June 6, 2019

Secretary Patrick McDonnell
Department of Environmental Protection
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17101

Michael Kutney, P.G.
Chief, Permits and Technical Section
Department of Environmental Protection
Pottsville District Mining Office
5 West Laurel Boulevard
Pottsville, PA 17901

Re: Rockhill Quarry (Pierson Materials/Hanson Aggregates)
Rockhill Environmental Preservation Alliance, Inc. Comments on
Qualitative Geologic Survey Sampling Plan

Dear Secretary McDonnell and Mr. Kutney,

On behalf of Rockhill Environmental Preservation Alliance, Inc. (REPA), enclosed please find comments prepared by Erskine Environmental Consulting on the Geologic Investigations Hazardous Materials Naturally Occurring Asbestos Qualitative Geologic Survey Sampling Plan (QGSSP), Rock Hill Quarry, SMP No. 7974SM1, East Rockhill Township, Bucks County submitted to the Pennsylvania Department of Environmental Protection by EarthRes, dated April 3, 2019, and subsequent response related thereto by EarthRes, dated April 25, 2019. While not a part of the QGSSP, a limited review (air sample collection and test methodology) of the Asbestos Air Monitoring Plan (AAMP), East Rockhill Quarry Site, submitted to the Pennsylvania Department of Environmental Protection by Richard E. Pierson Materials Corporation, dated April, 2019, is also incorporated in the comments.

Thank you for your attention to this matter.

Respectfully Yours,

Rockhill Environmental Preservation Alliance, Inc.

cc: Steven Baluh, P.E (via email)
Marianne Morano, Township Manager (via email)
Amiee Bollinger PADEP (via email)
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Erskine Environmental Consulting

Geologic Investigations   Hazardous Materials   Naturally Occurring Asbestos

June 6, 2019

Subject: Review of Qualitative Geologic Survey Sampling Plan
Rockhill Quarry
East Rockhill Township
Bucks County, PA

This report presents a technical review of the following documents and provides recommendations for improvement:

- Qualitative Geologic Survey Sampling Plan (QGSSP), Rock Hill Quarry, SMP No. 7974SM1, East Rockhill Township, Bucks County submitted to the Pennsylvania Department of Environmental Protection by Earthres, dated April 3, 2019.

- Response to PA DEP and East Rockhill Township Comments, Qualitative Geologic Survey Sampling Plan (QGSSP), Rock Hill Quarry, SMP No. 7974SM1, East Rockhill Township, Bucks County submitted to the Pennsylvania Department of Environmental Protection by Earthres, dated April 25, 2019.

While not a part of the QGSSP, a limited review (air sample collection and test methodology) of the following document is incorporated:

- Asbestos Air Monitoring Plan (AAMP), East Rockhill Quarry Site, submitted to the Pennsylvania Department of Environmental Protection by Richard E. Pierson Materials Corporation, dated April, 2019.

Purpose

The purpose of the review is to provide an independent analysis of the QGSSP to assess whether the Plan is adequate to characterize the site for the presence of Naturally Occurring Asbestos (NOA), and if identified, sufficient to provide data allowing informed decisions regarding dust mitigation during quarrying, potential risk to offsite receptors, and air monitoring requirements to verify that offsite receptors are not adversely exposed to asbestos.

This review includes opinions produced solely by the author. This review is based on more than 30 years of experience of the author within asbestos testing laboratories and consulting in the field of NOA. In particular, many of the observations, comments, conclusions and recommendations are shaped by experience with two recent major NOA projects: The Boulder City Bypass Project in Nevada, a three-year construction project and the first large NOA project in Nevada, and the Calaveras Dam Replacement Project, an eight-year project that represents the largest and most technically advanced NOA project in the U.S. Both projects included construction activities similar to the Rock Hill Quarry site (drilling, blasting, sorting and sizing, crushing and screening), and the challenges and potential solutions are similar.

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The QGSSP includes procedures, terminology, test methodology and other subjects that are difficult to understand without extensive experience in the field of NOA. An attempt was made in this review to explain some of the more difficult concepts and communicate in language that may be comprehended by those who have limited experience with NOA, particularly the application of standards and regulations to a quarrying project.

This review focuses on the following:

- Does the QGSSP include procedures which will produce a thorough geologic assessment that allows each litho-structural unit to be identified and tested independently?
- Are the proposed procedures for inspection and sample selection for testing adequate to fully characterize the site for NOA?
- Are the proposed test methodologies described in the QGSSP and AAMP appropriate for the intended applications, and will they adequately characterize the concentration of NOA in rock, water and air?

Summary of Conclusions

The following is a summary of findings from the QGSSP review. Details that led to these findings are presented below. Recommendations for improvement of the QGSSP are presented at the end of the report, as well as references cited in the review.

Geologic Assessment

There is little evidence that an appropriate geologic investigation has been conducted to identify each litho-structural unit that requires independent testing. Before sampling is to be conducted, the rocks at the site need to be mapped in detail and broken into independent units that are distinct in lithology and structure.

Questions to be answered include:

- Are there different geologic facies within the diabase, such as a coarse-grained component, fine grained component, xenoliths, and other variations that may include differences in the composition or relative percent of amphiboles?
- Are there ductile or brittle shear zones (outside of the veins under investigation), each of which require sampling?

It appears from the description in the QGSSP that the diabase was considered a single homogeneous unit, and that the sampling program will provide a result that represents a composite (average) of the rock unit. Sampling within each unit should include incremental sampling to assess the average NOA composition within a unit as well as targeted sampling at locations with the highest potential for NOA. The incremental sampling will provide data on the overall disturbance activities, while the targeted sampling will provide data for OSHA compliance. The geologic investigation should be guided by the most comprehensive NOA-specific regulations and guidelines available, notably the CARB 435 and CARB 435 implementation guidance, protocols outlined in the California Department of Toxic Substances Control guidance for NOA investigations at school sites, guidance provided by the California Geological Survey, and the California Air Resources Board Asbestos Airborne Toxic Control Measure for Construction, Grading & Quarrying operations. References are incorporated herein and within the references cited section of this review.

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Procedures for Sample Selection for Testing

The procedures for sample selection are unorthodox, and do not conform to basic principles for geologic investigations. In particular, it appears that the QGSSP prescribes a field test using visual methods in the field to determine if asbestos is present, and screens samples from further testing. The procedure is subjective, and based on a definition of asbestos where no consensus has been arrived at. Most importantly, fine particles, such as asbestos particles of the size of interest, are commonly not visible using a hand lense or even a binocular microscope, and these rocks would be excluded for testing. The proposed field methods should be employed to help differentiate rock units for independent testing, and not as a screening tool.

The QGSSP appears to exclude the diabase from further sampling, and focuses on the veining where asbestos has been identified. A thorough analysis of the diabase is Important because diabasic rocks containing tremolite/actinolite amphibole often exhibit asbestos mineralization through replacement of olivine and pyroxene minerals which is rarely obvious in the field. The sample selection procedure that was employed does not appear to have been sufficient. In addition, the sample preparation procedures are not well described and likely were not in accordance with standard of practice, and therefore, the results may not be reliable. It is recommended that the QGSSP include proper sample selection, preparation and analysis of this unit as well as all litho-structural units at the site.

Test Methodology

The proposed test methodology for rock, water and air sampling are not appropriate for the goals of the investigation (e.g. to make informed decisions regarding potential exposure to offsite receptors), and for water and air testing, the use of the data is not consistent with intended purpose of the test methods.

Rock Sampling

The QGSSP procedure prescribes polarized light microscopy (PLM), which commonly cannot detect fine asbestos particles, and if potential NOA is reported, uses transmission electron microscopy (TEM) only to verify the positive result rather than eliminate the possibility of a false negative. The QGSSP procedure is somewhat reverse of the standard of practice. PLM is used as a pre-screen, and TEM, which can positively identify fibers that are less than 0.001 microns in width, is used to confirm the lack of detection by PLM. The methodology in the QGSSP will not reveal asbestos if it is in relatively low concentrations (<0.25% by point counting) or where present as fine particles, which is common for NOA. It is recommended that both PLM and TEM be employed on all samples to fully characterize the rocks.

Water Sampling

The method chosen (EPA M100.2) counts and reports fibers that are greater than 10 microns only. A sizable fraction of asbestos in water from runoff has lengths less than 10 microns, particularly where rocks have been subjected to highly energetic disturbance such as blasting, drilling, pneumatic hammering, and crushing beneath heavy equipment and during crushing and screening. EPA 100.1, a companion method to EPA 100.2, counts and reports all fibers greater than 0.5 microns. If the water is to be used for dust suppression, the release of respirable fibers through evaporation is possible. It is recommended that previous sample preparations be reanalyzed by EPA 100.1, and this method be employed throughout the project.

Air Testing

The AAMP prescribes sample collection and testing procedures using the NIOSH 7400 and 7402 methods. The NIOSH methods are designed specifically for worker exposure, and use the OSHA

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Permissible Exposure Limit (PEL) standard for workers, which is not a standard for the general public. In addition, the 7400 method uses Phase Contrast Microscopy (PCM), which is not allowed by EPA for purposes related to non-worker exposure. Unlike the EPA TEM test procedures, The NIOSH counting rules selectively remove any fiber that is less than 5 microns in length, and less than 0.25 microns in width. Therefore, the actual concentration of asbestos in air is under represented. This is particularly important with the close proximity of a school within 0.5 mile of the quarry along the proposed truck route, and homes in which families with small children live within 300 ft and adjacent to the quarry. It is recommended that the AAMP prescribe the sample collection and testing following the standard of practice for perimeter monitoring using the TEM method prescribed under the Asbestos Hazard Emergency Response Act (AHERA). This method counts all structures that are greater than 0.5 microns in length, and the result should be compared to a risk-based perimeter threshold that is determined to be protective of offsite receptors. The latter method is the standard for perimeter monitoring at NOA sites.

Other Considerations and Recommendations

Air Modeling

The AAMP presents a series of graphical wind rose charts that provide information on the wind speed and direction. While informative, they have limited value and do not include important data that contribute to asbestos concentrations offsite. For example, asbestos concentrations attenuate through dispersion on warm windy days where turbulent conditions exist. On cold days with low wind speeds, the asbestos concentrations can be exceedingly high, and offsite receptors exposed for longer periods of time.

It is recommended that the perimeter monitoring program be supported by air modeling to provide a predictive capability to airborne dust concentrations at off-site locations. The standard modeling program is EPA's AERMOD, a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence and other inputs. Using standard EPA emission rates for equipment at the site, particle concentrations can be evaluated at any point offsite for the duration of the project. Air modeling is fairly commonplace at sites such as quarries where high emissions are predicted, and the data from the model can be used to calculate a risk-based threshold for the site perimeter program.

Definition and Reporting of "Asbestos"

Some consultants and many laboratories rely on the commercial definition of asbestos and report asbestos only when the composition of an amphibole fiber is equivalent to the very narrow compositions that were mined and applied to building materials. This practice eliminates many amphibole compositions and morphologies that are present in rock and soil, and can produce a deceptive result (in rock, water and air samples). There is consensus among many researchers, particularly mineralogists, that this definition and practice is not appropriate for NOA. It is recommended that a mineralogical definition of asbestos be employed, and all amphibole compositions be determined and reported. This method was successfully employed at the Calaveras Dam site, and its application was instrumental for the protection of workers and offsite receptors. Using a mineralogical definition of minerals will prevent eliminating amphiboles from lab reports that are not precisely the same compositions as those applied in building materials.

It is also recommended that the laboratory refrain from arriving at an opinion whether a particle is asbestiform or a cleavage fragment. There is no approved test method to make this determination, and the opinion is subjective. It is also recommended that the laboratory refrain from classifying a particle as asbestos based on parallel extinction relative to the long axis of the fiber. This may be appropriate for asbestos in building materials or commercially exploitable asbestos, but not appropriate for NOA. NIST, the accrediting agency for asbestos testing labs supplies asbestos testing

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standards with inclined extinction, requires reporting of parallel or inclined extinction, and does not exclude fibers with inclined extinction from being counted as asbestos. EPA is in support of this view.

Activity Based Sampling

One method advocated by EPA to assess whether asbestos present in rock and soil results in adverse air concentrations is to conduct activity-based sampling (ABS). This form of sampling involves the collection of air samples during an activity designed to mirror an activity that will be performed at the site. One simple test is to collect air samples behind moving vehicles and along unpaved roads that are currently present at the site. On a park road near the Calaveras Dam site, sampling inside and outside three vehicles while driving on an unpaved road with asbestos concentrations of <0.25% produced dust plumes with high airborne asbestos concentrations. The purpose was to assess whether park visitors may be exposed to adverse asbestos concentrations when contractors used the road to access a project. It also solved a mystery regarding elevated asbestos concentrations at an ambient air monitoring station near the road. If significant concentrations of asbestos are reported in the air samples, it would imply that asbestos is present in rock and soil at the quarry site. If little or no asbestos is reported, it would support a conclusion that the quarry rocks are not NOA-bearing. It is recommended that ABS sampling be conducted to augment the rock testing.

Construction Area Activity Monitoring

The perimeter monitoring station array provides, if designed properly, verification that offsite receptors are not exposed above prescribed thresholds. They do not provide information regarding individual emission sources or potential dust generated off site due to trackout. It is recommended that an additional component of air sampling be conducted at the points of highest potential emission activities such as the rock crushing and processing facility and the main quarrying operations. In addition, because wheel washes and other trackout prevention methods do not necessarily prevent trackout, it is recommended that additional air monitoring stations be established along roads where haul trucks may track out dust near and through the community.

Reliability of Test Data from the Diabase

The QGSSP focuses on testing of veins, and does not include the diabase or any other lithologic unit. It cites previous data tested by EMSL Laboratories that found no asbestos detected. Review of several reports attached to a letter from Hanson Aggregates Pennsylvania LLC to the Pennsylvania DEP, dated October 29, 2018, presents some questions. In particular, the lab report states that the preparation method utilized CARB 435 Prep (milling). It does not state what milling apparatus was used. Based on concerns regarding over-pulverization of samples and interlaboratory variations in asbestos reporting, CARB tested several milling methods, and recommended in their CARB 435 guidance document that a disc pulverizer be used. However, at the ASTM International Beard Asbestos Conference last April, EMSL presented a study using spiked samples and employing a milling method other than the disc pulverizer. EMSL reported that samples spiked with low concentrations of amphibole asbestos yielded no, or greatly reduced levels of, asbestos detected after milling, and was unable to suggest the reason. Over-pulverization was most certainly the reason, which was a key reason why CARB recommends the disk pulverizer in its CARB 435 Implementation and Guidance Document. If the diabase samples were prepared using the same equipment presented at the conference, and the diabase contains low concentrations of asbestos, then the laboratory results are highly suspect and the diabase should be resampled and appropriately tested.

Processed Aggregate Stockpile Sampling and Testing

The information provided by applying the CARB 435 sampling and testing protocol is of value, and should be used to augment but not as a surrogate for data collected from a well-designed sampling program. In particular, the results provide concentrations that represent a weighted average of asbestos on a site, and may be misleading when used to assess potential for exposures to the public who reside offsite.

The procedures and intent of sampling protocols for processed material becomes apparent when considering CARB's four documents that collectively specify the procedure for sampling, purpose of the sampling protocol, and purpose of the procedures (CARB Method 435 (CARB 1991); CARB 435 Implementation Guidance (CARB 2017); CARB ATCM for surfacing applications (CARB 2001); and CARB ATCM for Construction, Grading, Quarrying and Surface Mining Operations (CARB 1992). The CARB 435 protocol is required to test materials for its use for surfacing applications. The test invokes a binary response action: if the test result is 0.25% or greater, then the material is defined as a Restricted Material, and cannot be bought, sold or used for the purposes of surfacing applications. It is not restricted for other uses such as fill. The intent is provided in the Construction ATCM. In the section titled *Post Construction Stabilization of Disturbed Areas*, roads, stockpiles, and disturbed areas must be stabilized using one of four methods: 1) establishment of a vegetative cover, 2) placement of at least three inches of non-asbestos-containing material (interpreted to mean less than 0.25% by CARB 435), 3) paving, or 4) any other measure deemed sufficient to prevent wind speeds of ten miles per hour or greater from causing visible dust emissions. Thus, the purpose of the CARB 435 protocol as applied to the Surfacing ATCM is to prevent significant re-entrainment of asbestos particles by wind, and is not intended to establish the potential for exposure during disturbance.

The CARB 435 protocol is not applicable for the use for regulatory compliance (outside of surfacing applications), and the mixing and compositing of materials is not compliant with EPA and OSHA requirements for the purposes of triggering response actions such as engineering controls and air monitoring. Consider the process: material from a quarry is mined, crushed and screened to produce a specified size distribution. The various rock units, therefore, have been homogenized, providing a material that in effect produces a weighted average of the asbestos content. If the diabase is a non-asbestos unit, for example, and asbestos is present in the veins, the result will be a very low "diluted" level of asbestos. The stockpile is sampled using an incremental sampling approach (compositing) to further determine the average asbestos content. The CARB 435 method requires that all samples collected must be averaged, and the numeric average used for compliance. All sample results, regardless of who collected the sample set, must be included in the sample set for averaging. The overall goal is to achieve the most precise measurement of the average asbestos concentration in a mixture of one or more lithologies.

To fully characterize asbestos at a site, each rock type and variations within a rock unit must be sampled individually using both an incremental sampling approach to account for natural variation in a unit combined with targeted sampling to establish the highest concentration of asbestos within a unit. Once the occurrence, location, and concentration of the rock units, and even the stockpiles, is fully evaluated, the actual concentrations in air during disturbance becomes the critical part of the project. Personal air monitoring using PCM and the NIOSH 7400 method is appropriate for OSHA compliance, and perimeter combined with construction area activity sampling and along roads off of the site and tested by TEM will provide the verification that offsite receptors are not adversely exposed.

Level of Investigation and Standard of Practice

The characterization of NOA in rocks and soil is a highly complex and technical field, and each site is unique in terms of lithology, structure, geologic history, and occurrence of NOA. The NOA investigation must be designed to incorporate these variations. In addition, the level of investigation and approach is often driven by the overall goal and relative risk that the project may present. In the case of the Rock Hill quarry site, the standard of practice for a geologic NOA investigation is elevated due to the following two issues:

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1. Rock Cannot be Adequately Wetted

Typical NOA project sites involve weathered rock or loose unconsolidated sediments or materials that can be adequately wetted using standard water application techniques. Once wetted at the source of disturbance, the material remains wetted, and the potential for fugitive emissions remains low during the source-to-disposition process (for example, cutting and filling on a common commercial or grading project). These types of projects are successfully completed on a daily basis in northern California where chrysotile-bearing serpentinite is common. However, neither the Rock Hill quarry project nor the materials to be disturbed are of this type. As correctly noted in their response no. 6 to a question regarding blasting (Response to DEPs comments on the AAMP by Compliance Solutions dated May 12, 2019), *"During normal blasting, there is no effective dust control method"*. The reason for this is that hard rock cannot be wetted, and therefore, fine asbestos particle emissions cannot easily be controlled. Fine particles cannot be captured by airborne misting methods. As a result, a unit volume of rock becomes a repeated emission source throughout the process:

1. Drilling - emissions are not effectively captured by shields and vacuum systems that are not designed for fine asbestos particles,
2. Blasting - no dust control measures are effective,
3. Sorting and sizing - pneumatic hammers with no effective dust control measures (pressure sprayers only disperse the fine particles, and do not capture them),
4. Bulldozing - where rock is moved and crushed beneath metal tracks (with emissions blown away by large engine cooling fans),
5. Excavation and loading - (also with crushing beneath the tracks),
6. Hauling - to the crushing and screening operations,
7. Crushing and screening - a particularly high emission source with no effective dust control measures (misters do not capture fine asbestos particles because the size of the water droplet is too large compared to the size of fine asbestos particles- see NIOSH Dust Control Handbook for Industrial Mining and Processing, Chapter 2- Water Spray Systems, Subsection 1- Principles of Wet Spray Systems, Subsection 3- Controlling Water Droplet Size).
8. Hauling - processed material,
9. Treatment of vehicles before leaving the site - Standard wheel washes at the egress points are designed for large particles but not fine asbestos particles. Unless designed as a single pass system, recirculated water containing fine asbestos particles are tracked off site as water drips from vehicles.

2. Residential Receptors are Located Near the Site

According to the AAMP, residential receptors and a school are located nearby, as close as 65 feet from the perimeter of the site. This close proximity increases the potential for adverse exposure. Asbestos concentrations can be particularly elevated on cold days with low winds when little dispersion occurs.

Summary

The combination of disturbance of hard, crystalline rock that cannot be adequately wetted, the repeated emission source of the material, the use of heavy equipment with high emission potential, and close proximity to residential receptors, combine to elevate the quarry project to a potential high-emission and asbestos concentration status. EPA and general industry have come to recognize that asbestos emissions, particularly from amphibole asbestos containing sites, are much more based on activities than the concentrations of asbestos in the ground, with low concentrations in source materials leading to high airborne emissions when disturbed in highly energetic ways such as occur at a quarry site. The dust control measures and air monitoring program cannot be adequately designed without highly reliable data collected during the NOA investigation. A finding at the quarry site of "no asbestos present" as has been cited for the diabase in the documents under review, requires the standard of practice for the geologist conducting the investigation to be elevated above standard regulatory protocol.

Comment 1: The NSSGA Qualitative Geologic Survey Procedure, Which is the Basis for the QGSSP, is Not Appropriate for an NOA Investigation to Assess Potential for Exposure to the Public.

The QGSSP under review mirrors and appears to be derived from the procedures specified in the NSSGA Mineral ID and Management Guide (NSSGA 2009). The stated goal of the program outlined in the Identification Guide is to *"identify and manage potential areas where protocol mineral fibers occur in order to avoid producing aggregate materials which release such protocol mineral fibers in excess of federal, state, or local limits related to asbestos exposure, including Permissible Exposure Limits (PELs) established by the Occupational Safety and Health Administration and Recommended Exposure Limits (RELs) established by the Mine Safety and Health Administration"*. The reference to PELs and RELs suggest that the focus of the program is for worker protection, and that success is tied to worker exposure below regulatory thresholds that have been established for workers. There is no reference to potential exposure to offsite receptors. Thresholds for public exposure are generally much lower than for workers, and the test methods used to determine airborne concentrations are vastly different (see the discussion on air test methods, below). The goal of an NOA investigation should be to provide an accurate and complete data set so that informed decisions can be made regarding both worker and public potential exposure.

The document also states: *"The program outlined in the Identification Guide is intended to be tailored by geologic personnel or consultants such that it is appropriate for the geologic and production realities of a particular site".* This passage suggests that the survey may be modified in accordance with achieving a desired outcome at the quarry, in this case, impacts related to "production realities". An NOA investigation should be unbiased, not tailored to meet a desired outcome, and be fully transparent.

The QGSSP is, therefore, based on a procedure that was designed for the internal use of the mining industry, and it is not consistent with general standard of practice for geologists conducting NOA investigations. This subject is discussed in a later section, below.

Comment 2: The QGSSP Definitions of "Asbestiform", and "Asbestos" are Ambiguous and Subjective, and Cannot be Determined by Current Test Methods.

The QGSSP refers to "asbestos" and "asbestiform", and uses these terms to differentiate NOA from non-NOA materials. There is no consensus regarding the definition of these terms among the NOA scientific community, and there is no regulatory-approved test method to differentiate between elongate mineral particles and "asbestos" particles of the same amphibole mineral. This has led many laboratories to use the properties of commercial asbestos as the definition (see the definition in the NSSGA (2003), for example), and apply it to every natural occurrence of asbestos. Many in the scientific and regulatory community find this inappropriate, and advocate a broader definition for NOA (see the introduction of Erskine and Bailey, 2018, for further details).

The National Institute of Occupational Safety and Health (NIOSH) described the problem as follows:

> "Imprecise terminology and mineralogical complexity have affected progress in research. "Asbestos" and "asbestiform" are two commonly used terms that lack mineralogical precision. "Asbestos" is a term used for certain minerals that have crystallized in a particular macroscopic habit with certain commercially useful properties. These properties are less obvious on microscopic scales, and so a different definition of asbestos may be necessary at the scale of the light microscope or electron microscope, involving characteristics such as chemical composition and crystallography. "Asbestiform" is a term applied to minerals with a macroscopic habit similar to that of asbestos. The lack of precision in these terms and the

> difficulty in translating macroscopic properties to microscopically identifiable characteristics contribute to miscommunication and uncertainty in identifying toxicity associated with various forms of minerals. Deposits may have more than one mineral habit and transitional minerals may be present, which make it difficult to clearly and simply describe the mineralogy" (NIOSH, 2011).

EPA concurrence with the view that the properties of asbestos in building materials should not be universally applied to NOA is suggested in a response to comments by the NSSGA and R.J. Lee Group regarding asbestos in the California El Dorado Hills, a key investigation that supported the NOA regulations in California.

In response to a comment regarding the length and width of fibers as an indicator of asbestos, EPA responded:

> "The R. J. Lee Report further states that EPA's data inflated the asbestos fiber count by ignoring the Agency's own "definition" of asbestos. To support this claim, the R.J. Lee Report cites the glossary of "Method for Determination of Asbestos in Bulk Building Materials", EPA 600/R 93/116, 1993, which states, in part, "With the light microscope, the asbestiform habit is generally recognized by the following characteristics: Mean aspect ratios ranging from 20:1 to 100:1 or higher for fibers longer than 5 microns." The building material analytical method is designed to detect commercially processed asbestos in items like floor tiles, roofing felts, paper insulation, paints, and mastics, not naturally occurring asbestos on air filters or in soil samples. To present the 20:1 aspect ratio for commercial grade asbestos as a universal EPA policy, and to advocate its use as an appropriate standard for analyzing air samples of naturally occurring asbestos is inappropriate and contradictory to use of the PCME dimensional criteria as a tool for assessing exposure risk" (EPA, 2006).

In response to the elimination of particles that do not meet the characteristics of commercial asbestos (essentially the practice of screening apparent cleavage fragments from the test), EPA responded:

> "The R. J. Lee Report relies heavily on the geologic distinction between asbestos fibers and cleavage fragments of the same dimensions, with the implication that exposure to cleavage fragments is benign and of little or no health significance. For the purposes of public health assessment and protection, EPA makes no distinction between fibers and cleavage fragments of comparable chemical composition, size, and shape. The EPA Region 9 approach, which is supported by most public health agencies and scientists, as well as the American Thoracic Society, is based on the following: (1) The epidemiologic and health studies underlying EPA and Cal/EPA cancer risk assessment methods were based on exposures to both cleavage fragments and fibers, and were unable to distinguish between the two, (2) The most recent panel of experts to review asbestos risk assessment methods, the 2003 Peer Consultation Panel convened by EPA, concluded that "it is prudent at this time to conclude equivalent potency [of cleavage fragments and fibers] for cancer," (3) No well-designed animal or epidemiological studies have adequately tested the hypothesis that cleavage fragments with the same dimensions as a fiber are benign or that the human body makes any distinction, (4) Studies that purport to show that cleavage fragments are benign are questioned by many asbestos health experts, (5) There are no routine asbestos air analytical methods, including those used by EPA, NIOSH, the Mine Safety and Health Administration (MSHA), the American Society for Testing and Materials (ASTM), and ISO which differentiate between cleavage fragments and crystalline fibers on an individual fiber basis" (EPA 2006).

The problem is further exacerbated when laboratories rely on reference materials supplied by the National Institute of Standards and Technology (NIST) to report fibers as asbestos. For example, if a sample of asbestiform blueschist at the Calaveras Dam site is sent to a commercial -asbestos based laboratory, the fibrous amphibole, glaucophane, would be declared a non-asbestos particle because the amount of aluminum in the mineral exceeds the amount in the reference material for crocidolite in building materials. Mineralogists consider fibrous glaucophane to be crocidolite (Amphibole Nomenclature, IMA 1978, and NIOSH Pocket Guide to Chemical Hazards), but the lab would report no asbestos present. If the properties of commercial asbestos were to be applied at the Calaveras Dam site, no respiratory protection for workers would be required by OSHA, no asbestos-specific dust control measures would be required by the California Air Resources Board, and no perimeter monitoring to verify that offsite receptors would be required as well. The result would have been a clear overexposure to workers, and a likely overexposure to offsite receptors. Another example is the Libby superfund site, where amphibole chemical compositions grade from the "regulated" tremolite to the "non-regulated" winchite and richterite. If the properties of commercial asbestos were applied, the richterite and winchite compositions would not be reported, and airborne concentrations and exposures would have been severely understated. These examples illustrate a need to rely on the test methods to determine whether a particle under the microscope is defined as a fiber (rather than arbitrary field methods- see Comment 3, below), and reporting all compositions of amphiboles. This broader data set can then be interpreted, and informed decisions made.

Comment 3: The Field Pre-Screening Procedure in the QGSSP is Neither Consistent with Standard of Practice for a Geologic Assessment for NOA, Nor Likely Compliant with Regulatory Protocol.

The sampling protocol prescribed in the QGSSP begins with a procedure as stated on page 3: *"Found mineral veins will be examined using a hand lense and fine steel pick to assess the presence of fibrous mineral morphology. If potentially suspect mineral morphology is identified, the mineral veining will be photographed and sampled in the following manner…"*.

This procedure is certainly an aspect of every field investigation, but reliance upon it to discriminate the presence, or absence of asbestos, is not consistent with the standard of practice for a geologic assessment for NOA. The underlying assumption is that all NOA is similar in morphology to commercially exploitable commercial-grade asbestos that was mined for the application in building materials (see the definition of asbestos in the NSSGA Mineral ID and Management Guide). This is an incorrect assumption. Large veins or other occurrences in rocks that can be detected visually or using a hand lense are relatively rare. Many igneous and metamorphic rocks are fine grained or include mineral components that are fine grained, and can be detected only through petrographic analysis of thin sections, polarized light microscopy of pulverized samples using oil immersion techniques, or transmission electron microscopy. Even in many building materials where significant quantities of commercial grade asbestos were applied, the asbestos cannot be detected using a hand lense. Examples include floor tiles, plasters, window putty, mastics, sheetrock and joint compound, and many others. If this method was to be used to screen materials from sampling and analysis, the majority of asbestos containing building materials would be assumed to be non-asbestos containing. The application of this screening method in rocks has a similar result: the majority of rocks that contain asbestos would be screened out for testing and assumed non-NOA. Three recent important investigations illustrate this point. At the Libby Montana superfund site (EPA 2014), the asbestos that coexists with vermiculite cannot be detected using the QGSSP field protocol. At the Boulder City Bypass project site, asbestos was first discovered in granitic rocks and sediments derived from granitic rocks using scanning electron microscopy and x-ray diffraction techniques (Buck and Goossen, 2013), even though these rocks have been studied by geologists for decades. At the Calaveras Dam Replacement Project site, fibrous amphiboles were documented in blueschist for the first time using TEM, a significant discovery considering that these rocks have been studied by numerous geologists for more than a hundred years (Erskine and Bailey, 2018). The initial field technique should be used to identify each rock type that will be subjected to standard testing techniques, but not used as a subjective screening tool to eliminate samples from testing.

The procedure in the QGSSP is also not likely compliant with procedures for asbestos investigations where required by EPA and OSHA, nor consistent with the standard practice outlined in the CGS Special Publication 124. The procedure for asbestos in building materials and NOA in rock and soil is

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the same: each suspect material ("homogeneous area") is differentiated by color, texture, condition, and age, and each are to be sampled and tested independently. On a site where suspect asbestos containing materials are present, each geologic unit must be assumed to be Asbestos-Containing Material (equal to or greater than 1% asbestos) unless otherwise determined by appropriate testing. There can be no pre-screening screening using field and visual methods.

Comment 4: The Test Methods Prescribed in the QGSSP for Rock, Water and Air May Severely Underestimate Asbestos Concentrations.

Test methods for asbestos in bulk, air and water are somewhat unique in that the number of particles, and therefore concentrations, differ depending on the test method selected. The method that is selected must be based on the regulatory requirement combined with the information that is needed for an informed decision. Some methods have an inability to detect fine particles. Others report fibers of particular lengths and widths, and eliminate the remaining fibers. In the case of air, for example, a single sample can yield as many as five different concentrations depending on the test method selected. Which one to use? The test methods that are prescribed in the QGSSP are inappropriate largely because they are not the correct method for the application that it was designed for, or do not reveal the data of interest. In each case, the concentration of asbestos can be severely underestimated, including a finding of no asbestos present when this may not be the case. The following is a summary of the test methods that are prescribed, a description of their deficiencies, and recommendations for alternative methods that meet the standard of practice for NOA investigations.

Testing of Rock and Soil

The testing protocol and test methods prescribed in the QGSSP are described in its Attachment 1: Sample Analysis Procedures and Methods. The following is the procedure prescribed in Attachment 1 (in black font), with comments at various points (indented in red italics).

Attachment 1
Sample Analysis Procedures and Methods
(From the QGSSP)

"For obtaining a representative sample from a large bulk sample, the AASHTO procedures for reducing the sample should be used".

> *The AASHTO procedures for reducing the sample was not designed for NOA investigations. The sample collection and preparation should follow, as a baseline, the CARB 435 Method (CARB 1991) and in particular, the CARB implementation guidance document that investigated deficiencies and recommends improvements (CARB 2017). It should be noted that in response to comment 2 in the April 25th Response to PA DEP and Rockhill Township document, Earthres stated that the CARB 435 method for sample frequency was not designed for the site because the CARB 435 method was originally designed for serpentine aggregates. However, CARB later specified that the CARB 435 method be used for "aggregate and other bulk materials" (see the subheading titled "test methods" in CARB, 2002). The CARB 435 method and guidance document, while having deficiencies that are corrected using TEM augmentation (see below), are considered the standard of practice for collection, sample preparation, and testing. It should be noted that the sampling frequency selected for characterization at the site and a frequency selected for characterization of processed aggregate material are different and selected for different reasons and purposes. This subject and recommendations are described below Comment 5: Frequency of Testing for Processed Aggregate Stockpiles and other units.*

"The subsequent analyses of the submitted samples will follow a three-step procedure: 1) Basic microscopic analysis to assess the presence of asbestiform mineral habitat";

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Basic microscopic analysis, or any microscopic analysis cannot definitively determine whether a particle is asbestiform (see Comment 2 and 3, above).

2) “Polarized Light Microscopy (PLM) to determine the presence and asbestos mineral type, if present”;

PLM analysis, if employed, should follow the CARB 435 method which assigns a numeric value based on point counting. The use of Table 3 in that document is considered to be erroneous for NOA, and should not be used.

“and, 3) Should positive results be indicated by PLM, follow-up Transmission Electron Microscopy (TEM) analysis will be completed to confirm the minerals present and their morphology”.

It has been well established that PLM analysis cannot detect small and narrow fibers, particularly this that are less than 0.25 microns in width. This is a significant cutoff point because asbestos fibers average about 0.3 microns, and fibers less than about 0.25 microns are thought to have a higher toxicity than wider fibers. Because of this limitation, PLM is generally used as a pre-screening. If a trace amount of asbestos is detected (<0.25% as determined by the method), or asbestos is not detected, then the sample is tested by TEM to truly quantify the concentration in weight percent, of verify that it is not present at an analytical sensitivity of 0.005 – 0.0001 structures per gram. This is the procedure used by the California Department of Toxic Substances Control for school sites, and is considered the standard of practice for NOA sites.

“The techniques and methods to be employed in sample analysis are provided below:

• A geologist will inspect hand and core samples initially using a stereo binocular microscope, with magnification ranging from 10x to 60x. Using a fine steel pick (dental pick) the geologist will scrape the surface of the suspect mineralization to determine if any of the minerals display typical asbestiform habit and characteristics such as fiber bundles, splayed ends, or matted or fibrous masses”.

See Comments 2 and 3, above. While observing minerals in hand sample and under a stereo binocular microscope is standard practice, a determination, other than an opinion, if a particle is asbestiform cannot be made, and therefore, cannot be used to screen out the sample for proper testing.

• “Further examination of the sample will then be conducted using the Polarized Light Microscope (PLM) using EPA 600/R-93/116”.

This method is designed for commercial asbestos in building materials. The CARB 435 method and guidance document incorporates this method and adds needed protocols for sample preparation and other important procedures that are specific to rock and soil.

• “If asbestiform minerals are found, representative samples will be further analyzed by Transmission Electron Microscopy per EPA 600/R-93/116 to confirm mineral identification and morphology”.

The reporting of asbestos cannot be pre-screened for testing based on an arbitrary definition of “asbestiform”. See Comments 2 and 3, above. It is recommended that each lithology or structure at the site be tested by both CARB 435 and TEM. CARB 435 can identify large bundles, and TEM can identify all fibers and provide a concentration needed for OSHA compliance (certain mandatory controls and protection are triggered at the 1% level, including mandatory use of respirators).

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• "Where appropriate, the microscopic PLM and/or TEM analyses will include a count of the asbestiform fibers, representative digital images, and measurements of the width and length dimensions of found fibers counted".

> *Both analyses should include a count and concentration (or value in the case of PLM) of asbestos. All structures defined as fibers or bundles per the test methods should be included, not just those determined by an arbitrary definition of "asbestiform". No counting rules allow for the elimination of countable structures based on an opinion of whether the structure is asbestiform in habit or not.*

<u>Testing of Water</u>

Appendix 1 of the QGSSP provides the protocol for the testing of water at the site. It states:

"Water samples will be collected as grab samples and will be analyzed by TEM per EPA 100.2."

Some water samples have been collected at the site and the laboratory reported no asbestos detected. These results should not be accepted because the test method was not designed for the intended purpose, and may severely under report asbestos in the sample. There are two standard EPA methods for reporting the concentration of asbestos in water: EPA 100.1 and EPA 100.2. Both methods are similar in the collection, sample preparation, identification of asbestos fibers, and calculation of concentration. They differ in one significant aspect: EPA 100.1 counts and reports all fibers that are greater than 0.5 microns in length, while EPA 100.2 counts and reports fibers that are greater than 10 microns in length. EPA 100.2, the method specified in the QGSSP and the method used for samples collected at the site, was designed for potable water supplies for the purpose of measuring asbestos concentrations against the EPA drinking water standard of 7 MFL (million fibers per liter) represented by fibers that are greater than 10 microns in length. This method should be used only for potable water quality compliance purposes. For all other applications, EPA 100.1 is the standard. This method reports all lengths and widths (above 0.5 microns in length), and provides a complete data set regarding the dimensions and concentration of asbestos in water.

To get a feel for the importance of the different counting rules, consider the presence of asbestos in California reservoirs. Reservoir water in northern California where serpentinite and other NOA-bearing rocks are present in the reservoir's watershed contain asbestos, a subset of particles that are delivered to the reservoir through winter storm runoff. A detailed analysis of chrysotile and amphibole asbestos within the Calaveras reservoir was conducted to assess potential impacts to workers and offsite receptors due to the use of millions of gallons of water applied for NOA dust suppression and control (the primary concern was the application of asbestos in areas outside of the OSHA Regulated Areas, and the possibility of the escape of asbestos as fine airborne water droplets evaporate on warm days). Over the time period of two years, the average concentration of asbestos was approximately 50 MFL, a concentration that is comparable to other northern California reservoirs. Over the project duration, this equated to approximately 10^{12} fibers applied to the site through hoses, sprayers and water trucks. However, no fibers that were detected exceeded 10 microns in length. When the counting rules of EPA 100.1 were applied, the average concentration was 50 MFL. When the counting rules of EPA 100.2 were applied, the laboratory reported no asbestos detected. Therefore, the water samples tested at the Rock Hill quarry site by EPA 100.2, with no asbestos detected, did not provide a reliable assessment of asbestos concentration. Assuming that the filter preparation of the water samples has been archived by the laboratory, they should be reanalyzed using the counting rules of EPA 100.1. A reported concentration of asbestos in the water would indicate that asbestos is present in the source material of the particles in the water. A negative test at a low analytical sensitivity may suggest that little or no asbestos is present in the source materials.

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Testing of Air

The Asbestos Air Monitoring Plan (AAMP) describes the procedures and test methods for the analysis of samples collected at perimeter air stations. The purpose of the perimeter stations is usually to verify that the dust control measures are effective, and the concentration of asbestos leaving the site will not produce an adverse exposure to offsite receptors. The collection and test methods for perimeter stations and worker personal monitoring are distinctly different, and the results are compared to very different thresholds. It is important that the worker personal samples are collected in accordance with OSHA mandated methods for comparison with the OSHA asbestos Permissible Exposure Limit (PEL) of 0.1 fibers per cubic centimeter (0.1 f/cc), and perimeter samples are collected and analyzed in accordance with EPA standards, for comparison with a risk-based threshold. In California, the standard risk-based threshold for sites where offsite receptors are located within a mile of the perimeter is 0.016 asbestos structures per cubic centimeter (0.016 s/cc). Note that for each type of monitoring (personal vs. perimeter), the collection media (0.8 micron vs. 0.45 micron filter pore size), the counting rules (fibers greater than 5 microns in length and greater than 0.25 microns in width vs. all structures greater than 0.5 microns in length), and identification of a countable particle (fibers vs. structures) are different, and cannot be directly compared. This will be discussed further below.

The procedures and analytical techniques used for the perimeter monitoring are inappropriately applied for exposure assessment to offsite receptors because they are designed for worker protection and OSHA compliance. The standard for OSHA compliance is the application of the NIOSH 7400 and NIOSH 7402 methods, which are specified in the AAMP. NIOSH 7400 specifies a 0.8-micron pore size filter for two reasons. First, OSHA is interested in fibers that are greater than five microns in length, and a 0.8-micron filter will adequately capture the particle size of interest, but this is not true for perimeter and ambient monitoring where asbestos structures of 0.5um in length would pass through the filter.

The required protocol specified by NIOSH 7400, and proposed in the AAMP, begins with the collection of air in the breathing zone of the worker using portable low-flow pumps (the AAMP specifies sample collection at a height equal to the breathing zone). The sample is then analyzed by Phase Contract Microscopy (PCM) using a strict set of counting rules. PCM cannot differentiate asbestos fibers from non-asbestos fibers, so the concentration of all fibers that meet the counting criteria are reported, and will include both asbestos and non-asbestos fibers. An 8-hour time weighted average (TWA) is then calculated, and this value is compared with the PEL. Exceedance of the PEL triggers additional dust control measures and respiratory protection to reduce the exposure to below the PEL. When exposures exceed the PEL, the NIOSH 7402 method may be employed. This method uses TEM to calculate the ratio of asbestos to non-asbestos fibers, and this ratio is then applied to the original concentration, often reducing the final TWA. This asbestos-only concentration is then compared to the PEL. Note that the NIOSH 7402 method does not allow a concentration to be reported that can be used as a surrogate for the PCM result. Only the ratio of asbestos to non-asbestos is reported, and applied to the original sample (note that a concentration can be calculated, and the value used for management purposes, but not for compliance or comparison with a site threshold).

Perhaps the most critical component that is relevant to offsite exposure is the counting rules employed by the 7400 method. It counts and reports only fibers that are greater than 5 microns in length and 0.25 microns in width. All fibers that are less than 5 microns are not included, and all fibers less than 0.25 microns in width are not reported, and therefore, the AHERA-equivalent concentration is severely under reported for offsite exposure analysis. For example, a dimensional analysis of asbestiform amphibole fibers at Calaveras Dam perimeter stations showed that only 6% of the fibers and bundles met the NIOSH 7400 size criteria, and therefore, the concentration reported at the perimeter stations would have been 6% of the actual concentration.

EPA methodology for non-workers specify a 0.45-micron filter because loading is lower at a distance from soil disturbance, and the test method to be applied is the method referred to as the AHERA method (Asbestos Hazard Emergency Response Act, 40 CFR Pt. 763, Subpart E, App. A), which counts asbestos structures that are greater than 0.5 microns in length. The AHERA method is the standard of practice for establishing fugitive airborne concentrations, and should be employed at the quarry site.

Comment 5: Frequency of Testing for Processed Aggregate Stockpiles and Other Units.

Several comments and responses in various documents are related to the appropriate frequency of testing. In response to a comment by the East Rockhill Township (letter dated April 17, 2019), Earthres responded in a letter dated April 25, 2019: *"However, as California has the most developed programs and guidance for asbestos determinations, we surmise that the Department mandated a conservative (greater) initial sampling frequency for the processed aggregate stockpiles based on that available guidance".* This is a sound decision because the CARB 435 method and subsequent improvements in the CARB 435 Implementation Guidance Document was developed largely to assure that samples collected at the stockpiles are representative of the material, and that the material remains representative throughout the sample preparation and testing process. It should also be noted that these documents should not be considered in isolation. Two other relevant documents, the CARB ATCM for surfacing applications (CARB 2001) and the CARB ATCM for Construction, Grading, Quarrying and Surface Mining Operations (CARB 2002) also represent restrictions and practices developed following years of experience with NOA projects. They should not be considered "conservative", rather, they represent the core of the standard of practice for NOA projects, and should be used as a starting point, with additional practices applied where appropriate.

To reiterate a point made in Comment 4, the statement by Earthres that the CARB 435 method for sample frequency was not designed for the site because the CARB 435 method was originally designed for serpentine aggregates is not correct. A review of the four CARB documents will reveal that the CARB ATCM for surfacing applications define aggregate as "a mixture of mineral fragments, sand, gravel, cobbles, rocks, stones, or similar minerals that may or may not be crushed or screened". The ATCM for construction clarifies the use of CARB 435 for non-serpentinite sites as follows: *"References in ARB Test Method 435 to "serpentine aggregate" shall mean "gravel" or other "bulk materials" to be tested for asbestos content"*.

Processed aggregate stockpiles, in situ rocks on the bench faces, and rocks occupying the boulder field are independent entities, and require testing independently with a frequency based on the intent of the sampling. The sampling protocol and frequency for the overall site has been discussed above. Comments on the processed aggregate materials and boulder field are provided below.

<u>Processed Aggregate Stockpiles</u>

CARB Method 435 (CARB,1991) originally specified a single test for 1000 tons of aggregate for piles and conveyor belts. The test method was to be applied to a companion Asbestos Airborne Toxic Control Measure (ATCM) that specified restrictions for the sale and use of aggregate material for surfacing applications (CARB 2001, reviewed in 2008). The CARB 435 method provides a value related to the surface area projection of particles, not a true concentration. Restrictions for surfacing applications are placed at 0.25%. After several years of review and study, CARB conducted extensive tests and updated protocols in the CARB 435 Implementation Guidance Document (CARB, 2017). One improvement was increasing the sample frequency to a minimum of three random grab samples per 1000 tons. It goes on to state: *"In situations of observed aggregate heterogeneity, such as notably different rock types that may indicate variable sources of aggregate material, ARB staff recommends collecting more than the minimum of three grab samples, each consisting of about 20 to 30 increments".*

Although the sampling frequency meets the minimum CARB requirement for the use of material for surfacing applications, such as use on the surface of a highway embankment, the frequency is too low to provide assurance for material being processed and hauled through residential or commercial areas.

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Also note that the CARB 435 test uses PLM as the required microscopic method. As discussed above, PLM cannot detect fine particles, and if potential health risk is the issue, TEM should be employed as well.

It should be emphasized that the concentration of asbestos in rock cannot be equated to the potential for airborne asbestos. EPA has determined that very low concentrations in rock and soil can result in elevated airborne concentrations resulting in adverse exposures to the public. Based on this determination, the California Department of Toxic Substances Control uses a threshold of 0.01% by weight, measured by TEM, as a threshold for response actions such as capping and long-term NOA management on school sites.

The most direct way to assess the potential for airborne emissions of asbestos is through direct air testing using TEM. CARB specifies air testing as follows: "*Analysis of all air samples shall follow the analytical method specified by the United States Environmental Protection Agency, Asbestos Hazard Emergency Response Act (AHERA) criteria for asbestos (40 CFR, Part 763 Subpart E, Appendix A, adopted October 30, 1987), with the following exceptions: (A) The analytical sensitivity shall be 0.001 structures per cubic centimeter (0.001 s/cc); and (B) All asbestos structures with an aspect ratio greater than three to one (3 to1) shall be counted irrespective of length".* This is what is referred to as the CARB/AHERA method using TEM, and is the standard practice on NOA sites.

Area-specific air monitoring may assist at areas where high disturbance activities occur. One example, is the rock crushing facility. At the Calaveras Dam project, the Certified Industrial Hygienist for the Contractor measured high emission rates, airborne asbestos concentrations, and personal exposures associated with rock crushing operations. The concern for worker exposure and potential unacceptable asbestos concentrations at a nearby perimeter monitoring station, combined with logistical challenges, led the Contractor to discontinue crushing operations and instead import aggregate material for finger drains, blanket drains, chimney drains and lateral filters during dam construction.

It is recommended that, in place of additional testing above that required to achieve a sample set that is representative of each rock unit, the air monitoring program include Construction Area Activity monitoring near the points of major rock disturbance and locally where the generation of dust may impact offsite receptors. This system was successfully used at the Calaveras Dam project. Three areas that would benefit from this second layer of air testing would be at the rock crushing facility, surrounding the primary quarrying area during all disturbance activities, and along roads where hauling of material may track out NOA onto the public streets. Air samples should be collected and tested by the CARB/AHERA TEM method, not PCM by the NIOSH 7400 method which is designed for worker exposure.

<u>Boulder Field</u>

The boulder field is not processed aggregate, and is more aligned with the undisturbed rocks at the site. It is recommended that the approach for investigation be included into the site survey as a separate unit. The approach and frequency of sampling should mirror the overall investigation, and an independent data set be collected. The boulders should be inspected for differences in lithology, color, texture, mineralogy, and each sub unit be sampled and tested independently. The number of samples should not be tied exclusively with the tonnage of material. Rather, the sample set for each sub-unit should be adequate to characterize the materials and be considered representative of each material. It is appropriate, considering that these materials are now out of place, to use the frequency as a guide and use the three samples per 1000 tons as a lower limit. This frequency may not achieve representativeness, and more samples would be required. Once the material is processed, an additional test by CARB 435 protocol will be required for this material that consists of a composite of each geologic unit that is represented in the volume of rock processed.

Summary of Recommended Procedures for NOA Sampling and Testing

The QGSSP as written is procedurally and technically flawed, and should be revised to meet a standard of practice for a geologic investigation for NOA. While the standard of practice may vary from site to site, the standard should be elevated due to the intensity of rock disturbance during quarrying operations and the close proximity to residential receptors. The procedures employed at the Calaveras Dam and Boulder City Bypass projects should provide the model. Both projects were completed successfully, with all challenges that come with unforeseen conditions solved. If no asbestos is present, or sufficiently low concentrations that would not drive significant response actions are present, then the geologic investigation should produce sufficient, complete and accurate data to provide a high level of confidence that this is the case.

The following is an outline of the sample procedures and testing requirements recommended to meet the project goals:

- A thorough geologic survey should be conducted to identify each lithologic and structural unit "homogeneous area" that may contain different compositions or concentrations of amphiboles. Differences with in the diabase such as grain size, color, composition, presence of xenoliths, veining, ductile and brittle shearing, and other units that can be distinctly broken out or mapped should be tested independently.

- Duplicate samples should be set aside for quality assurance purposes.

- Each unit should be sampled using both incremental and targeted methods. Sample frequency should be a minimum of three samples from small volume units such as xenoliths, to a minimum of ten for large volume units. If the diabase is relatively homogeneous, then the frequency should be elevated to 30 or more incrementally composited samples. Units of particular concern such as the green veining should be sampled at a higher frequency to characterize differences across the site because of the geologic conditions operating during vein formation is not known, veining may have occurred over a large period of time (perhaps millions of years) during a phase where fluid processes and chemistry is changing, and visual inspection may not be adequate to differentiate significant mineralogic and chemical differences of veins that appear to be similar. In each case, the frequency should be sufficient to collect a sample set that is representative of the unit, and sufficient to characterize differences that may not be visually apparent.

- The out of place rocks comprising the boulder field should be sampled as per the site materials, but considered a separate unit. Because they are out of place, it is appropriate to use the frequency as a guideline for minimum sample frequency, but the overall objective is to collect a sample set of each lithologic and structural unit that is representative of those units.

- To address concerns for potential exposure, the sampling of processed aggregate material should be at a higher frequency than the three per 1000 tons (minimum) requirement specified in the CARB 435 guidance document.

- Samples should be prepared by the CARB 435 method and CARB 435 guidance document, with milling by a disc pulverizer. The milled samples should be mixed by using a four-axis mixer to prepare a homogeneous sample.

- Samples should be tested using both PLM, using the CARB 435 method, and TEM, using the EPA 600/R-93/116 and CARB-modified bulk TEM protocol modified for NOA analysis (CARB/AHERA method). Amphibole fibers by PLM should not be excluded from reporting on the basis of inclined extinction. Amphibole structures by TEM should not be excluded on the basis of a chemical dissimilarity with those in building materials or reference materials for building materials. All amphiboles should be included in the analysis, and each should be identified per the International Mineralogical Association classification system.

- Water samples should be analyzed using EPA Method 100.1, using the same mineralogical classification specified above for rock samples.

- Air samples that are not for personal protection purposes should be sampled and analyzed by the AHERA method, with the same requirements for mineralogical classification specified for rock samples.

- It is recommended that thin sections of each rock unit be prepared for petrographic analysis. The analysis of the minerals *in situ* is a powerful technique to investigate the presence of fine structural detail such as fibrous overgrowths coexisting with non-asbestiform minerals, asbestos in micro-veins, and other microstructural features.

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Appendix

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