

The Environmental Corner

By: Steve Henshaw



Advancements in Fingerprinting Contaminants Compound Specific Isotope Analysis (CSIA)

Among the challenges in environmental consulting is determining responsible parties in comingled plumes. With so much money and liability at stake, confident determination of contaminant sources (fingerprinting) becomes vital to not only our clients' personal stake, but to the timely cleanup of potentially dangerous contaminant plumes.

The first and most utilized fingerprinting method is basic compound analysis. Generally, it is known what hazardous substances were released to the subsurface and what chemical compounds can be associated with that release. Analysis is completed by comparing compounds detected. For example, two drycleaners next to each other are located directly upgradient from a residence where one drycleaner has used Stoddard solvents and one has used perchloroethylene (perc) in the drycleaning process. When laboratory analysis reveals the presence of petroleum compounds (perc contains no petroleum compounds whereas Stoddard

solvent does) in groundwater under the residence, it is determined that the Stoddard solvent plant is likely the responsible party.

But what if both drycleaners use perc and it was detected under the house? A multi-faceted method called Chemical Concentration Ratio Analysis (CCRA) might be able to differentiate the plumes and associated contribution to the comingled plume. Perc naturally breaks down in the subsurface due to biodegradation. During the breakdown process,

daughter products such as trichloroethylene, dichloroethylene and vinyl chloride are produced. Perc that has been in the ground for a longer period of time will have created more daughter products. The ratio of perc to trichloroethylene will be lower from an older release. If both drycleaners used perc at different time periods, the plumes will have unique ratios of chemicals. This is one example of how CCRA can fingerprint one plume from the other.

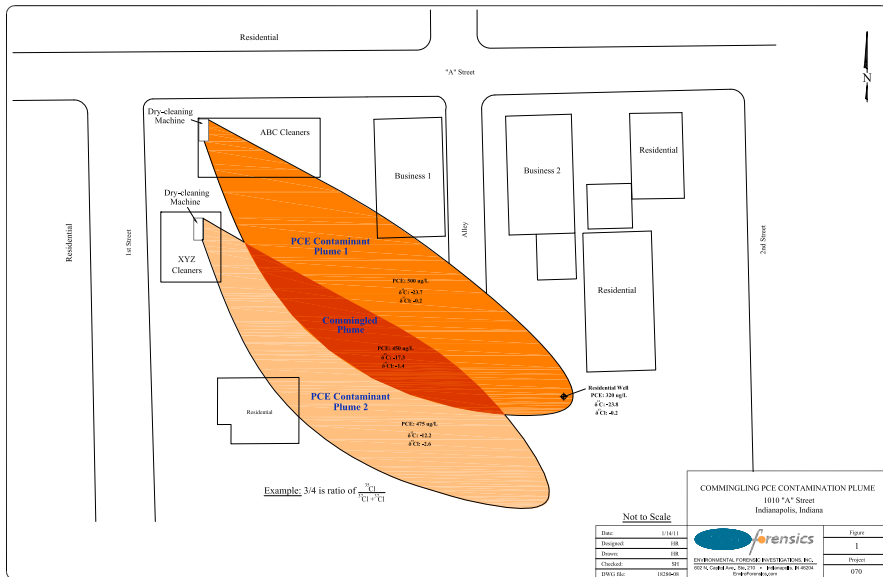
But what if both drycleaners had perc releases over the same time? In this case we may look at the perc molecule itself. To look into the

Continued on page 2

As Seen In...

Cleaner & Launderer

February 2011



perc molecule Compound Specific Isotope Analysis (CSIA) is utilized. Isotopes are different naturally occurring forms of the same element that have the same number of protons but varying number of neutrons. For example, most oxygen atoms have 8 protons and 8 neutrons, which add up to an atomic weight of 16 (^{16}O). 0.2% of oxygen atoms have 10 neutrons creating ^{18}O and 0.04% of oxygen atoms have 9 neutrons creating ^{17}O . Laboratory analysis can determine the different stable (non-radioactive) isotopes in various atoms that make up compounds. Perc is made up of two carbon atoms and four chlorine atoms. 98.89% of carbon is ^{12}C , while 1.11% is ^{13}C and 75.77% of chlorine is ^{35}Cl , while 24.23% is ^{37}Cl .

Soil or groundwater samples sent to the laboratory will be analyzed in a mass spectrometer for the quantity of the isotopes. The isotopic signature of the sample could potentially be quantified by calculating the ratio of the isotope to each other and to an international standard to normalize the data.

Stable isotopes can be utilized in several ways in the environmental world. One way is by knowing the unique isotopic signature of the perc

used at each drycleaner (chemical manufacturing processes produce different isotope concentrations) and matching it to the detected isotopic signature in the subsurface to the source. Another is by comparing the isotopic signature detected across the tested area looking for like signatures, which can delineate plume boundaries. Additionally, as the perc is naturally broken down by biodegradation, the isotopic signature becomes "heavier," allowing biodegradation to be monitored and a comparison of plume age might be able to be estimated. Stable isotopes can also be utilized in tracer studies. A volume of water with an isotopic signature unique to the study area can be injected and monitored allowing scientists to determine the groundwater flow characteristics. Tracers can be initiated at the source area and monitored to see where the plume would be expected to migrate.

Many tools are available for fingerprinting analysis. Should a situation exist where plumes have come together, one or more of these accepted methods are likely to be employed to determine the responsible party. However, use of stable isotopes has more recently emerged as a reliable

method for forensic analysis, and because several elements have stable isotopes, a more thorough analysis can be completed.

In summary, while each site has specific criteria and characteristics, it may be possible to delineate the plume boundary by using Compound Specific Isotope Analysis (CSIA). In such cases where such a situation exists, contact us and let us see if we can assist you in evaluating the merits of this technology. After all, the cost of cleanup can be enormous and no one wants to pay to cleanup somebody else's mess. This technique could save you tens even hundreds of thousands of dollars.

Stephen R. Henshaw, P.G. President & CEO - With over 20 years of experience, Mr. Henshaw holds professional geology registrations in numerous states. As President and CEO of EnviroForensics, Henshaw serves as a client and technical manager on projects associated with site characterization, remedial design, remedial implementation and operation, and litigation support and insurance coverage matters. He has acted as Project Manager or Client Manager on over 200 projects. These projects have included landfills, solvent and petroleum refineries, foundries, metal plating shops, food processors, wood treating facilities, chemical manufacturers and distributors, mines and quarries, heavy equipment manufacturers, computer manufacturers, and transporters. He has also served as a testifying expert on behalf of individual landowners and facility operators at several sites impacted by industrial activities and continues to provide technical and litigation support services. Contact him via e-mail: shenshaw@enviroforensics.com.