BEST PRACTICES FOR THE USE AND STORAGE OF CHLORIDE-BASED DUST SUPPRESSANTS

This is a synthesis of best practices related to the use and storage of chloride-based dust suppressants, specifically calcium chloride and magnesium chloride. Both liquid and dry forms of these dust suppressants are addressed within this best practices document. This synthesis is provided as advice to government agencies that arrange for the application of dust suppressants as well as those organizations that apply chloride-based dust suppressants. This synthesis is not intended to be used prescriptively but is to be used in concert with the legislation, manuals, directives and procedures of individual road agencies as well as the advice of chloride-based dust suppressant suppliers. Those organizations reviewing this best practices document should consider their own unique circumstances when determining which of the practices outlined below should be implemented.

INTRODUCTION

The two largest sources of total particulate emissions in Canada are road dust from unpaved roads and paved roads. These sources are also significant contributors to PM_{10} and $PM_{2.5}$ emissions in Canada (particulate matter less than 10 and 2.5 microns in diameter respectively). Road dust emissions have negative consequences on human health and the environment as well as reduce visibility and lower property values.

There are numerous activities that can mitigate road dust emissions such as applying dust suppressants, planting vegetation in proximity to the road, paving the road surface, etc. The two most commonly used dust suppressants are calcium chloride and magnesium chloride. These chlorides act as a desiccant, attracting moisture from the air, thereby maintaining a damp road surface and minimizing road dust emissions.

Apart from mitigating road dust emissions, chloride-based dust suppressants also provide other benefits, for instance:

- Maintaining a high percentage of fines on the road surface. When fines are lost, the gravel loosens on the surface, leading to wash-boarding and reduced skid resistance. Therefore, fresh gravel with a higher percentage of fines needs to be hauled in, which can be expensive.
- Maintaining a high percentage of fines on the road surface also allows the stone portion of the gravel to remain embedded in the surface. Therefore, the stones are not thrown to the edge or even off of the road. This reduces the amount of gravel that has to be replaced.
- Road surfaces that are tightly bound and stable require less grading. This reduces equipment and labour expenses.

While there are numerous benefits to the use of chloride-based dust suppressants, excessive use or poor application practices can have negative environmental impacts. As a result, road authorities and applicators of dust suppressants are taking actions towards implementing best management practices. The purpose of this document is to assist these organizations in maximizing the effectiveness of chloride-based dust suppressants and consequently reducing their releases to the environment.

Outlined in this document are the best practices that may be applied when using and storing chloride-based dust suppressants. These best practices apply to both calcium chloride and magnesium chloride and are discussed within the following categories:

- Road preparation prior to application of chloride-based dust suppressants;
- Application of chloride-based dust suppressants;
- Maintenance of unpaved roads; and
- Storage of chloride-based dust suppressants.

CONTENTS

ROAD PREPARATION PRIOR TO APPLICATION OF CHLORIDE-BASED DUST SUPPRESSANTS

The application of chloride-based dust suppressants will be more effective and cost efficient on unpaved roads that are already in good shape – having a proper crown, adequate drainage, a good mix of fines and aggregates, and a well-compacted surface.

Ensuring that the road base is properly constructed as well as selecting and applying the most appropriate gravel specifications will maximize the effectiveness of any chloride-based dust suppressant that is applied.

It is prudent to adopt the following practices in the preparation of road surfaces prior to applying chloride-based dust suppressants:

- Repair unstable areas of the road/subgrade with compatible materials prior to using chloride-based dust suppressants. Grade sufficient depth of roadway to remove ruts, potholes, washboards, loose excess surface material, and erosion gullies to expose a hard surface. Adequately drain (type "A" crown and crossfall) the road surface (i.e. shape the road surface into a proper crown of ½ inch per foot). Provide adequate crossfall from the crown - minimum of 3 to 4%, maximum of 5%.
- To achieve the best dust control and stabilization results, it is suggested that the average gradation mix be used as a guide. The material specified should contain sufficient moisture to ensure compaction to design density. When needed, incorporate any fines from the shoulder into the road mixture. Moistened aggregate or fines may have to be added to ensure proper compaction. Recycled asphalt can also be used as a source of aggregate when sufficient fines are present. Make the additions in layers, blending with existing material.
- If quality gravel is not present on the road, fresh gravel should be brought in prior to the application of the dust suppressant. The selection and application of proper gravel specifications (i.e. typically 5/8 or 3/4 inch) for the unpaved road is extremely important to achieve maximum dust control with chloride-based dust suppressants.
- Where possible, utilize gravel material that results in less road dust. Some limestone gravel can result in severe dusting, while other gravel with a portion of highly plastic clay, impart strong binding properties that resists dusting. The gravel itself must have a good gradation, specifically a good percentage of fines (e.g. 8-10%) with some plasticity.
- Aggregate material should be distributed evenly from a moving truck spreader box or a powered spreading machine. Do not dump aggregate material upon the surface. If the material is placed in windrows, spread by blading. Final surface materials should be comprised of 10 to 15% fines and no gravel in excess of 1 inch in diameter. If the fines content is over 25%, the road surface tends to become impervious resulting in frost heave and consolidation problems.
- A densely graded material will retain moisture longer and therefore generate less dust. More highly processed materials with durable and well-shaped aggregates can usually bind together with less fines than naturally occurring materials, and thus generally produce less dust. Add clayey (cohesive) material to a coarsely graded material to improve binding.
- Consider applying stone dust or clay fines to unpaved roads where the gravel is too clean. This can significantly mitigate road dust and reduce the need/quantity of chloride-based dust suppressant.
- Do not compact the road prior to the application of the chloride-based dust suppressant.
- Since standing water is the main cause of potholes and road base failure, reshape shoulders to promote runoff, clean ditches for good drainage and clean and repair culverts. Remove all sod berms and grass that prevent free drainage.
- Ensure that prior to the application of chloride-based dust suppressant, the windrows of aggregate are in place at both sides of the unpaved road. This will avoid any run off during application or if there is a rupture of one of the lines on the applicator unit.
- Depending on the manufacturer's directions, the dust suppressant may be applied on top of the old surface and mixed into the new lift or just applied to the surface. Consider mixing in chloride-based dust suppressants when stockpiling surface course gravel.

APPLICATION OF CHLORIDE-BASED DUST SUPPRESSANTS

Once the unpaved road has been properly prepared, dust suppressants can then be applied. There are many different factors to take into account when applying dust suppressants in order to minimize their usage and maximize their effectiveness. The best practices with respect to the application of chloride-based dust suppressants are discussed within the following categories:

- When to apply;
- How much and how often to apply; and
- How to apply.

When to Apply

- Ideally, application should begin in late spring, after the seasonal rains so that sub-grade and surface materials will not have dried. Do not apply chloride-based dust suppressants during or just before a heavy rainfall or if rain is threatening for at least 36 hours. If applied just before a rain, the material may wash away.
- Chloride-based dust suppressants work most effectively if they are applied to a wet road. Application to a dry road surface makes a noticeable difference in how much less effective the solution works for dust control. If possible, apply chloride-based dust suppressants after a rain so materials are moister (aids mixing) and more workable. A light rain is helpful, provided the moisture can soak into the ground and not run off.
- If the surface has minimal natural moisture, pre-wet the surface with water to reduce surface tension, to develop the capillary action that allows maximum penetration of chloride-based dust suppressants, and to ensure uniform application. Ensure that water applied to the road is free of contaminants that could adversely affect the fill material or the environment. It has been suggested that the top 25 mm of the surface should be saturated with water prior to the application of chloride-based dust suppressants. If a dust-coat has already developed, regrade and moisten. If dry flake is to be applied, a water spray prior to application is recommended.
- In general, cooler and/or more humid periods result in decreased evaporation, increased surface moisture, and thus significant increase in control efficiency. However, be careful of applying chloride-based dust suppressants when the temperature is below 4ºC. For example, higher concentrations of liquid calcium chloride (e.g. 42%) can crystallize in early spring (in the cold weather), thereby making the road surface extremely slippery. Typical concentrations of calcium chloride (e.g. 35%) should be applied at this time of the year.
- Early morning or evening application is preferred during hot sunny periods to avoid rapid evaporation of applied water.
- The application of chloride-based dust suppressants should be staged in the spring based upon how quickly the road dries out. Built up roads, which usually have the highest traffic volumes and are the driest, are treated first while they still retain some moisture. Wet roads should be treated last.
- Road managers should evaluate their roads to determine the proper application rate for chloride-based dust suppressants as well as the order in which dust suppressants are to be applied to these roads. Traffic count information could be utilized to determine the most heavily used roads, as well as those roads that are used more often by trucks, school buses and farm equipment. Balance the application of chloride-based dust suppressants based upon traffic volumes.
- Restrict the use of chlorides within 8 meters of a body of water. In areas of shallow groundwater, determine if significant migration of the chloride would reach the groundwater table. Restrict the use of chlorides if low salt tolerant vegetation is within 8 meters of the treated area. Typical low-tolerant vegetation includes various varieties of alder, hemlock, larch, maple, ornamentals and pine.
- Chloride-based dust suppressants should not be applied at profile grade for the 2 weeks prior to the road surface being paved. These dust suppressants promote the retention of moisture at profile grade causing asphalt cement to be stripped from the pavement material.
- Consider applying chloride-based dust suppressants during the weekends on ideal moisture days.
- Use dry chloride-based dust suppressants for smaller applications. The bags are easy to store and the dry material requires less specialized equipment to apply. Liquid chloride-based dust suppressants, which are less expensive, easier to handle, and easier to apply, are best for larger projects.
- If there is uncertainty with respect to the suitability of the gravel, equipment or other products being utilized, then apply the chloride-based dust suppressant on a 100-200 meter section of the road. This will allow a determination of effectiveness, prior to the full-scale application.

How Much and How Often to Apply

- More than one treatment with chloride-based dust suppressants is often necessary per year, although the second treatment should probably be significantly diluted. Follow manufacturers' application rate suggestions. Some initial application rates for calcium chloride and magnesium chloride are listed in the following table.

Comparison of Calcium Chloride and Magnesium Chloride Application and Performance[1]

Source	Application	Functional Mechanism	Performance Advantages	Performance Restrictions
Calcium Chloride				
Three forms : ➢ Type I flake, at 77% to 80% purity. ➢ Type II flake, at 94% to 97% purity. ➢ Clear liquid at 35% to 38%.	➢ Usually one to two treatments per year. ➢ Follow-up: apply 1/2 to 1/3 initial dosage. Flakes: ➢ Initial application, flake: at 0.5 to 1.1 kg/m^2 Liquid: ➢ Typical application 0.9 kg/m^2. ➢ Typical application liquid: 35% to 38% solution at 0.9 to 1.6 l/m^2.	➢ Attracts and retains moisture at a relative humidity of 29% at 25^{o}C and 20% humidity at 38^{o}C. ➢ Assists compaction. ➢ Treated road can be regraded and recompacted with less concern for losing moisture and density.	➢ Retains moisture and attracts moisture from the air. ➢ Lowers freezing point of water minimizing frost heave and reducing freeze-thaw cycles. ➢ Increases compacted density of road material. ➢ Effectiveness retained after reblading.	➢ Slightly corrosive to metal, highly to aluminum and its alloys. ➢ Rainwater tends to leach out highly soluble chlorides. ➢ If high fines content in treated material, the surface may become slippery when wet.
Magnesium Chloride				
➢ Produced from natural salt brine. ➢ By-product of potash production.	➢ Usually one to two treatments per year. ➢ Initial application: 28-35% solution. ➢ Typical application: 1.4 to 2.3 l/m^2. ➢ Follow-up: apply 1/2 initial dosage.	➢ Attracts and retains moisture at a relative humidity equal to or greater than 32% independent of temperature. ➢ More effective than calcium chloride solutions for increasing surface tension, resulting in a very hard road surface when dry. Treated road can be regraded and recompacted with less concern for losing moisture and density.	➢ Reduces evaporation rate of moisture in the road. ➢ Lowers freezing point of water minimizing frost heave and reducing freeze-thaw cycles. ➢ Increases compacted density of road material more so than calcium chloride.	➢ Corrosive to steel, though inhibitors can be added. ➢ Solubility results in leaching during heavy precipitation.

[1] Table based upon the National Guide to Sustainable Municipal Infrastructure (InfraGuide), 2005. Dust Control for Unpaved Roads, version 1.0. October 2005. InfraGuide is a national network established by the National Research Council (NRC), the Federation of Canadian Municipalities (FCM), Infrastructure Canada and the Canadian Public Works Association. For update information, please visit www.infraguide.ca

- Application rates are typically increased on unpaved roads with the highest traffic volume. Dust suppressant application rates should be increased when relative humidity is low (e.g. <40%) as well as when the fines content is low (<10%).
- Treat the road a second time before the first application becomes totally ineffective. Make the second treatment in late summer or early fall if the first was in the spring. A second application in late summer will maintain dust control throughout the fall months and will help protect the road from frost heave during winter.
- Liquid chloride-based dust suppressants are preferred due to greater assurance of more even distribution of the chemical. Users can sparge (mix with water) dry flakes to produce a liquid. However, flake dust suppressants can be spread directly onto unpaved surfaces without first being put into solution. Special consideration must be taken to make sure adequate moisture is available to the dry flake dust suppressant. This is usually accomplished by adding water to the unpaved surface, before or after the flake chloride-based dust suppressant has been applied.
- Ensure that the necessary "residual" of the product is obtained. The residual is the amount of product that remains after the evaporation of water from the concentrate, as well as that used to dilute the product prior to application. The residual is the portion of the product that is responsible for the binding and/or agglomeration of the particles.
- Maximum benefits can be achieved by adequate penetration of the liquid dust suppressant. This penetration should be on the order of 10 to 20 millimetres (3/8 to 3/4 inches). Proper penetration mitigates loss of the dust suppressant resulting from surface water. Adequate penetration also resists leaching, imparts cohesion, and resists aging.
- Due to the pounding of logging and mining roads, it is recommended that the application rate for chloride-based dust suppressants be increased over the standard rate when practicing dust control. Also the aggregate may be compacted more firmly on curves to help keep the material in place. In addition, because drivers frequently make sharp turns and turn-arounds in parking lots and particularly trucking terminals, the standard application rate of chloride-based dust suppressants may be increased when practicing dust control.

How to Apply

- Chloride-based dust suppressants can be applied in one of several ways, depending upon the width of the road and traffic volumes:
  - Narrow roads with low traffic volume require only a single pass down the centre.
  - Wider unpaved roads (i.e. three tracks) typically receive two passes, with a 6-foot overlap. This enables better coverage in the centre of the road, where twice the amount of traffic and wear occurs.
  - Two-lane gravel roads, which get the highest traffic volumes, should be sprayed in two passes with little (1 foot) overlap.
- The method of application of chloride-based dust suppressants depends on whether mixed-in-place application or topically sprayed application is desired. For topically sprayed application, power sprayers are used, while flakes are spread. In the case of mix-in-place application, the road surface is scarified, after which the suppressant is spread at an appropriate rate and thoroughly mixed with the road material.
- Chloride-based dust suppressants require accurate and efficient equipment for the delivery of the solution. Dry flakes are distributed onto the surface by means of an automatic spreader. Liquid dust suppressants are best applied by a positive displacement pump driven from a power source or from the wheels of the spreader/unit assembly. This system develops sufficient pressure at the spray bar nozzles to ensure uniform distribution of the solution at the specified application rate. Dribble-bars or a gravity-fed truck are unsuitable. Trucks should have automatic shut-off nozzles so that the chloride-based dust suppressant does not pool when the truck comes to a stop. Aluminium and its alloys must not be used in spreading equipment, as they deteriorate rapidly upon exposure to chlorides.
- Trucks should employ a rear-mounted distribution bar that spreads the liquid dust suppressant evenly. This distribution bar should be able to be set parallel to the road surface in varying increments and be set at varying widths so that the entire road surface can be sprayed (if necessary), including the shoulders.
- Distribution bar nozzles should ensure uniform fan-shaped spray without atomization. Nozzles should be set in the distribution bar at an angle that will allow each spray fan to pass behind the other such that if there is malfunction in one nozzle, the fans on either side would substantially spray the area what would have been missed.

- The vehicle used to apply chloride-based dust suppressants should be capable of maintaining a constant speed during application. The tank truck or spreader/unit assembly should be equipped with a suitable device, visible to the driver, to accurately determine the rate at which the solution is being applied. Suitable charts should be furnished to enable correlation of the vehicle speed and rate of application. If possible, use a programmable computerized system that will allow the most accurate application of the dust suppressant.
- Apply chloride-based dust suppressants evenly over the road surface. Typically, these dust suppressants should not be applied only to the middle of the road. One pass down the middle of the road may be acceptable, if the proper road preparation has been conducted. A proper crown will allow the dust suppressant to work its way to the shoulder of the road.
- Excessive application at the shoulder can lead to unwanted releases to the environment. Splash guards or other devices for shoulder application (on paved roads) should be used to enable spraying immediately adjacent to the pavement without over-spraying onto the pavement surface.
- Follow dry applications with enough water to ensure that the pellets or flakes are completely dissolved. When applying liquids, avoid runoff or puddling. Use several light sprays if the surface is tight. If areas are left uncovered by poor driving of the distributor, stop and add water before beginning to spread again. If penetration is poor, you may need to use a mix-in-place procedure.
- Following application, compaction of the final road surface is recommended to ensure penetration and particle cohesion. This will generally increase roadbed performance and dust suppressant life. Normal traffic can be used to compact the road surface on low-volume roads. For roads with a higher volume of traffic, use a roller to compact the bladed and shaped surface. Pneumatic rollers are preferred, however compaction can also be attained by the use of a steel roller, a rubber-tired roller or commercial vehicles (do not use a vibrator packer). Use of packers should continue until the surface is smooth and will not be disturbed when traffic passes. Ensure that the gravel does not start picking up from the surface when compacting. If this is occurring, wait until the surface cures until compacting is initiated again.
- Allow the treated road to cure up to 4 hours – until vehicles can drive on the road without picking up treated material on their wheels. Curing may take longer on roads with finer grained materials. If the road must be reopened to traffic in less than the desired curing time, apply a light coating of sand evenly over the surface of the road.
- Do not spread chloride-based dust suppressants over bridge decks (use auto shut-off valve to ensure no application). If the dust suppressant is spilled on a bridge deck or paved surface, immediately apply sand to cover the surface or commercial products to pick-up and clean the surface to prevent creation of a slick spot. Prevent road traffic on the slick spot until it is addressed.

MAINTENANCE OF UNPAVED ROADS

After application of chloride-based dust suppressants in the spring, certain maintenance activities can be undertaken to maximize the performance obtained from the dust suppressant. Application of the following maintenance practices should be considered:

- Most dust suppressants are re-workable unless otherwise stated by the supplier. Grading should be performed only when necessary, preferably when surface course materials are naturally moist. If necessary, grading may be performed on a dry surface course, but only following sufficient watering. Grading under dry conditions is very difficult and can lead to increased losses of suppressant and fines due to dusting.
- Grading should be performed at minimal depth, only deep enough to rework imperfections and allow the mixing in and reduction of float gravel. Grading should never be deeper than 10 cm to prevent excessive dilution of the suppressant. The "A" crown should still be retained. The number of gradings necessary is dependant on the desired level of maintenance and the roadbed performance.
- When grading prior to re-applying chloride-based dust suppressants, loosen a minimum of 1-2 inches of the existing surface and leave it loose at a uniform depth across the roadway. This will allow the chloride-based dust suppressant to penetrate quickly and evenly into the gravel.
- The grader should blade lightly from edges toward the centre and then feather the material back toward the edges. It is a good practice to blade in short sections so the area can be compacted before it dries out.
- During dry periods, water the road periodically to reactivate the chemical's hygroscopic properties. Apply water at the rate of 0.45-0.90 litres/m^2.
- Generally two applications of chloride-based dust suppressants are required during the year. The second application is usually applied on top of the freshly graded damp surface course regardless of initial application procedures.
- Do not apply chloride-based dust suppressants to hard packed roadways or to unpaved roads with little or no gravel. Road surfaces can become very slippery (after the dust suppressant is applied) when it rains under those road conditions.

- Re-gravel unpaved roads every 2-4 years. Ensure that an appropriate lift is applied when re-gravelling. Re-gravelling should only occur on those roads that can be done properly in a season with the resources available. Consider the need for fresh gravel when applying chloride-based dust suppressants in order to maximize the effectiveness of the dust suppressants.
- Avoid re-gravelling during the summer. Since there is no moisture during this time-period, it is hard on the roads. Re-gravelling and applying dust suppressant in the fall is more appropriate.
- Dust suppressant spreaders should be properly calibrated and periodically checked to ensure continued calibration. They should be recalibrated following any servicing of the delivery system.

STORAGE OF CHLORIDE-BASED DUST SUPPRESSANTS

To minimize releases of chloride-based dust suppressants to the environment during storage, there are several best practices that can be employed. Best practices are discussed with the following sections:

- General;
- Dry chloride-based dust suppressants; and
- Liquid chloride-based dust suppressants.

The "general" practices apply to either dry or liquid chloride-based dust suppressants.

General

- Locate and operate storage sites to minimize impacts to the natural environment and control nuisance effects, including noise, dust, litter and visual intrusion on adjacent landowners. Handle and clean up spilled material to minimize loss to the environment. Collect and reuse or properly manage chloride impacted site drainage and vehicle wastewater to comply with local water quality regulations and protect surface and groundwater resources.
- Properly space buildings and material storage facilities in order to manuver vehicles properly and safely. Locate parking, fuelling and loading/unloading areas as well as paved pathways to permit efficient vehicle movements and limit backing operations.
- The site should be graded to direct drainage away from the storage areas and to the extent possible, away from any down gradient groundwater well locations or chloride vulnerable areas. Chloride-laden water should be collected and properly managed. The water can be sent for disposal at sewage treatment facilities if permitted.

Dry Chloride-Based Dust Suppressants

- All deliveries should be covered when being transported to the maintenance yard. Deliveries should be arranged such that material is placed within the covered storage facility as soon as possible upon delivery. Deliveries should be scheduled for periods of good weather.
- Chloride-based dust suppressants can be stored in buildings, silos or covered piles. The storage system must be airtight, well ventilated, and protected from wet, humid conditions.
- When stored outside, the dust suppressant should have polyethylene or vinyl tarp covering the entire area. This cover must be held firmly in place by means of timber, old tires, sand, or other anchorage.
- If possible, place the dust suppressant inside storage structures. The roof and exterior of the storage structures should be constructed of waterproof material such that precipitation and moisture are prevented from entering the building. Where possible, the storage facility should be generally oriented such that the door is facing away from the prevailing wind direction.
- Bags of dust suppressant should be stored covered on an impermeable base. The storage floor at ground level should be paved asphalt or treated concrete. The floors should be inspected annually for cracks and repaired/resealed as required. The floors of all structures should slope away from the centre of the storage area for draining purposes.
- Any roof leaks, tears, or damage should be repaired to reduce the entrance of precipitation. At no time should leaks be allowed to persist when materials are being stored inside.
- Bags of dust suppressant should be placed on pallets or planks raised about 4 inches above the floor to permit air to circulate below the bottom tier. Bags should be kept in a flat position unless they are being used. Turning the bags from a flat position can break the seal on the bag valve sleeve. Once this happens the bag will not seal airtight.
- Typically, older bags should be used first. If, however, a bag becomes damaged it should be mended and used ahead of others. The tops of partially used bags should be rolled down tightly to the unused portion. If individual bags must be temporarily stored outdoors, the bottom tier should be laid on raised planks or pallets.
- Spills outside of storage facilities or within, or adjacent to maintenance yards should be collected and returned to the storage facility as soon as possible. Some yards use mechanical sweepers.

- Containers of the dust suppressant may be hazardous when empty since they retain product residues. Observe all warnings and precautions listed for the product. Containers may be recyclable, check with local recycling depots for details.

Liquid Chloride-Based Dust Suppressants

- Designers should consult with local environmental regulatory authorities regarding siting and containment requirements for storage facilities. Crash protection should be provided to prevent vehicles impacting the storage facilities.
- Construct storage facilities on low permeability pads to limit infiltration of chloride-laden drainage. Construct the loading pad of asphaltic concrete or other low permeability material at the entrance of the facility.
- Carbon steel is suitable for storage tanks. In general, 1/8 inch to 3/16 inch material should be added to the thickness to allow for normal corrosion losses. For intermittent service using a steel tank, a protective coating on the inside of the tank is recommended. Storage tanks should be of seal welded construction. Entrances and other openings of storage tanks should be gasketed to minimize the admission of moisture. Vents, manholes, overflows and proper pipe fittings should be included with the tanks.
- Storage tanks should be designed with a clean-out or flushing capability to remove settled impurities. Some liquids may require periodic circulation to prevent settlement of impurities, additives or product separation.
- Where practical, secondary containment should be provided through double walled tanks or containment dykes. Typically, containment capacity is 110-125% of the capacity of the largest tank.
- The required storage capacity will depend on the security of supply, production/delivery times and rate of use. Storage capacity can be reduced by using an “on demand” system. Designers must take into account the desired fill time for application trucks when selecting pump and line sizes. Pumps and lines that are too small will prolong the time it takes to refill onboard tanks.
- Periodic inspection of tanks, pumps and pipes/hoses should be carried out and any leaks should be repaired immediately.
- For discharge elevations above 30 feet, the dust suppressant should be unloaded using a pump. Once the unloading is completed, water must be available so that any chloride remaining in the unloading hose can be washed out and diluted. Collection facilities should be provided to handle spills and wash out streams.
- Connections to the tank car or truck, or sparger car, should be by flexible hose to allow greater flexibility in spotting tank cars. Thinwall pressure hose should not be used for suction or siphoning.
- Use reverse suction pumps when transferring the dust suppressant, so that the remaining liquid in the hose can be sucked back into the truck prior to removing the hose from the storage tank. Use catch basins (e.g. 5-gallon pail) to catch any drips during the loading of the dust suppressant. Spill pads may also be utilized.
- After application, pressure-wash trucks on a spill pad, with the wash liquid collected in a settling tank for re-use via the storage tank.

RECORD-KEEPING AND MONITORING

Maintenance of comprehensive and accurate records will lead to a better understanding of factors that enhance the performance of chloride-based dust suppressants. This will allow maximum performance to be achieved, at minimum cost. Records should be kept of the following activities:

- Road preparation conducted prior to the application of chloride-based dust suppressants. This includes the amount and type of gravel that was applied, percentage of fines in the gravel, percentage crown that was shaped, ditches that were cleaned, new culverts that were placed, etc. The date when these activities occurred should be recorded.
- Which roads were treated with chloride-based dust suppressants, along with the percentage of chlorides in the dust suppressant, application rate, level of compaction applied, date and weather conditions (prior to/during/after application).
- Maintenance operations during the summer to maximize performance obtained from the dust suppressant such as amount of water applied and re-grading of the road. The date that these activities were conducted along with weather conditions should be recorded. If a second application of dust suppressant is applied during the year, record the date, application rate and weather conditions.
- The date and quantity of chloride-based dust suppressant shipments as well as the amount of dust suppressant currently stored on site. Accidental releases that occur from storage or loading of applicator trucks should be recorded, as well as the date and circumstances relating to the releases.

Monitoring of various conditions will also enhance the performance of chloride-based dust suppressants and minimize their impact on the environment. Recommended monitoring activities include:

- Conditions of unpaved roads, for instance their crown, percentage of fines, loss of gravel, compaction levels, etc. Poor road conditions contribute to road dust emissions and indicate that road maintenance and dust suppressants are required.
- The amount of dust from unpaved roads during the year in order to determine when the application of chloride-based dust suppressant is required.
- Vegetation in the proximity of where chloride-based dust suppressants are applied for any signs of distress. Particular emphasis should be placed on low-tolerant vegetation (i.e. alder, hemlock, larch, maple, ornamentals and pine).
- The extent to which the best practices, outlined in this document, are being applied by those responsible for road preparation and maintenance as well as the application and storage of chloride-based dust suppressants.

TRAINING

It is essential that adequate training be provided that addresses the various best practices discussed in this document. This training will increase the effectiveness of chloride-based dust suppressants as well as minimize their usage and unnecessary releases to the environment.

Training should be provided to those personnel responsible for road preparation/maintenance as well as the application and storage of chloride-based dust suppressants. This training should be provided annually in the spring, prior to the application of dust suppressants.

Training should be carried out through the following activities: (i) pre-spring briefings; (ii) observation and correction action; and (iii) informal briefings during the season.

CONCLUSION

Particulate emissions from road dust negatively impact human health and the environment. Chloride-based dust suppressants are an effective option to mitigate road dust emissions. They also assist in road stabilization and can reduce road maintenance costs. However, these dust suppressants are not without their own impacts, primarily to vegetation surrounding unpaved roads. As a result, care should be taken in preparing roads for, applying and storing chloride-based dust suppressants to ensure that the desired dust control is achieved, while minimizing the amount of dust suppressant that has to be applied.

The best practices outlined in this document identify those actions that will maximize the level of dust control that can be achieved with the application of a given amount of chloride-based dust suppressant. It is recommended road managers and those personnel preparing/maintaining roads as well as applying and storing chloride-based dust suppressants review the best practices outlined in this document. This review will reinforce the best practices that are already being applied as well as hopefully identify some that are not currently being employed.

WHERE TO GO FOR ADDITIONAL INFORMATION

This best practices document was prepared through discussions with chloride-based dust suppressant manufacturers, distributors and applicators. In addition, numerous literature sources were reviewed. Some of the most relevant literature sources include the following:

1. Day, Thomas E., *Gravel Roads and Calcium Chloride – What Every Road Manager Should Know*.
2. Foley, G.,S. Cropley, and G. Giummarra, *Road Dust Control Techniques: Evaluation of Chemical Dust Suppressants' Performance*. Special Report 54. Arrb Transport Research, 1996.
3. United States Department of Agriculture, *Dust Palliative Selection and Application Guide*, November, 1999.
4. United States Department of Transportation – Federal Highway Administration, *Gravel Roads Maintenance and Design Manual*, November, 2000.
5. Wisconsin Transportation Information Center, *Dust Control on Unpaved Roads*, Wisconsin Transportation Bulletin No. 13, 1997.

Acknowledgements

This best practices document was made possible with funding provided by Environment Canada.

To prepare this best practices document, calcium chloride/magnesium chloride manufacturers, distributors and applicators were contacted as well as Provincial Ministries of Transportation. The input provided by these organizations was invaluable and the time spent discussing various best management practices was appreciated.

Principal Consultant
Cheminfo Services Inc.

Environment Canada thanks all those organizations and individuals that provided input into the development of this best practices document.

First version: March 2004
Revised version: February 2007

Environment Canada
Chemicals Sector Division
351 St. Joseph Blvd., 12th Floor
Gatineau, Quebec K1A 0H3
www.ec.gc.ca/nopp/roadsalt/