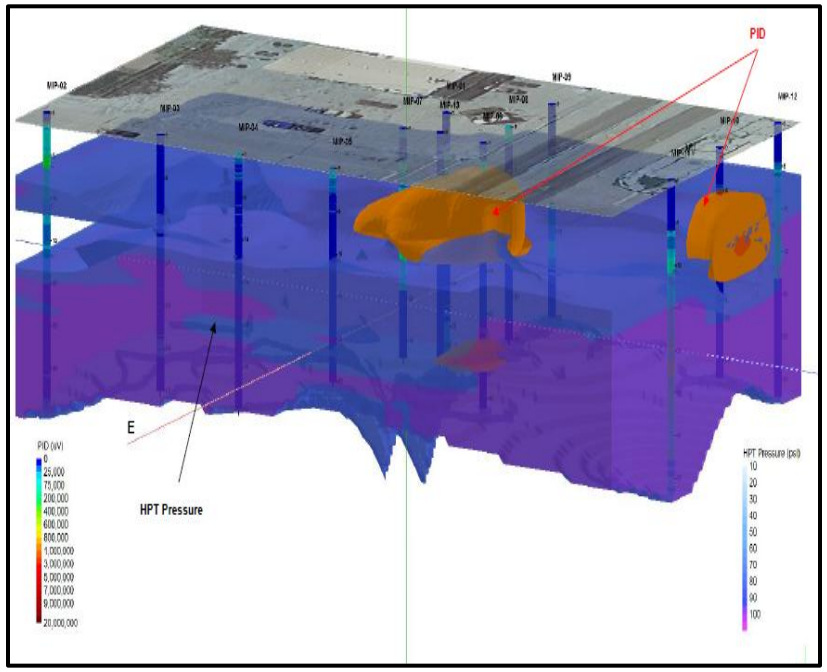
Advanced Site Characterization Tools and High-Resolution Site Characterization: Guidance, Applications, and Case Studies

Alex Wardle EPA OUST

National Tanks Conference, Spokane, Washington

September 2025

High Resolution Site Characterization



- Collects detailed geologic, hydrogeologic, and contaminant information at appropriate scale and density.
- Fills data gaps in the project Conceptual Site Model left from traditional characterization techniques.
- Uses surface and downhole geophysics, passive soil gas sampling, direct sensing probing techniques, and high- density soil and groundwater sampling in space and time.

Recommend HRSC at LUST sites when:

- Delineate a large catastrophic release quickly.
- Receptors at risk from rapid migration
- Complex geology
- Multiple traditional investigation rounds
- Unexplained LNAPL.
- High cost cleanups.
- Chemical Injections planned

HRSC provides holistic understanding

Qualitative, semi-quantitative and visual.

Three-dimensional perspective connects the dots.

Immediate to rapid data.

Minimizes mobilizations required to get to decision making information.

Accessible information promotes stakeholder involvement.

Used effectively reduces overall project costs.

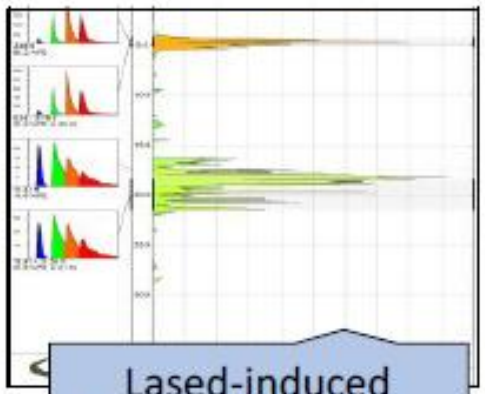
HRSC Tools

- Direct sensing
- Downhole geophysics
- Surface geophysics
- Remote sensing
- High density sampling: soil, soil gas, and groundwater.
- Temporal data collection

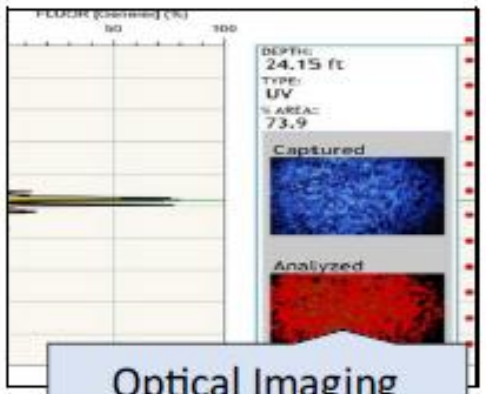
https://www.epa.gov/system/files/documents/2025-03/hrsc-indian-country-2025-03-04.pdf

Alex Wardle and Tom Schruben, EPA Office of Underground Storage Tanks

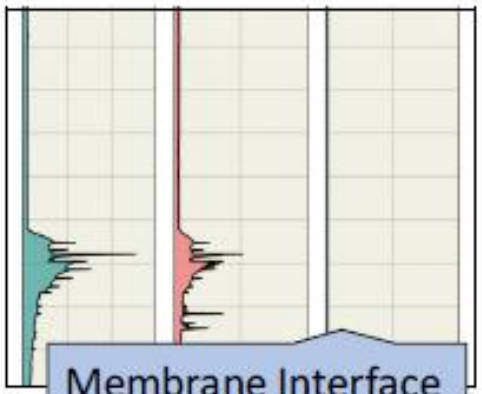
Direct Sensing HRSC Tools



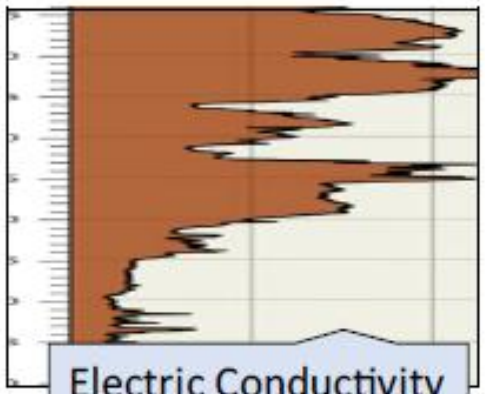
Lased-induced Fluorescence (LIF)



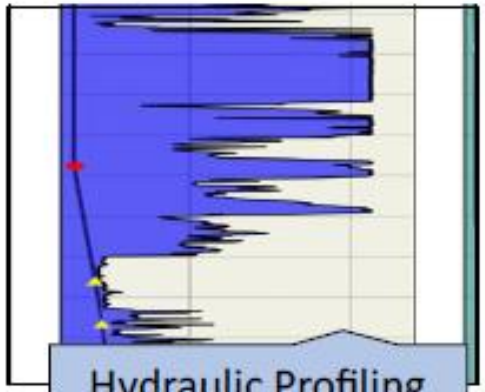
Optical Imaging Profiler (OIP)



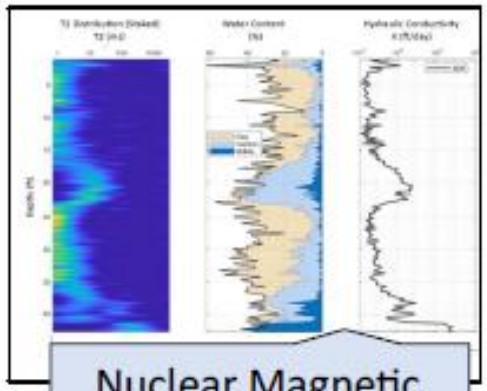
Membrane Interface Probe (MIPS)



Electric Conductivity (EC)



Hydraulic Profiling Tool (HPT)



Nuclear Magnetic Resonance (NMR)

High Density Sampling (HD)

Design Investigation

Answer qualitative and semi quantitative questions:

- Where are hot spots needing detailed investigation?
- What geology does the LNAPL sit in?
- How is contamination distributed in high and low permeability zones?
- How does the geology connect the dots?
- Is contamination above or below groundwater?
- How should I design monitoring and remediation wells
- Where should I inject reagents?
- Do I have comingled plumes?

Target contamination hot spots and delineate with grids or transects.

Target points of exposure or monitoring wells of concern.

Example of suggested investigation grid

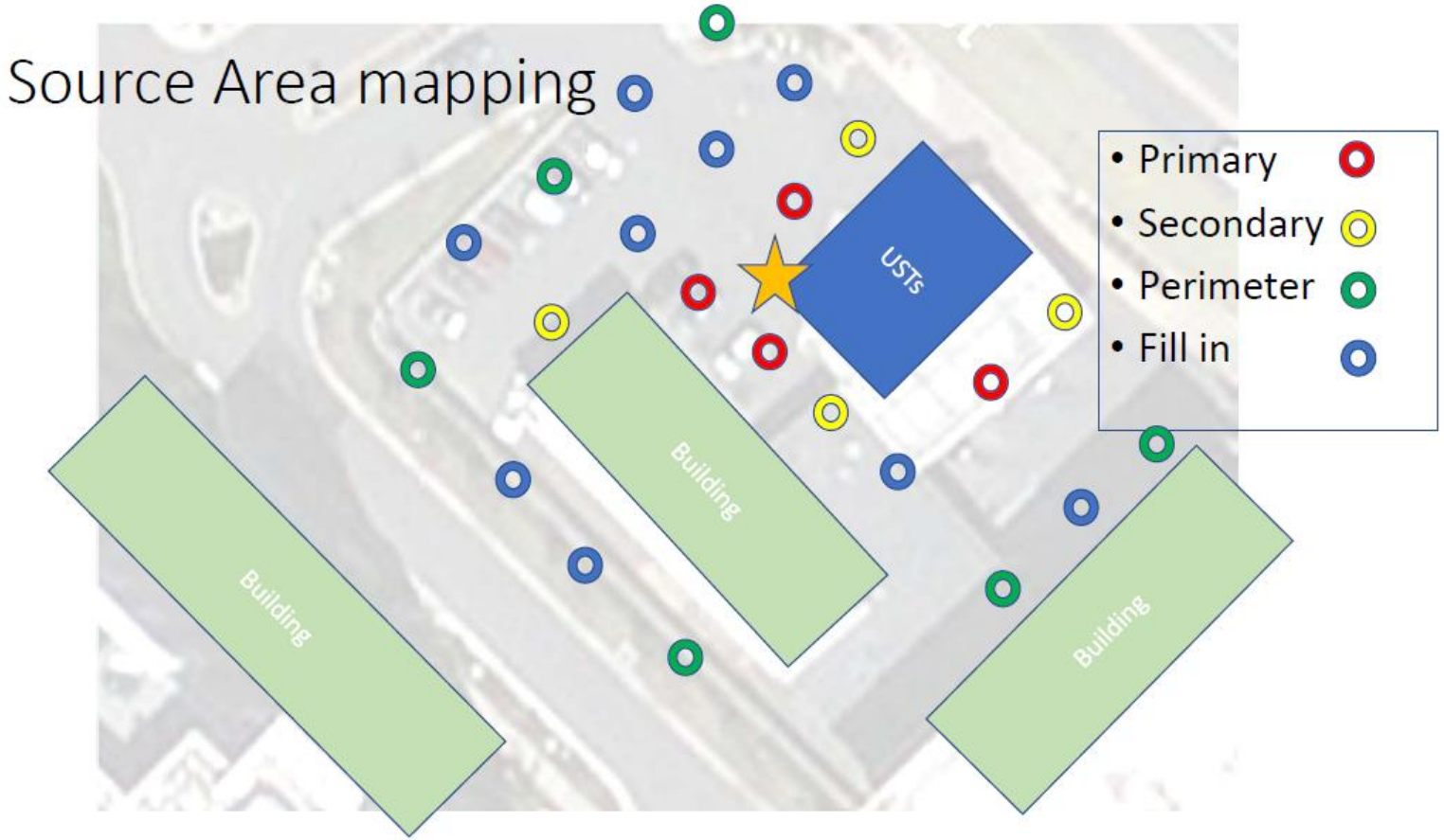


Table 2.1. Project Objectives, Data needs and appropriate HRSC Tools for Petroleum UST Release Sites.

Project Objective	Data Need: Locate non-aqueous phase li	Identify dissolved-	Identify geologic variability,	Estimate
Where is the subsurface source: LNAPL delineation?	UVOST® MIP HD			
How far have contaminants travelled: plume extent?	UVOST® MIP			
LNAPL residual, mobile or migrating.	UVOST® HD NMR m LNAPL h has not			

Table 3.3. Key information and Key Data Outcomes from HRSC Tools.

Sensor	Attribute	Detection	Reading interval	Key decision-making information	Caution
Electrical conductivity	Soil grain size, water quality	Layers as thin as 1-2 cm	1.5 cm intervals	Identify potential confining layers and permeable zones.	Salinity and other ionic fluids (e.g. injected bioremediation chemicals) can affect measurements.
Hydraulic profiling tool	Water injection into soil to	0.03 to 25 m/d: silt to	1.5 cm intervals	Estimates hydraulic conductivity and identifies	Unable to quantify low (clays) or very high (gravel) hydraulic conductivity
Nuclear magnetic resonanc					

Table 5.0. Project Data Needs, Data from HRSC, and Confirmatory Results.

Data Needs	HRSC Data: Chemistry	HRSC Data: Geology	Confirmatory Results: Soil Results mg/kg	Confirmatory Results: Groundwater
Where is the secondary source in the subsurface?	UVOST®>2% and a wave form consistent with petroleum. MIP-FID>10^7µv, OIP fluorescence	EC and HPT data can help delineate where contamination might be expected based on stratigraphic predictions.	>100	>15 mg/l TPH or measured LNAPL
Is LNAPL residual, mobile or migrating?	UVOST®>2% and a wave form consistent with petroleum. MIP-FID>10^7µv, OIP florescence Discrete soil samples.	Does EC or HPT data show potential pathways for LNAPL movement? Use EC and HPT data combined with UVOST/OIP to design confirmatory wells.	NA	Measurable LNAPL in confirmatory wells, Collect Transmissivity data, e.g., is T>0.1 ft^2/day?
Is there a PVI risk based on EPA screening criteria?	UVOST® petroleum %RE>2%, MIP-FID>10^7µv, OIP fluorescence within 15 ft of structure Soil vapor samples	Does EC or HPT data show a barrier to vapor movement? HPT dissipation test groundwater elevation	>100	>15 mg/l TPH or LNAPL. Groundwater elevation in wells: use HRSC data to confirm elevation is confined or unconfined.
How far have contaminants travelled:	FID and PID data from MIP Groundwater sampler	EC and HPT data showing pathways.	NA	Longitudinal transect of wells located using HRSC log

Example Tables

HRSC Case Studies

Three case studies describe:

- Objectives.
- Scope.
- Tools used.
- Decisions made.
- Cost.
- Stakeholder engagement.

Advanced Site Characterization Tools – ITRC Update June 2025 to December 2026

ITRC ASCT Update Wish List

Update tools.

Additional Remote Sensing guidance.

Use of time lapse geophysics data.

High-density temporal data, including groundwater elevations, flow, and groundwater chemistry.

Holistic design of HRSC investigations at small scale sites, including LUSTs and dry cleaners.

Case Study!

Contact Info for EPA LUST HRSC:

Alex Wardle
Wardle.Alexander@epa.gov

Tom Schruben
Schruben.Thomas@epa.gov