sites from page 21

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Field Notes

from Robert N. Renkes, Executive Vice President, Petroleum Equipment Institute (PEI)

PEI RPs Just Keep Rolling Along

For more than 25 years, the Petroleum Equipment Institute's (PEI) Recommended Practices have been an authoritative source of information for PEI members, end-users, regulators, fire marshals, and code officials. These heavily researched and peer-reviewed technical documents address the biggest operational issues facing the petroleum equipment industry. Many of the recommended practices involve the storage and dispensing of liquid hydrocarbons, a subject near and dear to most *LUSTLine* readers.

PEI recommended practices currently cover 13 separate areas, with two more slated to make their debut in 2013 and 2014. Here's what you can expect from PEI on the recommended practice-front in the months ahead.

The Installation of Aboveground Storage Systems for Motor Vehicle Fueling (PEI/RP200) is currently going through its fifth revision since it was originally published in 1992. The committee met and acted on all the proposed changes this winter and will issue the updated edition early this spring. RP200 was created in 1992 in response to industry's decision to move some of the storage of petroleum products at service stations and other motor-vehicle fueling sites from underground tanks to aboveground tanks. This document has continued to evolve as environmental requirements and emerging technologies influence the way petroleum products are stored.

The Design, Installation, Service, Repair and Maintenance of Aviation Fueling Systems (PEI/RP1300) is a new document that was released this month. The recommended practice covers fueling systems at general aviation airports, usually owned and operated by fixed-base operators (FBOs), which offer aviation gasoline and jet turbine fuel. The proper design, installation, and testing of tanks, piping, and tank accessories used to store and transport these fuels are discussed in PEI/RP1300. The recommended practices in this publication do not cover the design or operation of hydrant systems or ground equipment fueling systems for fuel distribution.

PEI's Bulk Plant Installation Committee is accepting comments and suggested revisions to the *Recommended Practices for Installation of Bulk Storage Plants* (PEI/RP800) through March 18, 2013. This document

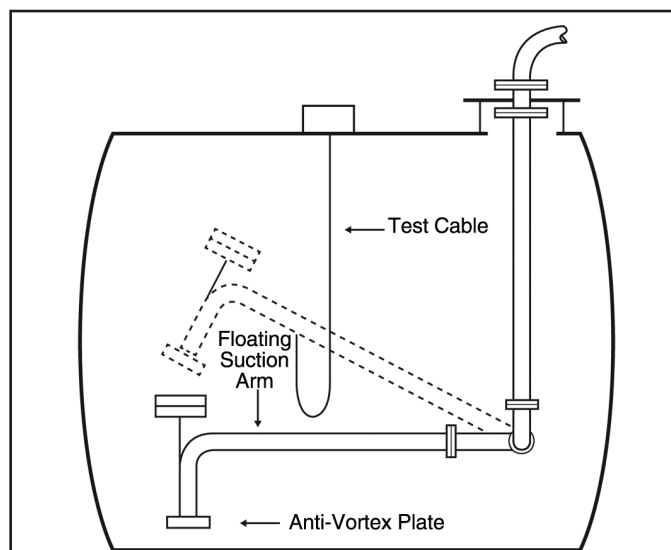


FIGURE FROM PEI/RP1300. The test fluid level in the tank sump must be at least 4 inches above the highest sump penetration or sidewall seam.

will be undergoing its first revision since it was originally released in 2008. PEI/RP800 provides sound practices for the installation of underground, aboveground, atmospheric, and shop-fabricated tanks. It includes procedures for piping, diking, spill containment, and related equipment intended for the bulk storage and transfer of petroleum, biofuels, and related products to and from wheeled delivery vehicle trucks.

Work has begun on two new recommended practices: one on the installation of equipment used to control the flow of fuel from the tank(s) (underground, aboveground, day, and belly tanks) to the emergency generator and/or boiler (PEI/RP1400) and the other on the proper installation of CNG fueling equipment (PEI/RP1500). We hope that RP1400 will be published toward the end of 2013 and believe that RP1500 will be published during the first half of 2014.

To comment on and/or purchase any PEI Recommended Practice, go to www.pei.org/rp. ■

FAQs from the NWGLDE

...All you ever wanted to know about leak detection, but were afraid to ask.

Do All Implementing Agencies Recognize NWGLDE Listings as Acceptable?

In this LUSTLine FAQs from the National Work Group on Leak Detection Evaluations (NWGLDE), The NWGLDE discusses how acceptance of leak detection equipment may vary in different implementing agency jurisdictions. Note: The views expressed in this column represent those of the work group and not necessarily those of any implementing agency.

Q. When a leak detection method is listed on the NWGLDE List, does that mean it can be used in every state?

A. Once a leak detection method or piece of equipment is listed on the NWGLDE List, the decision as to whether it can be used in any state is solely up to each implementing agency. Many states recognize an NWGLDE listing as fundamental to acceptance in that state, but just because a method or piece of equipment is listed does not automatically mean that an implementing agency will or must accept its use. The decision to accept any method or piece of equipment is a policy decision and the NWGLDE does not make policy decisions for any implementing agency. The List maintained on the NWGLDE website (www.nwglde.org) was created by the NWGLDE to fulfill our mission. Our **Mission Statement** summarizes the role of the Work Group as follows:

- Review leak detection system evaluations to determine if each evaluation was performed in accordance with an acceptable leak detection test method protocol;
- Ensure that the leak detection systems under review meet EPA and/or other regulatory performance standards, if applicable;
- Review only draft and final leak detection test method protocols submitted to the Work Group by a peer review committee to ensure they meet equivalency standards stated in the EPA standard test procedures;
- Make the results of such reviews available to interested parties.

Implementing agencies are free to use the **List of Leak Detection Evaluations** (or not use it) as they

see fit. Indeed, some implementing agencies maintain their own lists and establish their own restrictions or conditions that govern leak detection approval and/or operation in those jurisdictions. Acceptance of, and any conditions established to meet leak detection requirements in any jurisdiction state, tribal or local, is at the sole discretion of that implementing agency. The NWGLDE List does not replace, substitute for, or supersede any regulatory authority, because the Work Group is not a regulatory body and the List is not a regulatory document. Information contained on the List may be used by the implementing agency, but ultimately tank owners are held accountable to the rules and enforcement authority of the implementing agency and not to the Work Group or the List.

If you wish to know if a certain leak detection system or test method protocol is acceptable within your jurisdiction, you will need to contact your local implementing agency to determine if they recognize the leak detection equipment and protocols included in the NWGLDE list. ■

About the NWGLDE

The NWGLDE is an independent work group comprising eleven members, including ten state and one USEPA member. This column provides answers to frequently asked questions (FAQs) the NWGLDE receives from regulators and people in the industry on leak detection. If you have questions for the group, contact them at questions@nwglde.org.



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CALL FOR CASE STUDIES

UNUSUAL ISSUES WITH UST SYSTEMS IN BIOFUELS SERVICE

Are you experiencing unusual issues with any of your biofuel UST systems? Have your USTs been taken out of service because of things noticed during routine maintenance inspections or release investigations? Do your USTs require more servicing by service contractors? To help us understand unanticipated issues with biofuels compatibility, we are looking for real world, unusual UST situations that may involve the failure of or severe degradation of tanks and or components.

Battelle Memorial Institute (Battelle) is working with USEPA to investigate reports of failures and/or severely degraded components and equipment associated with USTs that store biofuels. (Find out more on this in the next issue of *LUSTLine*.) Battelle will investigate reasons for these unusual UST issues through case studies. A suite of microbiological, chemical, and forensic techniques will be used on each case study to characterize the circumstances that lead to UST failure or the degradation of equipment and components.

A copy of the report, including all data and findings, will be given to tank owners to help them decide how to address the observed UST issues. Overall, the report will be used to gain a better understanding of the root causes of such equipment failures so that steps can be taken to help prevent future releases, thereby reducing impacts to our groundwater.

The tank owner must be willing to participate in this study by allowing Battelle (or designee) to collect samples of fuel and failed/degraded UST equipment. Likely scenarios may include the softening of plastics, degradation of fiberglass tanks, corrosion of metallic UST components, or other unusual or unexplained phenomena in USTs that store biofuels.

To volunteer, notify Anne Marie Gregg at 614-424-7419 or gregga@battelle.org when failed or severely degraded UST equipment in biofuels service is observed. ■

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