Best Management Practices to Mitigate Road Dust from Winter Traction Materials

March 2005

Ministry of Water, Land and Air Protection
Acknowledgements

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Background

Two key aspects of the BC Ministry of Water, Land and Air Protection’s (MWLAP) mandate are:

1. To limit adverse effects of the individual and collective activities of British Columbians on the environment; and
2. To contribute to health and well-being (including safety) of British Columbians through the provision of clean and safe water, land and air.

Many communities in BC face the issue of road dust generated from winter traction materials (i.e., sand, aggregate, and associated de-icing compounds) applied during the snow and ice season. Fine fraction particulates contained within accumulated winter traction materials can be entrained and suspended by vehicular traffic, contributing to reduced air quality.

In response to this issue, local municipalities of BC’s interior have developed various measures to mitigate the generation of road dust associated with winter traction materials including the reduction of quantities applied, the selection of specific traction materials, and the implementation of specialized maintenance procedures. An acute dilemma faced by municipal planners and road managers is the trade off between ensuring the safety of the travelling public (i.e., road users) through the application of winter traction materials and addressing air quality issues associated with dust from these materials.

To aid local governments, planners, and road maintenance crews, MWLAP has developed this best management practices document to guide the management of road dust generated from winter traction materials. The following BMPs provide municipal planners and road maintenance staff with options for reducing road dust while achieving road safety and environmental requirements.
Air Quality Issues

Loose materials, such as silt and sand, that have accumulated on roadways can be suspended into the atmosphere by the tires of vehicles. These suspended particulates are referred to as “road dust”. At some locations near roadways the measured concentration of dust or fine particulates in the air is significant, resulting in impaired air quality and poor visibility.

Sands and other aggregate applied to roadways as winter traction materials can be a significant source of road dust particularly in the spring when snow melts and winter traction materials have accumulated on the dry road surface. The movement of passing vehicles suspends particles contained within the these materials and creates dust. A visible dust cloud can often be seen behind passing vehicles in the springtime before roads have been mechanically swept clean or naturally washed by rainfall. This dust may reduce visibility for roadway users and may lead to elevated concentrations of inhalable particulate such as PM$_{10}$ (particulate matter less than 10 microns in diameter), resulting in poor air quality. Occasionally, the province will issue air quality advisories to protect the public during periods when elevated concentrations of PM$_{10}$ persist.

Figure 1 shows the seasonal variations in PM$_{10}$ in communities where traction material is applied heavily in winter. The peak seen in February and March at all sites is primarily due to traction material left on the roads and highways after snow and ice have melted.

The amount of road dust generated from sands and aggregate applied as winter traction materials depends on the quantity, size and shape of applied materials, the ability of work crews to remove these materials from the road surface, and the level of traffic on the roadways. The timing and frequency of road surface cleaning is critical to ensure that winter traction materials do not remain on roadways where they may lead to air quality and visibility concerns.

In general, the term ‘winter traction materials’ also refers to de-icing and anti-icing compounds (i.e., road salts). While these compounds are known to have potential impacts on water quality, they have been shown to have only a small impact on air quality. They are often applied in liquid form and even when used in solid states are formed of soluble particles which do not lodge in the lungs in the same way that fine silt particles do. Research studies in the American cities of Denver, Colorado and Reno, Nevada indicated that while winter traction materials contributed around 60% to the ambient PM$_{10}$ levels, de-icing materials contributed approximately 1% (Salt Institute. 2001). Based on this evidence, the use of road salts and de-icers alone (i.e., applied without sand or aggregate) may seem attractive to reduce potential air quality impacts. In fact, some jurisdictions such as Colorado and Utah have moved towards replacing sands and aggregate with salt in order to reduce road dust.
Seasonal variations in 24-hour PM$_{10}$ measurements at select TEOM sites.
From: National Library of Canada Cataloguing in Publication Data, Suzuki, Natalie M. Particulate matter in BC : a report on PM$_{10}$ and PM$_{2.5}$ mass concentrations up to 2000.
Seasonal variations in 24-hour PM$_{10}$ measurements at select TEOM sites.
However, winter traction materials are often required when temperatures are too low for de-icers to work and for less traveled roadways where it is impractical to maintain bare pavement. It is also necessary to consider the impacts of increased use of road salt on local aquatic environments, groundwater, plants and animals.

Legislation and Performance Standards

There are no specific federal or provincial regulations concerning road dust from winter traction materials. In its Maintenance Services Manual, the BC Ministry of Transportation lists highway maintenance requirements (i.e., standards) that include the quality of winter abrasives, the application rate, and timing of application. The broader issue of air quality impacts from road dust are indirectly managed through the provincial Environmental Management Act. Because dust is one of many PM$_{10}$ sources, it is best managed through airshed plans, which are mainly voluntary, but which can use both provincial and municipal legislation when required.

Ambient ground-level concentrations of particulate pollutants (i.e., particulate matter smaller than 10 microns (PM$_{10}$) and particulate matter smaller than 2.5 microns (PM$_{2.5}$)) are regulated by provincial and national air quality objectives. Objectives exist for the 24-hour averaging periods as shown in the table below. These are objectives that communities should meet for all forms of particulate, including road dust.

**Relevant Air Quality Objectives and Standards for PM$_{2.5}$ and PM$_{10}$ (µg/m$^3$) (Air Quality Objectives for British Columbia and Canada. MWLAP. 2004)**

<table>
<thead>
<tr>
<th>Particulate Species</th>
<th>Jurisdiction</th>
<th>Level</th>
<th>Ambient Air Quality Objective (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{2.5}$</td>
<td>Canada-Wide Standard</td>
<td>Target*</td>
<td>30</td>
</tr>
<tr>
<td>PM$_{10}$</td>
<td>Provincial</td>
<td>Objective</td>
<td>50</td>
</tr>
</tbody>
</table>

*The achievement of this standard is to be based on the 98th percentile ambient measurement annually, averaged over three consecutive years. The standard is to be achieved by 2010 with requirements for periodic reviews and interim reporting beginning in 2005.*
Traction Material Management in the US

Several US jurisdictions that have had trouble achieving US national standards for ground-level particulate concentrations have gone further in their efforts to regulate road dust.

Several US states have established specific requirements for winter traction materials including:

- sizing, hardness and shape of the particles;
- legislated reductions in the application of winter traction materials;
- sweeping procedures;
- reporting requirements for users of winter traction materials; and
- the development of local management plans in cooperation with state and local street maintenance officials and winter traction material suppliers.

Some jurisdictions such as Montana, Utah and Colorado have amended their state clean air plans to replace sand with salt to the greatest extent possible. These actions, while reducing road dust, have increased the amount of salt applied to roadways and may result in increased environmental effects on vegetation and water bodies near the roadways.

The MoT requires their contractors to meet the following specifications for winter traction materials:

<table>
<thead>
<tr>
<th>Maximum Particle Size</th>
<th>Class A &amp; B</th>
<th>All Class C and Class D Paved Only</th>
<th>All Class D Gravel Highways</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metric Screen Size*</td>
<td>12.5 mm</td>
<td>16 mm</td>
<td>19 mm</td>
</tr>
<tr>
<td>19 mm</td>
<td>n/a</td>
<td>n/a</td>
<td>100%</td>
</tr>
<tr>
<td>16 mm</td>
<td>n/a</td>
<td>100%</td>
<td>n/a</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>100%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>n/a</td>
<td>80-100%</td>
<td>80-100%</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>50-95%</td>
<td>50-95%</td>
<td>50-95%</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>30-80%</td>
<td>30-80%</td>
<td>30-80%</td>
</tr>
<tr>
<td>0.600 mm</td>
<td>10-50%</td>
<td>10-50%</td>
<td>10-50%</td>
</tr>
<tr>
<td>0.300 mm</td>
<td>0-25%</td>
<td>0-25%</td>
<td>0-25%</td>
</tr>
<tr>
<td>0.075 mm</td>
<td>0-6%</td>
<td>0-6%</td>
<td>0-6%</td>
</tr>
</tbody>
</table>

* The figures shown represent the percent of material which passes that particular screen size.

Road Salt Use

Because of the potential for environmental harm to result from salt use, road salt is considered a scheduled substance under the Canadian Environmental Protection Act. Several documents, provide direction on the legislative standards that apply to road salt use; two of these are: Roadsalt and Winter Maintenance for British Columbia Municipalities - Best Management Practices (Warrington, 1998) and the Federal Code of Practice for Environmental Management of Road Salts (Canada, 2004). http://canadagazette.gc.ca/partI/2004/20040403/pdf/g1-13814.pdf.
Best Management Practices

The following BMPs are provided as guidelines to help you mitigate road dust generated by winter traction materials. Many of these strategies are already successfully used locally by road maintenance agencies.

Material Selection

Winter traction materials include abrasive materials used on snow- and ice-covered roads to improve vehicle traction. To reduce potential dust generation from sands and aggregate applied to road surfaces in winter, one of the most basic steps that can be taken is to reduce the finer particle fraction of traction material.

- Select a sand or aggregate that has been screened or washed to reduce the fine particle fraction. Very small particles have actually been found to decrease traction. Material larger than 300 microns in diameter has been found to be most effective.
- Use winter traction materials with angular particles (i.e., crushed) for better traction. This material is better able to embed in or hold to the road surface than rounded traction materials (i.e., pit-mined aggregate). Traction materials can therefore remain on the road surface longer and reduce the need for, and cost of, reapplication. Even the selection of a coarser sand can lead to a reduction in the volume of material applied as each application stays on the road surface longer.
- Use a durable aggregate less likely to breakdown through road wear. Some of the fine particulate found on road surfaces is created by the crushing action of vehicle travel. By selecting more durable materials (coarser sands, harder crushed aggregate), you can retain the larger fraction particles that contribute to improved road friction and reduce the generation of fine particles.

Material Application

Once winter traction materials have been selected, several application options exist to reduce the total volume of traction materials applied to winter roads without compromising public safety.

- Reduce application rates as much as possible while maintaining service that is appropriate to your area. Application rate standards are not provided in this BMP; rather, efforts should be made to choose application rates suitable for your local road conditions (i.e., type of surface, grade, travel speed, level of use), and current and forecast weather conditions (i.e., temperature, precipitation, time of day).
- Consider applying liquid de-icing compounds in conjunction with winter traction materials. Pre-wetting aggregate with a liquid Magnesium Chloride (MgCl₂) or Calcium Chloride (CaCl₂) brine as the traction material is spread can help the material to embed into ice or snow on the road’s surface. By increasing the durability of the traction material applied to the road surface, these chemicals can significantly reduce the...
volume of winter traction material used. While the use of de-icing compounds brings an added cost, operations departments have offset the costs of purchasing and applying de-icing chemicals through savings achieved by resulting reductions in the volume of winter traction material used.

- Consider the use of alternative winter traction material treatments. Several studies in Scandinavia have tested the application of heated aggregate. In these studies, heated aggregate was seen to provide longer lasting increased surface friction than sand/salt combinations.
- Consider the use of innovative equipment for applying winter traction materials and for maintaining them on road surfaces. As an example, spreaders are available that discharge material with a rearward velocity equal to the truck’s forward velocity, so that the material lands on the roadway with zero net velocity and stays in the travel lane. Graders and plows equipped with toothed blades are also used in some areas to help retain aggregate on road surfaces.
- Apply materials with appropriate equipment to limit spillage and unnecessary application of materials, such as that which may occur if sand is continually spread when a sanding truck is stopped or reversing. Calibrated spreaders, particularly those equipped with electronic spreading devices, can apply winter traction materials at a precise and consistent application rate regardless of the truck’s speed, so that material is not overly applied when trucks slow down for curves and intersections.

**Material Collection/Clean-up**

In spring, road surfaces warm and snow and ice melt. Accumulated winter traction materials loosen and dry, and their fine fraction can be entrained by traffic and wind. Because of this, spring cleaning of accumulated winter traction materials is an essential part of mitigating road dust.

- Consider the application of dust suppressants to control dust generation in later winter as snow begins to melt. Several areas use de-icing compounds or other dust suppressants for this purpose.
- Schedule the removal of accumulated winter traction materials as early in spring as possible to shorten the potential period of dust generation. Material collection should be initiated as early as local weather permits.
- Apply dust suppressants during spring clean-up activities. Wetting traction materials with water or other dust suppressant compounds will help reduce dust generation during collection. Some municipalities use de-icing compounds for dust suppression as this allows them to begin material collection during the cool temperatures of early spring.
- Ensure that equipment used for material collection is well maintained and functioning. Several types of road sweepers are available, including mechanical broom sweepers (useful for heavier materials but less efficient in removing fine particles), vacuum sweepers (effective pick-up of material near curbs but inefficient cleaning along the entire sweeping width), and regenerative air sweepers (more thorough cleaning of all
particle sizes over the road surface). The cost of regenerative air sweepers may be 2 to 2.5 times the cost of a traditional sweeper, however the operation cost and service life are comparable.

**Prince George's Example**

Through material and technique choices, the City of Prince George has been successful in addressing road dust concerns arising from the use of winter traction materials.

**Material Selection**

The City of Prince George uses winter sand as a primary winter traction material. In 1997 they began to use a coarser winter fracture product in their downtown area and on arterial roads. The coarse fracture aggregate contains virtually no silt (0% passing through a 1.2 mm screen) but comes with an increased cost (approximately three to five times that of winter sand). This cost is partially balanced by savings seen in the reduced volume of material needed, as the coarser fracture product has greater durability on icy winter roads.

**Material Application**

Coarse fracture material and winter sand is applied with standard spreaders equipped with spray equipment to pre-wet the traction material with a liquid salt brine. In 1998, the City began trials of anti-icing techniques (with a Pacific Northwest Snowfighters (PNS) approved salt brine) used to address traction concerns on their downtown area and arterial roadways. By pre-wetting material at application and using anti-icing to limit the accumulation of snow and ice on road surfaces, coupled with the increased durability of the winter fracture, the volume of winter abrasives applied to these roads has been reduced.

**Material Collection/Clean-up**

Spring cleaning activities usually begin in mid- to late March, depending on weather conditions, and extend for a period of approximately 10 weeks. Both day and afternoon shifts (winter crews transition from nights to afternoons to take advantage of warmer temperatures when the need for nighttime snow and ice control is reduced) are used to complete cleaning activities as quickly as possible. The City uses mechanical sweepers; vacuum sweepers were tested several years ago, but the City found them to be less efficient at removing the volume of material found on Prince George roads although their use at collecting fines remaining after mechanical sweeping was considered.

Use of a dust suppressant before sweeping is mandatory for Prince George crews. The City of Prince George uses salt brines in their spring sweeping and spends up to $1250 per day on the brine necessary for it. By using a salt brine rather than water as a dust suppressant during spring clean up, sweeping activities can begin in very early spring and be carried out both day and night, when low temperatures prevent the use of water.

Concerns have been raised regarding the use of salt brines with early spring clean-up activities. While the severity and duration of springtime dust episodes may be lessened by the use of salt brines, road salts contribute chloride to soils, groundwater, and watercourses. Salt brines are also more expensive than the water used typically as a dust suppressant for spring cleaning. In Prince George's case, the use of salt brines was considered an acceptable trade-off for allowing increased sweeper productivity and earlier clean-up of accumulated traction materials – a key step in mitigating spring road dust.

For more information, contact:

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City of Prince George Tel. 250-561-7503; or fblues@city.pg.bc.ca
http://www.city.pg.bc.ca/
Key Information Sources

The documents and websites listed below are recommended resources for managing road dust and winter traction materials. Additional information on materials and equipment options is appended to this document.


**Particulate matter in BC : a report on PM\(_{10}\) and PM\(_{2.5}\) mass concentrations up to 2000.** Environment Canada and Ministry of Water, Land and Air Protection, May 2003.
http://wlapwww.gov.bc.ca/air/particulates/pdfs/pmreport_final/pmreportfinal_feb04.pdf

http://www.sicop.net/Abrasives%20report.pdf


http://wlapwww.gov.bc.ca/air/particulates/fpwtaaht.html

http://wlapwww.gov.bc.ca/wat/wq/bmps/roadsalt.html

**Road Salt and Snow and Ice Control Primer.** Transportation Association of Canada. December 1999.

http://www.ec.gc.ca/science/sandejan02/article3_e.html


Checklist for Environmental Protection Requirements

☐ Have you selected winter traction materials (i.e., sands and aggregate) that are:
  - Washed/screened to reduce the fine particle fraction;
  - Angular; and
  - Durable?

☐ Have you taken steps to reduce over-application of winter traction materials by:
  - Carefully selecting application rates suited to current road and weather conditions;
  - Applying sand and aggregate in combination with de-icing compounds or heat;
  - Using maintenance equipment (e.g., spreaders, plows) that will help retain winter traction materials on the road surface; and
  - Using computer-aided or calibrated spreading equipment that allows better control of application rates?

☐ Does your materials collection plan to reduce the potential for spring road dust generation include:
  - Using dust suppressants in later winter to control dry materials prior to spring cleaning;
  - Scheduling road surface cleaning activities for early spring, as soon as weather permits;
  - Using dust suppressants during cleaning activities (i.e., pre-wetting materials before collection); and
  - Using equipment able to remove fine particles as well as coarser grains from the road surface?
Appendix 1: Annotated Bibliography

North America


The strategy reviews air quality impacts of traction materials applied to roads for the Bulkley Valley – Lake District, BC. The highest impacts occur during air quality episodes that are a result of freeze / thaw cycles in the spring before road maintenance operators can remove traction materials. Strategies and techniques employed by local road maintenance operators are reviewed and planning goals are outlined.


The Air Quality Control Commission Regulation 16 was included as part of the Colorado State Implementation Plan strategy and establishes specific requirements for abrasive materials, sanding reductions, sweeping requirements and reporting. Street sanding material requirements including percent fines and durability index are specified. Reduction requirements of wintertime street sand and paved road dust emissions are outlined for different PM$_{10}$ non-attainment areas.


The use of abrasives in winter maintenance and current practice in Iowa Counties is reviewed. The report includes a survey of literature on the effectiveness of sanding as a winter maintenance procedure. Evidence is presented that demonstrates that applying abrasives dry is of limited value in providing lasting friction enhancement especially to high speed roadways. Recommendations for the application of abrasives on different road types are provided. Several novel methods of abrasive application that improve performance such as pre-wetting of abrasives before application and using salt/ sand mixtures are discussed.


The report focuses on the impact of winter traction materials on water bodies adjacent to roadways; however, numerous best management practices are presented that would minimize fugitive dust impacts of winter traction materials.
Mitigation of Road Dust From Winter Traction Materials

materials, including: street sweeping, improved anti-icing and de-icing practices, improved sanding practices, appropriate application rates and snowplow technologies. The report focuses on cold regions and rural transportation.


The Prince George Airshed Technical Management Committee prepared this Air Quality Management Plan based on input gathered from the public, industry, environmental groups and health professionals. Among other recommended actions, measures to mitigate dust from street sanding, unpaved areas and other sources in the City of Prince George are put forward.


After the completion of the three-year air quality assessment by the Quesnel Air Quality Roundtable, 28 recommendations were developed for improving air quality, specifically with regard to PM$_{10}$ and PM$_{2.5}$. These recommendations pertain to improvements in air quality by all sectors: industry, municipal and regional governments, business owners, and local residents. The recommendations range from public education on backyard burning and home heating to improved dust control and reductions in emission levels by industry.


This document provides a review of a number of studies conducted in Albany, NY, Denver, CO and Reno, NV where the impact of wintertime road sanding and/ or salting on ambient particulate loadings were assessed. These studies indicate that sanding contributed to more than 45% of the PM$_{10}$ particulate loading to as high as 89%. Particulate loading from de-icing salt was reported around 1%.


Road Salting and Sanding regulations and contribution to observed PM$_{10}$ concentrations are discussed. Under the Utah Air Conservation Regulations, sand applied to roads in any PM$_{10}$ non-attainment area must have no more than 10% passing through #16 mesh, less than 3% fines and a Vicker Hardness of 1000+. 

The bulletin provides a short summary of environmental impacts due to abrasives and indicates that cleaner abrasives and quicker clean-up after a storm event are required in areas with severe air pollution problems. The application of abrasives is reviewed and includes recommendations for the quality of abrasives, combining chemicals with abrasives and rates of application.


The current knowledge regarding street cleaning operations is reviewed. The authors conclude that while recently improved sweepers seem to effectively deplete the reservoir of material from which PM$_{10}$ particles can be generated, no studies to date have conclusively demonstrated the effectiveness of street sweeping to reduce ambient concentrations of suspended PM$_{10}$ after sweeping is complete. Several studies have indicated that the sweepers themselves generate substantial fugitive dust PM$_{10}$ emissions.

**Europe**


Nineteen European countries participated in an initiative conducted by COST, an intergovernmental framework for European Cooperation in the Field of Scientific and Technical Research. The project, known as COST Action 344, included six areas of research to generate improvements in program management, planning operations, operational practices, anti-icing products and spreading controls, measures to treat modern road and bridge surfaces, and driving information. The aim of the task group’s work was to find the “best practice” of winter maintenance in Europe. The different winter maintenance practices currently in place in the European countries are documented and the reader is suggested to select the best practice according to his/her own characteristic boundary conditions.

In light of the new Swedish ambient air quality standard for PM$_{10}$ (effective January 1, 2005), the Swedish government directed the County of Stockholm to develop a set of measures to meet the new standard. Suggested measures for immediate implementation include pre-wetting of abrasives, pavement improvements, and improved street sweeping activities. Mitigation measures to be implemented in the long-term are also discussed.


This study investigates the road dust mitigation methods and strategies that are used by Swedish municipalities and road authorities, as well as the awareness among these concerning the dust mitigating efficiency of measures taken. The results show that dusting from roads is to a high degree considered a problem among municipalities and road authorities but a majority of municipal environmental directors do not regard it as a problem. The knowledge about the contribution of road dust to ambient PM$_{10}$ concentrations is low among local and road authorities. Sanitary concerns, as well as safety and health concerns, are the main reasons quoted for undertaking road dust mitigation measures, of which the most common method is wet sweeping. There are no methods currently in use with the goal of reducing PM$_{10}$ concentrations. Neighbouring countries to Sweden were also surveyed on their knowledge of road dust and sweeping by means of literature studies as well as contacts with various road authorities. In Helsinki, Finland, the road dust problem is mainly blamed on winter sanding and has been addressed since the late 1980s by use of an ambitious sweeping method. In Oslo, Norway, road dust is blamed on studded tires and efforts have been focused on reducing studded tire frequency. Sweeping methods have been evaluated and the results have been implemented in road and street sweeping. Neither in Helsinki nor in Oslo have the sweeping methods and strategies used been proven to reduce PM$_{10}$ concentrations. The report recommends that municipalities and road authorities test different strategies while drawing upon Finnish and Norwegian experience.


This study investigates new sanding methods based on a mix of hot water and sand. Studies that are reviewed indicate that by adding hot water to the sand a friction level above the standard can be maintained after the passage of 2,000 vehicles. Under favourable road and weather conditions, satisfactory friction values have been maintained for up to 3 to 7 days with annual average daily traffic of 1,500 vehicles. This compares to using cold and dry sand on winter roadways where traction is reduced after the passage of only 50 vehicles. The new sanding method can be used under conditions
such as hard blue ice, roads with high percentage of heavy vehicles and thin ice or frost on asphalt, where traditional methods have little effect.

Other Papers of Potential Interest


Kinsey, J.S. 1992. Selection criteria for antiskid materials as a control for fugitive PM$_{10}$ from paved roadways. Prepared by Midwest Research Institute, Kansas City, MO.