DRAGUN CORPORATION'S

ENVIRONMENTAL MINUTE

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Mike is a hydrogeologist with a passion for getting things right the first time. He also isn't afraid to buck conventional thought, when necessary. Mike brings these two characteristics to every environmental project he touches. Mike has a deep and broad background in hydrogeology, formed from a demanding geological engineering undergraduate degree, followed by a Ph.D. from the world-class hydrogeology program at the University of Waterloo. Mike's 15-year academic career prior to consulting served to further broaden his knowledge and hone his communication skills.

Dragun Corporation
Environmental Advisors

Conceptual Site Models (Part 2 of 8)

How do we decide whether, how, and where to remediate?

Environmental remediation problems often occur because remediation design is not based on what is actually in the subsurface ... ***the design is based on what is believed to be in the subsurface***. And, if what is believed to be in the subsurface is wrong, effective solutions will constantly remain out of reach.

As discussed in our first Environmental Minute, remediation often goes awry because the site characterization is poorly designed and implemented. Often, too little is known about the site, or more often, what is known about the site is not well integrated (i.e., the site is poorly characterized).

So, how do you improve your understanding of your site conditions? You develop a **Conceptual Site Model** (CSM) to paint a clearer ***picture of what is believed to be in the subsurface***. It is like a paint-by-number game, but the numbers that generate the picture come from data and information gathered from and about the site. Decisions regarding remediation, risk, etc. are not made based on the actual subsurface conditions; decisions are made based on the CSM. That is, they are based on the integration of that limited information into a "representative" picture and belief of what is in the subsurface.

Building a CSM is, or at least should be, a rigorous process that involves critically integrating site data from technical and legal perspectives. Building this CSM has a number of steps that can be broken down into (1) the Preliminary CSM, (2) the Revised CSM, and (3) the Robust CSM. The development of the CSM through this process will determine just how well you understand the site and will enhance your potential to design a remediation that will be successful.

The CSM should integrate everything we know about the site, including the following:

- Release source, material, timing (sudden vs. long-term release, etc.).
- Physical and chemical properties of the release (liquid, solid, density, solubility, etc.).
- Contaminant concentration distributions ("hot spots," single plume, etc.).
- Hydrogeologic information and history (groundwater depth, flow direction, flow rate, etc.).
- Distribution of chemicals.
- Risks/exposure pathways/receptors (current, future)

However, site information is frequently missing or is not available; often, there is no, limited, or incorrect integration of the site information. Thus, the picture is not always "good enough" to accurately represent the conditions of the site.

As an example of making sure your CSM is "robust enough," look at the picture below. Some people see alternating chess pieces, while some see men talking.

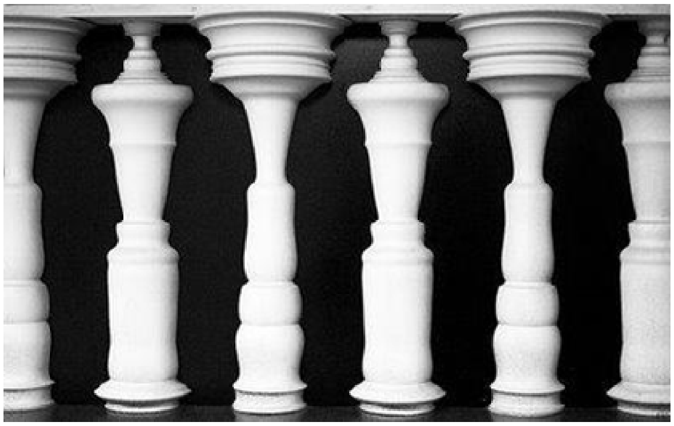


Image Credit: CC 2.0 Sha Sha Chu

And, if your CSM is not clear in the picture it portrays, you probably need more information to corroborate a *single*, more definitive picture.

The **Preliminary CSM** should consider the literature, a records review, an air-photo review, and interviews. These are all aspects of a Phase 1 Environmental Site Assessment (ESA).

Taking it a step further, a **Revised CSM** should integrate information from the Preliminary CSM with site-specific information on the following:

- geologic framework
- groundwater flow
- soil and groundwater chemistry
- contaminant transport processes

These are all aspects of a Phase 2 ESA.

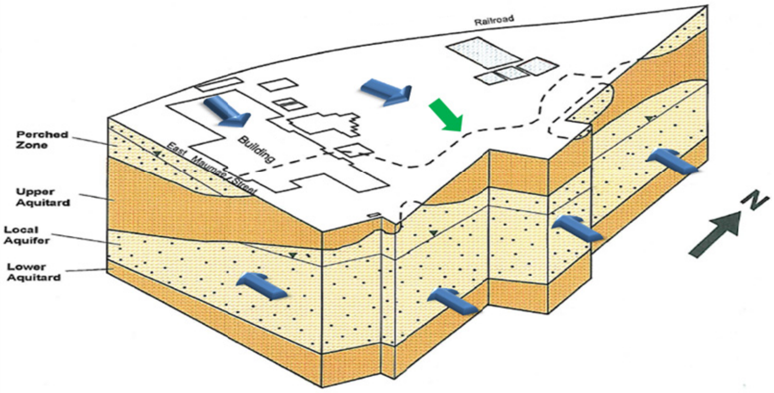
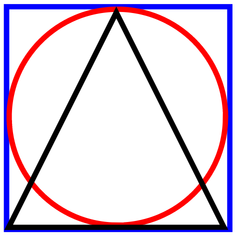


Figure 1: Basic Hydrogeologic Conceptual Site Model

A **Refined or Robust CSM** integrates the Revised CSM with other information that is complementary and independent. We use this approach in Court cases to make sure our site conceptual model is rock solid. We also use this approach in designing the most effective soil and groundwater remediation approach.

The additional information for developing a robust CSM includes data from more advanced investigation, such as geophysics, groundwater modeling, fingerprints, and isotopes.

- Independent data – answer the same questions, but answer it from a totally different angle by using different tools.
- Complementary data – constrain the answer, but do not answer the question directly.



For example, to understand groundwater velocity, scientists use Darcy's Law. Mathematically, Darcy's Law is expressed as v=K i/n

1. Darcy's Law uses site-specific data to calculate the groundwater velocity: hydraulic conductivity (K), hydraulic gradient (i), and porosity (n).
2. Once you have calculated the velocity using Darcy's Law, it is important to check it and compare it with independent data, which can include:
   - Evaluation of travel time using environmental isotope like tritium.
   - Evaluation of plume extent with a conservative chemical like chloride that would travel similarly to the groundwater.

You then need to ask yourself if these data are consistent with and support the calculated value?

3. Having a calculated velocity, use complementary data to constrain the answer, such as:
   - Are geologic conditions consistent with calculated velocity? In other words, is the calculated velocity what you would expect given a clay soil, for example?
   - You may want to run a simple groundwater model. Is the groundwater modeling realistic?
   - Are literature values consistent, or even conceivable, given the calculated value?

Each step of development of the Robust CSM improves your chances of selecting the best remedial option for the site and getting the remediation to the impacted material.

There are numerous guidance documents that discuss preparation of CSMs, including ASTM, Interstate Technology Regulatory Council (ITRC), U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), and many state regulatory agencies. Knowing the basic steps from the guidance documents only gets you the pieces to the CSM. It does not tell the story. Only when the pieces are integrated, prioritized, and corroborated does the CSM present a reasonably-accurate picture.

Developing a really good CSM is invaluable. In fact, in our experience, Robust CSMs sometimes can be used to show that remediation is not even required and to support scientifically-based monitoring schedules, both of which can save substantial amounts of money.

Our next Environmental Minute in this eight-part series will be titled "Before you 'dig' in, dig into the files." If you have any questions about this series of Environmental Minutes, or if you have an immediate question or concern, please contact Dr. Michael Sklash (msklash@dragun.com) at 248-932-0228, ext 120.

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