Environment Canada | Ontario Region | Environmental Protection Branch

# TABS ON CONTAMINATED SITES

Contaminated Sites Program - Federal Sites

This is one in a series of Technical Assistance Bulletins (TABs) prepared by
Environment Canada - Ontario Region for Federal Facilities operating in Ontario

# TAB # 28

## Expedited Site Characterization : Criteria For Selecting Tools And Technologies

**DESCRIPTION:**
This TAB reviews the criteria for selecting the tools and technologies for the Expedited Site Characterization (ESC) methodology. The criteria place emphasis on the tools and technologies that meet regulatory requirements, are goal-oriented, technically innovative, and corroborative of each other. Together with other key elements of ESC, such as, a dynamic work plan, an experienced multidisciplinary team, daily data analysis/integration in the field, and daily refinement of the conceptual model, tool and technology selection is improved.

**INTRODUCTION**

The ESC strategy for applying characterization tools and technologies is to begin with the easy measurements (samples from existing wells) and wide area measurements (aerial photography) and later proceed to the more difficult and expensive ones (processes associated with deep penetration of the sub-surface). There is an emphasis on selecting tools that corroborate each other, especially if one of the tools is developmental or relies on innovative technology.

For characterizing the geological and hydrogeological properties of the site, there is a need to first understand the regional geologic setting and environment of the site, followed by focusing on smaller scale details. For example, is the site in an alluvial geological environment, a coastal plain, a glacial area, etc.? Regional geologic studies and reports can be most useful. In addition, the study of air photos by experienced personnel can reveal the regional setting, and possibly indicate the presence of larger scale local features (e.g. buried channels, karst features, faults) that would be less apparent from direct observation at the site.

Geophysical surveying methods would be applied next, combined with groundwater samples from existing monitoring wells, samples from surface soils and waste samples. Geophysical methods inexpensively provide up to 100% aerial site coverage, and are extremely effective in detecting anomalies, and mapping the continuity of strata, such as aquitards, on a site wide scale. A limitation of these methods, however, is that measurement results may have multiple interpretations. Thus, geophysical measurements must be calibrated and corroborated to determine the correct subsurface structure that may be giving rise to the measured signals. The direct push technologies (DPT) are generally more productive and less intrusive than drilling technologies. DPT methods can provide depth discrete soil, groundwater and soil gas samples, as well as continuous soil samples for both geological characterization and chemical analysis. In addition, on-board sensors may be deployed by the DPT systems for both stratigraphic logging and chemical detection. Once the geology and hydrogeology of the contaminant migration pathways have been sufficiently defined, the updated site geological and hydrogeological model can be used to forecast the locations of the contaminant plumes. Field analytical methods, such as the use of a mobile lab, permits continuous updating of the spatial distribution and concentration of the contaminants, in the conceptual site model. This information can be used effectively, to delineate the extent of contamination in one mobilization. All the while, the data and information are integrated into the conceptual site model using data management and visualization tools.

The ESC process is not technology specific. It is designed to optimize selection and use of the most appropriate technologies for a particular site. It stresses non- and minimally invasive methods and multiple methods for characterizing the hydrologic and geologic site properties that determine the relevant migration pathways. Agreement between different methods used to obtain information about the same subsurface regions increases the likelihood that the measurements' interpretation is correct. When interpretation of measurement results disagree, additional investigation is required to resolve the differences. Examples of methods that complement each other include: (1) use of multiple geophysical surveys (such as, ground penetrating radar, electromagnetic induction and magnetic surveys) to detect areas of buried waste; (2) collection of continuous soil cores adjacent to an Electronic Cone Penetration Technology (ECPT) boring to correlate ECPT measurements with directly observed stratigraphy; (3) use of multiple borehole geophysical measurements (resistivity, induction, gamma probing) in a single borehole; (4) comparing chemical and isotope concentrations in groundwater at many locations to differentiate aquifers; and, (5) analysis of the same soil or ground water sample using different analytical methods.

It is not always necessary to use multiple methods at all sampling points. In some situations, when the investigating team is satisfied that a good correlation is established between one type of measurement (e.g. ECPT) and other observations (e.g. sampling and analysis of the subsurface material; borehole geophysical measurements), it may be justified to stop collecting the redundant observation(s), inferring that, sufficient confidence in the measurement technique (ECPT) has been established. If, on the other hand, the measurements never seem to correlate after many sampling points, it will normally be decided to abandon the technology.

Complementary methods are essential when one of the methods relies on an innovative technology. The core technical team should be prepared for the skepticism of client and regulators. Innovative technology-based measurements must be fully cross-referenced with accepted methods.

## SUMMARY:

The criteria for selecting the five categories of tools and technologies used for ESC include:

**1. <u>Aerial Images</u>**

- Generally, good up-to-date, and cost effective sensing techniques, that can transmit photographs and/or other output of aerial images, within the time limit set, for refinement of the conceptual model.

**2. <u>Non-intrusive tools</u>**

- Because multiple interpretation of measurements is required, it is necessary to be

able to calibrate and corroborate these tools against other types of measurements.
- Another criteria is, that experienced professionals who can handle these tools, should be engaged.

**3. Subsurface Access Technologies**

The tools and technologies for subsurface access operations should:
- generate small volumes of secondary waste;
- be minimally disruptive to the subsurface, and;
- should require less funding than if new wells were drilled.

**4. Chemical Analytical Methods**
- The tools and technologies selected, whether an off-site fixed base laboratory or an on-site mobile laboratory would be used, should meet regulatory requirements.
- Equipment and personnel for specific chemical contaminants must be engaged.
- The methods must be within budget limit.
- Analysis must be adequate and fast, to enable data to be integrated into the conceptual model for refinement, if this is needed.

**5. Data Management and Visualization**

The tools and technologies for data management and visualization should:
- Be able to accommodate spatial data management.
- Be a simple, flexible database system.
- Be efficient in the integration of new data into the database.
- Assure the quality of data and make this data accessible to all team members.
- Be able to produce the final site conceptual model with associated map, cross sections and visualization.

These criteria, together with other key elements of ESC, such as, a dynamic work plan, and an experienced multidisciplinary team, make the following objectives achievable:
- Addressing data needs to minimize the uncertainty in the Conceptual Site Model.
- Determining the tools that are appropriate for the specific site and contaminants.
- Defining the geological/hydrogeological properties of the site after understanding the regional geologic setting and environment of the site.
- Preferentially using non- and minimally invasive techniques that return data rapidly.
- Utilizing multiple complementary methods to minimize uncertainty.

## GLOSSARY

**Aquitard:**

Geologic formation(s) of low hydraulic conductivity, typically saturated, that yield a limited amount of water to wells.

**Direct Push Technologies (DPT):**

Any method by which the subsurface (soil) is penetrated without the removal of material. The soil is pushed aside. Typically consists of small diameter (approximately 20 to 50 mm) steel rods or casings with a conical tip. They are either impacted, vibrated or pushed at a constant rate.

**Electronic Cone Penetration Technologies (ECPT):**

One type of DPT where the conical tip and (perhaps) the lower sleeve of the penetrating rod is equipped with an electronic load cell, a pore water pressure transducer and possibly an array of sensors capable of detecting selected chemicals.

**Stratigraphy:**

Relates to the vertical distribution of the subsurface materials. Generally limited to the nature of the soil or rock, not the pore fluids.

**Stratigraphic Logging:**
In the context of this document, stratigraphic logging is the systematic recording of measurements generally along a vertical profile that helps to define the distribution, lithologic composition, fossil content, geophysical and geochemical properties of rock strata. Typical ECPT measurements that are tailored for stratigraphic use, are those associated with pore water pressure and resistance to penetration.

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