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The Case of the Missing Bolts

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Murphy's Law says that whatever can go wrong, will go wrong, at the worst possible moment, causing the most damage. I believe Murphy was an Environmental Engineer. Many environmental problems are not straightforward. There are always compounding factors that confuse the picture. Without recognizing this, and taking these factors into account, money and time can be wasted. This came home to me very clearly when I was working on a project in Central Vermont. While this specific incident involved a residential building, it could have easily been a commercial building.

In the Beginning

The residential oil burner had been serviced by the oil company's burner maintenance technician at the end of November, prior to the start of the heating season. The technician neglected to install the retaining bolts in the bottom of the burner. When the oil heat was turned on, the pressure of the oil knocked out the bottom of the burner, releasing 275 gallons of fuel oil into the basement of the residence. A small flash fire occurred at the instance of the initial release.

The Emergency Response…

A local environmental contractor was called in to clean up the release. By the time they arrived, all of the oil was lost through the extensive cracking in the concrete basement floor. The environmental contractor removed approximately one-third of the concrete floor and approximately 14 cubic yards of soil. They brought in clean fill and installed three monitoring well points and two petroleum collection points with absorbent socks in the basement prior to pouring a new slab.

…And What Came Afterward

The lack of a bulkhead access to the basement required that all of the broken-out concrete and removed soil to be brought through the house in buckets. This resulted in heavy layers of oil-soaked dust and grime throughout the first floor of the residence. A professional cleaning company was retained to clean the house of the dust and dirt resulting from the emergency response action. Following the cleaning, the house was fogged with a deodorizing chemical, and a sealant was applied to the basement floor to address the lingering odors.

We're Not Done Yet

After cleanup, the owner complained that the interior of the house had a very strong odor and was unlivable. Upon investigation, the environmental contractor used for the emergency response determined that post-cleanup interior air samples indicated high levels of petroleum compounds. The contractor proposed the installation of a soil vapor extraction

system (SVE) through the basement slab to address the assumed lingering contamination, which they concluded was causing the odors in the house. The approximate estimated cost for installation of this system would be $4,500; given the unknown amount of assumed contamination, an operation cost could not be estimated. This left an open-ended financial liability question for the insurance company, which was responsible for paying the bills.

And Now…The Rest of the Story

Upon reviewing the information provided by the various contractors involved, we discovered that the fuel oil release was not the lingering issue, and that an SVE system would have done absolutely nothing to address the problems remaining. This was based on the following findings:

1) There could not be a significant amount of oil remaining below the slab. Oil will travel through the subsurface, leaving behind residual in the void spaces of the soil. The oil will stop moving once it has reached a point of residual saturation. (Residual saturation can be described as the amount of liquid a volume of soil will hold without dripping.) Assuming a 30% void space in the soil below the slab (a conservative assumption), the amount of soil removed would have held 1,414 gallons of oil. This equates to five times the amount of the original release.

2) The sealant used on the basement floor was a waterproofing sealant designed for outdoor use. It contained 70% xylenes and 15% ethyl benzene. Initial air testing indicated concentrations of xylenes and ethyl benzene in excess of 2000 and 700 parts per billion (ppb), respectively. The concentrations of benzene and toluene were typical of a residence with oil heat. Because the concentration of xylems and ethyl benzenes were more than two orders of magnitude greater than expected, it was clear that the indoor air concentrations could be directly linked to the use of the waterproofing, which was not designed for indoor use. The Greatwood Management Company installed a self-contained, vapor-phase, carbon absorption unit in the basement. (The unit pulls in the surrounding air, and passes it through absorptive carbon to trap the volatile organics.) Two charges of 100 pounds of carbon were required to lower the xylene and ethyl benzene concentrations to acceptable levels.

3) The deodorizer used by the cleaning company was designed for high soot environments. The material is dispensed via a fogger throughout the affected area. The deodorizing chemical combines with, and clumps together, the odor-causing soot particles, settling them out of the air and thus eliminating the odor.

Now, recall that the only fire at this residence was a small flash fire at the moment of the initial release. There was no long-term burn and hence little soot. The majority of material in the air and on the walls was dust and grime from the removal of the basement floor and oil saturated soils, not soot from a fire. The deodorizing chemical was specifically formulated for removing fire odors; therefore, it was not appropriate for this situation.

Further, the manufacturer of the material recommends against using an electric fogging machine (which the consultant used) to disburse the deodorizer since these units do not

produce the pressure needed to properly disperse the agent in fine particles. As a result of using the electrical fogging machine, large drops of the chemicals formed and settled on the horizontal surfaces.

The source of the odor in the house had been found: over application of the deodorizer solution. The solution: deep cleaning of the carpets, upholstery, and furniture with a water-based cleaner.

The Saga Continues

To prove that the oil had been removed and groundwater was not impacted, two more monitoring wells were installed and sampled on the down gradient side of the house. The drinking water well was also sampled to confirm that it was not impacted. No indication of petroleum compounds above detection levels were indicated in any of the samples.

Following approval by the state regulators, all of the monitoring points were sealed and closed. The absorbent socks were also removed and disposed of. The site was closed in accordance with the regulatory requirements.

Epilogue

This environmental situation was approached by the emergency response contractor/consultant as a standard oil spill. The appropriate activities conducted included removal of the slab and underlying soils. However, the activities that followed the initial cleanup, including the sealing of the floor and the cleaning of the carpet, significantly complicated the situation. Not recognizing these complications resulted in inappropriate recommendations for further work, lost time to resolution, and wasted money.

An example of the recommendations that resulted from this tunnel-vision assessment of the problem is the choice of an SVE system. SVE is ideal for removing volatile organic compounds from the unsaturated soil. Since gasoline contains a high fraction of short-chain, highly volatile compounds, it is a good example of a contaminant for which an SVE system is ideal. Fuel oil, on the other hand, has a significantly higher fraction of longer chain, lower volatile compounds. Therefore, SVE systems, under ideal conditions, would need to work longer to remove this lower volatile fraction, if they could handle the compounds at all.

Further, SVE systems should not be used as the sole remedial technology when free product is present. For an SVE system to work efficiently, it requires the contaminants to volatilize from the free product layer on the water table and travel to the vapor extraction points to be collected and removed. It is more efficient to install a separate product collection system when free product is indicated on the water table in addition to a soil vapor extraction system to address contamination in the unsaturated soil matrix.

The Moral of the Story

Tremendous amounts of data are typically available on most environmental projects. This data is not always presented in neat columns from analytical laboratories. Further, a wide-angle view of an environmental issue is crucial to properly address the issues in a timely,

intelligent, cost-effective manner. A monofocal view will result in lost time and wasted money.

Beneficial information can be collected by a review of the work performed, the equipment used, and the chemical agents employed. Combining this with a good understanding of the benefits and limitations of various remedial technologies and the behavior of the various contaminants helps to determine the best methods to address an environmental situation. In the case of the forgotten bolts, examples of this include:

- Improper use of an exterior sealant in the interior of a building resulted in contaminated indoor air.
- Improper application of deodorizer chemicals resulted in significant interior odors.
- Improper interpretation of indoor air quality data.
- Recommendations to use a costly SVE system to address unsubstantiated contamination.

Such a review will typically save you significant amounts of time and money, and will allow for the rapid closure of a site. Ignoring this data will quickly lead you to conclude that Murphy was an optimist.

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