

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 #6



Alternative Field Screening Methods

DESCRIPTION:

Field screening methods are utilized early in the site assessment process during site investigations to define and delineate the contaminants present, and the general extent and location of the contamination.

This TAB is a compilation of innovative technologies that are available for use as field screening methods. These methods utilize instruments which can either be carried with relative ease (portable), and can be set up and used in the back of a van or field trailer (a mobile field laboratory), or are instruments that require a stable environment, but can be relocated from site to site (transportable). These techniques are intended to supplement existing methods, and to provide options based on the specific needs of the sampling/analytical activity.

These field screening methods are suitable for identifying contamination "hot spots", determining the necessity of emergency response, defining general site conditions, and assisting in boreholes and monitoring well locations.

Note: $\mu\text{g/L} = \text{ppb}$; $\text{mg/kg} = \text{ppm}$

METALS ANALYSIS

(A) Using Field Atomic Absorption

Summary:

Atomic Absorption (AA) is used to analyze for metals in water and soil samples. A low mass tungsten furnace is used in a field laboratory to provide analytical results in about 1.5 to 2 minutes.

Applications:

Mobile field analysis for trace metals in water and soil matrices.

Analysis Time:

2 minutes per sample after sample preparation.

Detection Limits:

0.1 mg/kg for most metals.

Comments:

Easily set up for field work in mobile or stationary field laboratory. The furnace requires a 110/220 volt electrical connection. In remote areas, a portable generator can be used for power.

(B) Using X-ray Fluorescence (XRF)

Summary:

X-ray Fluorescence (XRF) is good for on-site screening of some metals in soil. This method has been used to screen soil and sediment samples for concentrations of lead, zinc, copper, arsenic, iron, and chromium.

Applications:

Rapid on-site screening for lead, zinc, copper, arsenic, iron, and chromium in a soil matrix, similar to continuous monitoring.

Concentration Range:

From 25 mg/kg for arsenic to 140 mg/kg for iron, but is dependent on site-specific matrix and calibration techniques.

Comments:

XRF is non-destructive, enabling storage of samples for future reference after analysis. The data reporting format is either direct LCD read-out or paper printout.

VOLATILE ORGANIC COMPOUND ANALYSIS

Note: "Headspace" is the area between the sample and the top of the container.

(A) Using Headspace Technique with a Gas Chromatography/Mass Spectrometer (GC/MS) system

Summary:

A mobile field laboratory is used to analyze head space above soil, sediment, and water for identification and quantitation of most volatile organic compounds (VOCs) using a gas chromatography/mass spectrometer (GC/MS) system.

Applications:

This technique is good for identifying and quantifying most VOCs (e.g. unsaturated hydrocarbons, halogenated hydrocarbons, aromatics, etc.) in soil, sediment, and water at the 1 µg/L concentrations levels. Results for soil are semi-quantitative.

Analysis Time:

10 to 20 minutes per sample.

Detection Limits:

1 µg/L for most VOCs.

Comments:

Excellent identification capabilities. The interpretation of results requires a trained chemist.

(B) Using Headspace Technique with a Gas Chromatograph/Photoionization/Flame Ionization/ or an Electron Capture Detector

Summary:

A portable gas chromatograph (GC) is used with either a photoionization detector (PID), a flame ionization detector (FID), an electron capture detector (ECD), or all 3 in combination to analyze the head space above soil, water, and air samples for identification and quantitation of most VOCs at the 0.5 µg/L level.

Applications:

Good for identification and quantitation of most VOCs in head space above soil, sediment, and water to low concentrations. Can detect halogenated methanes and ethanes, chlorinated hydrocarbons, aromatics, arsine, phosphine, hydrogen sulphide, and carbon disulphide among others.

Analysis Time:

10 to 20 minutes per sample.

Detection Limit:

1 µg/L for aromatics, 40 µg/L for some chlorinated hydrocarbons.

Comments:

The interpretation of results requires a trained chemist. Soil results and identifications are semi-quantitative and considered tentative. GC/ECD is used for detecting halogenated compounds such as carbon tetrachloride, while GC/FID or GC/PID detects alkanes/alkenes, aromatics, ketones, etc.

TOTAL VOLATILE ORGANIC ANALYSIS USING HEAD SPACE TECHNIQUE WITH AN ORGANIC VAPOUR ANALYZER/ PHOTOIONIZATION DETECTOR

Summary:

A portable organic vapour analyzer (OVA) with a photoionization detector (PID) that gives rapid analysis of total organic vapour concentrations in the headspace above soil, sediment, and water to a 100 µg/L benzene equivalent.

Applications:

Used to measure total organic vapour concentration in headspace above soil, sediment, and water. The OVA may be used to detect unsaturated hydrocarbons, chlorinated hydrocarbons, aromatics, nitrogen and sulphur compounds, aldehydes, ketones, alcohols, acids, and others, but is unable to identify any individual compound.

The detection ability of the OVA varies with the probe that is used:

Probe	Detection Ability
9.5 ev	• Aromatics and large molecules.
10.2 ev	• Aromatics, large molecules, vinyl chloride, methylethyl ketone, trichloroethene, and other 2-4 carbon compounds.
11.7 ev	• Aromatics, large molecules, vinyl chloride, methyl ethyl ketone, trichloroethene, other 2-4 carbon compounds, chlorine, halocarbons, methanol, and other single carbon compounds.

Analysis Time:

Allow headspace to develop for at least 10 minutes. OVA gives results in less than 5 seconds.

Detection Limit:

100 µg/L for most volatile organics.

Comments:

It is easy to train personnel to use the OVA. Total response is reported as a benzene equivalent. The system is unable to identify any particular individual compounds. It is insensitive to methane. Refer to TAB #1 For OVA screening procedures.

SOIL GAS SAMPLING

(A) Using a One Litre Syringe

Summary:

A portable gas chromatograph (GC) is used for rapid sampling of volatile organic compounds (VOCs) in soil gas, for on-site analysis, to determine contaminant plumes. A borehole is drilled with a hollow-stem auger. A length of Teflon® tubing, with a one litre gas-tight syringe attached, is lowered into the borehole. A one litre sample is drawn into the syringe and prepared for GC analysis.

Applications:

Used to sample soil for volatile organics.

Analysis Time:

15 to 30 minutes to drill borehole; 1 minute for sample collection; 30 minutes for GC analysis.

Detection Limit:

0.2 to 0.02 µg/L.

Comments:

Simple sample collection. Allows for adjustment of sampling area for further investigation based on immediate results. No repeated sampling is conducted once the auger is removed.

(B) Using Direct Injection

Summary:

A portable gas chromatograph (GC) is used to sample for volatile organic compounds (VOCs) in soil gas to determine ground water contaminant plume. A 12 to 17 foot borehole is drilled using a hollow-stem auger, into which a sample probe is inserted. The borehole walls are allowed to collapse as the auger is withdrawn. The ground-level perimeter of the borehole is sealed with a bentonite-slurry plug, and the probe is sealed with a stopper and screw cap. Samples are collected by a syringe after a 2 day equilibrium period.

Applications:

Used in soil to define and delineate extent of ground-water contaminated by VOCs. It is also used for long-term sampling of true soil gas concentrations.

Analysis Time:

15 to 30 minutes to drill boreholes; 2 days for sample probe equilibration; 1 minute to collect sample; 30 minutes for GC analysis.

Detection Limit:

0.2 µg/L.

Comments:

Long-term changes in soil gas concentration will not be evident without mixing of probe contents.

GLOSSARY OF TECHNOLOGIES

Gas Chromatography (GC):

The purpose of gas chromatography is to separate, identify, and quantify organic compounds. GC is well suited for the analysis of volatile and semi-volatile organic compounds. A GC consists of the following:

- **A mechanism to introduce the sample into the GC.** Either a direct injection or purge and trap method is used for sample introduction. The purge and trap method usually provides lower detection limits than direct injection.

- A **GC column**, separates the sample into its various volatile components. Compounds passing through a column travel at different speeds, resulting in a separation of the samples volatile components which enable future quantitation of compounds. Depending on the separability of the substances being sampled, a column may range from a few metres to 100 metres long.
- A **detector**, provides positive identification of compounds. The detector may be a mass spectrometer (MS), a flame ionization detector (FID), a photoionization detector (PID), or an electron capture detector (ECD) depending on the compounds being analyzed.
- A **means of quantifying identified compounds**. Quantification may be with a simple strip chart recorder or by computerized means.

Mass Spectrometer (MS):

The GC detector can identify and quantify unknown organic compounds. MS, in combination with a GC, is a widely used analytical technique, and is generally more specific, but less sensitive than other detectors.

Flame Ionization Detector (FID):

This detector is useful for identifying and quantifying combustible substances, such as aliphatic hydrocarbons, ketones, and alcohols. FID can detect the broadest range of compounds with the greatest response.

Photoionization Detector (PID):

A PID detects aromatics as well as some conjugated bond compounds. Since this method is nondestructive, it is often used in conjunction with another detector to confirm analytical results.

Electron Capture Detector (ECD):

An ECD can detect compounds containing halogens.

X-Ray Fluorescence (XRF):

XRF is used to identify metals. A flux of high energy x-rays bombard a sample causing the elements in the sample to emit characteristic wavelengths. The instrument separates the wavelengths of elements into a spectrum, enabling identification and quantification of specific elements.

Atomic Absorption (AA):

AA is used to identify metals. A sample is introduced into a graphite furnace and slowly

evaporated, charred, and atomized. An atomic absorption spectrometer absorbs radiation during the atomization process. The amount of radiation absorbed allows identification of a specific element within the sample.

Sources

Cheremisinoff, Paul & Bruce Manganiello (1987). *Environmental Field Sampling Manual*.

Sutton, Gale (1991). *A non-chemist's Guide to Methods of Analysis for Volatile Organic Compounds*.

United States Environmental Protection Agency (1988). *Field Screening Methods Catalogue - Users Guide*.

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