Asbestos Site Assessment Framework – Day 1

Technical Review Workgroup Asbestos Committee

https://www.epa.gov/superfund/asbestos-superfund-sites-technical-resources

Asbestos TRW Overview

Please contact the TRW for any questions regarding this presentation or other asbestos related questions: asbestoshelp@epa.gov

Mission

- To provide technical support for questions concerning the assessment, removal or remediation of asbestos contamination at CERCLA sites.

Co-chairs

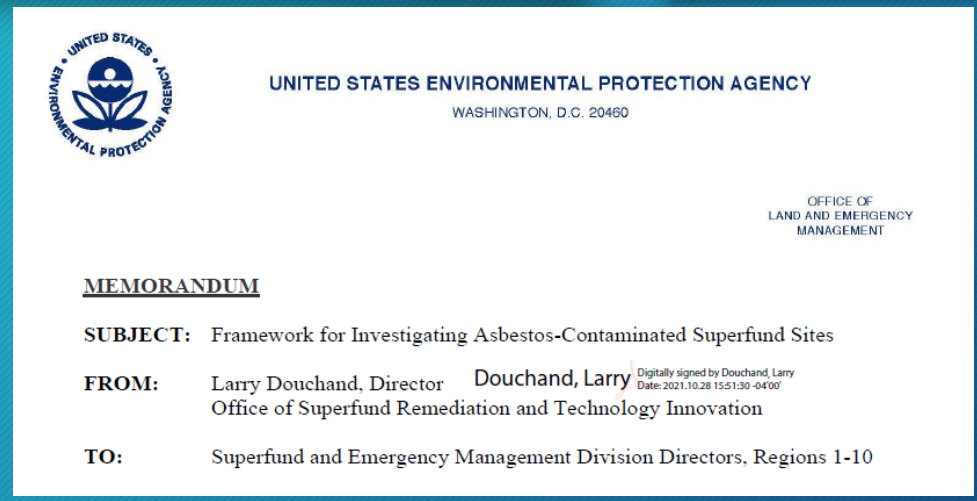
- Lisa Raterink (HQ – OSRTI)
- David Berry (R8)
- Joey Gawarzewski (R3)

Members include staff from:

- Regional Offices
- Office of Land and Emergency Management (OLEM)
- Office of Research and Development (ORD)
- Agency for Toxic Substance Disease Registry (ATSDR)

Framework for Investigating Asbestos Contaminated CERCLA Sites

- Provides Superfund site decision makers with information to assist in asbestos risk evaluation
- Recommends a site-specific approach to using air measurements of asbestos fibers released during soil- and dust-disturbing activities
- Released in 2021 and updates the 2008 version: OLEM Directive No. 9200.0-90



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
LAND AND EMERGENCY
MANAGEMENT

MEMORANDUM

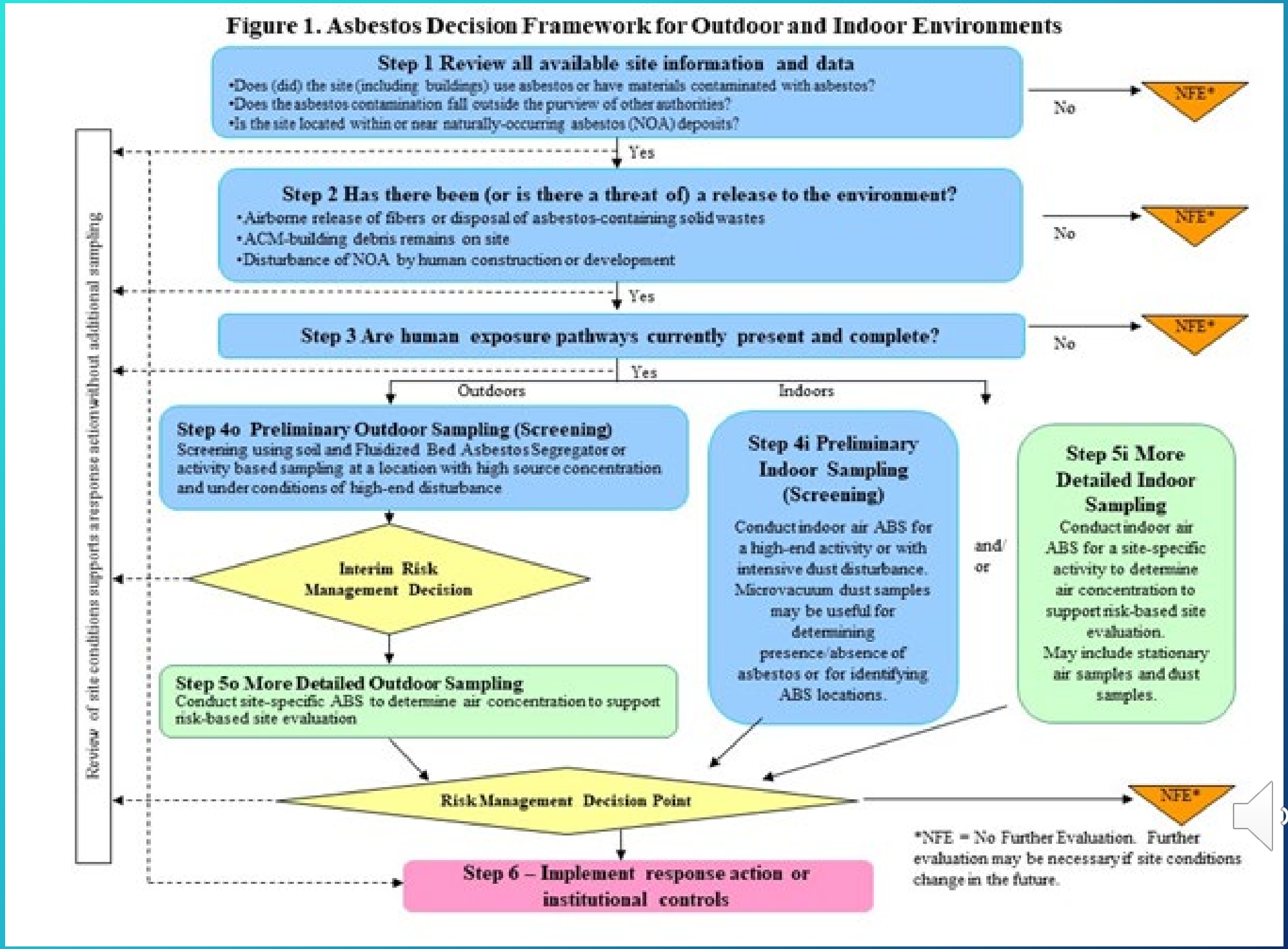
SUBJECT: Framework for Investigating Asbestos-Contaminated Superfund Sites

FROM: Larry Douchand, Director Douchand, Larry Digitally signed by Douchand, Larry Date: 2021.10.28 15:51:30 -04'00'
Office of Superfund Remediation and Technology Innovation

TO: Superfund and Emergency Management Division Directors, Regions 1-10

Find the updated Framework here:

Outline of the Framework

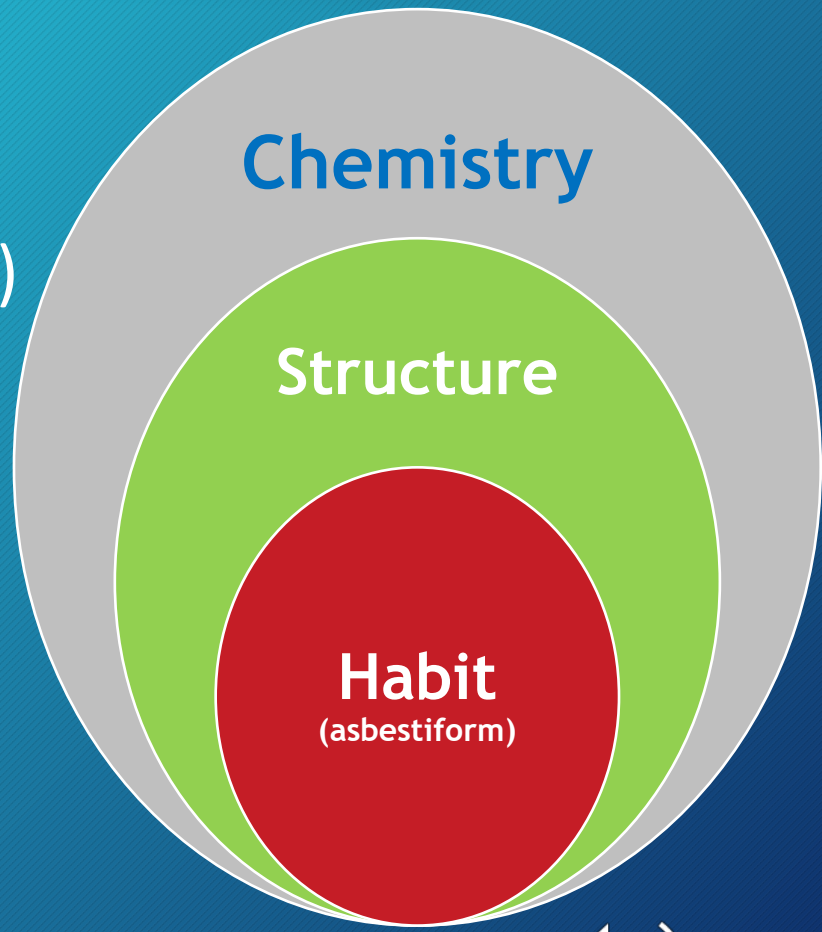


Asbestos: What Is It?

- Asbestos from different perspectives:
  - Geological
    - Mineralogically – mineral type
    - Morphologically – size, habit
  - Commercial
    - Used in manufacturing
  - Analytical
    - What is seen under microscope
  - Regulatory
    - Regulated by agencies and organizations

Asbestos: Geological Perspective

- Basic chemistry - Silicates
  - Silicon and oxygen
  - Tetrahedron shaped ionic group (SiO_4)
- Also classified by:
  - Crystalline Structure
  - Cations present (Ca, Fe^{+2}, Al, Mg, etc.)
  - Habit of formation
    - Asbestiform



Asbestos Mineral Groups/Types

- There are over 60 known varieties of asbestos
- The term asbestos has often been applied to six types listed below:

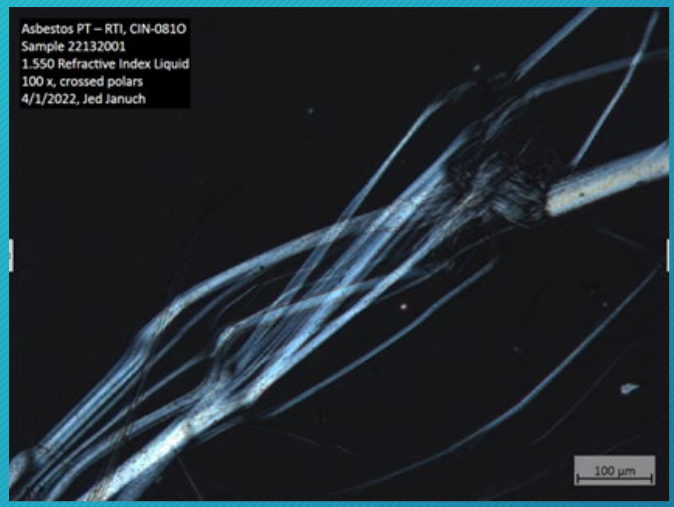
Serpentine

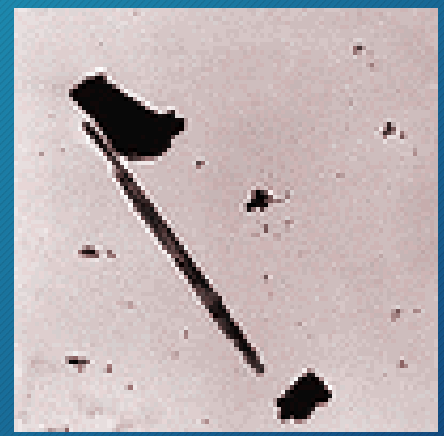
- Chrysotile
  - Comprises >90% of the asbestos used in products

Amphibole

- Amosite
- Crocidolite
- Anthophyllite
- Actinolite
- Tremolite

"Wavy"





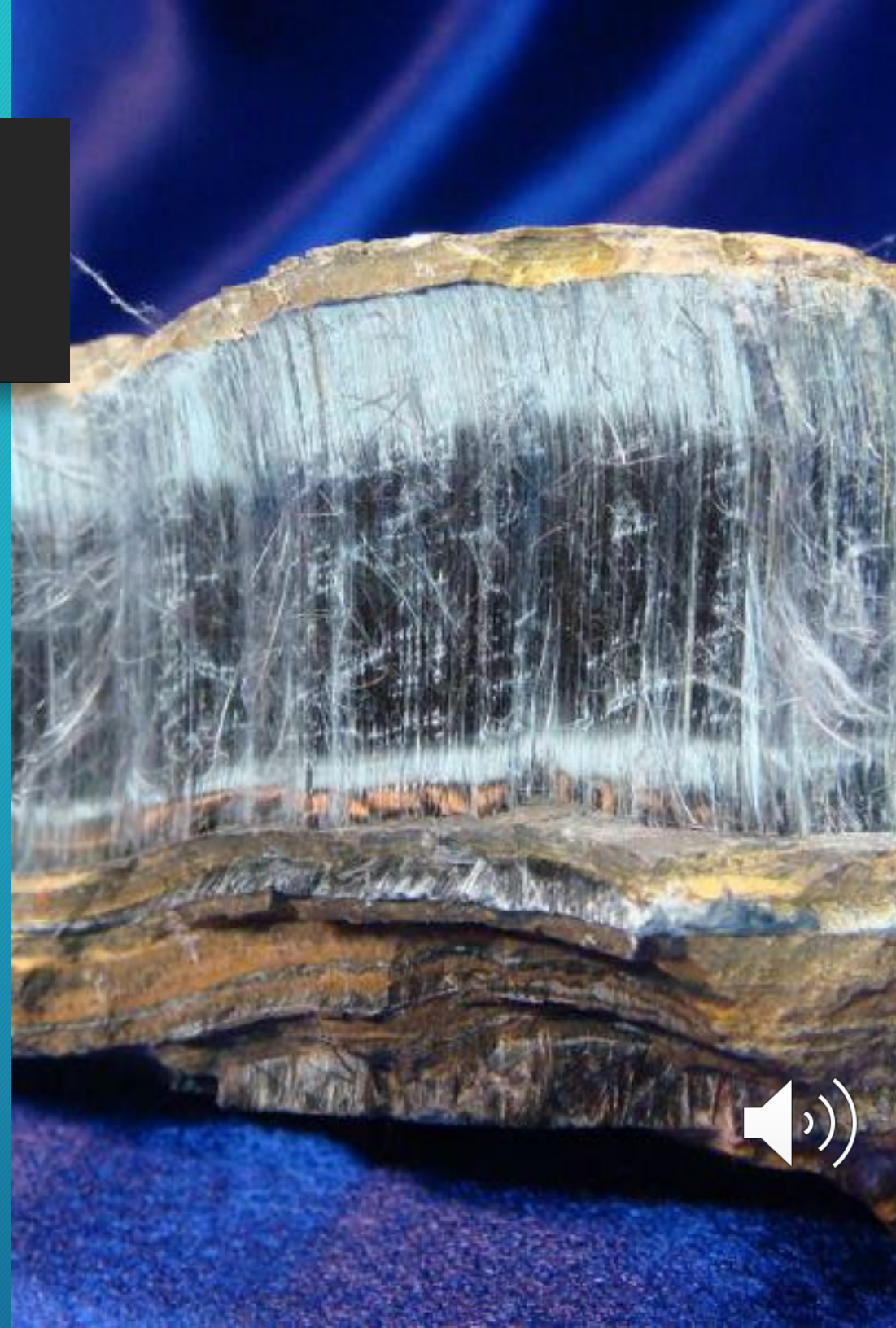
"Straight"

Chrysotile

- Known as white asbestos
- Fibrous form of mineral serpentine
- Most common type of asbestos used around the world, with some countries still permitting “controlled use”
- 93% of Asbestos Containing Materials (ACM) is made up of chrysotile
  - Large majority is asbestos cement
  - Other examples: roofing, flooring and brake pads
- Largest users are developing countries

Crocidolite

- Known as blue asbestos
- Member of the amphibole group of minerals
- Rarely used in commercial products because found to be less heat resistant than other asbestos fibers
- Used in steam engines, spray-on coatings, pipe insulations, plastics, and cement products



Amosite

- Known as brown asbestos
- Member of the amphibole group of minerals
- Most frequently used in cement sheets and high-temp, high-heat capacity pipe insulation

Anthophyllite

- One of rarest types of asbestos
- Not a long history of commercial use, but can be found in cement, insulation, roofing material, and rubber due to being relatively inert and stable in presence of heat or acid
- Mining of anthophyllite began in Finland
- Coloring can vary from grey to green, brown, and beige

Sapphire Valley Gem Mine (Region 4)

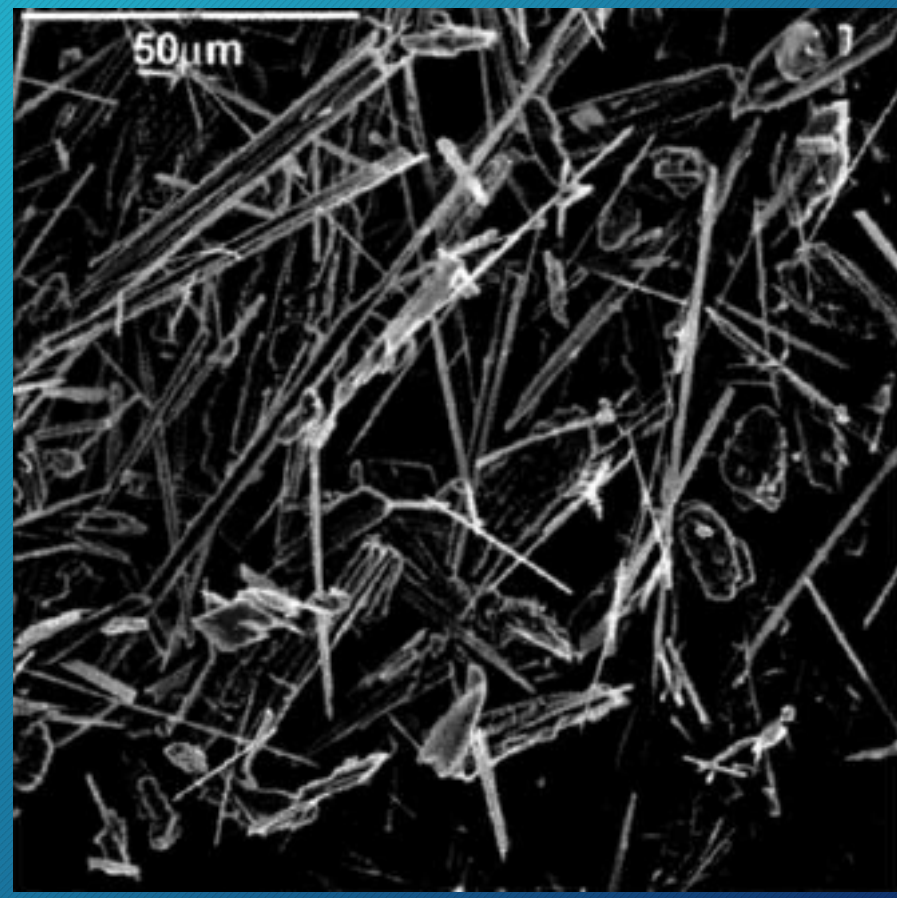
Tremolite and Actinolite

- Rarely included in commercial products (general ACM)
- Usually found in trace amounts when other minerals are being mined, but high levels of tremolite may occur in vermiculite mines (e.g., Libby Mine, MT)
- **Tremolite** can be brown, white, green, grey, or transparent
- **Actinolite** can be pale to dark green, yellowish green, and black, and appears to be white or transparent

Tremolite asbestiform fibrils are “born” from crystalline growth of mineral-rich solution

Libby Amphibole Asbestos (LAA)

- A mixture of amphibole mineral fibers that have been identified in the Rainy Creek complex at the Libby, MT vermiculite mine
- Comprised of several amphibole minerals:
  - Winchite (84%)
  - Richterite (11%)
  - Tremolite (6%)
  - Magnesio-riebeckite (~1%)
  - Magnesio-arfvedsonite (~1%)
  - Edenite (~1%)



Asbestos properties that make it appealing for commercial use

- Long flexible mineral fibers
- High tensile strength
- Durability
- Heat resistance
- Acid/alkaline resistance
  - amphiboles
- The general term “asbestos” was applied to mineral fibers selected for these properties

Commercial Perspective

- Asbestos-Containing Materials (ACM): Asbestos-containing material; any material containing >1% asbestos
- Any one of these minerals that have been chemically altered (i.e., adding binder to make product); includes presumed ACM (PACM)

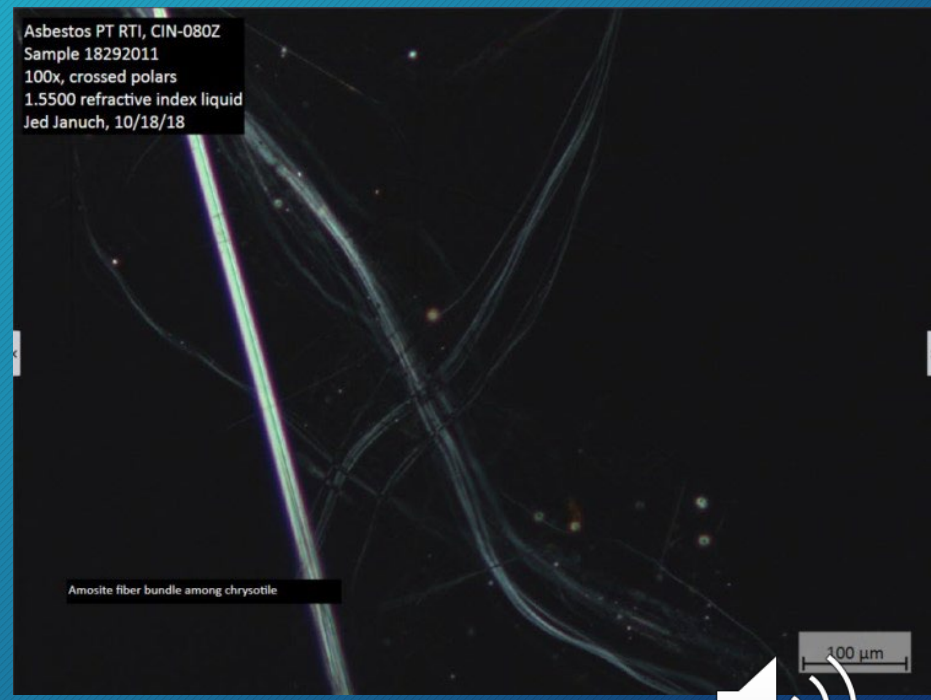
Analytical Perspective

- The analytical method used will determine the counting rules for asbestos analysis.
  - Different types of structures (fibers, bundles, etc.)
  - Different sizes (length, width, aspect ratio) may be excluded
  - Mineral types

Asbestos Mixtures

Mixture of different particle sizes and structure types (Tremolite)

Mixture of different mineral types (Amosite and Chrysotile)



Regulatory Perspective

- Asbestos listed as CERCLA hazardous substance under **40 CFR, Part 302**
  - CAS No. 1332-21-4
- Addressed by other statutes and regulations, such as:
  - AHERA under TSCA
  - Asbestos NESHAP under the CAA
  - OSHA General Industry and Construction Standards
  - Asbestos MCL under the CWA
  - Different laws have different perspectives/ definitions of asbestos

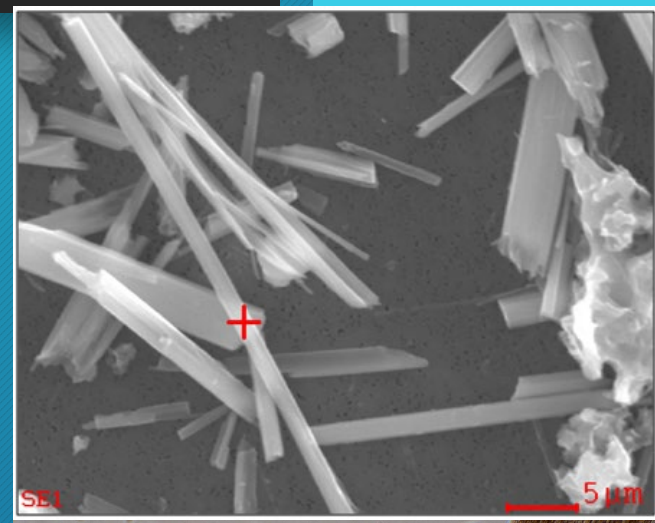
Asbestos: Framework Discussion

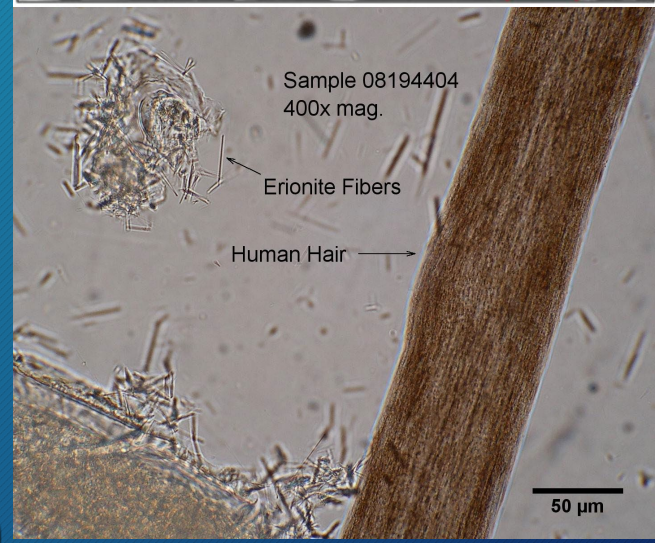
"A group of highly fibrous silicate minerals that readily separate into long, thin, strong fibers that have sufficient flexibility to be woven, are heat resistant and chemically inert, are electrical insulators, and therefore, are suitable for uses where incombustible, nonconducting, or chemically resistant materials are required. The generic name used for a group of naturally occurring mineral silicate fibers of the serpentine and amphibole series, displaying similar physical characteristics although differing in composition."

"Intended to cover all mineral forms of asbestos that may be subject to CERCLA authority and are associated with health effects in humans."

Erionite
(mineral with an asbestiform habit)

- Similar to asbestos, it occurs as an elongate mineral particle with a blade-like to fibrous morphology
- Some physical properties and health effects are similar to asbestos
  - Like asbestos, erionite may pose health risks to those who breathe in the fibers
- Color varies from white to clear





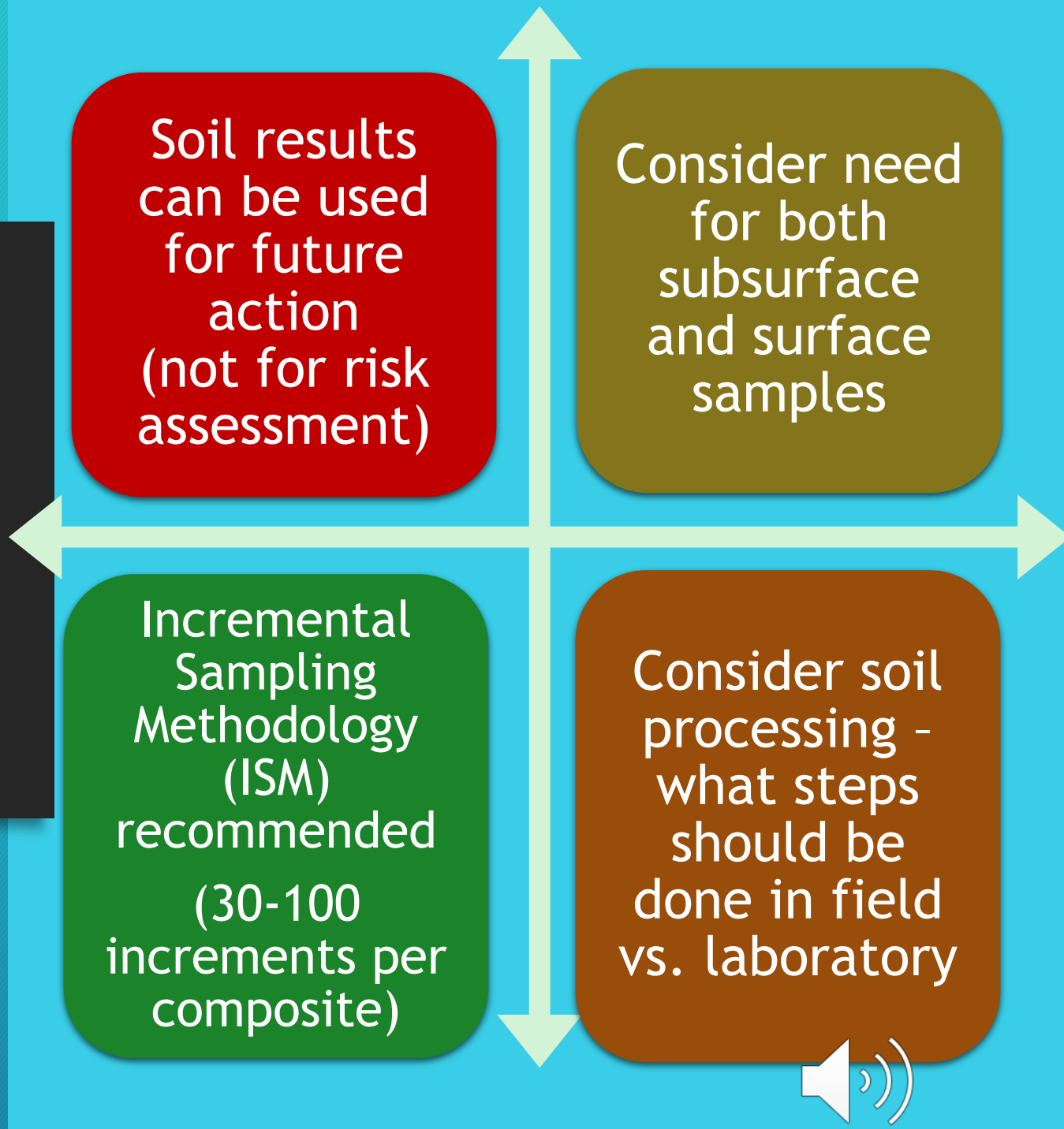
Rome, Oregon (Region 10)

Q&A Break

Asbestos Sampling Recommendations

- Soil
- Settled Dust
- Air

Soil Sampling (Outdoor)



Incremental Sampling Methodology (ISM) Process

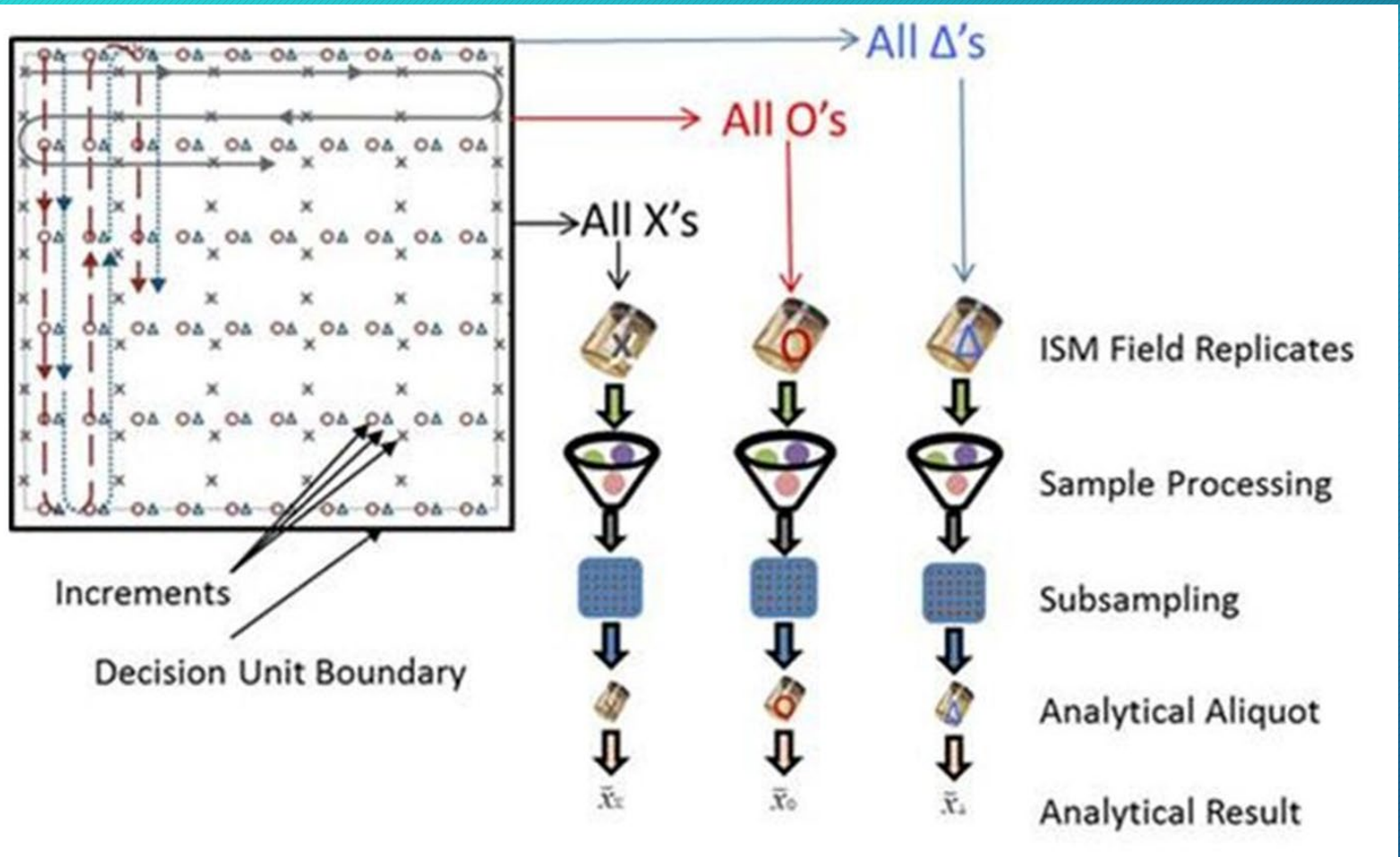


Figure from ITRC

The Interstate Technology & Regulatory Council (ITRC) provides ISM Guidance:

https://ism-2.itrcweb.org/

Dust Sampling (Indoor): Microvacuum

- ASTM 5755 method
  - Recommended method
- Low-suction vacuum
- Captures dust and fibers on filter cassette
- Preserves dust matrix
- Used to assess presence of fibers (s/cm^2) in settled dust (solid, nonporous surfaces)
- Microvacuum (and wipe) results can be used for response action (but not for risk assessment)

Dust Sampling (Indoor): Wipe

- ASTM D6480-19 method
  - May be considered on a site-specific basis
- An area of a surface is wiped with a cloth material to collect a sample

- Screening level for dust results (both microvacuum and wipe) = 5,000 s/cm^2 (total structures)
  - Benchmark used at World Trade Center and Libby, MT

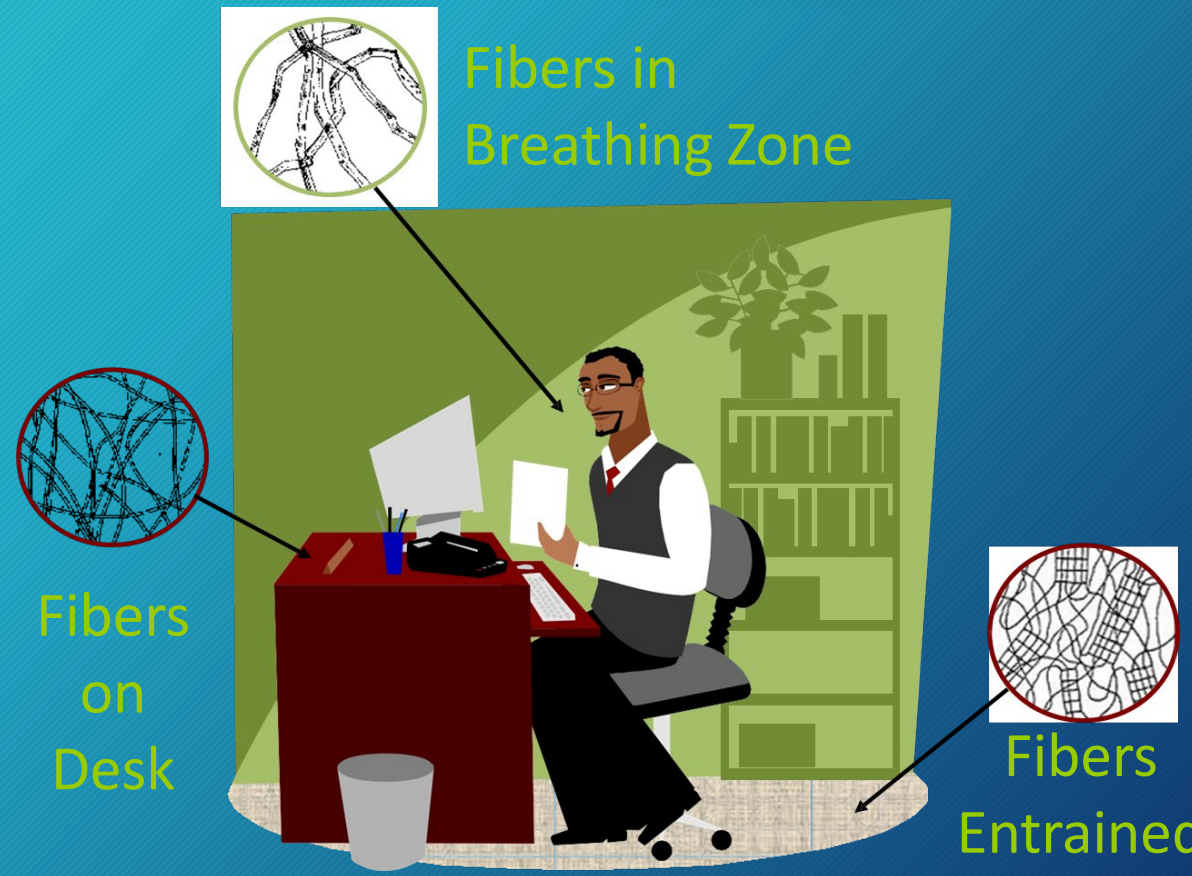
Air Sampling

- Used for:
  - regulatory compliance
  - environmental condition assessment
  - human exposure assessment
- Performed in the breathing zone if used for risk evaluation
- Activity-Based Sampling (ABS)
  - Recommended for human health risk assessment
  - Should be performed while conducting a high-end activity typical for the site (e.g., raking, jogging, gardening) along with perimeter air sampling

Additional info is available in Appendix E of the 2021 Framework (ERT Helpful Hints for ABS) and is also available here: https://semspub.epa.gov/work/HQ/100002942.pdf#page=122

Why Activity-Based Sampling?

- Air concentrations cannot currently be calculated using soil and dust concentrations
- Resuspension of particulates (including fibers) from human activity produces a measurable personal cloud



Why Activity-Based Sampling?

- Asbestos is NOT uniformly distributed in soil
- Soil concentrations <1% have been demonstrated to represent significant risk when disturbed

1% Unconsolidated Chrysotile

1% Consolidated Chrysotile

1% As[illegible]stos

Activity-Based Outdoor Sampling

- Uses an activity that provides a high-end soil disturbance
- Currently recommend a “raking scenario” as the high-end outdoor activity
- Rake for specified time over an area of concern
- Collect personal air samples (breathing zone) and perimeter air samples
- Provides a site-specific measure of fiber release from soil

Example ABS Scenarios

- Raking (leaf rake)
  - Generic ABS
- Rototilling
- Child playing in the dirt
- Lawn mowing
- Bicycling
- Jogging
- Soccer
- Driving
- ATV riding
- Digging
- Weed whacking
- Walking with stroller
- Basketball
- Hiking
- Motorcycling
- Gardening

Refer to Appendix E of the Framework
EPA ERT "Helpful Hints for ABS Sampling"
and EPA ERT SOP 2084

https://semspub.epa.gov/work/HQ/100002942.pdf#page=122

https://response.epa.gov/sites/2107/files/ERT-PROC-2084-21R1.1%20SOP%20Manual.pdf

ABS Examples – Working/Occupational Scenarios

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ABS Examples – Working/Occupational Scenarios

ABS Examples – Recreational Scenarios

ABS Examples – Recreational Scenarios

ABS Examples – Recreational Scenarios

Bike Riding

ABS Examples – Recreational Scenarios

ABS Examples – Recreational Scenarios

Sports - Soccer

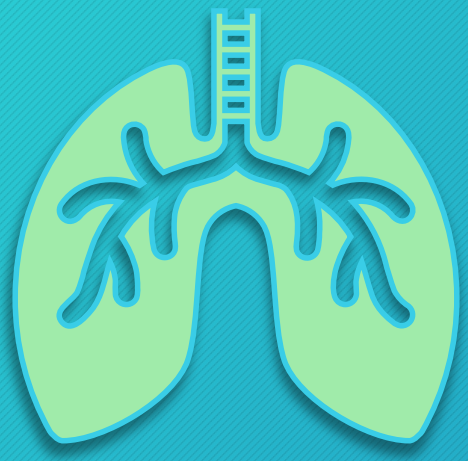
ABS Examples – Recreational Scenarios

ABS Examples – Recreational Scenarios

Activity-Based Indoor Sampling

- Fans, leaf blowers and sweeping may be used
- Collect air samples (breathing zone) and perimeter air samples
- Provides quantitative concentration of fibers in air resulting from dust disturbance suitable for risk evaluation

ABS/Air Sampling Key Points



(1) Measurements made directly from the breathing zone are most valuable

(2) ABS is the most reliable estimate of exposure

(3) **<u>Dust</u>** measurements and/or **<u>solid media</u>** (soil, ore, ACM, etc.) data cannot currently be converted to air concentration data for risk assessment

(4) Measurements from stationary air monitors may not provide reliable estimates of human inhalation exposure

Video – ABS for Asbestos: Overview and Considerations

- https://www.youtube.com/watch?v=N9diHf68ZA4

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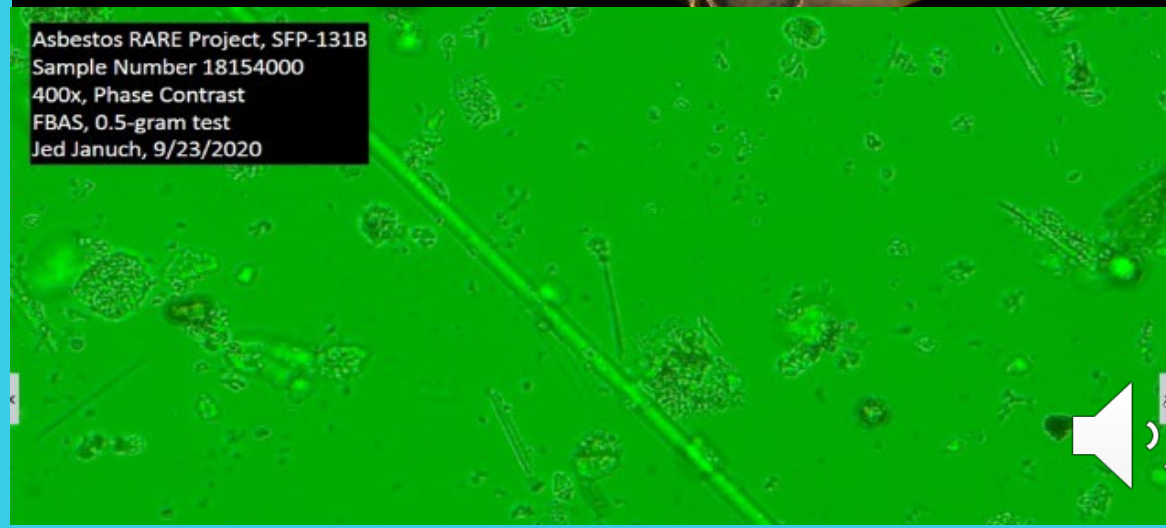
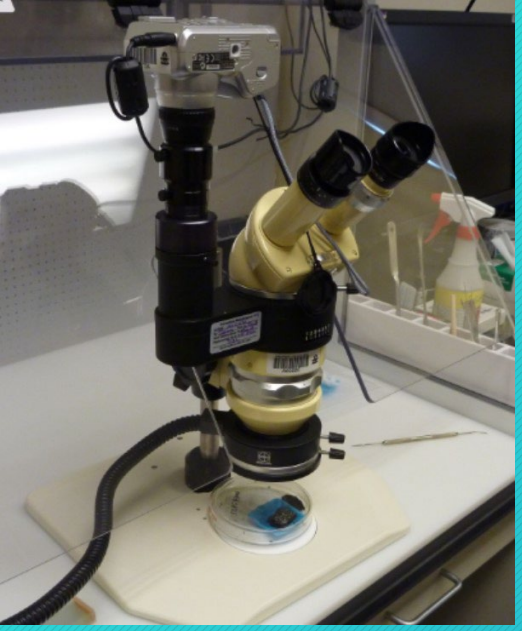
Q&A Break

Asbestos Analytical Recommendations



Instrument Overview



Stereoscopic Examination

Polarized Light Microscopy (PLM)

Phase Contrast Microscopy (PCM)

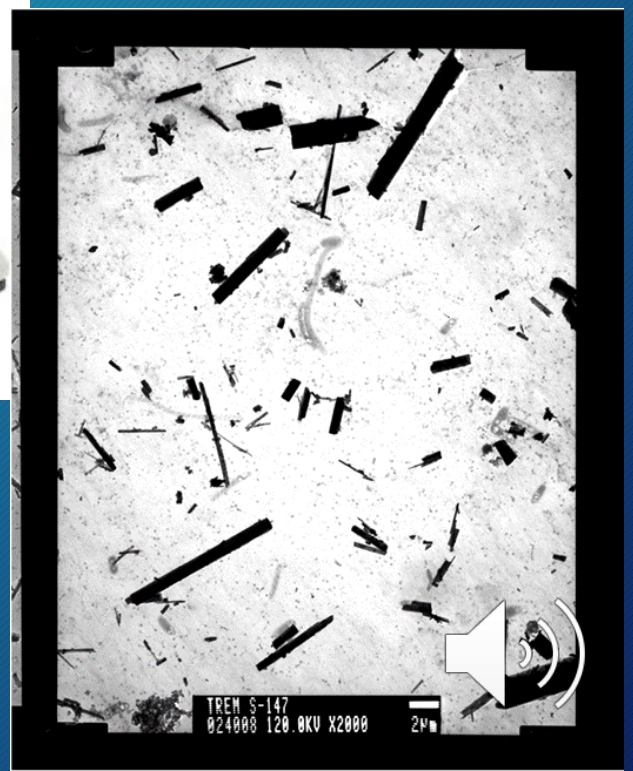
Transmission Electron Microscopy (TEM)

Scanning Electron Microscopy (SEM)

Instrument Overview

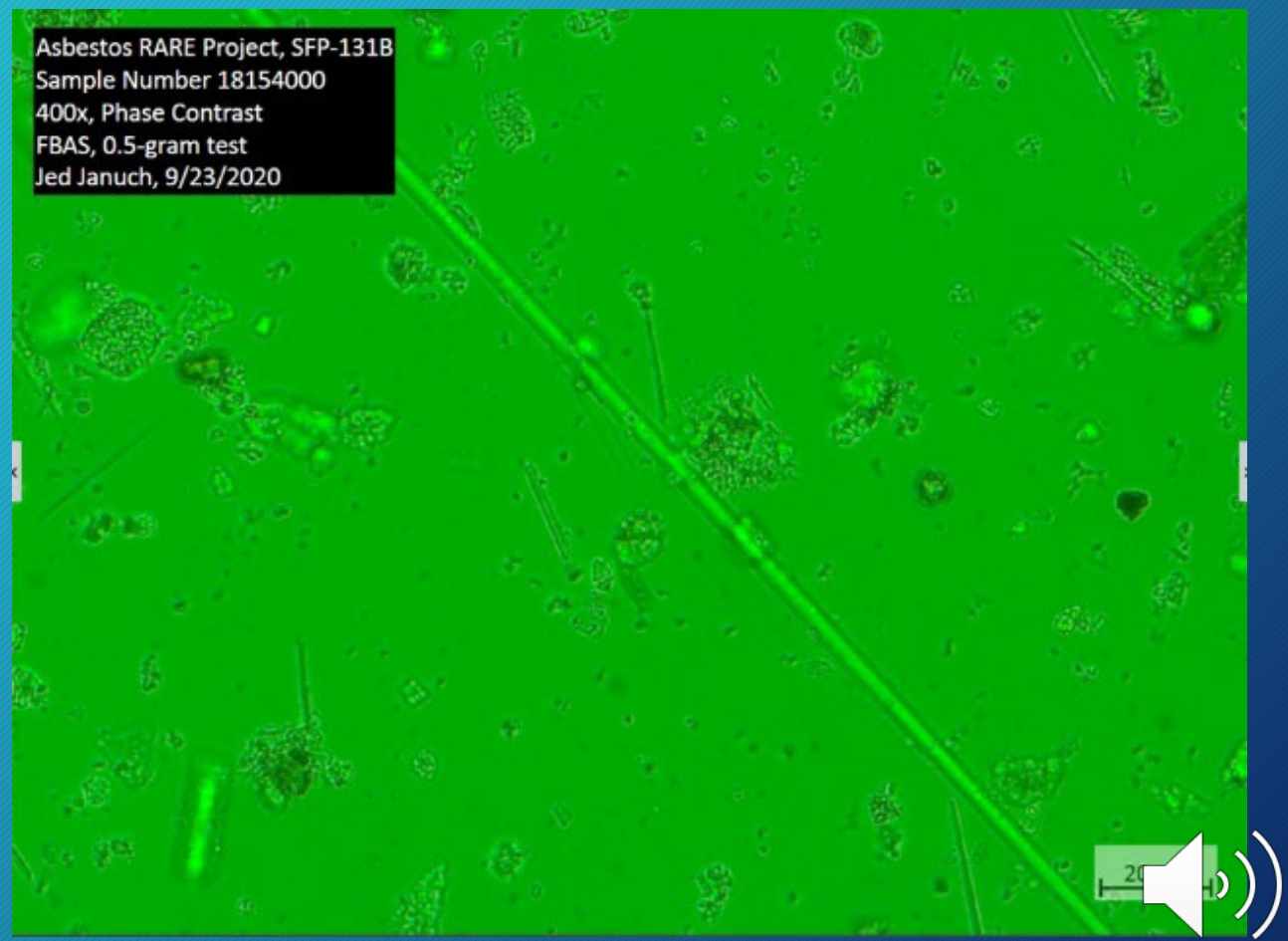
Stereoscopic Examination

Polarized Light Microscopy (PLM)



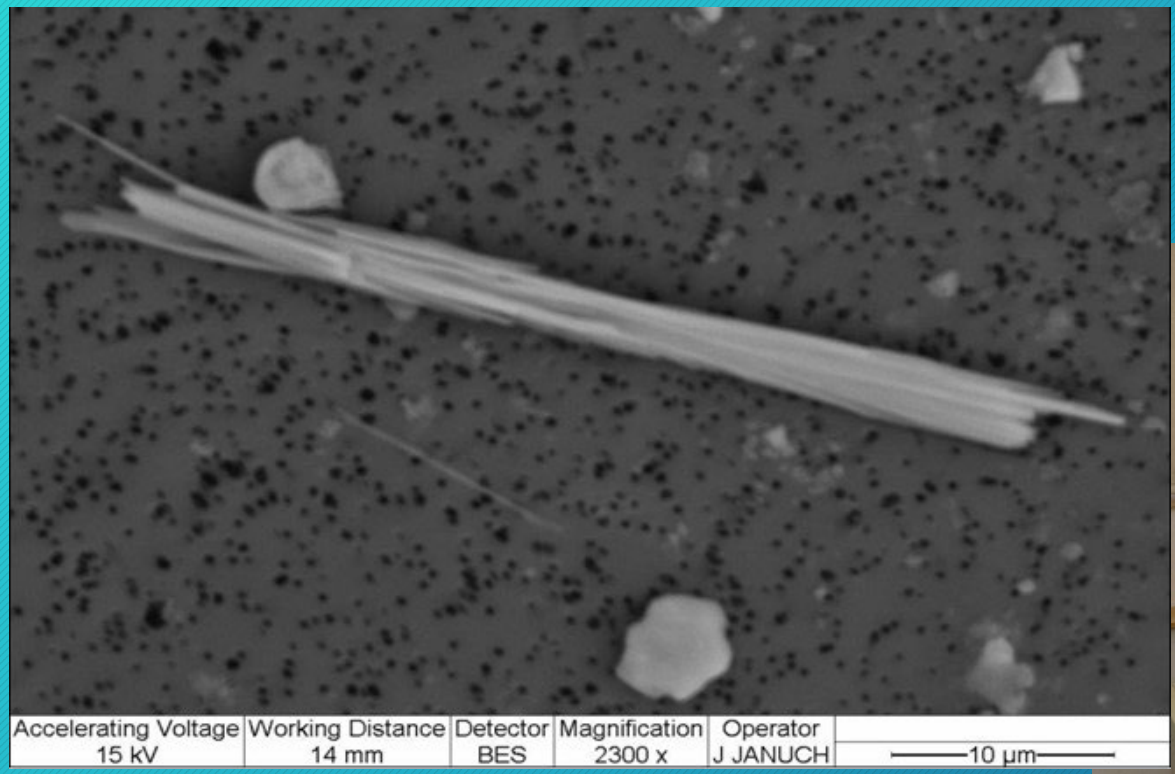
Instrument Overview

Phase Contrast Microscopy (PCM)



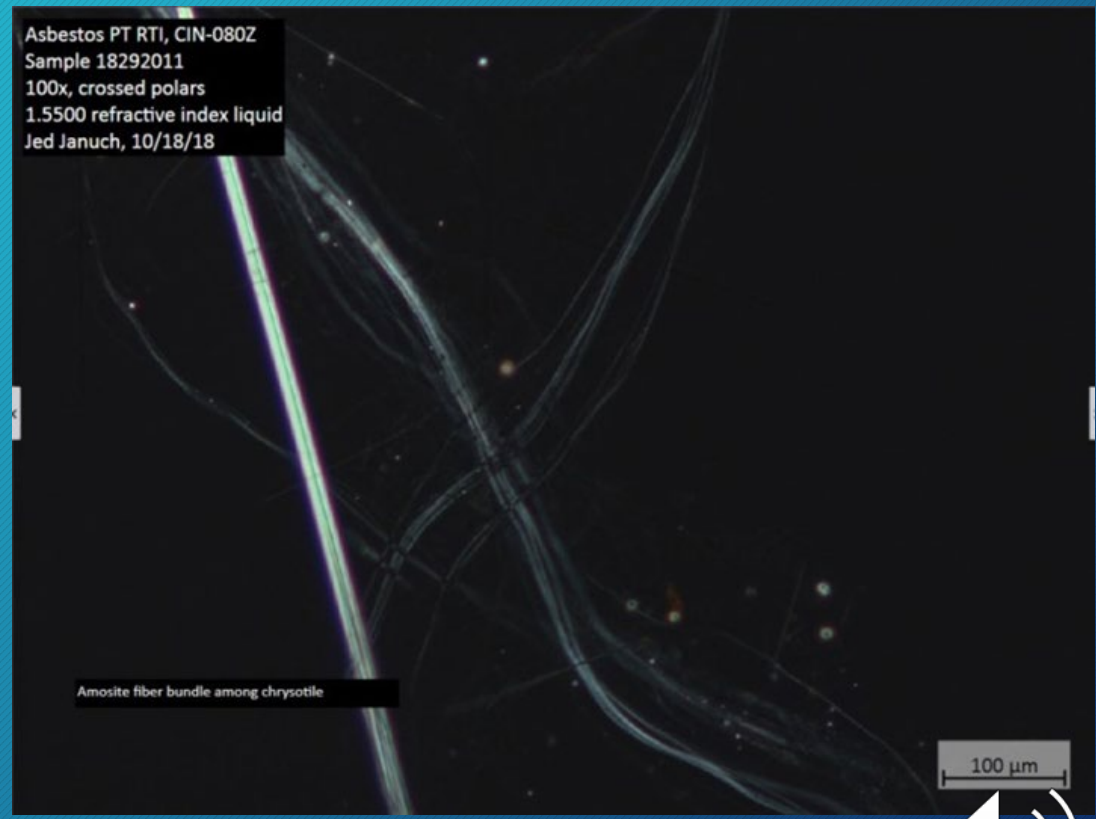
Instrument Overview

Scanning Electron Microscopy (SEM)



Instrument Overview

Transmission Electron Microscopy (TEM)



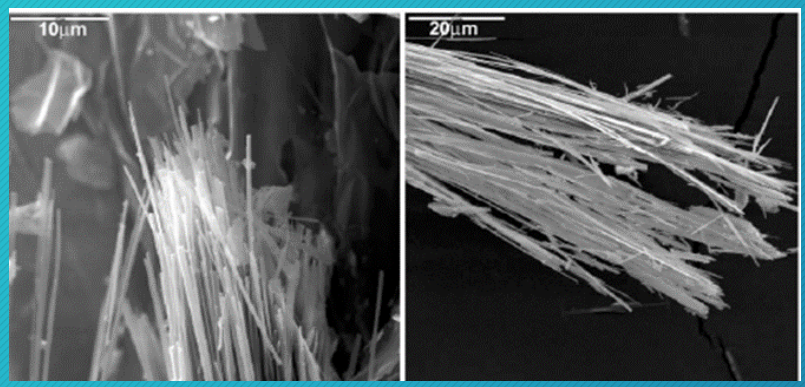
Analytical Methods for Soil Samples

- Methods differ in preparation steps
- Method selection is a site-specific decision

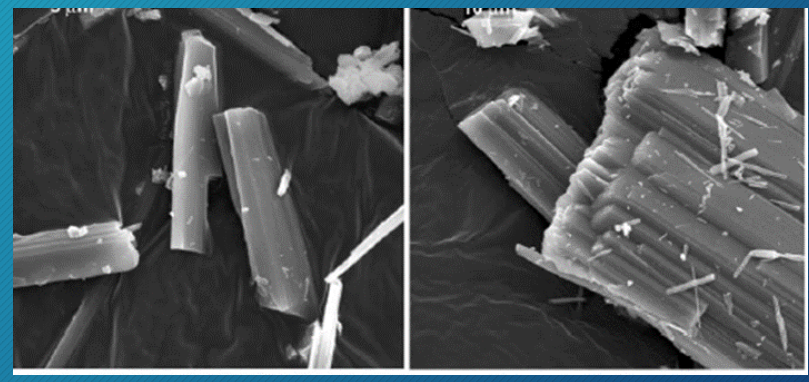
Method	Instruments	When to Use
EPA/600/R-93/116 with Milling	Stereoscopic + PLM TEM Optional	Visible ACM in the soil and/or suspected source of asbestos is ACM
CARB 435	Stereoscopic + PLM	Expected asbestos content between 0.25% and 10%
ASTM 7521	Stereoscopic + PLM TEM Optional	Expected asbestos content at trace levels
Fluidized Bed Asbestos Segregator (EPA OTM 42)	TEM	Potential for residual low levels and susceptible populations; characterizing borrow material

Limitations of Soil Results

- Soil results are not used for risk assessment but may guide the placement of air samples.
- Laboratory interpretations of geology may vary and may exclude structures counted in air samples used for risk assessment. For example, laboratories may exclude structures from soil results that they believe to be “cleavage fragments”.



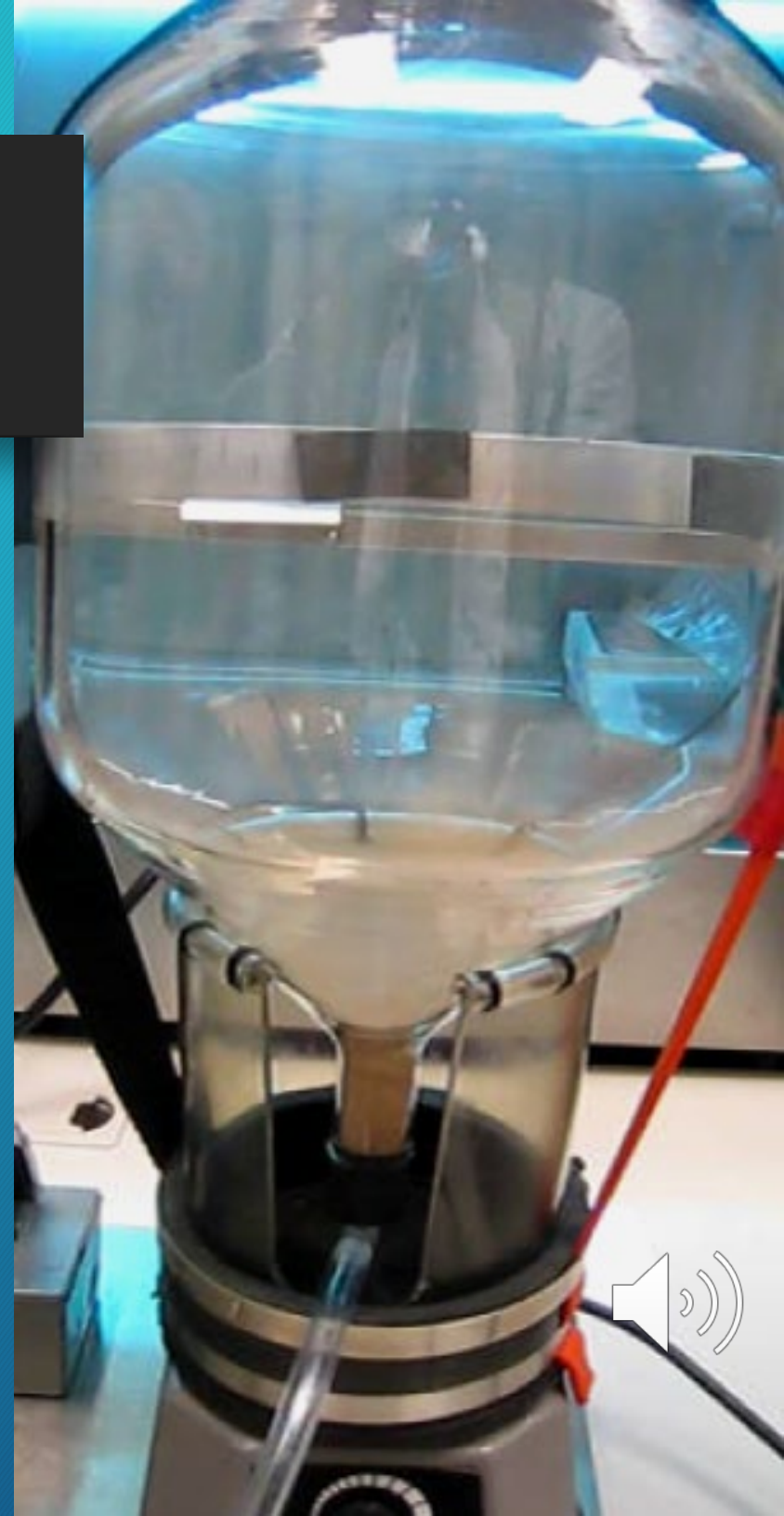
Asbestiform – formed as a fiber

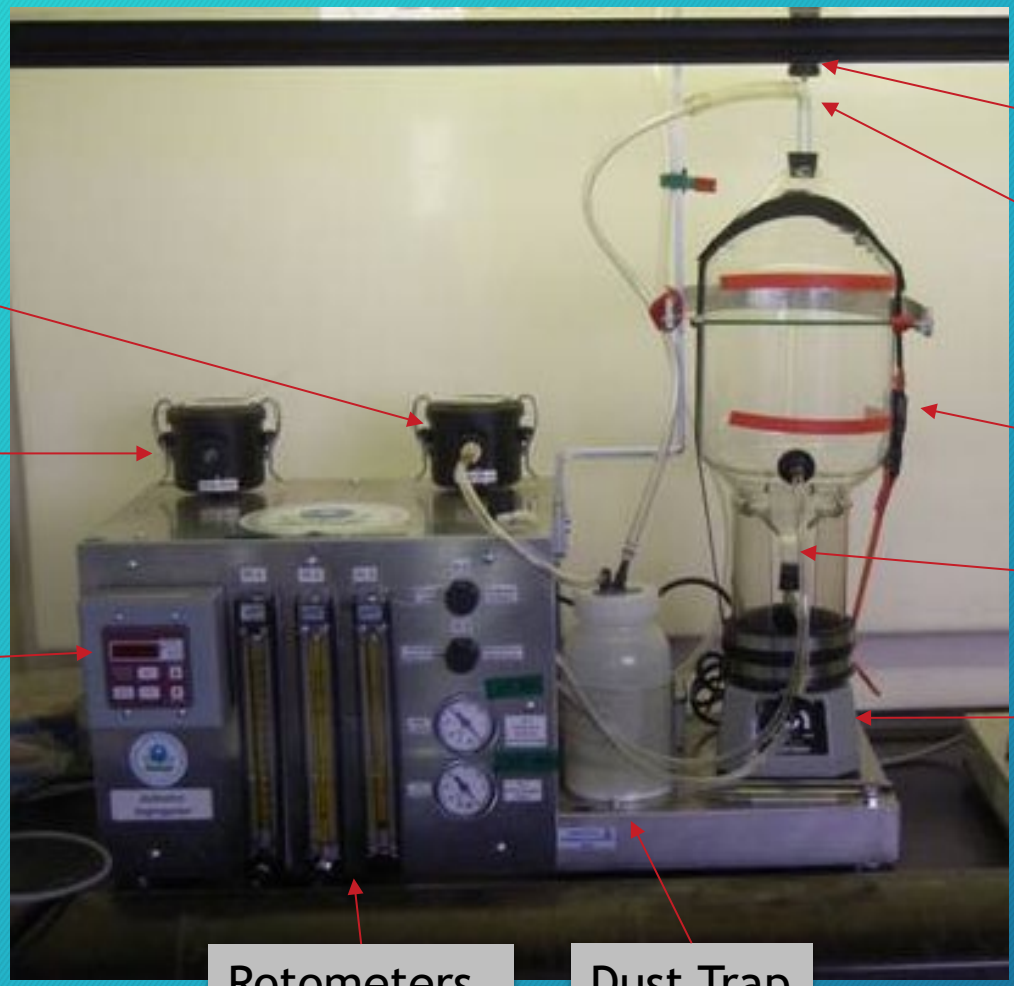


Cleavage Fragment – formed by breaking

Fluidized Bed Asbestos Segregator (FBAS)

- Developed for EPA to help determine low-level concentrations of asbestos in soil and other matrices (e.g., vermiculite)
  - It can also be used for the determination of other elongated mineral particles (e.g., erionite)
- Bulk soil samples are processed in FBAS using air to elutriate asbestos structures from sample soil and deposit them onto filter for analysis by microscopy (TEM)





Fluidized Bed Asbestos Segregator (FBAS)

Fluidized Bed Asbestos Segregator (FBAS)

- Approved EPA Method (OTM-42)
- Currently Limited Availability
  - Region 10 Lab
  - Commercial Lab
- Newly incorporated into the Framework
- Additional research being conducted to help better interpret data
- Used at multiple sites including Davidson Asbestos, Libby, Northridge Estates, Swift Creek, Frank Foundry, and Dort Food Storage

Analytical Methods for Dust Samples

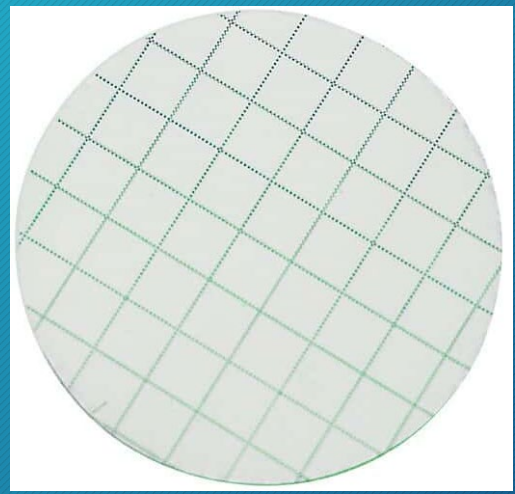
- Dust sampling may be used for limited purposes:
  - Determine the area of contamination
  - Confirm a release has occurred
- Settled dust analysis by TEM (ASTM 5755)
  - Preparation steps may break asbestos structures (esp. Chrysotile bundles) into multiple fibers
  - Different counting rules potentially lead to higher or lower results than air analysis
- Small sample area means results may not be representative of a larger area

Analytical Methods for Air Samples

- Stationary or personal monitors
- Phased Contrast Microscopy (PCM)
  - 400x magnification; Screening only
  - NIOSH 7400
- Transmission Electron Microscopy (TEM)
  - Low Magnification vs. High Magnification
  - Direct vs. Indirect Analysis

Recommended Air Analysis Approach

- TEM is preferred to PCM for characterization of exposures to inform decisions at CERCLA sites
- Collection on 0.8 µm MCE filters for most CERCLA air sampling applications to avoid filter overload
- ISO Method 10312 (Direct TEM)
  - Low Magnification (at least 5,000x)



Recommended Air Analysis Approach

- Modified PCMe Counting Rules for Structure Type
  - **PCMe = PCM equivalent size range**
  - **<u>PCMe Counting Rules:</u>**
    - Count asbestos **fibers and bundles** meeting all criteria as follows:
      - Width range between 0.20 µm and 3.0 µm inclusive
      - Length >5 µm
      - Aspect ratio ≥ 3:1
    - The Framework provides additional details about what should be counted

Alternate Approaches for Air Analysis

- ISO Method 13794 (Indirect TEM) - used only when filter overload does not allow for direct analysis
- ISO Method 14966 (SEM) - supplement to TEM for visualization

Sensitivity and Detection Levels for Air Analysis by TEM

- Determined by user based on
  - the volume of air collected
  - the area of the filter counted by the analyst
- S (sensitivity) = 1 structure detected
- LOD (level of detection)
  - the upper bound of counting error for zero structures
  - 2.99 x the analytical sensitivity or about 3 structures
  - Should be at or below the LOC (level of concern)
- Practical considerations
  - Time for collection of air volume
  - Potential for filter overload at high air volume
  - Time and cost for counting by analyst

Video – Analytical Laboratory Methods for Asbestos

- Asbestos Analysis Video

Final Day 1 Q&A

The Asbestos TRW technical resources page contains multiple resources that may be helpful including:

- Asbestos Framework
- ERT Helpful Hints for ABS document
- ABS SOP
- ABS and Analytical Videos
- Asbestos TRW Consultations

https://www.epa.gov/superfund/asbestos-superfund-sites-technical-resources

- For asbestos questions, email the TRW at asbestoshelp@epa.gov

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