ENVIRONMENTAL FORENSICS: Courting Science?

Leo S. Leonhart *– Hargis + Associates Inc.*

Forensics and hydrology are two terms that may not seem to go together well. To the uninitiated, this combination may evoke images of the crime scene investigation that ensues when some patsy goes into the drink wearing cement overshoes. Rather, the term *environmental forensics*, essentially the parent discipline of *forensic hydrology,* has found its way into contemporary parlance owing to increasing instances of scientists lending support for environmental litigation. Such support may come in the form of expert testimony, factual testimony regarding site investigation matters, or simply consultations with attorneys to identify and explain the technical merits of a case. A scientist or engineer may even become involved in litigation related to errors and omissions arising from his/her own professional practice.

Most commonly, environmental forensics involves "… scientific investigations that address contamination within the environmental media of air, water, soil and biota, and is subject to law court, arbitration, public debate, or formal argumentation" (International Society of Environmental Forensics). Forensic hydrology, of course, would be limited to the water component of the definition.

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But forensic hydrology is not necessarily limited to contamination issues. It may also be concerned with such matters as flooding, drainage, runoff, water supply, pumping, or design failures involving dams, bridges, or impoundments. Regardless of the circumstances, it behooves environmental scientists and engineers to be aware of certain realities well before becoming involved in litigation.

Scientists in the Courtroom

First and foremost, there are important differences in the respective roles of attorneys and testifying experts in the courtroom. Attorneys are advocates who speak on behalf of or in defense of the client. In fact, the word *advocate* derives from a root word meaning lawyer; in French and Italian, the words meaning lawyer are *avocat* and *avvocato*, respectively. Although scientists and engineers may be retained as testifying experts by the attorney representing the client, they are not hired to be client advocates. Technical experts are bound by the ethical rules of scientific practice and are required by these standards to be factual and objective when called upon to offer an opinion in such situations. And of course, they are sworn to tell the truth when giving testimony before the court.

Ethical practice in scientific investigation usually means adherence to precise procedures and methods. Fundamentally, the scientific method is a systematic procedure for understanding natural phenomena that comprises observation, hypothesis, experiment, validation, and generalization. Good science requires objective adherence to this method. Junk science results from short-cutting or avoiding this method.

In court, testifying experts may be called upon to opine on a variety of issues that are relevant and important to the decision before the court. For example:

- **cause and effect**: Did pumping of the well cause another well to go dry?
- **allocation**: How do we apportion blame for contamination among multiple parties?
- **timing**: What is the sequence of events that led to this damage? Did this damage occur within a specified timeframe?
- **exposure**: Is there a complete groundwater pathway between a source of contamination and a well? If so, what is the travel time? What was the historical distribution (concentration) of contaminants?

How to Make an Attorney Squirm

Because of inherent uncertainties in scientific practice, opinions are often qualified. This uncertainty often is not comforting to the attorney. Experts may be pressed by the client's or the opposing attorney to characterize the uncertainty of their opinions with such qualifications as:

- "More often than not …"
- "To the best of my knowledge and belief ..."
- "At the present time …"
- "Based on the materials that I have reviewed …"

Attorneys are generally uncomfortable with opinions that present alternative hypotheses, limitations, uncertainties, and assumptions about the investigation that might invalidate conclusions.

Other considerations are the so-called "Daubert criteria," which originated as a result of a federal court decision, *Daubert v. Merrell Dow Pharmaceuticals, Inc.* This decision established the trial judge as a gatekeeper for admissibility of expert testimony and established criteria for determining such admissibility. The essential criteria involve a demonstration of the relevance of the testimony to the legal matter of the trial and, secondly, its reliability.

As to relevance, it simply must be demonstrated that the expert's testimony supports facts of consequence to the trial's outcome. The reliability criteria, however, invoke questions that more directly challenge the quality of the science underlying the testimony. Specifically, with regard to the methodology used to arrive at the expert opinion: 1) Has it been tested? 2) Has it been subjected to peer review or publication? 3) Are the error rates known or quantifiable? 4) Are there standards controlling its use? 5) Is the underlying theory of the methodology generally accepted in the relevant scientific community?

If the opposing counsel can demonstrate shortcomings in one or more of these criteria, a Daubert challenge may be made, and, if successful, the testimony may be ruled inadmissible by the judge.

What's the Question?

At this point, one might ask how it would be possible for opposing technical experts, faithfully abiding by all of these rules and standards, to legitimately have opposing opinions on a particular technical matter. This happens commonly in technical forums, and therefore it can happen in the courtroom. However, in litigation support, the conflicts may or may not be real, depending on how they are orchestrated by the attorneys. Remember, the answers you get depend largely on the questions that you ask. Experts who are retained by attorneys are not given free reign over their investigations. Generally, they are asked specific questions and the scope of their investigation is therefore limited. The concept of the "whole truth" may be jeopardized by this strategy and hence the aforementioned qualifications become important in terms of the witness' integrity and credibility.

For example, an opinion about the extent of a contaminant plume in groundwater may or may not be answered on the basis of a complete data set. A decision to drill a new well or wells to fill in a data gap is generally made by counsel, based on expectations of the outcome.

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utility of perchlorate isotope data together with other forensic techniques to distinguish sources. Nevertheless, deliberations continue; it remains to be seen whether regulators will find the isotope data persuasive.

Several factors can complicate the interpretation of perchlorate isotope data. Perchlorate is biodegradable by naturally occurring soil microbes under anoxic conditions where a carbon substrate is present. When biodegradation of perchlorate occurs, the remaining perchlorate may become enriched in the heavier isotope of oxygen through fractionation. It is therefore important to distinguish fractionation from other processes that may affect bulk isotopic signatures, such as mixing of waters bearing two or more different sources of perchlorate (Sturchio and others, 2007).

To confirm that isotopic fractionation from biodegradation is not affecting the isotopic signature, analysis for presence and activity of perchlorate respiring bacteria is recommended (Coates). Through such analyses, the JPL study confirmed that biodegradation did not affect perchlorate isotope signatures.

An Ongoing Study

Another perchlorate isotope study is underway in southern Santa Clara County. The Santa Clara Valley Water District is conducting a large-scale study of background levels and sources of perchlorate affecting the Llagas groundwater subbasin, where perchlorate from a former highway safety flare production facility was released to groundwater, affecting hundreds of wells. It remains to be seen whether possible additional sources in the Llagas study provide sufficiently distinct isotopic signatures to allow reliable interpretations of different origins of perchlorate at different locations, or whether only a single source is present.

Perchlorate isotopes provide a strong line of evidence, but must be interpreted within the basic hydrogeologic framework of the problem. The perchlorate isotope method is an effective tool that can add clarity where the right conditions and circumstances permit unambiguous interpretation. That interpretation is strengthened where multiple conventional indicators also point toward the same conclusion.

Thomas Mohr is a hydrogeologist with the Santa Clara Valley Water District and President of the Groundwater Resources Association of California. The views presented are the author's alone and do not reflect policy or positions of the Santa Clara Valley Water District or the Groundwater Resources Association of California. Contact him at tmohr@valleywater.org.

References

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The Move Toward Standards?

Some professional organizations have begun to consider whether rules and standards should be set for their members' involvement in litigation. For example, the State of Arizona's Board of Technical Registration recently promulgated a rule prohibiting registered professionals from providing expert witness services if compensation is based all or in part on a contingency fee related to the outcome of the dispute. And recently, the American Society of Testing and Materials convened a subcommittee within its Environmental Assessment, Risk Management and Corrective Action Committee. The subcommittee, now ASTM E50-05, is exploring the need to develop standards in the field of environmental forensics, including qualifications for experts, and anticipates producing a document, *Standard Guide for Environmental Forensic Expertise*.

Whether or not there is a need to regulate or standardize the conduct of scientists in the courtroom could be a matter of continuing debate. Indeed, if all were to practice within the bounds of good science and ethics, it would not be so much a matter of discussion. In any case, it is good advice for any technical professional to: understand something about how the legal process works; keep good records on project work; always conduct work in a systematic manner using good scientific principles; be consistently professional, prudent, and patient; and above all maintain strict ethical standards. If called upon to present your technical opinions, remember the advice of the 19th century journalist, Charles Anderson Dana, who said, "Fight for your opinions, but do not believe they contain the whole truth or the only truth."

References

Arizona Revised Statutes §32-101 et seq., specifically Article 3, R4-30-301, Rules of Professional Conduct, no.21.

American Society of Testing and Materials (ASTM) WK13999, www.astm.org.

International Society of Environmental Forensics website, www.environmentalforensics.org/journal.htm