Incremental Sampling Methodology (ISM-2) Update

ISM-2 Update Training Question and Answer Digest

This question and answer digest was prepared based on the ITRC training classes, Incremental Sampling Methodology (ISM-2) Update

- Session 1: Introduction to ISM, Heterogeneity, and Statistical Applications to ISM Planning & Evaluation (January 26, 2021)
- Session 2: Field Sample Collection, Incremental Sample Processing & Analysis, and ISM for Risk Assessment (March 11, 2021)

This digest includes some additional questions that were not asked live in the classes. The user is encouraged to reference the ITRC ISM-2 Guidance Document for more details.

The two training sessions were hosted through EPA Clu-In and promoted with the following information:

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). You are welcome to watch the two sessions (Session 1 for Module 1-3 or Session 2 for Module 4-6) or watch a single module below:

Module 0: ISM-2 Update Introduction
Module 1: ISM Overview (ISM-2 Update, Section 1)
Module 2: Heterogeneity (ISM-2 Update, Section 2)
Module 3: Statistics, Data Use Planning, and Data Quality Evaluation (ISM-2 Update, Section 3.2; 3.3; 6)
Module 4: Field Sampling Collection (ISM-2 Update, Section 4)
Module 5: Lab Preparation (ISM-2 Update, Section 5)
Module 6: Risk Assessment (ISM-2 Update, Section 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
- 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). Participants interested in ISM background information prior to the ISM-2 training are encouraged to view the ISM-1 training at ITRC Soil Sampling and Decision Making Using Incremental Sampling Methodology 2-Part Training Series.

ISM-2 Session 1 and 2 Webinar Series Panelists

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1. Why is the maintenance worker not exposed to 0 to 12 inches?

They would be, but the concept is maintenance activities would involve both surficial exposure as well as at depth. The public would only be exposed to surface, so it is helpful to understand the two exposure scenarios, and subsurface is only applicable to the maintenance scenario.

Where samples at various depth are available, workers who might contact the subsurface would be exposed to the full soil column down to the applicable depth. Potential future scenarios where soil disturbances redistribute soil could be another reason a receptor may be exposed to soil from the surface and subsurface soil.

You would have to know the type of maintenance worker you have at the site. Some may be equivalent to commercial workers (just exposed to the surface), and some could be exposed down a few feet if they are engaging in activities like utility repair.

2. Why not 0-2 inch for public and 0-12 inch for MWs?

While you could do that, the purpose of breaking it up is to understand the exposure unit that would only apply to maintenance activities since that is a distinct exposure path not likely to be available to the general public.

3. Can you explain in further detail how ISM can be applied to VOCs without contaminant loss? In other words, what special sampling measures must be applied to get a representative sample result?

Soil increments are placed directly into a volume of methanol at a 1:1 ratio. Applying ISM to VOCs utilizes a large-scale version of the methanol preservation option of EPA Method 5035. When ground shipping is practical a large bottle with sufficient methanol for all increments is used. For example, if 30 X 5g increments represent the decision unit then 150 mL of methanol would be used. If air shipment is planned, then staying below the 30 mL methanol / container DOT limit is necessary. We could use 6 vials with 25 mL of methanol in each. Then 5 X 5g increments could be added to each vial. Back at the laboratory, an aliquot from each vial would be combined to produce a methanol extract that represents the decision unit.

4. If you exceed the standard of clean up in a DU, could you go back and collect smaller subsets of the DU to determine exactly where there might be isolated concentrations, or would the whole DU unit to be remediated?

Yes, you can always go back and split into smaller DUs. You could go back and divide the DU into smaller contiguous subunits termed sampling units (SUs) to isolate regions of the DU that caused the DU to exceed the cleanup standard.

5. How do you decide whether to take 30, 50 or 70 samples (etc.) per DU?

See guidance in Section 3.1 of ISM-2 for variables to help you decide how many increments to collect.

6. I missed the difference between DU decision unit and SU. What does S stand for?

SU = sampling unit.

7. Are replicates always collected at all locations or can they be collected at a subset of locations (e.g., 10%)?

Replicates are collected at each location where you collect an increment. The work plan and DQOs will dictate if each DU is sampled with replicates.

8. Is ISM recommended for acute toxicity metals?

If you are interested in the mean concentration for any volume of soil, regardless of concentrations, ISM is appropriate.

9. Why were there no decon between samples in the front yard sampling video?

Decon is not required between increments collected within a DU because the material is composited and therefore cross-contamination is not a concern. Decontaminating sampling equipment is recommended between replicates within the same DU and between DUs.

10. How do you select the number of increments you collect from a DU and the size (mass) of each increment?

The number of increments is based on your data quality objectives and other site-specific factors. The more increments collected the better your confidence in the result. Ideally, the bulk sample should be between 1 kg and 4 kg....so divide the bulk sample size by the number of increments to get the increment size.

See guidance in Section 3.1 of ISM-2 for variables to help you decide how many increments to collect.

11. If doing triplicates, do you have three separate sampling devices, or do you decon the one and rewalk the DU two more times to collect the sample?

While it is not necessary to decon between increments, it is recommended between replicates. So, yes, either decon the probe or use a new probe and rewalk the DU collecting replicates.

12. I didn't see any grids within the DU examples. We use grids within which each replicate is collected.

For the presentation, we didn't include the grids in which the increments are placed, but you are right, grids are almost always used to place the increments.

13. Can ISM address protection of organisms with small home ranges (e.g. plants, benthic)? In these cases an average over a large area might not be appropriate.

If you have a very sensitive or endangered species, you would have to establish DUs or SUs consistent with the home range to ensure a relevant exposure point concentration. However, ecological risk assessment is generally expected to protect the system, not individuals, so often the EPC from a larger area is appropriate.

14. Does ITRC's guidance further address statistics for averaging detects and non-detects?

Censored data is discussed briefly in Section 6.1.2 of the document. In general, more studies are needed on the use of imputation and substitution methods on ISM data.

15. If the average concentration across your decision/sampling unit is moderate or relatively low, how do you know that you haven't missed higher concentrations that are being diluted by the lower ones? Similarly, how do you know your decision unit was small enough? Are replicates expected to identify these issues?

ISM is designed to provide the upper confidence limit of the mean, not the max or min. Replicates will help the user understand data confidence (reduces the error bar around the confidence limit. Remember that DUs are sized for your study questions and decisions. Decision unit design and addressing concerns for elevated concentrations in localized areas are discussed in Section 3.1 of ISM-2. More information on this in training Module 2 and 3.

16. Are Decision Units always spatially discrete? For example, if I have a few small pocket parks within a larger industrial area, can I combine the small parks into one DU?

By definition, they are spatially discrete. You can use results from several DUs (or SUs) to make overall decisions. If you had 5 pocket parks, each differently sized, and you were interested in the overall exposure assuming a receptor spent equal time at each park, yes, you could collect a single ISM sample from each. Then you would apply a weighted average depending on the size of the park, which would give you an average concentration a receptor would be exposed to in the 5 parks, even if they are not contiguous.

17. For the examples that showed SUs within DU, were the SUs sampled with 30 increments each or were the minimum 30 increments spread across the multiple SUs within the DU?

An SU is treated just like a DU; it would have a minimum of 30 increments collected.

18. Has ISM been used in estimating risk?

Absolutely. ISM is ideal for understanding risk since risk is more focused on the average concentration across the exposure unit.

19. Are there any circumstances where ISM complicates field work?

Access to the entire area is a common challenge. Since the goal is as much coverage as possible – limited access can impact that. That would also apply to the collection of discrete samples. Deeper ISM samples are also challenging, in that borings are needed for each increment (so not as easy as just collecting by hand at the near surface). Still, if high confidence in your data regarding subsurface concentrations is desired, it is worth overcoming.

ISM can require more up-front planning than discrete sampling programs. Where obstructions (driveways, structures, etc.) may interfere with planned increment locations, a systematic method of offsetting is required.

20. How can ISM apply to media with large grain sizes such as gravel and slag, or situations where site soils are predominantly those kinds of fill materials?

ISM can be applied to a site with very coarse-grained materials. You would want to increase the number of increments. Depending on what the target receptor is, the lab may be directed to grind the sample into a fine powder prior to homogenization and subsampling. The lab only uses a small amount of sample to analyze, so you want to make sure their subsample is representative of the entire DU sampled, not just one piece of gravel/slag. If your study questions and decisions are risk-based, then it is important to think about the appropriate grain size(s) for your receptor(s) exposure(s).

21. Have you used ISM for characterization of large soil stockpiles slated for transport offsite to disposal site?

ISM can be used to characterize stockpiles. One will need to work with the landfill so they understand how samples will be collected and confirm they can accept the results.

22. Is the Data Quality Process described in more detail in this training?

Yes, data quality evaluation is discussed in Module 3, including data verification, validation and usability.

23. Is it recommended that discrete samples be collected from the increment locations if a DU/SU identifies contamination?

I would not take discrete samples, but subdivide the DU into smaller DUs (by 2 or 4) and take another phase or round of incremental samples; doing at least 1 of the DUs in triplicate. The DQO process is where the decision if/then rules are described so you know what you are making a decision on or if you would move to a phase 2 subdivision plan.

24. Do you implement ISM on sites covered with a concrete or asphalt cap or is ISM more geared towards sites with soil or vegetated surface cover?

ISM can work for any of these conditions. The sampling tools will differ based on field conditions (see Module 4).

25. Have you had issues characterizing sites with ISM then using discrete sampling for confirmation sampling post remedial excavation?

Unfortunately, discrete and ISM are like apples and oranges. The data are not the same, but that does not mean discrete can't be used. Just understand a discrete sample is not able to capture an average concentration across the area of interest the way ISM does. So discrete samples will most likely be either above or below the mean concentration and thus not correlate with ISM data all that well.

26. What is the best practice when collecting incremental samples from multiple BH by drilling?

The continuous core from each boring represents one increment. If your work plan identified multiple DUs vertically then the cores would be subdivided into the appropriate depths to form increments. The continuous cores for each DU would be combined to generate the bulk sample. Mass reduction is likely needed for subsurface investigations and is discussed in Section 4.6.

27. Explain how systematic/grid sampling can be considered random sampling.

Systematic grid samples are still random because the increment is collected from a random spot within the grid. True random is more of a shotgun approach and will likely result in larger areas within the DU without an increment being collected.

28. For the example about SUs and DUs only one ISM sample was taken per SU. Why was only one ISM sample taken per SU?

Many practitioners are very comfortable making remediation and final decisions based on single ISM results, based on the excellent sample coverage and high number of increments.

29. Are samples from an individual DU submitted to the lab by field staff as a single sample or packaged individually for the lab to composite?

Increments are combined into a bulk sample in the field and submitted to the lab as a single bulk sample. Section 5 of ISM-2 (and training Module 5) discusses how the laboratory will process and analyze the bulk sample.

30. Why no grids within the DUs? Wouldn't that make it easier to collect random replicates?

Yes, DUs can be gridded and that helps locating the increments. Also depends on how increments will be collected in the field (physical measurements or GIS or other?) See Section 4.3 of ISM-2 and training Module 4.

31. Can you discuss assessing variability applied to DUs without triplicate sampling?

Replicates are the best way to assess variability in a DU. Since you only obtain one "average" sample in a DU there is really no other way to determine if there is variability of results. If you would like to determine if there is variability with the DU, then you could split it up into separate smaller SUs and collect ISM samples for each of those.

32. In which guidance document does the EPA recommend at least 75 increments for PCB sampling?

US EPA published "Incremental Sampling Methodology (ISM) at Polychlorinated Biphenyl (PCB) Cleanup Sites" dated August 8, 2019. You should be able to find it online or contact your regional EPA TSCA office. This document notes 75 increments as an example, but in Region 9 for example, the TSCA program requires a minimum of 75 increments.

33. Are they any situations when use of ISM is not suitable?

ISM is suitable for any media which is heterogenous (soil, sediment, grain etc.). ISM is not necessarily needed for water samples as the media is typically more homogeneous and collection of a sample with reproduceable results is more likely. I would not use ISM where you are looking to characterize a specific source and gradient.

34. What does "EU" stand for?

EU = Exposure Unit for use in risk assessment and risk-based decision-making. EUs are established for the specific receptors evaluated (such as: child, small home range ecological receptor, adult worker, large home-range ecological receptor).

35. Is there ever a situation where a lower RSD (such as <20%) would be recommend? Maybe when sampling for acute toxicity metals or contaminants with high variability?

Ideally, the RSD will be in that range and that is actually a good target. If the RSD is elevated, additional increments should be included to reduce the RSD. Ultimately, what RSD is acceptable is a project decision, but relatively low RSD is achievable with good ISM design.

36. It seems like the actual volume analyzed (1 g) is greater for 10 discrete samples than one composite sample, is that correct?

ISM samples typically send a minimum of 1 kg to the lab. ISM samples are processed differently in the lab than discrete, and actually "sample" a larger volume than discrete. Typically, a minimum of 10 grams is used for each ISM increment, which helps improve confidence. Most ISM subsamples used for digestion or extraction are in the 10-30 g range. These subsamples are collected after processing from field samples that are at least 1 kg. Module 5 covers lab procedures in much greater detail.

37. What is CSM?

CSM = conceptual site model.

38. What is rule of thumb for replicate collection and is that dependent on the number of DUs?

There isn't really a rule of thumb – depends on the user as well as regulatory constraints, but not necessarily associated with the number of DUs. For example, if the agency is comfortable using a pooled variance, then not all DUs need replicates. Some states do not require more than 10% replicates, others require 100%.

39. Based on your experience, will state regulatory agencies ask for discrete sampling to delineate the DUs?

This question is outside the scope of the guidance document. ISM can be used to delineate extents of contamination. For risk assessment, it is not necessary to delineate extents of a DU with discrete sampling because by definition the size of your DU is the area on which you will make a decision for a particular receptor.

40. If there is a potential for a significant spatial gradient (e.g., a large 'hot spot'), but no existing screening dataset of discrete samples, how can you confidently assign DU boundaries (other than guessing based on historical site uses)? If a DU captures an 'edge' of a hot spot, which brings the average above the compliance limit, how can you say with confidence that the entire DU needs to be addressed?

Investigating gradients or finding small source areas may be best done with discrete samples. However, ISM can be used to characterize zones a specific distance from a source. While one may not know where the fence lines will be for each residence in a large area slated for residential development, or other uses within a large area, there are two options for increasing confidence in identifying significant gradients or areas with elevated concentrations. One option, as described in Section 3.1 of ISM-2, is to use the Visual Sampling Plan (VSP) hot spots module for ISM. Another option is subdividing the DU into contiguous sampling units (SUs) for spatial delineation.

41. How do you determine the number of Increments (30 vs 100)?

See guidance in Section 3.1 of ISM-2 for variables to help you decide how many increments to collect.

42. Is there a recommended DU/SU size for non-point source contaminants?

ISM-2 is not prescriptive on DU sizes. Remember that DUs are sized for your study questions and decisions. Decision unit design, particularly for risk-based decisions, are discussed in Section 3.1 of ISM-2.

43. Can you elaborate on your comment that more increments may be appropriate for a larger DU? I thought the number of increments is not dependent on the size of the DU. If more increments are believed to be needed, doesn't it indicate that the DU has not been properly identified, and shouldn't consideration instead be given to downsizing the DU?

If your DU is sized appropriately for your study question, then additional spatial coverage from adding more increments and a larger sample mass provides more confidence in the representativeness of your ISM data and your decision.

Having increments closer together may be beneficial to increase precision in a larger DU, depending on the heterogeneity you expect. For example, if concentrations are generally consistent across the large DU but there is a lot of small-scale heterogeneity. However, if the precision achieved is low, it could be an indication that either more increments are needed or the DU hasn't been properly identified. That all depends on how you expect concentrations to be distributed across the DU. So, modifications of the study design could be considered like increasing increments or downsizing the DU, as discussed in Module 3.

44. Is ISM statistics included in ProUCL Program?

The ISM Calculator derives the UCL. You don't need ProUCL.

You can find the ISM UCL calculator in our ISM-2 guidance document which contains a link to the spreadsheet that is programmed for your easy use.

45. Will 95%UCL for the 3 ISM triplicate different from that for 90 increments (e.g., CV=3 on slide 13)? If so, which one is more representative of the DU?

Retaining sample results for all increments and calculating a UCL will give different results compared with calculating a UCL from three ISM samples, but the results of either UCL are not consistently biased one way or the other. Both UCLs are equally representative of the DU. However, note that sending 90 samples to the lab will significantly increase costs and may not be practical.

46. If the mean is 5 times higher than the action, do we need to take replicates?

You need replicates to calculate a UCL. If your sample concentrations are far lower or higher than your action limit then a single ISM sample may be sufficient.

47. Can you explain why an ISM data set can't be compared with a discrete data set?

Yes, it has to do with the variation for each dataset. Because of the way ISM samples manage heterogeneity, the variation among ISM samples should be much less than the variation among discrete samples for the same site. So, the means of each data set can be compared semi-quantitatively, but any analysis that uses the variance of each data set should not be used (e.g., testing if the means are statistically different, which takes into account the variance).

48. EPA Pro UCL recommends a minimum sample size of 8 for reliability. Is this true?

This recommendation for discrete data is meant to ensure you are getting a full picture of the distribution of concentrations. In ISM, due to the increased mass and spatial coverage, you should already be getting a full picture of the distribution which is then aggregated into a single sample. ProUCL sample size recommendations are for discrete data. They don't apply to ISM.

49. In the 80 acre DU example how do you know the concentration of contaminants is not that variable among the different squares?

It depends on the particular project and what information you have about historical uses, etc. It is only appropriate to use a design similar to this example, where not all of the SU squares will be sampled, when there is some prior knowledge about the site to indicate there should not be a difference in concentrations between the different squares. If more information is needed on the spatial distribution of contamination, it may be advisable to break up the DU into SUs such that all SUs can be sampled.

50. Can you compare background composite results with site ISM?

In general, discrete data cannot be directly compared to ISM data, However, they can in some cases be reviewed semi-quantitatively, such as if the Site ISM results are very much higher than the discrete background data.

This is similar with the case of composite results which typically have much fewer increments. Composite/ISM samples can only be truly directly compared if the same number of increments were collected for each, and the same volume or mass of soil were collected for each.

51. Is there a limit on how much data (increments) can be entered into the ISM calculator and is there a way to directly import the data into the calculator for large data sets?

For the ISM-2 UCL calculator, the data entered are the concentrations of the ISM samples and the number of increments (not the concentration of individual increments). The calculator takes up to 6 ISM replicate samples for each DU and up to 10 DUs, and calculates a UCL for each. Currently, there is no automation for data entry of large data sets.

Section 8.4.3 on Background Comparison Methods does not reference spreadsheets for hypothesis testing, rather it refers the reader to subsections of Section 3.3 Planning for the Use of ISM Data.

52. Please clarify if that number of increments is also decided based on the type of contaminants at the site.

VOCs need to be handled to avoid contaminant loss. See guidance in Section 3.1 of ISM-2 for variables to consider that are related to the contaminant type that influence the heterogeneity and thus how many increments to collect.

53. If continuous sampling (i.e., soil cores/borings) is a requirement for subsurface incremental sample collection, when/why is a hand auger considered a potential tool for ISM sample collection?

A hand auger would be an acceptable means to collect a subsurface ISM sample if your decision unit is 6 inches thick or less. A continuous core would be needed if your DU is thicker than what a standard sampler could collect. Module 2 discusses the selection of sampling equipment to accurately characterize a DU.

54. For subsurface sampling why wouldn't you take say the 4-5 ft interval from all borings and combine those into a replicate?

Combining all of the cores from 4-5 feet would provide you with a bulk sample representing the 4-5 foot interval. A replicate sample is a second bulk sample collected in an exact same manner.

If you need data on other depth intervals, those would need to be collected as separate ISM samples. In some cases, multiple depths can be combined but there are limitations in the ability to evenly collect material for each increment across larger depth ranges.

55. Due to difficulties (sample volume, equipment) when using ISM for subsurface soils, would you encourage ISM mainly for surficial soils?

Subsurface sampling is always more difficult, in general, but ISM for subsurface is still viable. The wedge method will generate sufficient volume and can be adjusted (thickness) up or down to get the volume needed (1-3 kg). Geoprobe by the day, rather than by the foot, can help control costs.

56. Can a DU be smaller than the site being investigated, but still allow conclusions to be drawn for the entire site?

There are instances where a portion of the site DUs can be sampled and conclusions regarding the entire site can be drawn. Some of the key considerations are the CSM and expected heterogeneity across the site. This is discussed within ISM-2 and the Not To Exceed Determination.

57. What tool do you recommend for collecting at different depths? I.e. our DU is at 3 stratified depths.

You can use the same method for all three depths. You just need to ensure that the soil cores are separated such that all cores from the same depth interval are combined into a single bulk sample. For your example, you would end up with three bulk samples from the borings.

58. How does removal of gravel from increments affect the consistency of the volume between increments? Are there special considerations for using ISM in gravelly soils?

This depends on your objectives and the contaminant of concern. The gravels can be crushed/milled to small size and analyzed. If there are difference concentrations of gravels in each boring, then your increments will be of different sizes (weights) and may be problematic.

59. If we are removing gravel, and gravel concentrations are variable across a DU, are there methods to normalize the volume of each increment?

Each increment is supposed to be a nearly equal volume, but if you have decided to remove material above a specified sieve size, then you will often have increments of varying size. The best you can do is note in your report what occurred. Anytime you are opting to sieve out oversize material, the work plan should address how this variation in volume/increment will be handled so you have advance buy-in from the team.

60. Is presenting standard deviation and/or relative standard deviation statistics for decision unit data commonly done when submitting to an agency for review? If so, are non-detects included as half detection limit values? What about J-flagged data (detected below qualitative reporting limit)?

The relative standard deviation, or RSD is a good way to evaluate whether the desired precision is met, but a goal for the RSD should be set prior to data collection. Non-detects can be dealt with the same as for discrete methods (e.g., using half the detection limit or other substitution method depending on the project). The one thing you might want to consider is the impact a non-detect has on your decision, especially if the sample size is small.

Normally J-flagged data are considered at face value (all analytical data are estimates, to varying degrees). Note that a “J” value is below the quantitative (not qualitative). Qualitative uncertainty (tentatively identified compounds) is typically denoted as an “N” qualifier, and additional caution should be used for those results as they are not confirmed as the respective compounds.

61. Do agencies want RSD?

It is difficult for the ISM-2 team to say if an agency would "want" something specific in regard to ISM sampling or analysis, since this is dependent on agency needs, project needs, and project objectives. I would recommend you reach out directly the agency you are working with on the project for a more direct answer.

62. Would you consider PAHs as stable in air?

Yes. Naphthalene is a bit more volatile, but PAH's are fairly stable as long as the soil is not heated.

Even the more volatile PAHs such as naphthalene can be stable with regard to air exposure when strongly absorbed to the soil particles. This commonly occurs in weathered surface soils.

63. Regarding organochlorine pesticides is there a specific sample container we should use?

We were told there is concerns with Chlordane and plastic "ziplock" baggies. Your sample containers should consider the COPCs just as done for discrete samples. In some cases, a plastic bag may not be appropriate for shipping to the laboratory. Discussion with your laboratory would occur prior to collection.

It is unlikely that a plastic bag would introduce chlordane as a contaminant. However, if technical chlordane is the contaminant of interest, then plasticizers in the bag might colelute within the chlordane pattern causing some interference. In short, use the same container materials as you would for discrete samples.

64. So sieving is done pre-slabcake not post slabcake sampling?

Yes, when sieving is appropriate based on project objectives it should be done prior to the 2D slabcake subsampling.

65. How can the lab recommended 1:1 methanol to soil ratio be achieved when many increments are aggregated in the field?

Using the number of planned 5 or 10 g increments, the lab can size the methanol volume in the VOC containers to match the sampling plan.

66. If you need to analyze for more than one type of analyte, for instance PAHs and dioxins, do you need to collect separate samples for the lab or can the lab process and collect the required sample from one ISM sample?

Usually the lab can process the ISM sample and then collect many different subsamples to support different types of analyses. It is common for a single ISM sample to support metals, SVOCs, dioxins etc.

67. Regarding field sampling: we are proposing collecting at three different depths (each depth is a DU). I understand there is no decon required within the same DU, but since we would be using the same boring at three depths, do you believe decon is required between depths?

That would depend on your sampling program. For example, if you are using a direct push drilling with acetate liners then only decon of the shoe is needed since the acetate liner is clean. Also, if your sample interval crosses two DUs (i.e. drill to 0-4 feet bgs with DU depths of 0-2 feet and 2-4 feet), deconning would only be needed if required by the regulatory agency.

68. Which processing techniques are appropriate for PFAS analysis?

PFAS most frequently uses air drying, disaggregation and 2D slabcake subsampling. Sieving can be used if the project objectives are focused on a specific particle size fraction. Milling PFAS samples is unusual at present.

69. Are you familiar with degradation of TNT during milling as a result of heating?

If temperature build up during milling is not managed with cooling steps between the 1-minute milling cycles, then some degradation can occur. Some of the energetics listed in Method 8330B are even more thermally degradable than TNT.

70. Is there a potential for cross-contamination during air drying? If so, how do labs mitigate that potential?

Cross contamination between samples can be an issue if the air flow over the samples is too turbulent. That is one of the reasons the air-drying towers were developed. In the tower's, filtered air is pulled across each individual sample and exhausted out the back of the tower without coming in contact with other samples.

71. Would milling potentially lead to any VOC losses?

Milling is not appropriate for samples intended for VOC analysis. The large-scale methanol extraction process from Method 5035 is the best choice.

72. The difference, if any, between DU and SU is unclear. A presenter during part 1 indicated they are essentially equivalent. Other presenters seem to indicate an SU is a sub-sample of a DU. Please clarify

A DU is the spatial scale for the decision and an SU is the spatial scale for an ISM sample. While a DU may also be defined as an SU, an SU may not be the area/volume scale of the decision so not equivalent to a DU. They can be functionally equivalent, but one or more SUs may be nested geospatially within a DU.

73. What section of the guidance has the UCL info?

The focused statistical information on UCLs is found in Section 3.2 of the ISM-2 document.

74. EPA recommends the lesser of the Max and the 95% UCL as exposure point concentration when using discrete sampling data. Why the difference with ISM?

In general, using the max instead of the UCL is a good rule of thumb if your sample size is relatively high (e.g., at least 8, though this depends on the distribution of the data), and that helps protect against overly conservative and unreasonable UCLs. If you take many samples, the upper estimate of central tendency should not be greater than the max. If you take many ISM samples, you may need to use professional judgement to determine whether it may be appropriate to substitute the max. But for only three ISM samples it would not be appropriate to substitute the max as the EPC due to the small sample size. Stated another way, with only three samples we are not necessarily confident we have captured the true mean, so even a reasonable UCL of three results may be greater than the max. With ISM, the precision is usually so good that there is not a large difference between the three samples or between the max and the UCL.

75. Regarding replicates: Hypothetically on a golf course, in assessing the Tees there would be 18 of them. If each tee is a decision unit, do we have to collect triplicates for each tee? Would this mean that 3*30*18 soil boring would be required?

It would depend on the variability you expect for the COCs and the use of the data. Replicates are not required for each DU to make a decision if the variability is moderate to low (again, goes back to your confidence in the data to make a decision and what the risk is relative to making the wrong decision). If you want to run a risk assessment for each DU, then yes you would need replicates for each DU.

76. There was not much discussion of sampling for nature and extent. We have used ISM at mine sites to better discern nature and extent, using decision units as ribbons extending out from a site, and it had the added bonus of allowing some risk assessment. Has nature and extent sampling been addressed in the update?

Yes, N&E is discussed in ISM-2. One of my favorite examples is delineating N&E of lead paint impacts from a house using the ribbon rectangles you discussed

77. The ISM soil collection tools that I have seen collect about 0.25 ft of soil. Some of the states and EPA regions define surface soil as 0-1 foot. Are these ISM tools useful for collecting surface soil in risk assessment or do we need to use a different type of sampler?

See guidance in Section 3.1 and Figure 3-4 of ISM-2 for variables to help you decide how many increments to collect. There is no such thing as a standard ISM sampling tool. You need to use what meets the purpose. I have some regulators that consider surface as 0'-2' so I use a 2' long sampling tool and for the ones who use 0'-1', then I use a 1' long sampling tool or only push the 2' long tool to 1', etc.

I try to consider what my exposed populations can account for. With lead paint, the results on the paint won't change whether it is milled or not – the aggressive digestion will get all the lead anyway. But milling oversized aggregate may dilute down the result.

78. Is presenting standard deviation and/or relative standard deviation statistics for decision unit data commonly done when submitting to an agency for review? If so, are non-detects included as half detection limit values? What about J-flagged data (detected below qualitative reporting limit)?

This likely depends on the particular agency. It is up to the practitioner how to handle non-detected values; note that limited studies have been done on the effect of non-detects on ISM results, and this adds additional uncertainty.

Presenting the relative standard deviation between replicates for a DU is typically done to demonstrate/determine if your ISM sampling strategy reduced the variability/controlled the heterogeneity or if redesigning the ISM sampling strategy may be warranted to obtain lower variability.

There may be instances when the large DU can be used to lead to a further action decision, but data from a DU larger than an exposure area cannot be used to support a risk-based no further action for unrestricted residential land use decisions. A phased investigation of residential lot sized DUs from various areas of the site may help guide the need for further action, without sampling each residential lot sized DU at the site.

79. For doing wedge sampling, what tools do you suggest to be able to collect identical wedges between cores?

Your ISM data should always correspond to the soil depth interval specific to the receptor's soil exposures. Best tool for wedge sampling: Stainless steel reagent digger.

80. If ball mill is not as effective as puck mill, what are the advantages of ball mill?

The precision improvement with the ball mill can be less than with a puck mill, but still might be sufficient for many projects. The ball mill equipment is less expensive. Also, less heat is produced during the milling process and this might be advantageous for some contaminants.

81. What RSD is considered acceptable for risk assessment? What if RSD exceeds criteria?

Acceptable RSDs vary from project to project. If you are using an RSD to evaluate precision, a goal for the parameter should be set during project planning. RSDs may vary depending on the project and analytical method, but are typically around 20% or 30%. It might also be helpful to consider in the planning process what should be done if the RSD is larger than expected. For example, will the number of increments be increased in a second mobilization? This determination is also project-specific and depends on a variety of factors, including whether the precision is likely to influence the decision, and the level of confidence needed in the decision.

82. If you have non-detects data, do you need more than 3 replicates to calculate UCL?

Additional studies are needed to evaluate the effects of non-detect for ISM data. It is correct that the presence of non-detect may present a problem particularly if the sample size is low. You can still compute a UCL with non-detects by using substitution methods or the Kaplan Meier method. However, there is additional uncertainty in this estimate that is not accounted for. Your project team may decide to collect more than three replicates in cases of non-detected data particularly if the DL is close to the screening level or decision rule. The conceptual site model will be a driving factor and there may be exceptions.

The exposure scenario is used to define the DU size. The size of an SU depends on the spatial resolution needed by the project team.

83. If a site is sampled half with ISM samples and half with discrete samples but exposure is expected over the whole area, how can this be assessed in the risk assessment?

It is not advisable to simply combine ISM samples with discrete samples and analyze them together; however, you can combine the information from these two types of samples qualitatively as a lines-of-evidence approach in order to make an assessment. It may be advisable to look at the data spatially, particularly if a few of the discrete samples show elevated concentrations and the ISM samples did not encompass the entire study area.

This is a challenge that cannot be solved by combining the ISM and discrete data sets. One option is assuming the receptor equally occupies only half of the area of the DU on a daily basis and calculating the risks independently for each half (one with ISM data and other half with discrete data) of the DU (essentially 2 separate DUs).

Site DUs may be compared to a background DU of a different size, but they should be roughly the same size. Furthermore, the background area should be evaluated with respect to the conceptual site model so that differences in concentrations and variation are not expected depending on the size of the background DU (i.e., the background area is relatively homogenous). If differences are not expected, any size background DU can be compared to any site DU. If differences are expected, multiple background DUs may be needed.

Section 3.1 and in the training modules both discuss background DUs and their design. Ideally, the ISM background DU should be of the same size/volume as the Site DU. This is not essential, but what is essential is having the same increment density (such as 30 increments per ½ acre; see ISM-2 Figure 3-10), the same number of increments and the same number of replicates in both the ISM and background DUs. It is possible that one may need to have multiple background DUs to obtain comparable sizes to the Site DUs.

84. Can you explain how to assess potential variability of DU without replicates from another DU with replicates?

This can be done if the DUs are conceptually similar (called CSM-equivalent DUs). Typically, the variances from multiple DUs collected with replicates are compared, and, if not significantly different, are pooled and applied to all CSM-equivalent DUs (including those without replicates). Refer to Sections 3.2.6.2 and 8.3.3.1 for more details on this topic.