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ENVIRONMENTAL SOIL AND GROUNDWATER SAMPLING

Procedures for Collecting Representative Data during Site Assessment Field Work

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GROUNDWATER SAMPLING

Traditional and Current Methodologies, Key Factors for Success

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GROUNDWATER SAMPLING METHODS

Bailers

- Requires removal of 3 well volumes (PVC casing area x water column)
- Disturbs sediments, creating turbid samples

Inertial Check Valves (Waterra)

- Effective for remote locations with deep groundwater (more than 29 feet)
- Can be labor-intensive for high well purge volumes

Electric Submersible Pumps

- Rapid groundwater removal
- Produces non-turbid purge water

Peristaltic Pumps

- Low flow, preferred method for current site assessment practice
- Requires several pieces of equipment, bulky to transport

Bladder Pumps (Submersible, Pneumatic)

- Low flow, preferred method for current site assessment practice
- Requires decontamination between monitoring wells

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GROUNDWATER SAMPLING METHODS

Bailers (Traditional)

- Limited Applicability
- Bail 3X Well Volume
- Disturbs Water Column, Sediments
- Turbid Samples
- Dedicated Equipment for each Monitoring Well

(Canpipe, 2025)

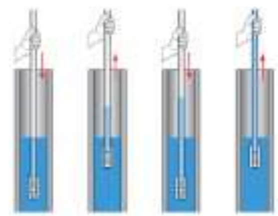
GROUNDWATER SAMPLING METHODS

Inertial Check Valves (Waterra)

- Requires Manual Force to Operate
- Easily Transported
- Moderate Groundwater Purge Rates
- No Depth Limitation (Up to 200 feet)
- Dedicated to Each Monitoring Well

(Solinst Canada Ltd., 2025)

(ECT Manufacturing, Inc., 2025)



(Solinst Canada Ltd., 2025)

(The Nevada Independent, Nevada News Bureau, Inc. 2025)

EPA LOW STRESS (LOW FLOW) PROCEDURE

Current Groundwater Sampling Practice

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EPA LOW STRESS (LOW FLOW) PROCEDURE

Applicability and General Scope

- Standard Approach for Site Assessment/Remediation Industry
- Minimizes Groundwater Disturbance (low turbidity)
- Designed to minimize Hydraulic Stress by Minimizing Drawdown within Monitoring Wells during Purging
- Produces Groundwater Samples More Representative of Aquifer Conditions, Compared to Traditional Methods (Bailer, Inertial Pump)
- Requires an Array of Equipment, including Multi-Parameter Water Quality Meter with Flow-Through Cell and Separate Turbidity Meter, Pump and Accessories (Peristaltic, Bladder or Submersible)
- Geochemical Parameters are Monitored in Purge Water to confirm Equilibrium Conditions between the Monitoring Well Void and the Aquifer
- Adequate for VOCs, SVOCs, Dissolved Gases, Pesticides, PCBs, Metals, other Inorganics or Naturally-Occurring Analytes
- A Current, Detailed EPA Guidance Document Exists for Sampler or Project Manager Reference, which is Periodically Updated by the EPA

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FIELD APPLICATION

Well Development

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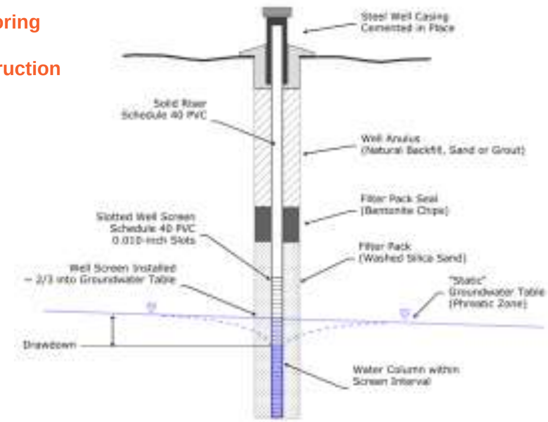
EPA LOW STRESS (LOW FLOW) PROCEDURE

Monitoring Well Construction



(Tighe & Bond, Inc. 2025)

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FIELD APPLICATION

Temporary Wells

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EPA LOW STRESS (LOW FLOW) PROCEDURE

Materials List

- Padlock Keys, Tools for Opening Well
- Site Plan
- Water Level Meter
- Groundwater Sampling Field Log
- Dedicated Tubing
- Pump and Power Source
- Purge Bucket
- Multiparameter Water Quality Meter and Flow-Through Cell
- Turbidity Meter and T-Valve
- Graduated Vessel
- Laboratory-Supplied Sample Containers and Cooler
- Laboratory Chain of Custody

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EPA LOW STRESS (LOW FLOW) PROCEDURE

(Activated Carbon Depot, 2025)

Water Level Meter

- Water Level Measurements Collected from PVC Rim
- Measurements in 0.01-Foot Increments (1/100th FT)
- Audible Beep and Light when Probe Contacts Water
- Measure Static Water Level, Drawdown, Total Well Depth (After Sampling)

(ENVIRO-EQUIPMENT, INC. 2025)

Interface Meter

- Measure LNAPL or DNAPL
- Audible Solid Beep and Light when Probe contacts product
- Intermittent Beep when Probe Contacts Water

FIELD APPLICATION

Significant Contamination

- Use Conceptual Site Model (CSM) during field sampling procedures
- Where are the “source” contamination areas?
- Collect groundwater samples from least-contaminated areas to most-contaminated areas

EPA LOW STRESS (LOW FLOW) PROCEDURE


Kosmos Scientific de México, S.A. de C.V.


HORIBA Scientific, Inc.


Hanna Instruments, Inc. 2025)


(Eco-Rental Solutions, LLC 2025)

Multiparameter Water Quality Meter

- Calibrated Meters Available from Rental Companies
- Requires Use of Flow-Through Cell
- Sonde (sensor) is fitted into Flow-Through Cell
- Purge Water is Pumped through Flow-Through Cell

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EPA LOW STRESS (LOW FLOW) PROCEDURE

Peristaltic Pump

- Electrical, Requires 12V DC Battery
- Forces Water Through Tubing via Peristalsis
- Maximum Head Differential of 29 Feet
- Dedicated Tubing, No Need to Decontaminate
- Pump Rate of 50 ml/min to 400 ml/min


Forestry Suppliers, Inc. 2025

Bladder Pump

- Pneumatic
- Can Use Air Cannisters or Electrical Air Pump
- Maximum Head Differential of 180 Feet
- Not Dedicated, Must be Decontaminated
- Pump Rate of 10 ml/min to 600 ml/min


ENVIEQ, Inc. 2025

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EPA LOW STRESS (LOW FLOW) PROCEDURE

(ENVIRONMENTAL HOLDINGS PTY LTD, 2025)

(Pine Environmental Services LLC, 2025)

Electric Submersible Pumps

- Can be Used for Low Flow Sampling, though Less Common in New England (shallow groundwater)
- Requires Decontamination between Monitoring Wells
- High Groundwater Purge Rates
- Requires Generator and Control Box (Vehicle Accessible Applications)
- Pump Rate of 50 ml/min to several L/min

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EPA LOW STRESS (LOW FLOW) PROCEDURE

Groundwater Sampling Field Log

- Static Groundwater Level
- Purge Rates (ml/min) for drawdown equilibrium
- Geochemical Parameters (5 min)
- Three consecutive readings within specified criteria
- Separate Turbidity Readings
- Collect sample following aquifer-well equilibrium

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GROUNDWATER SAMPLE DATA COLLECTION

Project Name: | Well ID:
Project Number: | Date:
Location: | Sample time:
Weather Conditions: | Collected By:

Reference Point: PVC / Steel Casing / Ground Surface
Purge Equipment:
Dedicated Equipment: Yes / No
Sampling Method: Tubing / Bailer / Other
Was Well Purged Dry? Time:

Diameter of Well: (IN)
Depth to Water: (FT)
Well Depth: (FT)
Length of Water Column: (FT)
1 Purge Volume: (GALLONS)
Volume Purged: (GALLONS)

Time	Depth to Water (ft)	Temp. (°C)	pH	Specific Cond.	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Volume Purged (gallons)

Temperature: | Dissolved Oxygen:
pH: | ORP:
Specific Conductance: | Turbidity:
Was the Sample Field Filtered? Yes / No | Filter Pore Size:

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EPA LOW STRESS (LOW FLOW) PROCEDURE

Low-Flow (Minimal Drawdown) Ground-Water Sampling

- EPA Guidance Document Available Online
- Last Revised September 2017

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING
PROCEDURE FOR THE COLLECTION OF
GROUNDWATER SAMPLES
FROM MONITORING
WELLS

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WHAT TO LOOK OUT FOR

Non-Ideal Conditions

- Well purged dry/turbid samples
- Geochemical parameters not equilibrating (practical/time constraints)

Trip Blanks, Equipment Blanks, Duplicate Samples

- Required? Implemented?

Field Filtering

- Private Wells are not filtered!
- “Drinking Water” vs. “Waste” analyses

Laboratory Quality Control Narratives

- Laboratory Log In Sheet
- RCP/MCP CAM Compliance Checklists

Low Flow Tubing

- Teflon/lined recommended for VOCs
- Teflon not recommended for PFAS

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WHAT TO LOOK OUT FOR

Sample Preservation

Table 1
Recommended Containers, Preservation, Storage, & Holding Times
For Water and Wastewater

Description	Method	Matrix	Sample Container	Preservative	Prep/Analysis Holding Time	Volume
Volatile/Semivolatile Analyses						
EDB, DBCP	504.1, 8011	H_2O	G (b) Tef Sep	Cool ≤6° C, 75µL $Na_2S_2O_3$ Solution	14 days	40 ml [illegible]
Haloacetic Acids	552.2	H_2O	AG(a) Tef Cap	Cool ≤6° C, NH_4Cl	14 days	250 ml [illegible]
GCMS-Purgeables	524.2	H_2O	G (b) Tef Sep	Cool ≤6° C Ascorbic acid & HCl to pH<2 [illegible]	14 days	40 ml [illegible]
GCMS-Purgeables	524.2- THMs only	H_2O	G (b) Tef Sep	Cool ≤6° C $Na_2S_2O_3$ Solution	14 days	40 ml [illegible]
GCMS-Purgeables	624, 8260C	H_2O	G (b) Tef Sep	Cool ≤6° C HCl to pH<2 [illegible]	14 days [illegible]	40 ml [illegible]
GCMS-Acrolein, Acrylonitrile, 2-Chloroethylvinyl ether	624	H_2O	G (b) Tef Sep	Cool ≤6° C [illegible]	3 days [illegible]	40 ml [illegible]
GC-Pesticides	608, 8081B	H_2O	AG (a) Tef Cap	Cool ≤6° C [illegible]	7/40 days [illegible]	1 L [illegible]
GC- PCBs	608, 8082A	H_2O	AG (a) Tef Cap	Cool ≤6° C [illegible]	1yr/1 yr [illegible]	1 L [illegible]

(Eurofins USA, 2025)

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WHAT TO LOOK OUT FOR

Data Quality Objectives

- What is the Goal?
- Not All Samples Are the Same!

Assessment

Remediation

Risk Characterization

- Reporting Limits (sensitivity)
- Analytical Methodology
- Sample Collection, Handling, Preservation
- Are you measuring remediation project outcomes?
- Or human exposures?

(Dreamstime.com, 2025)

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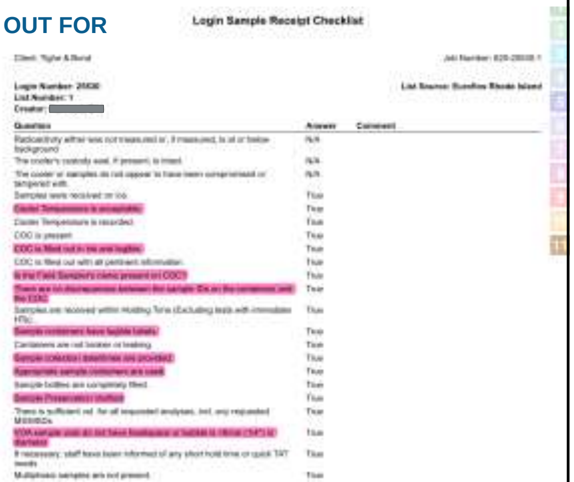
WHAT TO LOOK OUT FOR


Login Sample Receipt Checklist

Client: Tighe & Bond

Creator: [redacted]

Question	Answer	Comment
Radioactivity either was not measured or, if measured, is at or below background	N/A	
The cooler's custody seal, if present, is intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	N/A	
Samples were received on ice.	True	
[illegible]	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
[illegible]	True	
COC is filled out with all pertinent information.	True	
[illegible]	True	
[illegible]	True	
[illegible]	True	
[illegible]	True	
Containers are not broken or leaking.	True	
[illegible]	True	
[illegible]	True	
Sample bottles are completely filled.	True	
[illegible]	True	
[illegible]	True	
[illegible]	True	
[illegible]	True	
Multiphasic samples are not present.	True	

Sample Log-in Checklist

- Typically provided in laboratory report, near the end
- Identifies common deficiencies in sample preparation, handling and preservation
- Generally indicates overall quality of work by sampler

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QUESTIONS?

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SOIL SAMPLING

Current Methodologies, ISM, and Key Factors for Success

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CONCEPTUAL SITE MODEL (CSM)

CSM Development

- Physical Setting, Current Uses at and Surrounding Property
- Current and Historical Records Review
- Radius Search (government databases)
- Local, state or county records regarding environmental cleanups
- Municipal File Review
- Site Reconnaissance
- Interviews
- Conclusions

Objectives

- Research upfront
- Build a CSM first
- Site reconnaissance follows current and historical research (know what to look for)
- Interviews follow site visit (know what to ask)
- Analytical data drives further CSM development (Phase II ESA)

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SOIL SAMPLE COLLECTION

Planning for Assessment

- Site Access
- Spatial and Overhead Concerns
- Utility Concerns
- Damage from Equipment Treads
- Sensitive Receptor Areas
- Property Restoration

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SURFACE SOIL SAMPLING

Methods and Equipment

- Soil Sampling Accessibility
  - Utility Concerns
  - Minimal Site Disturbance
  - Precise Soil Sampling
- Bucket Auger
  - Extensions Available
- Dutch Auger
  - Easy collection of soil in heavily rooted areas
  - Good for both hard or wet soils
- Hand Trowel

(AMS, 2025)

(Amazon, 2025)

(PALMS Environmental, 2025)

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SUBSURFACE SOIL SAMPLING

Excavators

- Best Visibility Option
- Best Method for Evaluating Fill
- Bladed Bucket versus Toothed Bucket

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SUBSURFACE SOIL SAMPLING

Flush Joint Casing (FJC)
Drill Rig (Drive and Wash)

- “Cased” boring advanced with hammer
- Split Spoon Samplers
- 24” Sampler Hammered into the Ground
- Advanced in 6” Increments
- Most Accurate Vertical Sampling
- Indications of soil compaction
  - Low N-values = softer soils
  - Higher N-values = denser soils
- Considerations
  - Time Factor
  - Poor Recovery
  - Height Constraints
- Allows sampling below water table
- Best for deep samples/wells (50 ft +)

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SUBSURFACE SOIL SAMPLING

Hollow Stem Auger (HSA) Drill Rig

– Utilizes a Rotary Cutting Head
– "Screw" motion clears soil when augers are rotated
– Hollow Stem Augers act as Casing
  – Prevents Cave In
  – Limits Cross Contamination
  – Allows for Enhanced Sand Pack for Groundwater Monitoring Wells
- Faster than Flush Joint Casing
- For medium-depth samples/wells (10-50 ft)
- "Running Sands" issue at depths far below groundwater table

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SUBSURFACE SOIL SAMPLING

Direct-Push Tooling (DPT) Drill Rig

– Minimal ground disturbance (~4" holes)
– Quick and Cost Effective
– Minimal Cuttings Generated, Less Investigation-Derived Waste (IDW)
– Uses Dedicated MacroCore sleeves
– OK for shallow borings (30 ft)
– Beware of Compression Factor
  – Using Static Weight and Force which Results in Soil Compression
  – Soil compressed over 4-5 foot intervals
  – Compression as much as 5X
– "Running Sands" are a problem
  – Tooling completely removed from ground after each sample

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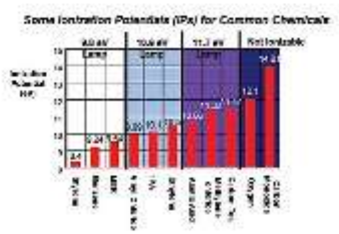
FIELD SCREENING TOOLS

Photoionization Detector (PID)

- Field/Headspace Screening
- PID Calibration
- Different Bulbs for Different Contaminants
  - Consult your Local Rental Company



(Rae Systems by Honeywell, 04/05/CW)

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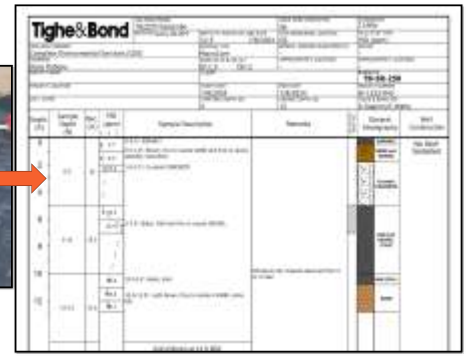
FIELD SCREENING TOOLS

Application and Reporting



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FIELD SCREENING TOOLS

(DEXSIL 2025)

DEXSIL Petroflag Kits

- Test for Total Hydrocarbons in Soil (TPH)
- Real Time Results using Extraction Solvent
- Analyzer Includes Response Factors and Detection Limits for TPH
- Calibration Temperatures are Important!
- Results Above the Upper Limit can be Re-Run with Less Sample Mass
- Potential Low Bias from Water Content
  - Poor Extraction
  - Dilution
  - Sample weight bias

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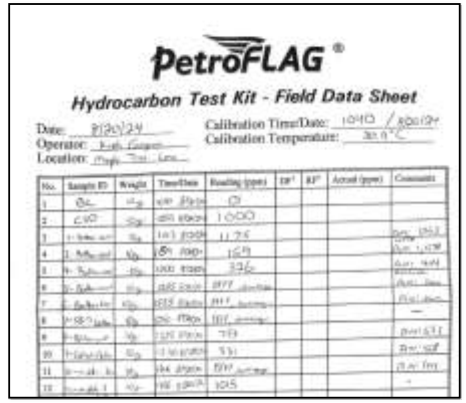
FIELD SCREENING TOOLS



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SAMPLING METHODOLOGIES

Representative Sampling

- Site Specific Data Quality Objectives
  - Discuss with Project Manager

Considerations

- Non-homogeneity of Soil
  - Contaminants tend to reside in finest fraction of soil particles (silt, clay, organic acids)
- Grab versus Composite Samples
  - Grab samples: single volume of soil homogenized and submitted for analysis
  - Composite samples: multiple volumes of soil (aliquots) homogenized and submitted for analysis
  - Volatile Organic Compound Samples **Never Composited!**
- Judgmental Sampling vs. Systematic Sampling
- Incremental Sampling
- Cross Contamination Issues, Decontamination Procedures

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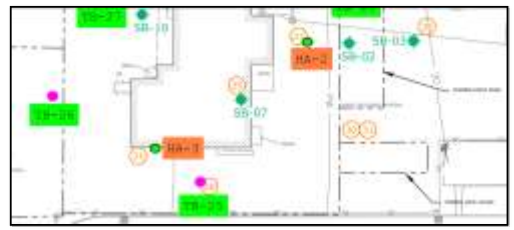
SAMPLING METHODOLOGIES

Judgmental Sampling

- Informed by the nature of the site, contaminant properties, and observations
- Focused sampling from an obvious release or the mostly likely release mechanism
- Known Conditions vs. Uncertainty
  - Has soil been previously disturbed in the past (e.g. construction activities, filled)
  - Is there existing information that suggests where the location of highest contaminant concentrations are likely?
  - Do contaminant physical properties allow observation of impacted media (odors, staining, field screening)



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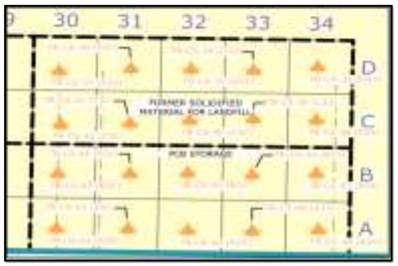
SAMPLING METHODOLOGIES

Systematic Sampling

- Used when Contaminant Distribution is Unknown (PCBs, metals, PFAS)
  - No odors, staining, point source
- Set up Grid Cells (Letter, Number)
  - Helpful to reduce uncertainty about nature, extent, and distribution of contamination at a site
  - Number of samples depends on variability of initial data (standard deviation)
    - Source Unknown
    - Soil has been Disturbed
    - Lower potential for "missed" areas with high contaminant concentrations
- Can include composite sampling or grab sampling, or a combination of both



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SAMPLING METHODOLOGIES

Incremental Sampling Methodology (ISM)

- Type of Systematic Sampling
- Structured Composite Sampling Process
- Samples representative of soil throughout a prescribed area/depth called a Decision Unit
- Can have multiple samples (Sampling Units) within a Decision Unit
- Soil non-Homogeneity addressed through "Sub-Sampling" (samples of composite sample)
- Compared to traditional systematic sampling approaches
- ISM yields an accurate estimate of the true mean soil concentration for a given area
- ISM manages micro-scale soil heterogeneity and minimizes potential bias errors

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SAMPLING METHODOLOGIES

Incremental Sampling Methodology (ISM)

- Site is segregated into areas, each called a decision unit (DU)
- Increments (aliquots) collected evenly throughout DU (30 to 100 increments)
  - Can include Sample Units (SU) for varying depths within a DU
- Increments are composited into single composite sample (1 per DU/SU)
- Composite sample is then Sub-Sampled (samples of composite sample)
  - Initial sample is sieved, "slab cake" prepared from finest portions of sample
  - Slab cake is re-sampled as "meta" composite sample
- Final "meta" composite sample is analyzed for contaminants
- Laboratory typically performs ISM processing and analysis
  - Bulk sample volume is a drawback (5-gallon bucket)
  - Can reduce sample bulk by Sub-Sampling in field and discarding initial composite sample

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SAMPLING METHODOLOGIES

Incremental Sampling Methodology (ISM)

Two-Dimensional Slab Cake

- Targets finest soil fraction for analysis
- Sieved composite sample spread in even thickness
- Divided into increments and "sub-sampled"
- Sub-samples are re-composited into "meta" composite sample
- "Meta" composite sample analyzed

(Mark Bruce, Eurofins, 2019) ITRC

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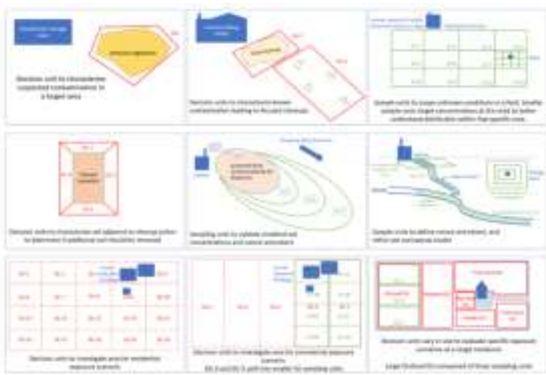
SAMPLING METHODOLOGIES

Incremental Sampling Methodology (ISM)



(ITRC, 2025)

LESSONS LEARNED

Non-Homogeneity of Soil is a Challenge

- Hoosac River Assessment
  - Mercury above the industrial hygiene level, reanalysis (from the same jar) showed much lower levels
- Emergency Response Situation in CT
  - Leachable lead concentration issues when analyzed via SPLP and reanalyzed showed different concentrations (some hazardous waste levels, some not)
- Field Screening Should Reflect Analytical Results
  - Sample loses "freshness" during screening
  - Should collect Duplicate Samples for field screening vs. lab analysis
  - Collect one for screening
  - One for lab analysis

Understand CSM, DQOs, Project Objectives before Sample Collection

- Soil sampling can be iterative
- Incorporate data quality issues, access issues, non-homogeneity into subsequent boring/sampling rounds

QUESTIONS?