DEPARTMENT: POLLUTION CONTROL AGENCY

STATE OF MINNESOTA
Office Memorandum

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TO: MPCA Advisory Committee Members

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SUBJECT: Proposal Regarding Airborne Mineral Fibers Emitted by Northshore Mining Company

I. Status

The Minnesota Pollution Control Agency (MPCA) is proposing to change how it regulates airborne particles, called "Minnesota fibers" or "fibers," emitted from Northshore Mining Company (Northshore). Specifically, the MPCA is proposing to remove the current fiber requirement from Northshore's air permit, referred to as the Control City Standard, and replace it with new requirements that limit concentrations of fibers in the ambient air around the facility.

Due to the long and complex history of the fiber issue at this facility, MPCA staff is seeking guidance from the Advisory Committee on the proposal before proceeding with any formal action.

II. Background

Northshore owns and operates a taconite ore mine near Babbitt and a processing plant in Silver Bay, Minnesota. Low-grade taconite ore from the mine is transported via rail to the processing plant. There, the ore is crushed into a fine powder, the iron-containing particles are separated from the mostly non-iron tailings, and formed into marble-sized taconite pellets. Taconite pellets are shipped from Minnesota to blast furnaces in the lower Great Lakes and made into a variety of steel products.

Due to the unique geology of the far eastern side of the Mesabi Iron Range where Northshore's mine is located, its ore contains minerals called amphiboles. When the ore is processed amphibole mineral particles, fibers, are released. Northshore is the only taconite operation in the state that mines ore containing amphibole minerals.

What is a fiber?

Amphibole minerals are of interest because they can occur in different physical forms depending on the geologic conditions when they developed. They can occur as long, thin, flexible particles. These types of amphiboles have physical and chemical properties which make them of commercial value, but also have well-defined and serious health risks. Alternatively, amphibole minerals can also occur as short, wide, inflexible particles, such as the majority of the fibers emitted from Northshore. It is unknown whether these short fibers have a health risk.

View of an amphibole mineral particle on a filter using a Transmission Electron Microscope (TEM). Source: Dr. Philip Cook, PhD., U.S. EPA NHEERL Mid-Continent Ecology Division

For a more detailed, technical discussion about research on the health implications of exposure to fibers, see Attachment 1.

Long fibers are commonly regulated as asbestos. Many federal agencies have occupational standards that limit exposure to protect health. The majority of the fibers emitted by Northshore are too short to fit within the definition of the fibers regulated by those standards and there is no health-based fiber standard that applies. See Attachment 2 for more information about existing federal and State regulations controlling exposure to airborne fibers.

Origin of the Control City Standard

The history of regulating fibers at this facility dates back to the mid-1970s. There were a series of court cases involving the Reserve Mining Company, which owned the facility at the time. Although the legal proceedings began because of Reserve's disposal of tailings into Lake Superior, the deliberations eventually focused on the potential health impacts of ingesting and inhaling amphibole mineral fibers. The scientific and medical evidence presented did not provide a clear answer whether there was a defined health risk. Instead, the court fashioned a standard, called the Control City Standard, which for the first time, limited concentrations of airborne fibers in Silver Bay. The Control City Standard required that the ambient air in Silver Bay contain no more fibers than that level ordinarily found in the ambient air of a control city such as St. Paul. The Control City Standard was adopted into the facility's Silver Bay permit and has remained essentially unchanged for the last 40 years:

> With respect to fibers, the air quality standards at or beyond the property line of the Silver Bay facility to which the Permittee shall adhere, consistent with the determination of the Minnesota Supreme Court, are:
>
> a. Fibers in the ambient air shall be below a medically significant level;
>
> b. The ambient air shall contain no more fibers than that level ordinarily found in the ambient air of a control city such as St. Paul;
>
> c. The fibers in the ambient air shall be maintained below a level which is injurious to human health or welfare in violation of Minn. Stat. Sec. 116.06 (3); and
>
> d. Such other standards which now or in the future may be applied to the Permittee's fiber emissions.
>
> The MPCA recognizes that the above fiber level standards or measurements applicable to fiber emissions emanating from the Permittee's operations are to be determined in the future to a degree which approaches reliable scientific and medical precision.
>
> The control city standard set forth in paragraph (b) was found by the federal courts to be based on a reasonable medical theory. Any future fiber level standards applied pursuant to paragraphs (a), (c) and (d) must likewise be based on a reasonable medical theory.
>
> "Fibers," for the purpose of this permit, are defined as chrysotile and amphibole mineral particles with 3-to-1 or greater aspect ratios.

If you are interested in the historical events that have shaped the way fibers are regulated in Minnesota, please see Attachment 3, Historical Background on Fibers in Minnesota.

Present Day Control City Standard

Ambient monitors near Northshore measure fiber concentrations in the air. Northshore operates two fiber monitors, one near Silver Bay and one near Beaver Bay. The MPCA operates an ambient fiber monitor in St. Paul. The samples from each of these monitors are sent to a third-party lab for microscopic analysis. The results of the Silver Bay and Beaver Bay monitoring are compared to St. Paul to determine if Northshore is in compliance with the Control City Standard.

While the Control City Standard serves to limit ambient fiber concentrations in Silver Bay, over the past 40 years several limitations with the standard have been identified:

- Fiber concentrations in St. Paul vary over time and thus the Control City Standard is constantly changing. If fiber concentrations in St. Paul decrease, the allowable ambient concentration applied to Silver Bay and Beaver Bay also decreases. If fiber concentrations in St. Paul increase, the allowable concentrations of fibers in Silver Bay and Beaver Bay also increase. Standards are often reconsidered and revised based on new science, but it is highly unusual to set a standard that may vary unpredictably and is arbitrarily based on the levels found in another location.

- The concentration of fibers that will comply with the Control City Standard is not known until after the ambient air monitoring samples are collected, sent to a lab for analysis, results are reported, and concentrations for the locations are calculated. The time between when fibers are monitored and when concentrations are calculated can be months. This makes it difficult for Northshore to anticipate how the concentrations of fibers around its facility compare to those in St. Paul. Additionally, Northshore cannot change its operations in an attempt to reduce fiber concentrations until after compliance is determined, long after the fiber samples were collected.

- The Control City Standard does not specifically address whether the fiber concentrations in the ambient air in Silver Bay, Beaver Bay, or St. Paul pose a health risk to the populations. The Control City Standard is not a traditional health-based standard in that the level is not a result of an evaluation of the potential risks of fibers to human health. The purpose of the Control City Standard was only to ensure that the residents of Silver Bay and Beaver Bay are not exposed to a greater concentration of fibers in the ambient air than the residents of a city not affected by taconite mining.

- Historical fiber monitoring data has shown that the predominant fiber type that makes up the fiber population found in the ambient air in St. Paul is chrysotile, while ambient fiber concentrations identified near Northshore primarily consist of the amphibole mineral fiber type. This results in comparing the ambient concentration of two different fiber populations that have potentially different health implications.

- The federal court provided no guidance on how the Control City Standard should be implemented, including how compliance with the standard is determined. MPCA has developed an interpretation on how to determine compliance, but this compliance method has not been made enforceable within the permit. This makes it challenging to enforce any exceedance of the Control City Standard.

On December 20, 2007, the United States District Court for the District of Minnesota ruled that the federal injunction (the Control City Standard), established in the 1975 Reserve Mining Court decision, no longer had any force or effect. The Agency has relied upon the federal injunction as a basis for including the control city standard in the air permit. The court decision had no impact on the permit but this ruling makes future regulation of fibers at Northshore a state-only issue.

In 2008, and again in 2013, Northshore has submitted requests to remove the Control City Standard and related fiber air monitoring from its air quality permit. However, the MPCA believes that some regulation of fibers at the facility is required.

Fiber regulation proposal

Absent a more traditional health-based standard, the MPCA believes there is a need to improve upon the limitations of the Control City Standard. So, it set out to construct a new regulatory method that would limit

concentrations of fibers in the communities of Silver Bay and Beaver Bay, be well defined and unambiguous, and be practical for Northshore to follow and implement.

Below is a list of the key elements of the MPCA's proposal followed by parentheses with references to where more detail on the MPCA's proposal for regulating fibers can be found in Appendix 4:

- Continue all existing control measures that prevent and limit concentrations of fibers (Attachment 4, page 2-3, Fiber Minimization Plan).

- Establish an Action Level; a set concentration of fibers in the ambient air that, if exceeded, requires additional control measures to attempt to reduce the release of fibers until they are less than the Action Level (Attachment 4, page 3-5, Fiber Action Level).

  The MPCA is proposing an Action Level of 3,300 fibers/m^3, a statistically derived value using ambient monitoring data from Silver Bay and Beaver Bay. It is representative of an upper bound of average fiber concentrations.

  The Action Level intentionally does not include the language of a "standard," as this would imply that it was based upon health risk information, which is not available. Although recent ambient fiber concentrations in Silver Bay and Beaver Bay have not been associated with an increased risk of asbestos related diseases within the surrounding communities, the Action Level is not based upon a human health risk data and should not be interpreted as such. The Action Level was developed to determine whether the fiber prevention and control measures being implemented by Northshore are working effectively to prevent fiber emissions and to limit concentrations in the ambient air.

- Maintain a plan, called the Action Level Exceedance Plan, containing the additional control measures that Northshore will implement if the concentration of fibers exceeds the Action Level (Attachment 4, Page 3, Action Level Exceedance Plan [ALEP]).

  The additional control measures in the Action Level Exceedance Plan are categorized into two tiers. The first tier will consist of actions that are quick to implement and will have an immediate impact on lowering fiber concentrations. If those actions are not successful in reducing fiber concentrations below the Action Level, Northshore must implement the second tier control measures. Second-tier control measures are actions that are predicted to require a longer period of time to implement and would require a longer period of time to have a measureable effect on fiber concentrations.

- Retain and strengthen existing fiber monitoring requirements to be in accordance with current-day expectations for ambient air monitoring (Attachment 4, Page 5-6, Fiber Monitoring Requirements).

MPCA staff consulted with the Minnesota Department of Health on its proposal and sought their concurrence before proceeding.

Next steps

In addition to seeking advice from the Advisory Committee, the MPCA is seeking feedback from Northshore and the Minnesota Tribal Nations. Less formally, the MPCA is engaging with parties who've previously been involved in fiber-related matters in the state, including Save Lake Superior Association, the University of Minnesota School of Public Health, and a group of federal agencies including the Environmental Protection Agency, the Center for Disease Control, and Agency for Toxic Substances and Disease Registry. The MPCA intends to collect and consider feedback from these stakeholders before it decides how to proceed.

Any change to how fibers are regulated at Northshore would require a major amendment to its air permit. The major amendment process has a formal period for public notice, where a draft permit is available for public review and comment. The MPCA would host a public informational meeting in Silver Bay during a formal public notice period. After public notice, a permit is typically revised to reflect any changes that result from comments.

III. Issues

A. Does it make sense to change how the MPCA currently regulates emissions of fibers from Northshore?

B. Absent a health based fiber standard, is MPCA's proposal an adequate replacement for the Control City Standard?

C. Have we engaged with the appropriate stakeholders? Are there others we should discuss this issue with?

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Attachments

- Attachment 1, Fiber Health Risks
- Attachment 2, The Regulation of Fibers
- Attachment 3, Historical Background on Fibers in Minnesota
- Attachment 4, Proposal for Regulating Fibers

Fiber Health Risks

Northshore mines ore from the Peter Mitchell mine pit located in the far eastern region of the Mesabi Iron Range, a geological area known to contain amphibole minerals. The following is a detailed technical discussion about the type of amphiboles in Northshore's mine pit and the research that has been done to understand health risks from these and other types of fibers.

Geology and Fibers at Northshore Mining

The Advisory Committee memo describes two different types of fibers in Northshore's ore body; long, thin, and flexible fibers and short, wide, inflexible fibers. More precisely, fibers are inhalable mineral particles that either occur in an asbestiform habitat (e.g., long, thin, fibers, such as asbestos) or in a non-asbestiform habitat (e.g., short, wide, inflexible fibers).

From a mineralogical perspective, an asbestiform mineral is chemically and elementally identical to its non-asbestiform analogue. The distinction between an asbestiform fiber and its non-asbestiform analogue begins with the geologic conditions in which the particular mineral crystal developed, which in turn affects the physical morphology and shape of the crystal. The term 'habit' is a general description given to the external shape and appearance of the formation of a mineral crystal.

Minerals that form in an asbestiform habit develop in a one-dimensional linear arrangement. This results in asbestiform minerals having long, flexible, poly-filamentous bundles that separate along grain boundaries between fibrils. Such physical properties are commonly associated with that of regulated asbestos and have contributed to the physical and chemical properties that made them commercially relevant. These properties include thermal, chemical, and electrical resistivity, which made them widely used in residential, commercial, and industrial applications where these material characteristics were desired. Conversely, non-asbestiform mineral crystals form in multiple dimensions that often results in 2-dimensional cleavage planes within the crystal. Non-asbestiform minerals do not share the same properties that made their asbestos analogs commercially sought after, thus reducing their direct commercial significance.

The non-asbestiform type of amphibole mineral is much more common than the asbestiform variety and this generalization holds true for the amphibole types found within the Peter Mitchell pits. The predominant form of amphibole minerals found in the Peter Mitchell ore is identified as non-asbestiform, whereas the asbestiform type makes up less than 1 percent of the total amphibole minerals found within the ore. The amphiboles in Northshore's mine are categorized as belonging to the cummingtonite-grunerite series, but also includes some actinolite and hornblende amphibole minerals.

Health Risks with Exposure to Mineral Fibers

There continues to be a lack of consensus surrounding the toxicity of non-asbestiform mineral particles and what parameters and doses of this fiber type contributes to toxicity. The Minnesota Department of Health (MDH) recognizes that a traditional health-based standard, applied to the specific type of amphibole fiber found in ambient air around the Northshore Mining facility, is the typical approach to establishing a medically significant level of exposure. The proposed Action Level does not establish a medically significant level of exposure, nor does it include the language of a 'standard', as this would imply that it was based upon health risk information which is not available. Although recent ambient fiber concentrations in Silver Bay and Beaver Bay have not been associated with an increased risk of asbestos related diseases within the surrounding communities, the Action Level is not based upon a human health risk data and should not be interpreted as such. The Action Level was developed to regulate fibers at a reasonably achievable, low level. The Action Level provides a means to determine whether the fiber prevention and control measures listed in the FMP and being implemented by Northshore are working effectively to prevent fiber emissions and to limit concentrations in the ambient air.

Research on the health implications of exposure to fibers requires an interdisciplinary approach involving many areas of the medical and environmental health sciences. Epidemiological studies have already indicated a causal relationship between exposure to asbestiform mineral fibers that are inhaled and the development of respiratory diseases that include asbestosis, mesothelioma, and lung cancer (it should be noted that the fibers emitted at Northshore are primarily non-asbestiform). In vivo animal studies and in vitro studies have added to the understanding of the possible mechanisms of toxicity. The dose, mineral type, dimensional parameters (e.g. length, diameter, and aspect ratio), physicochemical properties, and structure of a mineral fiber are clearly important determining factors of toxicity. How different physical properties translate into specific toxicity endpoints is still uncertain and part of ongoing research.

Most studies that have defined a specific health risk have been conducted on long fibers. There are some researchers that maintain that short fibers should not be dismissed as having no biological relevancy in respiratory toxicity. A 2009 report produced for the Minnesota Department of Natural Resources provides an extensive toxicological literature review of published research on asbestos-related diseases and the risks associated with exposure to long and short amphibole mineral fibers. This review identified multiple peer-reviewed studies that concluded that short fibers (<5 µm) should be considered to possess a potential for toxicity and carcinogenic risk. This report provides a much more thorough review of the published research on the potential risks associated with exposure to non-asbestiform mineral particles than can be provided here.

Even with results from these studies, a lack of consensus remains among the health regulatory and scientific communities on what conclusions can be drawn and what generalization can be made on the health effects of exposure to non-asbestiform mineral fibers, such as the fibers emitted from Northshore. National Institute for Occupational Safety and Health (NIOSH) has noted that the dimensional criteria used to define an elongate mineral particle as a 'countable fiber' for regulatory purposes has often not been based solely upon health research. There may also be an over-emphasis on fiber dimension as the parameter most associated with toxicity, while other physicochemical parameters are emerging as possible important contributors to toxicity as well. NIOSH uses the broadest definitions of fibers of any federal agency but notes that more work is needed to better understand the defining parameters of toxicity associated with exposure to mineral particles of all types. NIOSH provides an outline of its recommendations for future research on mineral particles in its 2011 report titled *Asbestos Fibers and Other Elongate Mineral Particles: State of the Science and Roadmap for Research*.

Any determination of fiber toxicity should be based on biological activity and the parameters of the fiber that determine toxicity (e.g. deposition in the lung, fiber translocation, retention, durability, fiber dimension, physio-chemistry etc.). One issue still under debate is over the long held belief that fibers equal to or greater than 8 µm in length and less than or equal to 0.25 µm in width are the predominant dimensions that exhibit a significant toxicological effect. These dimensional properties are associated with the "Stanton Hypothesis" in reference to the highly cited in-vivo animal studies by Mearl F. Stanton in 1981. One hypothesis for the observed toxicity is that alveolar macrophages are less able to effectively dissolve long fibers which may account for their high durability in the lung. In a 2001 Agency for Toxic Substances and Disease Registry (ATSDR) report on the toxicological profile of asbestos, ATSDR recognized that while there is strong evidence provided from in vivo and in vitro studies to support the argument that longer fibers are more carcinogenic than short fibers, there exists an unknown potential of shorter fibers, less than 5µm in length, to contribute to the development of disease. The majority of the fibers at Northshore are less than 5µm in length.

Limitation on Comparability of Health Data

There is no standard definition of a fiber, and current analytical methodologies do not have the ability to accurately distinguish between asbestiform and non-asbestiform fibers. Because of this, it is difficult to make direct comparisons between the results of studies using different definitions of a fiber and employing differing analytical methods (NIOSH 2011). It has been reported that the majority of fibers in the ambient air in Silver Bay and Beaver Bay are predominantly of the non-asbestiform type and shorter than 5 microns. The biological significance of exposure to airborne short fibers of these mineral types can be difficult to ascertain. The applicability of current health data on non-asbestiform fibers is often limited by use of microscopic methods that exclude shorter fibers from their fiber counting procedure. When

reviewing results from published studies, it should be recognized that many analytical methods may use a minimum length cutoff of 5 μm for the fiber counting procedures. This length cutoff was often chosen for the convenience of optical microscopic evaluation. For many epidemiological and experimental studies where fiber characterization is a part of exposure assessments, fibers shorter than 5 μm in length have often not been considered. Although TEM is the preferred method of measuring fiber concentrations, because many health studies and asbestos standards have been based on PCM methods, quite often health effects are reported in terms of PCM concentrations.

Libby Asbestos

When the public hears "fibers," they may automatically think about Libby, Montana, where excess rates of lung cancer and non-malignant respiratory disease were found as a result of a nearby vermiculite mine which exposed mine workers and residents to mixed amphibole asbestos, called Libby Asbestos, contained in the ore. From the experience with Libby amphiboles, exposure to airborne mineral fibers generated from the crushing and fracturing of non-asbestiform amphibole minerals has been of substantial interest to the public health community. But due to the differences in the minerology of the fibers, it is not accurate to apply Libby human health risk data to Silver Bay. The MPCA does not believe Libby and Silver Bay are analogs, because unlike primarily non-asbestiform Minnesota Fibers, the Libby vermiculite ore contains a complex blend of fibrous and asbestiform amphibole minerals, occurring in veins throughout the deposit.

Excess Cases of Mesothelioma in Northeastern Minnesota and Iron Miners

In 1997, it was first reported by the Minnesota Cancer Surveillance System (MCSS) that between 1988 and 1994, the rate of mesothelioma among men in Northeastern Minnesota was 70 percent greater than the statewide average for the disease. An updated MDH report in 2003 of MCSS data continued to show an excess of mesothelioma within this same group at 81 percent greater than the statewide average. A follow up report and case-series study published in 2008 linked the MCSS data with data provided from the Minnesota Iron Miner Cohort in order to investigate cases of mesothelioma among former iron miners. The study identified a link between developing mesothelioma and employment in the iron mining industry.

The study also concluded that occupational exposure to asbestos from employment within and outside the taconite mining industry was the "likely" cause of the excess of mesothelioma cases. However, the authors also point out that the excess risk is "not solely attributable to exposure within the mining workplace" and that the study did not address any potential health risks associated with exposure to respirable mineral dust, that include short fibers.

MDH has identified a number of factors that may be contributing to the elevated incidence of mesothelioma in that part of the state. In addition to the possible role of mining-related work, they also cite the experience of workers at the former Conwed facility in Cloquet, which made asbestos tile from 1958 to 1974. MDH officials have emphasized that, based on the available evidence, the elevation in mesothelioma cases in Northeastern Minnesota is most likely an occupational health concern, and does not reflect any increased risk for the broader community. They point to the fact that the elevation in mesothelioma rates is only occurring in men, while women in the region have actually been experiencing lower than expected mesothelioma rates. Officials have said this pattern suggests that the elevation reflects something people were exposed to in the workplace, rather than community-wide.

Thus a lack of consensus remains among the health regulatory and scientific communities on what conclusions can be drawn and what generalization can be made on the health effects of exposure to primarily non-asbestiform mineral fibers, such as the fibers emitted from Northshore.

Minnesota Taconite Workers Health Study

In 2008, the Minnesota Legislature funded the University of Minnesota School of Public Health to conduct a study investigating the excess number of mesothelioma cases among Minnesota taconite workers. The study, named the Taconite Workers Health Study (TWHS), was designed to assess questions relating to the occupational risks associated with developing mesothelioma among taconite workers. The study was concluded and final report submitted to the

Minnesota Legislature on November 24, 2014. One of the overall findings of the TWHS was that workers with above-average exposure to dust containing mineral particles were twice as likely to develop mesothelioma as workers exposed to below average exposures, though the overall incidence of mesothelioma was low compared to other disease frequencies.

The TWHS was made of five different component studies, each designed to accomplish a different study goal; Occupational Exposure Assessment, Mortality (cause of death) Study, Incidence Studies, Respiratory Health Survey of Taconite Workers and Spouses, and Environmental Study of Airborne Particulates (not yet released).

The Occupational Cohort Mortality Study component conducted a standard analysis of the causes of death in a taconite worker cohort. It found that workers in the cohort had higher than expected death rates from mesothelioma, lung cancer, and heart disease when compared to the general population of Minnesota. The conclusion of the Mortality Study component found that occupational exposure to mineral particles may be associated with increased risks of occupational disease development, but that non occupational exposure may also be important contributors.

The Incidence Studies component sought to determine whether employment in the taconite industry, and more specifically exposure to dust from taconite mining and processing, is related to developing certain diseases, such as mesothelioma, lung cancer or other non-malignant respiratory diseases. The result of a mesothelioma case-control study found that mesothelioma was associated with the length of time employed in the taconite mining industry, and also with the cumulative exposure to mineral particles. The case-control study of lung cancer found that exposure to dust from taconite operations is not supported as a cause of the excess lung cancer. No significant relationship was found between lung cancer and cumulative exposure to mineral particles.

The respiratory health survey component found a link between exposure to mineral particles and dust-related scarring of the lung and pleura among workers, but found no increase in scarring or increased risk for lung disease among the spouses of workers compared to the broader general public. A survey of spouses of taconite workers was included in the survey because of the possibility of spouses being exposed to both environmental ambient sources of fibers as well as to occupational “take-home” fibers brought home by their spouses. As a group, spouses showed a low frequency of lung disease that was comparable to the general public. The study report states that the current exposure potential in the communities surrounding the taconite mining and processing industries appears to be low based on the findings.

One limitation of the study’s design is that it does not allow a relationship to be made between the level of environmental or non-occupational exposure to mineral particles and the risk of developing mesothelioma, lung cancer, or non-malignant lung disease. Even with attempts to control for the effect of exposure to commercial asbestos, the study investigators were unable to conclusively state whether the association between fiber exposure and mesothelioma was due primarily to exposure to ore dust or commercial asbestos.

These studies were not able to resolve any outstanding questions regarding the potential role mineral particle size fraction have on health outcomes. Furthermore, the study was not designed to establish values of toxicity for different size categories of mineral particles, nor did it evaluate parameters of potential fiber toxicity, such as fiber length, diameter, aspect-ratio, surface area, physio-chemistry, or fiber mineralogy.

The study was not designed to evaluate the possibility of non-occupational environmental exposure as a potential source of community health concerns. The results also suggest that under current levels of community exposure, there does not appear to be an increased risk for developing the diseases associated with exposure to mineral particles or fibers beyond what would be expected in the general population.

Analyses showed an unexplained contrast between mineral particle exposures and mesothelioma incidence, showing higher rates of mesothelioma in the western most portion of the Mesabi Iron Range compared to east. Northshore’s mine is on the east end of the Mesabi Iron Range. In light of this study’s conclusions, limitations, and suggestions

provided by the investigators, it remains appropriate to continue to limit the public's exposure to fibers in the ambient air.

2003 International Fiber Symposium

On March 30 - April 1, 2003 the "International Symposium on the Health Hazard Evaluation of Fibrous Particles Associated with Taconite and the Adjacent Duluth Complex" was held in St. Paul, Minnesota to address unanswered questions about the health effects of fibers that occur on the eastern end of the Mesabi Iron Range. The symposium was organized by the Minnesota Blue Ribbon Committee on Mining and Minnesota's Mineral Coordinating Committee.

Some issues raised within the symposium and recorded in the published proceedings conflicted directly with the State's analysis of risks from Minnesota Fibers. A response to these concerns by former commissioners of the MDH and MPCA are stated in a letter to Dr. Gio Batta Gori, Editor of the Journal Regulatory Toxicology and Pharmacology written on January 20, 2009. The response stated that the agencies did not agree with the conclusions from the risk assessment developed by Wilson et al, which was included in the published symposium supplement. Furthermore, the commissioners did not agree with or support the symposium's conclusion that amphibole fibers are not associated with any health effects. The State did not participate in the development of this risk assessment, nor was anyone from the State involved in the review of the research presented at the symposium. The State felt that the proceedings did not represent the entire body of research presented at the symposium. While some valuable papers were presented at the symposium, not all were published.

The evidence provided in the published proceedings did not resolve the question regarding health risks from exposure to the types of particles characteristic of those emitted from processing taconite ore from the Peter Mitchell mine (the mine associated with the Northshore facility) or ore from the nearby Duluth Complex to the State's satisfaction. Resolving this question is critical if a health based standard for these particular fibers is ever developed.

The Regulation of Fibers

Federal and State regulations controlling exposure to airborne fibers have been in existence for multiple decades. Each agency defines what constitutes a 'countable fiber' under its specific regulatory goals and responsibilities. The definition of a mineral fiber for specific regulatory purposes has historically been constrained by the analytical counting method used to identify and quantify fibers in environmental samples, and is subsequently not based on the toxicological significance of the fiber in question.

Most existing fiber standards cannot be appropriately applied to ambient fiber concentrations in Silver Bay and Beaver Bay because they evaluate a different type of fiber and consider different types of exposures. Existing fiber regulations would exclude the majority of Minnesota Fibers because they're focused on limiting regulated asbestos concentrations and exclude short fibers, which comprise a significant portion of Minnesota Fibers in Silver Bay and Beaver Bay. Also, most existing fiber related regulations are intended to protect workers from occupational or short-term exposures to fibers, and not the long-term, environmental exposure setting experienced by the general population. And, generally, ambient concentrations of fibers in the community setting are significantly lower than in the associated occupational setting.

Analytical methods that employ Phase Contrast Microscopy (PCM) continue to be widely used to quantify fibers for most federal regulatory purposes. PCM does not have the ability to distinguish between asbestiform and non-asbestiform fibers and are unable to identify very thin fibers (< 0.25 µm in diameter). Methods involving the use of scanning electron microscopy (SEM) or transmission electron microscopy (TEM) can resolve very thin fibers and can be coupled with other techniques for mineral identification.

Ambient fiber monitoring is conducted in both Silver Bay and Beaver Bay. The monitors collect 96-hour (4 day) samples once every 12 days. The filters are sent to a third party lab to analyze the concentration and composition of fibers captured on the filters using a TEM.

The MPCA analyzed the 2013 monitoring data to understand the type of fibers found in the ambient air in Silver Bay and Beaver Bay. The monitoring data confirmed that airborne fibers reflect the composition found in the Peter Mitchell mine; the majority of amphiboles being cummingtonite-grunerite with some actinolite and hornblende.

Data about the physical characteristics of airborne fibers indicates that nearly all of the Minnesota Fibers found in the ambient air would not be classified as asbestos, as described below. Minnesota Fibers are shorter than regulated asbestos; the majority (89 percent) of the Minnesota Fibers on each filter were less than 5 µm in length, 11 percent were between 5-10 µm, and there was one fiber at each monitor during the year that exceeded 10 µm (both cummington-grunerite; one 11 µm and one 13 µm). Minnesota Fibers tend to have aspect ratios (length: width) less than regulated asbestos. Aspect ratios of the fibers on the filters were most commonly between 3:1 and 5:1 (43 percent), 42 percent are between 5:1 and 10:1, 14 percent are between 10:1 and 20:1, and less than 2 percent are greater than 20:1.

Occupational Safety and Health Administration (OSHA)

The first national asbestos standard was established in 1972 through the Occupational Safety and Health Administration (OSHA) (29 C.F.R. § 1910.1001). OSHA recognizes six regulated forms of asbestos that must meet the dimensional criteria of at least 5 µm in length with an aspect ratio of greater than 3:1 to be counted as a fiber. These regulated minerals include chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, and actinolite asbestos. OSHA makes a distinction between asbestiform and non-asbestiform fibers and does not establish an occupational permissible exposure limit (PEL) for the non-asbestiform types. Although OSHA chose not to include non-asbestiform

fibers in their asbestos regulation, they stated in their final ruling for Occupational Exposure to Asbestos, Tremolite, Anthophyllite and Actinolite that that the "evidence suggests the existence of a possible carcinogenic hazard and other impairing non-carcinogenic adverse health effects" with respect to non-asbestiform fibers (OSHA 1992). They also maintained that the available evidence at the time of rulemaking fell short of any conclusion on this issue of non-asbestiform fibers. OSHA has established a time-weighted average PEL of 0.1 fiber/cm^3 (100,000 fibers/m3) over an 8-hour period and an excursion limit 1.0 fibers/cm cm3 (1,000,000 fibers/m3) as averaged over a sampling period of thirty (30) minutes for asbestiform chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos. In its final rules for asbestos exposure limits, OSHA maintained that the PEL of 0.1 f/cm^3 leaves a remaining significant risk of material impairment of health or functional capacity but that this level is the lowest level to feasibly quantify fiber concentrations in a reliable manner. Additionally, these limits are based on OSHA-required analytical methods that include counting only fibers with a length greater than or equal to 5 µm.

Approximately 89 percent of the Minnesota Fibers in Silver Bay are less than 5µm in length so this definition would exclude the majority of Minnesota Fibers. Additionally, these limits are specific to occupational, short-term exposures to fibers, and not the long-term, environmental exposure setting experienced by the general population. Generally, ambient concentrations of fibers in the community setting are significantly lower than in the associated occupational setting. As a result, this standard cannot be applied to the ambient air in Silver Bay.

National Institute for Occupational Safety and Health (NIOSH)
In 1990, NIOSH revised its recommendation concerning occupational exposures to airborne asbestos fibers. At issue were concerns about potential health risks associated with worker exposures to short fibers and other non-asbestiform elongate mineral particles (EMPs). Another issue was the inability of the NIOSH 7400 analytical method, the method routinely used to characterize airborne exposures using PCM, to differentiate non-asbestiform EMPs from asbestos EMPs on the basis of physical appearance. To address these concerns and ensure that workers are protected, NIOSH has defined "airborne asbestos fibers" to encompass not only asbestiform fibers from the six listed asbestos minerals (chrysotile, crocidolite, amosite, anthophyllite, tremolite, and actinolite) but also EMPs from their non-asbestiform analogs, including any short fibers produced from these regulated minerals. NIOSH based the inclusion of non-asbestiform EMPs on the following factors; 1) evidence for excess lung cancer risk attributable to exposure to non-asbestiform EMPs, 2) evidence that carcinogenic potential may depend on a mineral particle's length and width, not its chemical composition or mineralogical origin, and 3) the lack of analytical methods to distinguish between asbestos fibers and non-asbestiform EMPs.

At its broadest and most scientifically accepted level of classification, all fibers fall within the category of an Elongate Mineral Particle or EMP. The National Institute on Occupation Safety and Health (NIOSH) defines an EMP as any particle of inhalable, thoracic, or respirable size that has a minimum aspect ratio of 3:1. All other definitions of a fiber, as they are specifically defined in their respective disciplines or organizations, satisfy this basic definition and can be classified as an EMP. The NIOSH Recommended Exposure Limit (REL) for airborne asbestos fibers and related elongate mineral particles is 0.1 countable EMPs per cubic centimeter from one or more of the covered mineral groups, averaged over 100 minutes. A countable EMP, per NIOSH Method 7400, is any fiber or fragment of a mineral longer than 5 µm with a minimum aspect ratio of 3:1 when viewed microscopically. This REL encompasses the asbestiform and non-asbestiform analogs of chrysotile and amphibole minerals (riebeckite [crocidolite], cummington-grunerite [amosite], anthophyllite, tremolite and actinolite).

Because the majority of the Minnesota Fibers in Silver Bay are less than 5µm in length, this definition would exclude the majority of Minnesota Fibers. It should be noted that the NIOSH REL is made for use in the occupational setting and does not extend to the ambient environmental exposure that may be experienced in a non-occupational setting, such as the ambient air in Silver Bay. And, generally, ambient concentrations of fibers in the community setting are significantly lower than in the associated occupational setting. As a result, this REL cannot be applied to the ambient air in Silver Bay.

NIOSH has identified asbestos to be a potential occupational carcinogen and recommends that exposure to asbestos fibers, which includes all forms of non-asbestiform fibers, be reduced to the lowest feasible concentration in occupational settings.

Mine Safety and Health Administration (MSHA)

In MSHA's 2008 Asbestos Exposure Limit Final Rule, MSHA adopted a PEL and excursion limit that is the same as the OSHA asbestos exposure limit and is based upon the same definition of a countable fiber (i.e. fibers at least 5µm in length with a 3:1 or greater aspect ratio). OSHA and MSHA both rely on PCM to analyze air samples to calculate fiber concentrations. MSHA limits apply only in an occupational setting to protect workers of all metal and nonmetal surface mining operations. Generally, ambient concentrations of fibers in the community setting are significantly lower than in the associated occupational setting. Because the majority of Minnesota Fibers in Silver Bay are less than 5µm in length the MSHA PEL would exclude a majority of Minnesota Fibers. As a result, this PEL cannot be applied to the ambient air in Silver Bay.

MSHA notes that it does not address exposure to short fibers as a potential source of increased risk for developing respiratory disease within its final asbestos exposure limit as that would require both a change to their working definition of a fiber and the adoption of an analytical method capable of accurately identifying them. This problem is highlighted in the insufficiency of the current MSHA regulations in addressing the amphibole minerals in the taconite ore along the Eastern section of the Mesabi Iron Range and has even led to proposed modifications to their existing asbestos protocol (Langer 2008). As is the case with OSHA, the limits that MSHA sets for mine workers cannot be generalized to the long term environmental exposure setting experienced in Silver Bay and Beaver Bay.

U.S. Environmental Protection Agency (EPA)

The EPA regulates asbestos under multiple laws and federal regulations. These include the Asbestos Hazard Emergency Response Act (AHERA) for regulating asbestos in schools, the Asbestos Information Act, the Asbestos School Hazard Abatement Reauthorization Act (ASHARA), the Clean Air Act, Safe Drinking Water Act, and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Each asbestos related law or regulation has a specific set of goals for protecting human health and applies to a specific environmental or occupation setting. The Clean Air Act (CAA) Section 112 establishes the National Emission Standards for Hazardous Air Pollutants (NESHAP). Under this provision, the EPA recognizes asbestos (CAS No 1332214) as a Hazardous Air Pollutant (HAP). This particular regulation is intended to minimize the release of asbestos fibers into the atmosphere whenever asbestos-containing material is handled, and covers many industries. The EPA defines an asbestos fiber in method *EPA/600/R-93-116 – Method for the Determination of Asbestos in Bulk Building Materials* as one having a length equal to or greater than 5µm with an aspect ratio of at least 20:1 (U.S. Environmental Protection Agency 1993). This definition would exclude nearly all Minnesota Fibers in Silver Bay because the majority are less than 5µm and fewer than 2 percent have an aspect ratio of 20:1 or greater. For this reason, these standards cannot be used to regulate Minnesota Fibers in the ambient air in Silver Bay

The EPA's Integrated Risk Information System (IRIS) program is tasked with characterizing the toxicity of health hazards through a health risk assessment process. The EPA's IRIS risk assessment for general asbestos (CAS No. 1332-21-4) involved a review of epidemiologic and animal studies, and provides a quantitative risk estimate for mesothelioma and lung cancer at various concentrations of exposure via inhalation. The EPA notes that the risk assessment from exposure estimates were based on data obtained from PCM-based analytical methods and that the unit risk values for this assessment should not be applied to measurements made by other analytical techniques, such as TEM (U.S. Environmental Protection Agency 1988). Recall that TEM is the analytical method used in Minnesota.

Minnesota Department of Health (MDH)

The MDH defines a mineral fiber as any amphibole or serpentine group mineral that has a 3:1 aspect ratio or greater with no minimum length cutoff, and refers to any fiber that meets this definition as a "Minnesota Fiber." The MDH

method uses TEM microscopy that also requires the use of energy dispersive spectroscopy (EDS) to determine the elemental composition of the fiber, as well as electron diffraction to identify the mineralogy of the fiber (i.e. amphibole, chrysotile, non-amphibole, ambiguous). Analysis of past and current fiber monitoring samples has been conducted using the Minnesota Department of Health T.E.M. Analysis for Mineral Fibers in Air – 852 method. Because this method employs TEM, it allows for the identification and counting of very thin fibers that could not otherwise be resolved with PCM. The MDH method also allows for the identification of particle mineralogy through the use of electron diffraction and energy dispersive spectroscopy.

Historical Background on Fibers in Minnesota

The history of fibers within the context of the mining industry in Northeast Minnesota is long, complex, and not without controversy. The following sections provide a brief overview of the important concepts and key historical events that have shaped the way fibers have been regulated at Northshore Mining Company as they are relevant to the Advisory Committee meeting. There have been many published articles, books, and reports on the historical experiences surrounding fibers in Minnesota that go into much greater detail than will be provided here. Some citations have been provided at the end of this section.

History of Taconite Mining at the Reserve Mining Company

Cliffs Natural Resources, Inc. owns the Northshore Mining Company (Northshore), which operates a taconite processing plant in Silver Bay, Minnesota. The Reserve Mining Company (Reserve) was the original owner of the Silver Bay facility, which began processing taconite ore in 1955. Reserve Mining closed the facility in 1986, when it was bought and briefly owned by Cyprus Minerals from 1989 to 1994. It was then purchased by its current owner, Cleveland Cliffs, Inc., now Cliffs Natural Resources.

Beginning in the 1860s and continuing into the 1940s, mining on the Mesabi Iron Range was dominated by extraction of a high-grade iron ore called hematite. A lower grade iron ore, taconite, was also found along the Iron Range, but for a long period it was considered a waste rock as there was no process to effectively extract the iron from this ore. As hematite deposits declined and advances in technology and engineering allowed iron to be extracted and concentrated from the taconite ore, a new era of taconite iron mining in Minnesota was ushered in. In 1947, Reserve obtained permits to mine taconite from what became known as the Peter Mitchell Mine Pit near Babbitt, Minnesota. Ore mined from this pit is transported by rail to a facility in Silver Bay, where it is processed into taconite pellets and loaded onto ships for transport to customers for the production of steel in blast furnaces.

The processing of taconite ore into concentrated iron pellets results in a fine-grained waste product called “tailings.” Between 1955 and 1980, Reserve discharged these tailings into Lake Superior. At the facility’s full operational capacity, 67,000 tons per day of tailings were discharged into Lake Superior. Environmental, water quality, and public health concerns soon began to emerge surrounding the in-lake disposal of taconite tailings from the facility. One such concern was that the taconite ore obtained from the Peter Mitchell mine pit contained an amphibole mineral called cummingtonite-grunerite. It was presented in the Reserve Mining Court cases of the 1970s that this mineral was chemically indistinguishable from a certain type of asbestos called amosite. These amphibole minerals were released into Lake Superior through the disposal of the tailings and could be identified in the drinking water of the communities that used the lake for their water supply. Amphibole fibers were also identified in the ambient air around the facility and in the nearby towns of Silver Bay and Beaver Bay. Ingestion and inhalation of fibers became the focus of a series of lengthy court cases involving Reserve, the Environmental Protection Agency, and other organizations. These proceeding began in 1973 and ultimately concluded in 1982.

The Reserve Mining Court Case and Legal History of Fibers

April 20, 1974 marked the date of a controversial ruling by Federal District Court Judge Miles Lord when he ruled against Reserve and ordered it to discontinue operation. At the center of the ruling was a scientific debate on whether fibers presented a health risk to the surrounding communities, as well as whether these fibers could be defined as asbestos at all. Testimony from world-renowned health experts on asbestos and other disciplines was presented at the trial on both sides. The shutdown of the facility lasted only two days, when the shutdown order was stayed by the U.S. Court of Appeals.

Reserve appealed the decision and in 1975 the Court ultimately struck a balance between protecting the public from unknown health effects from fibers and allowing the facility to continue to operate. During the proceedings, a distinction was made between asbestos fibers and the type emitted from the Silver Bay facility. It was argued that the type of fiber found in the ambient air and discharge water from the facility were shorter and blockier than traditional asbestos, and originated from a different type of geological formation than traditional asbestos. These specific fibers were called 'cleavage fragments' to differentiate them from asbestos. Even with this distinction, the morphology, chemistry, mineralogy, and crystalline structure were so similar between traditional asbestos and cleavage fragments that the court could not definitively conclude on the health risk of exposure to amphibole cleavage fragments.

Among many other rulings, the decisions of this case required that Reserve take steps to cease the disposal of tailings into Lake Superior and construct an on-land tailings basin where tailings could be disposed of. This tailings basin became known as Mile Post 7. The court also ordered that the facility comply with a requirement that has been called the 'control city standard'. The control city standard states that "*controls may be deemed adequate which will reduce the fiber count to the level ordinarily found in the ambient air of a control city such as St. Paul.* ". The concept and language of the control city standard eventually made its way into the facility's air permit, where it remains today. On December 20, 2007, the United States District Court for the District of Minnesota ruled that the federal injunction, established in the 1975 Reserve Mining Court decision, no longer had any force or effect. The Court ruled that the control city standard, along with the other fiber requirements, were effectively incorporated into Minnesota State administrative law within the air quality permit for the facility. The control city standard remains in the facility's air quality permit to this day.

Legacy of the Reserve Mining Case

Since the days of Reserve, greater particulate controls measures have been required at the facility and fiber concentrations in the ambient in Silver Bay and Beaver Bay have fallen significantly from where they once were during the days of Reserve. The regulatory mechanism for controlling fibers specifically at the Silver Bay taconite processing facility is still the control city standard, which has existed in the facility's air quality permit since the days of the Reserve Mining case. The expert testimony provided at the Reserve court cases revealed how much uncertainty and complexity there was surrounding the topic of mineral fibers and public health. Since 1975, scientific research and epidemiologic studies have advanced the understanding the role of exposure to asbestos and other types of fibers plays in the development of malignant and non-malignant respiratory disease, although the majority of interest has been given to understanding fibers in the occupational setting and has focused more on traditional commercial asbestos. There continues to be uncertainty surrounding the non-occupational or environmental exposure to the types of fibers that do not fit within the traditional definition of asbestos. The uncertainty and continued lack of consensus within the scientific community has so far prevented the development of a more traditional health-based standard for the specific type of fibers found in the ambient air in Silver Bay.

Other Resources on the History of Fibers in Minnesota

Bartlett, Robert V. 1980. *The Reserve Mining Controversy: Science, Technology, and Environmental Quality*. First Printing edition. Bloomington: Indiana Univ Pr.

Berndt, Michael E., and William C. Brice. 2008. "The Origins of Public Concern with Taconite and Human Health: Reserve Mining and the Asbestos Case." *Regulatory Toxicology and Pharmacology* 52 (1): S31–39. doi:10.1016/j.yrtph.2007.09.019.

Huffman, Thomas R. 2000. "Exploring the Legacy of Reserve Mining: What Does the Longest Environmental Trial in History Tell Us About the Meaning of American Environmentalism?" Journal of Policy History 12 (3): 339–68.

Proposal for Regulating Fibers

The following sections describe the changes proposed for the purpose of regulating fibers emitted from Northshore's facility. The proposed amendment removes the Control City Standard per Northshore's request. In its place, this amendment requires that Northshore develop a Fiber Management Plan (FMP) that lists the fiber prevention and minimization activities conducted at the facility, establishes an Action Level, and requires an Action Level Exceedance Plan (ALEP) that specifies what additional actions Northshore will take if monitored fiber concentrations exceed the Action Level. Updated monitoring, recordkeeping, and notification requirements would also be required.

Fiber Minimization Plan (FMP)
Northshore is required to develop and maintain a Fiber Minimization Plan (FMP) for its Silver Bay facility. The FMP is a written plan that follows an adaptive management approach for preventing and minimizing the emission of fibers from Northshore's facility. Under the requirements for the FMP Northshore is required to list, record, and submit to the MPCA the activities it is taking on a regular basis at the Silver Bay Facility that prevent and control fiber emissions. The FMP allows Northshore to select and adapt the actions it takes to limit fiber concentrations. To implement the adaptive management processes effectively, the FMP must contain several required elements. These elements are listed below.

a. A list of the control measures Northshore is undertaking at the Silver Bay plant site and the Mile Post 7 tailings basin that prevent and limit concentrations of 'Minnesota fibers,' in the ambient air around its facility. Minnesota fibers are defined as any airborne amphibole or chrysotile mineral fiber with a 3:1 or greater aspect ratio and henceforth will be referred to as 'fibers.' Northshore may use particulate (PM2.5, PM10, TSP) controls as a surrogate for fiber controls.

b. The frequency that each control measure occurs.

c. A list of individual(s) and position title(s) responsible for implementing each control measure and ensuring compliance with each control measure listed in the FMP.

d. Maps of the facility indicating the location of all potential sources of airborne fibers within the facility property boundaries, including but not limited to stacks, stockpiles, roads constructed of taconite tailings, active areas of tailings beach, etc.

In addition to the FMP requirements, Northshore shall keep regular records of any action taken in accordance with the control measures listed in the FMP. This includes recording at a minimum, the description of the control measure(s) undertaken, where and when the control measures were implemented, and the name(s) of the individual responsible for implementing the control measure(s).

The FMP must be developed, implemented, and submitted to the MCPA within 30 days of the issuance of any permit. The FMP must be reviewed annually by Northshore and modified whenever a change in the facility's operation, design, or maintenance may affect fiber emissions, or inspection identifies any deficiency in the listed control measures. Northshore must also review and modify the FMP whenever it adds, eliminates, or modifies control measures that are implemented on a regular basis. The requirements of the FMP are effective at all times (i.e. when the concentration of fibers is below or above the Action Level).

Due to the similarity in aerodynamic size between fibers and particulate matter, the MPCA believes that particulate control practices that control coarse (PM10) and fine (PM2.5) particulate matter are an appropriate surrogate for controlling fibers. From a public health perspective, these sizes of particles have the greatest chance of being deposited in the airways and gas-exchange regions of the lung. Mineral fibers of similar size fraction may possess similar aerodynamic behavior as general particulate matter of the same diameter. Therefore, this proposal contains

requirements that are based on the theory that actions that control PM10 and PM2.5 sized particulate matter will prevent and limit fiber emissions.

Action Level Exceedance Plan (ALEP)
Within 75 days of issuance of any permit amendment, Northshore is required to submit to the MPCA an Action Level Exceedance Plan (ALEP). The Action Level Exceedance Plan (ALEP) is a written document that describes Additional Control Measures Northshore must implement when the calculated concentration of fibers exceeds the Action Level at any or both of the fiber monitoring sites. Additional Control Measures are control measures, beyond those contained in the FMP, that are focused on minimizing the concentration of fibers in the ambient air. The ALEP allows Northshore to select and adapt the actions it takes to reduce fiber concentrations.

The Additional Control Measures in the ALEP are categorized into two tiers. The first tier will consist of those Additional Control Measures that are predicted to be the quickest to implement and will have an immediate impact on lowering fiber concentrations. The second tier will consist of Additional Control Measures that are predicted to require a longer period of time to implement and may require a longer period of time to have a measureable effect on fiber concentrations.

The ALEP must contain a detailed schedule for the implementation of each second-tier Additional Control Measure. This includes listing all the steps necessary to implement the measure and a timeline of how long each step will take for the Additional Control Measure to be fully effective. The timeline for the implementation of each Additional Control Measure shall be the shortest reasonable period of time. The ALEP must also contain an evaluation of the predicted effectiveness of the measure, justification for its inclusion in the ALEP, and provide the employee names and titles that are responsible for implementing and maintaining all requirements specified within the ALEP. An additional control measure is considered "fully implemented" when all steps necessary for the measure to be effective are complete.

Much in the same way the FMP employs an adaptive management approach to controlling fibers, the ALEP is designed to be modified by adding, eliminating, or modifying Additional Control Measures when Northshore identifies new and effective ways of controlling fibers. Northshore is required to review the ALEP at least annually and submit a modified ALEP to the MPCA within 7 days of any modification.

Fiber Action Level
This proposal establishes a fiber Action Level set at a concentration of 3,300 fibers/m^3 in the ambient air, and is applicable to both fiber monitoring sites F1 at Beaver Bay and F7 at Silver Bay. The Action Level is a statistically derived value that was calculated from recent monitoring data sampled fiber monitoring at these sites. It is representative of an upper bound of recent average fiber concentrations.

The Action Level intentionally does not include the language of a 'standard', as this would imply that it was based upon health risk information. Although recent ambient fiber concentrations in Silver Bay and Beaver Bay have not been associated with an increased risk of asbestos related diseases within the surrounding communities, the Action Level is not based upon a human health risk data and should not be interpreted as such. The Action Level was developed to regulate fibers at a reasonably achievable, low level.

The Action Level provides a means to determine whether the fiber prevention and control measures listed in the FMP and being implemented by Northshore are working effectively to prevent fiber emissions and to limit concentrations in the ambient air. It does this by requiring that Northshore calculate a 365-day rolling geometric mean (Geomean) of fiber concentrations from monitoring data sampled from sites F1 and F7. A Geomean is required to be calculated after the 5^{th} day of receipt of a fiber monitoring analytical result for each site. The Geomean is then compared to the Action Level in order to determine if the concentration of fibers is less than or greater than (i.e. exceeds) the Action Level. The Geomean is calculated using the following equation:

$$G = \sqrt[n]{x_1 x_2 \cdots x_n}$$

where *G* is the 365-day rolling geometric mean for a site, x_i are the individual sample results collected during the previous 365 days and *n* is number of individual samples. If the analysis of a fiber monitoring sample returns a value that is reported to be below the sensitivity of the analytical method (i.e. censored data), as reported by the contracted laboratory, the sensitivity level associated with that sample shall be substituted for the value of the censored data.

If the calculated Geomean is greater than or equal to the Action Level of 3,300 fibers/m^3 at F1 or F7 monitoring sites, this is considered to be an exceedance of the Action Level. In response to an exceedance of the Action Level, Northshore must employ Additional Corrective Actions contained in the Action Level Exceedance Plan (ALEP) to decrease ambient fiber concentrations below the Action Level. In this way, the Action Level serves as a mechanism to require actions to limit fiber concentrations.

By the 20th day after receipt of the monitoring result that triggers an exceedance, Northshore must evaluate the likely culpable sources responsible and potential causes for elevated concentrations of fibers. Northshore must then conduct an assessment of the control measures listed in the FMP and whether there have been any failures of the FMP control measures that may have caused elevated fiber concentrations. Finally, Northshore must choose and implement Additional Control Measures in accordance with the ALEP, or take other action that would address the likely culpable sources responsible and potential causes for elevated concentrations of fibers. The Additional Control Measures shall be implemented in accordance with the schedule in the ALEP.

Steps for Selection of Additional Control Measures

- If the Geomean exceeds the Action Level at one or both fiber monitoring sites, within 20 days of receipt of the monitoring result that triggered the exceedance (monitoring result), Northshore shall implement all of the first-tier Additional Control Measures contained in the ALEP that impact the monitor that exceeded the Action Level.

- If after 180 days of the monitoring result the Geomean is still above the Action Level, Northshore shall select and implement a second-tier Additional Control Measure. Northshore shall select a second-tier Additional Control Measure applicable to the likely culpable source that is responsible for elevated concentrations of fibers.

- If after 180 days of full implementation of the second-tier Additional Control Measure(s), the Geomean is still above the Action Level, Northshore shall implement another second-tier Additional Control Measure, subject to the same requirements above. Northshore shall continue implementing second-tier Additional Control Measures in this manner until the Geomean falls below the Action Level.

The purpose of a two-tiered categorization for Additional Control Measures is that it requires Northshore to choose those measures that may be quicker to implement on first exceedance of the Action Level. If the result of implementing these first-tier Additional Control Measures is that the Geomean falls below the Action Level within 180 days of the monitoring result that triggered the exceedance, it relieves Northshore from having to implement other Additional Control Measures that may be costlier and more time consuming to implement. If these first-tier Additional Control Measures fail to reduce fibers to below the Action Level then the requirement for implementing second-tier Additional Control Measures is justified.

Northshore shall notify the MPCA in writing of any exceedance of the Action Level by the 20th day after the receipt of each ambient fiber monitoring result. A notification is required each time a Geomean from any or both monitoring sites exceeds the Action Level. In addition to notification, Northshore must keep detailed records of any actions taken in accordance with the ALEP. These include recording a written evaluation of the likely culpable sources, the monitoring site(s) where the exceedance occurred, the date(s) Northshore completed each step of an Additional Control Measures implementation, the date that each Additional Corrective Measure was fully implemented, the name(s) of the

individual(s) responsible for implementing the control measure(s), and the Additional Control Measure(s) chosen from the ALEP to implement including the rationale for its choice.

Finally, it should be noted that an exceedance of the Action Level would not be a violation of the air quality permit; however, failure to follow the Fiber Minimization Plan, failure to employ Additional Control Measures as necessary to reduce ambient concentrations if the Action Level is exceeded, failure to make adaptive FMP modifications, or a failure to comply with other requirements contained in this proposal may be permit violations.

Monitoring Requirements

Northshore is required to operate and maintain ambient air monitors at Site F1 and F7 for the purpose of quantifying ambient fiber concentrations in Beaver Bay and Silver Bay. The data produced by fiber monitoring is used to calculate the 365-day geometric mean at both monitoring sites. This proposal would require that Northshore continue to monitor for fibers at sites F1 and F7 at the rate of one 96-hour sample per site every 12 days. A new 365-day rolling geometric mean will be calculated with every new sample result. The proposal contains additional monitoring requirements to ensure that the monitoring data is of sufficient quality that it can be relied on.

If any 365-day geometric mean at either sampling site exceeds the Action Level, Northshore is required to request that the laboratory performing the sample analysis use an expedited 10 day turn-around time protocol until any Geomean is below the Action Level. This requirement minimizes the lag time between when a fiber sampling event captures the concentration of fibers in the ambient air and when the Geomean can be calculated using that result. This allows Northshore to respond to changes in the fiber concentration based on the most recent data.

Northshore may request that a reanalysis of a monitoring sample be performed. The results of the first sample shall apply toward the calculation of the Geomean, until the results of the reanalysis have been completed and returned. Northshore shall apply the lower of the two results toward recalculation of the Geomean. Requirements of all permit conditions would apply any time the Geomean exceeds the Action Level, even if Northshore is awaiting the results of a reanalysis of a sample.