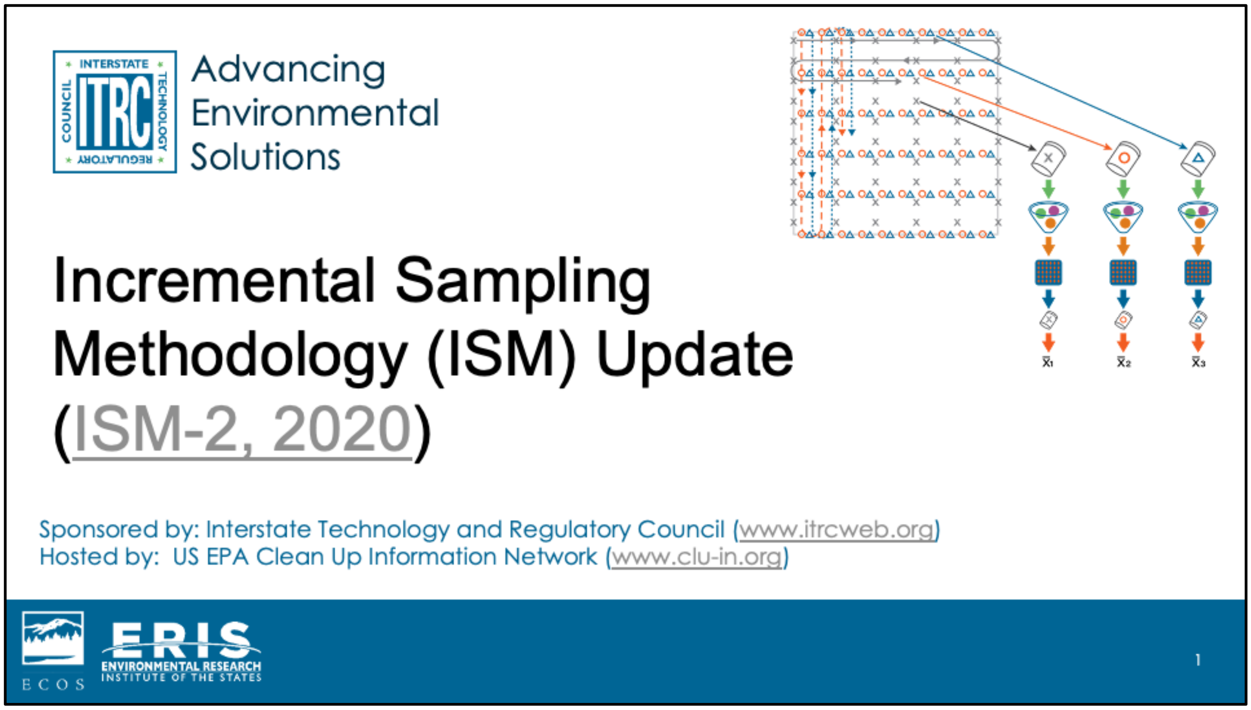


Training Course Overview:

The newly updated **Incremental Sampling Methodology (ISM)** training is a series of six modules providing an overview of ISM and presenting five sections from the ITRC guidance document (ISM-2, 2020):

- Overview (Sect 1)
- Heterogeneity (Sect 2)
- Statistics (Sect 3.2), Data Use Planning (Sect 3.3), and Data Quality Evaluation (Sect 6)
- Field Sampling Collection (Sect 4)
- Lab Preparation (Sect 5)
- Risk Assessment (Sect 8)

After this series, you should understand:

- Incremental Sampling Methodology (ISM) is a statistically supported technique for assessing the unbiased mean contaminant concentration in soil, sediment, and other solid media which can afford an economy of effort and resources in your projects.
- How the ISM structured composite sampling and processing protocol reduces data variability and provides for representative samples of specific soil volumes by collecting numerous increments of soil (typically, 30 to 100 increments) that are combined, processed, and subsampled according to specific protocols.
- The key principles regarding heterogeneous soil sampling errors and how ISM reduces those errors to have more confidence in sampling results.
- How to use the new ITRC Incremental Sampling Methodology (ISM-2) guidance document to learn the principles and approaches of the methodology to improve representative, reproducible, and defensible data to improve decision-making at your sites

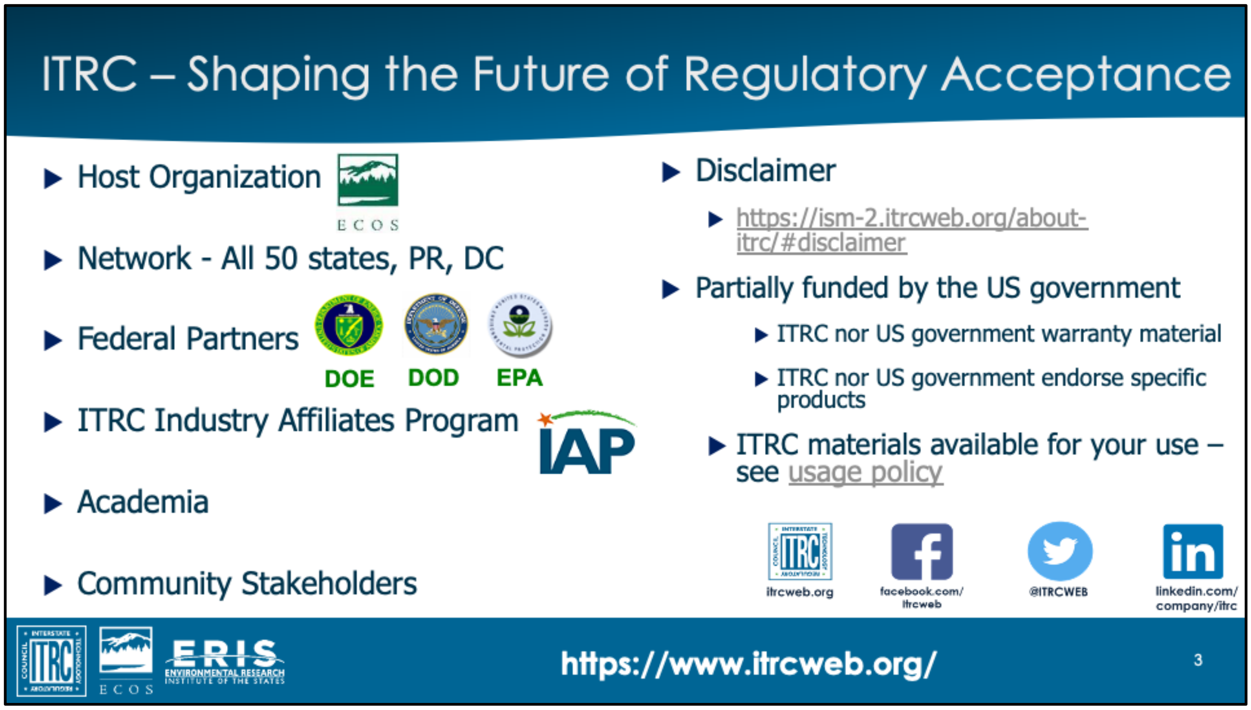
For regulators and other government agency staff, this improved understanding can hopefully be incorporated into your own programs. ISM is finding increased use in the field, as well as acceptance and endorsement by an increasing number of state and federal regulatory organizations. Proponents have found that the sampling density afforded by collecting many increments, together with the disciplined processing and subsampling of the combined increments, in most cases yields more consistent and reproducible results than those obtained by more traditional discrete sampling approaches.

Prior to attending the training class, participants are encouraged to view the associated ITRC guidance, Incremental Sampling Methodology (ISM-2). Additionally, for participants in a more detailed instruction to ISM, please view the ITRC Soil Sampling and Decision Making Using Incremental Sampling Methodology 2-Part Training Series.

Housekeeping

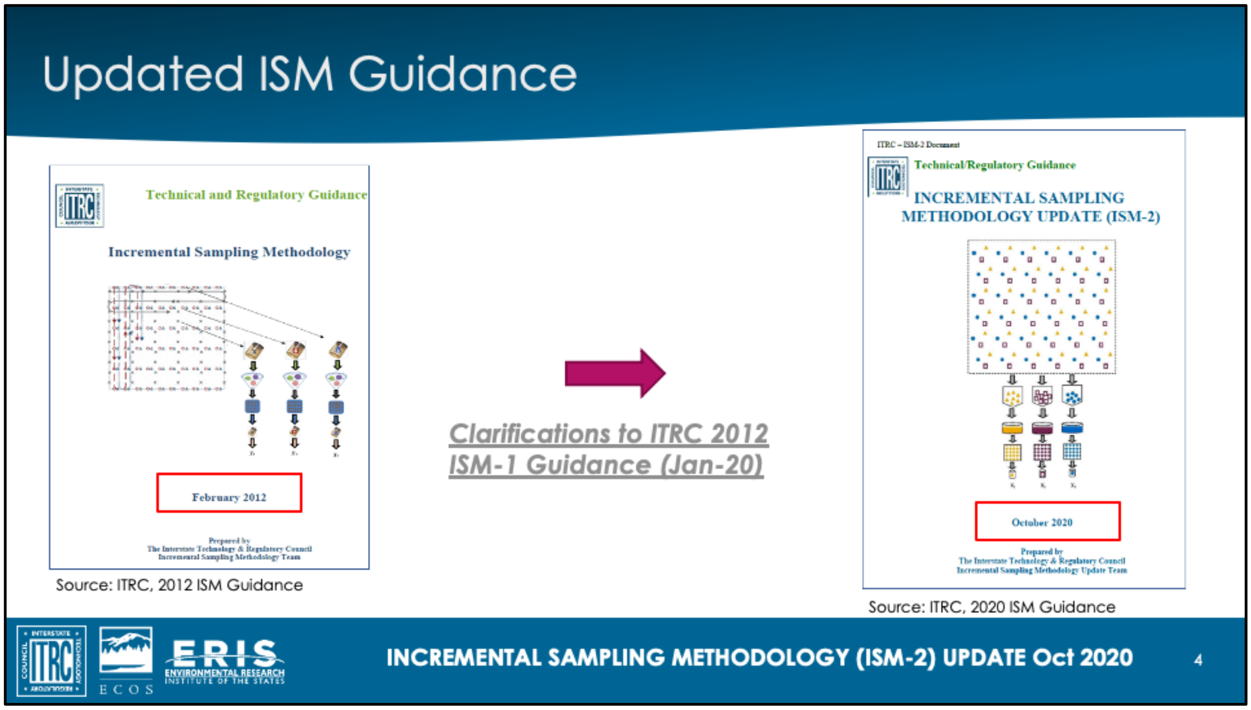
- This event is being recorded; Modules will be available On Demand after the event at the main training page
- Download slides for today at the CLU-IN training page https://clu-in.org/conf/itrc/ISM/ Under "Download Training Materials"
- If you have technical difficulties, please use the Q&A Pod to request technical support
- Need confirmation of your participation today?
  - Fill out the online feedback form and check box for confirmation email and certificate

Notes:
Use the "Q&A" box to ask questions, make comments, or report technical problems any time. For questions and comments provided out loud, please hold until the designated Q&A breaks.



The Interstate Technology and Regulatory Council (ITRC) is a state-led coalition of regulators, industry experts, citizen stakeholders, academia and federal partners that work to achieve regulatory acceptance of environmental technologies and innovative approaches. ITRC consists of all 50 states (and Puerto Rico and the District of Columbia) that work to break down barriers and reduce compliance costs, making it easier to use new technologies and helping states maximize resources. ITRC brings together a diverse mix of environmental experts and stakeholders from both the public and private sectors to broaden and deepen technical knowledge and advance the regulatory acceptance of environmental technologies. Together, we're building the environmental community's ability to expedite quality decision making while protecting human health and the environment. With our network of organizations and individuals throughout the environmental community, ITRC is a unique catalyst for dialogue between regulators and the regulated community.

For a state to be a member of ITRC their environmental agency must designate a State Point of Contact. To find out who your State POC is check out the "contacts" section at www.itrcweb.org. Also, click on "membership" to learn how you can become a member of an ITRC Technical Team.



ITRC issued the Incremental Sampling Methodology Guidance (known as ISM-1) in February 2012. Since that time, many more states and consultants have adopted its use, and we found that it could benefit from an update. But, what started as an update, really turned into a complete overhaul and improvement of the original document, with input from experts and new practitioners from around the world.

The revised and updated ITRC guidance (ISM-2) was developed to build on the 2012 version to reflect advancements in technology and to share case studies that simply were unavailable at the time of ISM-1, and that provide insight into potential applications, benefits, and challenges of the ISM approach. The ISM-2 Update Team also determined that clarification of incorrect, unclear, or inconsistent information in ISM-1 was also necessary. A clarification statement is now appended at the beginning of the ISM-1 document and ISM-1 continues to be a useful and valuable tool for those interested in learning the concepts of ISM.

Meet the ITRC ISM-2 Team Leaders

Caroline Jalanti
New York State DEC
Albany, NY
(518) 402-9621
Caroline.Jalanti@dec.ny.gov

Troy Keith
Tennessee DEC
Chattanooga, TN
423-634-5755
troy.keith@tn.gov

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Read trainer bios at https://clu-in.org/conf/itrc/ISM2/

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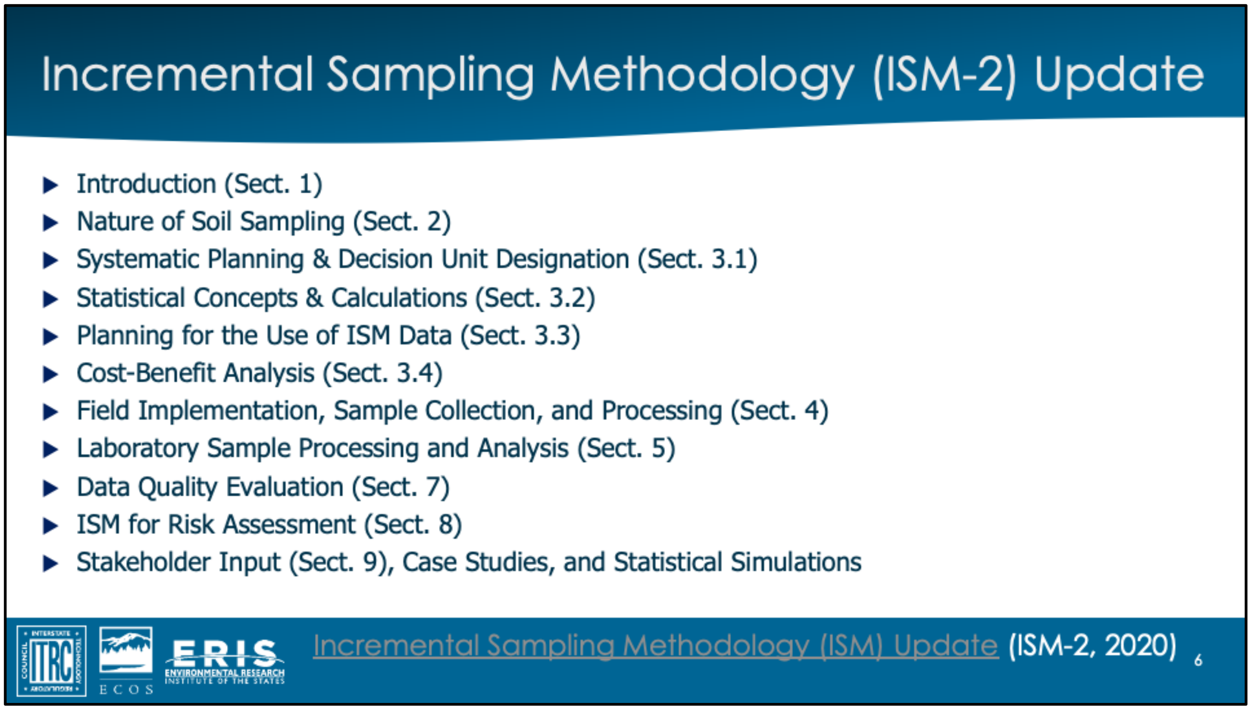
Caroline Jalanti received her B.S in Environmental Engineering from Worcester Polytechnic Institute and was recognized within the Environmental Engineering Department for her research into remedial technology advancements for the emerging contaminant 1,4-Dioxane. Caroline has been working as an Environmental Engineer with the New York State Department of Environmental Conservation (NYSDEC) since 2014. During her time with NYSDEC, Caroline has worked on various investigation and remediation projects across multiple state programs including: State Superfund, Brownfield Cleanup Program, and Petroleum Response.

Troy Keith, PG, has been working as a geologist in the environmental industry for thirty years, with the last 20 being with the Tennessee Department of Environment and Conservation, Division of Remediation. Mr. Keith has worked on investigation and remediation of numerous active and inactive DoD sites, NPL sites and State Superfund sites. In addition to traditional CERCLA and RCRA work, Mr. Keith has extensive experience with regional implementation and administration of the DoR's Voluntary Oversight and Assistance Program (Brownfield Program) for the Southeast Tennessee region.



The updated ITRC Incremental Sampling Methodology guidance document (ISM-2) was developed to build on the 2012 version (ISM-1) and to reflect advancements in technology, incorporate the lessons learned by practitioners over the past eight years, and share case studies that provide insight into the potential applications, benefits, and challenges of the ISM approach.

ISM-2 contains 9 sections and an appendix with case studies as well as an update to the Statistical Simulations contained in ISM-1. The ITRC ISM-2 Training Module will not cover all the sections of the guidance document, so we strongly encourage you to visit the web-based document and explore all the tools and resources available.

ISM-2 Training Modules (6 module series)

Module 1: Introduction (Sect. 1)

Module 2: Heterogeneity (Sect. 2, 3.1)

Module 3: Statistics, Data Use Planning, & Data Quality Evaluation (Sect. 3.2, 3.3, 6)

Module 4: Field Sampling Collection (Sect. 4)

Module 5: Lab Preparation (Sect. 5)

Module 6: Risk Assessment (Sect. 6)

ISM-1 Training: Soil Sampling and Decision Making Using Incremental Sampling Methodology
Two-Part Training On Demand Listening on Clu-In!

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The ISM-2 Team created this training as a series of six modules. These are designed to be stand-alone modules to help participants understand specific components of ISM. These can be viewed separately and in any order preferred by the participant.

Module 1 provides an overview of ISM to orient participants to the concept of ISM and the Guidance Document.

Module 2 discusses the importance of small-scale and large-scale heterogeneity – how ISM addresses soil contamination in such a challenging environment. Soil and other solid matrices are inherently heterogeneous and, because of that heterogeneity, traditional grab sampling approaches can substantially over or under estimate the true mean concentration of contaminants present. This module shows how ISM reduces the errors inherent in traditional sampling approaches and provides representative samples suitable for accurate decision making.

Module 3 recognizes the common statistical misconceptions and pitfalls in sample planning and analysis, and how to avoid them. Wondering which UCL to choose, and how to calculate it? Learn how to use our UCL calculator in the statistics module.

Module 4 provides a variety of examples and techniques to help you understand the field sampling methods used for ISM. This module goes over a comprehensive field planning checklist, and covers how to locate and collect your increments.

Module 5 provides a comprehensive review of the laboratory and analytical side of ISM and how it impacts the quality of your results. This module will help project planners select sample processing options to manage microscale heterogeneity and to preserve representativeness. It will explain the most common processing options and has video examples of milling and 2D slabcake subsampling.

And Module 6 is your go-to resource for what you need to know about using ISM data in risk assessment and risk-based decision making. You can use ISM data for risk assessment for providing an accurate estimate of the true mean for a scientifically defensible risk assessment and risk-based decision making. Module 6 covers designing DUs for risk assessment, including 95%UCLs. This module also touches upon use of ISM for establishing background concentrations, post-remediation confirmation sampling, and risk communication.

Also, don't forget that ISM-1 has a two-part training available on Clu-In that will provide more in-depth information on ISM for those still interested in digging deeper. This training is still relevant and current.

We are excited to present these new training opportunities for you and hope you can use the information to help with your environmental sites. Please remember to visit the full guidance document for all the tools and resources.

Incremental Sampling Methodology (ISM) Update
Module 4: Field Sample Collection

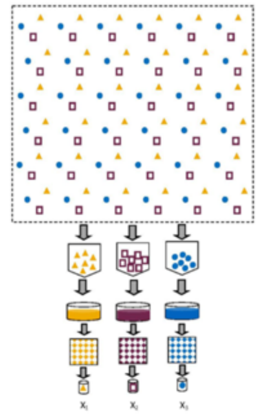
Meet the ITRC Trainer

Todd Miller
Kennedy/Jenks Consultants
Walnut Creek, CA
925-953-1530
toddmiller@kennedyjenks.com

Read trainer bios at https://clu-in.org/conf/itrc/ISM-2/

Topics

- Work Plan Review
- Field Checklist
- DU/Increment Locating
- Field Sampling
- Sample Handling



Source: ITRC, 2020 ISM Guidance

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In this session we will discuss:

- Field planning and preparation, including review of the Work Plan and Field Program Checklist
- Site and DU locating techniques
- Field Sampling techniques, including tool selection and mass reduction
- And sample handing

Work Plan Review

- Sampling Design
- Objectives
- Equipment
  - Sampling Equipment
  - Locating Equipment
- Schedule / Notifications

Source: MI-EGLE, 2017

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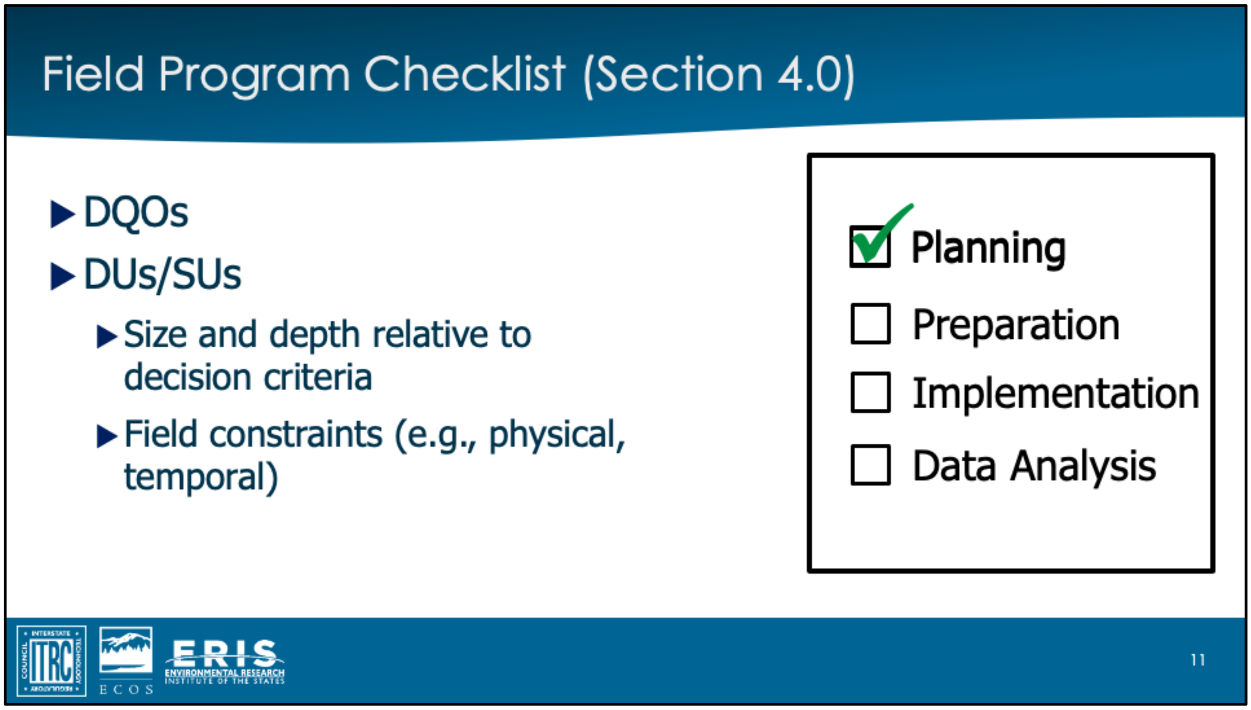
Prior to mobilizing to the field, the Team will want to review the Work Plan to understand how decision units correspond to each other, number of increments, and overall sampling objectives. **Further details about sampling design and development of work plans and DQOs are presented in Section 3 of the ISM-2 Document and in Training Modules 2 and 3.**

Review of the work plan should also confirm that the sampling equipment is appropriate for the media and the sampling environment; and should identify what equipment will be used to locate the DUs and increments.

The field team should also confirm that the project schedule is adequate for successful implementation – and understand if specific client or agency notifications are required.



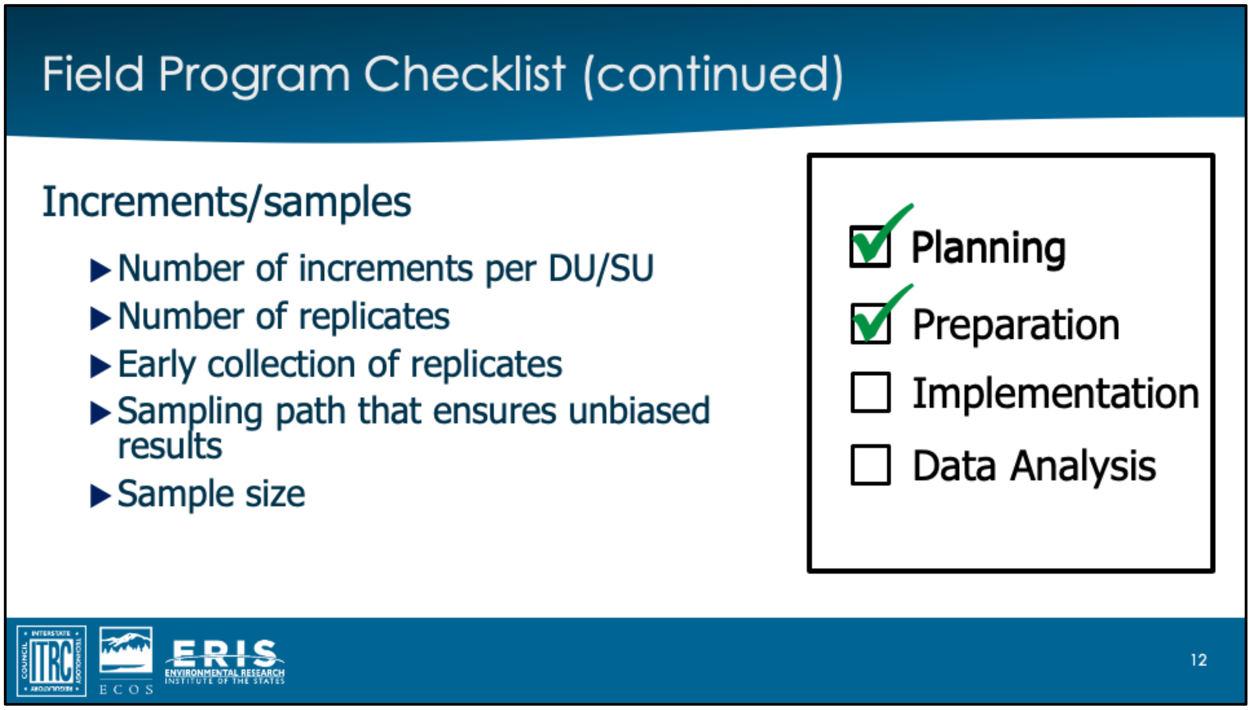
While reviewing the Work Plan, the team should create a checklist to help plan for the sampling event. **The first page of Section 4 of ISM-2** provides a checklist that you can use as a template: The checklist should cover:

- Reviewing the DQOs to understand how the sampling will meet the work plan objectives, and
- How the data collected will further the Conceptual Site Model and understanding of the site.

More information about DQOs can be found in Section 3 of the ISM-2 document and in Training Module 3.

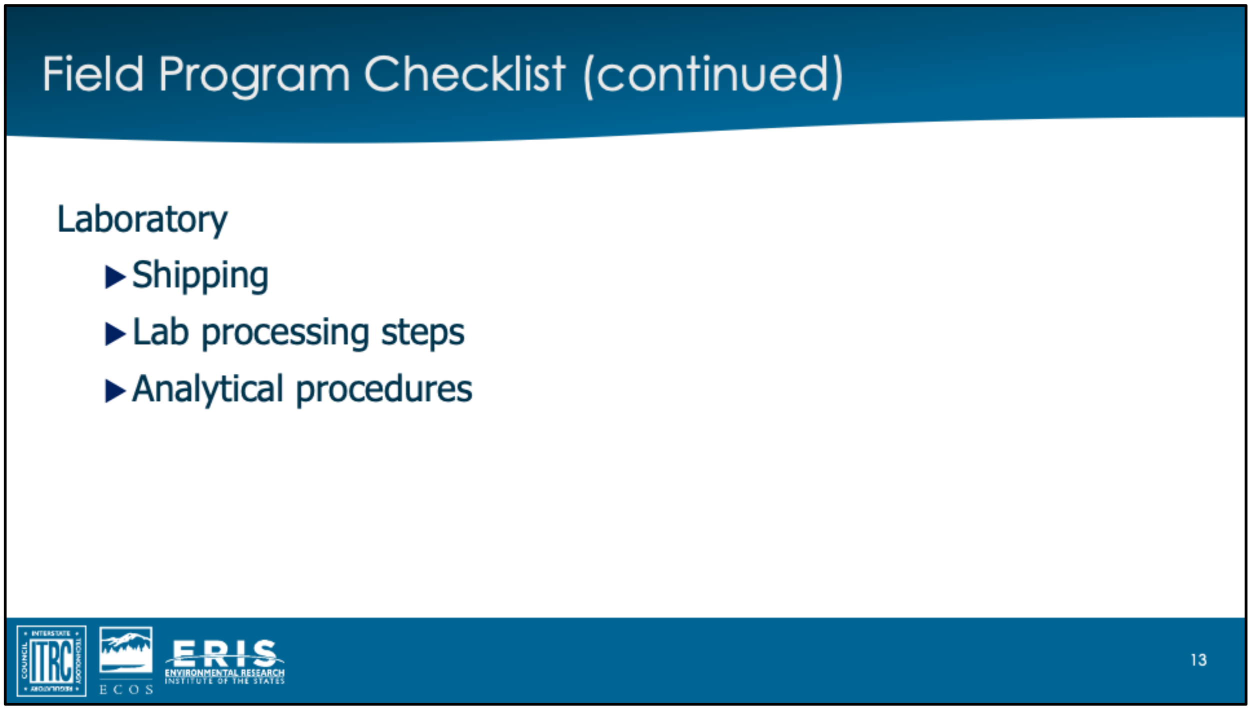
The field checklist should summarize critical information about the DUs such as:

- Their sizes and locations on-site
- Depth intervals to be sampled
- known or possible physical constraints that need to be taken into account for sampling



The program checklist should include information about the increments such as:

- The number of increments per DU
- The number or replicates and the need for the early collection of replicates in the sampling process - and knowing the frequency
- The sampling path – or – path of travel for collecting the increments that ensures unbiased results
- The sample size for the DU



As part of the planning process, the team should confirm a few items with the laboratory:

- Special handling and shipping procedures
- the sample processing steps
- And the analytical procedures, to confirm they:
    - meet regulatory requirements
    - selected sample containers are appropriate AND
    - that QC procedures will meet the QAPP requirements

Knowledge Check

Which of these factors is important to understand when preparing for an ISM sampling event:

A. The sampling path that provides biased-high results
B. Volume size and number of increments per DU
C. Collecting replicates late in the process for better quality control

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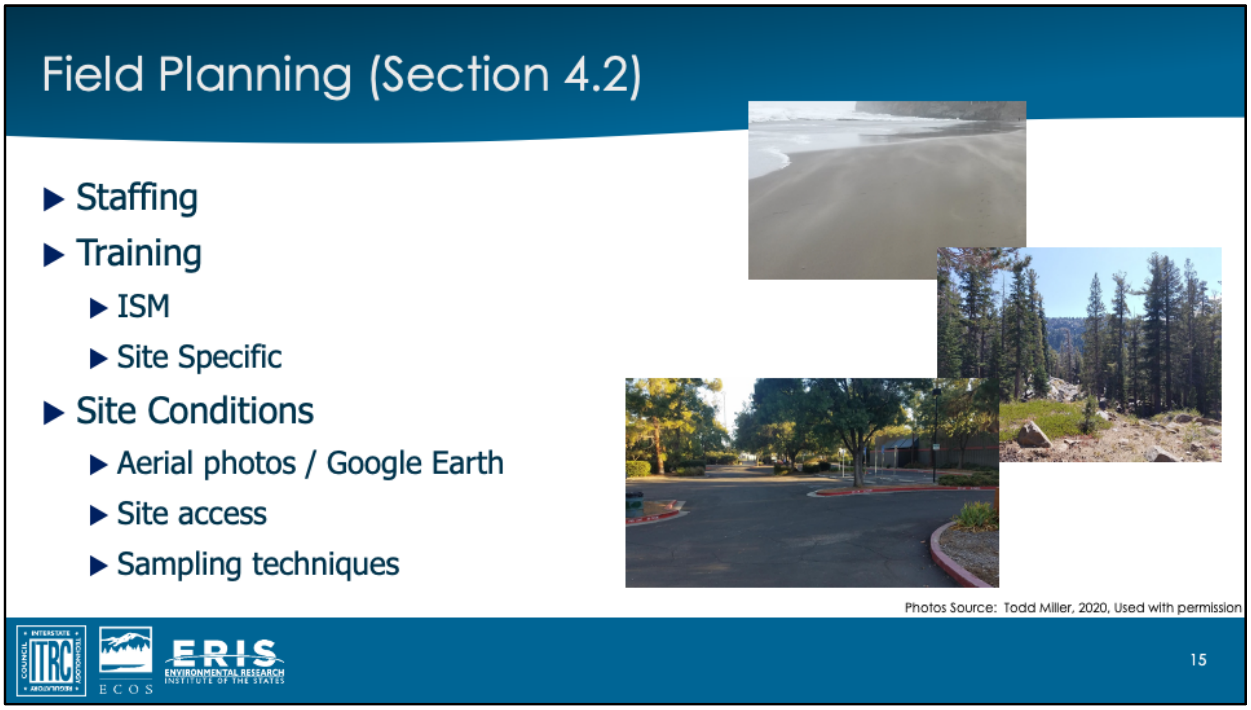


As described in Section 4.2, Field planning should also include a review of the staffing plan, and general site reconnaissance.

Although ISM sampling can be performed by a single individual, a two- to three-person team is often the most efficient method.

Ideally, one person lays out the DUs and increment locations

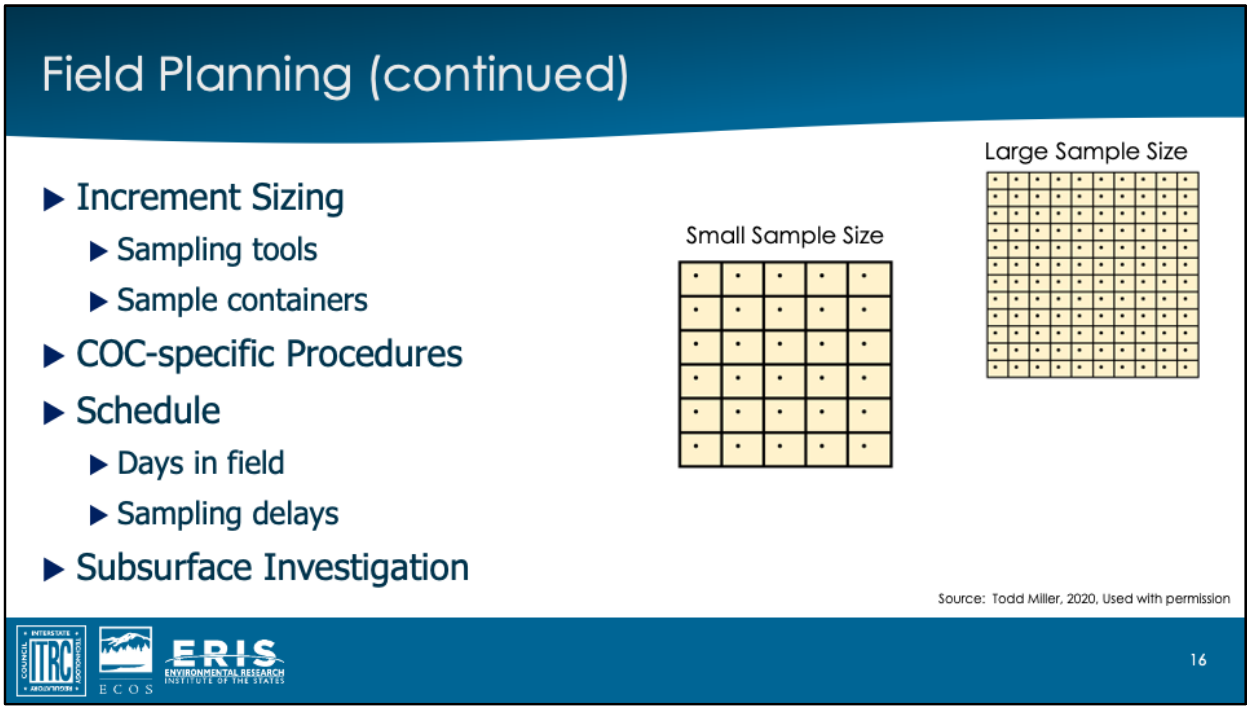
a second person collects the increments, and

a third staff manages the increments, bulk samples and sample containers

For training, staff should have a basic understanding of the sampling objectives and protocols specific to ISM AND understand some of the differences between "traditional" and "ISM" sampling techniques – for example – no need to decon sampling equipment between increments. The Project Manager should also confirm that client and/or site-specific training is provided to staff prior to mobilization.

Site conditions should be confirmed prior to mobilization. The photos on the right show three very different sites – each having different access and sampling constraints. Confirming site conditions prior to mobilization through either field reconnaissance or updated aerial photographs could result in re-evaluation of:

- sampling tools or techniques
- Or how the site or DU is accessed



As described in Section 4.2.3 - Planning should also take into account the number of increments per Bulk Sample.

The figures on the right show two DUs, one with a small number of increments and one with a large number.

The size of the Bulk Samples from these two DUs could be significantly different OR the increment sizes can be adjusted to generate the same sample size Bulk Sample from each.

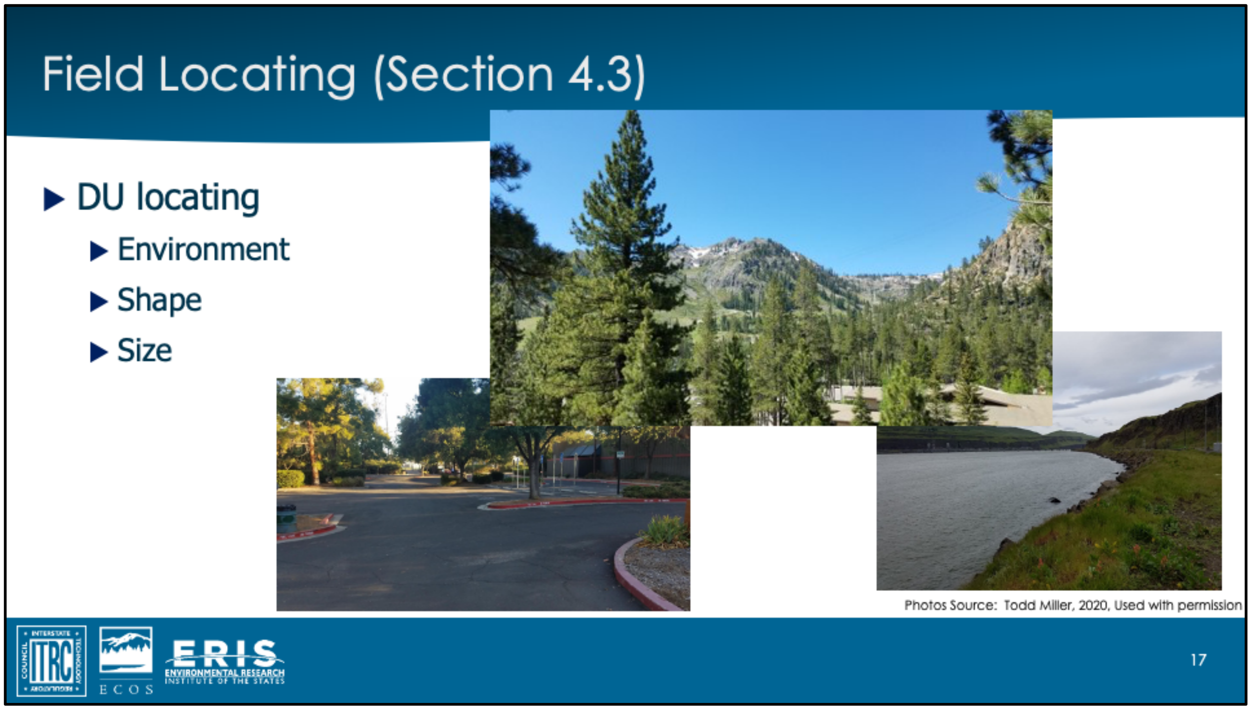
- The size of the increment to be collected will impact the sampling tools needed AS WELL AS the sample container

- Sample containers should also be selected based on the estimated volume of the bulk sample, constituents of concerns to be analyzed, storage, and shipping constraints. In most cases, a 1-gallon resealable plastic bag or a plastic bucket will be appropriate.

Field planning should also cover documentation for sample nomenclature, analytical requirements, and sample preparation procedures, and other items that will need to be included on the chain-of-custody.

Planning also needs to include schedule considerations - The field team should discuss and understand the number of bulk samples to be collected each day and sample storage, as well as how to manage field samples in the event of a significant sampling delay.

Subsurface Investigation planning is described in Section 4.2.4 of the Document. In addition to obtaining good spatial coverage, good vertical representation of the DU adds an additional element to the planning of Subsurface Investigations. As subsurface investigations are inherently labor- and equipment-intensive – additional planning should help minimize field time.

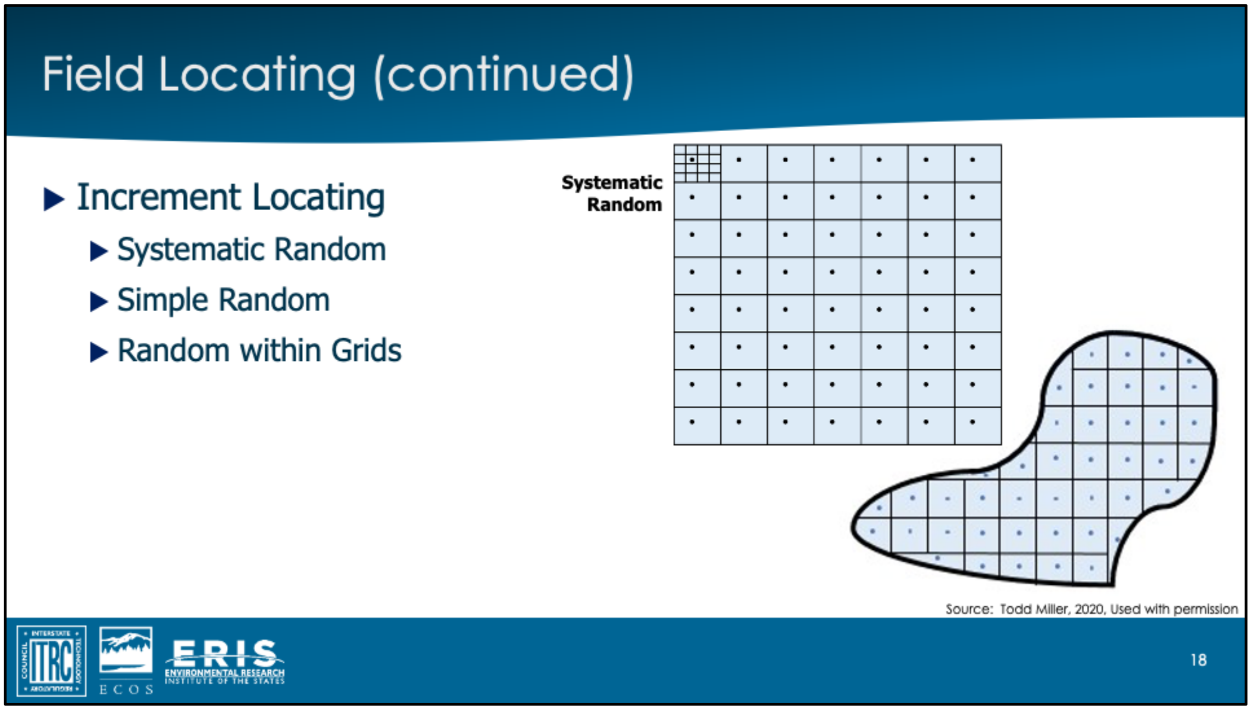


Depending on the environment, locating DUs can be a simple task or complicated.

- For DUs that are in defined areas, such as parking lots, or possibly structurally defined, such as a riverbank, and of a simple shape, like a rectangle, boundaries can be located and gridded with a field tape.

- However, for odd-shaped DUs, or those that are in heavily vegetated, uneven, or in open terrain, a GPS device might be needed.

The field team should be prepared to mark the boundaries of the DU and the increment locations with spray paint, pin flags or survey stakes, depending on the terrain features and surface type. **For other items related to field locating see section 4.3**

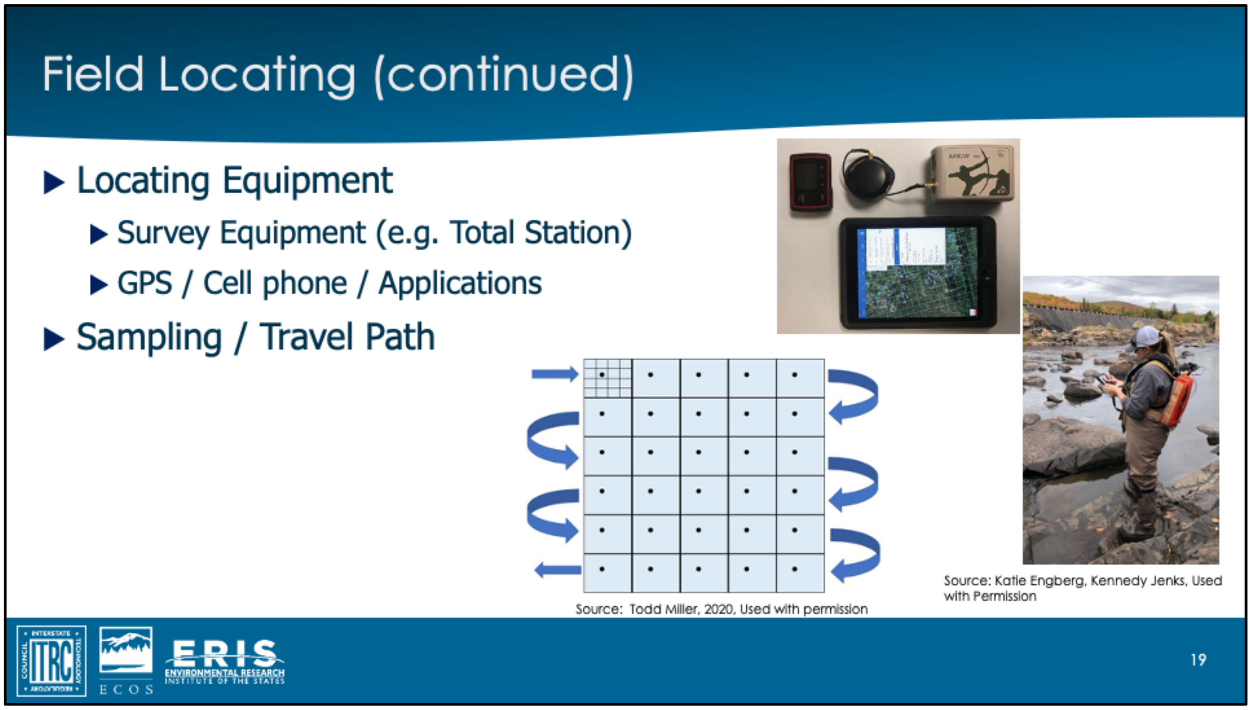


When DUs are square or rectangular in shape, spacing between increments is relatively straight forward.

- For example, a square-shaped DU could be divided into eight rows and seven columns, with one increment collected from each grid cell.
    - Document says 30-100 increments – a higher number of increments will increase confidence and reduce uncertainty in the data
- The preferred method is to collect increments from the same location within each grid cell (known as Systematic Random Sampling)
- Systematic Random Sampling **produces equally-spaced increments such that the entire DU is equally represented, and there are no significant gaps between increment locations.** And as previously discussed - the goal of increment spacing is to represent each part of the DU equally - without bias.
- Other techniques, such as "Simple Random" or "Random within Grid" can also produced unbiased representation of the DU **but can result in large spatial gaps between increment locations and are therefor less desirable. More information about these two locating techniques is presented in Section 3.1 of the ISM-2 document**.

For odd shaped DUs, cell size and shape can be adjusted such that each cell is approximately the same size (area)

row lengths and increments per row may vary throughout the DU. In these cases, ensuring equal spacing of the increments will require pre-planning.



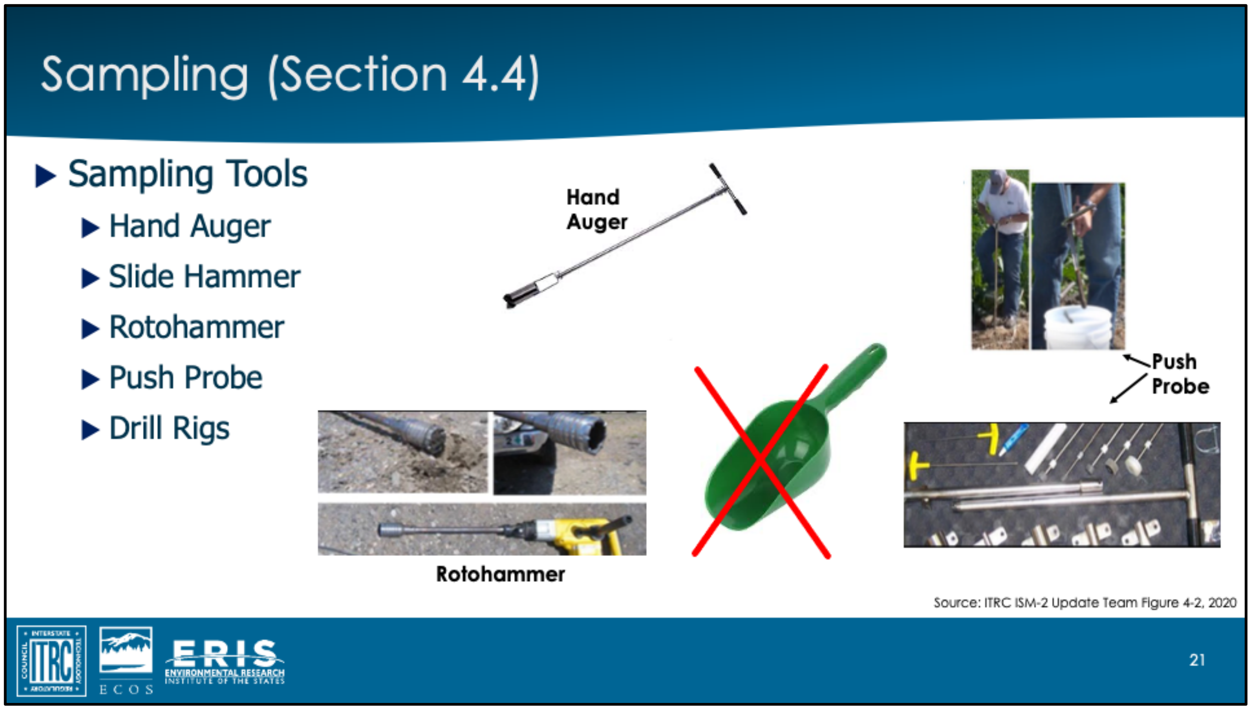
DU and increment locating can be performed using basic field equipment such as field tape or conventional survey equipment.

- GIS based tools can be used with a cellphone or tablet - and a GPS unit depending on the need for accuracy - to establish field locations.
    - GIS based positioning applications can be used in the field to record DU boundaries and increment locations, or
    - locations can be established in advance of sample collection and placed on a site map, then the application be used by the field team to confirm each increment location.

Pre-planning the travel path for increment collection will help save time in the field. The path is best selected during the planning stages to meet the DQOs; however, reviewing the selected travel path after mobilizing and prior to sample collection is recommended.

The video shows a field crew setting up locations and collecting increments. One member is laying out pin flags at each increment location, a second person is collecting the sample at each location and a third is collecting the samples into a single container. **The video show how quickly a surface soil investigation can be conducted using ISM.** Note that equipment decontamination is not occurring between increments.

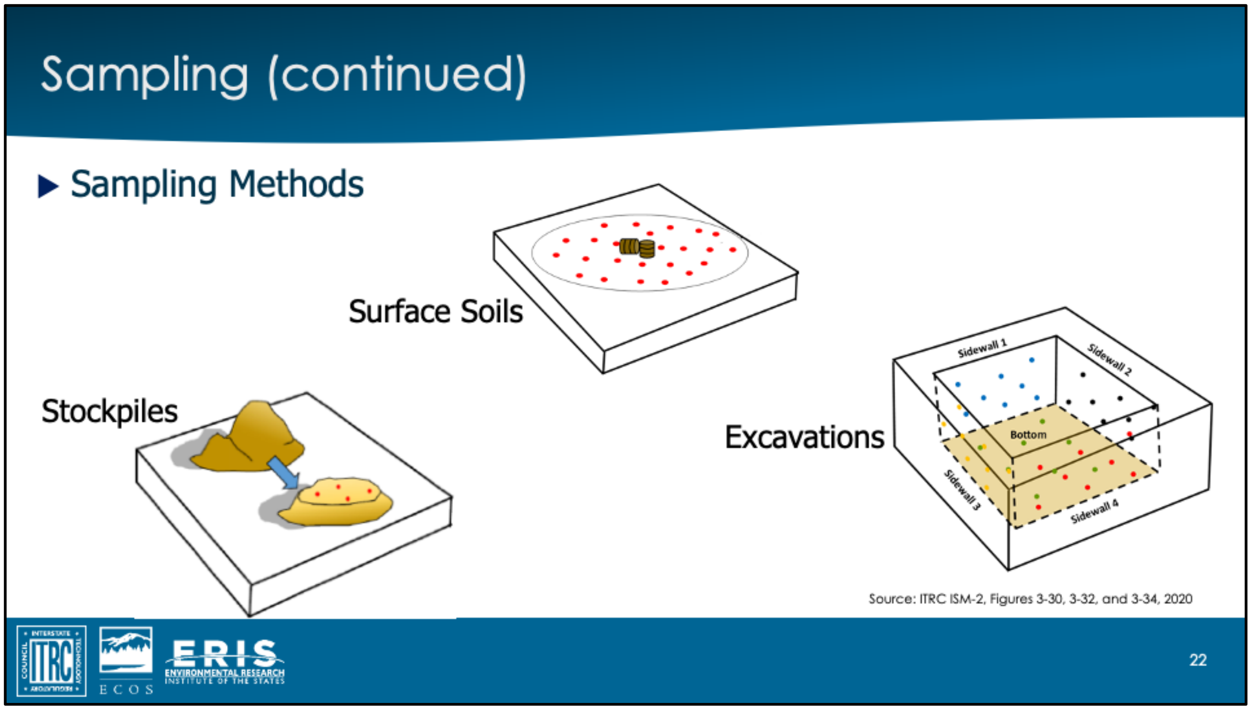
Increasing the number of increments increases confidence (narrows the confidence interval) in the results.



As described in Section 4.4, the sampling tools selected for the project will depend on the media being sampled, the sample depth or depths, and the volume of soil to be collected. Sampling tools may consist of:

- hand tools, such as augers, or slide hammers;
- power tools such as roto-hammers or vibratory probes, or
- large equipment such as direct-push drill rigs.

Typically, scoops are not preferred in the field as it can be difficult maintain a consistent increment volume.



Different sampling methods will be needed for different conditions and objectives.

- As previously discussed, Surface soil sampling, can be accomplished by starting in one corner or end of the DU and collecting samples systematically throughout the DU.

- Stockpile sampling can be accomplished in several manners and needs to consider the source of the material and how the stockpile was created

  - One of the best options is to coordinate sampling during formation of the stockpile. As the stockpile is being created, there is generally good access to sampling each portion of the pile over time. This provides access to the entire stockpile and ensures representativeness of the material. Other options include:

    - moving the stockpile and collecting the increments while it is being moved

    - flattening or spreading out the stockpile so that it is safely accessible to sample with a hand core or other device (as shown on the below graphic).

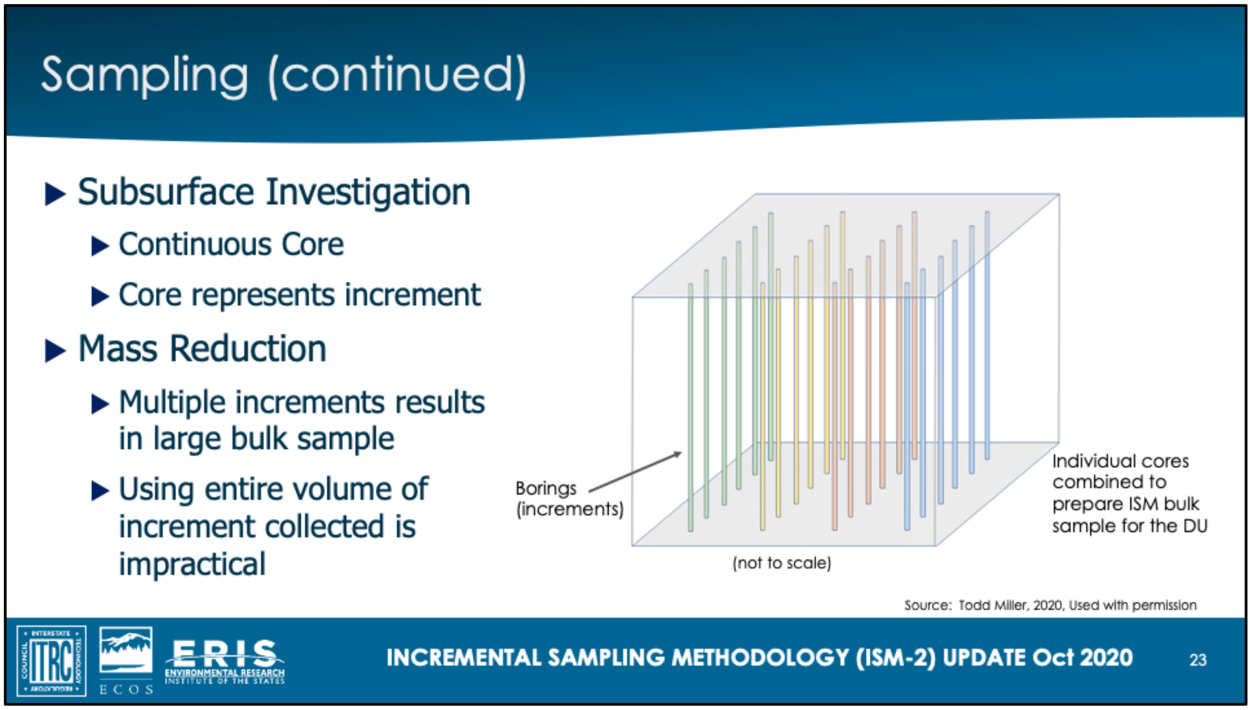
    - Core sampling the stockpile to obtain representative horizontal and vertical distribution of increments.

Excavation sampling can be completed by assigning different DUs to the different portions of the excavation.

As show in the lower right graphic

- Each sidewall is a separate DU and

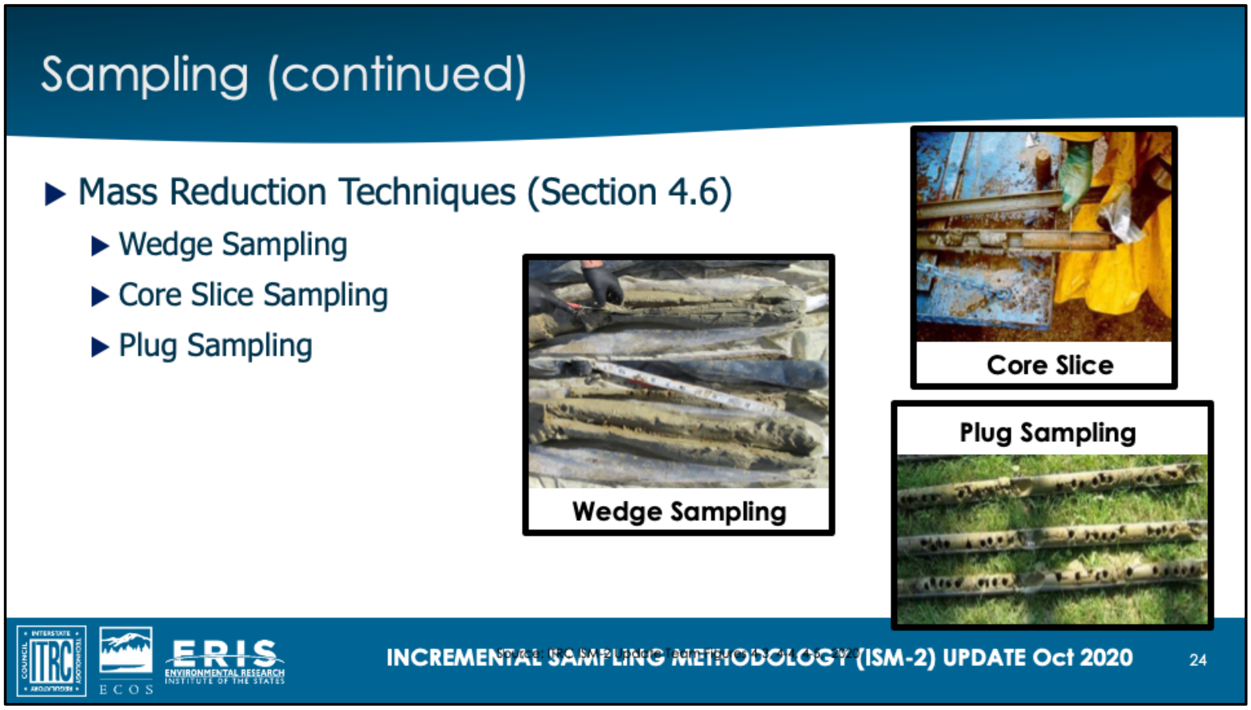
- The excavation base is a separate DU



Subsurface sampling is typically completed using continuous core techniques.

Ideally, to be representative, the entire core should be considered an increment. <EXAMPLE>

However, this can result in an ISM sample with a very large volume, making logistics, such as field storage, shipping, and laboratory processing, problematic.



To reduce the sample volume, mass reduction techniques can be use. **Mass Reduction techniques are described in Section 4.6**, and consist of:

- Wedge sampling
- Core slice sampling
- Plug sampling

Wedge sampling is preferred because the resulting increment represents the entire vertical distribution of the core. However, may still produce a large volume of sample.

Plug sampling and core slice sampling are good alternatives - but - will result in **vertical sections** of the core being UNrepresented.

Knowledge Check

Which of the following factors will impact how increments are collected:

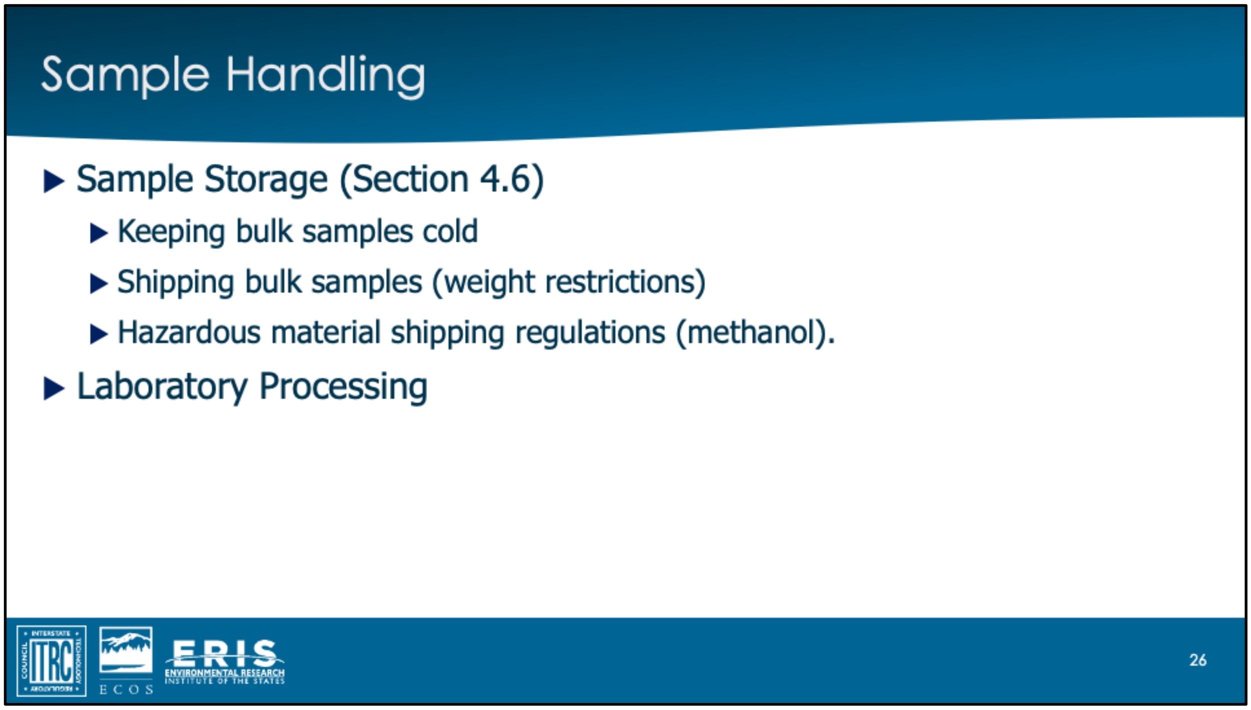
A. Soil Type

B. Terrain

C. Specified Sampling Equipment

D. Mass Reduction technique to be used (if needed)

E. All of the above



Section 4.6 of the document also provides more information about Sample Handling – a few key points here.

The primary concern for sample storage is the large sample volume.

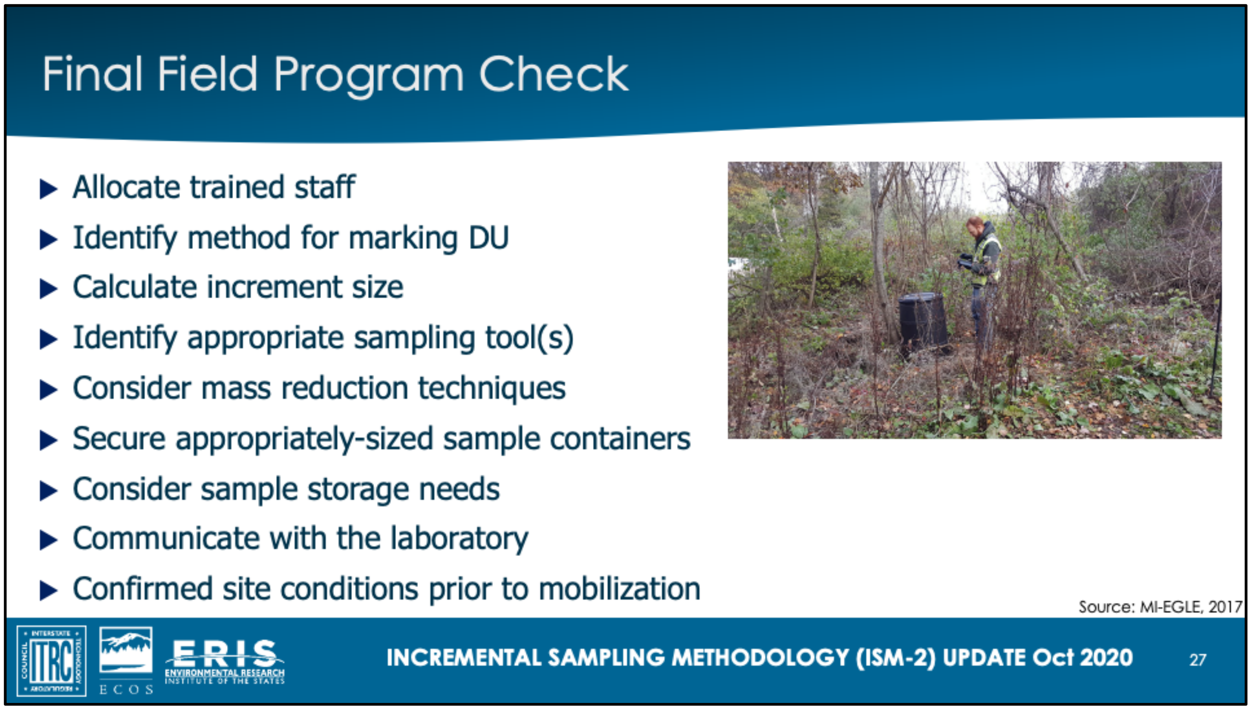
Significant storage space, using multiple coolers or a field refrigerator, is typically needed.

- Increments collected during a single day do not need to be cooled;
- however, the bulk sample, once processed and labelled, should be stored in a cooled ice chest or refrigerator and should remain cold until the sample is received by the laboratory.

Note that shipping large volume bulk samples requires good coordination with the shipping company and the laboratory receiving the samples. Large volumes of ice, or freezer packets will be needed for the multiple coolers. Shipping weight should also be considered.

The use of hazardous materials in the field, such as using methanol to preserve samples for VOC, can result in shipping restrictions. The field team will need to make sure they are familiar with and follow hazardous materials shipping regulations.

Because processing of ISM samples can take several days, sample holding times should also be considered in the logistics during planning and when consulting with the laboratory.



After reading Section 4, the following questions should also be able to be answered to ensure proper field preparation and implementation. Have you:

- Allocated appropriately trained staff to execute the task
- identified site-specific means of marking out a DU
- calculated the increment size based on the sample design total volume
- identified the appropriate tool(s) to obtain each increment from the required depth
- assessed if a mass reduction technique will be needed during increment collection
- requested/obtained sample containers specific to ISM (large volume, special considerations for VOCs for ISM)
- considered the added resources for sample storage (added ice and coolers)
- communicated to the laboratory the required processing and QC requirements for the chain of custody
- checked site conditions using photos, visual observation or other means to confirm site access and sampling equipment are appropriate

Thank you for attending! Questions & Answers?

- ISM Training Modules will be hosted for separate viewing On Demand
- Questions? itrc@itrcweb.org
- Want more? For additional training on ISM, visit https://clu-in.org/conf/itrc/ism/

ISM Update Modules

Module 1: Overview (Sect 1)
Module 2: Heterogeneity (Sect 2)
Module 3: Statistics (Sect 3.2),
Data Use Planning (Sect 3.3), &
Data Quality Evaluation (Sect 6)
Module 4: Field Sampling Collection (Sect 4)
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Module 6: Risk Assessment (Sect 8)

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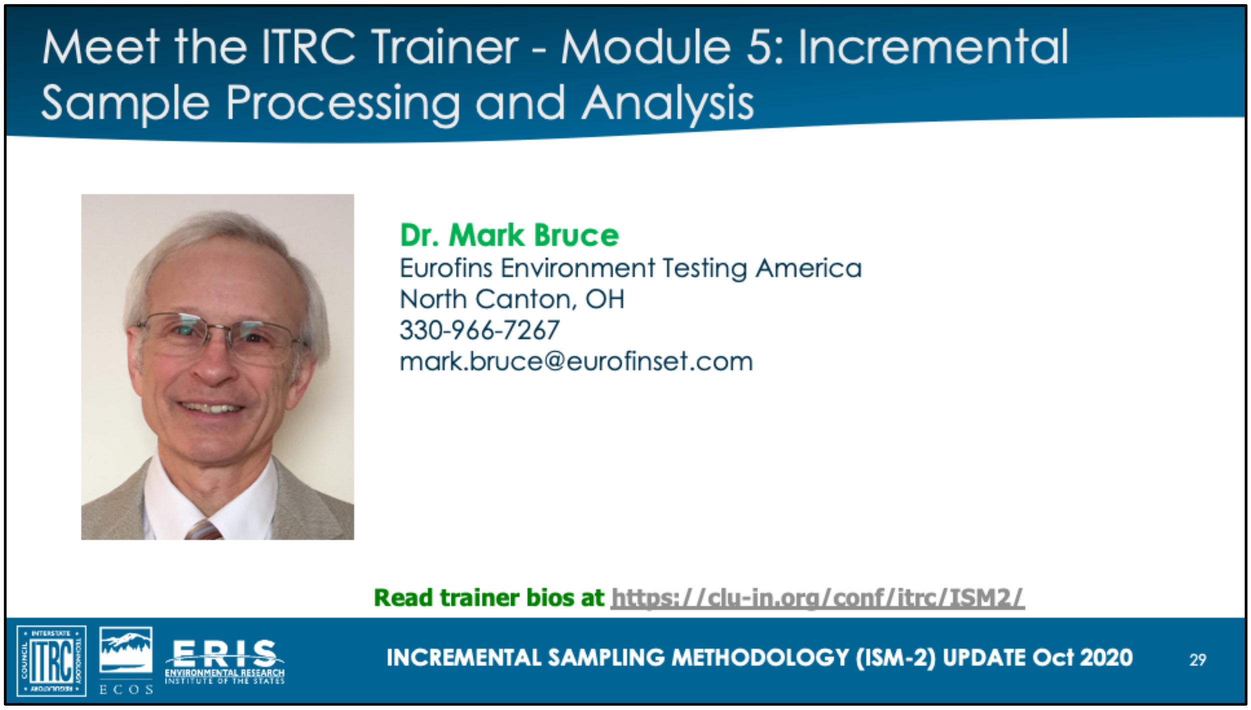
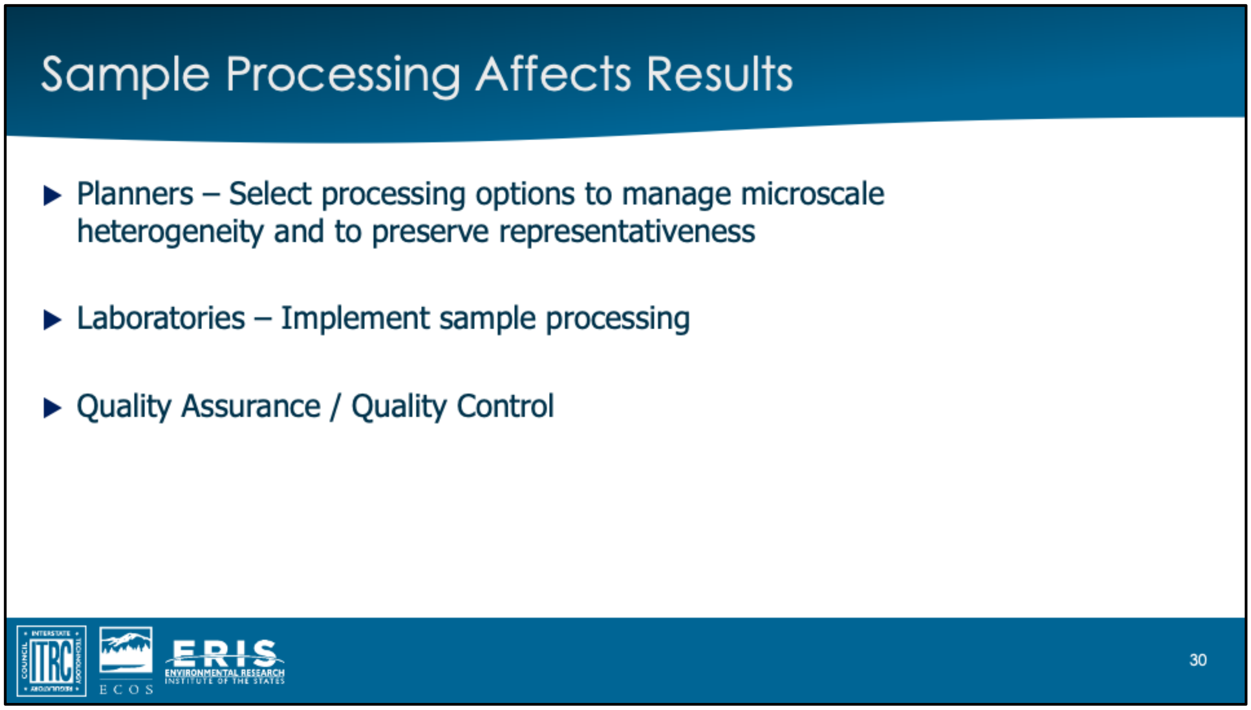
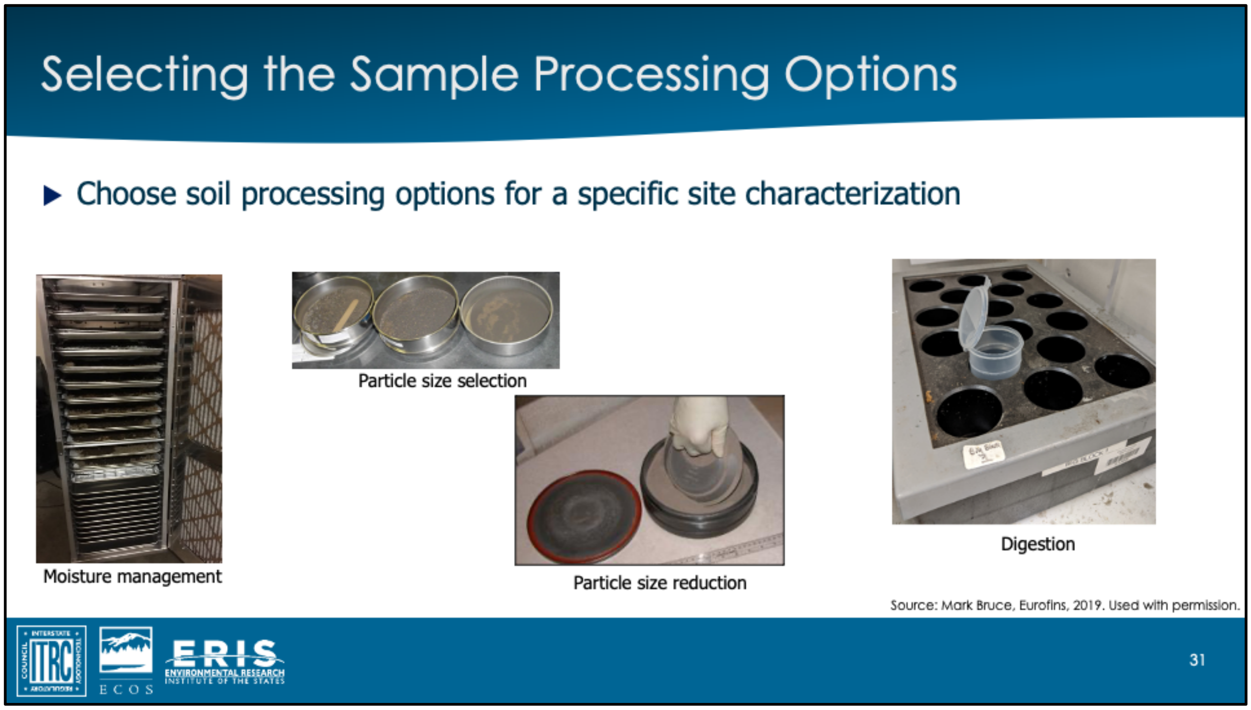


Incremental Sampling Methodology practitioners put a lot of effort into developing a sampling plan and then implementing that plan in the field. We want to maintain that level of effort for sample processing.



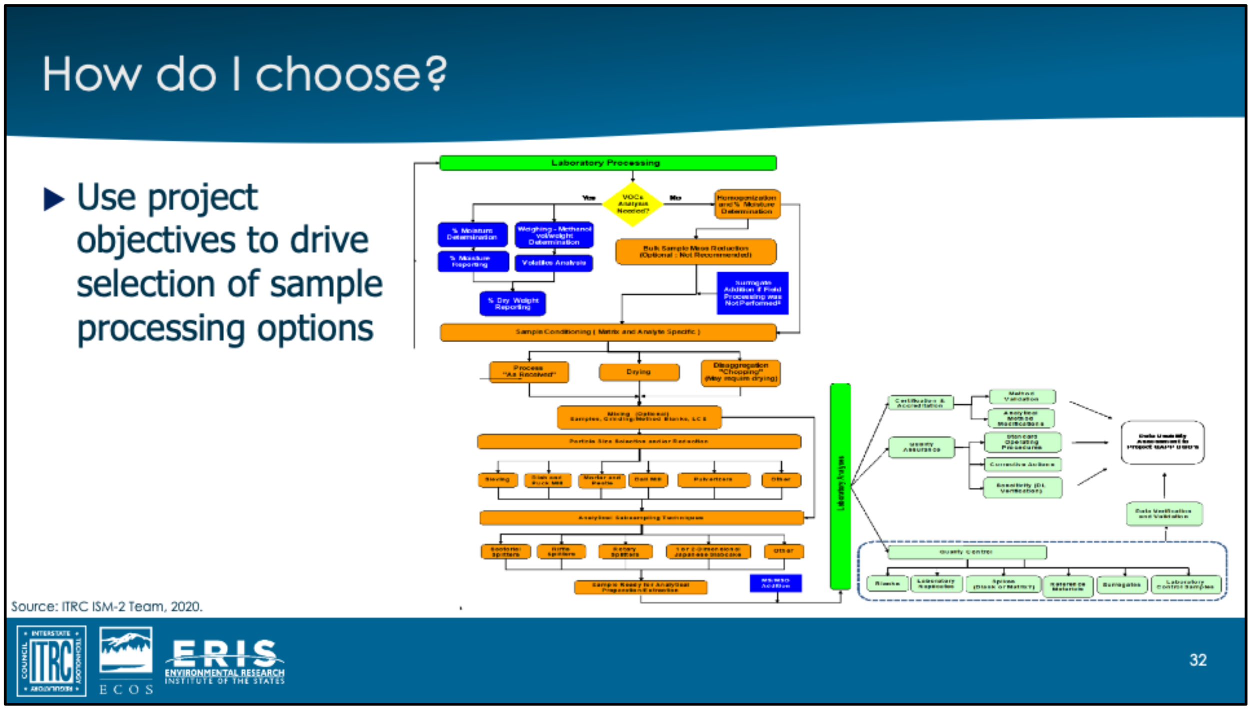
In this module we will cover how to maintain sample representativeness and improve precision by selecting the most appropriate sample processing options. We will also discuss how to implement the most common sample processing options and important aspects of quality.



The project team should choose the most appropriate processing options for a specific site characterization.

Objectives and site characteristics such as
contaminants of concern (analytes),
surface or subsurface soil,
contaminant release mechanism and
data usage scenarios

These influence the selection of sample processing options for
Moisture management,
Particle size selection,
Particle size reduction and
Digestion or extraction



No universal ISM sample process,

How to one choose

avoid making a decision error

discuss common processing techniques and decisions to be made during planning.

Air Drying

- Only air dry if the analytes are stable when exposed to air
  - Surface soil – usually stable
  - Subsurface soil – frequently stable
    - Potential volatilization losses if low boiling contaminants weakly absorbed on particles

Source: Mark Bruce, Eurofins, 2019. Used with permission.

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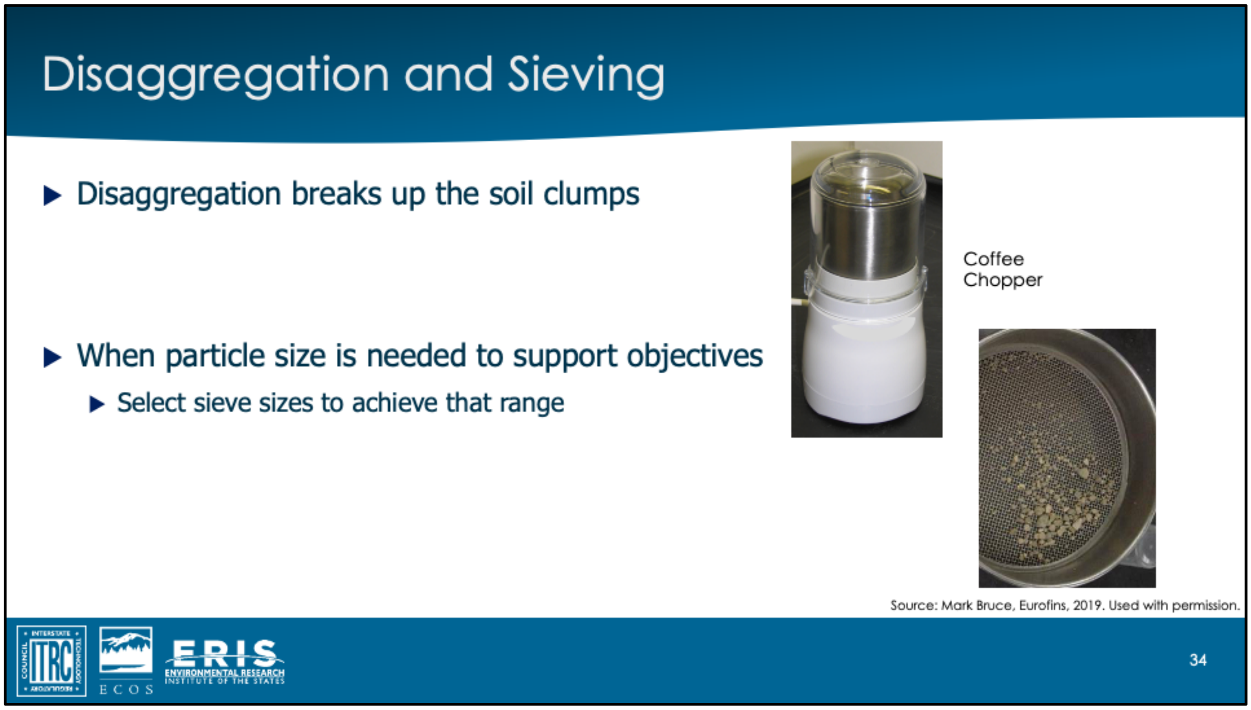
Lower cost when soil is dry

Facilitates disaggregation and sieving
Contaminants need to be stable
Consider volatilization losses,
Boiling point,
Binding to soil particles

Surface soils are usually stable with regard to air drying because they have already been exposed to air

Might need to skip air drying if low boiling semivolatile analytes are weakly absorbed on the particles.
subsampling on the as-received sample.

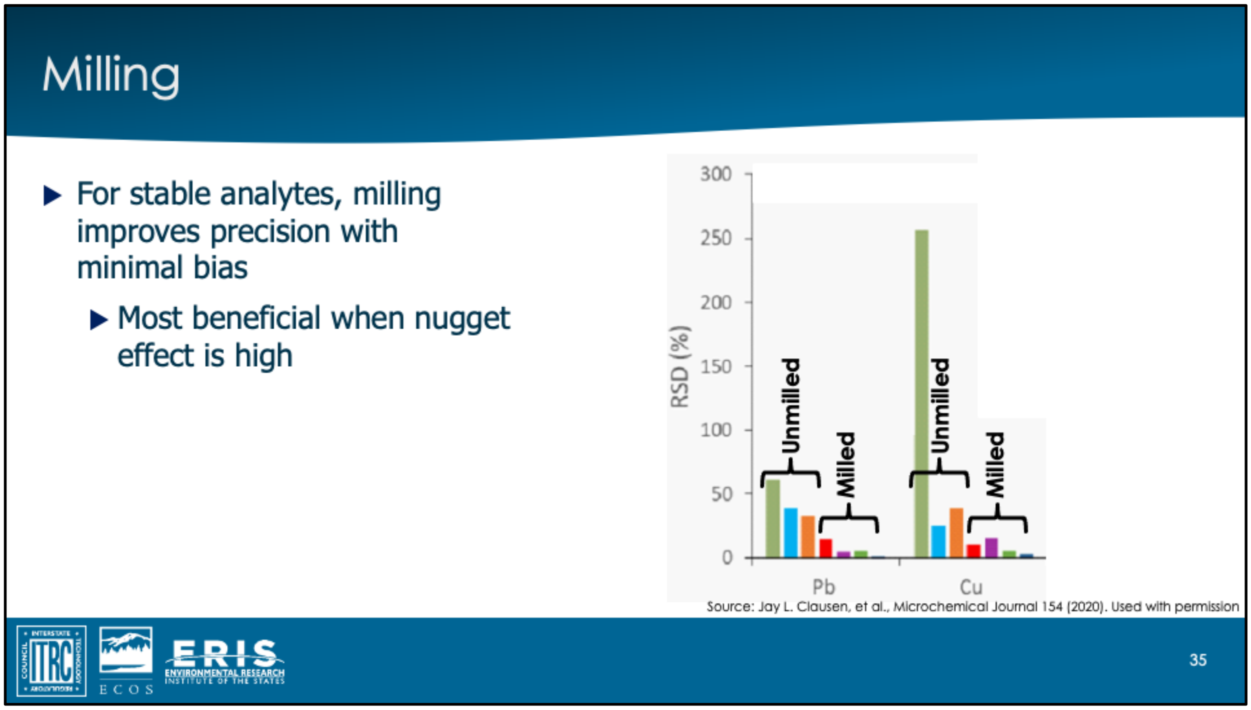


Disaggregation
used on dry, crushable soil
breaks up the soil clods
does not mill small pebbles

Facilitates sieving, milling and subsampling

Particle size selection determined by the DQOs.

Example
soil definition of < 2 mm particles, #10 sieve.
particles likely to stick to hands and be ingested, #100 sieve



Particle size reduction through sample milling
more reproducible subsampling
better precision.

Jay L. Clausen, et al., Microchemical Journal 154 (2020)

not recommended
volatilization or thermal decomposition.
metal mill can produce metal contamination Fe and Cr.
For some risk assessment purposes releasing the metals from inside the pebbles to produce higher measured concentrations is a potential high bias for the results.

Knowledge Check

- What are the most practical processing options when air drying is not appropriate? Select all applicable options
  - A. Disaggregation
  - B. Sieving
  - C. Milling
  - D. 2D Slabcake subsampling

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ECOS

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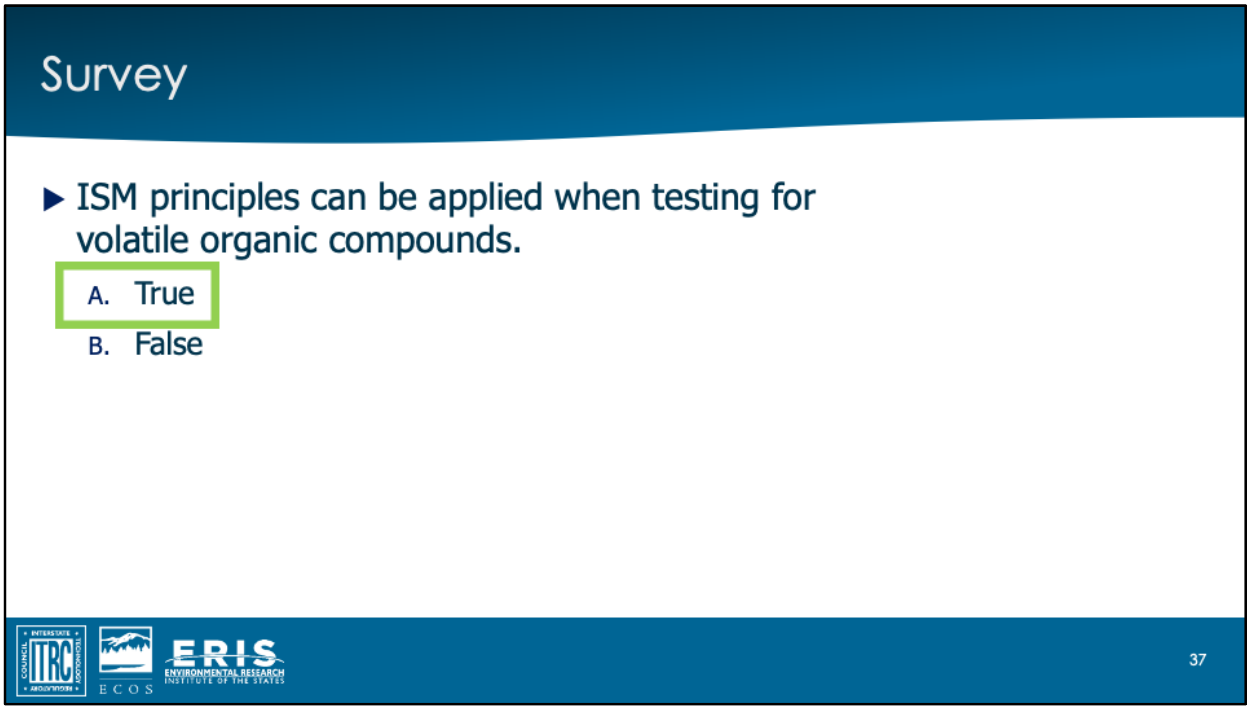
Best answer is (D) – 2D slabcake subsampling on the as-received sample

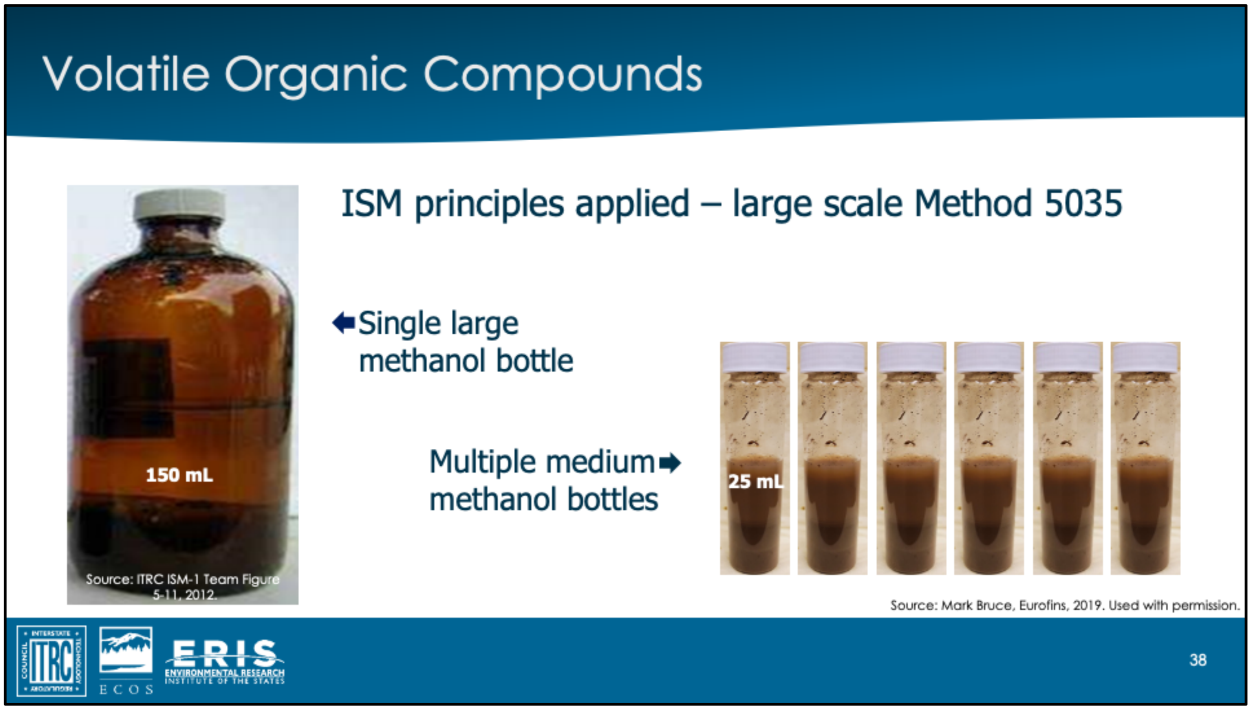
Sticky cohesive soil disaggregation can be partially accomplished by chopping the sample with a spatula.

Sieving and milling of sticky soils is not practical.



Correct answer is TRUE

Discussed on the next slide



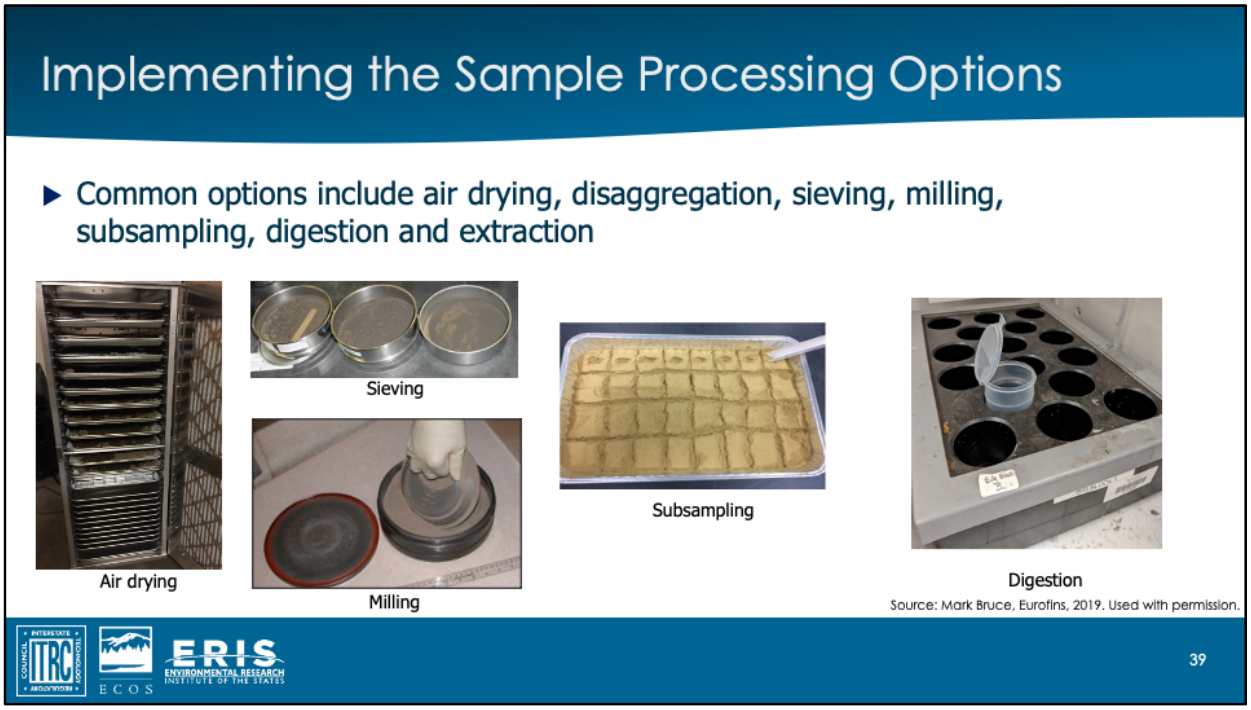
ISM principles can be applied to volatile organic compounds,

minimal air exposure

larger scale version of the methanol preservation option of EPA Method 5035

Large bottles capable of holding the entire sample can be shipped by ground.
Typically 150 g soil (30 increments) 150 mL methanol

Air shipment limits the methanol volume to 30 mL per container,
back at the lab composite several medium sized bottles per decision unit to contain the whole sample.



The laboratory must implement the processing options needed for a specific site characterization.

air drying,
disaggregation,
sieving,
milling,
subsampling,
digestion and extraction.

Most common sample conditioning step

air drying
room temperature

produce dry crushable dirt clods

wet sample is spread on a tray

moisture evaporates under ventilation

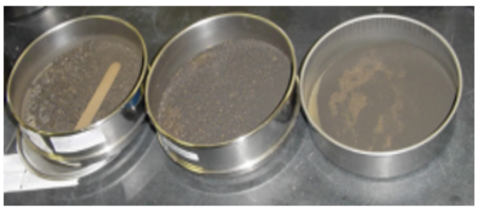
far right is an air drying tower capable of drying many samples

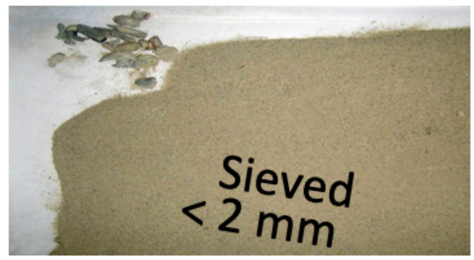
Disaggregating
breaking the soil clumps
Not milling small pebbles and other hard crystalline materials

Gentle hand mortar and pestle
coffee chopper
Rotary hammer disaggregator

Particle Size Selection

- Sieving





Source: Figure 5-7 ISM-2

Source: Jay Clausen, USACE, 2019. Used with permission.

Sieving selects particles above, within or below a specified size.
most common is the #10 sieve that removes all particles > 2 mm.

Particle Size Reduction – Milling

- Milling
  - Puck mill

  - Ball mill

Source: Mark Bruce, Eurofins, 2019. Used with permission.

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Milling

complete particle size reduction of all soil

puck mill has been demonstrated
for energetics (Method 8330B)
and some metals.
Significant precision improvement

ball mill is a
less expensive and less rigorous option that is still suitable for many applications.
moderate improvement in precision.

choosing the milling equipment consider
analytes,
concentration of interest,
mill materials
particle size needed.

Particle Size Reduction – Milling

Source: Mark Bruce, Eurofins, 2019. Used with permission.

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Demonstration of puck mill

Placing the sample in the bowl

Inserting the covered bowl in the shaker

Removal from the shaker

Empty the bowl

Some methods that include milling (e.g. 8330B)
Require multiple milling cycles
With cooling between to manage sample temperature

Knowledge Check

- What is the primary benefit of milling?
  - A. Improve analyte recovery
  - B. Improve precision
  - C. Improve QC results

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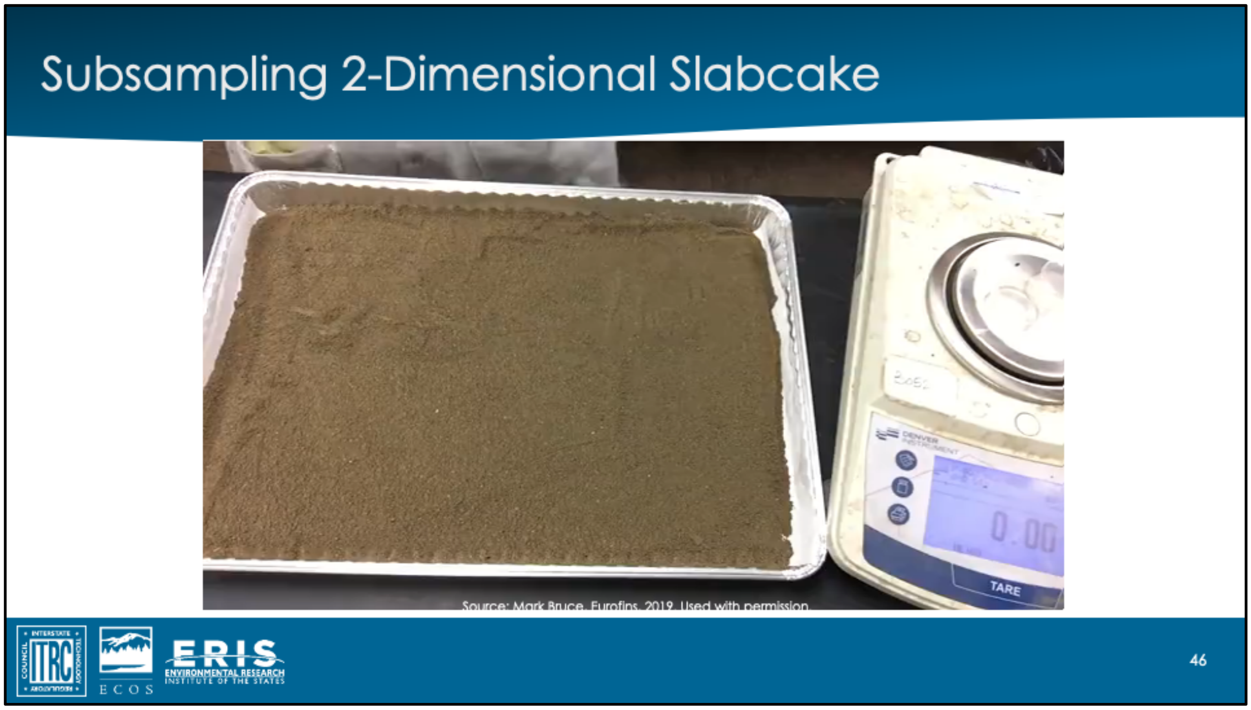
Correct answer – Improve precision



2 dimensional slabcake

acceptable subsample representativeness at reasonable cost.

miniaturized version of field sample collection process.
sample is spread evenly in rectangular slabcake and
divided into grids
analyst removes a small increment from a random location in the first grid.
Subsequent increments are collected from the same location in the other grids.
All increments are combined to form the subsample
best scoop has a flat end with sides.

Sample Digestion/Extraction

- Digestion for Metals
- Extraction for Organics
- Larger subsample mass for samples with expected high heterogeneity

Source: Jay Clausen, USACE, 2019. Used with permission.

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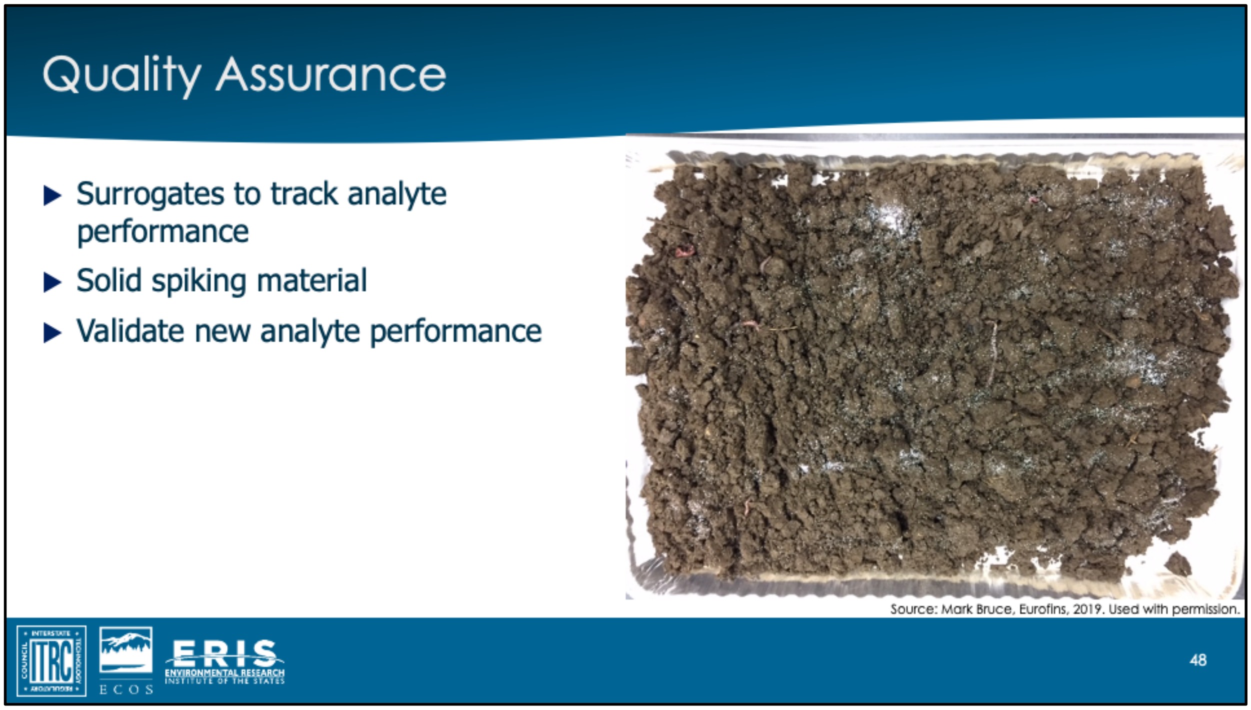
When milling has not been used the optimal subsamples are in the 10- 30 g.

Some labs have scaled up their metals digestions to accommodate 10 g subsamples rather than the usual 1-2 g subsamples.
Most organic analyte sample extractions already use 10 g subsamples or larger.

Other inorganic analyte sample preparations have less frequently been scaled up so it is important for the planners to discuss available options with the laboratory.



on-going effort to develop surrogates that can be added at the beginning of the ISM sample processing

to monitor for the potential bias that may be the result of the matrix and/or sample preparation steps.

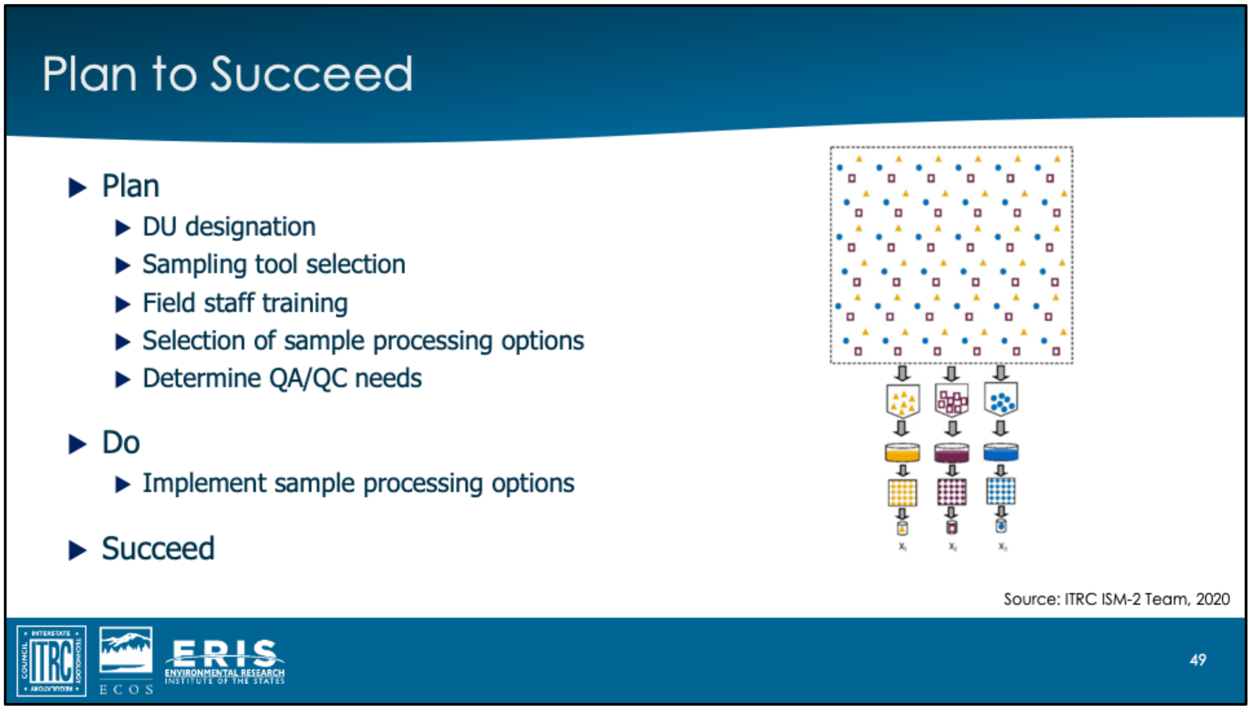
Surrogates are not intended to be added to each sample prior to any sample preparation steps.
Most environmental laboratories do not add surrogates to large (1-5 Kg) ISM samples that require drying and other processing

The picture on the right shows a
solid white surrogate powder sprinkled on the surface of a soil sample
at the start of the air drying process.
still in development.

The DoD is developing isotopically labeled PAH surrogates to track analyte integrity through ISM sample processing.

Addition of traditional solvent based surrogate solutions
to the sample prior to air drying over estimates losses of lower boiling organics
because of low absorbance on soil particles

Performance of new analytes should be demonstrated



Planning the QA/QC needs for ISM projects is
critical because ISM requires planning that includes
DU designation,
sampling tool selection,
field staff training, and
selection of sample processing options.

Project teams should work with
project chemists and laboratories to carefully plan for the appropriate QA/QC needs for a project.

Thank you for attending! Questions & Answers?

- Email further questions on today's session to: itrc@itrcweb.org
- ISM Training Modules will be hosted for separate viewing On Demand
- Want more? Visit https://clu-in.org/conf/itrc/ism/ for more in-depth training modules on ISM

ISM Update Modules

Module 1: Overview (Sect 1)
Module 2: Heterogeneity (Sect 2)
Module 3: Statistics (Sect 3.2), Data Use Planning (Sect 3.3), and Data Quality Evaluation (Sect 6)
Module 4: Field Sampling Collection (Sect 4)
Module 5: Lab Preparation (Sect 5)
Module 6: Risk Assessment (Sect 8)

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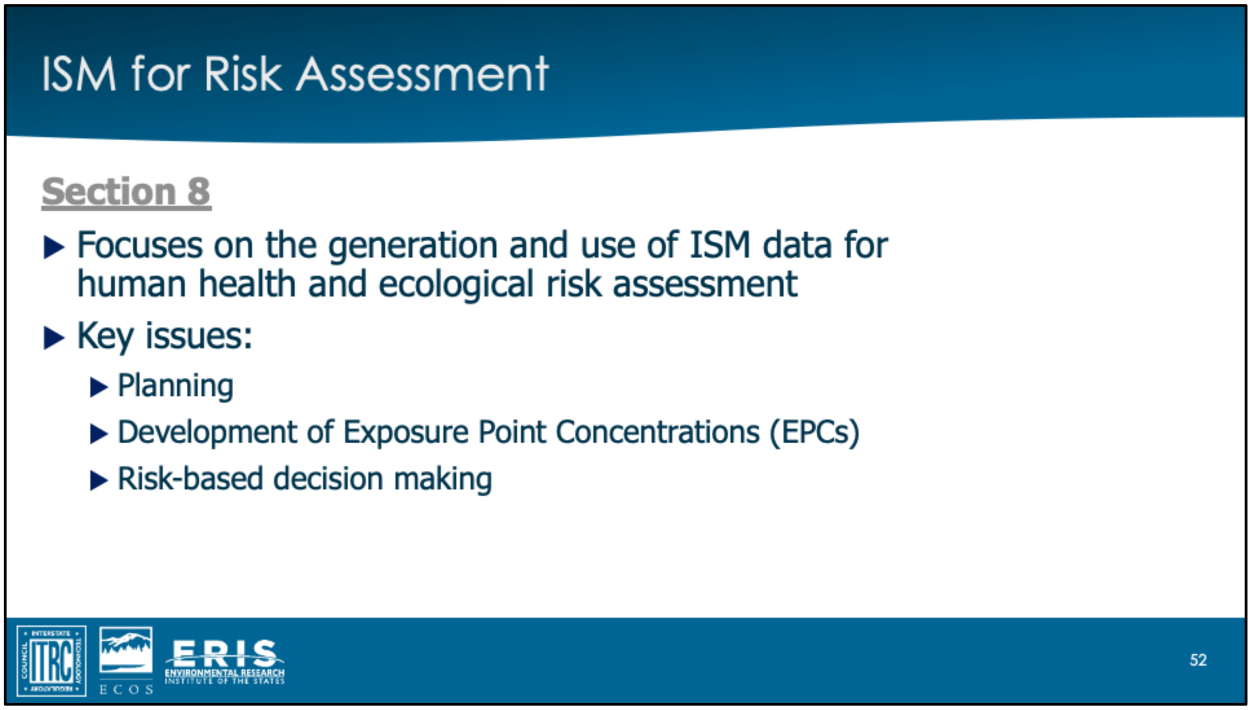
This training module focuses on the content of Section 8 in ISM2. Section 8 addresses the key issues risk assessors should consider when **planning** for the use of ISM data for risk assessment and provides guidance for **use** of ISM data in risk assessment and risk-based decision making.

As in previous training modules, **links** will be included **in the slide** to redirect you to the specific section location for additional detail on the topic. For example, this slide is linked to Section 8.

TRAINER BIOS

Tamara Sorell, PhD, BCES, has over 30 years of experience in the environmental consulting industry focusing on sampling and risk evaluation. She currently serves as the National Risk Assessment and Toxicology Practice Lead for Brown and Caldwell, primarily for Site Remediation and Investigation projects. Tamara has worked across the U.S under many State programs, as well as on CERLCA and RCRA sites. Tamara has been active in professional organizations and currently sits on the Society of Environmental Toxicology and Chemistry Career Development Leadership Committee; and works as a liaison to the Early Career Committee, supporting young professionals. Tamara has been working with ITRC since 2008. She served as a Co-Author and Internet-Based Trainer for both the Sediment Bioavailability and Sediment Remediation teams, and is an Interested Party on the 1,4-dioxane and Soil Background teams. Tamara has a bachelor's degree in Biochemical Sciences from Princeton University, and a Ph.D. in Pharmacology from Columbia University. She is a Board-Certified Environmental Scientist,

Dr. Karen Wernette DiBiasio has over 30 years of regulatory experience in toxicology and risk assessment. Dr. DiBiasio is a Staff Toxicologist for the State of California, California EPA, Department of Toxic Substances Control (DTSC) where she has worked since 1993. In the Human and Ecological Risk Office (HERO) at DTSC she serves as a technical expert in toxicology and risk assessment. She has a broad range of experience in human health multimedia risk assessment regulatory oversight throughout all stages from planning sampling (including ISM sampling) for use in risk assessment to post-remediation and long-term monitoring risk assessment for various types of CERCLA, Brownfields, and RCRA sites impacted by a diverse spectrum of chemical contaminants. Dr. DiBiasio earned her B.S. from Michigan State University in Microbiology and Public Health, M.P.H. from University of California at Berkeley (UC Berkeley) in Biomedical and Environmental Health Sciences with emphasis in toxicology, and Ph.D. in Pharmacology & Toxicology from UC Davis. Karen has served on the ITRC ISM2 team since its inception.



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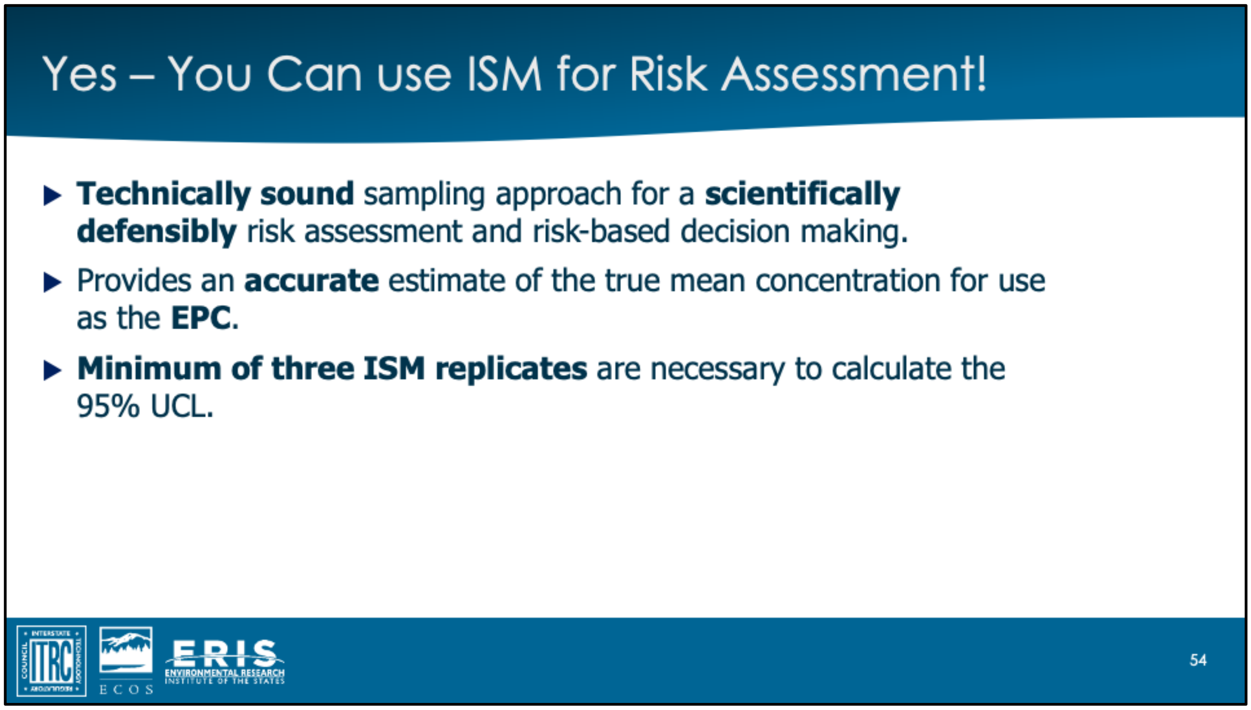
Relies heavily on earlier sections of the ISM2 Guidance, directing the risk assessor to the necessary within ISM2. A **go-to resource** for use of ISM data in risk assessment.

Will only touch on select high level topics in this presentation.

Poll

- Have you ever used ISM data for risk assessment?
- Were you aware that you can generate a reliable UCL to use as an exposure point concentration with three replicates?

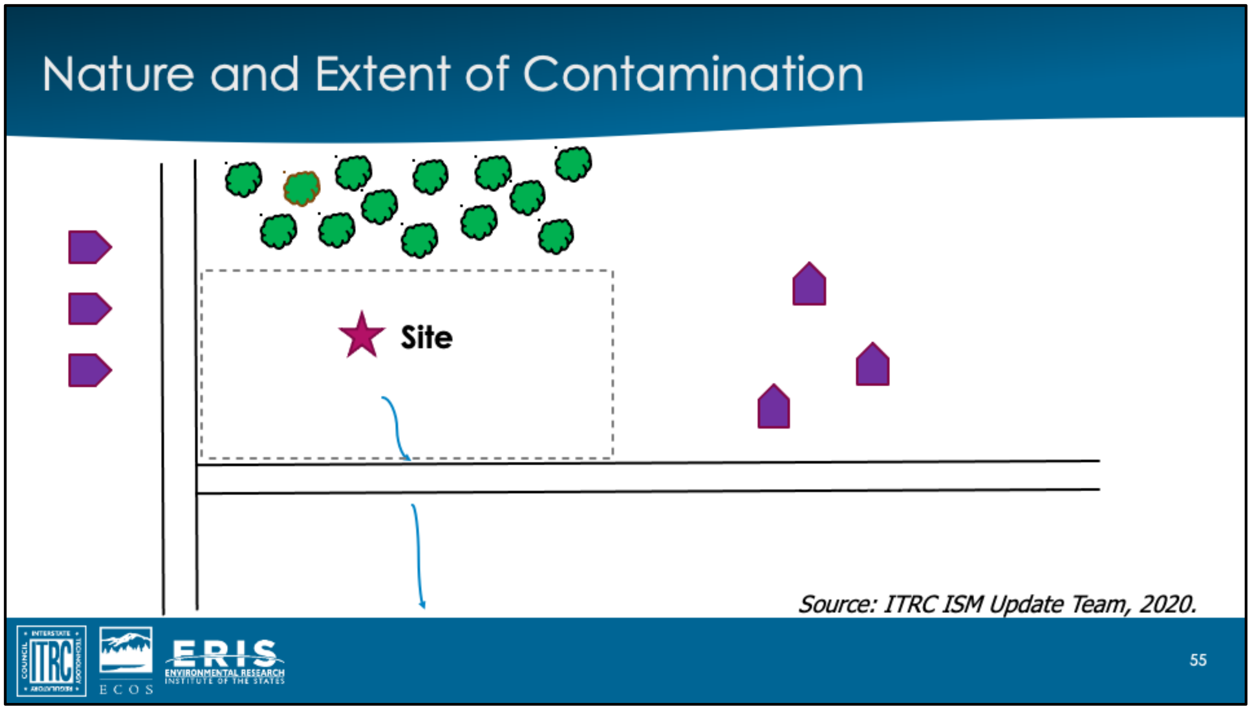


1. This section will explain the requirements for estimating the true mean, which is the EPC

2. ISM is a technically sound sampling approach to collect data for a scientifically defensibly risk assessment designed to assist in risk-based decision making.

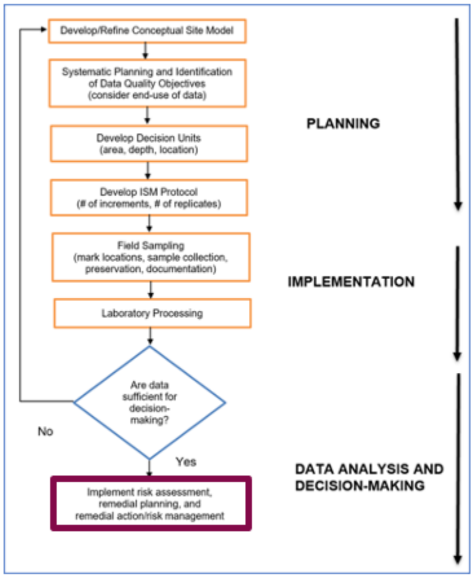
3. ISM provides an accurate estimate of the true mean concentration with a limited number of samples for use as the EPC.

4. A minimum of three ISM replicates are necessary for the calculation of the 95% UCL of the mean, typically used as the EPC.



- To define DUs based on anticipated spatial distribution of chemical contaminants.
- To determine Receptors
- To understand COPCs because their P/C properties are important for determining complete RA exposure pathways.
- Section 8.2.3 -
  - Section 3.1.5, delineating the nature and extent of contamination is a common objective of environmental sampling in a remedial investigation
    - **appropriate area** (for example, residential property, ecological receptor home range, and so on) and
    - **depths** (surface, or 0 to 1 ft; subsurface, or 1 to 10 ft) where receptors may be exposed to soil contamination,
    - integration of information about the nature and extent of contamination is essential for the risk assessor.
  - N & E to compile the CSM

    Both the horizontal and vertical extent of contamination essential for risk assessment process.
  - Examples
    - future land use - potential redevelopment where soil mixing may redistribute subsurface soils to shallower depths or the surface
    - lateral extents - critical for determining potential receptors (for both current and future human and ecological receptors), especially if the lateral extents go beyond the Site property boundary to an area where different land uses exist or could be present in the future.



The Conceptual Site Model (CSM) underlies the entire risk ISM process and must be fully developed.

Planning is key! – be sure to include the risk assessment team from the start.

Risk assessment study questions can help guide the decision unit development, which will be the basis of the EPCs.

Source: ITRC ISM Update Team, 2020.

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As with all risk assessments.....

Conceptual Site Model

- Describes the relationship between and paths of potential chemical sources to **current** and **future** receptor groups.
- Presents the current understanding of the project area
- Reevaluate and update throughout the life cycle of the project.
- Helps identify data gaps and focus the data collection efforts.
- Key in determining the size and distribution of DUs and SUs

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- **CSM** is not unique to ISM, but is critical for risk assessment or risk-based study questions.
- **Describes** the relationship between potential chemical sources, media, release mechanisms, fate and transport pathways, exposure pathways, exposure media, exposure routes, and current and future receptor groups. **Current** and **future** land use scenarios.
- **Presents** the current understanding of the project area and should be reevaluated and updated as new information is collected throughout the life cycle of the project.
- ID **data gaps** and **focus data collection** efforts – for example, to make sure we have ISM chemical concentration data for all on-site and off-site receptors, under both current and potential future land uses.

Example CSMs

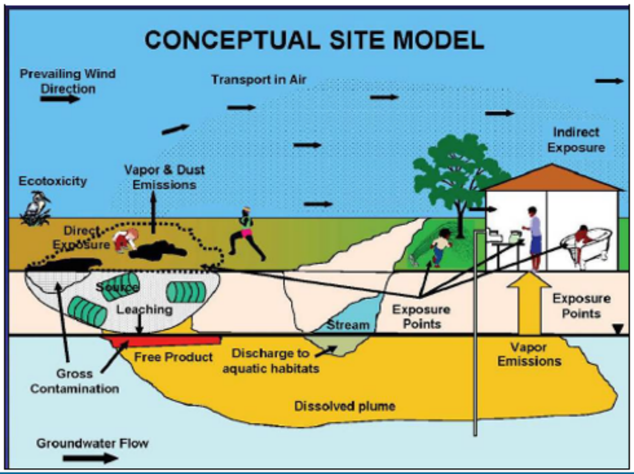

Figure 3-1. Pictorial CSM example.

Source: ITRC ISM-1 Team, 2012.

Pictorial example of CSM.

Example CSMs

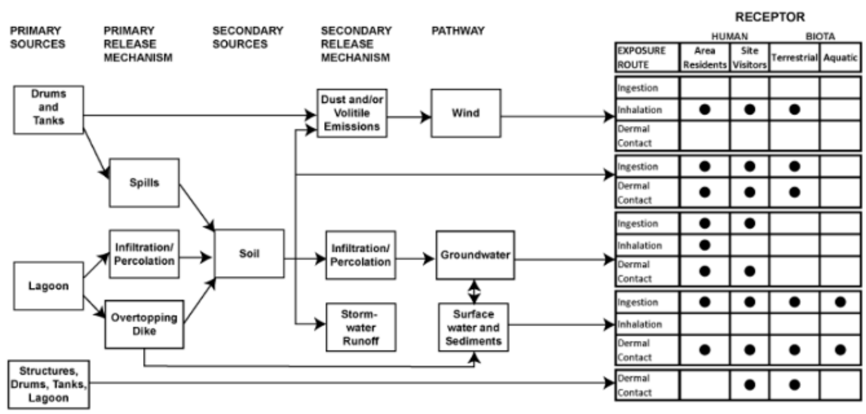

Figure 3-2. Graphical CSM example. *Source: USEPA, 2011.*

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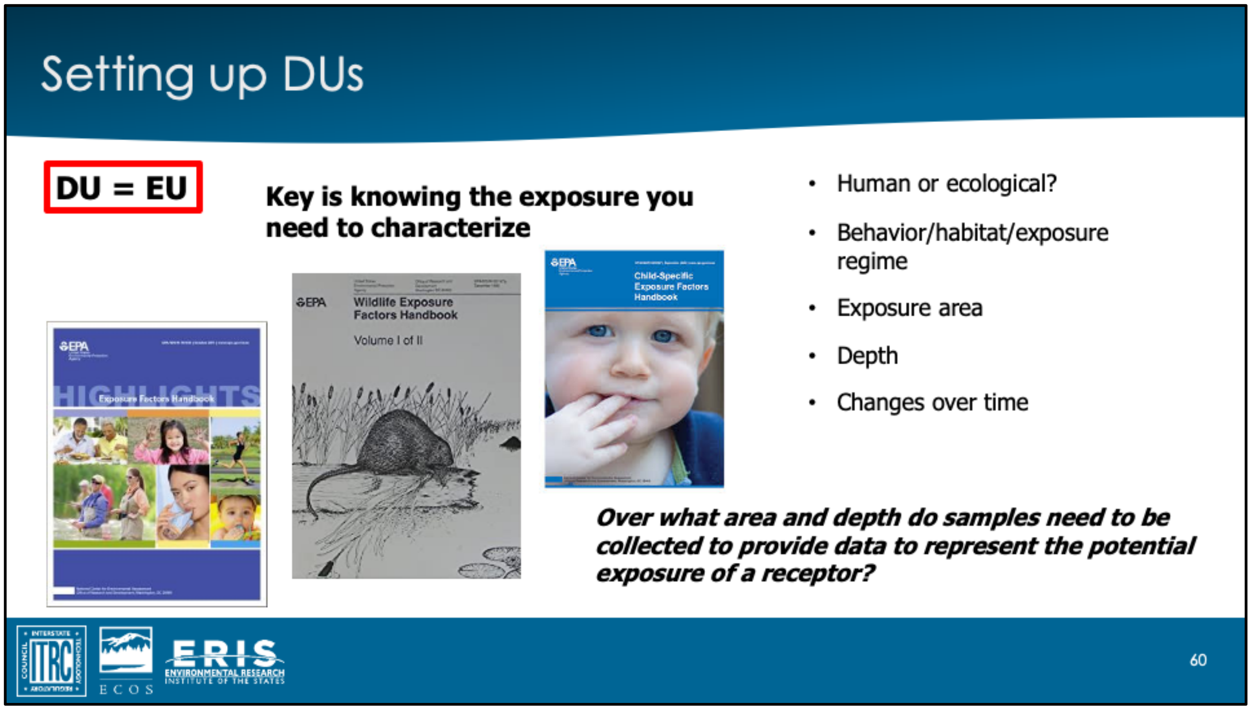
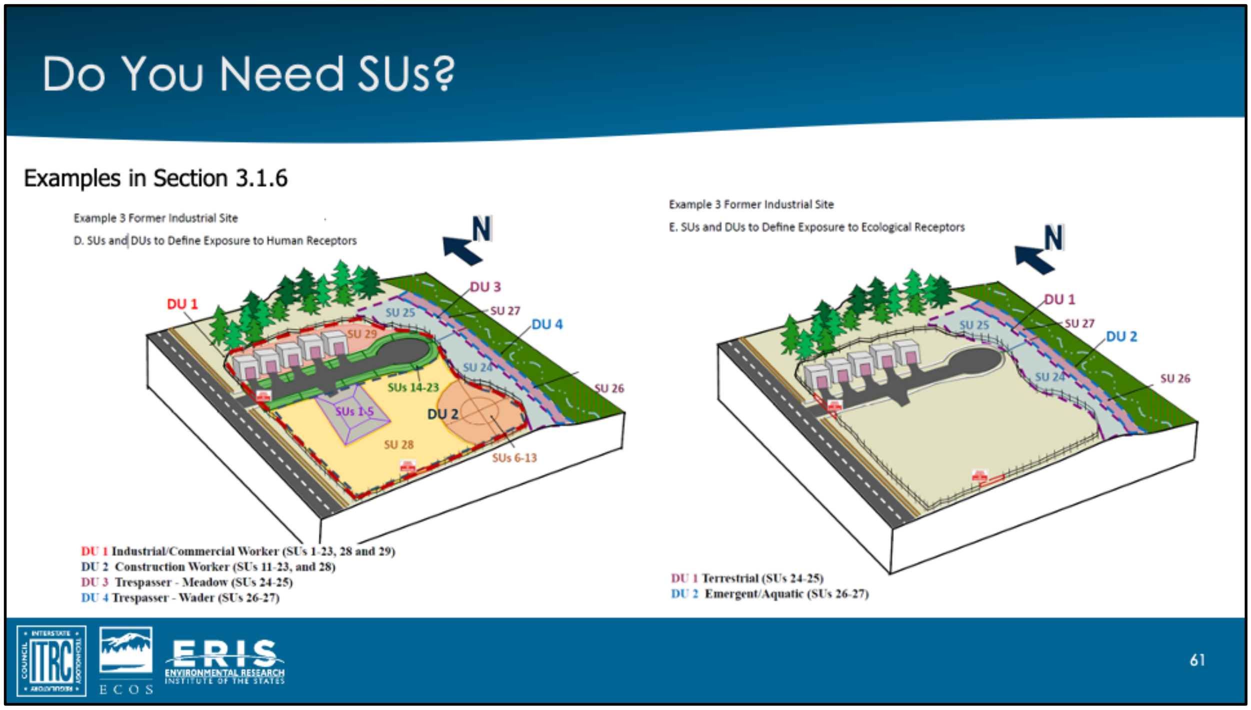
Schematic flow-chart
ISM most often **soil**



EPA exposure guidance shown – need to make sure the risk assessor understand both human and ecological risk

Example of small home ranges for important receptors (such as shrew); however ecological risk is based on populations so you don't necessarily need to go to the home range of the smallest receptor; key is a strong CSM

- Recall DU is the scale of the decision
- For RA and Risk-based decision making, DU = EU
- Design DU dimensions to address a specific Study Goal or multiple Study Goals.
- Site-Specific, Scenario Specific, Receptor-Specific
  - Worker or Resident, Adult and/or child
  - Human or Eco Receptor
  - Current and/or Future scenario
- Receptor's exposure is assumed to be spatially equal in all areas of the EU throughout the exposure period



Examples here show how SUs supplement DUs by capturing different exposure scenarios and source areas and SUs allow for spatial patterns of distribution which may allow more focused and thus less costly remediation.

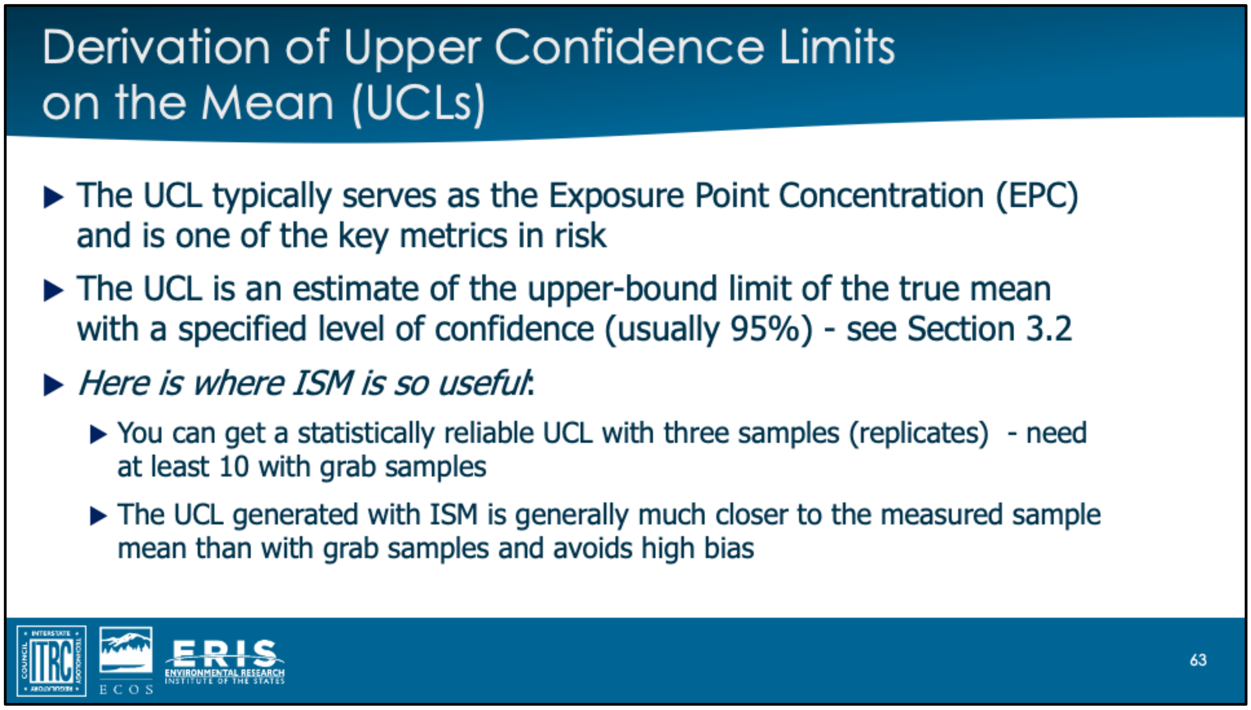
DUs of various sizes for different receptors (human compared to ecological receptors) - Figures from Section 3.1.6.3

Recall

- SUs are subdivisions of DUs
- SU boundaries define the spatial scale of the ISM sample

Poll

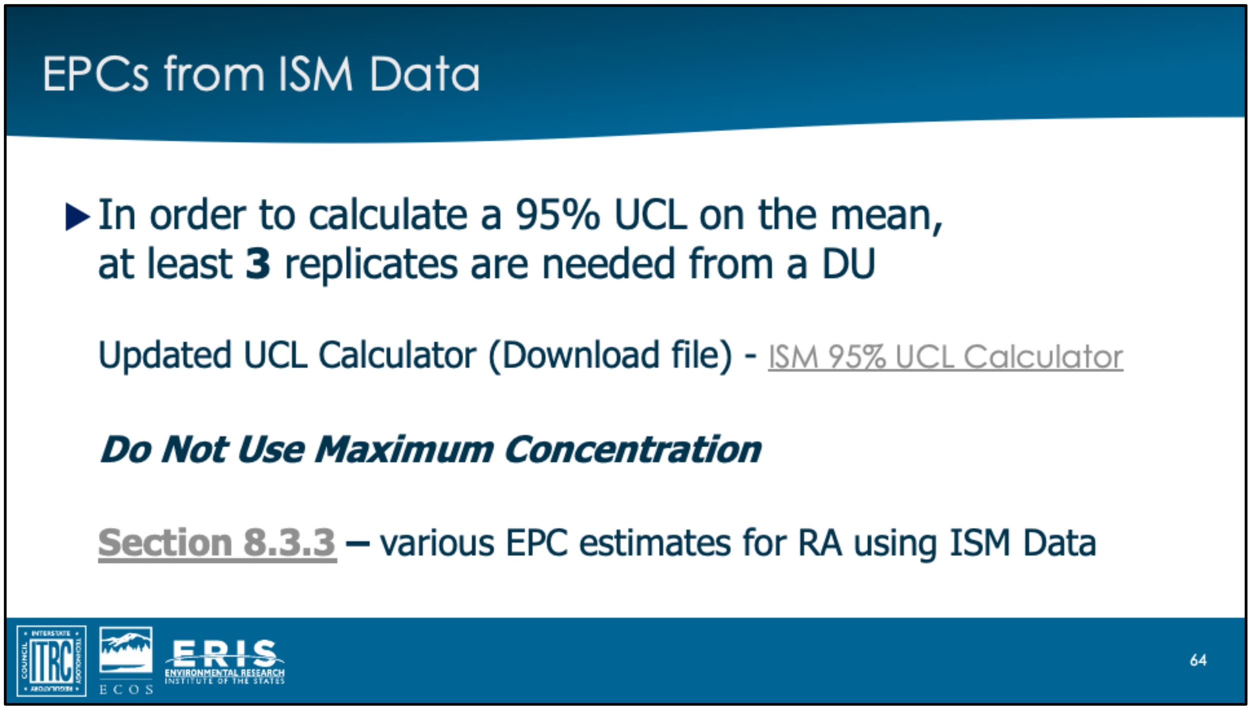
- Does your planning phase of the project typically involve the risk assessment team?
- At what point in the process do the risk assessors get involved?



Now we will move from planning to how to use ISM Data in Risk assessment.

- EPC - conservative estimate of the mean concentration contacted by the receptor over the daily exposure

- <u>UCL **is** an estimate of **central tendency**; it is not an estimate of the upper end of the range</u>
- ISM 95% UCL Statistically Sound

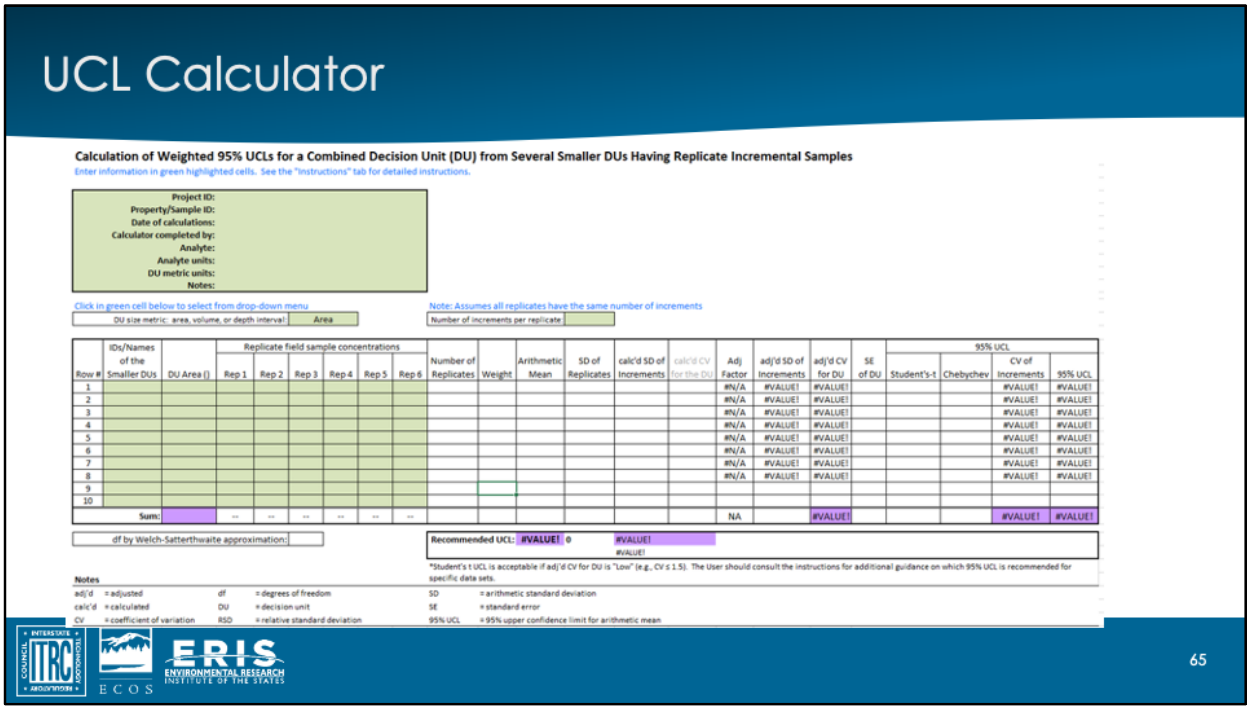


A single ISM sample (singlet) does not

- provide a confidence interval for assessing uncertainty in the mean
- or provide evidence that the common assumption of relatively low heterogeneity within the DU is met.
- May be unacceptable to regulators for use in risk assessment.
- A single ISM result might support a risk-based decision when the estimated mean concentration is much greater than or much less than an AL.

Updated ISM 95% UCL calculator - Presented in Module 3 on Statistics

- The first ISM team built an ISM UCL calculator in a MS Excel spreadsheet file that was updated since then with an improved modeling procedure.
- Simple!
- Section 3.2.4 – calculating the ISM 95% UCL
- For Risk Assessment
  - See Section 3.2.6.1 - the calculated 95% UCL value should always be used as the EPC with ISM samples, even if it is higher than any of the individual ISM results.
  - In fact, with three replicates, the UCL will always exceed the highest individual ISM result.



Screen shot of ISM2 95%UCL calculator from link in ISM2

3 – 6 replicates

Combining SUs, EUs, or DUs for 95% UCL calculation of EPC

- **Each SU or EU** has **three replicate** ISM samples with either the **same or different** spatial coverage.
- **Triplicates** from **one or more** random **SUs or EUs**; a **singlet** from **all others**
- **Very large CSM-equivalent EU** - **random subset** of **SUs or EUs** is sampled

Section 8.3.3.1 (link to Section 8.3.3)

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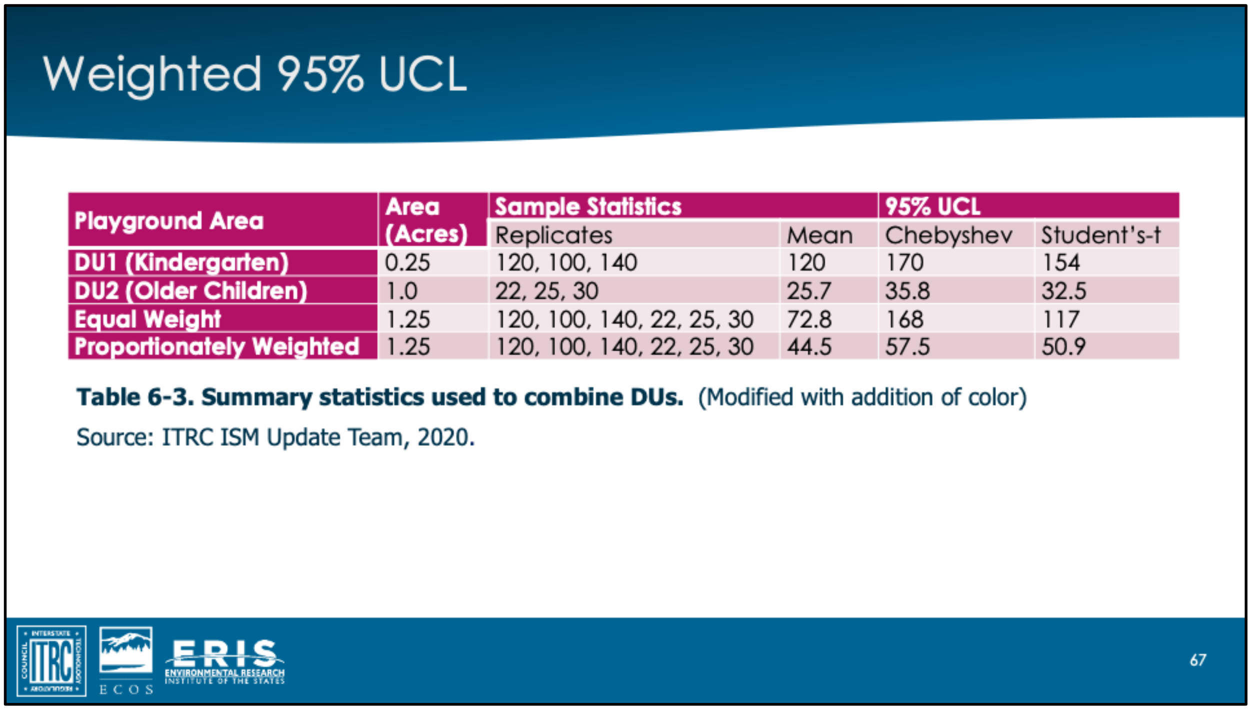


Weighted 95% UCL

Playground Area	Area (Acres)	Sample Statistics		95% UCL	
		Replicates	Mean	Chebyshev	Student's-t
DU1 (Kindergarten)	0.25	120, 100, 140	120	170	154
DU2 (Older Children)	1.0	22, 25, 30	25.7	35.8	32.5
Equal Weight	1.25	120, 100, 140, 22, 25, 30	72.8	168	117
Proportionately Weighted	1.25	120, 100, 140, 22, 25, 30	44.5	57.5	50.9

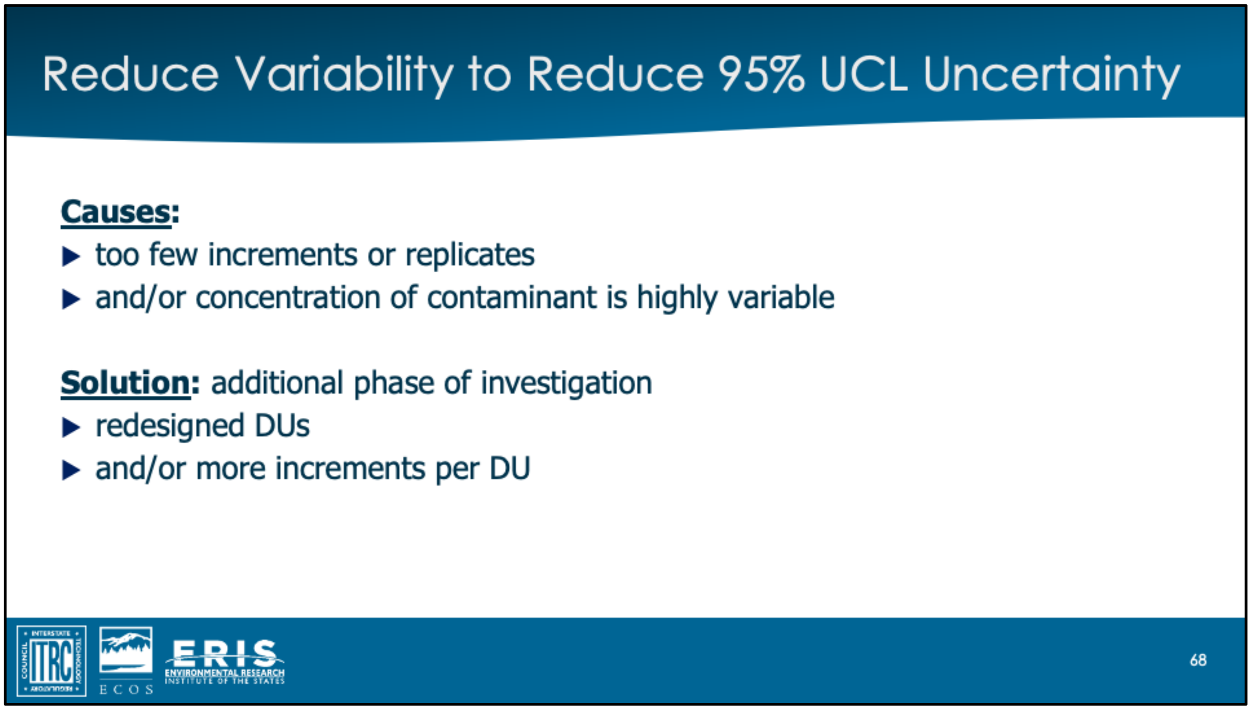
Table 6-3. Summary statistics used to combine DUs. (Modified with addition of color)

Source: ITRC ISM Update Team, 2020.

In Sections 6 and 8 of ISM2

Weighted 95% UCL for a DU subdivided into SUs of different sizes

- Covered in Statistics Module 3 of IBT
- Volume weighting - this example is a refresher on difference from **area weighted** as **compared to equal weighted 95% UCLs** for SUs of different spatial sizes within a larger DU.



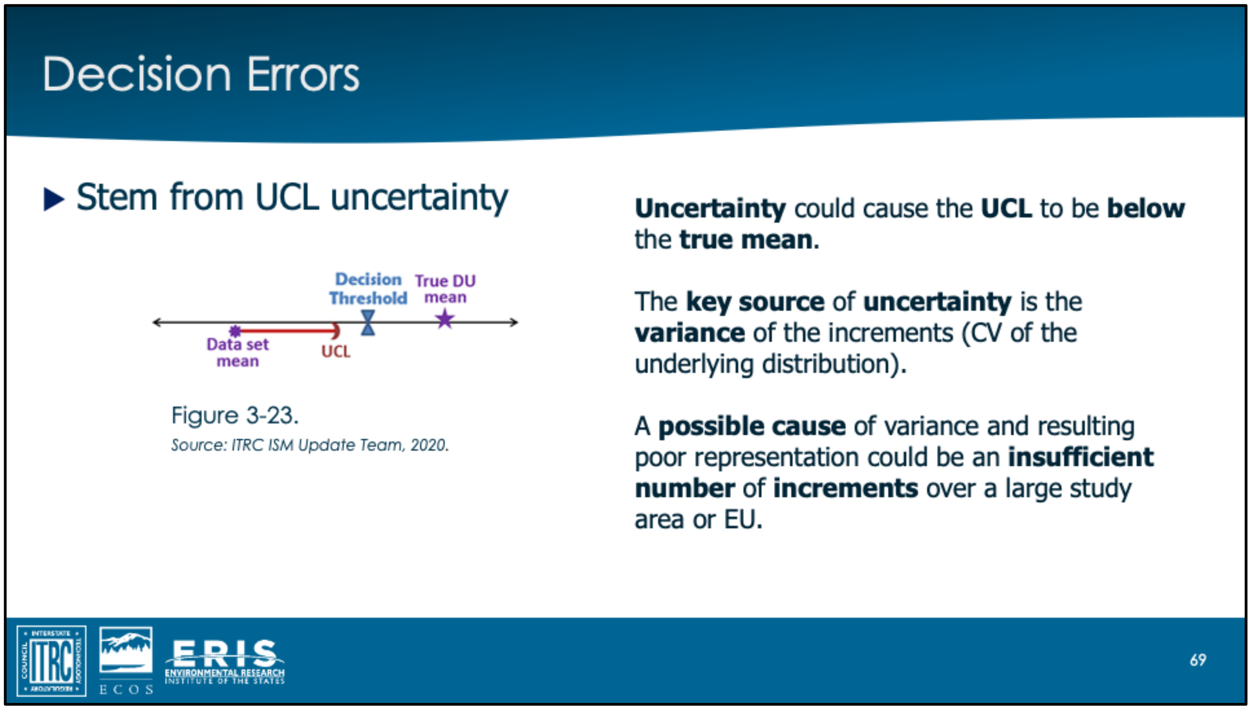
How can we reduce the Uncertainty in the EPC?
As discussed in Module 3 on Statistics

- The degree of variability (i.e., the range of data values) expressed as the standard deviation (SD), is a common measure of variability and is used in calculating the UCL.
- Less variability (i.e., a lower SD value) gives a narrower mean-UCL width.

Tolerance for the mean-to-UCL CI width (see Section 3.2.4.3) can be defined in the DQOs during systematic planning (See Table 3-2-2).

Causes: The ISM UCL may provide an unreliable estimate of exposure if the data set is from too few increments or replicates and/or is highly variable (Section 3.2.2).

Solution: additional phase of investigation with redesigned DUs and or more increments per DU **to achieve lower RSD, a narrower CI and more confidence in the EPC and risk estimates**.

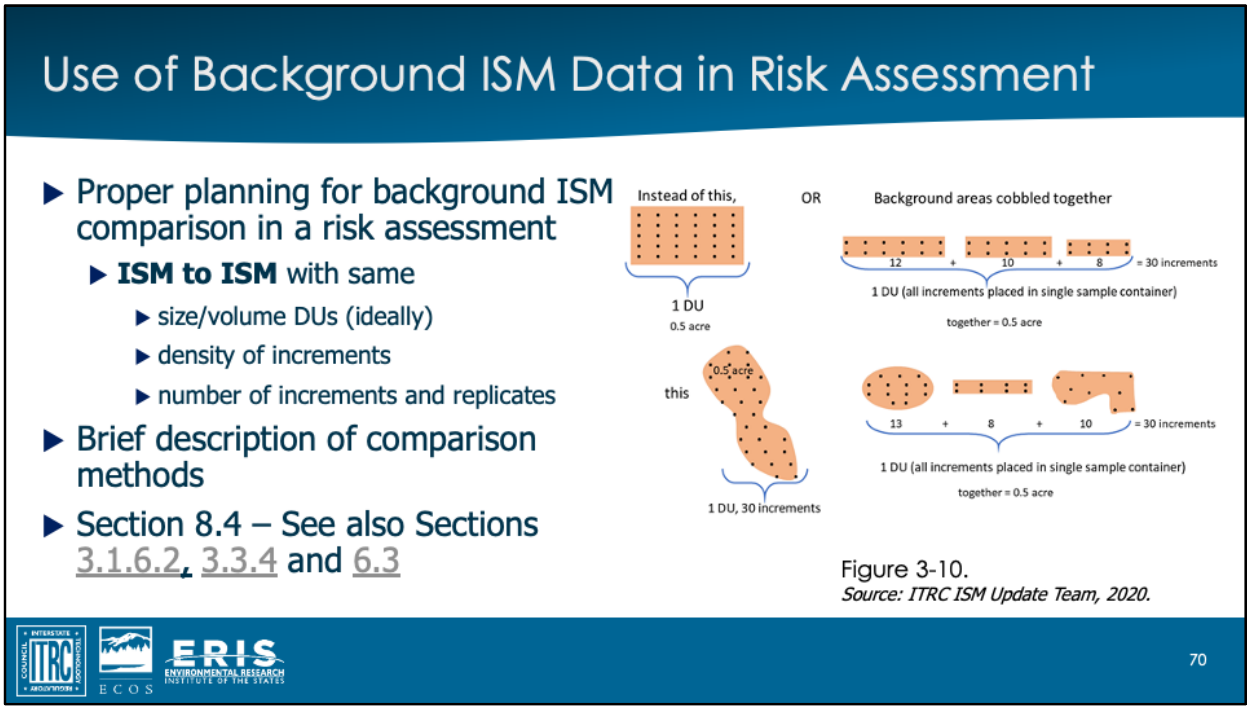


The decision error **(under or overestimation** of the mean) **correlates** to the **direction and magnitude** of the **uncertainty in the risk** estimate

where the **Decision threshold** is **a risk- threshold uncertainty could be critical**

More **uncertainty tolerated** when the COPC **concentrations are far below** the risk-based screening levels (or ALs), or the calculated risks and hazards are far below the regulatory thresholds (typically 1 x 10-6 risk and hazard index of 1).

Greater uncertainty in the **representativeness** of **the subset of SUs sampled** to the **entire very large EU** is **tolerated** when either the COPC concentrations are far below the risk-based screening levels (or ALs), or the calculated risks and hazards are far below the regulatory thresholds (typically 1 x 10-6 risk and hazard index of 1).



Section 8.4 – See also <u>Sections 3.1.6.2,</u> <u>3.3.4</u> and <u>6.3</u>
Background concentrations are **often used in risk assessment** to **help refine** the **COPC list** and **more easily identify** chemicals related to **site releases**.
Risk assessments may compare ambient background concentrations to site concentrations **to eliminate COPCs before or after quantitative risk assessment** is completed, **depending** on the stakeholders.
ISM **can be used** for assessing ambient background soil concentrations of **both native metals** and **ubiquitous anthropogenic** chemicals such as dioxins and PAHs.

Module 3 on Statistics covered
- factors to consider in collecting ISM background data and
- **Highlight ISM to ISM -** ISM Background comparisons to Site ISM data

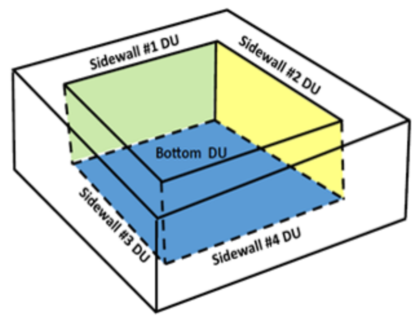
Key takeaway from this slide is the background shape and use of multiple smaller background areas to collect ISM background data are flexible components, as long as the increment density, the number of increments per replicate and number of replicates per DU are the same.

Section 8 of ISM2 includes brief description of comparison methods.

PLUG for ITRC SOIL Background and Risk TEAM – guidance expected end of 2021

Use of ISM for Post-Remediation Risk-Based Confirmation Sampling

- To evaluate if a remedial action meets risk-based benchmarks
- Properly designed ISM sampling plan
- A very robust estimate of mean residual contaminant concentrations in a DU
- True DU mean concentration < the remedial goal
- Comparison of a 95% UCL to the remediation goal Section 3.2.5
- Statistical confidence and scientifically defensible risk-based decision-making



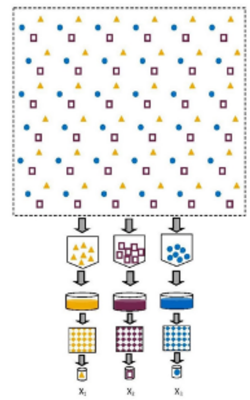
Section 3.4, Figure 3-31. ISM sampling for remedial excavation confirmation sampling.

Source: ITRC ISM Update Team, 2020.

Comparison to benchmarks previously addressed but in some cases action levels may be risk based.

Risk Communication for ISM

- Address common misconceptions about ISM
- Refines Exposure Assessment
  - Risk = Exposure x Hazard
  - Reduces uncertainty in the mean
  - Provides a representative EPC
- Additional Resources
  - ITRC RISK-3 (ITRC 2015) https://www.itrcweb.org/risk-3/
  - ITRC Risk Communication Toolkit https://rct-1.itrcweb.org/



Source: ITRC ISM Update Team, 2020.

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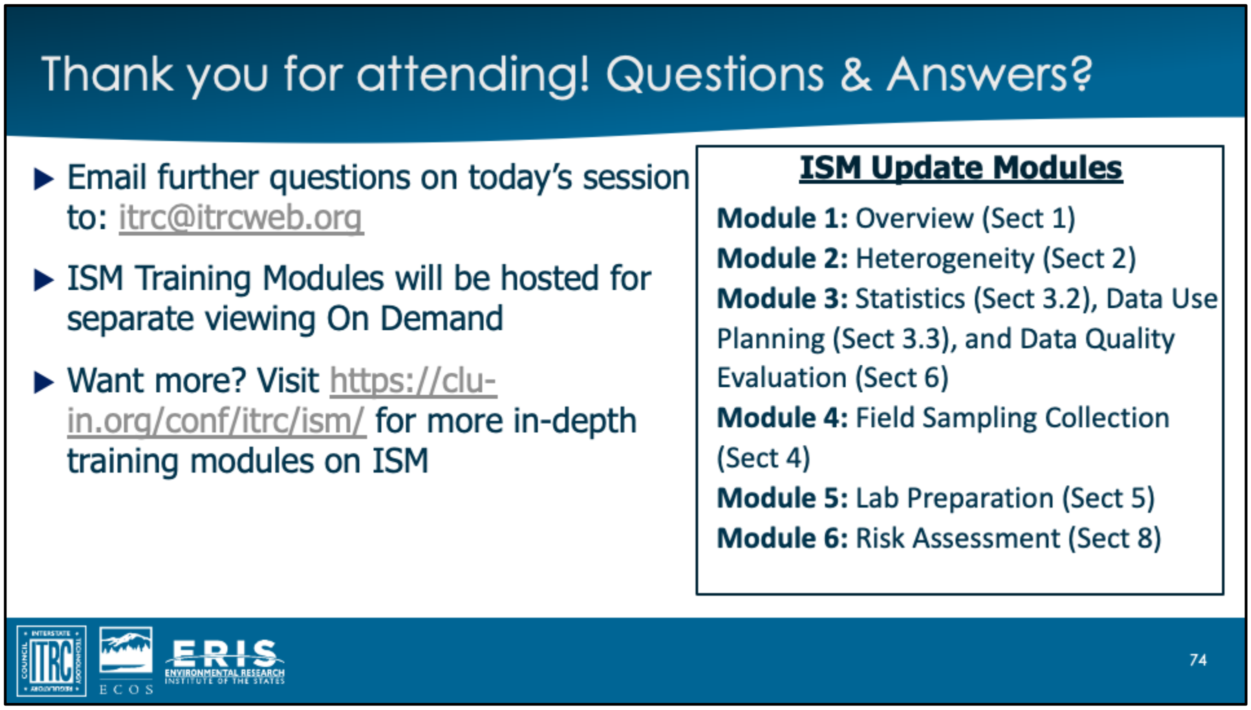
Section 8.6

- The goal of risk communication is for all stakeholders to have a common understanding of the results, processes, and assumptions used in risk assessment as well as how the risk assessment is used in risk management.
- Use of ISM for risk assessment input may necessitate communicating with stakeholders and others the differences between discrete and ISM sampling, as well as how the proper use of ISM enhances the defensibility of the risk assessment results in comparison to reliance on discrete sampling.
- Section 7 addresses common misconceptions.
- Less variability than discrete = less uncertainty, smaller mean to UCL width
- Much greater spatial coverage with adequately designed ISM investigations than typical discrete sampling designs
- when CSM suggests small areas of elevated concentrations could exist, sampling designs can be developed to address these concerns. Section 8.3.3.1 and Section 3.1
- Strengthens scientific defensibility of risk-based decisions.

It's All About the Receptors

Desert Cottontail

Photo Credit: James Michael Eichelberger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▶ ISM Training Modules will be hosted for separate viewing On Demand
▶ Want more? Visit https://clu-in.org/conf/itrc/ism/ for more in-depth training modules on ISM
ISM Update Modules
Module 1: Overview (Sect 1)
Module 2: Heterogeneity (Sect 2)
Module 3: Statistics (Sect 3.2), Data Use Planning (Sect 3.3), and Data Quality Evaluation (Sect 6)
Module 4: Field Sampling Collection (Sect 4)
Module 5: Lab Preparation (Sect 5)
Module 6: Risk Assessment (Sect 8)
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