Community Perspectives on VOC Response at Department of Defense Installations

Lenny Siegel
Center for Public Environmental Oversight
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Volatile organic compounds (VOCs) are among the most common environmental contaminants at Department of Defense (DOD) installations. A recent survey of 440 active DOD installations showed that trichloroethylene (TCE) is found above its preliminary remediation goal (PRG) at 383 facilities and tetrachloroethylene (PCE) is found at 252. The same compounds are also prevalent at closed bases, formerly used defense sites, and contractor-owned facilities where the Department has liability. In 2003, the Air Force estimated that the Department-wide cost of cleaning TCE in soil and groundwater at more than 1400 facilities, using the existing drinking water standard of 5 parts per billion, would exceed $5 billion. If regulatory agencies reduce the standard to 1 part per billion, a realistic possibility, costs could double.

Furthermore, the increasing national awareness of the vapor intrusion pathway—the migration of subsurface VOCs into overlying structures—has added challenges to the Defense remediation mission. The investigation and mitigation of the vapor pathway can significantly add to the cost of protecting public health, and cleanup decisions are being re-opened at a growing number of sites with remedies in place.

In view of these challenges, the Defense Department has been in the vanguard of the development, testing, and implementation of new technologies for the remediation of VOCs in groundwater and soil. As its vapor intrusion liabilities become more apparent, it is expected to focus more research dollars on that aspect of the problem as well.

CPEO Executive Director Lenny Siegel visited communities hosting Defense Installations and discussed VOC response technologies with community members. In the course of this project, he visited four bases with large environmental restoration programs, known contamination with TCE and/or PCE, and a history of significant community involvement and controversy. He talked with members of Restoration Advisory Boards and other community groups at the following installations:

- Camp Lejeune Marine Corps Base, North Carolina
- the Army's former Rocky Mountain Arsenal, Colorado
- former Kelly Air Force Base, Texas
- Otis Air National Guard Base, part of the Massachusetts Military Reservation
- former Moffett Field Naval Air Station, California. (Siegel has served on the Moffett Field Technical Review Committee and Restoration Advisory Board for more than 17 years.)

In addition, Siegel drew upon earlier visits to other military facilities and recent visits to contaminated civilian properties across the country.

Groundwater Treatment

Remedial technologies in place at these installations include conventional methods such as pump-and-treat (with carbon filtration), dig and haul, and soil vapor extraction; the Defense Department has also used innovative approaches such as in situ bioremediation and chemical treatment (using a variety of amendments), thermal desorption, horizontal wells, permeable reactive barriers, air sparging, and remedial project optimization.

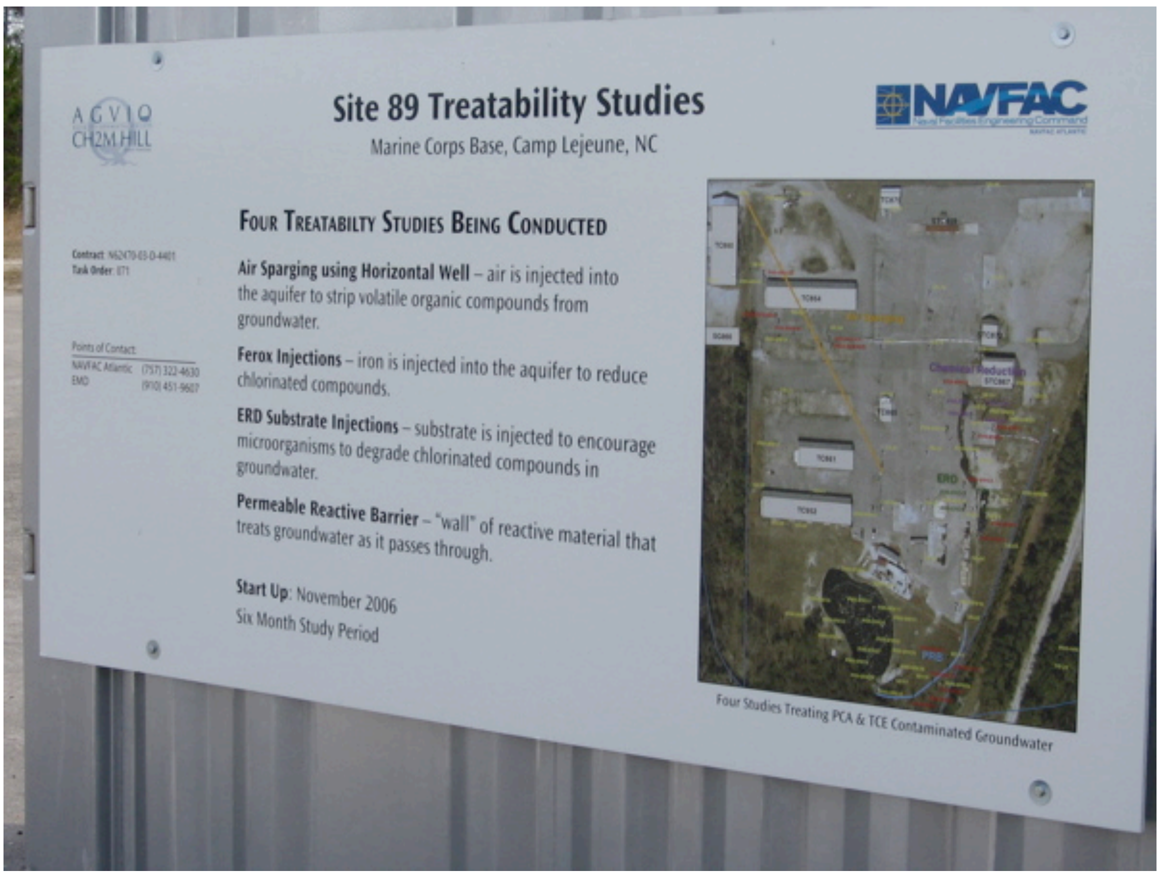
In most cases, community members take the same approach to remedy selection as the military and regulatory agencies. That is, they want safer, more complete, faster, and even *cheaper* cleanup. They are definitely open to innovative approaches, but whatever technology is used, they want verification that it is working as designed.

Pump and Treat System at Otis Air National Guard Base, Massachusetts

At Otis, community members support pump-and-treat because it appears to be working. The same permeability that has allowed pollution to move quickly underground in multiple directions has allowed significant reduction in the mass and size of at least some of the VOC plumes. One local resident, however, questioned the wisdom of reinjecting into the aquifer water that had been treated to meet drinking water standards, only to have local water providers re-pump it downgradient for public use.

On the other hand, Otis stakeholders are skeptical about the use of permeable reactive barriers because a demonstration project there failed, they say. Still, they recognize that a similar technology successfully treated phosphorous as it entered surface water at Ashumet Pond.

At Kelly, residents of low-income, predominantly Hispanic neighborhoods nearby have no problem with the technologies introduced by the Air Force, but they fault the overall remedial strategy. The Air Force is using reactive barriers to treat contamination as it moves toward the residences, but is doing nothing to reduce the plumes that already underlie the homes. In addition, one former Kelly neighbor faults the Air Force for not preparing for system failure or accidents. She says that the Air Force had no contingency plan in place for a reactive barrier that flooded.



Similarly, a member of the Restoration Advisory Board at Camp Lejeune did not oppose the air-sparging system installed by the Marines, but he wanted confirmation that the systems was degrading, not just spreading the contamination.

At Moffett, RAB members—including Siegel—supported the Navy's decision to shut down the pump-and-treat Eastside Aquifer Treatment System and conduct a pilot bio-remediation project there. Many of the same people have supported Intel Corporation's nearby bio-remediation project, implemented at a site where groundwater extraction appeared largely ineffective. But they have criticized the Navy's recent proposal to stop all treatment of the Eastside Aquifer.

The Moffett pilot grew out of the Navy's ongoing Remedial Project Optimization program, but community members also support simpler optimization strategies, such as the Air Force's adjustment of pumping rates, depths, and locations at Otis.

Vapor Intrusion

As vapor intrusion rises to the surface across the country, the military is finding that to be a problem, or at least a potential problem requiring investigation, at an increasing number of sites. For example, in 2004, while visiting the Raritan Arsenal, a Formerly Used Defense Site in New Jersey, Siegel learned that the Army Corps of Engineers had installed a subslab depressurization system to reduce PCE concentations in a childcare center located in a commercial building. Later U.S. EPA found vapor intrusion in its own research labs on the former Arsenal property. At Moffett Field, vapor intrusion has been measured on former Navy property, both at NASA Ames Research Center and the Army's Orion Park Housing Area. Near Hill Air Force Base in Utah, the Air Force has tested 1400 homes, finding TCE in about 16%. In April 2007, the Army agreed to test the indoor air at the Old Madigan Housing Area at Ft. Lewis, Washington.

No indoor air sampling has been conducted in homes above contamination from Kelly Air Force Base, San Antonio, Texas

Siegel has crisscrossed the country over the past few years, visiting vapor intrusion sites and participating in workshops where he has learned details about other locations. For this project, he made a special visit to former Kelly Air Force Base in Texas, where he learned that the Air Force and its regulatory agencies have not yet sampled indoor air, despite elevated levels of TCE and PCE in groundwater and soil gas below off-post neighborhoods. At Moffett he learned that military housing units in the same building often have significantly different levels of volatile compounds in indoor air.

Vapor intrusion is a newly recognized, complicated pathway. While the residents and occupants of at-risk structures may understand that toxic vapors are intruding into their space, they do not readily understand the complex investigative strategies used to determine whether vapor intrusion is a threat to their health. Formulas designed to predict indoor air concentrations from soil gas or even groundwater are difficult to understand, even for people with technical backgrounds, and recent evidence suggests that they are unreliable in the real world.

Siegel has found that most people can learn the basics of vapor intrusion, but that it may take more than one explanation or presentation. While many participants in Restoration Advisory Boards are able to offer quick feedback on groundwater contamination and cleanup, it takes time to bring them up to speed to provide constructive comments on vapor intrusion response.

Orion Park Housing Area, Moffett Field, California

The technologies for mitigating vapor intrusion—various forms of ventilation plus the installation of impermeable membranes—are mature, based upon the nation's history of radon mitigation. The technologies for removing or treating source contamination—the long-term solution to vapor intrusion—are the remedial technologies discussed above. But, from the point of view of both communities and those responsible for environmental response, the technologies for sampling soil gas, indoor air, and ambient air have significant room for improvement.

The conventional approach to sampling soil gas and air uses Summa canisters, bowling-ball sized metal containers prepared with a vacuum inside. Through carefully calibrated valves, gas is sucked into each canister and taken to an off-site laboratory for analysis. This method is used to determine if vapor intrusion is a problem, and if mitigation is conducted, it should be employed afterward to confirm the effectiveness of the response. Ideally, each sampling point is tested during different seasons of the year. By collecting samples for sufficiently long time periods, such as 8 or 24 hours, sampling teams are able to achieve detection limits below one tenth of a microgram per cubic meter (.1 $\mu g/m^3$.).

The process of sampling a large number of housing units or distinct airspaces in schools or commercial buildings is costly and time-consuming. Sampling protocols include the removal of background sources such as plastic cement, gun cleaner, and recently dry-cleaned clothes, as well as arranging with occupants to leave windows and doors closed and heating or air conditioning systems in operation. Subslab sampling requires that holes be drilled in floors, and that they be carefully sealed afterwards. Thus, investigators need to work closely with occupants and owners, both to obtain permission for sampling and to make sure the results are accurate.

In some cases representative units are sampled—introducing a chance of error. In other cases, particularly for new construction, mitigation is installed as a more cost-effective, timely approach than recurring sampling during different seasons.

From the point of view of the impacted residents, the weeks or even months it takes for laboratories to report results is a serious problem. They say that they've been warned that their children *might* be exposed to cancer-causing substances in their indoor air, round-the-clock, and then told to wait for a couple of months to find out for sure. In response to complaints from residents in upstate New York's "Southern Tier," New York enacted a law, signed by Governor George Pataki in September 2006, requiring that vapor test results be reported within 30 days of sampling.

Community members find that 30 days is still too long. They prefer real-time or near-real-time sampling, even with the caveat that quality assurance/quality control must be conducted before the results are "final." One instrument that provides instantaneous results is U.S. EPA's Trace Atmospheric Gas Analyzer (TAGA), a van-mounted triple-quadripole detector that, with the aid of a 200-foot plastic tube, displays concentrations of two analytes instantly on a computer screen within the van. The TAGA has been used to measure vapor intrusion at a number of sites, including the civilian Hopewell Precision Superfund site in New York and Moffett Field.

The TAGA is not used alone. Conventional laboratory analysis is necessary to identify the contaminants of most serious concern. Once deployed, in one day it can measure vapors within numerous homes or airspaces. It can be used to identify confounding sources, such as household products containing the contaminants of concern, and preferential pathways—such as sumps, openings along utility lines, or gaps between slabs and walls. And in general, community members like the TAGA because it provides instant, though preliminary, results.

On the down side, many regulatory agencies consider the TAGA too expensive. Indeed, EPA has only three in its inventory. When asked if it might procure more, EPA scientists warn that it is difficult to retain the necessary qualified technicians on a government salary. It appears that the TAGA is cost-effective today only where a large number of samples are needed in a short time period. The TAGA can only analyze two compounds at one time, and it may not be able to achieve the extremely low detection limits necessary at some vapor intrusion investigations.

There is a need, therefore, to develop and demonstrate real-time or near-real-time sampling devices that can be mass-produced and operated by technicians who are already conducting vapor intrusion investigations.

In addition, properly conducted vapor intrusion programs, such as at Hill Air Force Base or the Redfield site in Denver, conduct post-mitigation monitoring to ensure that membranes, depressurization, and other mitigation strategies are achieving health-based objectives for indoor air. Unfortunately, at many sites, the approach has been "mitigate and forget." That is, mitigation systems are installed or even built-in during construction, but there is no long-term monitoring to ensure that they are doing their job.

While it might not be necessary to quantify periodically actual indoor air concentrations in every home, residents clearly would appreciate methane-monitor-type instruments that would flag the presence of TCE, PCE, or other contaminants of concern, at the very low levels believed to pose chronic health risks. Warnings from such devices could be used to trigger more accurate measurement. Since the health risks at typical concentrations are chronic, there is time to verify warnings before taking action.

Recommendations

Public stakeholders at Defense Department installations, like community members at other sites, ask the same questions about groundwater and soil remediation technologies as the responsible parties and regulators: Will the technologies achieve remedial objections safely, reliably, completely, and cost-effectively? Even where there is a history of mistrust based upon past exposures, such as Camp Lejeune, the public is open to innovative cleanup approaches. However, some stakeholders express concern that the innovative systems might not work as advertised.

Recommendation 1: Innovative cleanup technologies should be presented to the public along with monitoring protocols designed to demonstrate whether they are working as intended *and* contingency plans designed to overcome both gradual and catastrophic failure.

The people whose homes, schools, and other building at potentially impacted by vapor intrusion are concerned about the impact of contamination on their families' health and their property values, but they tend to lack a full understanding of the complexities of investigation and long-term monitoring. In general, they seek better measurement of actual exposures, as opposed to intermediate metrics such as soil gas concentrations, but most lack the background to engage constructively in oversight of vapor intrusion programs.

Recommendation 2: The Defense Department should team with U.S. EPA and other agencies to organize a national stakeholders' workshop on vapor intrusion. This workshop should be designed to provide members of Restoration Advisory Boards and other public stakeholders with the background they need to oversee local responses and offer input on national and state guidance and policy.

Recommendation 3: The Defense Department should develop and demonstrate cost-effective equipment for the real-time or near-real-time detection of volatile organic compounds in soil gas and air, to enable the quick determination of the low VOC levels associated with chronic risk, at the point of exposure.