Use of Canines in Source Detection of Indoor Air Pollutants

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Vapor Intrusion

The intrusion of volatile organic compounds (VOCs) from contaminated soil gas into indoor air, i.e., vapor intrusion, is a public health problem that is receiving increased attention. Vapor intrusion can occur from the migration of VOCs from dissolved-phase groundwater plumes, soils contaminated by leaking storage tanks, or from landfills into industrial, commercial and residential buildings. Risk of vapor intrusion often occurs in the redevelopment of contaminated properties. Vapor intrusion is a multi-media phenomenon (soil, groundwater, soil vapor and air) that is influenced by a number of physical and/or chemical factors. Human health may be at risk from chronic exposure to very low VOC concentrations. These low concentrations challenge state-of-the-art sampling and analytical methods. Another complicating factor is that interior items or ambient air can also be sources of indoor air contamination (Figure 1).

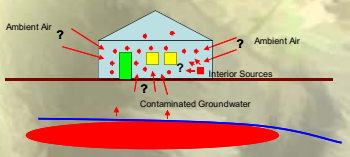

Figure 1. *Vapor intrusion from contaminated groundwater is only one potential source of indoor air pollutants. A variety of background sources inside the house and from outside ambient air can be culprits as well.*

Many of the chemicals implicated in vapor intrusion problems can come from a number of sources other than the contaminated soil or ground water plume from the site under investigation. Collectively these sources of indoor air pollution not caused by the release from the site are referred to as background sources. These background sources include household products, consumer activities, building materials and furnishings, and the ambient air.

Problem household products range from cosmetics to degreasers and paint strippers. Consumer activities such as cigarette smoking and dry cleaning can also contribute. Building materials and furnishings including pressed wood products, carpets, office machines and paints are other common sources of indoor air contamination. Finally, outside ambient air sources must be considered in an investigation. Typically three strategies are used to address background indoor air sources and help discriminate between background and site sources. First, the site specific profile of contaminants is characterized prior to indoor air analysis. A building survey is conducted and when possible potential background sources are removed. Finally, occupants are requested to refrain from activities such as smoking, use of cleaning products, paints and varnishes, and use of hair spray and cosmetics and to keep doors and windows shut prior to sampling.

These efforts, however, do not always allow clear discrimination between background sources and vapor intrusion from contaminated sites. Responsibility for remediation of buildings is often contested. Sufficient sampling and analysis to clearly document responsibility is often more expensive than the actual remediation required.

Why Dogs?

A dog's nose is a sensitive chemical detector with detection limits below 1 part per billion (ppb) (Figure 2). Dogs can detect a target compound even if masked by other compounds at orders of magnitude higher concentration and are capable of discriminating between a target compound and closely related ones. They can be trained to detect multiple target compounds (>20) and to move up gradient to the area of highest concentration. Dogs can rapidly screen large areas for specific compounds. Dogs can efficiently find specific pollutants for the same reasons they are effective in military and law enforcement at locating drugs, explosives, or other contraband, that is, they are specific, instantaneous, cost-effective, mobile chemical detectors. While a dog will not report an exact concentration of a chemical, when used to screen a site, they can indicate if and where expensive sampling and analysis is necessary. When used at the site of arson investigations, dogs typically reduce the number of samples analyzed in the laboratory by 80%. They can also be used to confirm whether a site is clean following remediation activities.

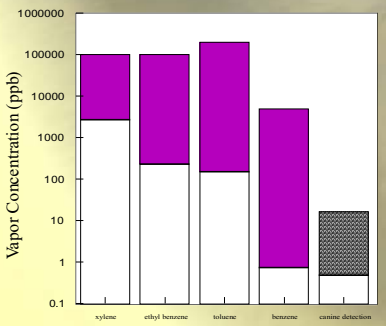

Figure 2. *The bottom of the purple bars show the equilibrium air concentration over a water sample containing benzene, toluene, ethylbenezene, or xylenes (BTEX), common groundwater pollutants at the allowed drinking water concentration. The top of the bars shows the OSHA eight hour permissible exposure concentrations in the workplace. The hatched area is a range of canine detection levels from a laboratory study at Auburn's Canine Detection Research Institute.*

A dog and handler team could screen a room for chemical contamination in a matter of minutes and an entire residence in well under an hour. For vapor intrusion investigations, a dog could be used both to cost effectively identify the source location of the air contaminant and to do follow up "sampling" after remediation is implemented.

Although there is widespread use of canine scent capabilities in military and law enforcement applications, relatively little use has been made of dogs in environmental work. In the mid 1980's, an EPA research program demonstrated the ability of canines to find small amounts of contaminants at field sites and to confirm that heavy equipment had been decontaminated following work at hazardous waste sites (Figure 3). Despite the success of this effort, dogs have not been adopted by the environmental community as a viable tool for use in site investigations.

Figure 3. *Ramos, a German Shepherd dog, was trained to screen heavy equipment after work at a site to assure decontamination was thorough during a successful EPA research project in the mid-eighties.*

Three issues need to be addressed before widespread consideration will be given to the use of dogs in environmental applications (1) cost effectiveness of using a dog and handler team compared to other technologies available to get a job done; (2) assuring health and safety of both dog and handler; and (3) development of standard methods and certification testing to provide quality control.

Canine Detection Program at ERD-Athens

The canine detection program at ORD's Ecosystems Research Division is a new in-house program located at the Field Research Annex (FRA) in Athens, Georgia. The program is small, currently with two canine participants and their handler/researchers. Both of the researchers are involved in other ORD research projects as well. The FRA includes a day time kennel facility, and the program dogs are housed with their handlers overnight and on weekends. Sammy, a 4 yr old Swedish Vallhund, joined the program a year ago when he and environmental engineer Sandy Bird began initial training in scent detection work. Recently Cocoa, a Labrador Retriever from the Madison-Oglethorpe County, Georgia Animal Shelter, has joined the program and begun training with project chemist, David Spidle. The canine program is part of the vapor intrusion research task led by Dr. Jim Weaver. Our long term goal is to identify a variety of environmental problems and related research efforts as well as vapor intrusion that can be addressed more efficiently and effectively using canine scent detection capabilities and apply the capability and expertise we are now developing to those issues.

Figure 4. *Sammy has been trained to a passive alert signal. When he detects a compound he's trained to detect, he moves to the point of highest concentration and sits to indicate a find.*

Figure 5. *The scent detection training relies on positive reinforcement and play-based training techniques. Sammy is rewarded for his work with treats or a game of fetch or tug.*

Figure 6. *Cocoa, a three year old rescue from the Madison-Oglethorpe County, Georgia Animal Shelter, has recently started training to become ORD's second canine detection dog.*

The vapor intrusion project includes three research phases. In all phases, careful planning and monitoring is included to assure the health and safety of dogs and handlers. First is a series of canine detection limit studies for low concentration aqueous solutions of compounds including test compounds, the BTEX (benzene, toluene, ethylbeneze, and xylene) suite of compounds, common contaminants from underground storage tank leaks, and other compounds commonly implicated in vapor intrusion problems. In an initial dilution series with one of our training compounds, isopropyl alcohol, Sammy detected vapor concentrations below 1 ppb. Testing is done blind, i.e., the handler does not know which are targets and which are blanks. Searches are also done with free hides of samples so we can understand limits likely encountered in the field demonstration phase.

Following laboratory studies, the program will move to a field test phase. Vapor intrusion project researchers are working with the Georgia Environmental Management Authority to identify petroleum sites where the effectiveness of the use of dogs can be evaluated. The final phase of the project will be the development of recommended training and testing protocols for the use of scent detection dogs. Development of "standard methods" and specific quality assurance protocols are a key component to acceptability of the use of dogs in environmental applications.