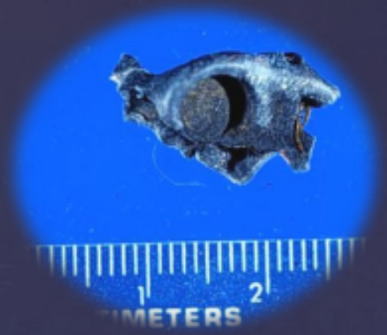
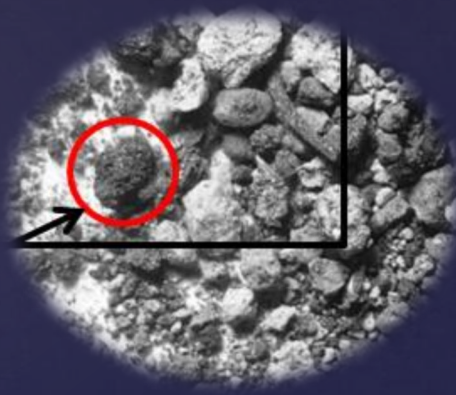
Highlights of Incremental Sampling

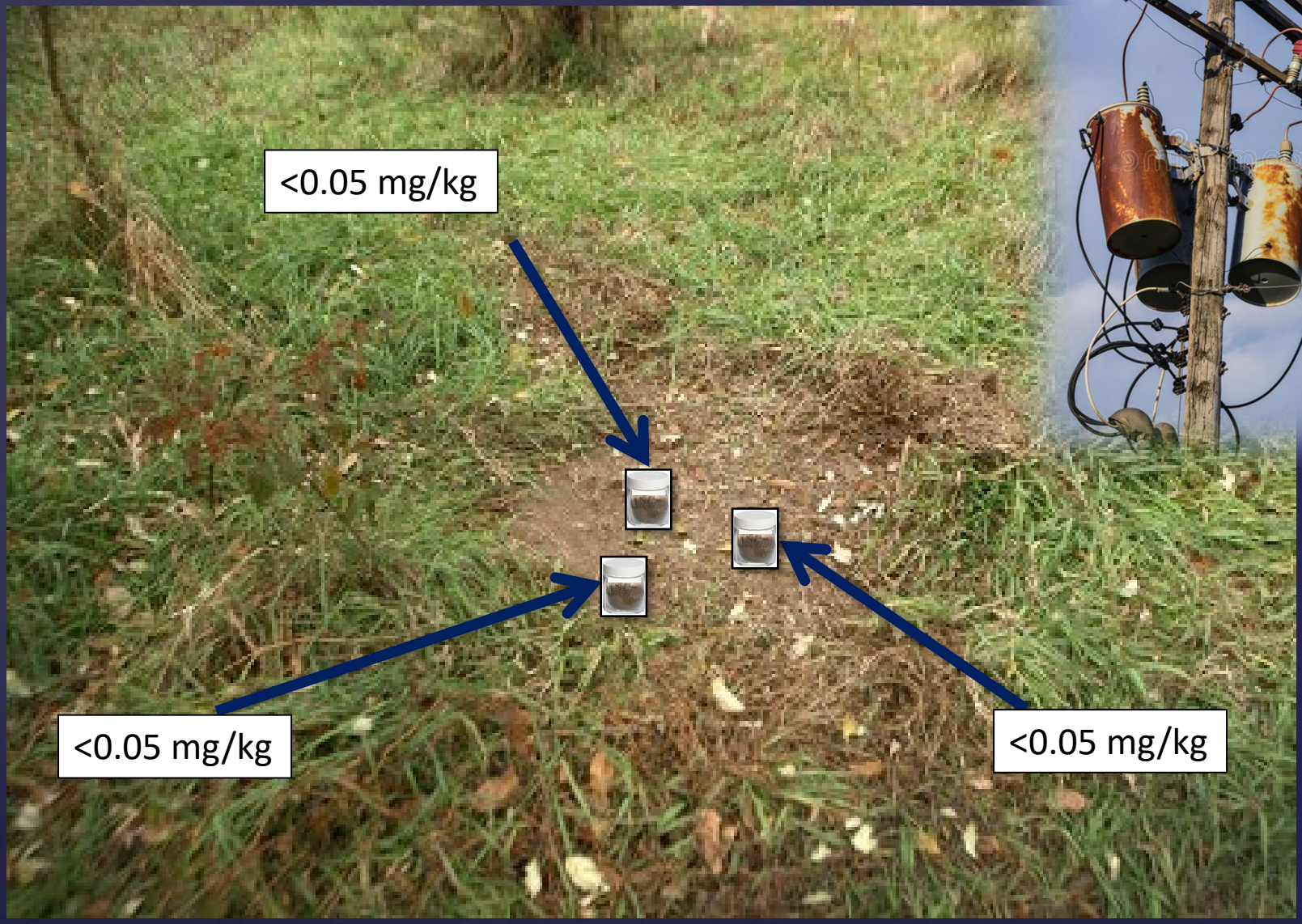




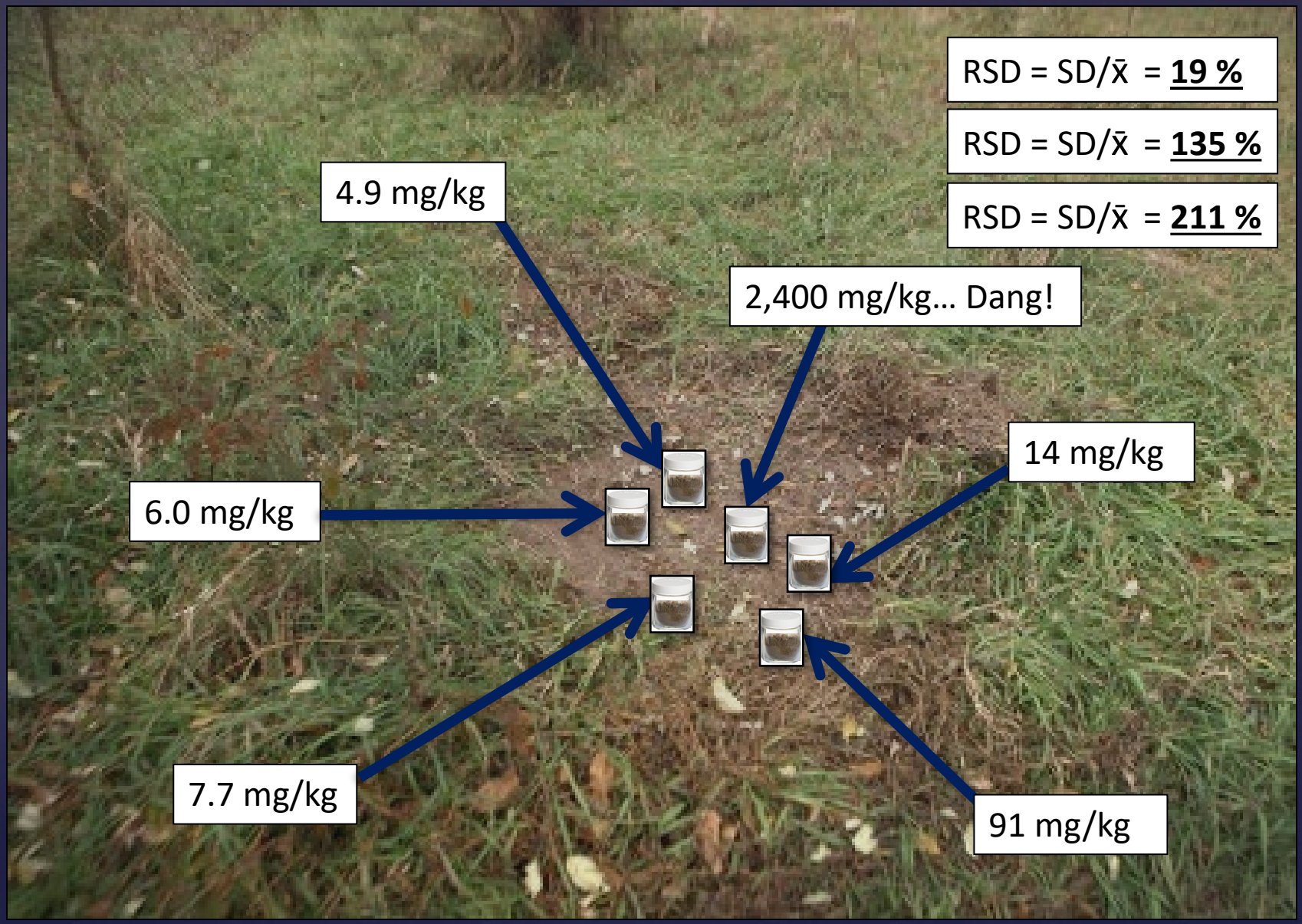
Jeremy Buck
Contaminants Specialist
U.S. Fish and Wildlife Service
Oregon Fish and Wildlife Office
Portland, Oregon

Has this ever happened to you?

Discrete Sampling…

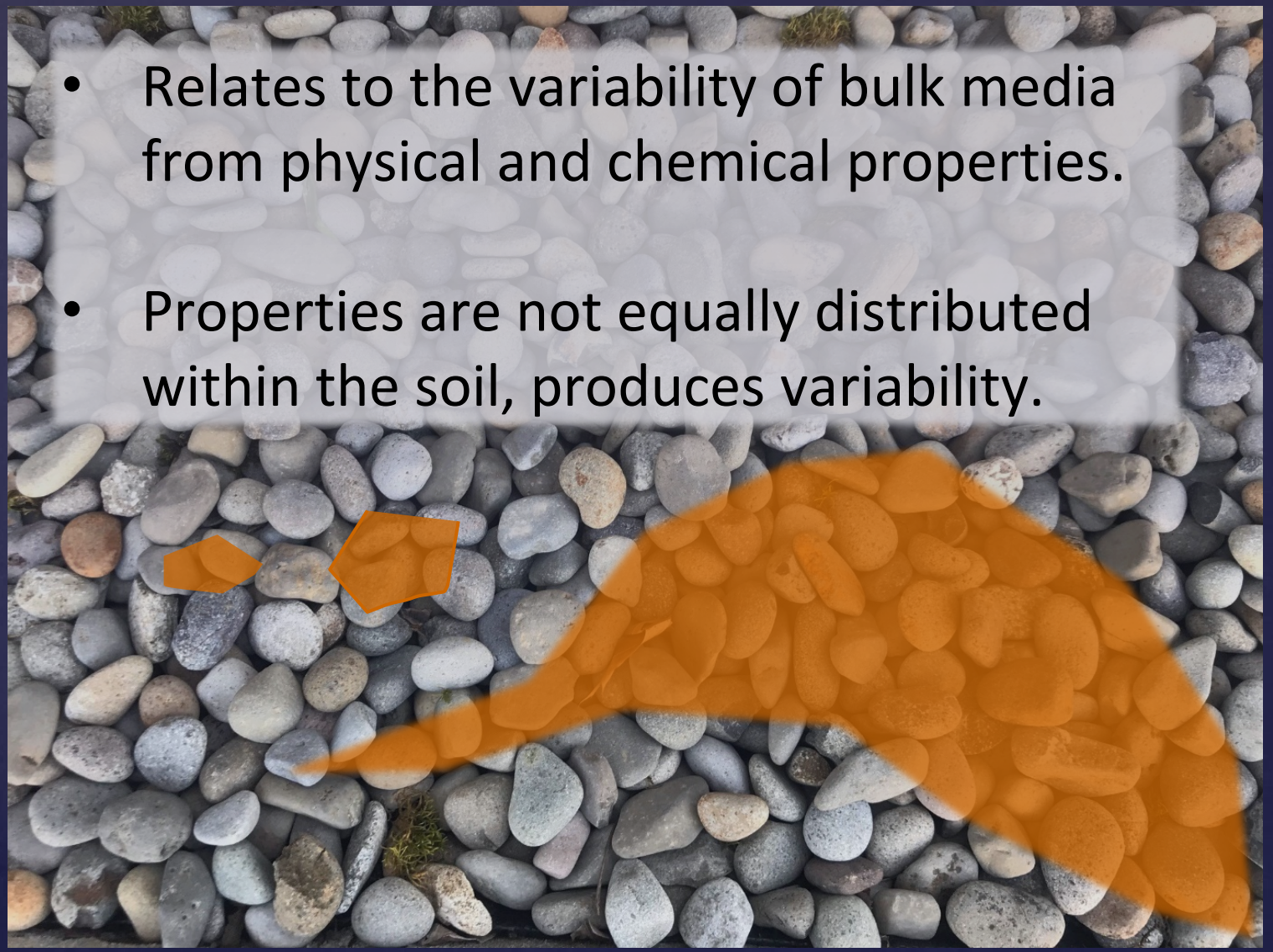


Is it Representative? Reproducible?



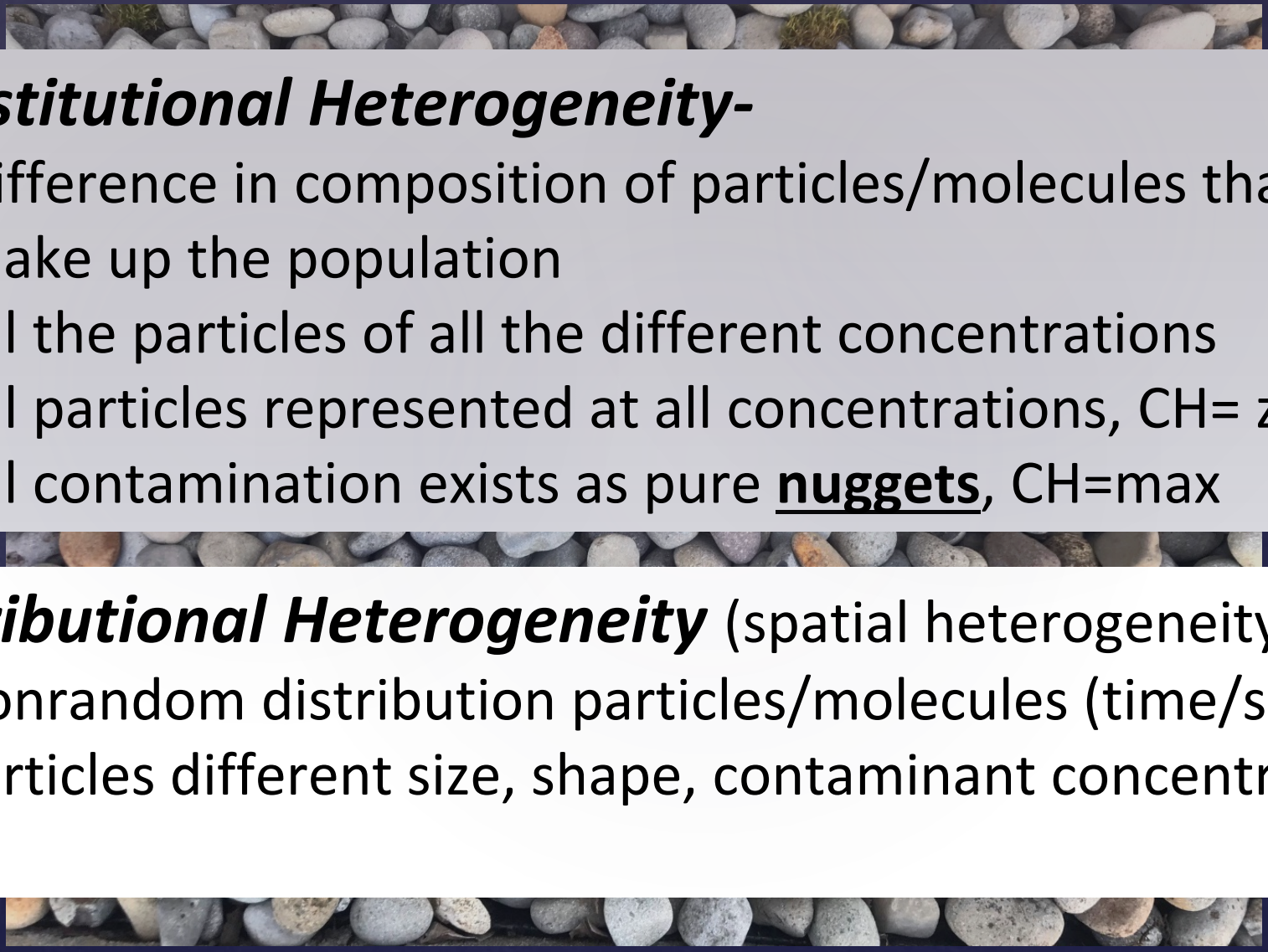
Why isn't it reproducible?

Heterogeneity



- Relates to the variability of bulk media from physical and chemical properties.
- Properties are not equally distributed within the soil, produces variability.

Heterogeneity…The Natural State



Constitutional Heterogeneity-

- Difference in composition of particles/molecules that make up the population
- All the particles of all the different concentrations
- All particles represented at all concentrations, CH= zero
- All contamination exists as pure **nuggets**, CH=max

Distributional Heterogeneity (spatial heterogeneity)

- Nonrandom distribution particles/molecules (time/space)
- Particles different size, shape, contaminant concentration

Nuggets

The Nugget Effect:

"…term describing the level of variability between samples at very small distances apart." Dominy et al. 2003.

"The term can be better understood by considering a football field strewn with diamonds. A given sample may contain 10 diamonds, and the sample next to it may contain none. " Simmonds 2009.

A needle in a haystack. In reality, no method is good to find the needle, just luck. Or a metal detector.

Heterogeneity problems led to the Theory of Sampling (TOS) Quiz- What is TOS?

A. An idea that should not be confused with the Theory of Everything (TOE)

B. An idea that should *really* not be confused with the Theory of Sampling Everything (TOSE)

C. An idea that I really should not concern myself with (NCMW)

D. A theory established over the last 60 years that defines incorrect sampling errors and states that when these errors are not appropriately reduced, or fully eliminated, all measurement uncertainty estimates are subject to uncontrollable and inestimable sampling bias

E. A, B, D

Pierre Gy- founder of TOS in 1950, Francis Pitard promoted, embraced by EPA since the late 1980s

Sampling Error

1. Fundamental sampling error (relates to CH)
2. Grouping & segregation error (relates to DH)
3. Delimitation error
4. Extraction error
5. Preparation error (sample handling)
6. Long-range heterogeneity fluctuation error (CE2)
7. Periodic heterogeneity fluctuation error (CE3)

How do we best address these errors?

Controlling **mass** addresses fundamental error

Controlling **number & size of increments** addresses GSE

Incremental Sampling directly addresses Mass and number and size of increments

Systematic Planning and Data Quality Objectives

1. Initiate Problem Statement
2. Develop Decision Statement
3. Identify Inputs
4. Specify Boundaries
5. Define Decision Rules
6. Specific Error Tolerances
7. Optimize Sample Design

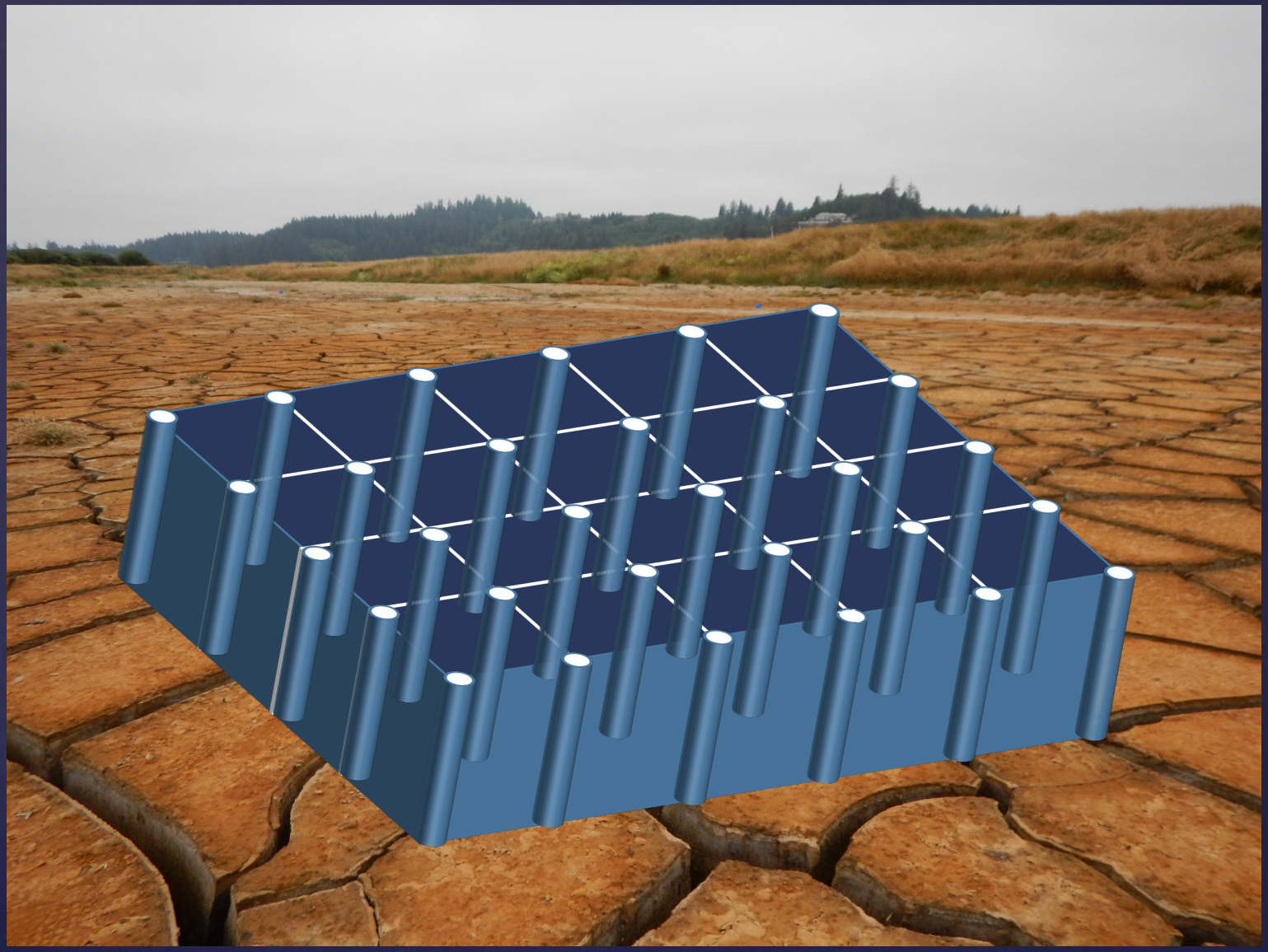
Ilwaco Dredged Material

Ilwaco Dredged Material

Decision Unit

Decision Unit – increments of 2 inch plugs

What about deeper Decision Units?

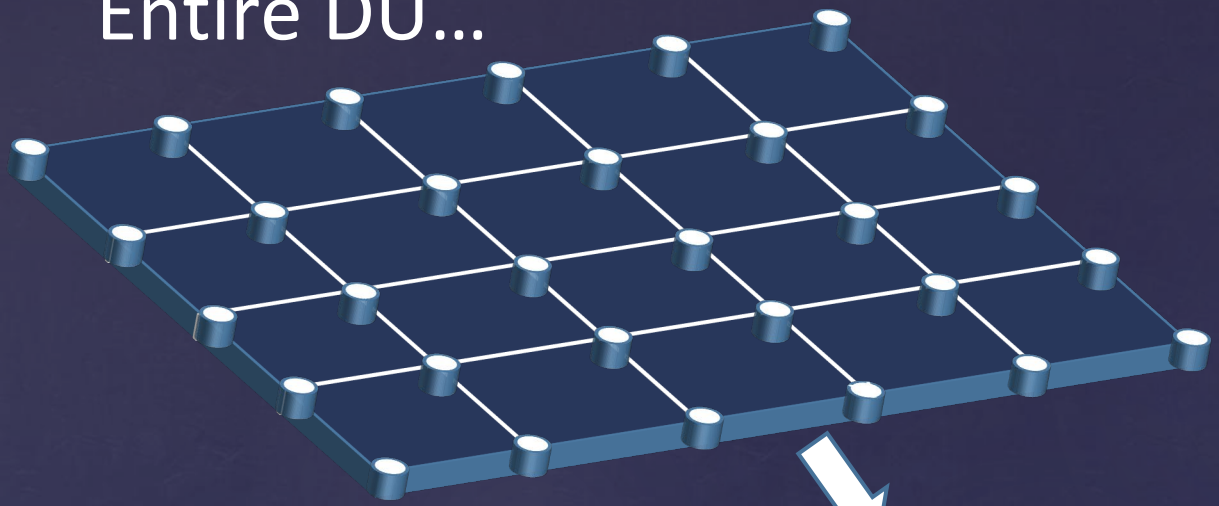


Decision Unit – zero to 4-foot core

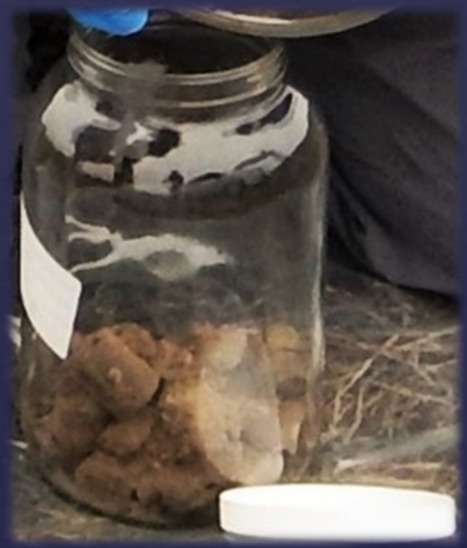
Ok. What about even deeper? Time for the Komatsu Sampler

Subsampling

Entire DU…



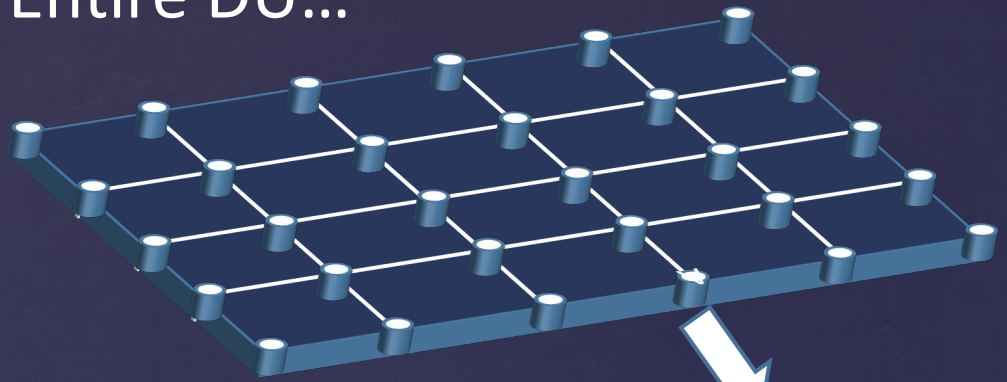
Sample Jar=Entire DU
…mass reduced to
1 to 3 kg!



?

Subsampling

Entire DU…



1 to 3 kg mass

Air drying

Disaggregation

Grinding- Ring & Puck

Entire DU…

Ilwaco Dredged Material

Surface Extent:
~1.8 acres

<u>3 Decision Units based on 3 horizons</u>

DU 1: Shallow – 33 increments

DU2: Core - to 4 feet – 33

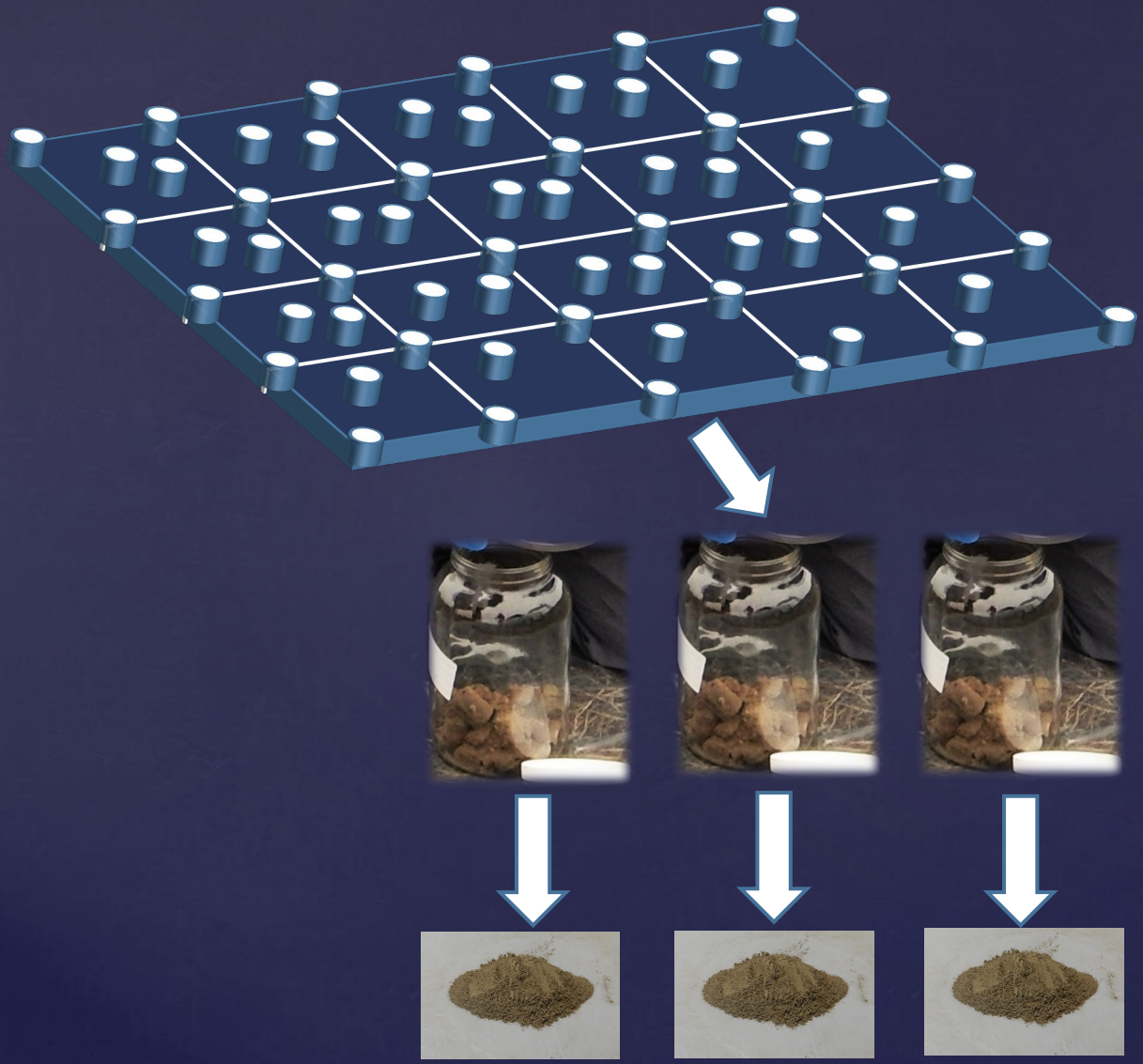
DU3: Deep - 6 locations

Ilwaco Results

Metals mg/kg	DU 1	DU2	DU3	RSD %
Arsenic	8.6	9.4	9.3	4.7%
Chromium	22	26	25	7.7%
Lead	17	20	21	10.7%
Mercury	0.10	0.14	0.14	16.3%
Zinc	114	126	123	5.2%

PAHs µg/g	DU 1	DU2	DU3	RSD %
BaP	47.3	47.4	52.5	6.1 %
Phenanthrene	54.1	54.1	83.1	26.3 %
Pyrene	136	143	196	21 %

1 DU or 10% of DUs = Triplicate



- Take the first increment
- Then take another in each grid cell
- Then another
- Each of these 3 samples now represent the entire DU
- 3 separate analyses
- This really never happens with discrete sampling, and addresses reproducibility

X X X

SD/x = RSD

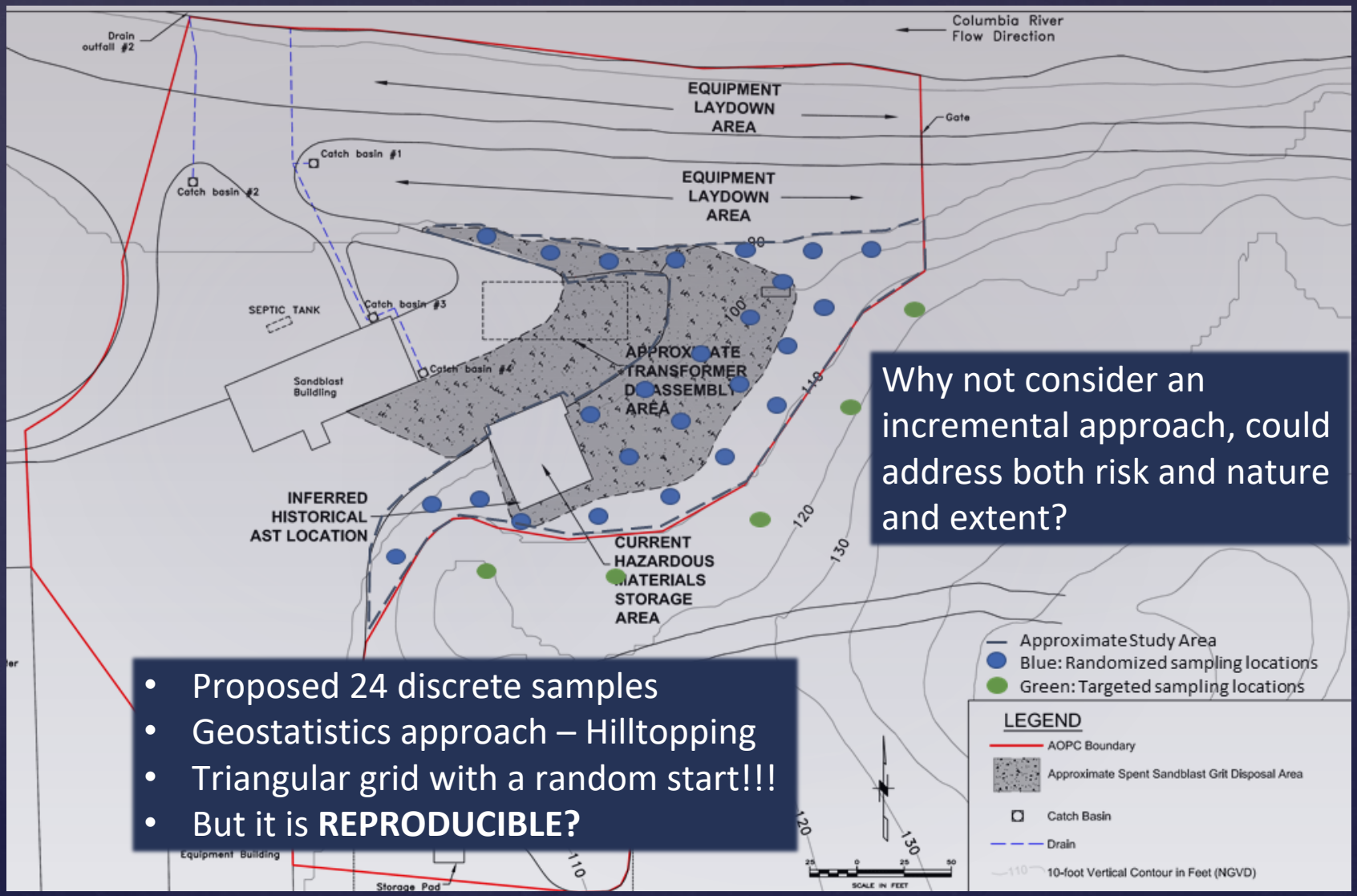
Quiz Question: 95% UCL

Many states prefer the 95% Upper Confidence Limit (UCL) over the average to determine an exposure point concentration (EPC) to compare to a risk threshold for an ecological receptor. How many samples does it take to calculate an upper 95% confidence limit?

A. One
B. Two
C. The same number as the licks it takes to get to the center of a Tootsie roll Tootsie Pop
D. Well, EPA's ProUCL Software says a minimum of 10, but I think it should be more like at least 30 if not 100…especially if using discrete samples

Bradford Island, Columbia River

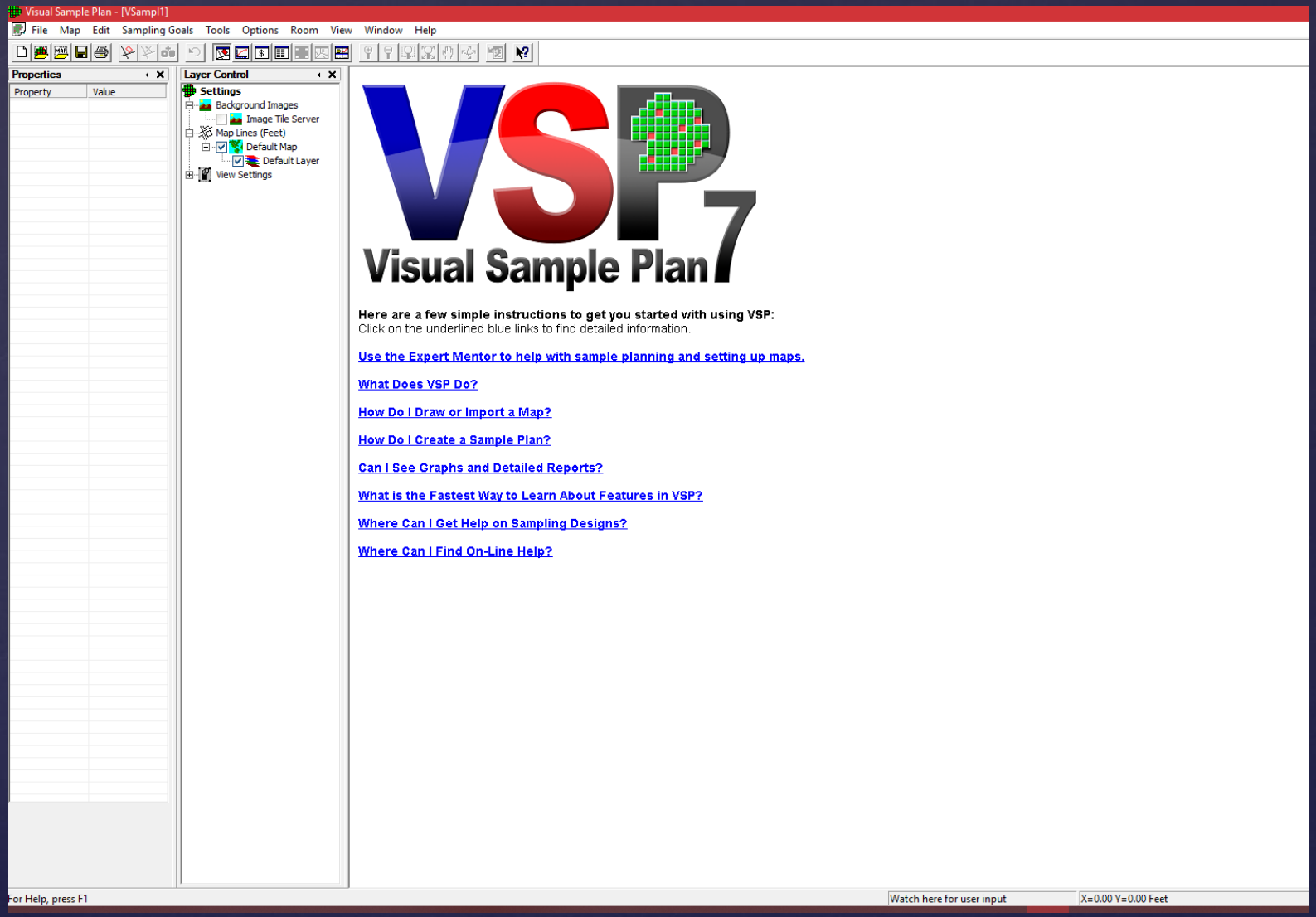
Proposed Sampling Plan – Sandblast Area



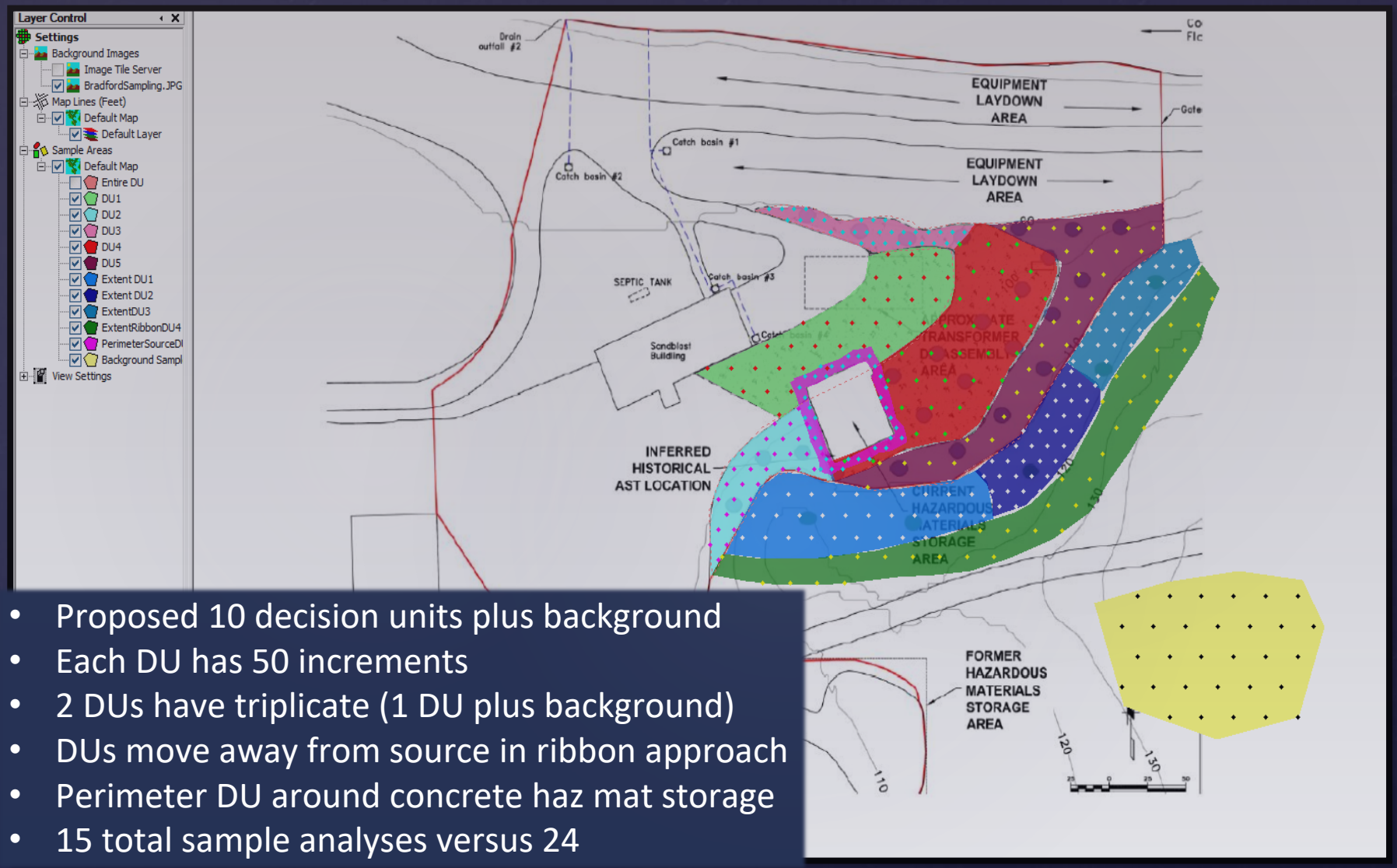
Why not consider an incremental approach, could address both risk and nature and extent?

- Proposed 24 discrete samples
- Geostatistics approach – Hilltopping
- Triangular grid with a random start!!!
- But it is **REPRODUCIBLE?**

VSP – A great tool to quickly design an IS Plan



Visual Sample Plan – Proposed Increments



- Proposed 10 decision units plus background
- Each DU has 50 increments
- 2 DUs have triplicate (1 DU plus background)
- DUs move away from source in ribbon approach
- Perimeter DU around concrete haz mat storage
- 15 total sample analyses versus 24

Representative AND we can test **Reproducibility**! (Meets the R&R test)

There are differences in methods…

Incremental Sampling – generic

Multi-Increment® Sampling – EnviroStat, Inc.

Incremental Sampling Method (ISM) – ITRC

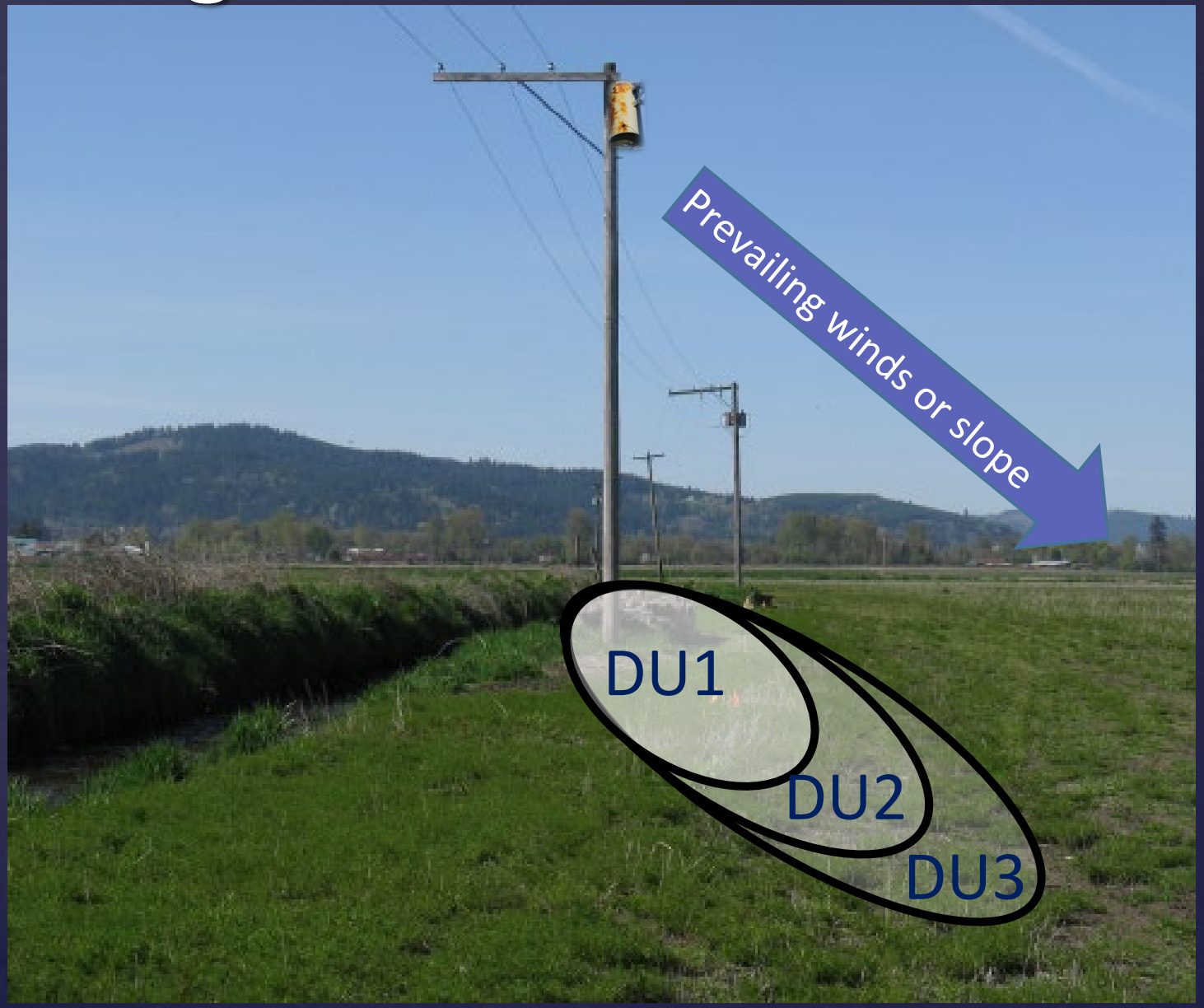
Hawaii protocol (MIS)

Disclaimers:

MIS and Hawaii Protocol much different from ITRC, especially in the risk component

This webinar is no excuse for taking an IS course

Hindsight…



When time is all spent
And the room fills with dissent
Why not increment?

Jeremy_Buck@fws.gov