

## **Real-time Site Characterization with the Membrane Interface Probe (MIP)** **Casey Hudson, P.E., CH2M HILL Constructors, Inc., Orlando, Florida**

### Introduction

A major challenge associated with cleanup of sites contaminated with chlorinated solvents is identifying the location or source areas of dense non-aqueous phase liquids (DNAPLs). Conventional groundwater sampling technologies rely on collection of groundwater samples either from a well screen typically at least several feet long or, more recently, from discrete-depth sampling probes such as the Waterloo Profiler®. Groundwater samples collected from monitoring wells may not reveal the highly elevated solvent concentrations that often suggest the possible presence of a DNAPL. The use of discrete-depth probes, while more useful in revealing high concentration groundwater zones than conventional monitoring wells, does not provide real time data, which can be highly beneficial to site investigators. Also, neither of these methods is useful in evaluating the presence of DNAPL in the vadose zone.

### Description of the Membrane Interface Probe

The Membrane Interface Probe (MIP), developed by Geoprobe Systems, Inc., provides real-time detection of volatile organic chemicals (VOCs) or NAPL in the vadose and saturated zones. The MIP fits onto conventional direct push technology (DPT) equipment and is inserted into the target investigation zone in a manner similar to a standard DPT sampling device. The tool tip has a membrane that is permeable to VOCs and a built-in heating element that causes VOCs near the MIP to volatilize from soil or groundwater. The volatilized VOCs pass through the membrane, where a carrier gas transports the VOCs through sealed tubing to one or more truck-mounted detectors (e.g., a Flame Ionization Detector [FID], Electron Capture Detector [ECD], or Photoionization Detector [PID]). The detectors measure total VOCs in the carrier gas and provide this information in real-time as an instrument response. The detectors do not provide a quantitative concentration of VOCs in the groundwater or soil. However, the response level from the detector corresponds to the amount of VOCs present in the carrier gas, which is proportional to the amount of VOCs in the soil or groundwater at the MIP location. A greater response from the detector indicates greater VOC concentrations in the subsurface. Figure 1 presents a general schematic diagram of the MIP system.

The MIP also measures soil conductivity and reports this parameter along with the output from the VOC detectors. Data are plotted as a function of depth below ground surface. With these data, project scientists and engineers can identify changes in soil permeability as well as elevated levels of VOCs. The data collected in the field can be immediately downloaded into software that presents a two- or three-dimensional interpretation of soil conductivity and detector response as a function of depth. The results of the MIP investigation assist in determining the locations of high-concentration source areas of contaminated soil or groundwater.

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## Field Results for an MIP Pilot Test

CH2M HILL has used the MIP for identifying potential chlorinated solvent-DNAPL source areas at several sites. One use of this occurred at a site contaminated with trichloroethene (TCE) at the Charleston Naval Complex in North Charleston, South Carolina. The purpose of the test was to determine whether the MIP could be used to determine the target treatment area for DNAPL source area remediation using aggressive methods such as in-situ thermal or chemical oxidation methods.

The hydrogeology at the CNC site consists of unconsolidated sediments, primarily fine silty sands down to a depth of approximately 31 to 37 feet below land surface. A finer-grained clayey silt unit is located beneath this silty sand. Beneath the clayey silt lies the Ashley Formation, a dense marl, which forms an aquitard that separates the surficial aquifer from deeper units. At this site, the suspected location of the DNAPL source areas in the vertical profile was at the interface between the silty sand and clay units and at the top of the Ashley Formation. The MIP was being evaluated to assess the effectiveness of the technology in determining the horizontal and vertical extent of the DNAPL source area.

A plot of the ECD output and soil conductivity data as a function of depth below ground surface (bgs) from a typical MIP boring from this effort is presented in Figure 2. In this figure, the increase in soil conductivity at a depth of approximately 33 to 35 feet bgs is consistent with boring logs from that area that indicate the presence of the clayey silt layer at that depth. Increased response from the ECD suggests that VOC concentrations increase significantly at the location of this finer-grained unit, indicating that TCE has accumulated at the interface of the silty sand and clayey silt layers.

The data on the far right of the graphs in Figure 2 represent analytical results for TCE in groundwater samples collected using direct push sampling methods in a boring directly adjacent to the MIP boring. The groundwater samples were analyzed for VOCs by an on site gas chromatograph/ mass spectrometer (GC/MS) using EPA method 8260B. The GC/MS results suggest that the MIP results have effectively identified the presence of a high-concentration TCE source area that would be an appropriate target location for source area remediation.

## Conclusions

The MIP is an effective tool for site management professionals to use when seeking to identify, in real-time, high concentration VOC source areas, on a semi-quantitative basis. Relative to other methods, a large number of MIP borings can be quickly installed and the data quickly integrated to provide an overall understanding of VOC distribution. After implementing an MIP investigation, confirmatory sampling with more conventional methods may be used to confirm the MIP results. This approach can expedite and focus efforts of the conventional investigation, resulting in significant cost savings.

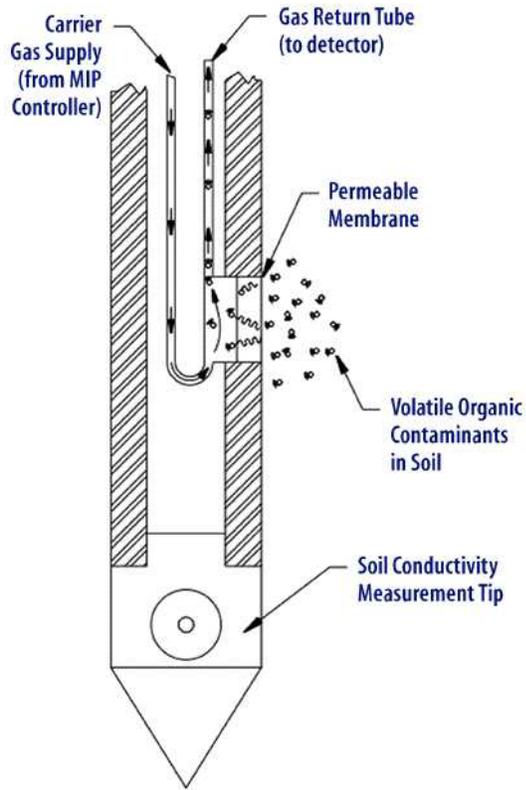


Figure 1 – Schematic Diagram of MIP Unit - Source: Geoprobe Systems, inc.

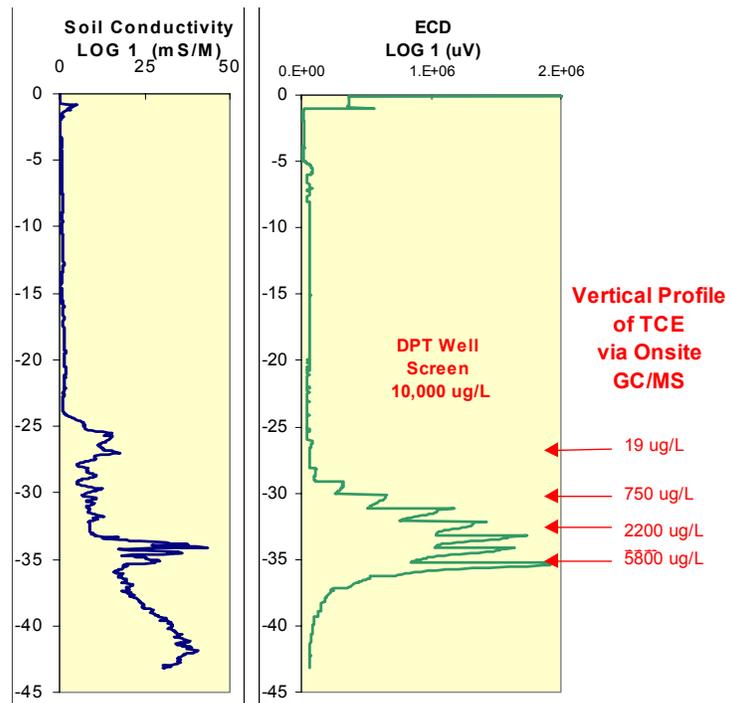


Figure 2 – Example Output from MIP Detector and Conductivity Log