

YORK REGION'S SALT MANAGEMENT PLAN

Transportation and Works Department

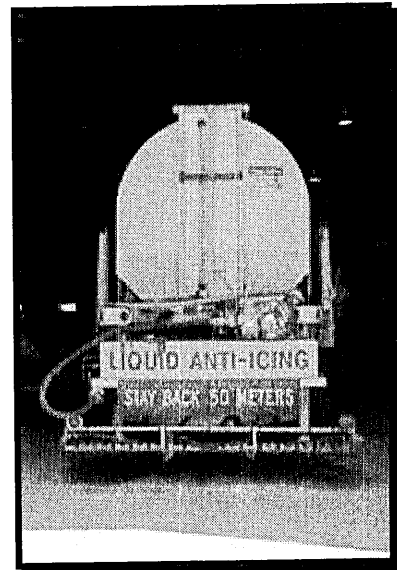
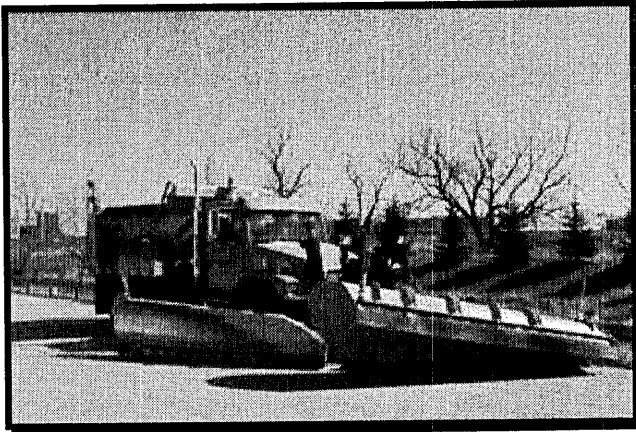


TABLE OF CONTENTS

1.0 INTRODUCTION.....	3
1.1 OVERVIEW	3 AND 4
2.0 SALT MANAGEMENT POLICY.....	5
2.1 PURPOSE AND OBJECTIVE OF DOCUMENT	5
2.2 RESPONSIBILITIES	5
2.3 POLICY STATEMENT	6
2.4 APPLICATION.....	6
3.0 WINTER MAINTENANCE POLICIES	7
3.1 INTRODUCTION.....	7
3.2 SALT AND SAND STORAGE	7
3.3 SALT/SAND SPREADING	7
3.4 ANTI-ICING.....	8
4.0 OPERATIONAL PRACTICES AND STRATEGIES.....	9
4.1 OVERVIEW	9
4.2 WEATHER MONITORING	9 AND 10
4.3 ANTI-ICING PROGRAM.....	11
4.4 LIQUID BRINE MAKING	11
4.5 WINTER EVENT	12
5.0 MONITORING AND UPDATING THE SALT MANAGEMENT PLAN	13
5.1 OVERVIEW.....	13
5.2 VEHICLE GLOBAL POSITIONING SYSTEMS.....	13
5.3 EQUIPMENT CALIBRATIONS	14
5.4 IMPROVED RECORD KEEPING	14
5.5 OPERATOR TRAINING	15
5.6 FUTURE INITIATIVES.....	15
6.0 SUMMARY.....	16

1.0 INTRODUCTION

1.1 Overview

In 2001, Environment Canada released an assessment report stating that road salts are entering the environment in large amounts and are posing a risk to plants, animals, birds, fish, lake and stream ecosystems and groundwater. The report recommended that salt be designated toxic under the Canadian Environmental Protection Act (CEPA). It should be noted that Health Canada stated that road salts are not harmful to humans. As of April 2003, the Minister still has not announced whether or not road salts are to be designated as CEPA-toxic. However, if Environment Canada designates road salts as toxic, they will not ban road salts, but rather they will encourage users to develop management strategies that encourage improvement of salt handling and salt reduction through the use of new technologies, and the initiation of salt management plans.

Road salts are used in Canada as de-icing and anti-icing chemicals for winter road maintenance, with some use as summer dust suppressants. The Government of Canada is not banning the use of road salts or proposing any measures that would compromise or reduce road safety. The environmental risk management strategy for road salts will focus on the development of best practices respecting storage, spreading and disposal, while ensuring that road safety is not negatively impacted. In response to Environment Canada's initiative to develop measures to manage the risks associated with road salts, The Regional Municipality of York has prepared this document, which summarizes the Region's current road salt management practice. The purpose of this document is to highlight key elements of the Region's current practice and identify plans for future implementation that will encompass the best management practices for road salt application and will comply with the proposed federal code of practice.

The Region has about 1,028 kilometres of paved arterial roads carrying large volumes of traffic. The current winter standard of bare pavement is used on all paved roads. Winter maintenance procedures involve plowing, sanding and salting to maintain the roads in a safe state of repair. Plowing is the preferred method of removing snow and ice from the road surface; however, plowing alone cannot remove ice that has become bonded to the pavement. Salt has been the de-icing chemical of choice to deal with this bond.

However, with the recent concerns that have been raised on the negative side effects that salt has on the environment, we look for ways to reduce our salt dependency, while maintaining user safety. This remains the most important priority within winter maintenance operations. Although there is ongoing research into the use of alternatives to road salt (sodium chloride) in winter maintenance, it continues to be the most cost effective de-icer across Canada.

Due to the adverse effects that salt has on the environment, the Salt Management Plan will minimize the amount of salt entering the environment. The Region's Transportation Branch has been working at ways to minimize salt usage. There are new technologies such as Road Weather Information Systems (RWIS), Global Positioning Systems (GPS) and electronic spreader controls to help our Patrollers know when to use salt and provide the tool to review the work done. There have been advances in equipment with the introduction of Salt Brine Spreaders, and drive-thru salt domes. This use of a Salt Brine and good housekeeping will reduce a large amount of salt going into the environment, along with improved staff training, documentation to track salt usage, and keep staff up to speed with advances.



2.0 SALT MANAGEMENT POLICY

2.1 Purpose and Objective of Document

This Salt Management Plan is intended to set out a policy and procedural framework for ensuring that the Region minimizes the amount of road salt entering the environment during winter maintenance operations.

Any modifications to the Region's winter maintenance activities must be carried out in a way that provides roadway safety and user mobility consistent with the weather conditions experienced during the snow and ice control season.

The Region is committed to exploring new approaches and technologies in winter maintenance activities to reduce the amount of road salt entering the environment and to ensure that roadway safety is not compromised.

2.2 Responsibilities

The following Transportation and Works staff members will be responsible for introducing the Salt Management Plan:

Director, Roads Transportation – Responsible for ensuring that the Salt Management Plan is developed, maintained, and implemented throughout the Region.

Roads, Maintenance Manager – Responsible for ensuring that the Salt Management Plan is developed, maintained, and implemented throughout the Region.

Patrol Supervisors – Responsible for ensuring that winter maintenance activities are carried out in a way that complies with the Salt Management Plan.

Winter Maintenance Personnel – Responsible for ensuring that they carry out their winter maintenance duties in accordance with the policies and procedures set out in the Salt Management Plan, as directed by their Supervisors.

2.3 Policy Statement

The Region has in effect a bare pavement policy that was adopted for all of the paved sections of the Regional road system. Since the adoption of the bare pavement policy, the Region developed a Quality Control Action Plan to ensure salt is only applied in a controlled and effective manner when required, in the right amount, at the right time and in the right place.

The plan includes the following major points:

- **Monitor salt use** - Application records are required each time material is applied to the road.
- **Application rates** - Rates are set for individual road sections based on the annual average daily traffic, speed and number of lanes.
- **Training of operators** - All equipment operators are trained on the policies for material usage and winter plowing operations.

2.4 Application

The Transportation Association of Canada has recommended that a Salt Management Plan should contain best management practices to protect the environment from the negative impacts of road salts, while it fulfills its obligation to provide safe efficient and cost-effective roadway systems. The guiding principles of the plan are outlined below:

- Salt Management Policy and Objectives
- Operational Practices
- Documentation
- Training
- Monitoring, Record Keeping, Reporting and Analysis
- Management Review

Adoption of the Salt Management Plan will formalize the Quality Control Plan process that has been in existence since the adoption of the bare pavement policy in 1994.

3.0 WINTER MAINTENANCE POLICIES

3.1 Introduction

The major activities related to winter maintenance are:

- Salt and sand storage
- Salt / sand spreading
- Anti-icing

3.2 Salt and Sand Storage

The Roads Transportation Branch operates four road maintenance facilities that have material storage sheds that allow for the storage of salt under cover. Presently, three of the four yards have drive-thru salt sheds that allow for the loading and unloading of salt inside. This limits the amount of salt exposed to the environment during a winter storm by containing all spillage within the shed.

All loading and unloading of road salt shall be done within the drive-thru salt sheds at the following road maintenance facilities:

- Southwest
- Central
- North

The southeast yard shall minimize the exposure of road salt to the environment by removing all spilled salt on a continuous basis during a winter event operation.

3.3 Salt / Sand Spreading

The Region shall utilize electronic spreader controls in all of the Regional and contractor combination plow/sander trucks. These systems allow for accurate placement of sand and salt ensuring improved material application, downloading of activity information, and the programming of variable rate material applications, as conditions dictate.

The Region's winter road salt and sand destitution rates are shown in **(Appendix A)**. These rates are based on road type (urban/rural) and traffic volumes.

3.4 Anti-Icing

The Region has implemented an anti-icing program for roads with an annual average daily traffic greater than 20,000 vehicles per day (majority of multi-lane and some two-lane roads). This represents approximately 1,450 lane kilometres of the Regional road system.

The anti-icing program is designed to address the following types of winter storms and road conditions:

- Light snow storm
- Light snow storm with period(s) of moderate or heavy snow
- Moderate or heavy snow storm
- Frost or black ice
- Freezing rain storm
- Sleet storm

Anti Icing Truck



4.0 OPERATIONAL PRACTICES AND STRATEGIES

4.1 Overview

This section of the Plan presents operational practices and strategies related to the effective management of road salt during winter maintenance activities.

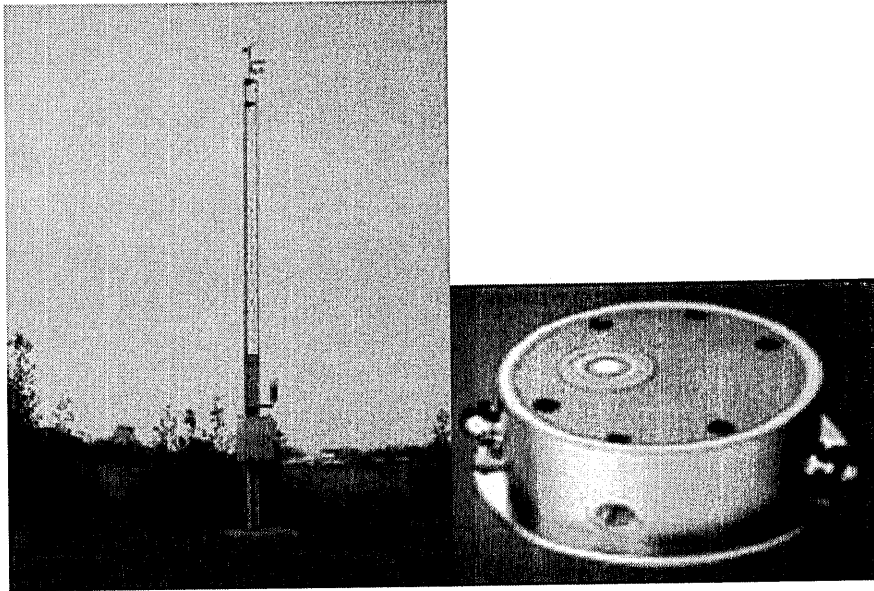
4.2 Weather Monitoring

The Region currently has five RWIS stations located in key geographic areas to address different weather patterns. Environment Canada supplies a site specific precipitation forecast at 6:00 am and 3:00 pm for each location everyday. To enable our Patrollers to plan and combat a storm, the patrol trucks have been equipped with new leading edge technology. This technology allows the Road Patrollers to monitor the RWIS stations over the internet. The RWIS sites provide real time information on road conditions to the Patrollers over the internet in the patrol truck. The Patrol vehicles also have mobile road temperature sensors that read the surface temperatures of the road they are travelling over. This information enables staff to make informed decisions as to when and where winter operations should commence or end, including what material application rates will work best for the forecasted or actual conditions present.

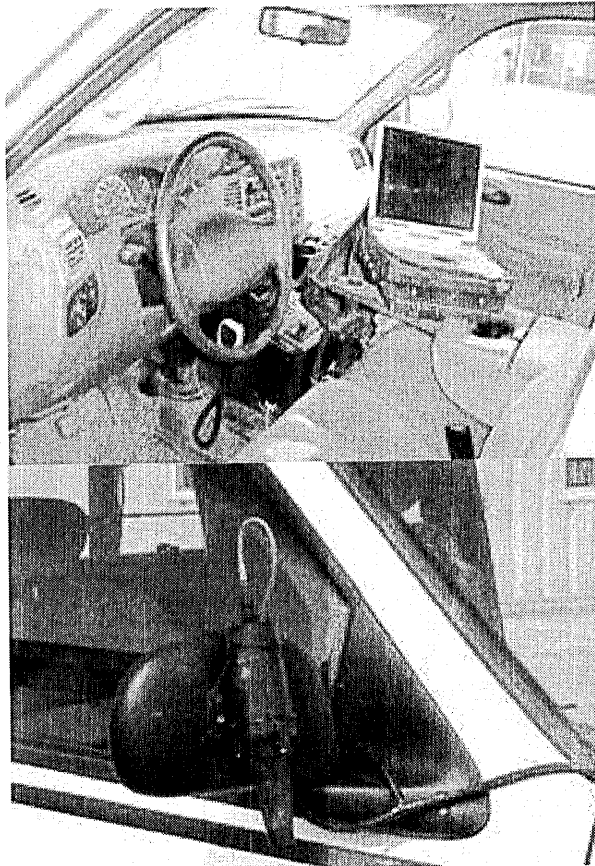
RWIS technology provides specific weather and precipitation forecasts. Five stations are currently installed at Stouffville Road and McCowan Road, Woodbine Avenue and Ravenshoe Road, King Road and Mill Street, York/Durham Line and ETR 407 and Highway 27 north of King Sideroad 17. Through the Five stations, we are able to get real time site conditions including:

- Pavement temperature
- Pavement condition
- Salt concentration
- Wind speed and direction
- Atmospheric temperature and humidity

RWIS Tower and Road Sensor Puck



Patrol Truck Weather Monitoring Equipment



4.3 Anti-icing Program

This section presents general recommendations for successful anti-icing practices that can be employed for various combinations of precipitation and pavement temperature and traffic volumes.

Anti-icing is the application of a chemical solution (salt brine) to the pavement before a storm to prevent the bonding of ice or snow to the road surface. To accomplish this, salt brine is sprayed on the road surface, the water component of the brine then evaporates or is dried up by traffic, and only the salt component remains on the road surface. A pre-treatment can be made well in advance of a storm (up to two days) provided that the storm does not start out with above freezing temperatures and rain, which will wash the chemical away.

The anti-icing program is designed to address the following types of winter storms and road conditions:

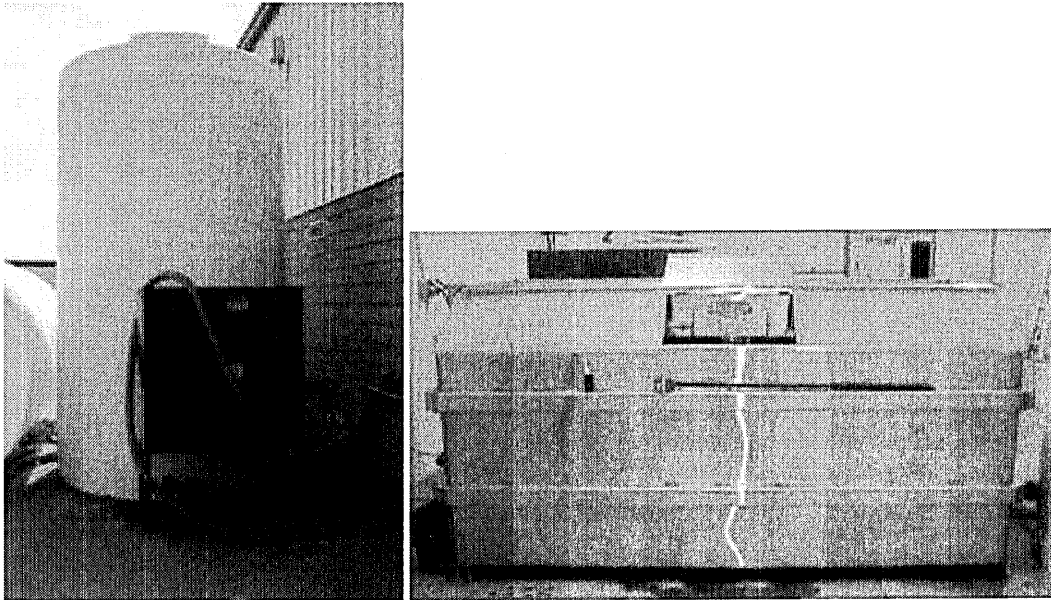
- Light snow storm
- Light snow storm with period(s) of moderate or heavy snow
- Moderate or heavy snow storm
- Frost or black ice
- Freezing rain storm
- Sleet storm

Guidance on maintenance actions for each event are provided in the **(Appendix B)** tables for several pavement temperature ranges and for initial and subsequent operations. Temperature trend, an important factor, is also indicated. Liquid application rates are suggested where appropriate.

4.4 Liquid Salt Brine Manufacturing

A 2,000 gallon brine making unit has been installed at our North Road Maintenance Yard to manufacture in-house liquid salt brine for use as an anti-icing agent. The Southwest, Central and the Southeast Road Maintenance yards are supplied with natural brine from a contracted source for their anti-icing operations.

Liquid Salt Brine Maker and Storage Tower



4.5 Winter Event

This section presents general recommendations for successful winter operation practices that can be employed for various combinations of precipitation and pavement temperature and traffic volumes.

The prime objective in applying salt on the road surface is to prevent the formation of ice rather than to melt an accumulation. Therefore, salting must be timely. The exact effective range of salt varies, being dependent on many factors. Salt applied at the beginning of a storm will prevent packing so that the plows can remove nearly all the snow. During a storm where plowing is continuous, further salt applications after each clean sweep of the plow will prevent ice formation. Salt applied in the early morning immediately after the clean sweep of the plow will have the advantage of any morning sunshine and traffic to aid the salting process. Traffic volume increases the effectiveness of salt. Speed and safety with a controlled distribution of salt are the important factors in efficient salting.

The provided (**Appendix C**) table shows the recommended treatments for bare and centre bare pavement.

5.0 MONITORING AND UPDATING THE SALT MANAGEMENT PLAN

5.1 Overview

The Salt Management Plan will be updated and reviewed each year, with new technologies and progressive advances added. With the improved monitoring, and record keeping our Roads Maintenance Division will achieve all the guidelines set by the Salt Management Plan.

5.2 Vehicle Global Positioning Systems (GPS)

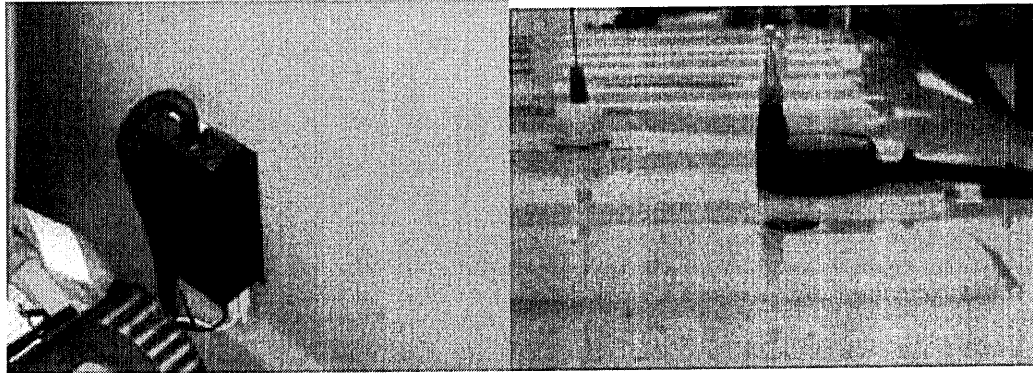
The Region has GPS installed in all of its winter maintenance vehicles. The use of the GPS system enables our staff to monitor these vehicles. This keeps track of the location and application rate where all the road salt material is spread. Along with making sure all the Regional Roads are covered, more importantly it helps to monitor how much material is used, and where it is spread.

In the future, we hope to control the application rates relative to the truck location (i.e. salt sensitive areas). This will ensure that reduced salt application rates are achieved in these areas. This will contribute to the Region's ability to control the amount of road salt used on the road surface.

The GPS allows for the recording and analysis of the following data:

Spreader/Plowing Trucks	Patrol Vehicles
• Material spread rates • Plow up, plow down • Truck speed • Material used • Vehicle location • Start and finish time	• Road conditions • Pavement temperature • Air temperature • Precipitation type • General comment • Vehicle location

Vehicle GPS Unit



5.3 Equipment Calibrations

All of the Regional winter operations vehicles are calibrated at the start of season, and again mid way through the season, and whenever material analysis shows abnormal material application. The following application rates are currently used:

- 70 kg/lane km for frost
- 130 kg/lane km for rural, mid speed two-lane sections
- 170 kg/lane km for rural, mid to high speed two-lane sections
- 220 kg/ lane km for urban and rural high speed multi-lane sections with high AADT

5.4 Improved Record Keeping

The Region's Roads Maintenance Division staff and contractors are committed to recording where and when all of their material is used, as well as the amounts that are taken out with each trip. This information is used to calculate and keep track of salt usage and distribution over the whole road system.

5.5 Operator training

To be eligible to operate winter maintenance equipment the operator must be on the approved operators list. To be placed on this list they must have a valid DZ driver's licence or higher and have attended the Region's comprehensive winter control training seminar prior to the start of the winter season. Liquidated damages are in place should a non approved driver operate a winter maintenance vehicle.

The Region's winter control training seminar consists of the following topics:

- Preseason preparation
- Weather basics
- Snow and Ice control
- Equipment Operations
- Salt Properties and Environmental Impacts

5.6 Future Initiatives

In future years, the Region will be implementing the following initiatives:

- The use of pre-treated road salts. With the addition of de-icing chemicals such as Calcium Chloride or Magnesium Chloride to road salt this will enhance the performance characteristics to allow an increased range of use. These chemicals have corrosion inhibitors and can melt snow and ice down to temperatures in the -30 to -60 degrees Celsius range, where regular salt only melts to -12 degrees.
- Work with Water resources protection to identify areas that are vulnerable to road salts such as:
 - Groundwater recharge areas
 - Areas with exposed or shallow water tables
 - Sources of drinking water
 - Salt sensitive wetlands
 - Salt sensitive kettle lakes
 - River with low flows
 - Salt sensitive habitats for species at risk

Once these areas are identified the Roads Transportation Branch will develop a plan to mitigate the impacts of road salts on these locations.

- The Southeast Yard's salt storage facility has been identified for replacement with a drive- thru salt shed. The replacement of the salt shed has been included in the 10-year Facility Capital Plan.

6.0 SUMMARY

With the need to develop and implement the Region's Salt Management Plan, the trial of new materials, equipment, and technologies has provided a positive step towards reducing our salt usage, while maintaining the same level of service the public has come to expect.

The Roads Maintenance Division will continue to measure and evaluate these benefits for operational improvement, cost savings, and environmental benefits on a yearly basis or as need dictates.

REGION OF YORK - WINTER ROAD SALT & SAND DISTRIBUTION RATES

(Based on Material Density - Salt 1190 kg/m³ Sand 1900 kgs/m³)

Revised: August 30, 2004

Road Type	LOAD SIZE		SALT				SAND			
	Spreader	Load Size (m3)	Nos Lanes Spread per pass	Salt Rate kg per spread km	Single Spinner Application Rate	Double Spinner Application Rate per shute	Sand Rate kg per spread km	Single Spinner Application Rate	Double Spinner Application Rate per shute	
1. URBAN High Volume multi-lane Class1 & 2			** (i)				Route Spread Length - kms			
		7.65	2.5	220	220	110	400	400	200	
		4.59		41			36			
		6.12		25			22			
2. RURAL High Volume two-lane Class 2 & 3				33			29			
		7.65	2	170	170	N/A	400	400	N/A	
		4.59		54			36			
		6.12		32			22			
3. RURAL Low Volume two-lane Class 3 & 4				43			29			
		7.65								
		4.59	2	130	130	N/A	400	400	N/A	
		6.12		70			36			
4. All Roads Frost Class 1 to 5				42			22			
		7.65		56			29			
		4.59								
		6.12								
		7.65	2	70	70	35	400	400	N/A	
		4.59		70			36			
		6.12		42			22			
				56			29			
		7.65								
		4.59								
		6.12								

STANDARD APPLICATION RATES:

SALT: 70 kg per 2 lane km;
130 kg per 2 lane km;
170 kg per 2 lane km;
SAND: 400 kg per 2 lane km;

MATERIAL DENSITIES:

SALT: 1,190 kg per cubic metre
1.00 Tons per cubic yard
SAND: 1,900 kg per cubic metre
1.60 Tons per cubic yard

EQUIPMENT SIZES/CAPACITIES

Spreaders (Operating Load Sizes):

Regional: 7.65 10.00 cubic yards
4.59 6.00 cubic yards
Contractor: 6.12 8.00 cubic yards
7.65 10.00 cubic yards

NOTES:

** (i) - Assumes half left turn lane, or paved shoulder per pass.
Additional later spot applications may be required to address local road cross section variations.
Such applications to be at standard route classification spread rate.

Table 1. Weather Event: Light Snowstorm

PAVEMENT TEMPERATURE RANGE, AND TREND	INITIAL OPERATION			SUBSEQUENT OPERATIONS		COMMENTS
	Pavement surface at time of Initial operation	Maintenance action	Chemical spread rate, kg/2lane-km (L/2lane-km)	Maintenance action	Dry chemical spread rate, (kg/2lane-km) Liquid Solid	
Above 0°C (32°F), Steady or rising	Dry, wet, slush, or light snow cover	None, see comments		None, see comments		1) Monitor pavement temperature closely for drops toward 0°C (32°F) and below 2) Treat icy patches if needed with chemical at 70 kg/2lane-km
Above 0°C (32°F), 0°C (32°F) or below is imminent;	Dry	Apply liquid or solid chemical	56 (220)	Plow as needed; reapply liquid or solid chemical when needed	56 (220) 130-170	1) Applications will need to be more frequent at lower temperatures and higher snowfall rates 2) Do not apply a liquid at the indicated spread rate when the pavement
ALSO -7 to 0°C (20 to 32°F), remaining in range	Wet, slush, or light snow cover	Apply liquid or solid chemical	56 (220)		130-170	Temperature drops below -5°C (23°F) 3) Do not apply liquid chemical onto heavy snow accumulation or packed snow
-10 to -7°C (15 to 20°F), remaining in range	Dry, wet, slush, or light snow cover	Apply solid chemical		Plow as needed; reapply solid chemical when needed	130-170	If sufficient moisture is present, solid chemical can be applied
Below -10°C (15°F), steady or falling	Dry or light snow cover	Plow as needed		Plow as needed		1) Do not apply chemicals in this temperature range 2) Abrasives can be applied to enhance traction

Notes

CHEMICAL APPLICATIONS. (1) Time initial and subsequent chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. (2) Apply chemical ahead of traffic rush periods occurring during storm. **PLOWING.** If needed, *plow before chemical applications* so that excess snow, slush, or ice is removed and pavement is wet, slushy, or lightly snow covered when treated.

SUMMARY TABLE 1
RECOMMENDED TREATMENTS FOR
BARE AND CENTRE BARE PAVEMENT

	TEMP (CELSIUS)	TYPE OF PRECIPITATION	ROAD CONDITION	ACTIVITY	RECOMMENDED TREATMENT		
					BEGINNING OF STORM	DURING STORM	AFTER STORM
1.	Below -18	Dry Snow	No Packing Dry Pavement	Plowing Sanding Salting	After 2 cm of snow accumulation If slippery No	Continuously Follow after plowing, if slippery No	Bare pvt/wing/shlds/clean up Slippery Sections only If temperature rising, to bare or assist in baring pavt.
2	-18 to -12	Dry Snow	No Packing Dry Pavement	Plowing Sanding Salting	After 2 cm of snow acculation If slippery No	Continuously No	Bare pvt/wing shlds/clean up Slippery Sections only
3	-18 to -12	Dry Snow	Packing	Plowing Sanding Salting	If temp rising, after salting, If temp falling, after 2 cm acc. If temp falling, if slippery If temp rising before 0.5 cm accumulation After 2 cm of snow accumulation If temp. falling, if slippery No	Continuously If temp falling, follow after plowing, if slippery If temp rising, as necessary after plowing Continuously Follow after plowing, if slippery No	If temperature rising, to bare or assist in baring pavement Bare pvt/wing shlds/clean up If temp. falling, Slippery sections If temp rising, to bare or assist in baring pavement Bare pvt/wing shlds/clean up Slippery sections only
4	-12 to -7	Dry Snow	No Packing	Plowing Sanding Salting	If temp rising, before 0.5 cm accumulation After 2 cm of snow acculation If temp. falling, if slippery No	Continuously Follow after plowing, if slippery No	If temp rising, to bare or assist in baring pavement Bare pvt/wing shlds/clean up Slippery sections only
5	-12 to -7	Dry Snow	Packing	Plowing Sanding Salting	0.5h after salting No	Continuously Follow after plowing, if slippery No	Bare pvt/wing shlds/clean up Slippery sections only
6	Above -7	Wet Snow	Packing Wet Pavement	Plowing Sanding Salting	If temp rising, before 0.5 cm of snow accumulates 0.5h after salting No	As necessary after plowing, to assist plowing Continuously Follow after plowing, if slippery As necessary after plowing, to assist plowing Continuously	If temp rising, to bare or assist in baring pavt Bare pvt/wing shlds/clean up Slippery sections only
7	Above -7	Sleet or Freezing Rain	Possible Icing Wet Pavement	Plowing Sanding Salting	Before 0.5 cm of snow accumulates No No When icing starts	As necessary after plowing No Yes Yes	To bare or assist in baring pavement Remove any slush Slippery sections only Slippery sections only

NOTES 1. Wingback shoulders should usually be done only once after the storm.

2. Recommended treatment for various conditions shown on this chart should be used in MOST cases. However, unusual circumstances may necessitate departure from the recommended treatment.

3. Temperature rising means temperature to remain in or rise above temperature range.

4. Temperature falling means temperature to remain in or fall below temperature range.

Table 2. Weather event: light snowstorm with period(s) of moderate or heavy snow.

PAVEMENT TEMPERATURE RANGE, AND TREND	INITIAL OPERATION			Maintenance action	SUBSEQUENT OPERATIONS				COMMENTS
	Pavement surface at time of Initial operation	Maintenance action	Chemical spread rate, kg/2lane-km (L/2/1ane-km)		Chemical spread rate, kg/2lane-km (L/2/1ane-km)				

Notes

CHEMICAL APPLICATIONS. (1) Time initial and subsequent chemical applications to prevent deteriorating conditions or development of packed and bonded snow. (2) Anticipate increases in snowfall intensity. Apply higher rate treatments prior to or at the beginning of heavier snowfall periods to prevent development of packed and bonded snow. (3) Apply chemical ahead of traffic rush periods occurring during storm. **PLOWING.** If needed, plow before chemical applications so that excess snow, slush, or ice is removed and pavement is wet, slushy, or lightly snow covered when treated.

Table 3. Weather event: moderate or heavy snowstorm.

PAVEMENT TEMPERATURE RANGE, AND TREND	INITIAL OPERATION				SUBSEQUENT OPERATIONS			COMMENTS
	Pavement surface at time of Initial operation	Maintenance action	Chemical spread rate, kg/2lane-km (L/2/lane-km)		Maintenance action	Chemical spread rate, kg/2lane-km (L/2/lane-km)		
			Liquid	Solid		Liquid	Solid	
Above 0°C (32°F), steady or rising	Dry, wet, slush, or light snow cover	None, see comments			None, see comments			1) Monitor pavement temperature closely for drops toward 0°C (32°F) and below 2) Treat icy patches if needed with chemical if needed
Above 0°C (32°F), 0°C (32°F) or below is imminent; ALSO -1 to 0°C (30 to 32°F), remaining in range	Dry	Apply liquid or solid chemical	56 (220)	130- 170	Plow accumulation and reapply liquid or solid chemical as needed	56 (220)	130-170	1) If the desired plowing/treatment frequency cannot be maintained, the spread rate can be increased to 170 kg/2lane-km to accommodate longer operational cycles 2) Do not apply liquid chemical onto heavy snow accumulation or packed snow
	Wet, slush, or light snow cover	Apply liquid or solid chemical	56 (220)	130- 170				
-4 to -1°C (25 to 30°F), remaining in range	Dry	Apply solid chemical		130- 170	Plow accumulation and reapply solid chemical as needed		130-170	1) If the desired plowing/treatment frequency cannot be maintained, the spread rate can be increased to 170 kg/2lane-km to accommodate longer operational cycles 2) Do not apply liquid chemical onto heavy snow accumulation or packed snow
	Wet, slush, or light snow cover	Apply solid chemical		130- 170				
-10 to -4°C (15 to 25°F), remaining in range	Dry, wet, slush, or light snow cover	Apply chemical		130- 170	Plow accumulation and reapply solid chemical as needed		130-170	1) If the desired plowing/treatment frequency cannot be maintained, the spread rate can be increased to 170 kg/2lane-km to accommodate longer operational cycles 2) If sufficient moisture is present, solid chemical without can be applied
Below -10°C (15°F), steady or falling	Dry or light snow cover	Plow as needed			Plow accumulation as needed			1) Do not apply chemicals in this temperature range 2) Abrasives can be applied to enhance traction

Notes

CHEMICAL APPLICATIONS. (1) Time initial and subsequent chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow -- *timing and frequency of subsequent applications will be determined primarily by plowing requirements.* (2) Apply chemical ahead of traffic rush periods occurring during storm.

PLOWING. *Plow before chemical applications* so that excess snow, slush, or ice is removed and pavement is wet, slushy, or lightly snow covered when treated.

Table 4. Weather event: frost or black ice.

PAVEMENT TEMPERATURE RANGE, TREND, AND RELATION TO DEW POINT	TRAFFIC CONDITION	INITIAL OPERATION		SUBSEQUENT OPERATIONS		COMMENTS
		Maintenance action	Chemical spread rate, kg/2lane-km (L/2/lane-km)	Maintenance action	Chemical spread rate, kg/2lane-km (L/2/lane-km)	
			Liquid		Liquid	Solid
Above 0°C (32°F), steady or rising	Any level	None, see comments		None, see comments		
-2 to 2°C (28 to 35°F), remaining in range or falling to 0°C	Traffic rate less than 100 vehicles per h	Apply solid chemical	70	Reapply solid chemical as needed	70	Monitor pavement closely; if pavement becomes wet or if thin ice forms, reapply chemical at higher indicated rate
(32°F) or below, and equal to or below dew point	Traffic rate greater than 100 vehicles per h	Apply liquid or solid chemical	25 (110)	Reapply liquid or solid chemical as needed	56 (220)	2) Do not apply liquid chemical on ice so thick that the pavement can not be seen
-7 to -2°C (20 to 28°F), remaining in range, and equal to or below dew point	Any level	Apply liquid or solid chemical	56 (220)	Reapply liquid or solid chemical when needed	56 (220)	1) Monitor pavement closely; if thin ice forms, reapply chemical at higher indicated rate 2) Applications will need to be more frequent at higher levels of condensation; if traffic volumes are not enough to disperse condensation, it may be necessary to increase frequency 3) Do not apply liquid chemical at the indicated spread rate when the pavement temperature drops below -5°C (23°F)
-10 to -7°C (15 to 20°F), remaining in range, and equal to or below dew point	Any level	Apply solid chemical	130-170	Reapply solid chemical when needed	130-170	1) Monitor pavement closely; if thin ice forms, reapply chemical at higher indicated rate 2) Applications will need to be more frequent at higher levels of condensation; if traffic volumes are not enough to disperse condensation, it may be necessary to increase frequency
Below -10°C (15°F), steady or falling	Any level	Apply abrasives		Apply abrasives as needed		Do not apply chemicals in this temperature range

Notes

TIMING. (1) Conduct initial operation in advance of freezing. Apply liquid chemical up to 3 h in advance. Use longer advance times in this range to effect drying when traffic volume is low. Apply solid 1 to 2 h in advance. (2) In the absence of precipitation, liquid chemical at 56 kg/2lane-km has been successful in preventing bridge deck icing when placed up to 4 days before freezing on higher volume roads and 7 days before on lower volume roads.

Table 5. Weather event: freezing rain storm.

PAVEMENT TEMPERATURE RANGE, AND TREND	INITIAL OPERATION		SUBSEQUENT OPERATIONS		COMMENTS
	Maintenance action	Chemical spread rate, kg/2lane-km	Maintenance action	Chemical spread rate, kg/2lane-km	
Above 0°C (32°F), steady or rising	None, see comments		None, see comments		1) Monitor pavement temperature closely for drops toward 0°C (32°F) and below 2) Treat icy patches if needed with solid chemical at 70 kg/2lane-km
Above 0°C (32°F), 0°C (32°F) or below is imminent	Apply solid chemical	70-130	Reapply solid chemical as needed	70-130	Monitor pavement temperature and precipitation closely
-7 to 0°C (20 to 32°F), remaining in range	Apply solid chemical	70-130	Reapply solid chemical as needed	70-130	1) Monitor pavement temperature and precipitation closely 2) Increase spread rate toward <i>higher indicated rate</i> with decrease in pavement temperature or increase in intensity of freezing rainfall 3) Decrease spread rate toward <i>lower indicated rate</i> with increase in pavement temperature or decrease in intensity of freezing rainfall
-10 to -7°C (15 to 20°F), remaining in range	Apply solid chemical	130-170	Reapply solid chemical as needed	130-170	1) Monitor precipitation closely 2) Increase spread rate toward <i>higher indicated rate</i> with increase in intensity of freezing rainfall 3) Decrease spread rate toward <i>lower indicated rate</i> with decrease in intensity of freezing rainfall
Below -10°C (15°F), steady or falling	Apply abrasives		Apply abrasives as needed		It is not recommended that chemicals be applied in this temperature range

Notes

CHEMICAL APPLICATIONS. (1) Time initial and subsequent chemical applications to *prevent* glaze ice conditions. (2) Apply chemical ahead of traffic rush periods occurring during storm.

Table 6. Weather event: sleet storm.

PAVEMENT TEMPERATURE RANGE, AND TREND	INITIAL OPERATION		SUBSEQUENT OPERATIONS		COMMENTS
	maintenance action	chemical spread rate, kg/2lane-km	maintenance action	chemical spread rate, kg/2lane-km	
Above 0°C (32°F), steady or rising	None, see comments		None, see comments		1) Monitor pavement temperature closely for drops toward 0°C (32°F) and below 2) Treat icy patches if needed with solid chemical at 70 kg/2lane-km
Above 0°C (32°F), 0°C (32°F) or below is imminent	Apply solid chemical	70	Plow as needed, reapply solid chemical when needed	70	Monitor pavement temperature and precipitation closely
-2 to 0°C (28 to 32°F), remaining in range	Apply solid chemical	70-130	Plow as needed, reapply solid chemical when needed	70-130	1) Monitor pavement temperature and precipitation closely 2) Increase spread rate toward <i>higher indicated rate</i> with increase in sleet intensity 3) Decrease spread rate toward <i>lower indicated rate</i> with decrease in sleet intensity
-10 to -2°C (15 to 28°F), remaining in range	Apply solid chemical	130-170	Plow as needed, reapply solid chemical when needed	130-170	1) Monitor precipitation closely 2) Increase spread rate toward <i>higher indicated rate</i> with decrease in pavement temperature or increase in sleet intensity 3) Decrease spread rate toward <i>lower indicated rate</i> with increase in pavement temperature or decrease in sleet intensity
Below -10°C (15°F), steady or falling	Plow as needed		Plow as needed		1) It is not recommended that chemicals be applied in this temperature range 2) Abrasives can be applied to enhance traction

Notes

CHEMICAL APPLICATIONS. (1) Time initial and subsequent chemical applications to *prevent* the sleet from bonding to the pavement. (2) Apply chemical