What you can't see may hurt you: A vapor intrusion primer for site owners and property developers

First in a two-part series on understanding and managing vapor intrusion risks

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A property developer just finished renovating a 75-year-old brick building into a mixed use complex with a restaurant in the basement, retail on the first floor, and condos on two floors above. After several months occupying the renovated building, the restaurant employees, retail workers, and residents, began noticing an increasing frequency of headaches and nausea.

Thinking it was a natural gas leak, the condo owners called the fire department that determined the gas line was intact. The fire department, in turn, contacted the state environmental agency that required the building owners to hire an environmental engineer. Upon testing, the engineer discovered a vapor intrusion problem due to gasoline vapors from contaminated groundwater originating from a leaking underground tank next door at a gas station.

During mitigation of the vapor intrusion problem, the restaurant and retail stores were shut down, and residents were forced to move out, subjecting the property developer to hundreds of thousands of dollars to compensate for alleged bodily injury, lost income, living expenses, clean-up and property improvements to abate the vapor intrusion event.

Vapor intrusion is a rapidly developing field of science and policy for industry and government regulators, and an increasing environmental risk for site owners and property developers. Until about 10 years ago, environmental scientists and risk assessors viewed contaminated groundwater affecting the drinking water supply and direct contact with contaminated soil as the primary threats to property owners and residents. Starting in the late 1990s, states started to become aware of the vapor intrusion issue, culminating in draft guidance by the U.S. Environmental Protection Agency in 2002.

The EPA describes vapor intrusion as "the migration of volatile chemicals from the subsurface into overlying buildings." Subsurface sources of vapor intrusion can include ground water or soil that contains volatile organic and inorganic compounds, buried wastes, and underground storage tanks or drums. A number of factors cause soil gas to enter a building including barometric pressure changes, wind load, thermal currents, or depressurization from building exhaust fans. For example, HVAC systems or a large

exhaust fan can create a negative pressure that draws soil vapor into the building.

Soil vapor can enter a building whether the building is old or new, or whether it is on a slab or has a crawl space or basement. These vapors migrate through cracks or other openings in the foundation or floor. Until recently, a potential vapor intrusion pathway was not a routine consideration in the Phase 1Environmental Site Assessments (ESAs) conducted for property transaction due diligence purposes or in assessments conducted by EPA, so the number of buildings or homes where vapor intrusion has occurred is unknown. Since there are a large number of current and former industrial, commercial, and waste processing facilities capable of causing soil and groundwater contamination, the potential human exposure to these vapors could create a significant potential risk for site owners and property developers.

Vapor intrusion poses the greatest immediate risks when the vapor concentrations are high enough to create a potential for fire and explosion. Acute chemical exposure that can result in immediate health issues such as nausea and headaches. Long-term exposure to contaminants in indoor air can cause cancerous and non-cancerous health effects. Humans are exposed to contaminated soil vapor through inhalation. Because inhalation allows chemicals to be readily absorbed into the bloodstream, the effects of vapor intrusion can be felt much sooner than with drinking contaminated drinking water. Negative heath effects to vapor exposure depends on several factors, including the length of exposure, the amount of exposure, the frequency of exposure, the toxicity of the volatile chemical and the individual's sensitivity to the chemical. People most affected by vapors tend to be the young, the elderly, and those with pre-existing respiratory problems such as asthma or bronchitis. In addition, children and seniors tend to spend more their time at home, which also increases exposure duration and risk.

The EPA identifies three factors that must be present for vapor intrusion to impact indoor air and cause public health exposures:

1. A source of volatile chemicals in the subsurface
2. Buildings have to be close enough to the contaminant source, typically within 100 feet
3. A clear pathway for the contaminant to enter the building such as a crack in the floor, a super-porous floor or wall, or pipe/drain openings.

Currently, the following 26 states have established guidelines for vapor intrusion because of the human health risks.

Alaska	Indiana	Minnesota	Pennsylvania
California	Kansas	Missouri	Rhode Island
Colorado	Louisiana	New Hampshire	Virginia
Connecticut	Maine	New Jersey	Washington
Delaware	Maryland	New York	Wisconsin
Hawaii	Massachusetts	Ohio	
Idaho	Michigan	Oregon	

The recent emphasis on vapor intrusion has resulted in environmental regulatory agency review of closed sites where vapor intrusion modeling or estimates were used to achieve closure, and in some cases, re-opening closed claims. The New York State Department of Environmental Conservation has reopened for vapor intrusion investigation over 400 sites which were subject to final closure prior to 2003. Reopening closed sites also raises the issue of who is liable for a previously closed site that is under new ownership. Additionally, because of what appears to be driven by media attention, bodily injury or fear of future injury claims are now emerging due to concerns related to vapor intrusion.

The 2002 EPA draft guidelines are still not finalized, due in part, because of the complicated nature of vapor intrusion that makes it difficult to evaluate in terms of assessing the public health threat. But there is increasing pressure on EPA from other national and state agencies to complete these guidelines. In 2007, a comprehensive vapor intrusion guideline was created by the Interstate Technology Regulatory Council (ITRC), which the EPA partially funded and a substantial portion of this document is expected to be included in the final EPA guidelines when completed.

It is recommended that if vapor intrusion is indentified as an issue in a remediation, the prudent course of action would be to sample, test and monitor for vapor intrusion risk as opposed to using modeling or other formulaic analysis. Without actual testing for vapor intrusion potential serving as a basis for site closure the owner or responsible party faces re-opener of the remediation and associated residual risks that remain even if the remediation is deemed completed.

In the second part of this series on vapor intrusion, an in-depth look at mitigating the risks of vapor intrusion will be explored.