

**“To recycle or not to recycle Asbestos-containing RAP: that is the question.”**

Presented By:  
Joe Chyc-Cies, P.Eng.  
Materials & Research Engineer  
The City of Calgary, Roads  
&  
Ben G. Wineberger, P.Eng.  
Environmental Specialist  
The City of Calgary, Roads

Based on:  
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## **Abstract**

In August 2008, as part of the City of Calgary's commitment to providing a safe work environment for its workers and contractors, The City requested that Golder Associates Ltd. (Golder) conduct an occupational hygiene assessment to determine the potential for worker exposure to asbestos during the various processes of The City Roads Business Unit that impact asbestos-containing asphalt and the use of recycled asphalt pavement (RAP). The final report, *Asbestos in Asphalt, Calgary, Alberta*, was submitted to the City of Calgary Roads Business Unit on November 27, 2008.<sup>1</sup>

Similar to other municipalities in North America, The City of Calgary incorporated chrysotile asbestos fibres (1-2 percent by weight) into their asphalt pavement to improve both durability and lifespan. From the mid-1960s to the mid-1980s, the asbestos-containing asphalt pavement installed by The City was primarily used as a surfacing material on major arterial roads. The prevailing opinion was that asbestos in pavement presented a negligible exposure risk as the asbestos fibres were bound within the asphalt matrix. In the 1960s and 1970s, occupational and environmental air monitoring data supported this opinion.

Occupational sampling conducted by The City in the 1980s found airborne asbestos concentrations below the allowable limits. However, due to concern for the health and safety of the workers handling bulk asbestos, the practice of adding raw asbestos to pavement was discontinued in 1984.

Since the mid-1980s, as part of pavement resurfacing, these roadways have been planed and recycled asphalt pavement (RAP) has been incorporated into new asphalt to pave various roadways around Calgary. This recycling effort further diluted the concentration of asbestos in newly-laid asphalt. Asbestos was identified in 2007 when roadway core samples were put through destructive laboratory testing and sieved down to their finest constituents. Control measures were instituted in laboratories which effectively reduced the potential for worker exposure based on current legislation.

Respecting The City of Calgary's 'triple bottom line' of social, environmental and economic sustainability, the Roads business unit is committed to environmental protection and providing a safe workplace for employees, contractors and the citizens of Calgary.

The City of Calgary's Roads Business Unit approached Golder in July 2008 to reassess the potential for asbestos exposure to workers during paving-related activities. The City also temporarily stopped using RAP until the outcome of this study was known.

## **Research and Communications**

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<sup>1</sup> Sections of this document were reproduced from the *Asbestos in Asphalt, Calgary, Alberta* report produced by Golder Associates Ltd. for The City of Calgary. Please see the reference section at the end of this document for more information about the *Asbestos in Asphalt, Calgary, Alberta* report.

As part of this study, Golder contacted the representatives of the following relevant jurisdictions by e-mail and/or phone to inquire about their approach about the removal of asbestos containing asphalt pavements:

- Alberta Employment, Immigration and Industry (AEII), Workplace Health and Safety
- Alberta Environment
- Calgary Health Region
- Work Safe British Columbia
- Saskatchewan Labour
- Manitoba Labour
- Canadian Centre for Occupational Health and Safety (CCOHS)
- United States Environmental Protection Agency (USEPA)
- United States Occupational Safety and Health Administration (OSHA)

Golder also contacted various technical associations including:

- Ontario Road Builders' Association (ORBA)
- B.C. Road Builders and Heavy Construction Association (BCRBHCA)
- Road Builders and Heavy Construction Association of Saskatchewan (RBHCAS);
- Transportation Association of Canada (TAC);
- United States Transportation Research Board (TRB);
- Canadian Technical Asphalt Association (CTAA);
- United States Asphalt Institute; and
- Ontario Hot Mix Producers Association (OHMPA).

For the most part, it was discovered that none of the individuals with whom Golder made contact knew of any specific procedures or of any occupational testing that was directly related to the removal of asbestos-containing asphalt pavement. Most simply directed Golder to their local regulation/legislation regarding asbestos-containing building materials and some felt that the asbestos fibres would be so tightly bound in the matrix of the pavement that fibre release would be negligible so typical asbestos-related precautions wouldn't necessarily apply. Some referred to the procedures that the City of Toronto recently adopted.

### **Regulations, Guidelines & Codes**

The regulations, guidelines and codes that pertain to asbestos include the Alberta Occupational Health and Safety Code, the AEII Asbestos Abatement Manual, and the Alberta Environmental Protection and Enhancement Act. These regulations, guidelines and codes are particularly relevant to the assessment, management and/or removal of asbestos-containing materials in buildings or building materials. There is no specific direction given under these regulations that addresses the topic of asbestos bound in asphalt pavement (nonfriable, industrial products) and all of these regulations must be interpreted and applied to the context.

## **Alberta Occupational Health and Safety Code**

The Alberta Occupational Health and Safety Code is law which was passed to protect the health and safety of workers on the job. As such, the Code and the sections under the Code are enforceable by law. The Code places the onus on both the employer and the employee to ensure a safe working environment.

Part 4, Chemical Hazards, Biological Hazards and Harmful Substances, represents minimum requirements and specifies, among many other things, the general requirements for working with and around harmful substances. Control of worker exposure to airborne contaminants is detailed and the OEL (occupational exposure limit) are specified in Schedule 1 of the Regulation.

Part 4 and Schedule 1, Table 2 in the Alberta Occupational Health and Safety Code outlines the general requirements to be followed when working with asbestos. It also defines OELs for a variety of airborne contaminants. The OEL for a particular contaminant represents conditions to which it is believed that nearly all workers may be exposed, day after day, without suffering from adverse health effects. Due to individual susceptibility, a small percentage of workers may experience discomfort at concentrations below the applicable OEL. An 8-hour OEL refers to the average concentration of a substance over an eight-hour period.

It should be noted that OELs are based on the assumption that worker exposure typically occurs for an eight-hour period with a 16-hour recovery period. When the worker is exposed for more than eight hours, an adjustment must be applied to the eight-hour OEL. This adjustment to the OEL compensates for unusual work schedules by reducing the permissible concentration in proportion to both the increase in exposure time and the decrease in recovery time. For 10-hour shifts, the OELs are typically reduced by 30 percent and for 12-hour shifts, reduced by 50 percent. The eight-hour OEL for asbestos is 0.1 f/cc and is based on the National Institute for Occupational Safety and Health (NIOSH) method 7400-A.

Sections 28 through 38 in Part 4 of the Alberta Occupational Health and Safety Code outline some specific requirements related to asbestos. In some instances, AEII Workplace Health and Safety does not consider materials containing less than 1percent asbestos by weight to be ACM requiring specialized handling, removal and disposal practices. The Alberta Asbestos Abatement Manual is a guide published by AEII Workplace Health and Safety that is used as a guide for determining compliance with the Occupational Health and Safety Code in the Province of Alberta. It covers basic information on asbestos, its health hazards, requirements for worker protection, safe work practices, and the basic principles to follow for the safe abatement of ACM.

## **Alberta Environmental Protection and Enhancement Act**

The Environmental Protection and Enhancement Act is law which was passed to protect and enhance the environment. As such, the Act and the regulations under the Act are enforceable by law. The Act places the onus on the owner, employer, and employee to ensure no adverse effects are experienced in the environment.

The Alberta Guide for Waste Managers identifies asbestos as a non-hazardous provided that it is managed according to the Guidelines for the Disposal of Asbestos Waste. Asbestos waste refers to waste containing asbestos in concentrations greater than one percent by weight 24. Within the guidelines, criteria have been established for the handling, transportation and disposal requirements of asbestos waste. Also within the guidelines, the types of landfills that can accept asbestos waste are outlined.

The Waste Control Regulation (Alberta Regulation 129/93 with amendments up to and including Alberta Regulation 257/93), refers to the Alberta User Guide for Waste Managers, which outlines the materials and criteria to be used to characterize waste as hazardous.

### **Other Regulations, Guidelines and Codes**

There are no regulations or guidelines specific to the use and handling of asbestos-containing asphalt. In fact, many jurisdictions would not consider asbestos-containing asphalt to be hazardous.

Health Canada acknowledges that asbestos was a popular material used widely in construction and many other industries and if asbestos fibres are enclosed or tightly bound in a product (e.g., in asbestos siding or asbestos floor tiles) there are no significant health risks. Products containing asbestos are regulated under Canada's Hazardous Products Act, which stipulates that non-chrysotile asbestos be encapsulated with a binder or that the materials are not friable after drying.

### **Scope of Work**

Golder conducted asbestos air monitoring from August 5 to September 4, 2008. The activities included in the occupational hygiene assessment were chosen for their potential to disturb or pulverize older asphalt and potentially break down the matrix in which the asbestos is bound:

- planing
- hauling
- stockpiling
- loading and handling
- saw cutting and jack hammering
- recycling
- paving
- scarifying

### **Testing Methodology**

Occupational air samples were collected during the various processes to assess the potential occupational exposure related to specific activities or tasks and to document whether current work procedures were effective at minimizing airborne fibre concentrations.

Golder consulted with site representatives before selecting the individuals they would use to test for occupational air samples. The area air samples were collected as near as possible to the potential sources of fibre generation without causing any potential harm to the testers and without disturbing any operations. Given that the machinery used in the operations is mobile, area air samples were taken all over the working area, maintaining a consistent distance, to ensure that the resulting data would be consistent. Whenever it was deemed both safe and practical, adjustments in sample taking were made to account for operating conditions such as wind direction and force. The area air samples were collected using battery-operated sampling pumps calibrated to draw known amounts of air through a 25 mm, 3-piece PCM conductive cowl cassette with a 0.8 µm mixed cellulose ester filter.

Once the occupational and area air samples were collected, two different analyses were conducted. First, a phase contrast microscopy (PCM) was conducted using the NIOSH method 7400-A. The air samples collected for the PCM analysis were analyzed by Golder's in-house laboratory, which participates in the Canadian Association for the Laboratory Accreditation's (CALA) proficiency program for asbestos. The PCM air samples with the highest fibre densities for a given process (approximately 20% of the samples) were then submitted to ATC Associates Inc. (who were doing business as Hygiea Laboratories Inc.), a laboratory recognized by the National Voluntary Laboratory Accreditation Program (NVLAP), for transmission electron microscopy (TEM) analysis. The TEM was conducted using the NIOSH method 7402. The American National Institute for Standards and Technology (NIST) maintains a listing of accredited asbestos laboratories under the NVLAP.

In order to compare the results against the Alberta Occupational Exposure Limit (OEL), the air samples were collected and analyzed in accordance with the NIOSH method 7400-A as mentioned above. While the NIOSH 7400-A method is regulated, it does have a number of limitations:

1. There is a certain margin of error associated with the NIOSH method. Possible sources of error include the measurement of the flow rate, the measurement of time, and the measurement of the graticule and filter area. In addition, the NIOSH method 7400-A requires fibres from a small portion of the filter to be counted manually. For example, Golder's in-house laboratory typically counts 100 fields, or 0.785 mm<sup>2</sup> of a 385 mm<sup>2</sup> filter, which is equivalent to less than 0.25% of the filter being included in the reported result. Therefore, we can only report with 95% confidence that the results are within the range of the lower and upper confidence limits.
2. In dusty atmospheres, samples can become overloaded with non-fibrous particulate rendering it difficult to differentiate between fibres and other particulate. In order to limit the effect of the dusty atmosphere, the sample volume must be lowered and consecutive samples must be collected. This is supported by Note 1, under the Sampling section of the NIOSH method 7400 – Asbestos and Other Fibres by PCM, which states that “dusty atmospheres require smaller sample volumes (≤400 L) to obtain countable samples. In such cases take short, consecutive samples and average the results over the total collection time.” A time-weighted average (TWA) calculation is then made where the sum of each concentration is multiplied by the sample duration which is then divided by the total collection time.

The formula is as follows:

$$TWA = (C_a T_a + C_b T_b + \dots + C_n T_n) \div \Sigma (T_a + T_b + \dots + T_n)$$

Where:

- TWA is the equivalent exposure concentration during the sample collection time;
- C is the concentration during any period of time T where the concentration remains constant; and
- T is the duration of the exposure at the concentration C.
- Assuming a continuous exposure and an 8-hour work shift, the value of the TWA shall not exceed the 8-hour OEL specified in Schedule 1, Table 2 of the Alberta Occupational Health and Safety Code, 2006.

3. In dusty atmospheres, the method indicates  $\leq 400$  L to obtain samples that can be analyzed. During our initial sample, Golder could not collect 400L without the samples being overloaded with non-fibrous particulate. The NIOSH method 7400 elaborates on non-fibrous particulate overloading in Note 1, under the Sampling section, which states "take care, however, not to overload the filter with background dust. If  $\geq 50\%$  of the filter surface is covered with particles, the filter may become too overloaded to count and bias the measured fibre concentration." The note in the Calculations and Reporting of Results section of the mother also states that "fibre counts above  $1300 \text{ mm}^2$  and fibre counts from samples with  $>50\%$  of filter area covered with particulate should be reported as uncountable or probably biased." In order to collect samples that could be analyzed but were below the 10% of the 8-hour OEL detection limit, we attempted to collect sample volumes of 180L.
4. Operations such as saw cutting and jack hammering conducted by The City of very short in duration (one hour or less) so that the volume captured was less than 180L resulting in higher detection limits.
5. The limit of quantification (LOQ) is an amount of analyte at which certain acceptable level of precision has been reached. The limit of quantification (LOQ) is 100 fibres/ $\text{mm}^2$  which is at the lower end of the working range. If a sample result falls below this value, as did all of the results in this assessment, it should be reported that there is diminished statistical reliability.
6. The limit of detection (LOD) of the NIOSH method 7400-A is 7 fibres/ $\text{mm}^2$  or 5.5 fibres counted in 100 fields. This value was obtained through the Proficiency Analytical Testing (PAT) program from blank values. Any filter that has a fibre count lower than 5.5 fibres per 100 fields is not statistically reliable because the number is below the blank value. Many of the results in this assessment were below the LOD.
7. As stated above, the LOD for this method is 5.5 fibres counted in 100 fields. The determination that concentrations are below the LOD does not mean that they are zero, only that the true concentration cannot be distinguished from the background interference of the sampling method. By using a single value such as the LOD rather than zero in calculations of the mean or TWA, the result will be overestimated. Statistical modeling of data below the LOD include approaches such as omission of results below the LOD which would result in a significantly

truncated data set or using a fraction of the LOD (e.g.,  $(LOD/2)$ ,  $(LOD/\sqrt{2})$ ) which may result in an underestimation<sup>30</sup>. As the most conservative approach, Golder chose to represent values below the LOD as the LOD when used in further calculations.

The NIOSH method 7400-A for PCM analysis does not distinguish between asbestos and other types of fibres. All fibres are counted and assumed to be asbestos. Although the TEM analysis, in accordance with the NIOSH method 7402, is not currently a requirement under the Alberta Occupation Health and Safety Code, this analytical method can distinguish asbestos from other fibres and can detect very thin fibres. The TEM analysis is valuable when other airborne fibres, present in the sample, may interfere with the PCM method. The disadvantages of TEM include increased cost compared to PCM, a more complicated sample preparation procedure, and a longer time required for analysis. Method 7402 provides a means of determining the fraction of asbestos fibres collected on the sample (fraction count) as well as estimating the total fibre concentration (distribution count). TEM analysis provides an added level of information for determining the potential for overexposure to asbestos. For regulatory purposes, the results were reported using the NIOSH method 7400-A PCM.

### **Core and Bulk Asbestos Samples**

The bulk samples were analyzed for type and percent asbestos content by weight using PLM methodology in accordance with United States Environmental Protection Agency dispersion staining techniques (Method for the Determination of Asbestos in Bulk Building Materials EPA/600/R-93/116). The asbestos content of the bulk samples was verified by gravimetric reduction using EPA 600/R-93/116 "Qualitative Problem" samples.



## Observations and Results

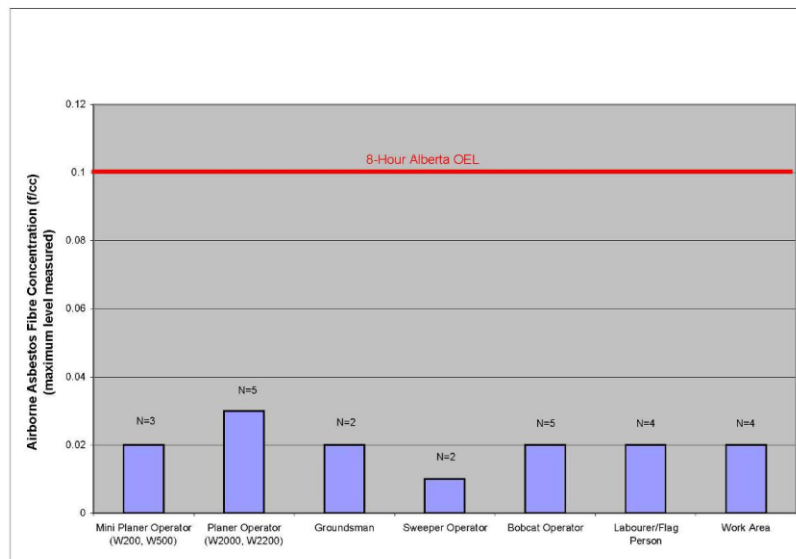
### Planing

Planing is the process of grinding up asphalt from roadways using planers and transferring the wetted material into trucks.



*Roads crews in the midst of planing.*

### Summary of Air Monitoring Results - Planing Process



Notes: f/cc = fibres per cubic centimetre of air  
N = number of samples taken

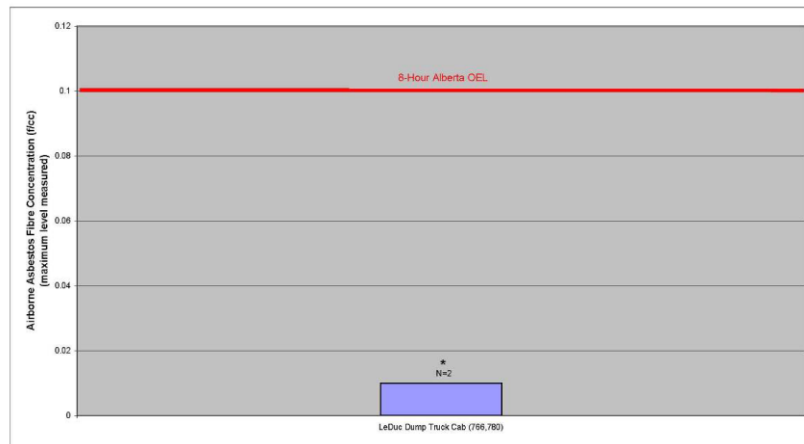
## Hauling

Hauling is the process of transferring milled asphalt or new asphalt from one location to another.



*A Roads crew hauling milled asphalt.*

## Summary of Air Monitoring Results - Hauling Process



Notes:  
f/cc = fibres per cubic centimetre of air  
N = number of samples taken  
\* = concentration is less than 0.01 f/cc

## **Stockpiling**

Stockpiling is the process of storing bulk aggregate and recycled materials for use in various processes at a later time.



*Stockpiling bulk aggregate.*

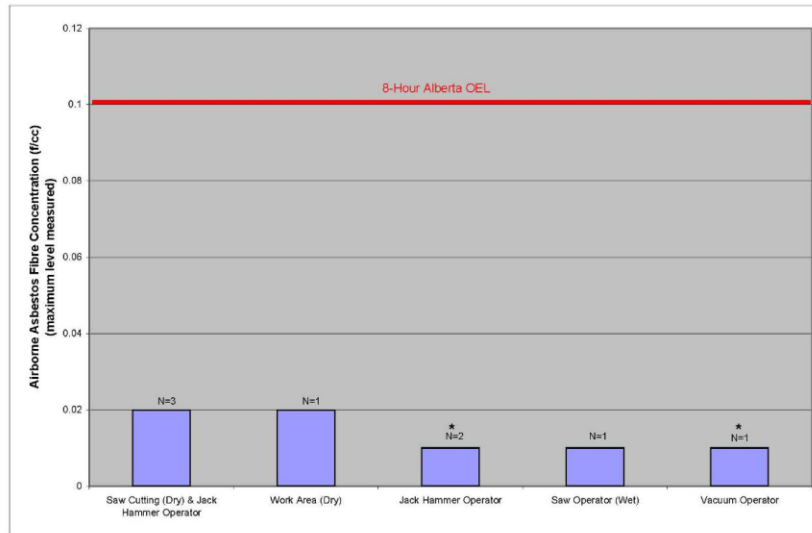
## **Saw Cutting and Jackhammering**

Saw cutting and jackhammering occurs when small sections of road are cut and broken out.



*Roads crews saw cutting asphalt.*

## Summary of Air Monitoring Results - Saw Cutting and Jackhammering Process



Notes:  
f/cc = fibres per cubic centimetre of air  
N = number of samples taken  
\* = concentration is less than 0.01 f/cc

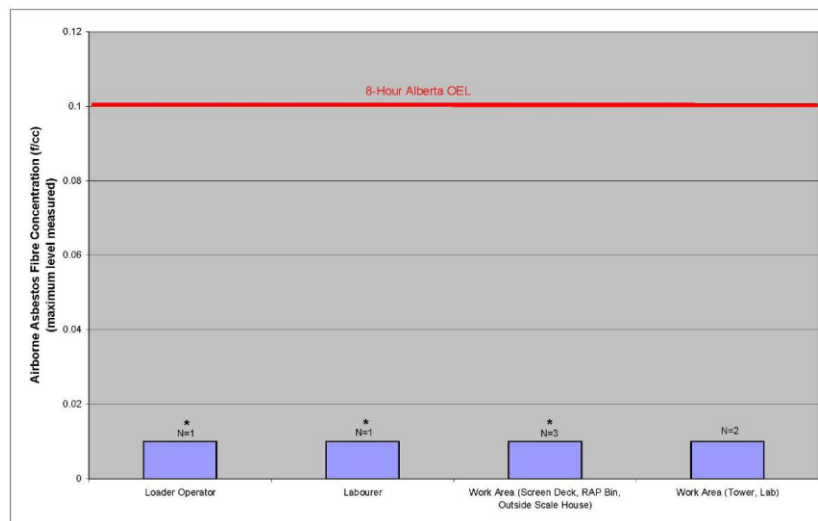
## Recycling Plant

The recycling plant includes areas where the recycled material is broken down, separated into different degrees of coarseness and new aggregate is re-introduced and mixed to form new asphalt.



*The City of Calgary's asphalt recycling plant.*

## Summary of Air Monitoring Results - Recycling Process



Notes: f/cc = fibres per cubic centimetre of air  
N = number of samples taken  
\* = concentration is less than 0.01 f/cc

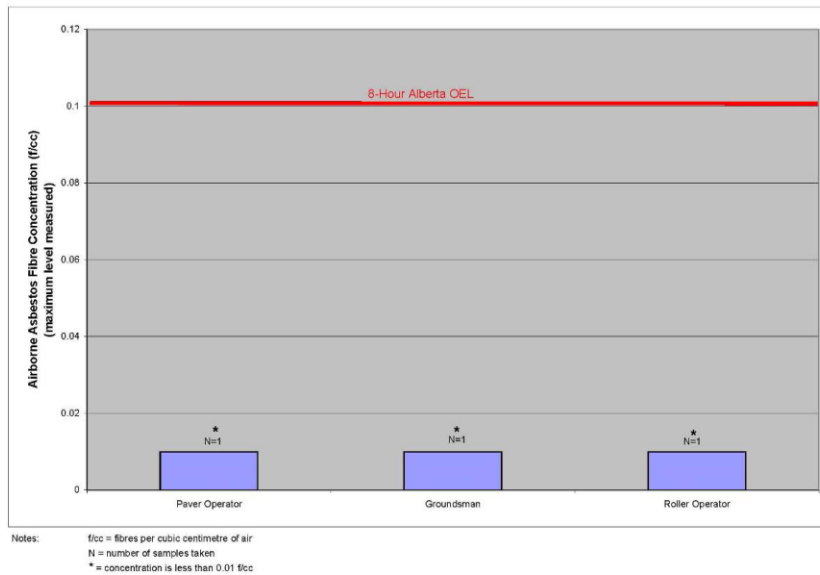
## Paving

Paving (or surface overlay) is the process of putting new asphalt over old asphalt or over previously milled surfaces.



*City crews paving.*

## Summary of Air Monitoring Results, Paving Process



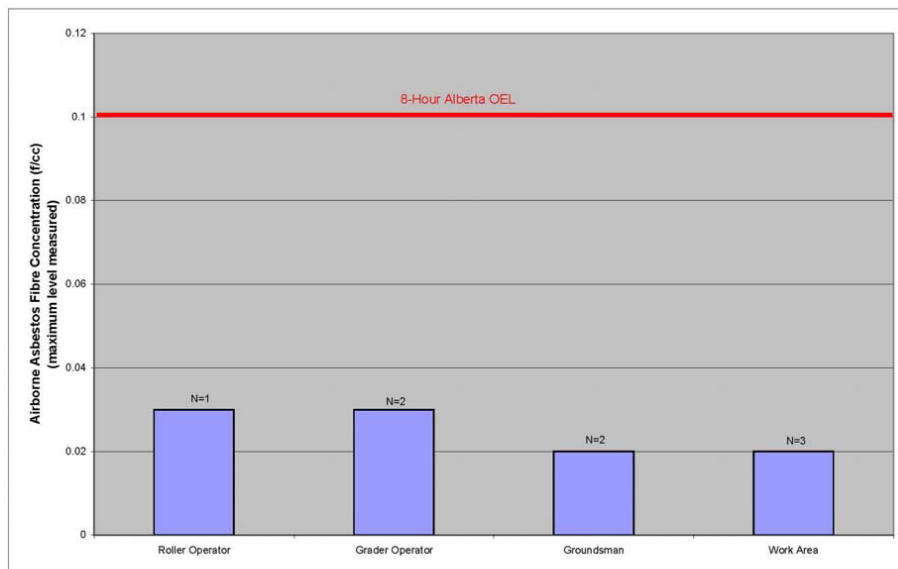
## Scarifying

Scarifying involves using a grader to re-grade roads or lanes where historically RAP has been distributed over gravel, shaped and compacted.



*Roads crews scarifying a road.*

## Summary of Air Monitoring Results - Scarifying Process



Notes: f/cc = fibres per cubic centimetre of air  
N = number of samples taken

## Core samples

Core samples were collected to determine the presence of asbestos-containing asphalt in roadways slated for maintenance.





## Conclusions and Recommendations

It was concluded that the occupational exposure results available are well below (<50 percent) the regulated OEL and have not demonstrated a significant risk of occupational exposure to asbestos during The City of Calgary's processes. Based on Golder's occupational exposure assessment and the current processes, no recommendations are being made to adopt immediate control measures (e.g., isolation of work area, hazard notification or respiratory protective equipment) as would typically be seen in the abatement of asbestos-containing building materials.

The creation and implementation of a Best Management Practice toward asbestos-containing RAP will be the major component in continuing to adequately protect workers. This Best Management Practice will include controlling dust generation, migration and accumulation; educating workers regarding the hazards associated with asbestos; addressing the testing methods of RAP, cores and other process material in asphalt plant laboratories through the use of fumehoods, cleaning methods and HEPA filters; and reassessment if there are significant changes to the equipment or the processes described.

The Best Management Practice will also respect The City's Triple Bottom Line of social, environmental and economic sustainability. Further, as the occupational exposure to workers at the source of the disturbance is below the regulated limits, and the road work continues to be conducted under similar conditions and work practices, this work presents an even lower potential asbestos exposure to individuals outside the work area.

Three options were considered to address the future use and outward supply of RAP from the planing operation:

- landfilling;
- separation of asbestos-containing RAP from non-asbestos-containing RAP
- recycling

Given the occupational exposure assessment, The City's Triple Bottom Line, the consideration of the three options, and the following findings and/or recommendations, Golder did not identify a reason to further suspend the use of asbestos-containing RAP:

1. The occupational exposure data available have not demonstrated a significant risk of occupational exposure to asbestos during the planing, hauling, saw cutting and jack hammering, recycling, paving, or scarifying processes.
2. The use and handling of RAP will be restricted to asphalt recyclers that will maintain the encapsulation or further dilution of the asbestos with virgin asphalt.
3. City workers and contractors will be made aware of the potential hazards and control measures associated with RAP.
4. Buyers or recipients of RAP will receive notification of the hazards and liability associated with the product in the form of a material safety data sheet and other contractual documents. These asphalt recycling facilities will be required to have documentation available for audit that illustrates their compliance with the asbestos requirements of the Alberta Occupational Health and Safety Code. The documentation should include appropriate work procedures to minimize the

potential release of airborne asbestos fibres, periodic asbestos air monitoring and laboratory surface-wipe testing to ensure the effectiveness of these control measures.

Recycling asbestos-containing RAP not only meets The City's recycling mandate, the process:

- reduces current and future burden on landfills to accept asbestos-containing asphalt
- reduces current and future demand for materials necessary for virgin asphalt production
- eliminates the need for extensive testing required to distinguish asbestos-containing pavement from non-asbestos-containing pavement
- reduces expenses resulting from logistics of separating asbestos-containing RAP from non-asbestos-containing RAP

Based on the exposure assessment and the current processes assessed, Golder concluded that The City, Roads Business Unit processes, with respect to asbestos, are being conducted in accordance with the Alberta Occupational Health and Safety Code.

### **Acknowledgement**

The opinions in this paper reflect the findings produced in the final report "*Asbestos in Asphalt*" Calgary, Alberta submitted to The City of Calgary Roads Business Unit by Golder Associates Ltd. November 27, 2008.

The presenters would like to express their appreciation to the staff of Golder Associates Ltd. for conducting an occupational hygiene assessment to determine the potential for worker exposure to asbestos during the various processes of The City, Roads Business Unit that impact asbestos-containing asphalt and the use of recycled asphalt pavement (RAP).

Without their help, this report would not have been possible.

### **References**

*Asbestos in Asphalt, Calgary, Alberta* submitted to The City of Calgary Roads Business Unit by Golder Associated Ltd. November 27, 2008.