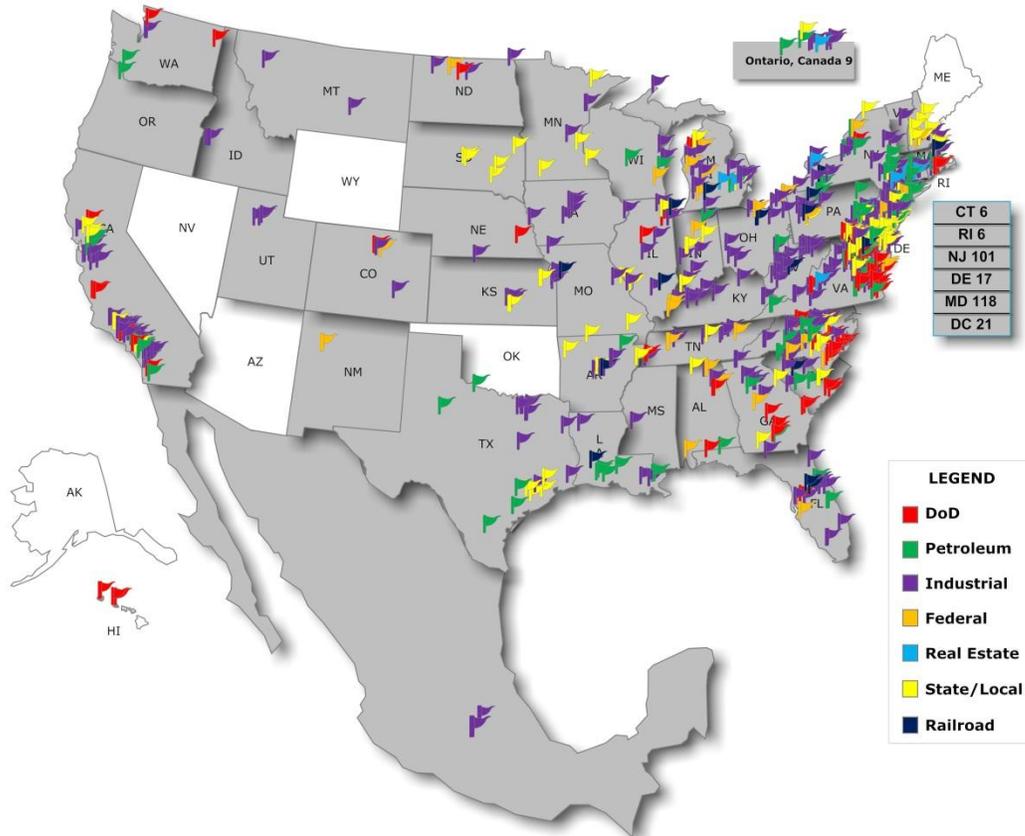


HIGH RESOLUTION SITE CHARACTERIZATION TOOL GUIDE

Introduction to High Resolution Site Characterization Using Direct Sensing Technologies

Since 1999, COLUMBIA’s global direct sensing team has successfully completed over 1,000 site characterization surveys on a diverse range of commercial, federal, and military sites throughout Mexico, Canada and 45 out of the 50 United States, including Hawaii. COLUMBIA is equipped to provide high resolution mapping of subsurface contamination using proven, real-time investigation techniques. Today’s direct sensing capabilities enable site managers to reduce the risk, uncertainty, and costs for contaminated sites while making better, more informed remediation-focused decisions.



1,000+ successfully completed site characterization surveys throughout Mexico, Canada and 45 out of the 50 United States, including Hawaii

Key benefits of a remediation-focused high resolution site characterization include:

- ✓ A greater range of high resolution information on subsurface conditions including hydro-stratigraphy and contaminant distribution to support environmental liability decisions
- ✓ Ability to deploy proven, rapid, innovative solutions to reliably and cost-effectively resolve contaminated sites on a comprehensive basis
- ✓ Reduction in remediation costs by an amount equal to 4-5x of the total investigation costs
- ✓ Collaboration among project managers, colleagues, and other stakeholders, wherever they are located, through a cloud-based browser platform

COLUMBIA's fleet includes several Dodge Sprinter vans and mobile systems equipped with all necessary tooling to conduct comprehensive high resolution site characterization assessments in the field.



COLUMBIA's Sprinter van at a rail yard site in the Northeast



Field staff discussing project objectives during an investigation

- ✓ On board generator for self-sustained electrical power
- ✓ Client "office" with workspace, computer, large flat-panel LCD screen and Internet access
- ✓ Dual rod racks to permit switching between multiple technologies to increase productivity
- ✓ Standard 150-foot Membrane Interface Probe with Electrical Conductivity (MIP/EC) trunklines (200-foot MIP/EC trunklines available), 150-foot Hydraulic Profiling Tool (HPT) trunklines (200-foot HPT trunklines available) foot and 120-foot Laser Induced Fluorescence-Ultra-Violet Optical Screening Tool (LIF/UVOST®) fiber cable to permit operation at a distance from the direct push rig location
- ✓ Modular approach can be deployed on various platforms, such as pickup trucks, all-terrain vehicles (ATVs), 4WD and utility vehicles as well as remote sites such as barges, reaching locations with our tools that otherwise would be difficult to access



Modular approach configured MIP system on a pickup truck at an industrial site in Mexico

Laser Induced Fluorescence-Ultra-Violet Optical Screening Tool (LIF-UVOST®)



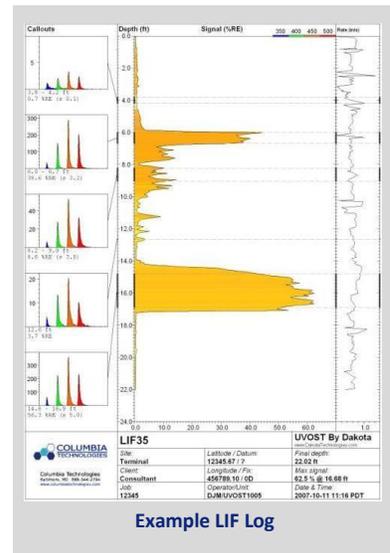
LIF-UVOST® system and field computer

The Laser Induced Fluorescence-Ultra-Violet Optical Screening Tool (LIF-UVOST®) system is used to delineate the depth and horizontal extent of free product and residual phase petroleum hydrocarbons contamination. On average, 200 feet of LIF logging can be completed per day.

The principle difference between UVOST® and previous systems is the use of an excimer laser rather than a solid state laser and the integration of the lasing and detecting systems into a compact, user-friendly package. Use of the excimer laser and the system integration provides greater reliability, better reproducibility, and

less room for operator error. The fiber optic-based fluorescence system is deployed with standard direct push technology (DPT) or cone penetrometer (CPT) equipment. All LIF systems use a laser to send pulses of monochromatic light down a fiber optic line to a probe where the light is emitted and excites any polycyclic aromatic hydrocarbon (PAH) containing compounds in the subsurface, causing them to fluoresce with a characteristic waveform signature. Using UV excitation we can detect gasoline, diesel and jet fuel; kerosene, motor oil and cutting fluids, hydraulic fluid, and crude oil.

The induced fluorescence from the PAHs is returned over a separate fiber optic line to the surface where waveforms are viewed using a detector system. The peak wavelength and intensity provide information about the type of petroleum or potential interferences. Applying LIF allows one to gain knowledge on different types of Light Non-Aqueous Phase Liquids (LNAPL) by separating fuel signatures.



LIF-UVOST® can be used on site with a **Hydraulic Profiling Tool (HPT)** probe to enable project decision makers to understand the details of soil permeability leading to LNAPL mobility and migration. Deploying both LIF-UVOST® and HPT during the same investigation would provide multiple lines of

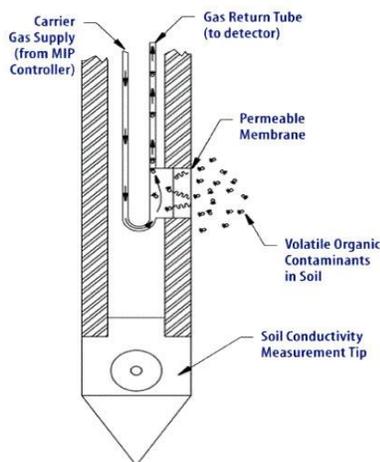


Geoprobe rig and operator at a petroleum refinery in the Gulf Coast

evidence with only one mobilization. LIF-UVOST® and HPT technologies are deployed on two separate tooling strings. Combining HPT information with LIF-UVOST® information enables project decision makers to select sampling locations while the field work is underway eliminating the costly delays associated with traditional investigation tools and approaches. The permeability information is also critical to selecting remedial alternatives and properly placing injection, extraction, and monitoring well screen intervals. Additional information on HPT can be found on pages 5 and 6 of this Tool Guide.

Membrane Interface Probe with Electrical Conductivity (MIP/EC)

The Membrane Interface Probe with Electrical Conductivity (MIP/EC) is used for field screening to rapidly map dissolved phase petroleum and chlorinated solvent contamination. The MIP/EC will quickly delineate both the horizontal and vertical extent of dissolved phase contamination and identify areas of highest concentration. The MIP/EC can be used in saturated or unsaturated zones. On average, 150 feet of MIP logging can be completed per day.

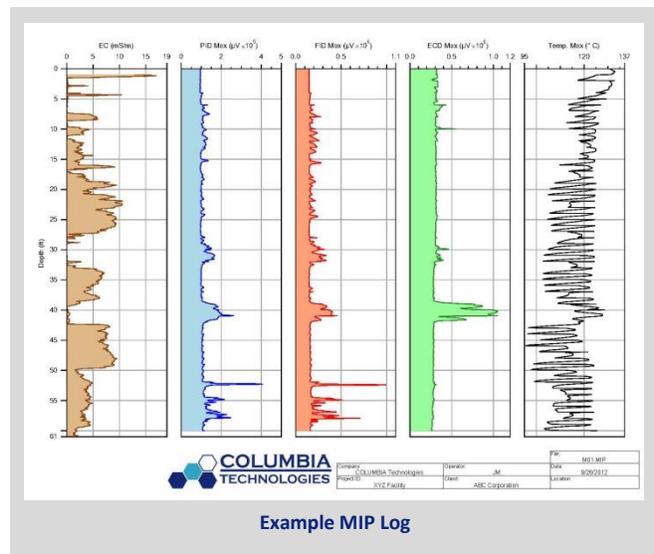


MIP probe diagram

MIP is a continuous volatile organic compound (VOC) sampling system that heats the soil, water, and vapor matrix as it is driven into the subsurface. The VOC mass that is extracted across a permeable membrane is carried to the surface by an inert purge gas via small diameter inert tubing. At the surface, the VOC mass is passed across a chemical detector suite to provide a correlation between contaminant detection and the depth of the probe at the point of detection.

COLUMBIA's standard MIP sensor detection system utilizes three laboratory grade detectors in its sensor detection system: a Photo Ionization Detector (PID), a Flame Ionization Detector (FID) and an Electron Capture Detector (ECD). COLUMBIA can configure the MIP system with a Halogen Specific Detector (XSD) depending on the project objectives, contaminants of concern, and contaminant concentration levels.

Just like in the laboratory each detector has a different sensitivity and linear range for various chemical compounds. In general, the PID and FID provide excellent response to VOCs such as benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds typically found in petroleum product, such as gasoline and diesel fuel. The ECD detector is highly sensitive to chlorinated or halogenated compounds, and is much more sensitive than the XSD for certain compounds such as tetrachloroethylene/trichloroethylene (PCE/TCE). However, the ECD also has a limited linear range and can saturate at lower concentrations (for PCE/TCE). The XSD detector will see a larger range of halogenated compounds and is a better responder for degradation products than the ECD. Many common chlorinated compounds will also respond on the PID depending on the compound ionization potential.



Example MIP Log

Use of multiple detectors is important for separating different zones of contamination such as petroleum (retail gas station) from chlorinated (dry cleaner). The complementary range of performance of the different detectors enables the system to function from low contaminant levels to near NAPL levels.

The MIP probe has an integrated Electrical Conductivity (EC) array to provide indication of general soil particle size which can help determine zones of sands, silts, and clays. Using the EC logs you can define zones of lower conductivity which allows the movement of contaminants into the subsurface.



COLUMBIA's direct sensing vehicle with Geoprobe rig at a site redeveloped for residential use in the Northeast

The MIP can be used on site with a **Hydraulic Profiling Tool (HPT)** probe which enables project decision makers to understand the details of soil permeability leading to contaminant mobility and migration. Deploying both MIP and HPT during the same investigation would provide multiple lines of evidence with only one mobilization. MIP and HPT technologies are deployed on two separate tooling strings, unless a combined **Membrane Interface Probe-Hydraulic Profiling Tool (MiHpt)** is pushed. Combining HPT information with MIP information enables project decision makers to more cost effectively select sampling locations early eliminating the costly delays associated with the traditional investigation tools and approaches. The permeability information is also

critical to selecting remedial alternatives and properly placing injection and extraction intervals. Additional information on HPT can be found on pages 5 and 6 and MiHpt is described in further detail on page 6 and 7 of this Tool Guide.

COLUMBIA offers a cold weather MIP system with a heated trunkline option for MIP investigations ideal for colder climates. The heated trunkline prevents water vapor in the trunkline so that you won't have freezing or blockages from frozen water in the trunkline. In addition to application for colder climates, the heated trunkline option is recommended for higher contaminated zones, as it allows for higher contaminant levels to efficiently move through the trunkline preventing contaminant carry-over. The heated trunkline option provides quicker cleanup times resulting in less downtime and better contaminant bottom definition, quicker contaminant response and cleanup.



COLUMBIA's direct sensing vehicle during a cold weather MIP investigation at a site in the Midwest

Hydraulic Profiling Tool with Electrical Conductivity (HPT/EC)

The Hydraulic Profiling Tool with Electrical Conductivity (HPT/EC) uses direct pressure response measurements of hydraulic permeability to determine migration pathways, remediation injection regions, and placements for monitoring wells. On average, 150 feet of HPT logging can be completed per day. The pressure response of the soil to injection of water is measured to indicate the hydraulic permeability. Real-time continuous data can be produced in both fine and coarse grained material with saturated or unsaturated conditions.



HPT probe and controller

The system consists of two sensors:

- A sensitive downhole transducer to record dynamic pore pressure
- An electrical conductivity sensor providing information on lithology



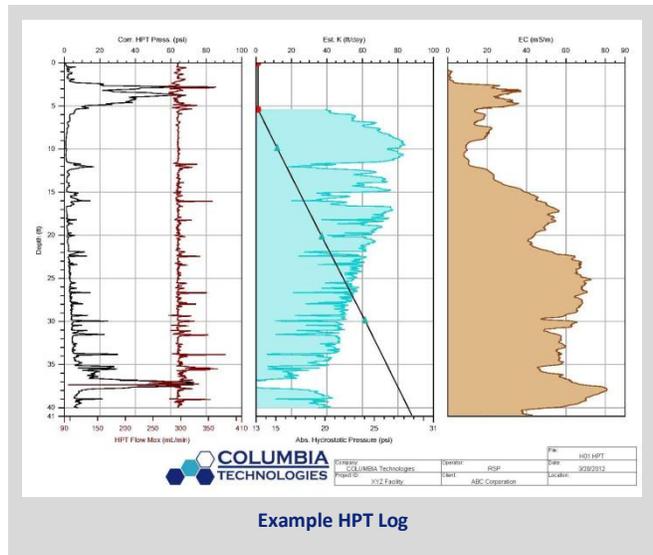
COLUMBIA, regulators, and client discussing site goals

While most soil profiling methods *infer* permeability from parameters like grain size or geotechnical properties, the HPT system can measure continuous data on hydraulic permeability directly by injecting water into the formation. Additionally, HPT can conduct static dissipation tests at individual depths. This data is used to determine static water level (or head pressure in confined aquifers) and hydraulic conductivity.

The HPT probe can be used on site with a LIF or MIP probe which enables project decision makers to understand the details of soil permeability leading to contaminant mobility and migration. Deploying HPT with LIF or MIP during the same investigation would provide multiple lines of evidence with only one mobilization. Combining HPT information with LIF or MIP information enables project decision makers to more cost effectively select sampling locations early eliminating the costly delays associated with the traditional investigation tools and approaches. The permeability information is also critical to selecting remedial alternatives and properly placing injection and extraction intervals.

The HPT probe has an integrated EC array to provide indication of general soil particle size which can help determine zones of sands, silts, and clays. Using the EC logs you can define zones of lower conductivity which allows the movement of contaminants into the subsurface.

The HPT probe can be used on site with a LIF or MIP probe which enables project decision makers to



Example HPT Log

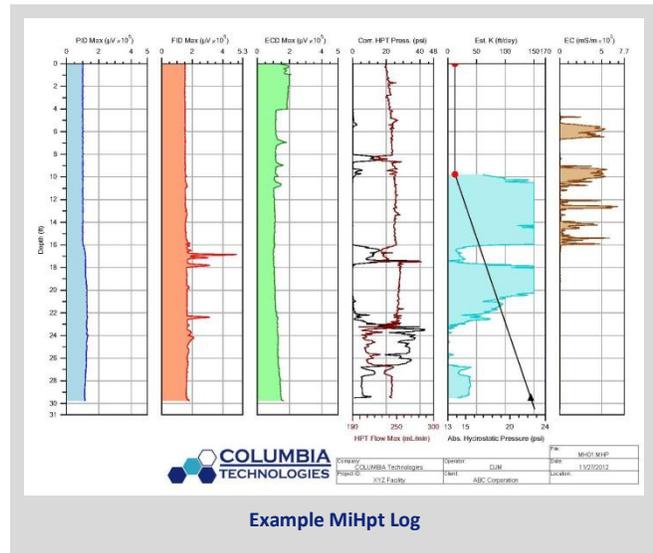
Membrane Interface Probe-Hydraulic Profiling Tool (MiHpt)

The Membrane Interface Probe-Hydraulic Profiling Tool (MiHpt) is a combined MIP-HPT probe for mapping soil and groundwater contamination, specifically VOCs such as halogenated solvents and petroleum compounds in addition to delivering hydraulic permeability data to determine migration pathways, remediation injection regions, and placements for monitoring wells. On average, 150 feet of MiHpt logging can be completed per day.



MiHpt probe

The data provided from a MiHpt probe enables project decision makers to understand the details of soil permeability leading to contaminant mobility and migration. Combined MIP-HPT information is collected in one push, providing both MIP data on contaminant distribution and HPT data on hydraulic permeability. This enables project decision makers to more cost effectively select sampling locations early eliminating the costly delays associated with the traditional investigation tools and approaches. The permeability information is also critical to selecting remedial alternatives and properly placing injection and extraction intervals. The HPT probe also includes an integrated EC array to provide indication of general soil particle size which can help determine zones of sands, silts, and clays. Using the EC logs you can define zones of lower conductivity which allows the movement of contaminants into the subsurface.



Discrete Groundwater Profiling with Onsite VOC Analyses

Discrete Groundwater Profiling with Onsite VOC Analyses provides onsite laboratory analytical screening for VOCs associated with petroleum related fuels.

These state-of-the-art systems are equipped with a range of analytical equipment to provide analysis in the field rather than waiting for fixed lab results. Our deliverables can be simple, easy to read results that can be incorporated into our other data packages delivered in hard copy or an electronic data format. The Discrete Groundwater Profiling with Onsite VOC Analyses systems are outfitted with Gas Chromatography (GC) instruments. Our system can analyze 10 to 20 samples per day and can be customized to meet the site objectives.



Onsite VOC Analyses Field GC

The Discrete Groundwater Profiling with Onsite VOC Analyses system is ideal for:

- ✔ Soil gas analysis
- ✔ Groundwater analysis
- ✔ Soil analysis

Real-Time Information Processing and Mapping Using SmartData Solutions®

COLUMBIA's patented and proprietary SmartData Solutions® process is the first and only solution for real-time data collection, analysis, visualization, mapping, and tracking of soil and groundwater pollution of contaminated properties.



Real-Time Information Processing with SmartData Solutions® data delivery provides collaboration among project managers, colleagues, and other stakeholders, wherever they are located, through a cloud-based browser platform

Benefits of our patented process, SmartData Solutions® include lowering the risk, cost, and uncertainty while providing environmental remediation decision makers with three key deliverables:

1. **Best Data.** High-resolution data of the horizontal and vertical extent of soil and groundwater contamination.
2. **Deepest Understanding.** A complete overview of local site geology, hydrogeology, geochemistry, and contaminant chemistry.
3. **Pinpoint Recommendations.** More accurate delineation for the best possible remediation design.

A password-protected secure website is created for your project, incorporating sitemaps and historical information provided by the Client. When in the field, all direct sensing data is uploaded via a wireless aircard to our headquarters in Baltimore after every borehole (assuming cell phone coverage is available) where a complete QA/QC check is immediately performed on the field data prior to posting the data to your website. Your field and office staff will have the ability to view all data logs and the raw data files 24/7 and will be informed via email notifications as data becomes available. In our experience, your client's investment in a high resolution remediation-focused approach with Real-Time Information Processing and Mapping using SmartData Solutions® will enable you to move directly to resolution or remediation.



COLUMBIA and client reviewing remediation-focused site data

Qualifications and Experience

COLUMBIA Technologies is a Veteran-Owned Small Business (VOSB) and has the most high resolution direct sensing (MIP, LIF/UVOST®, HPT, and MiHpt) field experience of any company worldwide. In 2012, COLUMBIA pushed over 15 miles of direct sensing equipment and since 1999 completed over 1,000 direct sensing surveys throughout Mexico, Canada and 45 out of the 50 United States, including Hawaii.

Our field staff is comprised of only exceptionally educated and trained individuals. All personnel have undergraduate degrees in a scientific discipline, and many hold master’s degrees. All field personnel have been trained by a senior geochemist at COLUMBIA, and have attended MIP training at Geoprobe Systems® headquarters and LIF/UVOST® training at Dakota Technologies, Inc.

COLUMBIA maintains the largest fleet of direct sensing units in North America. All units are mounted on Dodge Sprinter vans or similar vehicles, and can be deployed with standard DPT or CPT equipment. Our direct sensing systems can be mounted on other equipment including pickup trucks, ATVs, 4WD and utility vehicles for limited access sites as well as remote locations such as barges to increase your reach in locations that would typically be difficult to access.



Modular approach configured on a Gator setup at a Gulf Coast petroleum refinery site

Health and Safety

Health and Safety is a top priority to COLUMBIA. The company maintains a record ZERO lost workdays within our 14-year history. All field personnel hold Occupational Safety and Health Administration (OSHA) 40-hour/8-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) certifications, Loss Prevention System (LPS), First Aid and Cardiopulmonary Resuscitation (CPR) training.

We can also provide teams trained and certified with e-RAILSAFE, Transportation Worker Identification Credential (TWIC®), OSHA 10-hour Construction Safety, and OSHA Site Supervisor credentials. Additionally, COLUMBIA has been vetted through the RAPIDGate® Program for military bases. Each operator adheres to COLUMBIA’s approved Standard Operating Procedure (SOP) for direct sensing.



COLUMBIA, driller, and client staff during a Health and Safety project kick-off meeting

COLUMBIA has experience with obtaining site specific Health and Safety training courses such as API WorkSafe, Regulatory Training Center (RTC), Workplace Hazardous Materials Information System (WHMIS), and has been trained for

specialty sites for Department of Energy (DOE), various Department of Defense (DoD) agencies, and has supported investigation activities at radioactive waste sites. All field staff participates in an annual medical surveillance program and drug testing consortium.

Memberships

- National Ground Water Association (NGWA)
- Small Environmental Business Action Coalition (SEBAC)
- Society of American Military Engineers (SAME)
- Sustainable Remediation Forum (SURF)

Awards and Patented Technology

COLUMBIA has received the following awards and patents for its work with optimizing direct sensing technologies with SmartData Solutions®:

- Three U.S. and two international patents on managing data uncertainty during site characterization using our award winning SmartData Solutions® process
- Environmental Business Journal 2012 International Expansion Achievement Award
- Environmental Business Journal 2010 New Business Practice Achievement Award
- Environmental Business Journal 2008 Remediation Achievement Award
- Environmental Business Journal 2008 Environmental Information Achievement Award
- Environmental Business Journal 2004 IT Merit Award
- Maryland Innovative Technology Firm of the Year 2002