

L.U.S.T.LINE



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

A Mile-High Perspective on Petroleum Brownfield Redevelopment

by Mahesh Albuquerque

It's a beautiful sunny day in Colorado, and I am headed over to The Source to talk about petroleum brownfields with a couple of colleagues. The Source, a 25,000+ square foot brick building in an old industrial district, is just north of mile-high downtown Denver. The building once housed a steel foundry. A couple of years ago, an abandoned underground storage tank (UST) was removed from this property. The tank removal was conducted in conjunction with major redevelopment activities in the district. The old iron foundry is now a foodie's delight, housing an indoor artisan food emporium that features two great restaurants, a craft brewery and distillery, a butcher, a baker, a fresh market, a florist, an art gallery, a world food market, a coffee roaster/shop, and more.

The Source is located in the River North area along the South Platte River. Because of its industrial nature, the River North district has been isolated from the rest of the city and the development community. River North, which goes by the nickname "RiNo," is now one of the hottest up-and-coming districts in Denver, with a mix of industrial grittiness and urban creative businesses.

When we arrive at The Source, the parking lot is full and the surroundings are bustling with people and activity. We sit down for lunch and reflect on RiNo's transformation from an isolated industrial enclave into a thriving mixed-use district. What caused this incredible renaissance?

The Race Is to the Fit

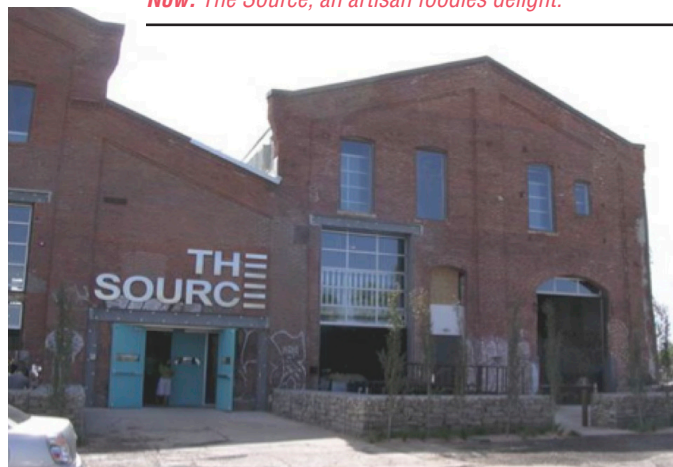
Several factors have led to the RiNo transformation; basic supply and demand created by Denver's current and expected growth rate is at the top of the list. There is very limited space for new buildings in downtown Denver, and most old buildings have already been renovated, so one has to look outward to expand. RiNo is one of the few remaining areas adjoining downtown that still has

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Then: UST removal at a former steel foundry.



Now: The Source, an artisan foodies delight.



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an abundance of vacant warehouse buildings, lots, and walkable proximity to mass transit.

The availability of funding to address environmental issues has also had an impact. In late 2010, a USEPA Brownfields Area-Wide Planning grant was awarded to the City and County of Denver in Partnership with the Greenway Foundation and the Colorado Brownfields Foundation. This funding has allowed for the extensive study of the potential cleanup and reuse of river-oriented development and neighborhood revitalization along the urbanized South Platte River corridor in Denver. Results from an area-wide planning study have spawned highway improvements, a new light rail station and plans to make Brighton Boulevard, a former industrial route, the new gateway to Denver.

The decisions to invest in and develop any real estate are heavily influenced by cost and profitability, which is driven by supply, demand,

location, and timing. For decades, RiNo was an unattractive proposition for investors or developers because of a variety of barriers, but new opportunities have torn down some old barriers, and now it's the place to be.

As a colleague pointed out, brownfield redevelopment is like running a 110-meter hurdle race, with numerous barriers that must be overcome to make it to the finish line. Just like athletes who practice and refine their techniques to shave off a few seconds and break old records, we need to continuously work on improving our processes to help remove barriers that prevent or slow down brownfield redevelopment. We also need to pay close attention to the actions and behaviors of those that have thrived in spite of barriers so we can learn and emulate what they are doing.

So how can tank regulators influence and promote petroleum brownfield redevelopment? I think we need to take a thoughtful look at what we are doing, what we can do to promote brownfield redevelopment within our own programs, and then start changing behaviors and mindsets. But first, to better appreciate and understand how petroleum brownfields have come about, let's take a few steps back in time.

Days of Yore

Over a century ago, Henry Ford started mass-producing and selling affordable automobiles like the Model T. The demand for "filling stations" quickly followed, popping up on Main Street corners across the country. By the mid 1920s, the network of roads and highways expanded and with them more than 250,000 filling stations. Then the great depression of 1929 hit, dropping the average price of gas to 10 cents a gallon in some cities, causing many stations to go out of business.

Later on, during the mid 1950s, came the Interstate Highway System that diverted the lion's share of traffic away from the nation's main streets and byways, putting many gas stations along these now less travelled paths out of business.

Fast-forward past the 1973 Oil Embargo and on to the mid 1980s. Federal UST regulations were on the horizon, and many gas station

owners were left facing new challenges again, upgrade by 1998 or shut down. For some, these hurdles were too high, and now more than a quarter century after the federal UST rules took effect, we have less than half the number of gas stations as there were in the mid 1920s.

Fortunately most of the former gas stations, especially those that have closed since the mid 1900s, have had their USTs properly closed in accordance with fire codes or with regulations in effect at the time. However, many of the stations that didn't undergo some kind of proper closure have now become potential brownfield sites.

We usually define "brownfields" as real property where the expansion, redevelopment, or reuse of which may be complicated by the presence or perceived presence of a hazardous substance, pollutant, or contaminant. Based on this definition, I contend that every UST site is or can be considered a "brownfield," even though many of them may not qualify for conventional brownfield funding.

Our National Scorecard

As a nation, we have made some great strides related to the regulation and cleanup of USTs since the '80s. Most of the 500,000 or so USTs across the country today are part of a regulated tank universe, usually with a viable business and known owners and operators. We encountered some hurdles along the way but for the most part we have been able to overcome them, and as of March 2014, we have successfully cleaned up and closed over 85 percent of the 517,000 releases from federally regulated USTs across the country. [Note: the numbers associated with benefits referenced in this article are estimates.]

These are some impressive stats, and we should pat ourselves on the back for what we have done to protect the environment through this work. Yet while we have become experts at petroleum cleanup, we typically look at the cleanup without much consideration of property use from a community or economic impact standpoint. A recent Association of State and Territorial Solid Waste Management Officials (AST-SWMO) survey (<http://www.astswmo.org>)



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org/Files/Policies_and_Publications/Tanks/2013_State_Funds_Survey/2013.summary.table.pdf) indicated that the average cost to clean up an UST site is around \$144,000. So if you do the math, we have spent almost a trillion dollars in cleanup, or as I look at it the national LUST program has had nearly a trillion dollar impact on the U.S. economy.

The challenges are still with us. Around 76,000 known releases and probably thousands more from abandoned USTs at petroleum brownfield sites, many of which have not yet been discovered, still need to be cleaned up.

Community-Based Social Marketing

I recently attended a USEPA workshop in Denver on Community-Based Social Marketing (CBSM) and was excited to find out how CBSM concepts and strategies can be used to foster sustainable behavior with regard to brownfield redevelopment.

The following are the five simple steps in CBSM.

1. Select a behavior to target.
2. Identify barriers and benefits.
3. Develop strategies to reduce barriers and enhance benefits.
4. Pilot strategies.
5. Evaluate broad-scale implementation.

CBSM draws heavily on research in social psychology which indicates that initiatives to promote behavior change are often most effective when they are carried out at the community level and involve direct contact with people. These strategies are very much like what athletes do as they prepare for competition; in a nutshell, it's about effectively changing behaviors and mindsets. Let's look at how these steps relate to brownfield redevelopment.

1. Target Behavior – Redevelop Brownfields

You have all seen petroleum brownfield properties in your neighborhoods—the abandoned gas station with windows boarded shut and weeds growing out through cracks in the lot.

A typical behavior often associated with these properties is to do nothing and let them languish, as there are too many challenges asso-



Figure 1. Targeting petroleum brownfield redevelopment.

ciated with cleaning up and redeveloping them. Sometimes, petroleum brownfield sites are not even considered as viable candidates for redevelopment under the notion that development requires large tracts of property. The targeted behavior, then, is to change mindsets to focus on redeveloping petroleum brownfield sites. (See Figure 1.)

2. Identify Barriers and Benefits

Cleaning up a brownfield site raises a unique set of concerns. As the brownfield definition implies, one of the biggest barriers to brownfield redevelopment is fear of the unknown or, more specifically, cleanup cost concerns. Property owners are reluctant to open up a can of worms without access to funding, especially with upside-down economics where their property value is significantly less than the potential cleanup cost.

Economics play a vital role in any brownfield redevelopment. All of the incentives in the world won't make any difference if the economics don't work out. The economics need to make sense, and if they do, those properties are redeveloped without any dependency on public funding. If you were to plot brownfield properties from an economic perspective they would form a normal distribution, or bell curve. For the vast majority of the brownfield properties that lie in the center of the bell curve, a nudge in the form of public funding may be necessary to make something happen. This is where we come in; petroleum storage tank funds can often provide that nudge.

Lenders, investors, and developers share similar concerns to those of

property owners and are sometimes also deterred by potential liability issues. In addition, many gas station properties have been built on limited space with footprints that sometimes restrict the redevelopment possibilities. And, just like any other real estate transaction, it's all about location, location, location, and timing. There are many more barriers, and I could go on and on...

The benefits from redeveloping brownfields are numerous. By addressing contamination, redevelopment benefits not just the property owners, but the community as a whole by reducing urban sprawl, increasing the tax base, encouraging urban revitalization, and creating jobs. Brownfield redevelopment may even be less expensive than developing previously undeveloped land because roads and infrastructure are already in place, and these properties may be located near potential markets and labor, thus reducing the financial and social costs associated with transportation of workers and products. It also tends to foster social diffusion, or the "If you build it they will come" mentality, and soon others can't wait to be part of the action.

3. Develop Strategies to Reduce Barriers and Enhance Benefits

There have been some great joint initiatives between USEPA's Office of Underground Storage Tanks (OUST) and USEPA's Brownfields Program, and their collective outreach has focused on providing brownfields grants and other resources for the clean up and reuse of petroleum-contaminated sites. The Petroleum Brownfields link on the USEPA OUST website is one of the best resources out there, as it provides guidance, toolboxes, funding opportunities, success stories, and more. (<http://www.epa.gov/swerst1/petroleumbrownfields/index.htm>)

Many states and local governments have also developed creative and effective mechanisms to fund environmental site assessments and cleanups so that petroleum brownfield properties can be redeveloped. One of the most effective mechanisms that we often overlook is the state petroleum storage tank funds across the country that have already funded almost a trillion dollars in

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enabling assessment and cleanup of petroleum contamination from regulated UST sites.

Sometimes it seems as if we have reimbursed a lot of this money to tank owner/operators with our focus primarily on completing cleanups without appreciating the fact that many former gas stations are now Walgreens, Starbucks, and other thriving businesses. And even if they are still gas stations, we have addressed environmental impacts and made those properties more marketable. If these funds were not available, many of these properties may have looked very different, likely remaining vacant and weed-infested. It is critical to have public and private partnerships throughout the redevelopment process. Public funding is a bridge to making some projects work.

Since “fear of the unknown” is one of the biggest barriers to petroleum brownfield redevelopment, implementing mechanisms to enable site assessments to minimize uncertainty is one of the best places to start. The use of risk-based criteria, and the ability to fast-track cleanups and closures is very beneficial, especially given some of the tight timelines associated with redevelopment.

Finally, and most importantly, we must do more outreach on what our programs are doing to promote petroleum brownfield redevelopment. Public outreach is the effort by our organizations to connect ideas or practices to the efforts of other organizations, groups, specific audiences, or the general public. There are a variety of ways to connect and partner with other organizations or groups. Effective public outreach activities promote relationships that ensure positive outcomes for all stakeholders.

4. Pilot Strategies

Colorado, like many states, has made its way into the petroleum brownfield arena. Just like the hurdler, we have had to pick ourselves up at times, and continue practicing and refining our techniques to be more effective. The goal of the Division of Oil and Public Safety (OPS) Petroleum Brownfields Program is to

promote environmental protection through the sustainable redevelopment of brownfield properties.

Here are a few strategies we have utilized that have proven effective.

- **Staff as a Trusted Resource:** The most valuable assets we have in our UST programs are our staff. In Colorado, our staff are available to provide assistance to property owners, developers, or any other interested parties with questions they may have related to brownfield redevelopment.
- **Risk-Based Closures:** For decades, we have used two primary means to get to closure—Tier I and Tier II—both of which utilize RBCA to ensure compliance with MCLs at the property boundary. OPS has recently included two additional means to get to closure—Tier III and IV—which essentially continue to employ RBCA, but now recognize the elimination of exposure pathways with MCL exceedances beyond the property boundary. The RBCA process has helped us fast-track some cleanups so that redevelopment can proceed.
- **Creative Funding Mechanisms:** Since the inception of our fund in Colorado, we have reimbursed over half a billion dollars on cleanups. In addition, our fund has a 20 percent set aside for addressing non-responsible-party cleanups. This has enabled hundreds of abandoned tanks at brownfield properties to be cleaned up and the sites to be redeveloped.

We have also recently created the Petroleum Cleanup and Redevelopment Fund (Redevelopment Fund), which provides competitive grants for the investigation and cleanup of contamination at petroleum brownfield properties that have been unaddressed for decades, mainly because these unregulated former storage tank sites were not eligible for reimbursement from the fund.

The Redevelopment Fund provides awards of up to \$50,000 for site assessments with a 10 percent applicant match, and up to \$500,000 with a 50 percent appli-

cant match for cleanup. In addition, the Redevelopment Fund provides up to \$2,000 per tank for each UST removed, which is tremendously helpful for those owners who don't have the monies to remove their tanks (<https://www.colorado.gov/pacific/ops/BrownfieldsProgram>).

- **Interagency Collaboration:** Redeveloping petroleum brownfields often requires addressing non-petroleum contaminants, such as asbestos and dry cleaning solvents. Therefore, collaborating with agencies that have jurisdiction over different aspects of a redevelopment project is critical. OPS works closely with the Brownfields Program at the Colorado Department of Public Health and the Environment (CDPHE) and USEPA, as well as with various federal, state, and local governmental agencies and non-governmental organizations.
- **Community Engagement:** Engaging the community helps build public trust and credibility in the redevelopment/reuse project. Generally, communities create a vision of how their neighborhood should look and feel, and successful projects reflect that vision. The property owner's recognition and interaction with stakeholders, local government, and business improvement districts are essential in successful redevelopment of these former storage tank properties.
- **Outreach to Partners and Stakeholders:** We have utilized various forms of outreach from the traditional posting of information on our websites to flyers and brochures. For several years we have actively collaborated with the former Colorado Brownfields Foundation, which offered training and workshop opportunities throughout the year and an annual conference on issues relating to the cleanup and redevelopment of brownfield properties. We also reach out to communities that have established planning areas, business improvement districts, development and improvement districts, urban renewal authorities,



Figure 2. The site of Denver's former airport is now a sustainable community and one of the largest urban infill projects in the U.S.

and downtown development authorities.

However, some of the most effective outreach occurs at the community level and involves direct contact with people. A coworker recently shared a story of making an unscheduled stop to do some outreach concerning our Redevelopment Fund with the city planner in Gunnison. The planner was so excited to hear about the program that he asked our staff person to take a drive with him to a bulk plant that was being redeveloped so she could meet the property owner. When they showed up at the bulk plant, the workers said the property owner was working out at the gym. The planner insisted they head over to the gym to meet the owner to discuss this excellent opportunity. The sweaty property owner was immediately interested in learning about the opportunity the Redevelopment Fund presented, and will likely apply for funding soon.

It's personal, one-on-one unscheduled outreach like this that sometimes is the most effective means of changing behavior toward petroleum brownfields redevelopment.

5. Evaluate Broad-Scale Implementation—Some Bright Spots

Now that we have piloted and implemented some strategies, let's take a quick look at a few bright spots along the way.

- **From a former airport to a sustainable community:** In 1995, facilities owned by rental car companies, airlines, and the airport authority were closed in conjunction with the decommissioning of Denver's Stapleton Airport. Many of the facilities with underground and above-ground storage tanks were eligible for our Petroleum Storage Tank Fund (Fund). Denver's vision was to redevelop the old airport area into a new community with mixed residential and commercial use (Figure 2).

OPS staff worked closely with the tank owner/operators, the city, the site developer, the airport authority, and CDPHE to ensure that petroleum contamination was adequately assessed and cleaned up in a timely manner to enable redevelopment. Millions of dollars from the fund were reimbursed for assessment and cleanup to residential stan-

dards at many of these facilities. For years after the cleanup, OPS staff provided potential Stapleton residents with information related to the cleanup after the decommissioning of the former petroleum storage tanks at the airport.

The mixed-use redevelopment created the new Stapleton community with commercial businesses, shopping, and housing, and it is now Denver's premier sustainable community and one of the largest urban infill projects in the United States.

- **From gas stations to housing and shopping center:** In 2002, we received a \$100,000 USEPA USTfields Pilot Project grant to assess and clean up four UST sites located in the Northeast Park Hill and Sunnyside Acres neighborhoods. OPS partnered with the City and County of Denver who agreed to match funds as both of these sites were within their Brownfield Showcase Community boundaries (Figure 3). There was almost no contamination at one of the sites and minimal contamination at the other. The sites were closed and redeveloped with a neighborhood shopping center and affordable housing.
- **Promoting Heritage Tourism:** In 2005, OPS was awarded a \$200,000 USEPA Brownfields Assessment Grant that was used to assess and clean up communities located along Colorado's Scenic Byways and Historic Districts. OPS focused on former gas station sites whose cleanup and

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Figure 3. From gas stations to affordable housing in Northeast Park Hill.



Figure 4. Part of the 26-mile long Colfax Avenue corridor in Denver and Lakewood targeted for Main Street redevelopment.

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redevelopment supported local economic development plans for promoting heritage tourism.

- **Rural Development:** In 2009, Kit Carson Rural Development received a \$200,000 USEPA brownfields cleanup grant. Located in Cheyenne County, Kit Carson (population 253) has at least four known brownfield sites along the same main highway that runs through town. The 0.4-acre Paxson Building was home to a variety of operations, including an automobile dealership and repair shop, fuel station, and café. OPS staff assisted with the UST removal oversight, assessment, and cleanup. Cleanup of the Paxson site is expected to serve as a catalyst that will enable the town to redevelop this and other sites in town.

- **Main Street Revitalization:** In 2011, OPS reached out to the cities of Denver, Lakewood, and Aurora to discuss a potential brownfield grant application to address former UST sites along Colfax Avenue, one of two principal highways serving Denver (Figure 4). Soon thereafter, the Colfax Mainstreet Coalition (Coalition), a partnership between the City and County of Denver, the City of Lakewood, and the Denver Urban Renewal Authority was formed with the sole purpose of applying for a USEPA brownfields assessment grant.

OPS worked closely with the Coalition, assisting them with preparing the grant application and providing technical assis-

tance. The Coalition was successful and in 2012 it was awarded a \$900,000 brownfields assessment grant from USEPA to examine potential site contamination along the Colfax Avenue corridor in Denver and Lakewood. The goal is to help foster redevelopment of Colorado's original main street by funding environmental site assessments. These assessments will help determine the presence, nature, and extent of potential contamination at sites and identify specific cleanup needs that will assist in restoring the properties to beneficial and higher reuse for the community, property owners, and prospective purchasers.

The River North Workout

So let's wrap up by going back to the beginning of this article—the redeveloping River North area along the South Platte River. It is estimated that there are over a hundred old USTs along that former industrial route, which will be the new gateway to Denver. OPS has already conducted several UST assessments and cleanups in the area utilizing monies from the Petroleum Storage Tank Fund and anticipates using the Redevelopment Fund for other cleanups.

More than a decade ago several USTs were removed from the former Yellow Cab dispatch center and corporate headquarters in the River North area. Assessments and cleanups were conducted using monies from the fund. In 2001, Zeppelin Development transformed the 25,000 square feet brick building into flexible workspaces for a variety of creative businesses, called Taxi.

A notable property in the area is a formerly regulated gas station that was no longer in use. The tank owner

was out of compliance with our regulations and, during an enforcement meeting, we found out he did not have the financial means to address our requirements. It was ironic that even though his undeveloped property was worth a lot, he did not have the money to empty the tanks and conduct a site assessment.

We decided to enter into a settlement agreement where we would do the required work on his behalf and put a consensual lien on his property for our expenses. When the results of the assessment indicated no contamination, the owner was able to sell his property for over \$6 million. We were paid our expenses before recording a lien on the property, which will be developed into a residential high rise building in the RiNo area.

At another property, the Blake TOD redevelopment project, OPS staff facilitated and provided oversight of site assessment activities. Work included the removal of two USTs, the petroleum assessment, and removal of a sand trap. The work was funded using USEPA Targeted Brownfields Assessment dollars (<http://www.epa.gov/region1/brownfields/programs/targeted.html>) and has played an integral part in preparing the site for redevelopment.

Soon the property was secured by the Urban Land Conservancy, a Colorado nonprofit organization that uses real estate as a tool to benefit urban communities. This project property is suitably located adjacent to the Blake Street Station along the RTD FastTrack's East Corridor line that connects downtown Denver and Denver International Airport (Figure 5). The redevelopment of this site will have a direct impact on temporary and permanent job creation through the planned building of a

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A Message from Carolyn Hoskinson

Director, USEPA's Office of Underground Storage Tanks

The National Underground Storage Tank Program: 30 Years of Protecting Groundwater



What does the national Underground Storage Tanks (UST) program have in common with Mark Zuckerberg, Virgin Atlantic Airways, and Papa John's Pizza? If you guessed all were "born" in 1984 and turn 30 this year, you are correct.

The UST Program Then

In November 1984, Congress passed and the President signed legislation directing USEPA to develop a comprehensive regulatory program for underground storage tanks storing petroleum or certain hazardous substances to protect the environment and human health from UST releases. The 1984 legislation applied to approximately 2.1 million USTs in the United States.

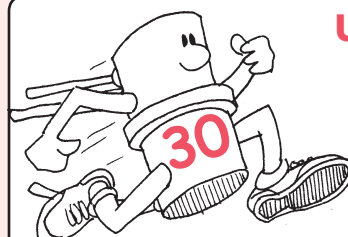
USEPA published federal UST regulations in 1988, which covered three areas: technical requirements, financial responsibility requirements, and state program approval objectives. The technical requirements set minimum standards for new tanks and required owners of existing tanks to upgrade, replace, or close them. The financial responsibility requirements required UST owners and operators to demonstrate they have the financial resources to carry out corrective action. The state program approval regulations set criteria for states to obtain the authority to operate in lieu of the federal UST program, with state programs being at least as stringent as USEPA's.

Subsequent legislation created the Leaking Underground Storage Tank (LUST) Trust Fund, added additional prevention authorities through the Energy Policy Act of 2005, and provided a one-time infusion of \$200 million to assess and clean up petroleum releases through the American Recovery and Reinvestment Act of 2009.

...And Now

Fast forward three decades, and our regulated universe is now approximately 571,000 active underground storage tanks, storing petroleum and other fuel products at 205,000 facilities nationwide. Those active underground storage tanks are located in every community: at gas stations and other non-retail facilities, such as school district bus fueling stations, police and fire stations, marinas, taxi fleet facilities, postal and delivery service facilities, and federal facilities such as military bases.

To protect our communities, USEPA's UST program has worked with our state, territorial, tribal, and industry partners over the past 30 years to keep our environment safe from underground



UST PROGRAM AT 30 YEARS FAST FACTS

(as of September 30, 2014)

- **521,000 releases confirmed**
- **447,000 releases cleaned up**
- **74,000 releases remaining to be cleaned up**
- **The percent of confirmed releases where cleanup completion is pending has steadily declined, from 29 percent in 2004 to 14.2 percent in September 2014**
- **More than 1.8 million underground storage tanks closed**
- **USEPA UST website www.epa.gov/oust**
- **USEPA 30th anniversary UST program timeline www.epa.gov/oust/30year-timeline.pdf**
- **EPA's state fund website www.epa.gov/oust/states/fndstatus.htm**

storage tank petroleum leaks. Our collective progress in protecting our groundwater and land from underground storage tank leaks is impressive; together we have:

- Cleaned up more than 447,000 releases; that means we cleaned up more than 85 percent of the releases that have occurred.
- Cleaned up more than 447,000 releases; that means we ensured that 72.5 percent of all UST facilities are in compliance with release prevention and leak detection requirements.
- Cleaned up more than 447,000 releases; that means we decreased the number of new releases from a high of almost 67,000 in 1990 to just over 6,800 in 2014.

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These accomplishments show the dedication and teamwork of our UST partners to implement the national UST program, prevent releases, detect leaks early, and clean up leaks when they do occur. Together we have accomplished much.

What Is on the UST Horizon?

Where will the national UST program be in 10 or even 30 years? I don't have a crystal ball, but I am certain about a few things in our near future.

We still have a lot more work ahead of us. Although we made great progress so far, there is still much we need to do.

We need to complete the approximately 74,000 cleanups remaining in the backlog. We need to continue decreasing the number of newly confirmed releases through enhanced prevention techniques and on-site inspections. We need to bring the remaining UST facilities into compliance and keep them in compliance.

To help our partners with this work, USEPA will develop technical information, such as the petroleum vapor intrusion guidance, and other training to aid our UST partners in assessing and cleaning up releases. And in 2015, we will implement revisions to the federal UST regulations. In fact, the Office of Management and Budget is reviewing the revised UST regulations as I write this.

We must continue protecting our country's land and groundwater, a source of drinking water for approximately 50 percent of United States' citizens, from petroleum and other fuels stored in USTs.

All of our partners involved in UST work have shown great dedication to the National UST program, enthusiasm in addressing the enormous task of preventing and cleaning up UST system

EVENTS FROM 30 YEARS AGO

Date	Event
1/24/84	Apple unveiled the Mac personal computer
6/7/84	Ghostbusters movie premiered
7/28/84 through 8/12/84	US Olympic Games held in Los Angeles
9/15/84	Prince Harry was born
11/6/84	President Reagan won re-election by defeating Walter Mondale

COSTS AND PRICES FROM 30 YEARS AGO

Amount	Description
4.3%	Yearly inflation rate in United States
1,211	1984 year-end close of Dow Jones Industrial average
10.75%	1984 year-end interest rate Federal Reserve
\$86,730	Average cost of new home
\$1.10	Cost of 1 gallon of gasoline

leaks, and collaboration in working toward our common goal of protecting our groundwater and land.

I thank you for your cooperation and support over these past 30 years. We all have a right to water and land that is free from contaminants. Your efforts each day are protecting that right and keeping our water clean and our land safe for our and future generations. ■

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mixed-use development with up to 100 residential units.

What's Next?

Focusing on petroleum brownfield redevelopment clearly makes sense. Initiatives to promote behavior change are often most effective when they are carried out at the community level and involve direct contact with people.

In the past, gas stations were often the gateway to the community. Even though their individual footprints may be small, they are pieces of the bigger puzzle where environmental protection, economic prosperity, and community values meet.

The petroleum brownfield may be a central feature of a redevelopment, or it can be part of an assemblage.

Just like the hurdler, we need to constantly strive to improve the effectiveness of our programs. Petroleum brownfield sites are catalysts for furthering redevelopment and stimulating new economic investment opportunities while also protecting human health and the environment.

Redeveloping petroleum brownfields sites makes a great story and sends a great message for tanks programs. The successful redevelopment of LUST sites is a win for the environment, a win for the local community, AND a win for our tanks programs. This demonstrates the results and positive impact of our work, and can showcase our



Figure 5. Light rail expansion is a catalyst for transportation-oriented development.

program. It's time to begin the next race, so on your marks...get set... GO! ■

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Field Notes

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

Great Today and Even Better Tomorrow

There are relatively few advantages to getting older. I have firsthand knowledge of some of them. You get more frugal (I always ask for the senior discount). You become more open; say what's really on your mind (it's as if you kept it in, all these years, under the guise of being courteous, but as you age your inhibitions melt away). And you wear comfortable clothes (as long as I leave the house with a matching pair of comfortable shoes on my feet, I'm happy).

Another advantage of getting older is having great long-term memory (just don't ask me what I did with my car keys an hour ago). From the UST program perspective, I remember that PEI predicted in the 1970s that state and federal controls related to tank and piping leaks would proliferate. At about the same time, the American Petroleum Institute's (API's) Operations and Engineering Committee recognized that UST leaks presented a growing industry problem and formed a task force to recommend procedures for detecting and dealing with leaks. In 1981, fewer than 10 percent of all USTs in the ground were protected from corrosion.

Emphasis shifted in the early 1980s from tank regulations for safety reasons to regulations for protecting the environment and public health. Pressure to deal with the impacts of leaking USTs on groundwater mounted when *60 Minutes* aired a disturbing segment on leaking underground service station tanks. Shortly after that, Congress stepped in with the 1984 Subtitle I RCRA Amendments that Carolyn Hoskinson referred to in her column (page 7).

There were over two million USTs in 1984. Many of them were bare steel that were corroding and leaking fuel into the ground—over 85 percent of the USTs were made of unprotected steel. By 1988, somewhere from 10 to 48 percent of existing tanks were failing their tank-tightness tests, depending on which study you believed. And when you consider that from 8 to 20 percent of all USTs had releases, UST regulators back then had their hands full.

Carolyn's article does a great job describing how far USEPA's UST program has come and the contribu-

tions to the environment it has made. The accomplishments are real and there is much that regulators and the regulated community can point to with pride.

Part of the reason this governmental program works so well after 30 years is because Ron Brand and other founders of the UST program involved everyone in the process of protecting our environment from UST releases. States, territories, tribes, industry, owners/operators, service providers, equipment manufacturers, and trade associations were called partners and, speaking for our industry, we were treated that way back then and continue to feel that way today. This is a unique program with unique relationships that has produced quantifiable results. It's been 30 years and the environment has benefitted each and every year of the program.

I think that successful managers and leaders should continuously focus on what can be rather than what is. And I also believe that the best leaders are always focused on improving. From the equipment and contractor side of this partnership—and in that spirit—this is what I see still needs to be addressed to make a great program even greater:

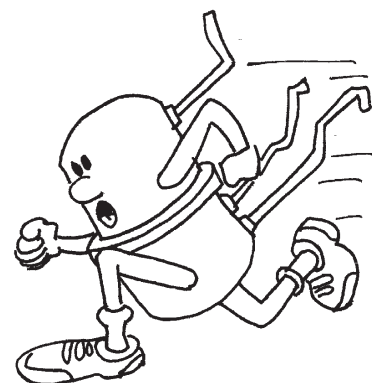
- Let's figure out what is causing the metal components of our UST systems to corrode in the presence of ultra low sulfur diesel fuel.
- Let's bring that 25 percent of underground tank systems in the U.S. into compliance with release prevention and leak detection requirements. That will cut down on the number of newly confirmed releases.
- Let's work together to determine why equipment is deteriorating in sumps containing ethanol and/or ethanol vapors.
- Let's find ways to clean up the releases in the backlog before state cleanup funds sunset or get diverted.
- And let's kick off an inspection and testing program that will identify equipment that no longer works as it was supposed to work.

Let us know how we can help. ■



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A “Pig” Chews Over Meeting Federal UST Regulatory Goals

Part 2 – New Tank Standards and Financial Responsibility

by Patrick Rounds

In a breakfast of bacon and eggs, the chicken is involved, but the pig is committed.

Attributed to Fred Shero



On November 8, 1984, Subtitle I of RCRA, became federal law as part of the Hazardous and Solid Waste Amendments of 1984, Public Law 98-616. Subtitle I – Regulation of Underground Storage Tanks. The administrator of the USEPA was directed to “promulgate release detection, prevention, and correction regulations applicable to all owners and operators of underground storage tanks, as may be necessary to protect human health and the environment.” It has been 30 years since UST regulations became a federal priority.

As discussed in *LUSTLine* #75, I am the pig at the bacon and eggs table. My company provides financial responsibility coverage for thousands of our customer’s UST facilities. As insurers, we are the fully committed pig that is all in—if an insured tank leaks, we pay. Unlike the chicken we don’t get to lay another egg. So, although we don’t write the regulations, we need the regulations to achieve their intended goals so we can achieve ours. So in this three-part series of articles I focus on how well our regulatory goals are being met.

In the first part of this series (*LUSTLine* #75) we discussed Leak Detection, Release Reporting, Corrective Action, and Tank Closures. In this article we’ll look at New Tank Standards and Financial Responsibility. In Part 3 we’ll look at Energy Policy Act requirements.

■ New Tank Standards

Tank Construction

The federal UST law required the USEPA administrator to issue performance standards for new under-

ground storage tanks that included, but were not limited to, design, construction, installation, release detection, and compatibility. In addition, there was a prohibition on new installations unless a system: (a) would prevent releases due to corrosion or structural failure for the operational life of the tank; (b) was cathodically protected against corrosion, constructed of noncorrosive material, steel clad with a noncorrosive material, or designed in a manner to prevent the release or threatened release of any stored substance; and (c) the material used in the construction or lining of the tank was compatible with the substance to be stored.

To implement the new tank standard, USEPA established an “upgrade” deadline of December 1998 (yes, the deadline was 16 years ago). All tank systems had to meet the upgrade requirements or new tank standards by that date.

Results

To track compliance with the tank standard provisions, USEPA tracks significant operational compliance (SOC) with release prevention regulations, which is the percentage of UST facilities deemed to be in SOC with the UST spill, overfill, and corrosion protection requirements. As of March 31, 2014, USEPA reported a low of 56 percent SOC in one jurisdiction to a high of 100 percent SOC in another jurisdiction—an average SOC of 84.9 percent for release detection nationally. Of all inspected sites nationwide, 72.1 percent are in compliance with both release detection (see Part I) and release prevention regulations.

Areas for Improvement

Nearly 30 years after the enactment of the federal law, we still have “upgraded” or “legacy” facilities operating with field-installed corrosion protection (CP) systems. We have removed more than two million tanks since 1984, but many legacy systems still remain. Many of these legacy systems rely on field-installed CP, internal lining, or both. Our fuel loss studies indicate that upgraded tanks have significantly higher loss costs than tanks that meet the new tank standards.

Early on field upgrade methods were a reasonable compromise to allow businesses an opportunity to plan for and finance the construction of new tank systems. However, field constructed CP systems and internal lining have proved to be temporary fixes that in many cases have exceeded their usefulness. In many states where sources and causes of petroleum releases are posted, “corrosion” ranks as the most significant cause of releases after “unknown.” In most cases it is a field-upgraded tank that is subject to the corrosion failure.

Although some states have a high percentage of “new standard” tank systems, many do not. Florida reduced its upgraded tank population by requiring double-walled tank systems by December 31, 2009. California, which recently adopted a 2026 deadline for removal of single-walled tanks, reported that last year 39 percent of tank losses and 27 percent of piping losses were caused by corrosion.

At the Association of State and Territorial Solid Waste Management Officials’ (ASTSWMO) spring meeting in Tampa, Florida, one state

noted that approximately 65 percent of its registered tank sites predate the new tank standard requirements. Tanks installed before the new tank standards are at least 30 years old today. The business model for retail petroleum distribution should allow for infrastructure changes at least once every 30 years, and if the replacement time were reduced to 20 years, our infrastructure would have a much better chance of being compatible with the changing fuel mandates. We need to do a better job of investing in our tank infrastructure.

■ Compatibility

The federal mandate required that tank systems be compatible with the substance stored. There are at least 18 different gasoline-based fuels stored in petroleum tank systems, with numerous additional ethanol blends (EPA Section 1541 Boutique Fuels Report to Congress, December 2006, Figure 100). In addition, there are numerous diesel blends and biodiesel blends and other fuels such as kerosene and racing fuel that may be stored in tanks at different times of the year. Compatibility is not always easily determined, and should not be assumed. (See *Compatibility of UST Systems with Biofuels, Final Report*, June 2013 Alternative Fuels Workgroup Tanks Subcommittee, AST-SWMO, which noted lining and FRP compatibility issues with biofuels in various tanks in various states.) Lack of compatibility may be the number one cause of leaks today (hidden in the “unknown” cause category).

USEPA federal regulations require that UST systems be compatible with the substance stored. In order to help guide owners and operators on how to demonstrate that their system is compatible with a substance, USEPA identified in its 2011 *Guidance on Compatibility of UST Systems with Ethanol Blends Greater than 10 Percent and Biodiesel Blends Greater than 20 Percent* the following UST components determined to be critical for demonstrating compatibility:

- Tank or internal lining
- Piping
- Line-leak detector
- Flexible connectors
- Drop tubes

- Spill and overfill prevention equipment
- Submersible turbine pump and components
- Sealants (including pipe dope and thread sealant), fittings, gaskets, O-rings, bushings, couplings, and boots
- Containment sumps (including submersible turbine sumps and under-dispenser containment)
- Release detection floats, sensors, and probes
- Fill and riser caps
- Product shear valves

Although compatibility of tank systems is required, for older tank systems compatibility issues are sometimes not identified until a release occurs. Compatibility of dispensing equipment is not included in the federal Underground Storage Tank requirements because dispensing equipment is above ground and not subject to UST regulations, but may be covered by other federal regulations.

Areas for Improvement

State and federal mandates associated with air or other environmental issues have greatly increased the number and quantity of alternative fuels being used in the regulated UST industry. It is therefore important to ensure compatibility before storing any new substances as UST equipment may be designed to be in the ground for 30 or more years, and new fuels that may be developed may not be compatible with currently existing infrastructure.

■ Financial Responsibility

The USEPA administrator was also required to “promulgate regulations containing requirements for maintaining evidence of financial responsibility (FR) as he deems necessary and desirable for taking corrective action and compensating third parties for bodily injury and property damage caused by sudden and non-sudden accidental releases arising from operating an underground storage-tank.”

Results

The purpose of the FR requirements is to have funding available

to address corrective action and third-party liabilities if leak prevention requirements are not successful. Since 1984 more than 517,000 petroleum UST releases have been reported with an average of approximately 6,000 releases per year in the last four years. Of all these releases, over 85% or over 441,600 releases have been addressed. Less than 15 percent of releases cases remain open.

In 36 states owners can rely on publicly subsidized assurance funds to satisfy the FR requirement, while in the other 14 states, DC, and U.S. territories, the primary mechanism is private insurance (USEPA lists at least 16 carriers that offer UST coverage). State funds have paid over \$15 billion for UST corrective action. With fewer than 76,000 confirmed releases still subject to corrective action requirements, financing corrective actions seems to be a success.

Areas for Improvement

There are no consolidated records tracking the number of existing releases that lack adequate funding to address corrective action or third-party liabilities. To determine if our FR requirements are adequate and fulfilling their objectives, such data should be tracked by USEPA. The lack of funding could be caused by many factors, including inadequately funded state programs, lack of compliance with insurance contracts, violation of state and federal technical requirements, or the lack of an acceptable FR mechanism (an audit of one state determined that only 35 percent of facilities were in compliance with the FR requirements). In simple terms, corrective action may be delayed either because the FR mechanism won't pay or because the FR mechanism can't pay.

Based on “anecdotal” concerns raised by state regulators and tank owners, USEPA conducted a study on the effectiveness of UST insurance as an FR mechanism. The study was inconclusive and was unable to document any system-wide failure of insurance as an FR mechanism. The report determined that insurance generally complied with federal UST regulations. Unfortunately the report did not evaluate facts associated with releases that were not funded

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■ Meeting Regulatory Goals from page 11

because an insurance carrier denied coverage. The anecdotal information indicated that there could be reasons why the carrier would not pay for a release—because the release occurred prior to the coverage, was not from the insured tank system, or the policyholder or tank system did not comply with the terms of the policy. However, factual determinations were not provided.

USEPA also issued a directive to monitor the soundness of approved state funds in 1993. The process has continued since then. Since 1993, many state funds have prioritized claims, stopped accepting applications for reimbursement, or just stopped paying claims because of inadequate funding. These funds have been allowed to continue as acceptable FR mechanisms. The issue may be that there is no consistent evaluation process and there are no criteria established to determine whether a state fund is an adequate FR mechanism.

All FR mechanisms should be evaluated using the same criteria so that all owners are able to immediately respond to a confirmed release. Any FR mechanism that cannot immediately fund corrective action should not be considered an adequate FR mechanism. Self-insurance, private insurance and state funds should all be evaluated equally. The questions should be “will the mechanism immediately respond to a release and does the mechanism have the financial capability to fully fund its liabilities?” If the mechanism is financially capable, the next issue is whether the tank owner is in compliance with the mechanism’s requirements.

Most state funds and private insurance contracts have some form of compliance requirements and eligibility dates. Any owner that acts in such a manner to invalidate their selected FR mechanism should be required to re-establish compliance with their FR mechanism or be required to obtain another accept-

able mechanism before a release can occur. Failure to comply with the requirements of an FR mechanism should be addressed in the same manner as other regulatory violations, including the use of red tag authority if necessary.

FR mechanisms should also be continuous, which means that the retroactive date should be the date of install or the last date when the facility was determined not to have an unfunded release.

Owners should not change FR mechanisms without obtaining continuous coverage or without adequate site testing between mechanisms to determine if a release has occurred. If tank owners know that FR requirements will be

enforced, the owners will do better. If FR mechanism providers know that they must be financially solvent, they will do better.

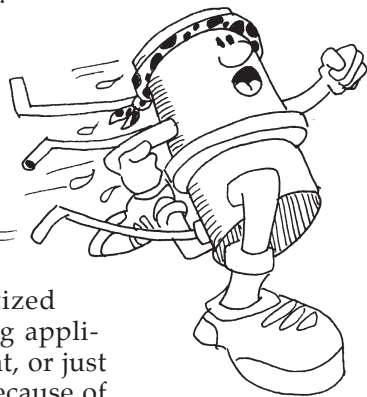
The most significant issue associated with financial responsibility may be related to gaps in coverage. Gaps occur when an owner changes FR mechanisms without maintaining the original retroactive date. Most releases are “nonsudden” and

are discovered a year or more after they occur. If owners are going to change FR mechanisms the best way to protect their financial interests is to keep the previous retroactive date (this will require a premium for a new provider to cover this risk), or conduct an assessment with soil and groundwater testing around the tanks and dispensers to identify any significant contamination.

Although assessment costs vary widely between regulatory jurisdictions, they will cost much less than corrective action costs should the owner become liable for a release that occurred prior to a new retroactive date. Owners should conduct assessments before purchasing existing UST facilities, before a state fund sunsets or ceases, or when switching to a new FR provider if the retroactive date is not maintained.

The federal financial responsibility requirements are detailed and comprehensive. If properly enforced, FR regulations will achieve the intended goals and most releases will be addressed without significant financial harm to the tank owner. We don’t need more regulations; we do need to focus on better business judgment with respect to managing risks. ■

Patrick Rounds is President and CEO of PMMIC Insurance. He can be reached at pjr@roundsassociates.com. Your comments are welcome.



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Wander LUST

a walkabout with Jeff Kuhn.....

Jeff Kuhn is with the Montana Department of Environmental Quality (MDEQ) and a venerable veteran of petroleum remediation at the state and national levels. Through this column he takes us on “walk abouts” across the fascinating world of underground storage tanks. Jeff welcomes your comments and suggestions and can be reached at jkuhn@mt.gov.



Oil Trains and the UST Program

We’ve had a beautiful fall here in Montana. Recent vivid sunrises and sunsets and the clear, full moon remind me how fortunate I am to live in a beautiful place. With this November being the 30th anniversary of the national UST Program, it’s a good time to reflect on our accomplishments. In fact, the program has made tremendous progress in 30 years through the dedicated efforts of a number of folks who will never receive the credit that is due.

But it’s hard to appreciate that in these days of shrinking budgets, staff reductions, and difficult decisions we have something about which we can be truly proud. State UST Programs have cleaned up and closed some 447,000 petroleum releases nationwide, many of which directly impacted or threatened drinking water supplies. And the job is far from over. But there’s always something...and now many states are grappling with a new threat to water quality, a threat created by tremendously successful petroleum extraction from historic oil production areas: Enter the oil trains.

In our National Tanks Conferences we’ve often discussed the difficulty of gauging the success of the UST Program, where extensive

cleanups of soil and groundwater go mostly unnoticed by the public. Often neither the damage done by an underground release, nor the progress made in remediating and minimizing the damage, is clearly visible. Contrast that with any of dozens of major oil train derailments such as the horrific accident in July 2013 in Lac-Mégantic, Quebec that killed 47

storage tanks,” no different from any other petroleum tanker transport. But here’s the rub, we’re talking about a train length that runs about two kilometers (1.2 miles) with one hundred DOT-111 tanker cars. Furthermore, assume a full tanker contains approximately 30,000 gallons—a total volume of 3.0 million gallons. Even smaller, partially loaded 50-car oil trains carry more than a million gallons. That’s a lot of fuel.

As early as 1991 the National Transportation Safety Board (NTSB) noted design flaws that make DOT-111 tankers prone to failure in derailment incidents¹. These weaknesses were again noted when ethanol tanker traffic increased in the mid-2000s; increased production created the need to move more and more ethanol to petroleum terminal blending facilities. During that time the mid-west experienced a series of well-documented

ethanol tanker car derailments that resulted in large spills (a number of those ethanol spills are the subject of ongoing groundwater and vadose zone research). In July 2014, the U.S. Department of Transportation (USDOT) proposed rules that would phase out rupture-prone DOT-111 tanker cars that comprise most of the Canadian tanker fleet and a large portion of the U.S. fleet².



An oil train running through Montana.

people—one of the worst disasters in Canadian rail history. There have been many other oil train accidents in the last two years due to the huge increase in oil train traffic (Figure 1). Most have resulted in significant environmental impact and subsequent cleanup.

We’re Talking Mobile

Many of us in the UST Program would simply define oil trains as “mobile

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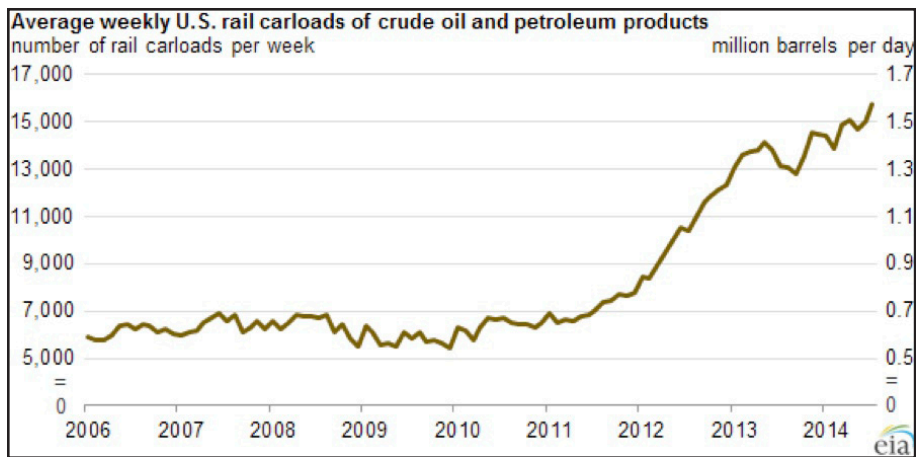


Figure 1. U.S. railroads moved 9 percent more crude oil and refined products from January to July 2014, compared to the same period in 2013. U.S. Energy Information Administration, based on Association of American Railroads (<http://www.ibtimes.com/us-oil-boom-2014-us-railroads-are-moving-greater-volumes-crude-oil-year-amid-bakken-1672564>).

■ Oil Trains and USTs from page 13

Despite heightened awareness and action on the part of the NTSB, the USDOT, the rail industry, and nearby communities who have beefed up oil spill response capabilities, the potential for disaster is still high along rail traffic corridors. Concern in my state and other nearby western states involves the probable impact to surface water since most major rail lines in our states follow river valleys.

Fragile ecological areas, such as the Middle Fork of the Flathead River, along the edge of Glacier National Park, are especially vulnerable to surface spills³. Washington's Governor, Jay Inslee, has taken significant steps to address possible derailment scenarios. He plans to ask the Washington legislature and the rail industry to share oil spill prevention and response costs. Washington currently does not tax oil moved through the state via rail or pipeline. Proposed legislation may change this in Washington in 2015⁴.

There are immediate solutions to the increased traffic of oil trains: better tanker cars, safer rail crossings, and lower speed limits through narrow canyons and river corridors. More permanent solutions could involve construction of pipelines, such as the Keystone XL Pipeline. Certainly one advantage of the pipeline would be the decrease in rail transportation of crude oil from production areas in Canada, Montana, and North Dakota. One big disadvantage would be a more immediate threat to groundwater resources.

The discussion easily evolves into a debate over what is best for the citizens of affected states and the vulnerability of specific areas (e.g., the Ogallala aquifer) the pipeline would cross. Still, my initial response to the current risk inherent in transporting large volumes of crude oil on railways across my state, is one of grave concern. Given the number of trains moving petroleum from production areas in Canada, North Dakota, and Eastern Montana, how can we assure residents that they and their water supplies will remain safe, and that ecologically fragile areas are protected? Like the issue of chemical tanks⁵, many states, in the absence of clear regulatory guidance, are trying to catch up and tool up for more rapid response scenarios involving oil train derailments.

No Need to Reinvent the Wheel

There is a strong connection to the UST Program in this discussion. After all, we are cleaning up the same petroleum compounds as our counterparts in oil spill response programs. For states whose staff members are responsible for both regulatory program areas, kudos! For the rest of us, especially for states most affected by petroleum production, it's time to reach out across program boundaries to share expertise in the areas of emergency response and petroleum remediation.

More than other environmental regulatory programs, those of us who deal with LUST remediation have a wealth of experience to share in the

area of assessing risks and cleaning up petroleum-contaminated soil and groundwater to acceptable standards. It would be a shame to see 30 years of progress in the UST/LUST program marginalized by huge surface spills of petroleum that many state spill response programs are poorly equipped to handle.

The petroleum industry is worthy of respect for its investment in horizontal drilling technologies, and the role this is playing in helping us be less dependent on foreign crude. The current glut of oil on the U.S. market has resulted in a decrease in gasoline prices nationwide—good for consumers and perhaps a gain for energy independence. But there are always “unintended consequences,” and when disaster strikes we usually find out the consequences are a bigger deal than anticipated. Oil train derailments are finding the weakest links in our emergency response structures; links that we need to be able to diagnose and correct.

We can all take a page from the book of those who address natural disasters. Many of the response scenarios that affect humans also affect the environment directly linked to humans. And we know from Hurricane Katrina that there is a long-term delayed environmental response affecting humans in a way that is often difficult to quantify and even harder to estimate cost-wise due to the unintended consequences—the unforeseen ripple effects that last for years.

Since the UST Program has driven many of the advances in petroleum cleanup technology, we should share our experience before our aging workforce falls out of the formula and the wheel is reinvented at considerable cost both inside and outside of the UST program. Petroleum cleanup veterans, representing government, industry, and environmental consulting have a part to play in this discussion and should work together to get on the right track in the oil train debate. ■

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 - ² USDOT website, July 23, 2014. <http://www.dot.gov/briefing-room/us-dot-announces-comprehensive-proposed-rulemaking-safe-transportation-crude-oil>.
 - ³ “Flathead Basin Commission to ask federal agency to require oil trains to slow down near cultural and environmental landmarks.” *Flathead Beacon*, Sept. 16, 2014.
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Transmissivity—the Emerging Metric for LNAPL Recoverability—Part 2

A Tangible Perspective on the Hydraulic Recovery Endpoint

by Andrew J. Kirkman, P.E. & Michael J Hawthorne, P.G.

In the October 2014 *LUSTLine* article on LNAPL transmissivity we explored the science behind the LNAPL recoverability metric. In this article we focus on two critical concepts related to the application of LNAPL transmissivity:

1. When LNAPL transmissivity (T_n) values are low at one or more wells the majority of the LNAPL volume within the represented area is residual rather than recoverable. Attempting to hydraulically pump LNAPL from a site with a very small ratio of recoverable to residual LNAPL will not meaningfully reduce the total volume of the remaining LNAPL. The effectiveness of hydraulic recovery at low T_n values is limited as a result of approaching two boundaries: a) the low LNAPL transmissivity inhibits the rate at which LNAPL can be recovered for a given resource input (drawdown), and b) the mobile fraction of LNAPL has been reduced such that the residual LNAPL represents the majority of the remaining mass and is unaffected by hydraulic recovery.
2. LNAPL transmissivity might vary temporally but may not necessarily vary at all sites. It is a worthwhile part of the site conceptual model to understand how future changes in the water table or site setting (e.g., fill, soil profile) could affect the values of any metric being used today to make decisions.

The discussion in this article is based on our observations at multiple sites, as well as documented site-specific reports submitted to various regulatory agencies and, in general, the experiences of professionals within the industry. Peer-reviewed published work is not yet available. In 2009, the Interstate Technology Regulatory Council (ITRC) published the document *Evaluating LNAPL*

Remedial Technologies for Achieving Project Goals, which referenced multiple sites that had been granted closure or no further action for LNAPL recovery. These sites exhibited T_n values between 0.1 and 0.8 ft²/day at the time of closure.

The ITRC guidance provides a basic understanding as to why T_n is an appropriate metric for LNAPL recoverability. The guidance also advocates for a less arbitrary definition of maximum extent practicable, and identifies a T_n range of 0.1 to 0.8 ft²/day, which represents the T_n magnitude at sites where stakeholders agreed that the maximum extent practicable had been met. Because T_n is a consistent recoverability metric across various soil and LNAPL types, it is directly comparable at all sites.

Subsequently industry experience has increased as illustrated by articles such as Paul Stock's June 2011 *LUSTLine* article on Laser Induced Fluorescence (LIF). Stock, with the Minnesota Pollution Control Agency (MPCA), discussed how LIF technologies helped us understand that LNAPL is "ubiquitous" at petroleum sites. Specifically, LNAPL can be found beneath the water table; it loves sand over clay; and any impacts that affect water quality are not limited to what is at or above the water table.

This distribution of LNAPL further helped MPCA realize why systems that targeted impacts at or above the water table were not successful at remediating sites. MPCA guidance relative to maximum extent practicable was revised based on these improved understandings, moving away from focusing recovery to reduce LNAPL thickness in wells at the water table and refocusing it toward cessation of migration. Remedial technologies beyond hydraulic recovery were then focused on addressing both mobile and residual impacts above and below the water table (e.g., air sparging). While there are currently no peer-reviewed pub-

lished articles that we can point to, situations where LNAPL recovery has had little or no success in remediating sites where residual dominates is commonplace.

As our understanding of the utility of T_n has become more widespread, states are beginning to incorporate this metric into their guidance and site-specific documents. For example, Michigan and Virginia have adopted guidance that incorporates T_n as a metric for hydraulic recoverability. Michigan has set a specified value of 0.5 ft²/day as one line of evidence for low recoverability of LNAPL, while Virginia utilizes the ITRC range of 0.1 to 0.8 ft²/day to identify when LNAPL recoverability is low and maximum extent practicable has been met. Both guidance documents use T_n as one of multiple metrics when evaluating the remedial direction of a given site.

In this article we explain why 0.1 to 0.8 ft²/day has been identified to represent low recoverability and why this threshold range is a plausible metric for maximum extent practicable.

ITRC's Guidance

When ITRC published *Evaluating LNAPL Remedial Technologies for Achieving Project Goals*, T_n was recognized as a preferred recoverability metric, and gauged LNAPL thickness was recognized as an inaccurate metric for recoverability. The following quote from this ITRC guide provides an overview of these metrics.

This guidance advocates ending historic "poor" practices, some of which have become commonplace and have resulted from the "recover LNAPL to the maximum extent practicable" requirements. For example, setting an arbitrary maximum allowable in-well apparent LNAPL thickness (e.g., LNAPL ≤1/8 inch) as a remedial objective ignores site conditions, LNAPL

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■ Transmissivity from page 15

type, and subsurface characteristics and may have limited or no correlation with LNAPL mobility, recoverability, or dissolved-phase groundwater or vapor-phase soil gas concentrations. Also, implementing a series of ineffective or inappropriate remedial approaches until all options have been exhausted to achieve “maximum extent practicable” is a poor practice.

With respect to gauged in-well LNAPL thickness, the ITRC guidance explains why it is a poor metric:

- For the same LNAPL in-well thickness, the volume of LNAPL per unit area of the formation can be different; it is generally higher in coarse-grained soils than in fine-grained soils.
- Due to the dependence of LNAPL thickness on geology and water table fluctuations, caution should be exercised in using it as a sole metric for recoverability and migration.

With respect to T_n , the ITRC guidance explains why this is a preferred metric:

- LNAPL transmissivity is an indicator of the formation to transmit LNAPL to a well.
- LNAPL transmissivity depends on soil type, LNAPL type, LNAPL saturation, and thickness of mobile LNAPL.
- Since LNAPL transmissivity is related to all key variables (see above) that can affect recoverability, it is a better metric than the conventionally used metric of in-well thickness.
- The higher the LNAPL transmissivity, the higher the LNAPL recoverability.

While the ITRC guide does not provide detailed guidance for the utilization of T_n as a recoverability metric for LNAPL, it does generally discuss the magnitude of values below which mass removal is ineffective. This “decision point” is presented as a range of values from 0.1-0.8 ft^2/day .

ITRC LNAPL Team members' experience indicates that hydrau-

lic or pneumatic recovery systems can practically reduce T_n to values between 0.1 and 0.8 ft^2/day . Sites in state regulatory programs in California, Kentucky, and Florida have been closed or granted no further action after developing comprehensive LCSMs and operating recovery systems, followed by demonstrating lack of LNAPL recoverability (irrespective of in-well LNAPL thickness) remaining. The T_n values at these sites were estimated to be between 0.1 and 0.8 ft^2/day .

The ITRC guide didn't just toss this range into the ring without explanation as to why it makes little sense to attempt to remove LNAPL mass below this threshold range:

Lower T_n values can potentially be achieved, but technologies other than hydraulic and pneumatic recovery technologies typically need to be employed to recover additional LNAPL. Further lowering of T_n is difficult and can be inefficient; that is, it can take very long to marginally reduce T_n without much benefit in terms of reduction of LNAPL mass, migration potential, risk, or longevity.

Finally, the ITRC guide recognized that the proposed T_n threshold range was relatively new, and that we could reasonably expect refinement of this range as we develop more experience with LNAPL transmissivity:

T_n is a relatively new metric; further study and experience may refine this T_n range.

The following are examples of former refinery RCRA programs that have incorporated T_n into the remedial approach:

- 1. Flying J Refinery, Williston, ND**
January 27, 2010 – North Dakota Division of Waste Management:
“The Department has selected an endpoint for the lower sand recovery system. The endpoint will be based on a LNAPL transmissivity of 0.5 ft^2/day in MW-5R and MW-89-04.”
- 2. Paramount Petroleum Refinery, Long Beach, CA**
January 18, 2013 – Los Angeles Regional Water Quality Control Board:
“LNAPL transmissivity testing

will be performed using methods described in the ASTM E2586-11, Standard Guide for Estimation of LNAPL Transmissivity or equivalent to evaluate LNAPL mass removal by hydraulic skimming.”

The following two case summaries represent a reference point against which to evaluate the benefit of LNAPL mass removal at other sites based on the measured T_n values.

The LNAPL Recovery Endpoint

Let's look at some data that will help place the magnitude of T_n in context with how much LNAPL at a given site is residual and immobile in nature. Residual LNAPL is LNAPL that is held in place by capillary mechanisms and is immobile to gravitational mechanisms. Mobile LNAPL represents LNAPL that has a sufficient saturation to create a continuous pore network through which LNAPL may flow. As LNAPL is recovered the saturation and pore network decrease, limiting the ability of LNAPL to flow. At residual saturation the continuous network no longer exists and LNAPL saturated pores are discontinuous (i.e., residual LNAPL).

The macro-scale result of this micro-scale behavior is fairly easy to observe and evaluate when the LNAPL recoverability is initially high (e.g., 10 gpd). Typically, LNAPL recovery rates observed shortly after an initial period do drop off at a fairly predictable rate that can be illustrated graphically using various types of decline curve graphs. The graphs can provide sufficient evidence that LNAPL recovery has likely reached its effective limit in further reducing source impacts. The graphs can be used to illustrate the point where a site is approaching residual saturation.

■ **SITE 1.** In Figure 1a, for example, the Site 1 LNAPL recovery was conducted from 13 wells each with a 100 to 200 foot finite radius of capture. The site is a former refinery and the subsurface aquifer consists of a sand and gravel unit that exhibits hydraulic conductivities of 200 to 500 ft/day .

Frequently LNAPL recovery systems that induce drawdown beyond skimming, redistribute the LNAPL

centrally around a recovery well. The conceptualization for these observations is that recovery wells are placed based on limited point data, so it is likely an area of higher LNAPL transmissivity is offset from the recovery well. Upon start-up, the extraction well is producing water and LNAPL as fast as it flows; however the conditions are transient due to transient groundwater drawdown distance relationships. Also, as the areas of higher transmissivity recentralize around the extraction well, LNAPL transmissivity increases to a peak and then declines.

The Figure 1a time-series graph of cumulative LNAPL and T_n demonstrates the decline in T_n as the cumulative recovery approaches asymptotic limits. If a recovery endpoint of $0.7 \text{ ft}^2/\text{day}$ T_n is selected, then as T_n decreases below $0.7 \text{ ft}^2/\text{day}$, it is observed that the bulk of the LNAPL has been recovered and the volume recovered does not significantly increase. The transmissivity value provided represents an average value of the recovery area represented by the 13 LNAPL recovery wells.

In this case it is easy to understand, based on the cumulative volume graph, that the majority of LNAPL has been recovered and perhaps the T_n values are not required to make a case that the majority of the mobile fraction has been recovered. However, how would one make the argument if a well started at out at $0.7 \text{ ft}^2/\text{day}$? We'll answer this question shortly.

Figure 1b presents the same data in a more useful expected ultimate recovery decline curve format. T_n is plotted against cumulative volume, which can then be used to forecast ultimate volume of recoverable LNAPL and demonstrate progress toward that physical limit. The initial T_n peak seen after startup is commonly observed as a system establishes boundary flow conditions. Similarly, the subsequent orderly decline in T_n as LNAPL recovery progresses is typical and expected. It also provides the empirical basis to forecast the ultimate recoverable volume, which in this case is estimated to be a little over 700,000 gallons.

The residual LNAPL for this case was estimated based on soil-core analyses. Figure 2 provides a bar chart of the relative volume of recov-

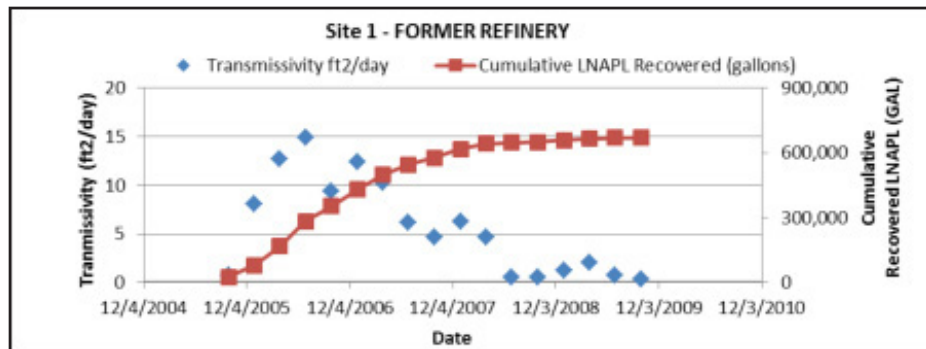


Figure 1a. Cumulative recovered LNAPL and LNAPL transmissivity over time.

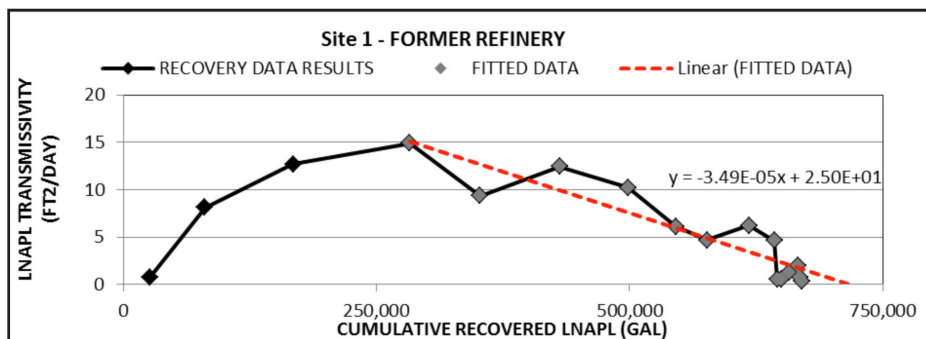


Figure 1b. LNAPL transmissivity decline curve.

ered LNAPL, unrecovered LNAPL, and residual LNAPL within the original mobile interval. At the selected endpoint, $0.7 \text{ ft}^2/\text{day}$, the remaining volume of recoverable LNAPL was smaller than the residual LNAPL mass. The residual mass as estimated above was limited to the residual mass in the mobile interval and did not consider a smear zone that existed above and below the initial mobile interval. If a smear zone existed and had been included in residual estimates, the recoverable fraction would have been even less relative to the residual mass.

For Site 1, the initial removal of 670,000 gallons (Figure 1b) of product reduced the plume longevity by 82 percent, whereas the continued recovery of LNAPL beyond this point would at most reduce the plume longevity by an addition 5.6 percent. However, the effort for this incremental improvement would be greater than the effort for the original source reduction when considering the volumes of water to be extracted, because the hydraulic recoverability of the LNAPL was significantly diminished by the recovery that had already occurred.

The final ratio of water generated per gallon of LNAPL was 6,770 gallons of water per gallon of LNAPL.

This represents a substantial increase in cost and groundwater loss versus the initial ratio of approximately 400 gallons of water per gallon of LNAPL. Based on the decline in LNAPL recoverability from this total fluids recovery network, the volume of extracted water necessary to recover the last 5.6 percent of LNAPL would be larger than the volume of water required to recover the first 82 percent (670,000 gallons) of the original LNAPL in place.

So is this scenario directly applicable to an UST site? UST sites are not likely to require 13 recovery wells that are extracting LNAPL from a 100 to 200 foot radius. However, if a site exists with $14 \text{ ft}^2/\text{day}$ LNAPL transmissivity values over a given area, that area is likely to exhibit a significant amount of recoverable LNAPL relative to residual. The removal of the mobile fraction may represent a potential to reduce plume longevity.

If an UST site exhibited $0.7 \text{ ft}^2/\text{day}$, rather than focusing efforts toward recovery, it would be worthwhile to focus efforts on quantifying the mass of LNAPL in the mobile interval versus the smear zone. This can be done by collecting TPH samples across the smear zone and mobile interval or by reviewing existing data

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■ Transmissivity from page 17

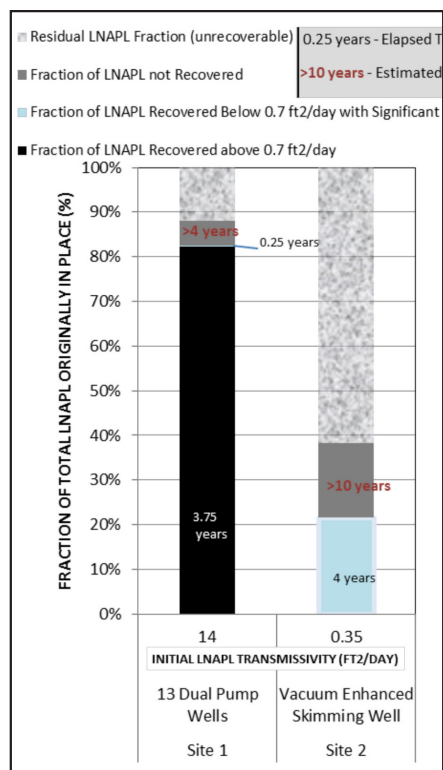


Figure 2. Recoverable versus residual LNAPL fractions.

(e.g., photo-ionization detector, laser induced fluorescence) to give a qualitative understanding of smear zone extent versus mobile interval.

However, while the qualitative tools provide an understanding of the relative intervals of mobile LNAPL versus smear zone, the magnitude of saturation will not be quantified. TPH across the gauged thickness and total smear zone is a valid quantitative means. If the residual mass dominates the total mass at the site, the plume is stable, and hydraulic recovery will not likely be an effective technology. This understanding combined with dissolved phase is a risk, and alternate technologies should be considered to address that risk.

One question often asked is: What if one of the T_n values obtained from one well at a site exhibits 2 ft²/day and three of my site wells are at 0.5 ft²/day? Should recovery be conducted at that one well with the higher T_n value? This is a site-specific decision and dependent on the individual CSM. If that one well represents a small area relative to the three other wells, and the mass across the site is still dominated by residual, then it may not make sense to recover from a minority portion of the site. If

that well represents a large area and a substantial reduction in source mass or significant improvement to the long-term stability of LNAPL, it may be appropriate.

■ **SITE 2.** This site (Figure 3) is an active rail yard with weathered diesel fuel in the subsurface, where no previous recovery system existed. The site consists of fine-grained silts overlying sand. The water table is typically eight feet below the silt materials, and mobile LNAPL exists solely within the sand unit, which exhibits hydraulic conductivity values ranging from 5 to 30 ft/day. The associated dissolved-phase plume was not a risk to receptors as no constituents exceeded regulatory standards beyond the property boundary. The plume was stable and no groundwater extraction wells existed onsite. The dissolved phase was addressed via natural attenuation.

Initial LNAPL transmissivities were estimated to range from 0.01 to 0.35 ft²/day, and a vacuum enhanced skimming (VES) remediation system was implemented at three well locations. Well 21 initially exhibited LNAPL transmissivities up to 0.35 ft²/day and produced the majority of the LNAPL at the site, recovering 680 gallons of LNAPL in four years of operation. The other two wells combined produced only 85 gallons over the same period.

Figure 3 provides the cumulative volume of LNAPL recovered versus the LNAPL transmissivity over time for well 21. No observable recovery trends could be seen in the two other wells. The 680 gallons of LNAPL recovered over four years match an LNAPL transmissivity decrease over this time period by a factor of five. Admittedly the data is scattered. All wells at this site exhibited intermittent recovery and this was the well that provided a noticeable recovery trend.

The strong recovery trend data from the former refinery (Site 1) was utilized in the previous portion of this article to provide a good understanding of ideal LNAPL recovery behavior during recovery efforts. At low T_n values, LNAPL is close to residual and factors such as soil heterogeneities and water-table fluctuations can induce variability to the LNAPL mobility that result in less clear trends compared with those observed in Figure 3.

Although 765 gallons of LNAPL were recovered from all three wells total, the overall saturation reduction across the three wells was one percent of the pore space, based on the area of impacts, representing a 150-foot diameter zone and a 1.4 foot vertical interval of soil treated. The residual LNAPL saturation estimated by calibrating the API LNAPL distribution model to a site-specific soil type was five percent. The achieved reduction in saturation of one percent did not significantly improve site conditions but did require energy consumption sufficient to run a one-horse power (1 HP) blower motor continuously for four years.

An energy balance was conducted to evaluate the net environmental benefit of the recovery. Based on public domain information, one ton of coal typically produces 2,460-kilowatt hours of electricity, and a 1 HP motor uses approximately 0.75 kilowatts per horsepower. The blower only produced one-fifth of the vacuum achievable, so we can conservatively assume that at a minimum, it ran at one-fifth of its total power (i.e., 1/5 HP) for four years (accounting for downtime). The total kilowatt hours over a four-year period, running at one-fifth HP would be 13,150-kilowatt hours, or 2.1 tons of coal. In terms of energy recovery, 2.1 tons of coal represents about 45 million british thermal units (BTUs), whereas 680 gallons of diesel recovered represents about 13 million BTUs. In other words, the energy consumption was approximately 3.5 times the energy recovery from the subsurface.

Sites 1 and 2 provide us with an understanding of how residual LNAPL mass comes to dominate the total LNAPL mass remaining as LNAPL transmissivity approaches the ITRC range. These empirical results are not intended to comprehensively represent all possible scenarios. The universally applicable understanding is that hydraulic recovery of LNAPL will not result in meaningful source reduction when the majority of the LNAPL mass is residual and non-recoverable. In combination with the sites discussed in the ITRC guidance (ITRC 2009), these two sites provide evidence that sites dominated by low LNAPL transmissivity values (0.1 to 0.8 ft²/day) are also likely to be dominated by residual impacts, and

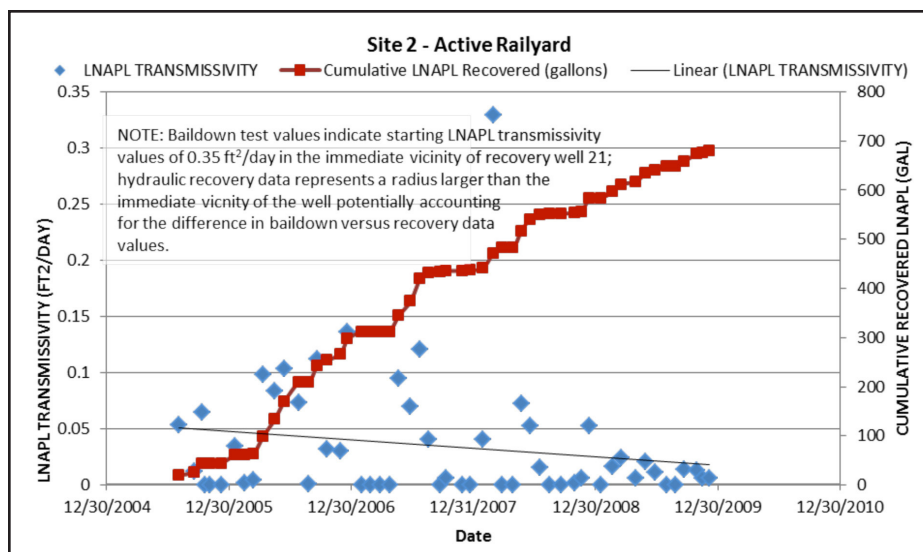


Figure 3. LNAPL transmissivity and recovery rate over time—well 21.

hydraulic recovery will likely not be effective.

Furthermore, based on the oil/water ratios from Site 1 and the energy consumption from Site 2, hydraulic recovery systems targeting low LNAPL transmissivity values require large amounts of effort (e.g., energy, water extraction, treatment, and/or time) to recover the remaining fraction of mobile LNAPL. Equivalent LNAPL transmissivity values for separate sites with different soil and LNAPL types require the same energy input to recover a given volume of LNAPL, though the residual LNAPL impact magnitude may vary.

LNAPL transmissivity values within the 0.1 to 0.8 ft²/day range are a useful indicator that professionals can use to look beyond hydraulic recovery to improve the conceptual site model and to understand if the majority of LNAPL mass is residual or if remediation is needed due to dissolved or vapor-phase impacts. If additional risk-driven remediation is required, then it's a good idea to consult the LNAPL conceptual site model to determine and focus remedy decisions on which phase-change technologies target residual LNAPL (specifically the fraction of the LNAPL that represents the chemicals of concern).

Variability in LNAPL Transmissivity

When considering LNAPL transmissivity it is important to understand how it may vary with changes in the water table. The temporal variability

in T_n for each site will be affected by water table fluctuations, site heterogeneities, plume stability, and LNAPL weathering. Temporal variations are typically observed because LNAPL redistributes vertically during water table fluctuation in the subsurface. LNAPL transmissivity is directly proportional to the magnitude of saturated pore space above residual saturation. Residual saturation values are lower for the vadose zone than the saturated zone. Essentially, water is a more effective oil flow inhibitor than air, so oil that is mobile under low water table conditions can be submerged under higher water table conditions, and hence immobile.

Consequently, the impact of these variables on LNAPL recoverability should be evaluated in a suitably comprehensive LNAPL conceptual site model, which will drive testing protocols with respect to the frequency and number of wells tested over time. At the end of the day, testing protocols are site-specific decisions that must be made by qualified professionals armed with suitably comprehensive LNAPL conceptual site models. Our discussion should help provide any group of professionals charged with providing reasonable assessments of LNAPL recoverability some context for their decision. Additional testing may not be needed if the desired level of confidence has been achieved.

Because LNAPL transmissivity is measured through tests that rely on the connectivity of LNAPL between the well and the formation, it is important to have wells that are

developed by appropriate means. The application of surge blocks across the screened interval, followed by extraction of silt-laden fluids is a valid means to develop wells for aquifer slug or LNAPL transmissivity testing. In some cases wells are installed primarily for groundwater sampling and over-pumping is the method used for development. This method's efficacy is limited to lowering turbidity. Increasing the hydraulic connectivity may not have been a primary objective in these cases because it does not affect the groundwater sample significantly. However, over-pumping does not reliably yield wells that are useful for aquifer pump, slug, or LNAPL transmissivity testing.

■ SITE 3. At Site 3, LNAPL occurs primarily in a sand exhibiting hydraulic conductivity values near 25 ft/day that is overlain by a fining upward sequence. The estimated contact between sand and finer materials occurs near 706 feet mean sea level. As the water table rises, LNAPL goes from an unconfined to a confined state. During unconfined conditions, as the water table rises a portion of the mobile LNAPL becomes submerged (residual) in the sand; however, as the water table continues to rise the remaining mobile LNAPL becomes confined against finer grained soils and ceases to move vertically with additional rises in the water table. Then, as the water table elevation lowers, the submerged LNAPL is released and becomes mobile LNAPL again.

LNAPL recovery consists of a dual-pump extraction system that maintains a constant fluid level system. As the water level in the formation rises or falls, the recovery rate increases or decreases proportionally to the water-table elevation to maintain a constant fluid elevation in the well, rather than a constant flow rate.

Well 6 has provided a useful data set for evaluating LNAPL transmissivity versus both time and water table fluctuations. Figure 4 shows a graph of the LNAPL recovery rate and LNAPL transmissivity over time. The piezometric surface, or water table, over time is also provided in Figure 4.

LNAPL recovery rates have varied between 65 gpd and 10 gpd over

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■ Transmissivity from page 19

the past few years. It is difficult to see a clear relationship between the water table and LNAPL recovery rate, or T_n , in Figure 4. Figure 5 shows a direct comparison by plotting LNAPL recovery rate and T_n versus water-table elevation. Figure 5 uses discrete time period data from 2006. Recovery data is collected more frequently than water-table elevation data; therefore, Figure 5 shows only where both water-table elevation and recovery-performance data were both measured.

The conceptual model for the site suggests that higher water-table elevations would both submerge LNAPL and eventually confine it where the water table may rise but no additional submergence of LNAPL would occur. This dual nature is evident in the Figure 5 LNAPL transmissivity data. These data were broken into a data series representing unconfined conditions (solid black triangles) and a second series representing confined data (diamonds).

The highest LNAPL transmissivity values are observed at low water-table elevations in the unconfined portion (black triangles) of the data. This is the portion of data where the LNAPL is not submerged, the LNAPL mobile saturation is relatively high and exists in the coarsest materials. As the water table rises from 705 to 707 feet, LNAPL transmissivity decreases to values near 0.15 ft²/day (diamonds) and then stabilizes. As the water table continues to rise above 707 feet the LNAPL transmissivity value remains the same. This constant transmissivity period exists because the LNAPL behaves as confined LNAPL. Although the aquifer pressure increases, the LNAPL mobile interval in the aquifer remains the same because it cannot penetrate the overlying finer-grained soil, similar to water in a confined aquifer.

When looking at the recovery rate data in Figure 5, the confined portion of the data (circles) identifies how increases in the water table above 707 feet are associated with increases in the LNAPL recovery rate. The mobility of transmissivity over this range is relatively constant; however, because these pumps maintain a constant fluid level in the well by increasing water extraction, they create higher

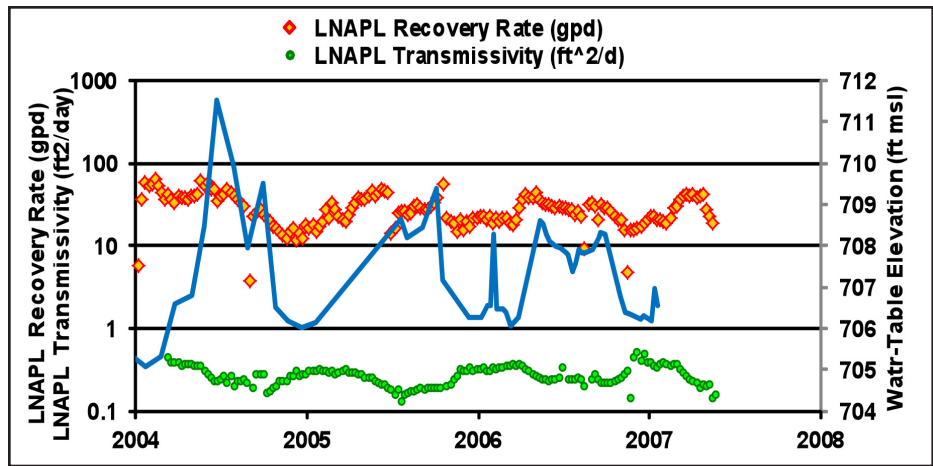


Figure 4. LNAPL recovery rate and LNAPL transmissivity over time – well 6.

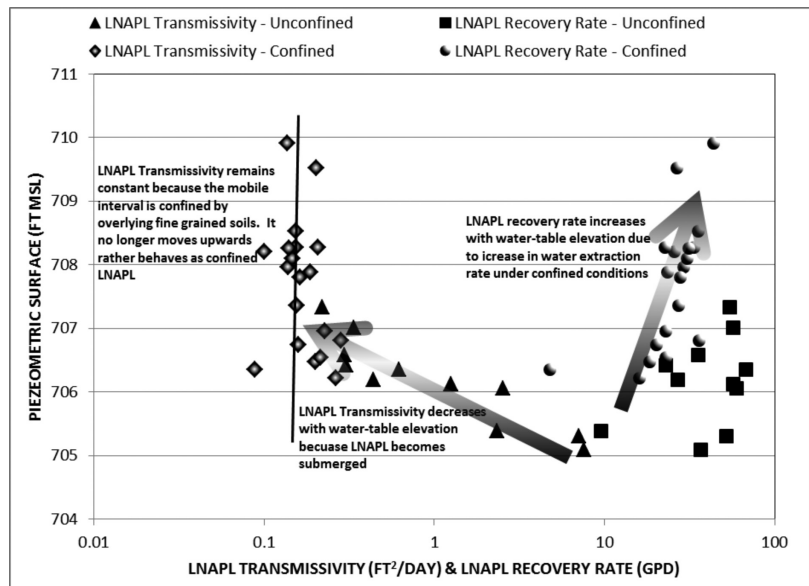


Figure 5. Water table elevation versus LNAPL recovery and LNAPL transmissivity.

drawdowns under higher water-table elevations. These higher drawdowns result in increased production under confined conditions. This trend is not observed in the unconfined portion (solid filled black squares) of the recovery-rate data. This is because while the water extraction rate is going up with the water table rise; the LNAPL transmissivity is decreasing simultaneously, which tends to negate the increase in water extraction.

These data indicate that LNAPL transmissivity can vary under changes in the water table but will not necessarily always do so. When utilizing LNAPL transmissivity as a metric, considering these temporal LNAPL transmissivity changes will provide increased confidence in the site conceptual model and remedial decisions.

Moving Forward

When evaluating a given site, we are continuing to confirm that LNAPL transmissivity is a useful metric for understanding the recoverability of LNAPL. LNAPL transmissivity might vary temporally but may not necessarily vary at all sites. It is a worthwhile part of the site conceptual model to understand how future changes in the water table or site setting could affect the values of any metric being used today to make decisions. As this metric is utilized more often, on-going improvements are to be expected. For example, it is now understood that wells representing the lowest recoverability are often the most difficult and costly conditions for measuring LNAPL transmissivity. For sites such as these, we, the authors, are developing improved

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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.

Can ATGs Find Leaks in Manifolded Tanks?

I recently received an e-mail from a perplexed regulator who was trying to determine which automatic tank gauges (ATGs) could be used for in-tank leak detection on manifolded tank systems. There has also been a trend lately for petroleum marketers to install blending dispensers to produce the mid-grade product. In some parts of the country, installers are converting three tank/three product storage systems to three tank/two product systems by installing a tank manifold rather than a piping manifold. So this seems like a good time to address the issues surrounding the use of ATGs for leak detection on manifolded tank systems.

Note that newly installed UST systems must use secondary containment and interstitial monitoring for leak detection. This discussion only applies to single-wall UST systems installed before the implementation of the secondary containment requirement.

What Exactly Is a Manifold?

In the UST world, the term “manifold” can be applied to several different aspects of UST systems. Three that come readily to mind are:

- **Tank manifold** – A piping connection between two tanks that allows fuel to freely flow from one tank to another. A tank manifold allows one submersible pump to draw product from two or more tanks, thus increasing the storage capacity for that product (see Figure 1).
- **Piping manifold** – Two submersible pumps provide fuel to a single piping run that supplies fuel to several dispensers. If the two pumps operate together, a piping manifold increases the flow rate through the piping. If the two pumps operate separately, a piping manifold, like a tank manifold, can be used to increase storage capacity.
- **Pump manifold** – A term used to describe the part of the submersible pump located above the top of the tank.

Each of these types of “manifold” brings leak detection issues to mind, but in this article I’d like to focus on tank manifolds and how they affect the ability of ATGs to detect leaks when the ATG is conducting in-tank testing. During an in-tank test, the ATG is monitoring the liquid level in the tank during quiet periods to determine whether a

leak is present. This discussion does not apply if the tanks involved are double-walled and the ATG is monitoring interstitial sensors.

How a Tank Manifold Is Set Up

In a typical tank manifold, there are two tanks installed next to one another. Each tank is equipped with its own fill pipe and vent pipe. Ideally, each tank also has the same diameter and the two tanks are installed at exactly the same level in the ground. If an ATG is to conduct testing, each tank will also have a probe to measure the liquid level.

The two tanks are connected together by a piping run that begins near the bottom of one tank, runs

out the top of the tank, horizontally over to the adjacent tank and then vertically down to near the bottom of the adjacent tank. This piping run contains no pump mechanism and usually contains no valves. It is often referred to as a “siphon bar.” When both tanks have fuel in them and the siphon bar is also full of fuel, the surface level of the fuel in the two tanks will always be exactly equal. If the tank bottoms are at slightly different elevations, the depth of fuel in each of the tanks will be different, but the surface elevation of the fuel will always be exactly the same. Now, if a delivery has just occurred and different volumes of fuel have been delivered into each tank, it may take a while for

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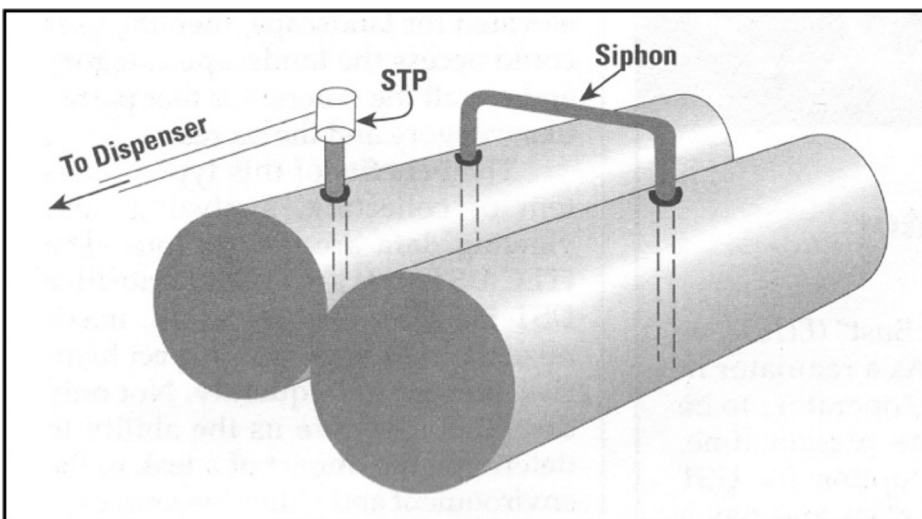


Figure 1. Tank manifold. A tank manifold connects two tanks so that product can flow freely from one tank to the other. A tank manifold allows one submersible pump to draw product from two tanks, thus increasing the storage capacity for that product.

■ **Manifolded Tanks** *from page 21*

the fuel to flow through the siphon until the liquid levels are in equilibrium, but as long as the siphon bar is air tight, this will happen.

What Causes Fuel to Move Through the Siphon Bar?

Though the siphon is simple to construct, there is still some controversy as to exactly what makes a siphon work. For our purposes, let's just say that the weight of the fuel in the vertical part of the siphon above the fuel level in each tank is what drives the siphon. If the level of the fuel surface in each tank is not exactly the same, one leg of the siphon will have a taller column of liquid above the surface, and this taller column of fuel will weigh more than the fuel in the other leg of the siphon.

Gravity exerts a stronger pull on the fuel in this longer column of fuel than it does on the shorter column of fuel. This extra pull on the longer leg of the siphon reduces the pressure in the horizontal portion of the siphon. Think of this lower pressure as pulling the fuel up the shorter leg of the siphon; technically it is the atmospheric pressure pushing down on the surface of the liquid in the tank that moves the fuel up through the siphon and into the tank at the lower level. When the two liquid surfaces are equal, the movement of the liquid stops because now both legs of the siphon contain columns of fuel that are of equal length and equal weight.

Whenever the liquid level in one tank changes, whether it is due to fuel being added during a delivery, fuel being pumped into a vehicle, or a leak, liquid will flow from the higher to the lower liquid level until the two liquid surfaces are again at exactly the same height.

Why Doesn't a Siphon Bar Require Leak Detection?

A siphon bar routinely contains product and at first blush would seem to require leak detection, according to the federal rule. However, the siphon bar operates very much like safe suction. If a hole develops in the siphon bar, the product in the siphon bar piping will flow into each of the tanks and air will be drawn into the siphon, but there should be no leak-

age into the environment under ordinary circumstances. I can imagine a scenario where a tank is overfilled and fuel is pushed into the siphon bar and potentially out into the environment during the course of a delivery, but this should be a rare event. As a practical matter, no additional leak detection needs to be applied to siphon piping.

How Is a Siphon Bar Filled with Product?

The siphon bar will only work if it is full of liquid. In the days before overfill regulations, this was accomplished by overfilling one of the tanks, thus pushing fuel through the siphon bar into the adjacent tank. In the days of suction pumps, one of the issues with siphon bars was that they would cease to work after a while. This was because even very small leaks in the siphon bar connections would eventually allow enough air to enter the piping and "break" the continuous column of liquid that must be present in the siphon piping for it to work.

Submersible pumps addressed the problem of small leaks in the siphon bar through the addition of a siphon port on the submersible pump. The siphon port is a fitting in the submersible pump manifold that uses the flow of fuel through the pump to create a vacuum. A copper line is run from the siphon port of the submersible pump to the high point of the siphon bar. The submersible pump can generate enough vacuum to remove the air from the siphon bar when the system is first started up, and continues to remove air from the system whenever the pump operates. If no air is present, fuel is drawn through the copper siphon tube.

How a Manifolded Tank System Works

Let's look at an example of how a tank manifold is supposed to work. Imagine you have two tanks manifolded together with a siphon bar between the tanks. There is one submersible pump in Tank #1 (the "master" tank) and Tank #2 has no pump (the "slave" tank). The tanks have been inactive for a while, so the fuel levels in the two tanks are exactly equal. Then a motorist drives up and buys 10 gallons of gas. Ten gallons are pumped out of Tank #1,

but as the level of the fuel in Tank #1 goes down, fuel from Tank #2 transfers over to Tank #1. That is the whole purpose of the siphon. After the pumping activity is completed and fuel levels in the two tanks have stabilized, both tanks #1 and #2 will contain five gallons less of fuel.

What's the Problem with Testing Manifolded Tanks?

Now imagine that Tank #1 has a 0.2 gph leak in the bottom of the tank. Assuming no pumping activity, after a period of one hour, 0.2 gallons will have flowed out of the hole in the bottom of Tank #1. This will have lowered the fuel level in Tank #1, so some fuel has also transferred over from Tank #2. How much fuel moves over the siphon from Tank #2? Assuming everything is working properly, at the end of the hour there will be 0.1 gallons less fuel in Tank #1 and 0.1 gallons less fuel in Tank #2. From this example we see that a 0.2 gph leak in one tank of a two-tank siphon system will produce a volume change of 0.1 gallons each hour in each tank. So in a siphon system, if there is a leak in one tank, the observed leak rate in each tank is half the actual leak rate in a two-tank system, and a third of the actual leak rate in a three-tank system.

In order for an ATG to correctly identify leaks in a manifolded tank system, it will have to compare what is happening in all tanks that are manifolded together. Let's assume that there is a 0.2 gph leak in one tank of a tank manifold consisting of three tanks. Over a period of one hour, 0.2 gallons flows out of the bottom of one tank. Because the leak rate is divided among the three tanks, the leak will appear as a 0.067 leak in each of the three tanks ($0.067 \times 3 = 0.2$).

A measured leak rate of 0.067 gph in a single tank would normally result in a passing 0.2 gph test because the 0.067 leak rate is less than the typical threshold leak rate of 0.1 gph required to fail a test. In order to identify the leak, the ATG must be measuring what is happening in each of the three tanks and comparing the results to arrive at a leak rate for the manifolded tank system, not just what is happening in each individual tank. So if an ATG measures leak rates of 0.067 (plus or minus a

bit for inaccuracies in the measurements) in three tanks that are manifolded together the test result should be “fail” for a 0.2 gph test for the three tank system. The ATG will fail the manifolded system, but will not be able to identify which of the three tanks has a leak. To identify the leaking tank, the siphon bars between the tanks would need to be disconnected and Individual tank tests would then need to be conducted.

So How Do You Know if a Tank Gauge Can Test Manifolded Tanks?

So now which ATGs can test manifolded tank systems and which cannot? To answer this question, we have to turn to the manufacturer’s certification of equipment performance, commonly known as the third-party evaluations. A review of the evaluation summaries presented on the National Work Group for Leak Detection Evaluation (NWGLDE) website reveals that some ATGs have been evaluated for their ability to find leaks in manifolded tanks and some have not. Only ATGs whose evaluation include results for manifolded systems are certified by the manufacturer to find leaks in manifolded systems, so according to the federal rule, these are the only ATGs that can be used for leak detection on manifolded systems.

A review of the evaluation summaries presented on the NWGLDE website reveals that no ATGs that conduct periodic tests were evaluated for their performance in manifolded tank systems. But several brands of ATGs that conduct continuous tank tests did include manifolded tank systems in their evaluations. Remember that ATG testing software can be divided into two types: “periodic” and “continuous.” Periodic tests require the system to be shut down for several hours, while continuous tests don’t require pumping activity to be interrupted to conduct the test.

Essentially what this means is that the testing software in ATGs that conduct periodic tests is only able to look at the liquid level changes in individual tanks. ATGs that conduct periodic tests do not have the capability to compare the liquid level changes in several tanks that are manifolded together to see if all the

tanks are experiencing the same (or nearly the same) level change. ATGs that conduct continuous tests have more sophisticated software that is able to evaluate the leak rates in multiple tanks and accurately determine whether a leak is present in the manifolded tank system.

The Bottom Line

So the bottom line is that ATGs that conduct continuous testing and have used manifolded tanks in their evaluation process can be used for leak detection on manifolded tank systems because their software looks at what is happening in the entire system rather than individual tanks.

ATGs that conduct periodic tests cannot be used for leak detection on manifolded tank systems because their software only looks at individual tanks and not the manifolded system.

Unless...

That said, an ATG that conducts periodic tests can be used on manifolded tanks if the tank manifold is disabled while the test is run. Disabling the manifold can be done if there is a valve in the siphon bar that can be

closed to prevent the flow of liquid through the siphon, or if there is a valve that can be opened to allow air into the siphon bar so that the two tanks are now separate. Once the tank manifold is disabled, a periodic ATG can conduct leak detection because the liquid levels in the two tanks will now vary independently of one another.

At least one periodic ATG manufacturer provides a remotely operated valve that is controlled by the ATG. When it’s time to conduct a test, the ATG opens the valve to allow air into the siphon bar so the tanks are separated, conducts the test, and then closes the valve so that the submersible pump can re-establish the siphon the next time the submersible pump comes on.

Any More Questions?

If you have more questions about tank manifolds or any other questions involving leak detection issues, send me a note at: marcel.moreau@juno.com. I’ll answer you privately if I can, and your question may become the prompt for a future *LUSTLine* article. ■

Ken Wilcox Made Honorary Member of the UK-Based Association for APEA

Ken Wilcox (right) was made an honorary member of the UK-based Association for Petroleum & Explosives Administration (APEA) for his services to Leak Detection this November at APEA’s Annual Conference in Coventry, England. According to Jamie Thompson (left) APEA Member and all round UK tank guru, “Ken



has been very instrumental around the world and especially in the UK for bringing credibility to leak detection. He has provided useful comments on our standards on leak detection and in the past has spoken at our conferences.” APEA Chairman Killian Tallon (center) presented the award.

Back in the states, Curt Johnson, speaking on behalf of members of the National Work Group for Leak Detection Evaluation (NWGLDE), says the work group considers Ken Wilcox to be “the father of petroleum tank leak detection evaluations.” According to Johnson, “Ken has performed 78 percent of all leak detection evaluations listed by the NWGLDE.”

Congratulations Ken! ■

And the Tank Also Rises

Sure, as underground storage tank (UST) regulators we expect to see tanks floating rapidly out of the ground during dramatic water events like floods or hurricanes. What we don't expect is another type of floating tank situation—the slow riser. This situation can develop over years due to underground water issues. These slow-rising tanks are not as easy to predict or manage as the rapid floaters, but they are just as important to catch as they also pose significant safety and environmental risks.

The following is a series of photographs and narratives depicting stages of a slow-rising tank. As most LUSTLine readers are regulators and have experienced this situation, it would be great to hear about how you would deal with slow-rising tanks at these different stages. Following this article, there is an opportunity for you to contribute your ideas and help answer some questions.

by Heather Peters

2008

When this northwest Missouri tank was inspected in 2008 (Figure 1), there appeared to be nothing out of the ordinary that would immediately alert field staff to the potential issue



Figure 1. Tank site 2008.

of a slow riser. The inspection problems that were found seemed to be routine issues. Some of the concerns listed were a spill bucket containing liquid, a cracked spill bucket, dirt around the edge of a flexible connector, and a drive-plate lid resting on a ball float valve access cap. Everything looked typical, except there was a minor, hairline crack forming in the concrete; so small that it could be easily overlooked. The reported findings were considered common and mundane.

2011

The site was re-inspected in 2011 and again, there were common issues such as liquid in a spill bucket, a cracked spill bucket, and a damaged fill cap. The old drive-plate issue was resolved by raising the concrete around the ball-float-valve access riser. A new issue emerged during this visit; a drive plate was resting on a tank probe cap and wire. Snow covered the ground, so that little crack, mentioned before, was not visible. Over all, the reported findings appeared relatively common and did not seem worthy of too much concern.

2012

Once the snow and ice were melted, inspectors realized this site had more going on than just the normal issues of an aging tank. They found several drive plates resting on tank-top equipment (including fill caps/risers, line-leak detectors, and probe caps) and discovered two cracked spill basins. There was evidence of multiple concrete repairs down the length of the tank. The crack was rising at this point and had grown to be very noticeable in spite of multiple concrete patches. Inspectors noted cleared water alarms but saw no evidence of current water ingress.



Figure 2. Tank site 2013.

2013

By April 2013 (Figure 2), the slow rising tank was obviously a concern. It rose to the point where it caused the concrete above the tank to crack and buckle. Drive plate lids were resting on the highest riser or piece of equipment beneath. The rise was steep enough that when cars passed over this area, they scratched the concrete with their undercarriages.

In August 2013, gaps in the drive plates are visible and the responsible party was told to empty the tank and start sampling.

2014

The tank was removed in May 2014 (Figure 3). When the concrete surrounding the tank was first broken during excavation, this slow riser resembled a submarine rising from the ocean.

As majestic as that sounds, unfortunately, assessing the damage caused by the slow-rising tank



Figure 3. Tank Pull May 2013.

is often problematic. Broken piping can sometimes be attributed to both shifting tanks and abrupt tank pulls. Throughout the pull, water continuously flowed through cracks of the concrete. Samples were taken at the site, and surprisingly, little contamination was found...but with all the water running through the site for years, the water could have simply washed contamination away.

Answers? Thoughts? Experiences?

So what do you think? I would appreciate hearing your thoughts on any or all of the questions below. Please send your responses to Heather Peters via email to

heather.peters@dnr.mo.gov. I will let LUSTLine learn whatever we learn.

1. Have you had any experience where early repair(s) have prevented the tank from being pulled? If so, what repairs have you required?
2. In your experience, do repairs cost less than a complete tank pull? If so, how much cheaper would you estimate?
3. In the early stages of slow-rising tanks, what do you believe are the initial warning signs owners could identify and report?
4. At what point do you think it is most effective for a regulator to require an owner to "Do something now"?

5. What action(s) should we, as regulators, take before a leak is confirmed?
6. In your opinion, at what point did the minor drive plate/tank issue cross into being a significant, system-encompassing problem? Do you consider this a violation and if so, at what point did it occur?
7. If this was your site, what steps would you have taken and when?

Heather Peters is an Environmental Specialist working in the Missouri Department of Natural Resources UST Inspection and Technology program.

California Makes Significant Program Changes

by Laura Fisher

California's Senate Bill 445 (Chapter 547, Statutes of 2014) contains significant changes to the underground storage tank (UST) Prevention, Cleanup Fund, and Enforcement Programs that far exceed anything California's UST Program has encountered over the past decade. This new law is a collaborative effort between the California Legislature, State Water Resources Control Board (State Water Board), and various stakeholders. The major provisions of the law require the removal of single-walled tanks and piping by December 31, 2025; extension of the UST Cleanup Fund until January 1, 2026; and new enforcement tools to prevent and enforce against fraud, waste, and abuse of the Cleanup Fund.

While the legislative process was only a one-year endeavor, the work leading up to it spans several years of data collection, program analysis, risk and needs assessment, knowledge sharing, and cooperative compromises to benefit all. The resulting significant improvements to the State of California are broadly outlined below. The full language of California Senate Bill 445 can be

found at http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB445.

UST Leak Prevention Program

The new law as it applies to the UST Leak Prevention Program requires that on or before December 31, 2025, owners and/or operators permanently close (i.e., remove) single-walled tanks and/or piping if designed and constructed without approved secondary containment. The law also provides the State Water Board the authority to adopt regulations that require the closure of single-walled tanks and/or piping at an earlier date if the continued use of these components poses a high threat to water quality or public health.

State Water Board staff research shows approximately 2,000 of the 14,250 UST facilities in the state have one or more single-walled tank or piping configurations that would be subject to the December 31, 2025, closure deadline. Many of these UST facilities have been identified as small businesses, some of which are in rural locations.

The law makes available grant and loan money through the UST

Cleanup Fund's Replacing, Removing, or Upgrading Underground Storage Tank (RUST) Program to assist eligible small businesses to permanently close single-walled tanks and/or piping and replace with new double-walled tanks and/or piping. The law makes additional loan and grant money available for rural owners/operators so as to avoid fueling infrastructure gaps.

To learn more about the UST Leak Prevention Program visit <http://www.waterboards.ca.gov/ust>. The UST Leak Prevention Program has an email distribution list to advise interested parties on current activities. To subscribe to this email distribution list visit http://www.waterboards.ca.gov/resources/email_subscriptions/ust_subscribe.shtml.

UST Cleanup Fund

The new law makes significant changes to the UST Cleanup Fund that include extending the fund sunset date by 10 years to January 1, 2026, increasing the fee assessed on petroleum stored in USTs from \$0.014 per gallon to \$0.02 per gallon, and limiting the cap to \$1 million for claims submitted to the State Water Board after December 31, 2014.

The law requires that \$0.003 of the \$0.02 per gallon be used to help small businesses comply with UST regulatory requirements (RUST loans and grants) and provide funding to a new Site Cleanup Subaccount established to investigate and clean up

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contaminated sites without regard to the source of the contamination, particularly where there are no viable responsible parties, and reimburse school districts for UST cleanups.

Other important elements of the law include expanding eligibility for Orphan Site Cleanup Fund sites, auditing the Cleanup Fund every five years, requiring an Expedited Cleanup Pilot Project; and conducting a study to determine the cost-effectiveness and feasibility of issuing bonds to satisfy obligations against the Cleanup Fund.

To learn more about the Cleanup Fund please visit http://www.waterboards.ca.gov/water_issues/programs/ustcf/. The Cleanup Fund has an email distribution list to advise interested parties on current activities. To subscribe to this email distribution list please visit http://www.waterboards.ca.gov/resources/email_subscriptions/swrcb_subscribe.shtml and click on the option labeled Financial Assistance.

Fraud, Waste, and Abuse

Finally, the law provides valuable tools that will assist the State Water Board's Office of Enforcement with investigating and combating fraud against the Cleanup Fund. The law authorizes the board to impose administrative civil liability penalties of up to \$500,000 per violation on those who make fraudulent claims and misrepresentations to the Cleanup Fund. Additionally, the new law authorizes the State Water Board to recover the costs associated with investigating and prosecuting fraud and prohibit claimants and/or consultants convicted of fraud from further participation in the fund. Lastly, the State Water Board has been granted administrative authority to prosecute cases.

While the goal is to deter claimants and contractors from submitting fraudulent claims to the fund, the new tools provided by the law will enable the State Water Board to swiftly and consistently enforce against those who commit Cleanup

Fund-related fraud, waste, and abuse. These tools will help root out fraud, waste, and abuse by consultants and claimants who submit false, misleading, or inflated invoices for reimbursement to the Cleanup Fund.

To learn more about the Office of Enforcement and enforcement cases, visit http://www.waterboards.ca.gov/water_issues/programs/enforcement/index.shtml. The Office of Enforcement also has an email distribution list to advise interested parties of cases and current activities. To subscribe to this email distribution list please visit http://www.waterboards.ca.gov/resources/email_subscriptions/swrcb_subscribe.shtml and click on the option labeled Enforcement. ■

Laura Fisher is Chief of the California State Water Resources Control Board's UST Leak Prevention Unit. She can be reached at laura.fisher@waterboards.ca.gov.

NIST Research on Ethanol "Corrosion": What It Really Says

by Lorri Grainawi

The National Institute of Standards and Technology (NIST) published a study titled, "Corrosion of copper and steel alloys in a simulated underground storage tank sump environment containing acid-producing bacteria" in the October issue of the peer-reviewed journal *Corrosion Science* (www.sciencedirect.com). NIST is a federal agency under the Department of Commerce. Its mission is "to advance measurement science, standards, and technology in ways that enhance economic security."

The intent of this NIST study was "focused on investigating the potential cause" of "rapid corrosion of components in some underground sumps," according to Jeff Sowards, the NIST researcher interviewed for this article. Another goal was to "develop a repeatable, lab-based test methodology for evaluating corrosion in a headspace environment."

While the intent and scope of the NIST research is made clear in its paper, some reports about the study extrapolated its conclusions to imply that the study included ethanol-blend vehicle fuel storage tanks themselves, not just the sump environment.¹

"This study was not aimed at investigating underground storage tank corrosion, but...at looking at the sump corrosion reported by inspectors."

—Jeff Sowards, NIST

NIST Studied the Sump Environment, Not Tanks

I recently interviewed NIST metallurgist Jeff Sowards to clarify the agency's study intent, methodology, and conclusions. Sowards stated that:

"The research originally began when we were introduced to accounts from state inspectors by the Steel Tank Institute (STI). Inspectors noticed rapid corrosion of components in some underground sumps at gas stations and were beginning to report them from around the country. The reports indicated an unusual, sporadic, and unexpected pattern of corrosion on components inside liquid-tight sumps. This corrosion was reported to occur in as little as a few months. When the covers of the sumps were opened, a vinegar smell had been reported. Visually, the metallic components are seen to have experienced aggressive, accelerated corrosion.

"Specifically, in this case, our research was focused on investigating the potential cause of this accelerated corrosion of materials exposed to biofuels and microbes inside a sump. We planned to use a

few materials (1018 steel and copper) and exposed them to a “simulated sump environment” where water, ethanol, and acid-producing microbes, specifically *Acetobacter* sp, were present. We chose the test conditions based on research that was first conducted by EPA’s Office of Research and Development.”

Controlled Conditions for Microbial Growth

“Our test was based on one set of conditions that we could control in the laboratory, mimicking those reported in an EPA study on sumps,” Sowards said.² Tightly controlled conditions included temperature, same number of microbes inoculated into identical growth media, and ethanol concentration of five percent.

The microbes reproduced under these ideal conditions “processed the ethanol into acetic acid, so the vapor phase contained ethanol, water, and acetic acid vapors,” Sowards said. “In actual conditions, the ethanol concentration could vary depending on fuel type and how well sealed the sump pump chamber is.”

Sump Headspace Components Exhibited Corrosion

In the test phase of NIST’s research, metal test coupons were exposed to both a liquid and a vapor environment and inoculated with *Acetobacter* sp. Sowards noted these conclusions:

- Corrosion rates of copper coupons submerged in liquid and those exposed to vapors were similar and exhibited pitting and intergranular corrosion due to the acetic acid exposure.
- Corrosion rates of steel (coupons) were greatly accelerated when exposed to vapor with acetic acid and exhibited pitting corrosion.
- Corrosion rates were dependent on formation of corrosion product in the headspace. It was observed that headspace samples experienced the greatest corrosion rates and immersed coupons experienced lower rates.
- The laboratory test method developed for this study demonstrated that *Acetobacter aceti* can cause the accelerated corrosion observed in sump pumps.

Ethanol Storage Was Not Linked with Steel Tank Failures

“The NIST research study focused only on the sump pump components of underground storage tanks,” Sowards said, “and the corrosion in storage tanks was not within the scope of the work.” Therefore, STI/SPFA maintains that this research should not be extrapolated to imply that microbial contamination in ethanol-blend vehicle fuel storage tanks can be linked to corrosion other than in the sump head space. ■

Lorri Grainawi is STI/SPFA Manager of Technical Services. She can be reached at lgrainawi@steeltank.com.

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- 1 Kiplinger Letter, Vol. 91, No. 32, August 8, 2014.
- 2 Jeff Sowards and Elisabeth Mansfield, “Corrosion of copper and steel alloys in a simulated underground storage tank sump environment containing acid producing bacteria.” http://www.nist.gov/manuscript-publication-search.cfm?pub_id=914581.

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methods and hope to share any insight in the near future. ■

Andrew Kirkman is the lead LNAPL Technical Specialist for BP America. Andrew has led and participated in multiple industry advocacy efforts related to LNAPL. These include: chairing the ASTM task groups related to LNAPL transmissivity and LNAPL Conceptual Site Models; generating publications for Applied NAPL Science Review, American Petroleum Institute, and Groundwater Monitoring and Remediation. Supporting ITRC since 2008,

Andrew became an ITRC LNAPL trainer in 2012. He can be reached at andrew.kirkman@bp.com.

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New STI Standard for Inspection and Repair of Underground Steel Tanks

The Steel Tank Institute announces publication of SP131, *Standard for Inspection, Repair and Modification of Shop-Fabricated Underground Tanks for Storage of Flammable and Combustible Liquids*. “SP131 was developed in response to requests from several state environmental agencies,” said Lorri Grainawi, Director of Technical Services for STI/SPFA. “These agencies are responsible for ensuring the safety of the public and the environment from spills of hazardous flammable and combustible liquids.” STI standards are the most widely recognized in the steel tank fabrication industry. Many state and federal regulations reference them directly in their rules.

“We invited a group of regulators, tank manufacturers, contractors, and other stakeholders to form a committee to develop SP131,” Grainawi said. “They spent over a year meeting, drafting, and re-drafting the document, ensuring it fairly addresses the needs

and concerns of agencies, regulators, and the industry.”

In the Scope description, SP131 states that:

“This standard covers the inspection, repair, and modification of an atmospheric-type, shop-fabricated, carbon and/or stainless steel underground storage tank. It applies to tanks storing stable liquids at atmospheric pressure. This standard covers tanks built to a nationally recognized standard for underground storage tanks....This standard applies to tanks that are installed and also to tanks that have been temporarily removed to achieve a repair...”

Copies of STI’s SP131 are available for purchase from the STI/SPFA Store. Technical questions may be addressed to Lorri Grainawi, 847-550-3831. ■

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Steve Purpora, Purpora Engineering, leading a site visit at a high-throughput facility at NEIWPCC's Region 10 Inspector Training in Boise, Idaho.



John Kneece, Underground Storage Training & Consulting, Inc., uses volunteers to demonstrate how a line-leak detector works at NEIWPCC's Region 8 and 9 Inspector Training in Salt Lake City, Utah.

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