ASBESTOS-CONTAMINATED SOIL
HW/VRP GUIDANCE DOCUMENT

SECTION 1: INTRODUCTION & BACKGROUND

Asbestos is a carcinogen. The International Agency for Research on Cancer classifies asbestos as Class 1, carcinogenic to humans. The USEPA classifies asbestos as Class A, carcinogenic to humans. Inhaling asbestos fibers (either serpentine or amphibole) into the lungs increases a person's risk of developing disease, commonly mesothelioma (cancer of chest cavity, or abdominal cavity), lung cancer and asbestosis (restrictive lung disease caused by asbestos fibers scarring the lung) (ASTDR 2001, USGS 2007). Some common materials that have contained asbestos in the past include: roofing and pavement repair materials, roofing shingles, asphalt paper, floor and ceiling tile, sheet vinyl, spray-on acoustic or plastic walls, mortar and concrete, cement board (type of siding), cement patching and caulk, drywall and joint compound.

1.1 Mineralogy

Asbestos refers to the specific asbestiform varieties of the serpentine mineral group and amphibole mineral group. There is regulated and non-regulated asbestos. Regulated asbestiform minerals include:

- Serpentinite (commonly called chrysotile) – "white asbestos" that is in the serpentine mineral group, fibers are curly, used more than any other type, it accounts for 95% of the asbestos found in buildings in the U.S.
- Cummingtonite-grunerite (commercially called amosite) – "brown asbestos," is an amphibole mineral found frequently in fire retardant, thermal insulation products and ceiling tiles.
- Ribeckite (commercially called crocidolite) - is an amphibole mineral found in South Africa and Australia.
- Anthophyllite.
- Actinolite.
- Tremolite.

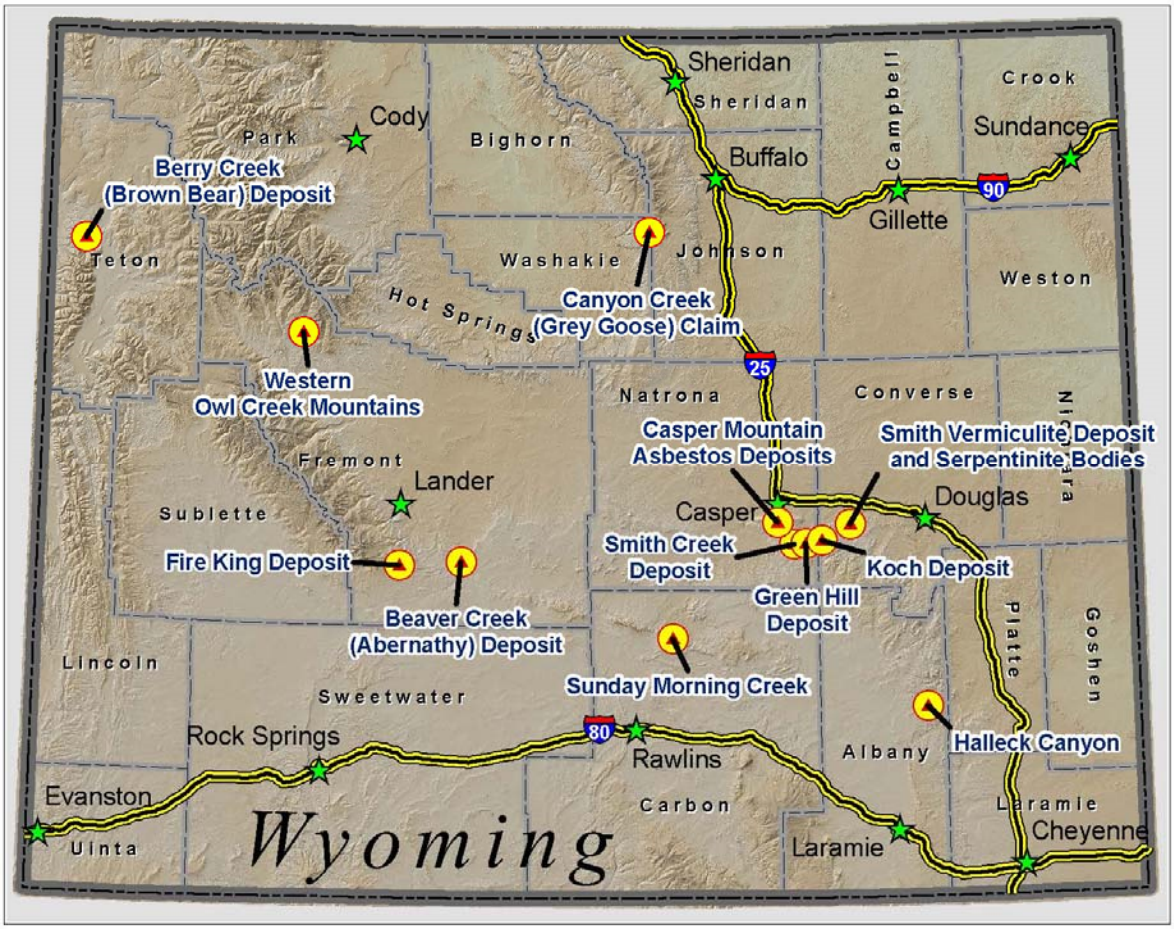
Common Types of Regulated Asbestos
Chrysotile, Amosite, Crocidolite, Anthophyllite, Actinolite, Tremolite

Two additional types of fibrous asbestiform found in association with vermiculite include richterite and winchite. These are amphibole minerals and are as harmful as the regulated minerals, but are not Federally regulated. They are sometimes referred to as "Libby Asbestos" minerals. Another asbestiform

mineral found in large deposits in the northeastern portion of Wyoming is Erionite. This unregulated material has often been used as fill on road beds. Exposure to Erionite has been proven to cause diseases similar to the amphibole minerals. Regulatory asbestos means the asbestiform varieties of chrysotile (serpentinite), crocidolite (riebeckite), amosite (cummingtonite-grunerite), anthophyllite, and actinolite-tremolite. Any detected asbestos at VRP sites will trigger cleanup under the program.

Asbestos is also a commercial term applied to particular silicate minerals. These minerals form in bundles as long and very thin mineral fibers, and are known to have high tensile strength, flexibility and resistance to: heat, chemicals, electricity. Silicate asbestos minerals have been used historically in over 3,000 commercial products in the United States.

Naturally Occurring Asbestos (NOA) and "background" levels of asbestos refer to the outdoor air concentration of asbestos without disturbance. No standard approach has been implemented for managing incidental NOA and/or background levels of asbestos and will therefore require management on a site-by-site basis. The WDEQ may consider background in known areas of NOA.

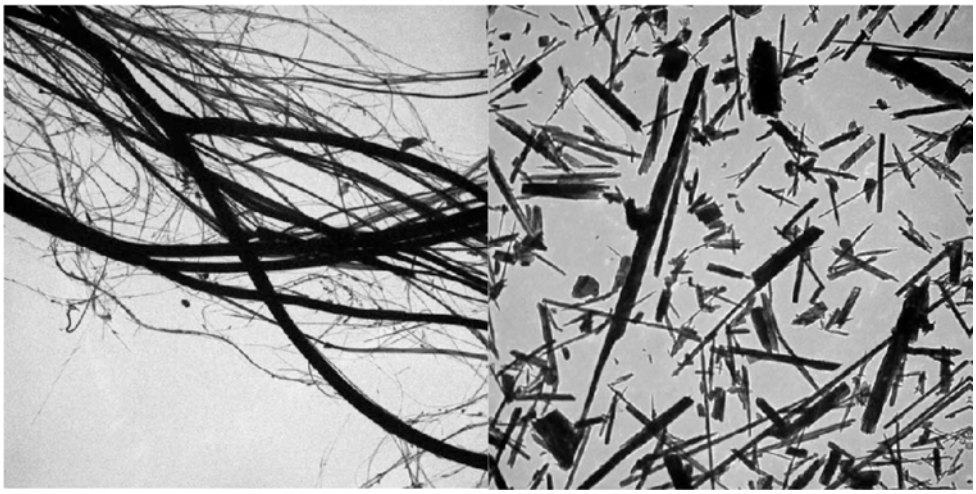


Documented Locations of Naturally Occurring Asbestos in Wyoming (USGS 2007)

1.2 Morphology

Amphibole fibers are two orders of magnitude more likely to cause mesothelioma (ERG 2003), and five times more likely to cause lung cancer (Berman and Crump 2003) than serpentine (e.g. chrysotile) fibers. Fiber length has been found to be important in the toxicity of asbestos: > 5µm can cause cancer (ATSDR 2003). In addition, fibers < 5µm may: increase the risk of non-cancer effects such as asbestosis, cause inflammation, and stimulate pulmonary reactions to longer fibers (animal and in vitro studies) (ATSDR 2003).

Amphibole fibers, such as those found in association with vermiculite, are associated with asbestos-related disease (ATSDR 2008) and pleural mesothelioma (Comba et al. 2011). It has been conclusively demonstrated in numerous studies of occupationally exposed workers and confirmed in animal experiments, that inhaling asbestos fibers (either serpentine or amphibole) into the lungs increases a person's risk of developing lung cancer, mesothelioma, or certain types of non-cancer respiratory disease (ATSDR 2001).



Chrysotile fibers are flexible and curved. Amphibole fibers are brittle, rod- or needle-like shape.

1.3 Asbestos Regulations

1.3.1 NESHAP – USEPA, National Emissions Standards for Hazardous Air Pollutants –for asbestos (40 CFR Part 61) outlines specific provisions for the application, removal due to planned renovation and demolition projects pertaining to the "built" environment, and disposal of asbestos-containing waste material. The USEPA's asbestos NESHAP regulation includes specific inspection, notification, work practice, packaging, labeling and disposal requirements.

1.3.1.2 Based on a review of EPA's NESHAP regulation, the following are key elements for consideration when encountering asbestos-contaminated soils:

1. EPA has established training and accreditation requirements for conducting asbestos work, which includes inspection (asbestos building inspector), design (Project Designer), and renovation or demolition activities (Contractor/Supervisor and Worker).
2. EPA has established requirements for the proper packaging, labeling, transportation and disposal of asbestos-containing waste material (ACWM).
3. EPA has established adequately wet and no visible emissions requirements as part of proper removal, material handling, and disposal requirements.

1.3.1.3 Prior to the start of renovation or demolition activity in all covered facilities, a thorough asbestos inspection must be completed.

1.3.1.4 Volunteers are responsible for complying with the EPA NESHAP and TSCA program for Wyoming and copying the HW/VRP on any reporting under these programs. Wyoming Air Quality Standards and Regulations (WAQSR) Section 8 addresses Emission standards of asbestos for demolition, renovation, manufacturing, spraying and fabricating. The EPA NESHAP requires a Notification of Demolition and Renovation Form be completed at least 10-working days prior to each renovation activity that will create or disturb RACM and prior to every demolition activity.

1.3.1.5 The following summarizes disposal of ACWM under EPA NESHAP: *Friable asbestos waste and non-friable asbestos waste damaged to the point of being Regulated Asbestos-Containing Material must be properly packaged before being sent to the landfill. It must be tightly sealed, while wet, in 6-mil, leak-tight polyethylene containers or wrappings. If the waste will be disposed of off the facility site, the outermost layer of the packaging must be labeled with an "EPA Generator" waste label that gives the name and address of the generator of the waste. All packaged waste must include a label with the following language:*

CAUTION
Contains Asbestos
Avoid Opening or Breaking Container
Breathing Asbestos Is Hazardous
To Your Health
or
DANGER
Contains Asbestos Fibers
Avoid Creating Dust
Cancer and Lung Disease Hazard

Non-Regulated Asbestos Containing Materials (RACMs) such as non-friable vinyl-asbestos tile flooring and asphaltic roofing materials that are in good condition and not RACM prior to demolition may be disposed of as construction and demolition materials as long as they are not rendered RACM by the demolition activities.

1.3.2 **AHERA** – Asbestos Hazard Emergency Response Act (Oct. 1986) – the Act addressed identifying, evaluating and controlling asbestos-containing building material in K-12 schools both public and private.

1. EPA has established training and accreditation for conducting asbestos work, which includes inspection (asbestos building inspector), design (Project Designer), and response actions (Contractor/Supervisor and Worker).
2. EPA has established a permissible level of airborne asbestos (clearance level) that may be present within a building upon completion of a response action. For phase contrast microscopy (PCM) analysis, this level is 0.010 fibers per cubic centimeter (f/cc). For transmission electron microscopy (TEM) analysis, this level is 70 structures per square millimeter (st/mm^2).

1.3.3 **TSCA** – Toxic Substances Control Act –Section 206 of TSCA mandated that US EPA develop an asbestos Model Accreditation Plan (MAP). The original MAP was promulgated in 1987 and became codified as 40 CFR Part 763 (AHERA), Appendix C to Subpart E. Section 206 of TSCA was later amended by the Asbestos School Hazard Abatement Reauthorization Act (ASHARA). ASHARA mandated that the MAP be revised to:

1. Provide for the extension of accreditation requirements to work in public and commercial buildings for persons who inspect for asbestos-containing material, design response actions, or carry out response actions; and
2. Extend worker protection standards to state and local employees who perform asbestos work, and who are not covered by the OSHA Asbestos Standards, or by a state OSHA plan. The Rule currently parallels 1986 OSHA requirements and covers medical examinations, air monitoring and reporting, protective equipment, work practices, and record keeping. This regulation is in the process of being revised to include the amendments made to the OSHA asbestos standards since 1986.

1.3.4 **OSHA** – Occupational Safety and Health Administration –OSHA Standard is an exposure based standard, and as such, the regulations are not limited to only activities involving ACM, but materials with trace to 1% asbestos may also be subject to the OSHA standard if workplace air concentrations exceed the OSHA permissible exposure limit (PEL):

1. The permissible exposure limit (PEL) is 0.1 f/cc of air, on an 8-hour time weighted average (TWA). TWA means exposure concentration averaged over an 8-hour period.
2. An excursion limit (EL) of 1.0 f/cc, over a 30-minute TWA. This number is also known as a Short-Term Exposure Limit or STEL.

1.3.4.1 ACM construction projects are subject to the OSHA Construction Industry Standard for Asbestos (29 CFR Part 1926.1101) (OSHA 2011). Materials containing 1% or less asbestos may be subject to OSHA regulations under certain classes of work activity, or if air concentrations are at or above the permissible exposure limit (PEL) of 0.1 f/cc or the excursion limit (EL) of 1.0 f/cc. Activities covered by this standard include asbestos abatement, renovation, demolition and excavation. The OSHA asbestos standard includes requirements for hazard

communication, training, exposure assessment, respiratory protection, engineering controls, medical evaluations, and other provisions. The Wyoming Department of Employment is currently responsible for administering the OSHA programs for the State of Wyoming under the Construction Program, Chapter 26 - Toxic & Hazardous Substances (Z), (1926.1101). As with, the EPA programs, OSHA mandates specific requirements for worker protection when disturbing ACM. OSHA has identified four (4) work classes, each with specific training and work practices. It is the responsibility of the Volunteer to comply with OSHA and they should consult the Wyoming OSHA program to ensure that their planned work practices meet applicable regulations and protocols.

1. Class I asbestos work includes the removal of thermal system insulation and surfacing ACM and Presumed Asbestos Containing Materials (PACM).
2. Class II asbestos work includes the removal of ACM which is not thermal system insulation or surfacing material. This includes removal of floor tile, roofing products, construction mastics, etc.
3. Class III asbestos work means repair and maintenance operations where ACM is likely to be disturbed.
4. Class IV asbestos work includes maintenance and custodial work during which employees contact, but do not disturb, ACM and PACM, and activities to clean up waste and debris generated by Class I, II, and III activities.

1.3.4.2 OSHA mandates the use of respiratory protection under the following conditions:

1. During all Class I asbestos work.
2. During all Class II work where the ACM is not removed in a substantially intact manner.
3. During all Class II and Class III work that is not performed using wet methods.
4. During all Class II and Class III work where an employer has not conducted a negative exposure assessment.
5. During all Class III work where TSI or surfacing ACM or PACM is being disturbed.
6. During all Class IV work done within a regulated area where other workers are required to wear a respirator.
7. During all work when an employee is exposed to asbestos concentrations above the PEL or excursion limit (EL).
8. In emergencies.

1.3.4.3 Additional requirements under the OSHA asbestos standards include training, exposure assessment, hazard communication, special work practices, medical surveillance, and recordkeeping.

1.3.4.4 Warning signs to identify a regulated area must be posted. Warning signs must contain the following words:

DANGER, ASBESTOS,
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
AUTHORIZED PERSONNEL ONLY

Where respirators are required in a regulated area, the warning sign must also include the words:

WEAR RESPIRATORY PROTECTION AND PROTECTIVE CLOTHING
IN THIS AREA

Labels are to be attached to any product containing asbestos and to all waste containers. Warning labels must contain the following words and be Black, White and Red in color:

DANGER, CONTAINS ASBESTOS FIBERS,
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

1.3.4.5 Based on a review of OSHA's Asbestos Regulation, the following are key elements for consideration when encountering asbestos-contaminated soils:

1. OSHA has established specific elements of required training for "unclassified" work (work that does not fall into the 4 identified classes of work).
2. OSHA has established varied levels of training applicable to the type of asbestos (friable spray-on fireproofing vs. non-friable floor tile) and quantity of material disturbed that correspond to training levels established by EPA (Contractor/Supervisor, Worker, 16-hour O&M, 2-hour awareness, etc.). It is the responsibility of the Volunteer to comply with OSHA and they should consult Wyoming OSHA program to ensure that their program meets applicable regulations and protocols.
3. OSHA has established an occupational exposure level for asbestos of 0.1 f/cc, over an 8 hour time weighted average or 1.0 f/cc, over a 30-minute period (short-term exposure limit (STEL)).
4. OSHA has established requirements for the signage to establish regulated work areas and labeling requirements to identify asbestos-containing waste material.
5. OSHA has established specialized work practices including adequate wetting, the use of personal protective equipment (including respirators), and decontamination procedures.
6. OSHA has established procedures for exposure assessment and medical surveillance for asbestos exposure.
7. OSHA requires work to be performed under the supervision of a competent person, and the regulation lists the level of training that a competent person must have to oversee asbestos projects.

1.3.5 **DOT** –Department of Transportation regulates the packaging, labeling and transportation of asbestos under 49 CFR Part 173. Among these requirements is the use of a Class 9 (miscellaneous) label on containers/packages of asbestos-containing waste material and Class 9 placards for waste transportation vehicles (DOT 2011).

SECTION 2: SITE CHARACTERIZATION

2.1 Site Conceptual Model

The nature (type of contaminants and their concentrations) and extent (horizontal and vertical spatial distribution) of contamination should be determined through the development of Site Conceptual Models (SCM) prior to beginning the risk assessment process. A SCM is used to identify potentially complete exposure pathways and receptors. The SCM identifies sources of contamination, areas of impacted soil or other media, potential mechanisms of release and transport, exposure pathways of concern and potential receptors. The nature of the source is a key factor because risk depends on potential for asbestos to be disturbed, airborne, and inhaled. A SCM should consider the nature of asbestos (friable or non-friable, bonded or free-form etc.) and the potential for fibers to be released through anthropogenic or natural activities.

Potential receptors and anticipated exposure scenarios must be identified in the SCM. WDEQ defines three default exposure scenarios: residential, industrial and excavation worker (VRP Fact Sheet 20). An evaluation of recreational activities may also be needed in the SCM for a site.

2.2 Data Quality Objectives

Site-specific data quality objectives (DQOs) involve systematic planning to ensure the number and type of samples necessary to support site characterization. Volunteers may also consider DQOs that address risk assessment and remedy evaluation. Consideration should be given to the type of samples collected (bulk vs. air) and the intended use of the analytical results.

Where Activity Based Sampling (ABS) is required, DQOs should include the Analytical Sensitivity (S) for the ABS air samples and it should be sufficient for risk assessment purposes. The Analytical Sensitivity is calculated using the following equation:

$$S = \frac{At}{K\ Ag\ V}$$

where:
S = Analytical sensitivity (0.001 cc^{-1})
A_t = Active area of the collection media or filter (lab standard size in square millimeters [mm^2])
A_g = Mean area of the grid openings examined (lab standard size mm^2)
K = Number of grid openings examined (unitless)
V = Volume of air sampled (dependent variable on amount of time samples in cc)

2.3 Sampling

Asbestos sampling must delineate the extent and depth of known or discovered asbestos-contaminated soil (ACS). This includes surface and subsurface investigations. Site characterization investigations should consider the heterogeneity of the contamination. For example, Minnesota policy uses trenching and pothole investigation instead of soil borings to provide a more thorough examination of soils. Incremental Sampling Methodology guidance, published by the Interstate Technology & Regulatory Council (ITRC 2012), recommends 30-60 increments per sample ”decision unit” based on site and project specific variables to address the heterogeneity of contaminant distribution. Additionally, two replicate samples per decision unit should be collected and analyzed.

Visual inspections should be conducted by trained asbestos building inspectors, who have at least six months experience conducting asbestos contaminated soil inspections. The site should be marked with grids and the number and size of grids should be determined based on the size of the investigation and details outlined in a work plan to be submitted for approval to the VRP. Stationary and personal air monitors should be set up and worn by all personnel conducting asbestos remediation activities: including walking grids, hand-picking and bagging asbestos, and soil and ABS sampling. Inspectors should walk the grids to identify asbestos. Flag or demarcate locations of suspect asbestos material discovered in the grid. Note whether observed or no visible material is present in each grid. Grids with asbestos should be hand-picked by trained Contractor/Supervisors or Workers.

Grids should be sampled where asbestos was visibly identified or historically known or suspected to have occurred and conducted by trained asbestos building inspectors. Additionally, soil samples must be sampled from across the site to assess the concern the VRP has of the risk from fugitive asbestos in soil from site operations, especially but not limited to refinery sites. Inspectors should collect soil samples every 1/5 acres, or as outlined in a work plan to be submitted for approval to the VRP. Each soil sample includes 30-60 random aliquots of surface soil per grid from 0-2 in. depth. If asbestos is detected in soil, then Volunteers will be required to conduct asbestos remediation under a Remedy Agreement (see Section 3). Risk Characterization may be conducted to determine the risk associated with the level of asbestos in the soil by calculating a site specific exposure level for asbestos (see Section 2, Part 6). Note: stationary and personal air monitoring conducted to meet OHSA regulations is not acceptable for risk assessment evaluation purposes under this guidance.

2.4 Methods

Particle count methods for sampling include:

- Polarized Light Microscopy (PLM) – PLM is commonly used for determining asbestos content in soil and bulk material. Advantages: PLM can distinguish between asbestos and non-asbestos, and between different types of asbestos. It detects fibers with lengths > ~1µm, widths > 0.25µm, and aspect ratios (length to width ratios) > 3 (the longer the fiber, the more toxic it is, i.e. 5:1 is more toxic than 3:1).
  PLM measures percentage of asbestos, is moderately expensive ($8-20/sample) and has about an 8-hr. turn-around time.

- Phase Contrast Microscopy (PCM) – PCM is used primarily for air sampling. Advantages: PCM is cost effective and has a quick laboratory turn-around time. PCM can also be performed on site to reduce turn-around time if sampling is occurring in remote locations. PCM accurately assesses fibers > 5µm in length and approximately 0.25 µm in diameter. PCM cannot distinguish between asbestos or non-asbestos fibers. IRIS toxicity values are based on PCM counts. Therefore, PCM results can be directly used in models to assess risk. Because of its diameter limitation (approximately 0.25 µm), PCM is unable to detect a large number of asbestos fibers (ATSDR 2010). NIOSH 7400 involves PCM analysis of air samples to determine asbestos concentration. Under AHERA the EPA clearance level in a school = 0.01 f/cc. Note: 0.01 f/cc is about 20 fibers per sample.
  PCM is semi-qualitative, less expensive ($8-15/sample) and has 2-hr. turn-around time.
- Transmission Electron Microscopy (TEM) – TEM may be used to analyze air or bulk/soil samples. Advantages: TCM allows for greater resolution than PCM, detection of fibers with diameters approximately 0.002 µm, and distinguishes between asbestos and non-asbestos fibers (ATSDR 2010). The fiber count in a sample can be 50-70X higher than those counted by PCM. There is no generally accepted conversion factor between TEM and PCM. Because IRIS is based on PCM, TEM is not used in risk assessment; however, TEM is often used to determine the number of asbestos structures present in a sample that meet the PCM fiber size criteria and mineralogy definition. This concentration is referred to as the PCM-equivalent (PCME) in units of structures per cubic centimeter (s/cc). PCME fiber measurements can be used in risk assessment (Hardaker 2009). Under AHERA the EPA clearance level in a school= 70 st/mm^2 (structures per square millimeter). Note: 70 structures is about 4 fibers per sample. TEM examines a much smaller portion of the sample than scanning electron microscopy and PCM. Therefore, in order for a TEM analytical result to be representative of an entire soil sample, a very homogenized sample is required (CDPHE 2007). Sample aliquots should be sent to the lab and the sample homogenization conducted by the laboratory.
  TEM Analysis is quantitative, $30-40/sample, and requires a 24 hr. turn-around time.

The HW/VRP recommends a combination of PCM and TEM analyses. PCM is used for its quick turn-around time, low cost, and (importantly) because it's linked to IRIS and risk assessment. To verify the PLM and/or PCM data, TEM analysis will be added every 10% of the samples and on the highest PLM and/or PCM results. TEM should also be used if the air concentration level is reached (see Section 3, Remedy, for USEPA guidance regarding permissible level of airborne asbestos). TEM analysis should include the PCM-equivalent (PCME) in units of s/cc. The air concentration is measured during asbestos remediation activities; including walking grids, hand-picking and bagging asbestos, and soil and ABS sampling.

2.5 Analysis

The most common methods for asbestos analysis include:

1. National Institute for Occupational Safety and Health (NIOSH) Methods 7400 (air), 7402 (air), and 9002 (soil).
2. International Standards Organization (ISO) Method 10312 (air)
3. California Air Resource Board (CARB) Method M435 (air)

Other methods – The Scanning Electron Microscopy (SEM) method is capable of differentiating between asbestos and non-asbestos structures. It can also accurately assess fibers thicker than about 0.1 µm. However, this method is not widely available for use (CDPHE 2007). The Selected Area Electron Diffraction (SAED) and X-ray Energy Dispersive Spectroscopy (EDS) methods, often available as a complement to TEM, can provide detailed information on particle composition, but at an added cost (ATSDR 2010).

In their 2008 *Framework for Investigating Asbestos-Contaminated Superfund Sites* document, USEPA recommends the use of NIOSH Method 9002 for the analysis of bulk soil samples for asbestos content and a modification of the ISO 10312 method for asbestos air samples. ATSDR also commonly employs a modified version of ISO 10312 during ACS site studies.

A review of different state plans, programs and guidance documents indicates that asbestos in soil is most commonly analyzed using PLM and air samples are analyzed for asbestos using PCM or TEM, with TEM becoming more prevalent.

For air samples, the HW/VRP recommends PCM analysis (NIOSH 7400 method), and TEM analysis (NIOSH 7402 method). For soil and bulk samples, the WDEQ recommends PLM analysis and NIOSH 9002 for bulk soil samples (USEPA 2008).

2.6 Risk Characterization

Regarding exposure assessment, the concentration in soil is not well equated to level of hazard represented in the air. This is a complex relationship and no method exists to reliably predict it. Exposure Assessments combine anticipated exposure pathways with exposure point concentration (EPC) data to obtain semi-quantitative estimates of exposure. The EPC is the asbestos concentration in air which an individual is exposed to during disturbance of ACS through natural or anthropogenic processes.

Site specific EPCs for exposure scenarios are typically determined through the following:

1. Activity based sampling (ABS): Disturb soil in area (by individual with PPE and air monitor) in a way that will likely result in high air concentration (typically by vigorous raking) under conditions that favor high fiber release (dry, calm). ABS soil disturbances should be to 2 in. depth (USEPA 2007). Work plans should follow OSWER (#9200.0-68) guidance on ABS (USEPA 2008). ABS is often complemented by stationary air monitoring. EPA recommends the use of a modified version of the ISO 10312 method for air sample analysis and NIOSH Method 9002 or CARB M435 for soil samples (USEPA 2008). Care should be taken during ABS to limit dispersion of asbestos particles on/off site. Mitigate this concern by sampling during low winds (<20 mph).
2. Emission and Dispersion Modeling (EDM) is used to determine EPCs for a given site. In EDM, the amount of airborne fibers released during the agitation of a defined amount of ACS is measured in a controlled environment. The suspended dust is either drawn through a filter in a cassette (glove box, see EPA Region 10 Glove Box Method); deposited on a filter, weighted and sent for analysis (modified elutriator, see Berman & Kolk 2000); or, separated by a sampler that uses

vigorous mixing of soil to separate fine particulate that is separated onto filters for analysis (fluidized bed asbestos separator, see Idaho National Laboratory 2007).

Other factors which may affect the suspension of asbestos fibers into the air: environmental conditions (e.g. wind), moisture content of the soil, concentration of asbestos in soil, soil type, and characteristics of the asbestos present (knowing the source of the asbestos is important here).

HW/VRP recommends using ABS to estimate EPCs with flexibility to use EDM where appropriate for scenario-specific exposure circumstances.

2.7 Investigation Derived Waste

ACS work plans must specify provisions for proper equipment decontamination during investigation and removal activities, including proper collection and treatment of liquid waste as asbestos contaminated water (required filtration, discharge provisions, etc.), and proper packaging and disposal of solid waste from decontamination activities (including, soil, equipment and workers).

Containerization, transportation and disposal of asbestos should be in compliance with the WDEQ Solid Waste Rules and Regulations (SWRR), and any potential requirements under Chapter 8 of the SWRR and Guidelines 3-4, and applicable Wyoming Department of Transportation (WDOT) requirements for transportation and disposal.

SECTION 3: REMEDY ALTERNATIVES & REMEDY AGREEMENTS

Section 3 presumes asbestos remediation activities conducted under a Remedy Agreement (RA). If the Volunteer chooses a presumptive remedy (i.e. excavation), then confirmation sampling shall be conducted according to Section 3.3. The remedy will be considered to be completed once the performance standards in the RA have been met.

3.1 Asbestos abatement: presumptive remedy is removal (excavation) or containment (burial, cap).

3.2 Best Management Practices for asbestos abatement:

1. Anyone involved in projects with known asbestos (in particular site characterization with sampling, analysis etc.) should have TSCA training at level of worker or Contractor/Supervisor.
2. AQD should be notified 10 days prior to site activities.
3. Where possible, remove asbestos material intact and keep it non-friable.
4. Employ adequate wetting: the WDEQ recommends using amended water or a quick-drying encapsulant applied with a common garden sprayer that is set on fine mist. This will help prevent fiber release during abatement/removal activities. WDEQ also recommends adding a colorant to the water/encapsulant. This will allow an individual to spray the suspect asbestos and others to follow behind the sprayer and easily identify it for hand-picking and removal.
5. No visible emissions, no lateral drift of visible soil from source/impacted area.
6. Provisions for proper personal protective equipment and personnel decontamination procedures.
7. Personal and stationary monitoring.
8. Packaging and disposal requirements must follow the WDEQ Solid Waste Rules and Regulations, Chapter 8, Section 4. Please work with your WDEQ project manager regarding disposal requirements. At sites within the VRP, ACS must be wrapped in 2 layers of 6 ml polyethylene and disposed of at permitted and approved disposal facility.
9. Under AHERA the USEPA established a permissible level of airborne asbestos present within a school upon completion of a response action. The Air Concentration Level = **0.01 f/cc** for PCM analysis and **70 st/mm^2** for TEM analysis. During the cleanup of contaminated sites, Volunteers will be required to meet these air concentration levels. If the air level is higher than 0.01 f/cc during abatement activities, then Volunteers must conduct TEM analysis to determine presence and type of asbestos fibers.

3.3 Confirmation sampling

A confirmation sampling plan will need to be submitted to the VRP for approval. Post abatement and confirmation sampling frequency in excavated areas should follow Fact Sheet 10. The site will be gridded on 1/5 acres and one confirmation sample taken in each grid (every 1/5 acres). Inspectors should collect 30-60 random aliquots of surface soil per grid from 0-2 in. depth, and composite the sample per respective grid. For residential cleanups, asbestos confirmation sampling results must be non-detect.

3.3.1 Confirmation sampling potential outcomes:

1. Data indicate there is no detectable asbestos in soil. Issue liability assurance for asbestos.

2. Data indicate there is detectable asbestos in soil:

   Address remediation of ACS in the performance standards in the Remedy Agreement and contingencies to include:

   A. Excavate further and conduct (second) confirmation sampling.

   B. Pursue Use Control Area and institutional and/or engineering controls to be used at the site to limit exposure to ACS under the Remedy Agreement.

   C. Calculate a site specific exposure level for asbestos, or cancer risk calculation, in soil. Activity Based Sampling (ABS) or emissions and dispersion models (e.g. glove-box, elutriator) are used to measure an asbestos air concentration level. This is the Exposure Point Concentration (EPC). Calculate the site specific exposure level or excess lifetime cancer risk level (USEPA 2008) (See APPENDIX A). The target cancer risk level is $1X10^{-6}$.

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APPENDIX A

A1 Excess Lifetime Cancer Risks (ELCRs) Equation (USEPA 2008):

ELCR = EPC * TWF * IUR

- **EPC**s for each activity; units = f/cc
- Time weighting factors (**TWFs**) (i.e. the proportion of time over which specific exposure activities may occur, or hours per day, days per year).
  TWF = $\frac{\text{exposure time (hours exposed/day)}}{24} * \frac{\text{exposure frequency (days/year)}}{365}$
- Inhalation unit factors (**IUR**) values; units = $(f/cc)^{-1}$; IUR varies as function of duration and age of first exposure.

A2 Time Weighting Factors developed for the following exposure scenarios (USEPA 2008):

- Continuous: 24 hours/day, 365 days/year, TWF = 1;
- Baseline Residential: 24 hours/day, 350 days/year, TWF = 0.96;
- Gardening: 10 hours/day, 50 days/year, TWF = 0.057;
- Recreational Adult: 1 hour/day, 156 days/year, TWF = 0.018;
- Recreational Child playing in soil: 2 hours/day, 350 days/year, TWF = 0.080.

A3 Inhalation Unit Factors and selection of Less-than-Lifetime:

The Integrated Risk Information System (IRIS) is the preferred source of human health toxicity values (USEPA 1988). The IUR on IRIS for continuous exposure over a lifetime is 0.23 $(f/cc)^{-1}$. This represents a combined risk of lung cancer and mesothelioma (USEPA 2008).

The USEPA's framework (USEPA 2008) provides guidance on how to assess exposures at Superfund sites that may be shorter than a lifetime. The default exposure at a Superfund site is 30 years (USEPA 1989, USEPA 1997). Current EPA Guidelines for Carcinogen Risk Assessment (USEPA 2005) addresses risk from less-than-lifetime exposures where a lifetime average daily exposure or dose may underestimate risk. The framework lists lifetime IUR and less-than-lifetime IUR_{LTL} for set of exposure durations and population ages at the beginning of the exposure. IRIS IUR (0.23 $(f/cc)^{-1}$) is based on airborne fiber measurements using Phase Contrast Microscopy with no distinction made between different mineral forms of asbestos. Fibers used to estimate exposure risk are: longer than 5µm with aspect ratio $\geq$ 3:1 and width $\geq$ 0.25 to $\leq$ 3µm. Other factors influencing risk are fiber dimension, fiber morphology and surface charge, different asbestos minerals, and fiber sizes, but little information is currently available.

A4 ELCRs Example Calculations (USEPA 2008):

1. Residential Exposure – Receptors are exposed to asbestos 24 hours/day; 365 days/year. The airborne asbestos concentration in the breathing zone measured during ABS = 0.04 f/cc which is used as the EPC.

   $$\text{TWF} = \frac{24\ hours/day}{24\ hours/day} * \frac{350\ days/year}{365\ days/year} = 0.96$$

   IUR_{LTL} = 0.17 $(f/cc)^{-1}$ ((Table 3, Page 23, USEPA 2008); 30-year exposure starting age 0)

   ELCRs = EPC * TWF * IUR_{LTL}

   = 0.04 f/cc * 0.96 * 0.17 $(f/cc)^{-1}$

   = 6.5 X 10^{-3}

2. Recreational Exposure – Adult; Adult is assumed to run/walk 1 hour/day, 156 days/year over 24-year period from ages 20-44 years old. The airborne asbestos concentration in the breathing zone measured during ABS = 0.04 f/cc which is used as the EPC.

   $$\text{TWF} = \frac{1\ hour/day}{24\ hours/day} * \frac{156\ days/year}{365\ days/year} = 0.018$$

   IUR_{LTL} = 0.068 $(f/cc)^{-1}$ ((Table 3, Page 23, USEPA 2008); 24-year exposure starting age 20)

   ELCRs = EPC * TWF * IUR_{LTL}

   = 0.04 f/cc * 0.018 * 0.068 $(f/cc)^{-1}$

   = 4.9 X 10^{-5}

3. Recreational Exposure – Child: Child is assumed to play 2 hours/day, 350 days/year over 5-year period from ages 1 to 6 years old. The airborne asbestos concentration in the breathing zone measured during ABS = 0.02 f/cc which is used as the EPC.

   $$\text{TWF} = \frac{2\ hours/day}{24\ hours/day} * \frac{350\ days/year}{365\ days/year} = 0.08$$

   IUR_{LTL} = 0.045 $(f/cc)^{-1}$ ((Table 3, Page 23, USEPA 2008); 5-year exposure starting age 1)

   ELCRs = EPC * TWF * IUR_{LTL}

   = 0.02 f/cc * 0.080 * 0.045 $(f/cc)^{-1}$

   = 7.2 X 10^{-5}

4. Combined Residential Ambient Air Exposure & Gardening Exposure – Adult; Residential Exposure, period of exposure is 30 years, starting age 20. Gardening is assumed to be 10 hours/day, 50 day/year. Exposure to ambient air is assumed to occur at all times that gardening is not occurring (14 hours/day for 50 days/year, and 24 hours/day for 300 days/year). Asbestos concentration in the breathing zone while gardening during ABS = 0.02 f/cc (used as the EPC_G). The ambient air concentration measured by stationary air monitors was 0.0007 f/cc (used as the EPC_{Amb}).

$$TWF_G = \frac{10\ hours/day}{24\ hours/day} * \frac{50\ days/year}{365\ days/year} = 0.057$$

$$TWF_{Amb} = \frac{14\ hours/day}{24\ hours/day} * \frac{50\ days/year}{365\frac{days}{year}} + \frac{24\ hours/day}{24\ hours/day} * \frac{300\ days/year}{365\frac{days}{year}} = 0.090$$

(14 hours/day gardening plus 24 hours/day other days while at home)

IUR_{LTL} = 0.075 $(f/cc)^{-1}$ ((Table 3, Page 23, USEPA 2008); 30-year exposure starting age 20)

$ELCRs = [(EPC_G * TWF_G) + [(EPC_{Amb} * TWF_{Amb})] * IUR_{LTL}$

$= [(0.02\ f/cc * 0.057) + (0.0007\ f/cc * 0.090)] * 0.075\ (f/cc)^{-1}$

$= 8.5 \times 10^{-5} + 4.7 \times 10^{-5} = 1.3 \times 10^{-4}$