Vapor Anxiety at the Hanes-Lowrance Middle School Campus
Winston-Salem, North Carolina

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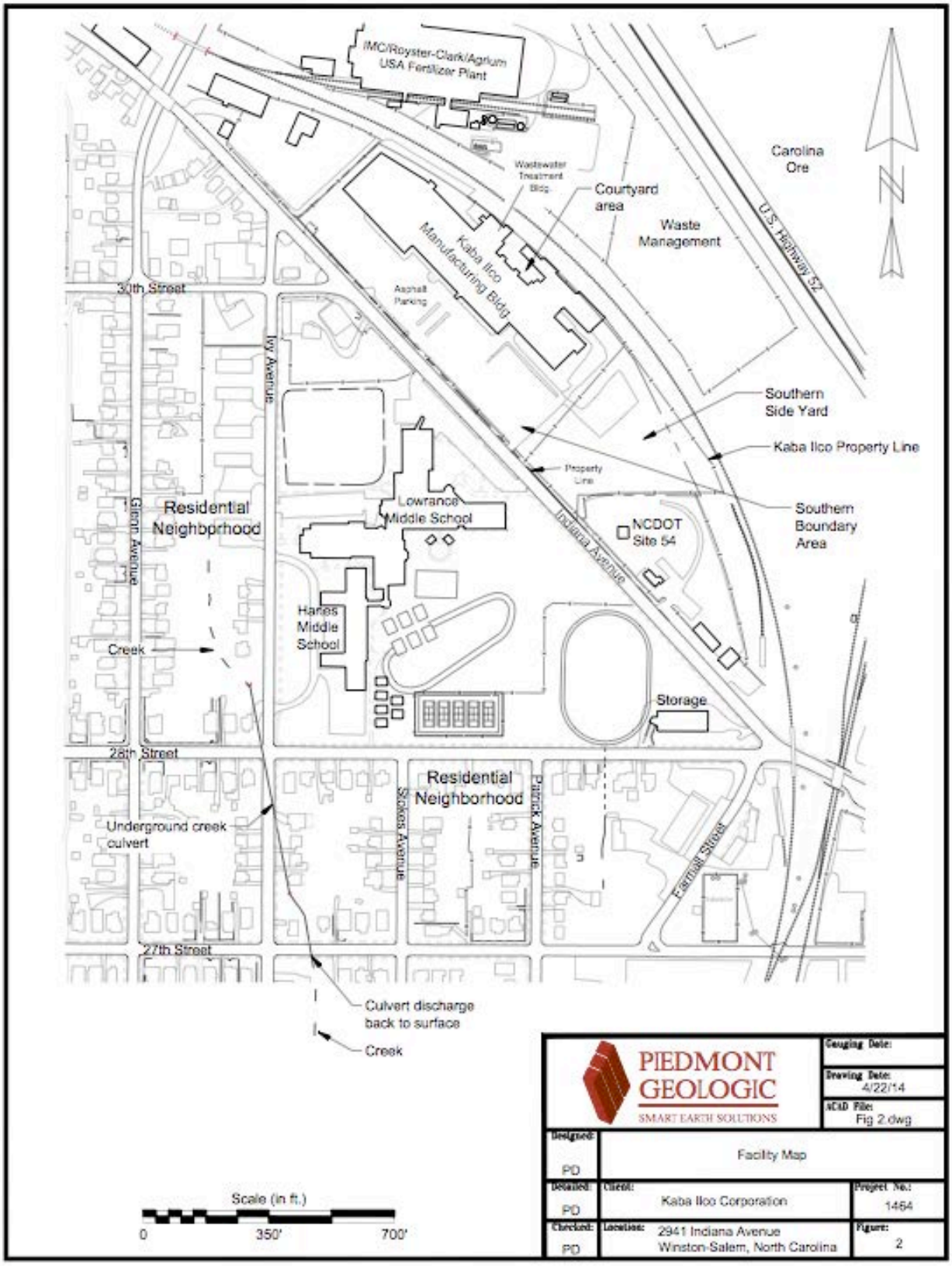
On January 24, 2015 the *Winston-Salem Journal* reported that the Hanes-Lowrance Middle School Campus, in Winston-Salem, North Carolina, sat above groundwater plumes of toxic chlorinated volatile organic compounds (CVOCs). The company responsible for the contamination, situated immediately across Indiana Avenue from the front of the school, had been addressing the contamination source for more than a decade.[1] The indoor air had been tested within the school building six times between 2005 and 2014, and each time it had met today's North Carolina exposure standards for tetrachloroethylene, also known as perchloro–ethylene (perc or PCE), a solvent used in a number of industries that is the principal contaminant of concern. But the disclosure ignited a firestorm of anxiety among parents who had no idea, until the news report, that hazardous substances underlay the campus. Using social media, a group of parents demanded that the School Board close the schools immediately, and they withheld their children from school.

One parent, seeking independent expertise with the help of the Superfund Research Program at the University of North Carolina (Chapel Hill), invited Kelly Pennell of the University of Kentucky and me to travel to Winston-Salem to explain the risks and make recommendations. We landed in North Carolina Monday morning, February 9. We met with several reporters, testified before the school board, and led an evening workshop on the

[1] The response has been conducted under the oversight of the Inactive Hazardous Sites (state Superfund) program of the North Carolina Department of Environment and Natural Resources. For background on this program, see http://portal.ncdenr.org/web/wm/sf.


IMC/Royster-Clark/Agrium USA Fertilizer Plant
Wastewater Treatment Bldg.
Courtyard area
Carolina Ore
Waste Management
U.S. Highway 52
Kaba Ilco Manufacturing Bldg
Asphalt Parking
30th Street
Ivy Avenue
Southern Side Yard
Kaba Ilco Property Line
Property Line
Residential Neighborhood
Glenn Avenue
Lowrance Middle School
NCDOT Site 54
Indiana Avenue
Southern Boundary Area
Hanes Middle School
Creek
Storage
26th Street
Residential Neighborhood
Scales Avenue
Patrick Avenue
Fairmill Street
Underground creek culvert
27th Street
Culvert discharge back to surface
Creek
Scale (in ft.)
0
350'
700'
PIEDMONT GEOLOGIC
SMART EARTH SOLUTIONS
Gauging Date:
Drawing Date: 4/22/14
xCAD File: Fig 2.dwg
Designed: PD
Facility Map
Detailed: PD
Client: Kaba Ilco Corporation
Project No.: 1464
Checked: PD
Location: 2941 Indiana Avenue Winston-Salem, North Carolina
Figure: 2

fundamentals of vapor intrusion. We supported the School District's plan for a new round of sampling at the school, and we suggested that the installation of active depressurization systems would provide more certainty that school air was safe than multiple rounds of sampling. Based upon past results, we concluded that the risk to students, teachers, and others remaining in the school buildings was low enough to keep the schools open at least until the end of the school year, unless the planned sampling detected unexpectedly high concentrations of indoor air contaminants.[2]

The following evening the School Board voted seven to two to move the students out as soon as practical, not even waiting for the new sampling results. The reaction of parents, at first, and school officials later is understandable. The demand for closure was not borne from science, but from mistrust. What we had here, in the words of Paul Newman as *Cool Hand Luke,* "is a failure to communicate."

Background

The Hanes-Lowrance campus, known locally as "HaLo," was actually home to two schools. Hanes was a STEM (science, technology, engineering, and mathematics) magnet school with about one thousand students. Lowrance's special needs student body numbered about 150. The two schools shared a cafeteria and other facilities. The main buildings were constructed in phases in the 1950s. The Hanes wing is three stories, including a basement, and the Lowrance section consists of two wings slab on grade. There are also a pod building with seven classrooms and six mobile classrooms, all with crawlspaces.

Kaba-Ilco Plant

[2] For background on how to investigate and respond to indoor air contamination, see U.S. EPA's Vapor Intrusion Technical Guides at http://www.epa.gov/oswer/vaporintrusion/guidance.html#EO12866OSWERVI.

Directly across Indiana Avenue is the Kaba-Ilco lock manufacturing plant. From 1945 to 1987 Stewart-Warner's Bassick Sack division produced metal furniture parts there, and those operations are believed to be the principal source of the CVOC solvents now found in the subsurface. Kaba-Ilco's consultant, Piedmont Geologic, asserts that APAC Inc.'s adjacent asphalt plant also released trichloroethylene (TCE), a different solvent, from its property. Even before Kaba-Ilco took ownership, Stewart-Warner removed contaminated soil and debris from the property, and Kaba-Ilco removed more dirt after it took over.

Contamination is found in both the saprolite (decomposed bedrock close to the surface) and bedrock aquifers. PCE from the site has flowed under the school campus and beyond, at both levels, and there is a smaller, less concentrated plume of TCE slightly to the east, underlying only a fraction of the school buildings.

Remediation

In 2000, Kaba-Ilco launched a soil vapor extraction system in the plant's courtyard area, near what it believed to be the principal source of PCE, a decommissioned, 150,000-gallon concrete-lined cooling basin. Though operation was suspended from 2008 to 2010, the system removed nearly 17,000 pounds of contaminant by December 2013. In 2008 the company started up a second treatment system, combining air sparging with soil vapor extraction on the property's southern boundary. By the end of 2013 this system had removed about 300 pounds of PCE.

Treatment Systems on Kaba-Ilco Property

Piedmont Geologic's May 2014 Remedial Action Plan (RAP) summarized the results of remediation thus far:

> Although both of these systems have been effective in reducing soil and groundwater COC [chemicals of concern] concentrations in the saprolite overburden on the facility property, they have not resulted in substantial reductions in groundwater COC concentrations in saprolite-aquifer-zone monitoring wells located on the adjacent property to the southwest, nor in bedrock-aquifer-zone monitoring wells located within the southern boundary area of the facility property.

The RAP also explained that while groundwater generally flowed downward on the source property, there were upward flows on the HaLo property. This conceptual model appears to explain fluctuations in groundwater concentrations on the school property. At one monitoring well near the portable classrooms, saprolite aquifer concentrations of PCE fell to 43 parts per billion in 2003, rose to 7,680 ppb in 2006, and fell again to 71 ppb in 2010 before jumping to an all-time high of 8,050 ppb in March 2014. A schools-hired expert may have been referring to the same well when he reported, earlier this year, that PCE levels had fallen to 2,950 ppb.

In response, the RAP called for the installation of three new extraction systems, one on the site boundary and two on school property. Reportedly those began operation this January. The discussions between Kaba-Ilco and school officials demonstrate that the district was fully aware of the contamination, but the public, including most school parents, was unaware.

Indoor Air

While the PCE levels on school property have been and remain far above the drinking water standard, there is no completed drinking water pathway at the site. The only likely exposure route is vapor intrusion, the migration of volatilized compounds from the subsurface into overlying buildings.

Piedmont Geologic conducted indoor air sampling at Hanes and Lowrance schools five times in seven rooms between 2005 and 2007. Another round was conducted in May 2014, with one Hanes room substituting for another that had been included earlier. The results showed two hits of trichloroethylene (TCE), measured at 17 micrograms per cubic meter ($\mu g/m^3$) and 4.5 $\mu g/m^3$, respectively. However, other evidence suggests that those were triggered by indoor sources, since removed.

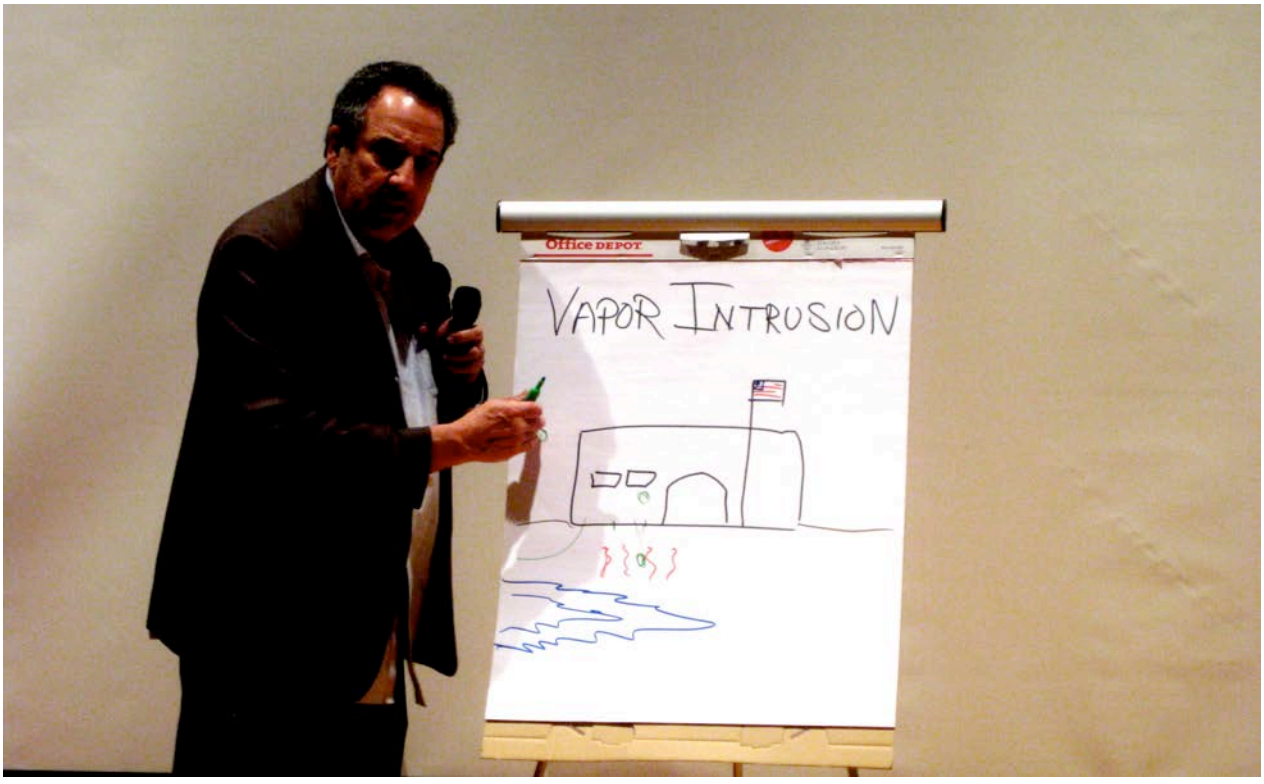
However, PCE was found several times at levels exceeding 1 $\mu g/m^3$ and one sample, in 2005, reached 6.8 $\mu g/m^3$. While none of the results exceeded North Carolina's current residential indoor air screening level of 8.32 $\mu g/m^3$, based on U.S. EPA's February 2012 IRIS Toxicity Assessment, several exceeded California's screening level of .41 $\mu g/m^3$, which EPA and many states were using at the time. The August 2005 sampling analysis actually does not specify a screening or action level, but it dismisses the results based upon generic PCE ambient (outdoor) air ranges. I believe this was a serious mistake. Indoor levels should have been compared to actual ambient air measurements, which they undoubtedly exceeded. The issue has been mooted, however, by the subsequent weakening of PCE exposure standards.

Disclosure

Though there was a brief mention of contamination in the summer 2014 discussions of the district's plan to construct a new $15.4 million building on the site, most members of the community knew nothing about the toxic plume underneath.[3] In response to questions from a small number of parents, the *Journal* investigated, publishing an article headlined "Schools sit on contaminated Earth" on Saturday, January 24, 2015. Reaction was swift and intense. Anxious parents launched a Facebook group and website. One parent told the newspaper, "They should have told people.… There are a lot of mad parents." But district administrators "said they didn't continue to tell parents about the site's environmental issues because the tests from 2005 to 2007 did not show cause for concern."

The following week school officials announced plans to conduct a new round of vapor sampling, funded by the district. And on Wednesday, January 28 they met with parents, who complained that they had been kept in the dark. According to the *Journal*, parents wanted to be able to decide whether to send their children to the "toxic school." And indeed they did. The following day 15% of the students at both schools were absent, and the number kept rising.

School officials backtracked. While continuing to argue that the children were safe, they withdrew the proposal to build on site. The following Tuesday, February 3, the School Board majority put off for one week the decision whether to keep the schools open.



[3] Those in similar circumstances might wish to consult U.S. EPA's voluntary School Siting Guidelines, designed to help local school districts and community members evaluate environmental factors to make the best possible school siting decisions. See http://www.epa.gov/schools/guidelinestools/siting/.

Meanwhile, a concerned parent who wasn't sure about closing the schools contacted the Superfund Research Program at the University of North Carolina, which in turn contacted vapor-intrusion expert Kelly Pennell of the counterpart Superfund Research Program at the University of Kentucky, and she contacted me. We both flew into North Carolina on Monday, February 9 for an intense day of meetings with media, the district's new consultant—Will Service of Mid-Atlantic Associates—and the school board itself before a large crowd. We capped off the day with an evening workshop, attended by about fifty people from the community with another hundred more watching on line.

We explained what causes vapor intrusion, how it is investigated, and how it is mitigated. We urged people not to panic, and we suggested waiting until Mid-Atlantic's new results were in before deciding whether to close the school. Noting that even if PCE levels inside the school exceeded levels of concern, the risks were chronic. Keeping students and others in the schools for weeks or even a few months was not a significant risk, particular if past testing results were accurate. We also said active mitigation—primarily sub-structure depressurization—even in the absence of regulatory exceedances, would provide more certainty than a series of new sampling rounds.

While our findings were reported widely, and some parents seem re-assured, others had already decided that their children would never attend school on the site. One parent told a TV reporter, "I don't want 15 years from now, for my children or any of the kids there, to be a data point in another study that has the EPA or DENR [North Carolina's Department of Environment and Natural Resources] reduce their current standards."

The Decision

The following night the School Board heard testimony from a divided public, according the *Journal*:

> "Make no mistake: At this point, the schools are toxic, irrespective of what the test results show," Carol Templeton, a Hanes parent, said Tuesday night during a meeting of the Winston-Salem/Forsyth County Board of Education.
> "The schools are toxic because they are sitting on poisonous water that can emit harmful vapor and because parents have lost trust.
> "The schools are toxic because parents have transferred their kids out of the school.
> "The schools are toxic because parents are not sending their kids to school right now. …
> "The schools are toxic because parents aren't going to send their sixth-graders to Hanes next year," Templeton said.

On the other hand, some Lowrance parents and teachers there were worried about the impact of closing the school mid-year. The *Journal* reported:

> Since students with special needs attend Lowrance, some Lowrance parents said that the burden of disrupting those children's schedules would be worse than staying put through the end of the year and waiting for a permanent solution— such as a new school building.

In the end, the Board voted seven to two to close the schools by March 2. One board member apologized profusely for not taking action sooner, and the Board Chair told the paper at the end of February, "I still think it was the right decision…. When you have students, children … you do what's right. You err on the side of caution." The closure process reportedly beat the March 2 deadline, and two weeks later the Board voted to keep the school closed next school year, before receiving any of the air sampling results.

The mid-year relocation cost the school district $3 million or $4 million, to say nothing of the impact on the student population. The *Journal* editorialized, "Kaba should share in the costs." The editors acknowledged that Kaba-Ilco might not be required to help fund the relocation by law, but it argued "it would be the right thing to do." A lawsuit demanding reimbursement would probably break new ground. Even though the company is responsible for legally required cleanup, closing the schools was not required by the applicable standards of any regulatory agency.

The Results

Mid-Atlantic's evaluation of the site, led by former DENR environmental toxicologist Will Service, was much more comprehensive than previous sampling rounds. He made a preliminary report on February 27—a remarkably quick turnaround—and issued his Final Report on March 16. Service collected soil gas, indoor air, and ambient air samples, and he measured radon in the subsurface and within the building to check for pathways and measure attenuation between the subsurface and indoors.

Though 14 of 31 subslab soil gas samples exceeded DENR's residential soil gas screening levels, none of the 45 indoor air samples exceeded the indoor air screening levels, even at the target risk level of one-in-a-million *excess lifetime cancer risk*. That is, using the current EPA toxicity assessment for PCE, exposures were acceptable when and where sampling took place. Still, Service's action recommendation paralleled what Pennell and I had suggested:

> Data from this assessment indicate that no additional assessment or mitigation of the vapor intrusion condition at HLMS [Hanes Lowrance Middle School] is necessary according to DENR DWM [Division of Waste Management] vapor intrusion guidance. Although sampling data do not compel mitigation of vapor intrusion in the permanent

> buildings, pre-emptive vapor intrusion mitigation may be used to provide assurance that the vapor intrusion exposure pathway is not creating unacceptable exposure to users of the HLMS buildings. Sealing slab openings and increasing outdoor air ventilation rates could be considered as immediate measures. Installation of active sub-slab depressurization (ASD) systems to mitigate soil gas entry into buildings is proven technology that should be considered as an interim mitigation measure while groundwater remediation progresses. Extensive sub-slab soil gas data collected during this assessment would be useful in guiding location and design of ASD systems. Installation of ASD systems and/or other engineering controls may be less costly than ongoing monitoring and may provide greater certainty that vapor intrusion is not creating unacceptable exposure risk for users of the buildings.

Beyond the School

Kaba-Ilco's May 2014 Remedial Action Plan suggested that the shallow PCE plume extends about a half-block south of the school and then discharges into an underground, culvert-contained creek. A RAP map shows the plume ending at the creek. But the evidence was weak, since no monitoring wells were shown beyond the creek. In April the city of Winston-Salem installed seventeen new wells in the residential area southwest of HaLo, in part because it planned underground infrastructure construction in the area. Those wells showed at least one location where PCE in shallow groundwater exceeded 500 ppb, so in early May the city considered adding fourteen more wells. Since then, Kaba-Ilco, at the request of DENR, has agreed to install more wells of its own, as well as soil vapor probes, immediately south of the school. As far as I know, no downgradient sampling has been conducted in the deeper bedrock aquifer, believed to be the source of upward groundwater migration at the school site,

While the current groundwater contamination levels are unlikely to produce PCE vapor intrusion at levels exceeding North Carolina's exposure standard, it cannot be ruled out without more investigation. That is, while schoolchildren and teachers may now be safe from the vapors emanating from the Kab-Ilco plume, it remains possible that homes in the area will need mitigation to protect the residents.

Lessons

The presence or absence of *trust* is the pre-eminent factor in lay communities' views on environmental risk management in their homes, schools, and neighborhoods. The school board rushed closure of the HaLo schools, justified as "erring on the side of caution," was not supported by the numbers or by the experts. The logical protective approach, pre-emptive mitigation, would have eliminated or at least minimized the potential for school-room exposures to PCE from the Kaba-Ilco plume, but installation probably would not have been completed until this summer. Enough parents and eventually school board members feared that because they were never fully warned about the *potential* for vapor intrusion at concentrations considered unsafe by environmental regulators, the children and other building occupants faced imminent risk. The failure of school officials, state regulators, and the responsible party to communicate fully information about the plume and past air monitoring led directly to the questionable closure of the schools.