TECHNICAL BULLETIN NO. 6

BEST MANAGEMENT PRACTICES FOR SALT USE

Canadian Parking Association
June 2005
The material contained in this technical bulletin is meant as a guideline only, and any action to be taken with regard to any of the subjects referred to herein should only be taken after obtaining the advice and direction of a professional with demonstrated expertise in the subject.

ACKNOWLEDGEMENTS

Following the publication of an environmental assessment report in December 2001 which found road salts to have adverse effects on the environment, Environment Canada began the risk management process to address the risks associated with road salts. Environment Canada began with the development of a Code of Practice to address releases from the use of road salts on public roadways with the assistance of a multi-stakeholder working group. To further assist Environment Canada with this task, a Parking Lot group was also established to provide a forum where stakeholders could discuss and provide strategic advice on the development of risk management measures for the environmental management of road salts used on parking lots and private properties.

Membership of the group was based on appropriate stakeholder representation based on experience in winter maintenance of parking lots and private properties. The group was chaired by Environment Canada. The document was authored by Bob Hodgins, Ecoplans Limited.

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BEST-MANAGEMENT PRACTICES FOR SALT USE ON PRIVATE ROADS, PARKING LOTS, AND SIDEWALKS

This guidance document discusses the environmental management of road salts used for the control of snow and ice on private roads, parking lots and sidewalks. The information contained in this document is provided as advice to property owners and contractors for consideration when developing their own policies, practices and procedures. The document is not intended to be used prescriptively but is to be used in concert with the legislation, manuals, directives and procedures of individual property owners and contractors.

1.0 INTRODUCTION

Over 5 million tonnes of road salts are used in Canada annually to control snow and ice on public roads and private roads, parking lots, and sidewalks. Owners of private roads and parking lots clear snow and ice to maintain these areas in safe and passable conditions during winter months. While in many cases salt use is necessary to ensure public safety, an Environment Canada scientific assessment found that high releases of road salts can be harmful to the environment and has recommended that the environmental risks associated with road salts be managed. Environment Canada's objective is to achieve reductions in salt use through the promotion and adoption of best-management practices, such as those which are described in this document.

Experience has shown that equivalent or safer conditions can be achieved with the proper use of salt-management practices. This guide provides information on proven practices and important principles of salt use that should be understood by owners and contractors to help ensure that salt is used effectively and efficiently. The topics covered by this guide include practices related to:

- Material storage and handling
- Salt application
- Snow storage and disposal
- Materials
- Equipment
- Decision-making tools
- Operational considerations
- Training

Nothing in this document should be interpreted as promoting salt reduction measures over safety. A Glossary of Terms used in this guide is also provided. A list of resource materials that provide additional information is also provided at the end of this guide.
2.0 BACKGROUND INFORMATION

Canada, having a typical northern climate, must contend with snow and ice during the winter months. Snow and ice control is a key part of any winter maintenance operation. Road salts (particularly Sodium Chloride) are the preferred deicing/anti-icing chemicals for maintaining safe, passable parking and property access because of their low cost, effectiveness, and ease of handling.

However, excessive use of road salts can have harmful consequences on the surrounding environment. Salt is a corrosive material and may cause deterioration of roadway surfaces, concrete structures, vehicles, and other indoor and outdoor surfaces. Salt applied to roadways and other surfaces can also damage or kill nearby grass, trees, or other vegetation. Most importantly, dissolved salt in snowmelt eventually drains to water systems, where elevated chloride concentrations can be toxic to fish and other aquatic life.

Due to concerns about the large quantities of chlorides being released to the environment and the resultant environmental impacts, road salts underwent a comprehensive five-year scientific assessment under the Canadian Environmental Protection Act, 1999. The study concluded that high releases of road salts can cause adverse impacts on the environment and that these impacts need to be managed.

2.1 ENVIRONMENTAL MANAGEMENT OF ROAD SALTS

Environment Canada is addressing the management of road salts in two sectors: 1) Salt use on roadways managed by provinces, territories, and municipalities, and 2) Salt use on private roads, parking lots, and sidewalks.

.1 Salt Use on Roadways

Public sector (federal, provincial, municipal) road authorities are the greatest users of road salt in Canada. During the period from 2002 to 2004, Environment Canada worked with a multi-stakeholder working group to develop a Code of Practice for the Environmental Management of Road Salts, which was published in April 2004. The Code recommends the development and implementation of Salt Management Plans. In response to this initiative and recognizing their responsibility to the environment, many public sector road authorities across Canada are taking actions towards implementing salt best management practices. A number of resources have been developed to assist road authorities to improve their salt-management practices and several of these have been included in the resource list at the end of this document.

.2 Salt Use on Private Roads, Parking Lots, and Sidewalks

Significant quantities of road salts are also used on private roads, parking lots, and sidewalks, and Environment Canada is recommending that best management practices be adopted by this sector as well. Environment Canada has also set up a multi-stakeholder advisory group to provide a forum where stakeholders can discuss and provide strategic advice on the development of risk management measures for the environmental management of road salts used on private roads, parking lots, and sidewalks.

This guide has been developed as a resource to help private-property owners and salt users learn about best salt management practices that can be used in snow and ice control operations.

1 Road Salts Priority Substances List Assessment Report, December 2001
3.0 BENEFITS OF BETTER SALT MANAGEMENT

Better salt management practices not only benefit the environment, but can also result in cost savings to the organisation. Numerous studies\(^2\) have shown that salt use reductions can be achieved through better salt management practices such as pre-wetting salt before application and the regular calibration of salt application equipment. These reductions in salt use can result in cost savings to the organization.

Here are some other examples of benefits of better salt management practices:

- Less damage due to corrosion is caused to salt application equipment, vehicles, and infrastructure such as concrete sidewalks and steps.
- Less salt is dragged indoors causing damage to carpets and floors.
- Less salt damage to vegetation surrounding roads and walkways.
- Reduced salt released to surrounding waterways.
- Overall, more efficient and effective service, which means safer roads and sidewalks for users.

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4.0 THE PRINCIPLES OF SALT USE

Road salts have been used for many years to help in the removal of frost, snow, and ice and to restore safe winter driving and walking conditions. When determining when and how to use salt, it is important to understand 3 key points:

1. When will slippery conditions occur?
2. How does salt work?
3. How much is enough?

4.1 WHEN WILL SLIPPERY CONDITIONS OCCUR?

There are two key ingredients for the formation of slippery conditions - moisture and pavement temperatures below the freeze point of the moisture (usually 0°C). Moisture comes in the form of rain or snow, which is easily seen, and as dew. Dew will form on a surface (e.g. pavement) when the surface temperature is at the dew point. If the pavement temperature is below freezing at the same time, frost will form.

Studies have shown that pavement temperatures are usually warmer than air temperatures, particularly during the day. This means that there are many times when the pavement temperatures will be above freezing even when air temperatures are well below freezing. Pavement temperatures can be measured using infrared thermometers.

When snow becomes packed onto a frozen pavement surface, it will bind to the surface making it very difficult to remove. As traffic increases, this snow pack can turn to an ice pack. Salt is applied to break or to prevent the formation of the ice-to-pavement bond to allow it to be removed mechanically (i.e. plowed or shovelled off).

Tracking weather conditions is also essential to knowing when to apply salt. Local weather forecasts can help to anticipate whether or not snow is likely to accumulate to the point that slippery conditions will occur. The speed that the storm is moving is an important consideration. Fast-moving storms are harder for weather forecasters to predict, and there is a greater potential for the forecast to be wrong with respect to timing and accumulation. Slower-moving storms, on the other hand, are easier to predict with respect to timing and accumulations. Radar images are readily available on the Internet and can help decision-makers to better understand the timing of a storm.

4.2 HOW DOES SALT WORK?

Salt is a freeze-point depressant. This means that when salt is dissolved in water, it lowers the temperature at which the resultant solution will freeze. As the concentration of salt in the solution increases, the freeze point decreases. This is illustrated in the Phase Diagram below. For Sodium Chloride (NaCl), the temperature at which a solution of salt and water will freeze decreases as the concentration increases until the concentration reaches 23.3%. This lowest point in a Phase Diagram is known as the Eutectic Point. A sodium chloride solution at this concentration will not freeze until the temperature drops below –21°C.

As a solution is cooled, the water component of the solution begins to freeze. Since ice can hold very little salt, the salt that is present is confined to the remaining liquid phase, which becomes more concentrated. This is represented by the area below the curve and to the left of the Eutectic Point. At this point, there is a mixture of ice/snow and concentrated brine, which appears as slush on the road. As the concentration of the remaining liquid phase increases, its freeze point is lowered. The salt solution remains in equilibrium until the temperature is lowered to the point at which the solubility limit is reached and the salt precipitates out of solution. The result is a mixture of recrystallized salt, water, and brine. This is represented on the Phase Diagram by the area below the curve and to the right of the Eutectic Point.

\[ \text{The freeze point of water is lowered below } 0^\circ\text{C by adding a freeze point depressant such as salt.} \]
There are similar phase diagrams for all freeze point depressants. As we can see from the diagram provided, a 29.8% calcium chloride solution will not freeze until the temperature reaches -51°C – this is its Eutectic Point.

When we place dry salt onto a pavement surface, we want the salt to dissolve and form a solution of salt and water, which is called brine. It is this brine, in fact, that melts the frost, snow, or ice. Our goal is to create a layer of brine at the pavement surface to prevent the snow pack or ice from bonding to the pavement. This makes it much easier to remove the snow mechanically.

It can take a long time to make brine on the road by placing solid salt and letting nature make the brine – particularly at lower temperatures. It is very difficult to create a high concentration of brine in this way. This is one reason why sodium chloride is usually not used below -10°C. Two ways many public road authorities and increasingly more private contractors are addressing this problem is by spreading straight liquid salt (liquid anti-icing) or adding brine to the solid salt (pre-wetting) as it is spread to help the salt dissolve more quickly. By applying liquid rather than solid salt, it is possible to speed up the melting action.

One must be careful of refreeze when working with any freeze point depressant such as salt. As more snow and ice melts, more water goes into the solution and the concentration of salt in the resultant mixture decreases. Therefore, this dilution raises the temperature at which the solution will freeze. Referring back to the phase diagram for NaCl, a 15% brine solution will freeze at -10°C. If snow melts and dilutes the brine concentration by half, then the resultant 7.5% brine will freeze at around -5°C. This is one reason why it is important to remove as much snow from the pavement surface as possible before adding salt. Similarly, if the temperature drops below the freeze-point of the brine, ice will form.

Contractors and owners need to ensure that the people making salt-use decisions understand how salt works.

4.3 HOW MUCH IS ENOUGH?

There are many factors that affect the answer to this question. A major factor is the amount of frost, snow or ice that needs to be removed. In the case of frost, relatively little salt will be required to melt the frost. Since moisture and heat are necessary to change a solid sodium chloride crystal to brine, applying dry sodium chloride (endothermic) can actually aggravate a condition where the pavement temperature is hovering near freezing by drawing heat from the pavement and lowering the pavement temperature. This phenomenon does not occur when a liquid anti-icing material is applied since there is no phase change required. Some other considerations include:

- Moist snow will activate salt more quickly than dry snow since there is more moisture available to begin the brine-making process.
- Warm salt will activate more quickly than cold salt since there is more heat available to activate the brine-making process.
- Fine salt will activate more quickly since it has greater surface area and therefore will dissolve faster.
- More salt is needed at colder temperatures because it is activated more slowly.
- Roads that have traffic to mix the salt and snow will clear more quickly than parking lots where vehicles tend to sit for long periods of time.
- Property owners and contractors should determine and agree on the application rates for different conditions.
5.0 BEST SALT MANAGEMENT PRACTICES

The following discussion of best practices is intended to guide private salt users on techniques that can be used to reduce the amount of salt entering the environment. When selecting practices it is important to ensure that safety is not compromised. However, this caution should not be interpreted as validating excessive salt use. The best practices are set out in the areas of sand and salt storage, salt application, and snow storage and disposal.

5.1 SALT AND SAND STORAGE AND HANDLING

Studies have shown that improper storage and handling of salt and sand/salt mixtures are major sources of salt releases to the environment. The following best practices apply to storage of solid materials (i.e. salt and sand/salt mixtures) and liquids.

• All sand and sand/salt mixtures should be covered to prevent salt from being washed or blown from the pile.
• All salt and sand/salt mixtures should be stored on pads of impermeable asphalt or concrete.
• Site drainage should be directed away from the stored materials to keep the stockpiles as dry as possible. This will prevent salt contamination of site drainage.
• Drainage that is contaminated with salt should be directed to a sewage treatment plant (subject to municipal approval), collected and used for brine production or sent for proper disposal.
• Solid bagged materials should be stored securely and indoors, if possible.
• Loading areas where spreaders are loaded from the storage facilities should be impermeable asphalt or concrete pads.
• Annual inspection and repairs should be carried out prior to the start of each season. Ongoing inspection of storage structures and tanks should be carried out during the season.
• Spreaders should not be overloaded such that material spills off the vehicle.
• Salt spilled at the storage yard should be collected and returned to the storage site.
• Spreaders should only be washed at a location where the washwater is properly managed.
• Liquid storage tanks should be designed such that a plumbing failure will not result in release of the contents.
• Liquid storage tanks should be protected from impact from vehicles moving about the yard and be located such that spilled material can be contained and retrieved in the event of a tank or piping failure. Secondary containment should be provided around large liquid storage tanks.
• Some liquids need to be agitated/circulated to prevent separation and settling. The liquid suppliers should be consulted for proper storage procedures.
• Sediment that collects in the bottom of mixing and storage tanks must be cleaned out periodically. The sediments may be mixed with abrasive piles.

Additional information can be obtained from TAC’s Syntheses of Best Practices Road Salt Management – Design and Operation of Road Maintenance Yards.

5.2 SALT APPLICATION

There are several factors affecting effective application of snow and ice control materials. One should consider the 4 R’s of snow and ice control.

.1 Right Material – The right material will depend upon the conditions being treated. In situations where the pavement temperature is extremely cold, chemicals with lower working temperatures or sand/salt mixtures may be warranted.
.2 Right Amount – The right amount of material is dependent upon the type of slippery condition being treated, the amount of residual chemical on the pavement surface, the expected pavement temperature and the amount of precipitation that is expected.
.3 Right Place – Precise placement of materials is important to keeping it in the right place to do the job rather than wasted to the environment. Proper material placement requires the right equipment and skilled operators.

* Studies have shown that up to 50% of the salt in sand/salt mixtures can wash from uncovered stockpiles.
.4 Right Time – The timing of salt placement is important to minimizing waste and maximizing chemical effectiveness. There are times when the pavement temperature is above freezing and therefore may not warrant salt application.

The following subsections discuss material, equipment, and decision-making tools to help achieve the 4 R’s of snow and ice control.

5.3 MATERIALS

Snow and ice control materials fall into two main categories:

1. Freeze point depressants – used to melt frost, snow and ice and to prevent or break the bond between the ice and the pavement; and

2. Abrasives – used to improve traction on potentially slippery surfaces.

A variety of freeze point depressants is available. These include road salts (i.e. sodium chloride, calcium chloride, magnesium chloride and potassium chloride), acetates (i.e. calcium magnesium acetate, potassium acetate, sodium acetate), and engineered products composed of agricultural products and one or more of the previously listed materials.

These freeze point depressants can either be solid or liquid. They will also have different working temperatures, and may have some additional characteristics that affect when, where, and how they are used. Each material has different costs and environmental implications associated with it. Some alternatives are less harmful to the environment and/or less corrosive to vehicles and infrastructure. The suppliers of these products should be consulted for specific information.

Applying solid salt has the advantage of ensuring that there is a supply of salt to go into the solution as more moisture is added through melting of snow or ice. One disadvantage is that it takes longer for solid salt to form brine, which is necessary to melt frost, snow, and ice. It is also unlikely that the brine will reach a sufficiently high concentration to provide the lowest freeze point depression. Consequently the effective working temperature will be higher than if the material was applied in a concentrated liquid form.

Applying a concentrated liquid anti-icing product has the advantage of providing instant melting capabilities, which can reduce slippery conditions more quickly. As well, because the concentration is at its optimum level, the effective working temperature can be much lower than with a solid form of the same product. A disadvantage is that there is not a continual supply of solid chemical present to maintain the concentration. Therefore, the brine will dilute with increased moisture making it susceptible to refreeze. Liquid anti-icing can be applied to dry pavement in advance of a storm or frost and will be present to begin melting when the frosting condition or snow arrives.

Pre-wetting salt involves the application of a concentrated liquid anti-icing product to solid salt either in the chute or at the spinner. The liquid increases the speed with which the salt begins to work while ensuring that there is solid salt present to slow the rate of dilution and the potential for refreeze. The amount of solid salt that is applied can usually be reduced when pre-wetted.

Pre-treating stockpiles is a technique being used by many public sector road authorities and some private snow and ice control companies. This technique involves mixing a liquid into the stockpiled solid material (e.g. abrasive or salt) to help the solid stick to the pavement surface and accelerate the melting process. Pre-treating has the advantage over pre-wetting of not requiring the same level of investment in infrastructure (i.e. chemical storage tanks) and equipment (i.e. on-board tanks and pumps).

Abrasives (e.g. sand, gravel, chips) are usually applied where a freeze point depressant is not desirable, either because the cost of a freeze point depressant is not warranted, or the pavement temperature is too cold for the product to work. These abrasives will usually be mixed with a small amount of salt to prevent the material from freezing in the storage pile or the spreader. The amount of salt should not exceed 3-5% by volume – enough to keep the pile from freezing.
5.4 EQUIPMENT
Placement of the right amount of material in the right place requires proper equipment. To minimize salt use, as much snow as possible should be removed through plowing. Proper plowing can significantly reduce the amount of chemical needed to keep an area ice-free. Solid materials are applied using truck-mounted spreaders for roads and parking lots and hand spreaders for sidewalks. Continuous uncontrolled spreading can be wasteful. Spreaders that can be set to meter out the right amount of material for the conditions and that can be turned on and off from the truck cab help the operator to place the right amount of material that is needed. Liquid anti-icing products are applied with tankers and spray trucks. The following considerations should be taken into account with respect to equipment:

- The owner/manager and contractor should ensure that sufficient equipment and staff are available to properly plow snow then apply material. It is not a best practice to quickly "burn off snow" with chemicals to avoid more time consuming plowing.
- Ensure that plowing equipment can reach all areas required and that the blade is appropriate and in good shape to remove the maximum amount of snow and ice.
- Spreaders should allow the operator to target material application so that materials are confined to the treatment area and not lost to adjacent areas.
- Operators should be able to control the spreader so that the amount of material being applied can be increased, decreased or stopped when appropriate.
- Combination plows and spreaders are efficient for removing snow and spreading materials at the same time.
- Drop spreaders rather than broadcast spreaders should be used on sidewalks to increase the amount of material retained on the sidewalks to work. This will also help to limit salt damage to vegetated areas adjacent to sidewalks.
- Broadcast spreaders should be used on parking lots to provide for rapid coverage since traffic cannot be relied on to distribute the salt.
- Each spreader unit should be thoroughly inspected and the mechanical spreader checked to ensure the spreading rate is correct.
- Pre-wetting kits (saddle tanks, pumps, and spray nozzles) should be added to salt spreaders to improve the reaction time of the salt.
- On-board pre-wetting units should be designed such that a plumbing failure will not result in release of the entire contents of the tanks.
- Spray trucks can be used to apply liquid anti-icing to sidewalks (using a hose and wand) and roads and parking areas (using a truck-mounted spray bar).

Additional information on equipment can be obtained from TAC’s Syntheses of Best Practices Road Salt Management – Winter Maintenance and Technologies.

5.5 DECISION-MAKING TOOLS
Supervisors and operators are operating in a dynamic environment and are called upon to make decisions often with limited information. The following provides some guidance on tools that are available to assist in making snow and ice control decisions:

- Localized weather forecasts can provide information on the nature, timing, and duration of winter storms.
- Local weather forecasts can provide information on dew point, however, pavement temperatures must be known.
- Pavement temperature trends can be determined using infrared thermometers.
- Internet-based radar images can provide information on where a storm is in relationship to the area being serviced. Decision-makers can determine when a storm is likely to arrive or end.
5.6 OPERATIONAL CONSIDERATIONS
The sequence by which snow and ice control techniques are applied will affect the amount of salt used. The following discusses some operational considerations to be taken into account:

- Weather forecasts and radar images should be monitored to determine when frost, freezing rain, and snow could be expected in order to predict the need to treat an area.
- Both the owner and contractor should understand the size and the characteristics of the site. Both should estimate and agree on how much chemical will be required for each application. A lower application rate, acceptable for frost events or spot applications, should also be determined. Benchmarking should be done separately for both mechanical spreading and hand spreading. Once the benchmark amounts are determined, they can be periodically compared to actual usage.
- Trends in pavement temperatures should be monitored using infrared thermometers and compared with the dew point to determine if frost conditions will exist.
- Trends in pavement temperatures should be monitored to assess when pavement temperatures are above freezing and freeze point depressants are not required, and when pavement temperatures are below the effective working temperature.
- The presence of residual chemical on the pavement surface should be monitored to determine if additional application of a freeze point depressant is required.
- Freeze point depressants should be applied at the start of a storm to prevent the formation of a bond.
- Snow should be plowed from the treatment area prior to the application of a freeze point depressant to minimize the amount of material needed, and the potential for dilution and refreeze.
- Freeze point depressants should be applied after plowing only when pavement temperatures are below freezing and the remaining snow/ice that could not be removed by plowing presents a hazard.
- Only enough material should be applied to do the job.
- Owners can reduce salt use and risk by closing low traffic or under-used areas or high-risk areas during storm events.

5.7 SNOW STORAGE AND DISPOSAL
In many cases, plowed snow is stored on remote or unused parts of parking lots. However, in some cases, snow must be removed from the site and transported to a disposal site. Snow that has been cleared from parking lots may contain salt and/or sand that has been applied to the pavement prior to the snow being plowed. When this snow needs to be removed and transported to centralized disposal sites, the contaminants are concentrated and then released to the environment when the snow melts. Disposal sites that are not properly located and designed can have significant adverse effects on the environment.

The following practices should be considered when storing and disposing of snow:

- Owners should ensure that site plans provide for sufficient snow storage to eliminate the need to transport snow off-site.
- Snow storage sites should be located such that meltwater that may contain salt is not directed towards salt vulnerable areas.
- Melt water should be directed to sediment ponds or sanitary sewers where permitted by the local municipal sewer use by-law.
- Snow should be stored on-site in paved areas where the melt water will not drain into the parking area or form puddles that cause slippery conditions that require extra salting operations to maintain safety.
- Snow should be stored in areas of the parking lot where puddles frequently form to deter vehicles and pedestrians from using these areas.
- Snow should not block drains.
- Salt should never be used to promote rapid melting of stockpiled snow.
- Snow should be stored in areas where the sun will promote rapid melting.
- Snow that is removed from a facility and transported for disposal should be taken to a properly designed snow disposal site. Property owners and contractors should determine the disposal locations prior to the winter.
- Snow disposal sites should be designed in accordance with the TAC’s Syntheses of Best Practices Road Salt Management – Snow Storage and Disposal Sites.
5.8 DOCUMENTATION
Good, thorough documentation is critical to the successful implementation of Best Practices, good salt management, and managing your liability exposure. Documentation is not limited to just collecting statistical information such as time spent and the amount of material used. It also includes documenting service expectations, describing how the expectations are to be met, and having site maps available. The documentation should also record the following for each site:

- Location.
- Date and time of treatment.
- Weather conditions (e.g. type of precipitation, air temperature) and pavement conditions (e.g. extent of snow cover, pavement temperature trends).
- Plowing activities.
- Type and quantity of material placed.
- Snow removal activities (e.g. amount removed, disposal location).
- Observed risk areas that could not be treated and why they could not be treated.

5.9 CONTRACTS
In addition to the weather, the amount of salt used by a snow and ice management contractor is determined by the terms of his or her contract with the property owner. In some circumstances, the property owner retains control over what and when ice melting products are to be applied to a premises, and in what amounts. In others, the owner authorizes the contractor to apply specified ice melting products, which may include salt, at his or her discretion to manage the risk of hazardous conditions.

Property owners will often seek to have the contractor assume all risks associated with a slip and fall with the most economical products available. This approach can lead to increased salt use as the contractor looks to prioritize the avoidance of claims. Property owners are accordingly encouraged to require in their contracts that contractors follow best practices for salt management.

In addition, the following should be considered when developing snow and ice control contracts:

- Contracts should be developed to encourage mechanical removal thereby reducing the amount of salt needed to maintain safe and passable conditions.
- Service areas and application rates should be established.
- Property owners and contractors should detail the extent to which the contractor will report on the amount of salt used in order to aid the ongoing improvement in practices.
- Property owners and contractors should consider the use of non-toxic ice melting products as an alternative to road salts.

5.10 TRAINING
Human behaviour is predicated upon attitudes, which in turn are based on knowledge and experience. A successful salt management strategy requires effective procedures, practices, and equipment. Success also requires acceptance of new approaches by property owners, managers, supervisors and operators. Any changes in approach will require changes in behaviour. Training of property owners, managers, supervisors and operators will help to demonstrate the purpose and value of new procedures and ensures that personnel are competent to carry out their duties. A comprehensive Synthesis of Best Practices on Salt Management Training has been produced by the Transportation Association of Canada and is available free of charge from its website (www.tac-atc.ca). This document sets out the learning goals for a training program as well as adult learning principles for people developing a salt management training module as part of their snow and ice control program.
6.0 CONCLUSION
Salt is an important tool in maintaining safe conditions on private parking lots, roads, stairs, and sidewalks. However, studies have shown that excessive use of salt can have adverse effects on the environment and infrastructure. Private owners and contractors are recommended to use best management practices for salt management to ensure that safe conditions are being maintained without compromising the local environment.
### Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Abrasive</td>
<td>A solid material placed on a slippery surface to improve traction for walking and driving. Abrasives may consist of natural materials such as sand, gravel, and chips; or manufactured materials.</td>
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<tr>
<td>Anti-icing</td>
<td>A proactive snow and ice control practice whereby a pavement surface is treated before a bond can form between frost, snow or ice and the pavement.</td>
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<td>Bond</td>
<td>A strong connection that forms between a snowpack and the pavement making removal by plowing difficult. The application of a freeze point depressant to the pavement helps break this bond (see deicing) or prevent the formation of the bond (see anti-icing).</td>
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<tr>
<td>Brine</td>
<td>A solution of water and salt.</td>
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<tr>
<td>CaCl2</td>
<td>Calcium Chloride</td>
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<tr>
<td>Deicing</td>
<td>A reactive snow and ice control strategy of applying a freeze point depressant on top of snow or ice during or after a storm to break an ice/pavement bond that has already formed. It is generally accepted that solid forms of freeze point depressants work better then liquid forms with this strategy.</td>
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<tr>
<td>Dew</td>
<td>Moisture that forms on a surface when water vapour in the air condenses.</td>
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<tr>
<td>Dew Point</td>
<td>The temperature at which water vapour in the air condenses and forms water droplets.</td>
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<tr>
<td>Effective Working</td>
<td>The lowest temperature that is considered to be appropriate for the use of a freeze point depressant that provides a sufficient likelihood that refreeze will not occur.</td>
</tr>
<tr>
<td>Endothermic</td>
<td>A freeze point depressant that requires heat to change from solid to a liquid. The heat is taken from its surroundings lowering the temperature slightly in its vicinity. Sodium Chloride (road salt) is an example of an endothermic freeze point depressant.</td>
</tr>
<tr>
<td>Exothermic</td>
<td>A freeze point depressant is exothermic if it gives off heat when it forms a liquid solution. The heat is transferred to its surroundings raising the temperature slightly in its vicinity. Magnesium Chloride and Calcium Chloride are examples of exothermic freeze point depressants.</td>
</tr>
<tr>
<td>Engineered Product</td>
<td>A product that is manufactured under controlled conditions to ensure consistent characteristics, quality and performance.</td>
</tr>
<tr>
<td>Eutectic Point</td>
<td>The lowest freeze point that can be achieved for a given solution of water and a freeze point depressant. This is the bottom of the &quot;V&quot;-shaped curve on a phase diagram.</td>
</tr>
<tr>
<td>Freeze Point</td>
<td>The temperature at which a liquid will change to a solid.</td>
</tr>
<tr>
<td>Freeze Point Depressant</td>
<td>A material (e.g. salt) that will lower the freeze point of a solution. Used for snow and ice control to either prevent or break the ice/pavement bond that forms on driving and walking surfaces.</td>
</tr>
<tr>
<td>Frost</td>
<td>Ice crystals that form when dew condenses on a surface that is below freezing.</td>
</tr>
<tr>
<td>Ground Speed</td>
<td>Electronic devices used to control the amount of material that is applied using a truck/tractor mounted mechanical spreader. The amount of material being applied is automatically adjusted according to the ground speed of the vehicle. This allows for a known, consistent amount of material to be applied regardless of the speed of the vehicle. Many public sector road authorities are installing these on their spreader fleets to better monitor and control their road salt use. Most modern controllers have the ability to collect, store and transmit application rate data allowing material use to be closely monitored and managed better.</td>
</tr>
<tr>
<td>Infrared Thermometer</td>
<td>A device used to quickly measure pavement temperatures and trends. Comes in both hand held and vehicle mounted (with digital readout in the cab) versions.</td>
</tr>
<tr>
<td>Liquid Anti-icing</td>
<td>Liquid anti-icing is a proactive method of snow and ice control in which a concentrated liquid freeze point depressant is sprayed directly on the pavement surface.</td>
</tr>
<tr>
<td>MgCl2</td>
<td>Magnesium Chloride</td>
</tr>
<tr>
<td>NaCl</td>
<td>Sodium Chloride</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pavement</td>
<td>The temperature of the surface of a paved area (e.g. parking lots, roads, sidewalks, stairs). The area may be paved with materials such as concrete, asphalt or paving stones.</td>
</tr>
<tr>
<td>Temperature</td>
<td>The state of a material (i.e. solid, liquid or gas).</td>
</tr>
<tr>
<td>Phase</td>
<td>A transition from one state to another. For example a change from a solid to a liquid such as melting ice, or solid sodium chloride forming brine.</td>
</tr>
<tr>
<td>Phase Change</td>
<td>A diagram that relates the freeze point of a solution to the concentration of the solution. It illustrates the phases of a material that exist in a mixture at various temperatures.</td>
</tr>
<tr>
<td>Pre-treatment</td>
<td>A technique whereby materials are mixed at the time it is stockpiled. For example, a liquid may be added to solid salt as it is stockpiled to enhance its performance when it is placed on a paved surface.</td>
</tr>
<tr>
<td>Pre-wetting</td>
<td>A technique whereby a concentrated liquid freeze point depressant is sprayed onto solid salt or sand at the time it is placed onto the pavement surface.</td>
</tr>
<tr>
<td>Reaction Time</td>
<td>The time taken for a freeze point depressant to enter into solution and begin melting frost, snow or ice.</td>
</tr>
<tr>
<td>Refreeze</td>
<td>The freezing of a solution containing a freeze point depressant resulting from the pavement temperature dropping below the freeze point, or the concentration of the freeze point depressant being diluted resulting in the freeze point rising.</td>
</tr>
<tr>
<td>Residual Chemical</td>
<td>Dry freeze point depressant remaining on the pavement surface after all the moisture has evaporated. This residual will dissolve when new moisture is added either as dew, rain or snow. This residual provides some anti-icing capabilities.</td>
</tr>
<tr>
<td>Road Salt</td>
<td>Chloride-based freeze point depressants including Sodium Chloride, Calcium Chloride, Magnesium Chloride, and Potassium Chloride.</td>
</tr>
<tr>
<td>Road Salt Management Plan</td>
<td>A detailed plan of how salt users propose to improve the management of their use of road salt through the introduction of best salt management practices. These plans take into consideration all activities potentially resulting in the release of road salts into the environment, including storage, application of salts on roads, and disposal of snow containing road salts.</td>
</tr>
<tr>
<td>Saddle Tanks</td>
<td>Small containers (usually plastic) that are attached to spreader truck to transport liquid anti-icing materials for pre-wetting or anti-icing operations.</td>
</tr>
<tr>
<td>Salt Vulnerable Areas</td>
<td>Salt vulnerable areas are areas of a receiving environment that may be particularly sensitive to road salts. Additional salt management measures may be required in these areas to ensure environmental protection. Guidance on the identification of vulnerable areas can be found in Annex B of the Code of Practice for the Environmental Management of Road Salts (see Resources).</td>
</tr>
<tr>
<td>Sand/Salt Mixtures</td>
<td>Common sand that has been mixed with a freeze point depressant to prevent the sand from freezing while it is being stored. A minimum mix of 3-5% salt by volume is usually sufficient to prevent freezing.</td>
</tr>
<tr>
<td>Secondary Containment</td>
<td>Measures to prevent the release of stored liquids in the event of a failure of the primary containment tank. This is usually either a secondary wall around the primary tank (i.e. double walled containers) or an impermeable floor and dyke constructed around the storage tank(s).</td>
</tr>
<tr>
<td>TAC</td>
<td>Transportation Association of Canada (<a href="http://www.tac-atc.ca">www.tac-atc.ca</a>).</td>
</tr>
<tr>
<td>Treated</td>
<td>The placement of aggregate or a freeze point depressant to pavement surfaces.</td>
</tr>
</tbody>
</table>
8.0 RESOURCES

British Columbia
• Road Salt and Winter Maintenance for British Columbia Municipalities - Best Management Practices to Protect Water Quality
  Web-site: http://wlapwww.gov.bc.ca/wat/wq/bmps/roadsalt.html

Environment Canada
• Conducted five-year environmental assessment on road salts and worked with stakeholder working groups to develop the Road Salts Code of Practice and these Best Management Practices for Private Roads, Parking Lots and Sidewalks.
  Web-site: www.ec.gc.ca/nopp/roadsalt/
  Telephone: (819) 997-1640
• Code of Practice for the Environmental Management of Road Salts
• Road Salts Priority Substances List Assessment Report, December 2001

Landscape Ontario
• Association of landscapers and winter maintenance contractors in Ontario.
  Web-site: http://www.horttrades.com
• Standard Form Snow Maintenance Contract
  Web-site: www.horttrades.com/displaynews.php?n=169&categoryID=8

Pacific Northwest Snowfighters Association
• Evaluates and establishes specifications for products used in winter maintenance based on safety, environmental effects, infrastructure protection, cost-effectiveness and performance.
  Web-site: www.wsdot.wa.gov/partners/pns/

Riversides Stewardship Alliance
• Municipal Low Salt Diet Program works with private parking lot owners and operators in the Greater Toronto Area to raise awareness about the environmental impacts of road salts.
  Web-site: www.riversides.org/review/riversides/low_salt_diet.htm

Salt Institute
• The Salt Institute has an extensive library of information and training materials related to the storage, use and management of road salts.
  Web-site: www.saltinstitute.org

Snow and Ice Management Association Inc. (SIMA)
• Organization providing a network and resources to the snow and ice industry. Web-site: www.sima.org

Snow Business Magazine Online
• Publication of the Snow and Ice Management Association.
  Web-site: www.snowbusinessonline.com
Transportation Association of Canada
• National association of federal, provincial and territorial transportation departments, municipalities, private-sector firms with an interest in road and urban transportation issues, academic institutions and other associations.
  Web-site: www.tac-atc.ca
  Telephone: (613) 736-1350
• TAC Salt Management Guide, 1999
• Syntheses of Best Practices - Road Salt Management
• Road Salt Management Information Site
  Web-site: www.tac-atc.ca/english/roadsalt/roadsalt.cfm

University of Wisconsin-Madison
• The University of Wisconsin-Madison has developed Best Management Practices for the use of road salts on their campus.
  Web-site: http://www2.fpm.wisc.edu/chemsafety/Saltbmp.htm
• Salt Reduction Status Report
  Web-site: http://www2.fpm.wisc.edu/campusecology/landscape/salt.htm