MUNICIPALITY
JANUARY, 2010

SNOW AND ICE CONTROL

GENERAL INFORMATION

GUIDELINES

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INTRODUCTION

I.A General

It is MUNICIPALITY’S goal to provide a transportation system that is passable and reasonably safe as much of the time as possible within the limitations imposed by the natural environment and the availability of equipment, material and personnel resources. As a result of those limitations, it is recognized that there will be occasions when the pavement and bridge surfaces will be slippery and/or snow and ice covered. During these periods customers (drivers) must recognize the conditions and operate their vehicles in an appropriately safe manor.

This manual provides information and guidance to assist MUNICIPALITY Public Works Department in conducting snow and ice control operations. It will serve as a basis for training MUNICIPALITY personnel.

The manual contains information on pre-winter operations and readiness, total storm management and decision making using MUNICIPALITY information resources, pre-storm preparedness, treatment options, post storm and post season activities. The provisions were developed to provide a reasonable balance among safety, cost, and environmental responsibility. The manual also contains related operational procedures and personnel procedures. The contents of this manual supersede all applicable prior manuals, directives and guidance relating to snow and ice control.

The contents of this manual reflect best practices as determined from a review of the relevant national and international literature and from information obtained from MUNICIPALITY maintenance personnel through surveys and interviews. It is intended to be a “living document” that is responsive to new technology and techniques developed within MUNICIPALITY and elsewhere. Suggestions for change may be submitted at any time to:

________________________________________________________________________
________________________________________________________________________

The words shall, must, should, recommended and may used in Section II of this manual have the following meanings:

shall and must - a required course of action
should and recommended - a recommended course of action
may - an optional course of action
I.B  Specific Information for Motorists, Residents and Property Owners

I.B.1 How Residents and Property Owners Can Help Assure the Safety and Efficiency of MUNICIPALITY’S Snow and Ice Control Operations, and their own Snow Removal Operations

- Do not park on MUNICIPALITY streets, especially during snow or ice events (they may be ticketed and towed where there is “no street parking” and other signage).
- Do not place trash cans within 2 feet of the edge of pavement.
- Keep basketball devices at least 10 feet from the edge of pavement.
- Do not park cars in driveways within 10 feet of edge of pavement.
- Do not allow children to build and occupy “snow forts” and similar creations within 10 feet of the edge of pavement.
- Do not relocate snow from driveways and sidewalks into the paved street. This is in violation of New York State Highway law (Article 8, Section 214) and will cause a hazardous condition on the street.
- Fences should not be within 10 feet of the edge of pavement.
- Remove all non-permanent seasonal items from within 10 feet of edge of pavement.
- Trim trees so that branches do not extend beyond the back of the curb.
- Pile most of the snow from the driveway throat on the traffic downstream side. This will minimize visibility problems.
- Shovel or plow an area immediately upstream of your driveway throat to accommodate plowed snow from the street. This will lessen build-up in your driveway throat.
- Cooperate with the winter parking regulations that are in effect.

I.B.2 Roads within the MUNICIPALITY that are NOT maintained by the BY THE MUNICIPALITY

Following is a list of roads/plans that are NOT maintained by the MUNICIPALITY
Table 1  Roads NOT maintained by MUNICIPALITY

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I.B.3  Winter Services Agreement

There are certain roads within housing developments in the MUNICIPALITY that have not yet been adopted by the MUNICIPALITY for maintenance. The developers for those areas are given the opportunity each fall to sign a “Winter Services Agreement”. That agreement, between the MUNICIPALITY and individual developers, establishes a commitment by the MUNICIPALITY to plow the roads within that development, for that snow season.

If the developer fails to process the agreement with the MUNICIPALITY by fall, it may cause a delay in plowing of roads, or in the most inconvenient circumstances, no available plowing services at all.
I.B.4  Private Driveways and Roads

MUNICIPALITY snow removal crews do not clear private roads, driveways or driveway entrances of accumulated snow.

I.B.5  Plow Trucks Having Plows Raised

A truck with a raised plow does not always mean the driver has completed your area. They may be:

1. Returning for fuel or vehicle service
2. Returning to the maintenance yard for additional treatment material
3. Responding to a call to assist Emergency Services, i.e.:
   a) Police Department
   b) Fire Department
   c) Volunteer Ambulance
   d) School District Transportation Department

I.B.6  Mailboxes, Mailbox Posts and other Features that may be Damaged by MUNICIPALITY Plowing operations

You can help reduce the possibility of a damaged/broken mailbox or mailbox post. Plow operators are urged to take precautions to avoid hitting mailbox posts. Experience has shown that reduced visibility during a storm makes it difficult for a driver to see a post in time to avoid striking it or pushing it over with plowed snow.

Any installation within the right of way - including a mailbox/post - is placed there at the owner's risk.

Owners are encouraged to install mailboxes at the maximum usable distance from the edge of the pavement. Posts should also be checked for deterioration to reduce the possibility that the weight of the plowed snow may simply break or push the post over. The MUNICIPALITY shall not repair or replace mailboxes or posts damaged by the force or placement of plowed snow.

MUNICIPALITY will not repair plow damage to grass and other plantings that are adjacent to the road.
I.B.7  Contacting the MUNICIPALITY During a Snow or Ice Event

Avoid calling municipal offices during a storm except in an emergency. Personnel are extremely busy dealing with storm conditions.

Please keep telephone lines clear for emergencies

Emergency calls during snow removal season should be placed to the MUNICIPALITY Public Works Department, ___________, Monday thru Friday 7:00 am to 3:30 pm. Customer Service Center__________) Monday thru Friday, 3:30 pm to 5 pm. Weekends and evenings, please call 911.

I.B.8  Emergency Information
- Contact information for: key functions in local, state, county and the federal government, utilities, emergency aid providers
- Snow emergency and emergency evacuation routes
- Sources of weather information
- Shelter information
- Sources of emergency provisions
- Alert and public information sources and systems

I.B.9  Priority of Treatment

Treatment priorities are found in Section II.B of this document

I.B.10  Winter Driving Safety Tips

AAA Offers Easy-To-Follow Winter Motoring Advice

Winter driving is tough on motorists and vehicles. To help drivers make it through the toughest winter conditions, AAA Southern New England offers the following tips:

Charge!! - Cold weather is tough on batteries. At zero degrees, a car’s battery loses about 60 percent of its strength. At a comparatively mild 32 degrees, a battery is 35 percent weaker. Keeping battery terminals clean helps, but a load test performed by a qualified technician will help determine whether a car’s battery is strong enough for winter starts.

Get a Grip - Before winter arrives, make sure your car is equipped with tires that are able to handle New England’s winter weather. For most motorists, all-season tires are adequate. In more northern or mountainous regions, replacing your tires with four snow tires will help give your vehicle traction for slippery and snowy road conditions.
See and Be Seen - Danger must be seen to be avoided. Driving with a snow-covered windshield, windows, side-view mirrors or lights invites a crash. Clear windows, mirrors and lights with an ice scraper, brush or spray de-icer. Make certain windshield wipers and defrosters are in good working order and that washer reservoirs are filled with no-freeze windshield washer fluid.

Slippery When Wet - In temperatures at or just above 32 degrees, a thin layer of water can cover the ice, causing extremely slippery conditions. The distance needed to stop on ice at 32 degrees is twice as long as at zero degrees.

Keep Your Engine Cool - Make certain cooling system antifreeze is mixed with an equal portion of water for maximum protection.

Fast Solution - A squirt of de-icer spray is a quick method to overcome frozen door locks.

Air It Out - Don’t let frigid temperatures tempt you into starting your car in a closed garage or idling your engine for long periods with the windows closed. Carbon monoxide, present in exhaust fumes, is almost impossible to detect and can be fatal when breathed in a confined area.

Finish Up - Road salt, slush and grime are especially hard on a car’s finish. To help prevent rust and paint damage, keep cars washed and waxed. A full or self-service car wash makes the job easier when temperatures are low.

AAA Offers Winter Advice For Parents of Young Drivers

Winter driving can be challenging to any motorist, but slippery roads can be especially difficult for novice drivers dealing with ice and snow for the first time, according to AAA Southern New England.

"Parents need to work with their teens to help them gain the experience they need for safe winter driving in the safest possible environment," said John Paul, AAA Manager of Traffic Safety and Public Affairs.

AAA offers the following tips to help parents teach their teens to drive in winter conditions:

• Under close supervision, let your teen practice slow speed maneuvers on a wide open snow- or ice-covered parking lot. Have him or her practice hard braking and steering in skidding conditions.

• A novice driver’s first on-the-road experience with winter-weather driving should not occur during a major snow storm. Wait until conditions are less severe.
• Consider limiting your teen’s driving on slippery conditions to daylight hours until they have gained experience.

• Remind your teen that driving under the influence of drugs or alcohol is dangerous under any conditions, and that the risk is even greater on slippery roads.

• Make sure the vehicle your teen is driving is equipped with essential emergency equipment, including a flashlight, blankets, jumper cables, sand or non-clumping cat litter and a small shovel or ice scraper.

• SUV’s can lead to over confidence on the roads. All vehicles should be driven cautiously in poor weather conditions.

AAA Recommends Emergency Equipment Kit

Because even the best maintained vehicles can fall victim to frigid winter weather, AAA recommends every vehicle carry the following items to ensure safe winter travel:

**Flashlight** - A working flashlight should be stored where the driver can access it without leaving the vehicle. That will enable the motorist to see obstacles and be seen by other drivers when exiting the vehicle in an emergency. Also carry spare batteries.

**Jumper Cables** - Jumper cables can be an essential tool for starting vehicles with weak or dead batteries, but they should only be used by individuals familiar with the proper safety precautions. Vehicle owner’s manuals should be consulted for instructions.

**Abrasive Material** - Sand or non-clumping cat litter can be spread under the wheels to improve traction when a vehicle becomes stuck in snow or ice. Special traction mats and even floor mats also can be used for this purpose.

**Shovel** - A small shovel can be used to carefully dig snow away from the wheels.

**Warning Devices** - Flares or reflective triangles alert other motorists that you are broken down or stuck and helps give them enough time to slow down in order to pass safely. Safety Tip: When using flares/reflectors place them at least 100 feet from the rear of the car.

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**Blankets** - Cold weather can quickly turn an inconvenient breakdown into a life-threatening situation. Blankets can provide valuable protection against the cold and can help keep you comfortable until help arrives. Floor mats and newspapers can also be used to provide insulation in emergencies.

**Snow Brush/Ice Scraper** - It’s important that windows and lights are clear of ice and snow in order to maintain adequate visibility. The entire vehicle should be brushed clear
so blowing snow does not become a hazard for other motorists. Tip: If you drive an SUV or van along handle brush will make quick work of clearing snow from the roof.

**Cellular Phone** - A cellular telephone comes in handy when a motorist needs assistance in the event of a vehicle breakdown.

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**Plan Ahead To Avoid Frustrating Travel This Holiday Season**

To make the most of this holiday season, AAA Southern New England suggests planning ahead to avoid common holiday travel pitfalls.

"When you take a holiday, add the threat of bad weather and throw in 25 to 30 million motorists, you get a recipe for frustration," said Lloyd Albert, AAA Senior Vice President Public/Government Affairs and New Business Development. "With some advance planning, the season can be much more enjoyable."

AAA offers these tips for safe and happy holiday auto travel:

• Leave early, stay late. If possible, leave a day earlier than normal and return a day early or a day late. You can avoid wasting time in traffic and enjoy more time with family and friends.

• Plan ahead. Know your route and have an alternate plan in case of heavy traffic. Also make sure your vehicle is in top condition and carry a vehicle safety kit.

• Take your time. The current land speed record is 763 miles-per-hour. Don’t try to break it on the way to grandmas. It’s better to plan extra time and arrive safely.

• Take a 15- to 20-minute break every few hours. Stop at a safe rest area and stretch your legs. Also, drink plenty of fluids.

• Bring activities. Children’s attention spans are shorter than adults, so they quickly lose interest when traveling. Pack some special snacks and favorite toys to keep them busy. Try a recorded story or sing-along tape.

• Don’t eat and run. After the third helping, take a walk to get the blood flowing again. Better yet, take a long nap in your in-law’s recliner.

**Strong Battery Boosts Winter Car Starts**

One of the best ways to protect against winter car trouble is to be certain your battery is fully charged and in proper working condition, according to AAA Southern New England.

"When the temperature drops to near zero, the number of calls AAA receives from stranded motorists soars," said AAA Approved Auto Repair Manager John Ward. "The most common cause of these cold-weather breakdowns is a weak or dead battery."
AAA recommends motorists have a load test to closely monitor the condition of the vehicle’s battery, especially batteries more than two years old. "Although batteries can carry warranties of four years or more, a warranty is no guarantee an older battery will continue to work in severe weather," Mr. Ruggiero said.

The most common sign of a weak battery is an unusual sound coming from the starter motor when the ignition key is turned, indicating difficulty in starting the engine.

If the vehicle is difficult to start, check that the battery connections are tight and no corrosion is present on the battery terminal. To remove corrosion, use an old toothbrush to clean the cable connectors and terminals with a solution of baking soda and water. Next, inspect the tension of all drive belts. They should flex no more than one-half inch. If the battery’s fluid level can be checked, make certain the fluid covers the battery plates. If no problems are found and the vehicle is still difficult to start, drive to a service station or auto parts store to have the battery and charging system tested and, if necessary, replaced.

In addition to weak or dead batteries, starting problems can be caused by malfunctioning alternators or starter motors. A qualified repair facility can make an accurate diagnosis and repair.

If the vehicle will not start, use caution and follow instructions in the owner’s manual when attempting a jump start. If unsure about the proper procedure, call AAA or another qualified professional for assistance.

To help avoid winter breakdowns, AAA recommends motorists have their cars and trucks thoroughly inspected before cold weather arrives. In addition to the battery, fluids, belts, hoses, filters and tires should all be checked.

Because of the difficult driving conditions often encountered in the winter, motorists should also be sure their lighting systems, brakes and windshield wipers are functioning properly.

II. OPERATIONAL GUIDELINES

II.A Goal of Snow and Ice Control Operations

MUNICIPALITY will conduct snow and ice control activities that afford customers a reasonably safe and passable (not necessarily bare) road surfaces much of the time as possible. To accomplish that, snow and ice accumulations will be removed as soon as possible, consistent with stated priorities and resources. To the extent possible, the bond of snow and ice to the pavement will be prevented by the timely application of ice control chemicals (anti-icing strategy). Abrasives may be used as necessary to provide temporary friction improvement.
Certain conditions such as unavailability of equipment and personnel, blizzards, whiteouts, other locally severe snow or ice events, thin ice formation in the absence of or during very light and spotty precipitation, and other conditions unknown to or beyond the control of MUNICIPALITY maintenance forces may temporarily preclude achieving this goal.

II.B Operational Priorities and Personnel Policies

II.B.1 Operating Priorities

MUNICIPALITY has established a traffic volume and route type classification system for determining the priority of snow and ice control operations. A written description follows that includes: priorities and timing, level of service provided between 9 PM and 5 AM, a list of known icing or trouble locations, sidewalk policy and hydrant policy:

TO BE ADDED BY MUNICIPALITY

MAPS TO BE PLACED IN APPENDIX II

II.B.2 Personnel Policies

II.B.2.a Hours of Continuous Duty

A driver may be on duty a maximum of 16 hours. After that, the driver must be off duty for a minimum of 8 continuous hours before returning to work. Qualified drivers will be utilized first unless a state of emergency is declared.

II.B.2.b Call-In Procedures

Drivers are required to report for duty within 45 minutes of notification

II.B.2.c Fitness For Duty

Drug and alcohol policy as outlined by the New York State CDL requirements and MUNICIPALITY Policy

Other factors

II.B.2.d New York State Public Officers Law (Section 18)

MUNICIPALITY will provide legal defense to employees for actions resulting from performing their official duties as long as the employee:

- Did not break a law
- Was acting within the scope of his or her official duties
- See Appendix X for text of the law
II.B.2.E  New York State Vehicle and Traffic Law (Section 1103)
MUNICIPALITY employees conducting snow and ice control operations should adhere to the provisions of the vehicle and traffic law. However, it is recognized that in order to satisfactorily perform required maintenance, some provisions of the vehicle and traffic law must be violated. Actions like clearing over highway center line and backing into traffic flow to clear intersections are necessary. Any necessary violations of the vehicle and traffic law must be performed “with due regard for the safety of all persons”. In the event of an incident or accident that results from such a violation, the operator will most likely be liable. See Appendix X for text of the law.

II.B.2.f  New York State Insurance Law (Section 2335)
This law protects commercial and municipal drivers from having their personal insurance premiums impacted by accidents involving the employer’s equipment, unless the accident was intentional or caused by gross negligence. See Appendix X for text of the law.

II.B.2.g  New York State Highway Law (Article 8, Section 214)
A section of this law prohibits any person from depositing any material on to any highway (including snow and ice from driveways). There is a similar provision in the vehicle and traffic law. See Appendix X for text of the law.
## II.B.3 Operational Resources and Responsibilities

### II.B.3.a Equipment Type and Location

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<th>Type</th>
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<td>Excavator</td>
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<td>Skid Steer</td>
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<td>Tractor</td>
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<td>Light Truck</td>
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<td>Motor Grader</td>
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<td>Heavy Truck</td>
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<td>Snow Blower</td>
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II.B.3.b Personnel Available

Public Works Department
Streets Department
Water Department
Sewer Department
Parks and Recreation Department

II.B.3.c Budget Information

Materials
Overtime
Equipment
Total

II.B.3.d Facilities Information

Work and Garage Locations
Location and size of materials storage facilities

II.B.3.e Snow and Ice Control Responsibility

Road and Street Miles or Lane Miles
Number of Cul De Sacs
Number and Size of Parking Lots
Number of Park and Ride Lots
Length of Sidewalks and other Pedestrian Facilities
II.B.4 Operators Direct Communication with the Public

Operators are to report all stranded or stuck vehicles to the Public Works office. Operators may stop to check to see if the vehicles passengers are safe.

If an Operator is being flagged down to stop by a resident, the Operator may stop; however, the Operator should offer that all disputes or concerns be directed to the Public Works office. All Operators should have a business card of Public Works Manager to hand to the resident.

II.C Pre-Winter Planning Activities

II.C.1 Review and revise this manual as necessary

As this is a living document, appropriate changes should be incorporated as soon as possible. Areas that may change include: highway responsibility, technology, procedures, equipment, personnel, staffing, materials and level of service. Sources of changes may include: our customers, individual or work group suggestions, personnel meetings, post-season reviews and MUNICIPALITY management.

Levels of service goals should be reviewed for their impact on plow routes and required resources (personnel, equipment, materials, facility, etc.). Those resources should be assigned as necessary.

II.C.2 Review Emergency and Severe Weather Response Procedures

MUNICIPALITY road closure and reopening procedures should also be reviewed with all personnel likely to be involved. Procedures for re-deploying resources should be reviewed and coordinated within and among work areas. Arrangements, lodging and food for MUNICIPALITY personnel during emergencies should be arranged at this time. Other procedures that should be reviewed include chain control, internal and external communications, and command and control. Any emergency contracts and cooperative and resource arrangements among MUNICIPALITY Departments, The National Weather Service, other local governments, NYSDOT, and all levels of applicable emergency management should also be reviewed.
II.C.3 Equipment Readiness

All of MUNICIPALITY’s snow and ice control related equipment should be inspected, test run, repaired as necessary, and receive scheduled maintenance prior to the snow and ice season.

II.C.3.a Truck Readiness

The prescribed seasonal and use based maintenance service should be completed prior to the winter season. All trucks should be checked with full winter gear (plows and spreaders) well in advance of the first anticipated snow or ice event.

II.C.3.b Material Spreader Readiness

The materials spreaders should receive required maintenance and be lubricated, repaired, test run and calibrated. All ground speed controlled materials spreaders should have a backup or manual calibration that can be used if the automatic system fails. A calibration procedure is found in Appendix C.

II.C.3.c Liquid Materials Dispensing Systems

MUNICIPALITY uses some liquid dispensing systems during snow and ice control operations. These systems should be inspected, test run, calibrated, lubricated and repaired as necessary. Associated bulk storage tanks should be inspected per manufacturer’s recommendations. Large storage tanks should be tied down and have secondary containment systems. Appropriate safety gear (goggles, rubber gloves, etc.) and MSDS sheets should be conveniently available. Any time a liquid is added to a tank be sure it is compatible with the liquid that is in the tank. When changing liquids in a tank, it is advisable to flush the tank before refilling with a different material.

II.C.3.d Plow Equipment

Plow equipment should be inventoried, test mounted, and inspected for proper function, missing parts, structural damage, proper adjustment, and sufficient remaining wear depth on items like shoes and cutting edges. Necessary repairs and replacement should be made. Plows should be stored in a position for easy hookup and have easy-to-read identification to match them to the proper truck.
II.C.3.e  Spare Parts

The maximum allowable stock of commonly used spare parts should be acquired prior to the snow and ice season. These include: cutting edges, plow shoes, shear pins, nuts and bolts, filters, bulbs, spreader controller parts and truck springs. Windshield wipers should be new or near new at the start of the winter maintenance season.

II.C.3.f  Individual Tools and Safety Gear

Trucks should be checked for the required compliment of tools and safety gear. These include, for example: shovels, bars, hand tools, tire chains, flashlights, flags, flares, warning devices, gloves, hard hats, tow chains, ice scrapers, and snow brushes/brooms. Proper stowage for these and other in – cab loose items must be provided.

II.C.4  Personnel Readiness

II.C.4.a  Acquisition and Assignment

Sufficient personnel (permanent, temporary, reassigned and interdepartmental) should be acquired and trained for snow and ice operations prior to the winter season. Any within Department of Public Works reassignments and provisions for emergency reassignment from non-highway units should be accomplished before the first anticipated snow or ice event. Specific route assignments should also be made prior to the snow and ice season and added to this document. However, there should be contingency provisions to accommodate the lack of specific people and equipment.

II.C.4.b  Callout and Family Readiness

Callout procedures, impacts of winter maintenance on family life and family responsibilities should be reviewed and discussed with applicable MUNICIPALITY personnel before the snow and ice season.

II.C.4.c  Training

Snow and ice control training should be accomplished prior to the snow and ice control season. Training topics include, at a minimum: intra-MUNICIPALITY communication, cooperation and responsibilities; weather conditions, road conditions, road and weather information systems; safety issues; public relations/information issues; operational issues and procedures; level of service (local and system-wide); equipment readiness; materials management; new technology, new initiatives and procedures; and emergency response issues.
II.C.5  Materials Readiness

II.C.5.a  Contracts

MUNICIPALITY acquires most snow and ice control materials through the contract process. Given the time required to establish a contract, these requirements and contracts and purchase requisitions should be done early. Typical materials purchased include sodium chloride (salt or rock salt), calcium chloride (liquid and flake), abrasives (sand), liquid magnesium chloride with corrosion inhibitor, etc. Individual responsibilities in the contract administration process should be defined. Quality assurance procedures should be established for each material.

II.C.5.b  Materials Storage Structure

Most MUNICIPALITY snow and ice control chemicals are stored in a structure. This structure and associated run-off containment features, lighting systems, and ventilation systems should be inspected and repaired as necessary. It should be filled to working capacity prior to the snow and ice season.

II.C.6  Emergency Readiness

Staff likely to be involved should review relevant portions of this document. Cooperative agreements within and outside MUNICIPALITY should be reviewed and reaffirmed with the cooperating groups.

II.C.7  Highway System Readiness

Various elements of MUNICIPALITY’S highway system should be checked and given necessary attention as required. These include: crack and joint sealing, permanent pothole repair, striping, drainage clearing and marking, winter signage, obstacle markers and delineators

II.C.8  Maintenance Facility Readiness

Certain features of MUNICIPALITY’S maintenance facilities should be inspected and repaired as necessary prior to the snow and ice season. These include: buildings, yard traffic areas, fuel delivery systems, yard and garage lighting, emergency generators, and run-off control features.
II.C.9  Road and Weather Information System Readiness

MUNICIPALITY has acquired a variety of systems and measuring devices to help in defining road and weather conditions. These include hand-held pavement temperature measuring devices, NOAA weather band radios, and internet weather forecast providers. These systems should be checked for function prior to the snow and ice season. All measurement devices and sensors should be calibrated and maintained per the manufacturer’s recommendations. All computers, software and communication systems should also be checked and repaired as necessary.

II.C.10  Public and Customer Readiness

The traveling public and MUNICIPALITY customers should receive information to assist them in transitioning and adjusting to winter driving. MUNICIPALITY has a number of opportunities to deliver valuable information including: media clips, media press releases, public service announcements, public access TV (for local distribution), outreach speakers and web sites. MUNICIPALITY employees are to be as courteous and helpful to public inquiries as possible.

II.C.11  Communication Systems

MUNICIPALITY has a variety of communications systems including: radio, cell phone, and land line phone and fax. These systems should be checked prior to winter and any necessary training/retraining provided.

II.C.12  Responsibilities of MUNICIPALITY Police Department Associated with Snow and Ice Events

The Police are responsible for providing the Public Works Department with timely notification and description of the following snow/ice/weather conditions:

- Type and intensity of weather event
- Time event started
- Location(s) of observations
- Amount of snow/ice on road
- Locations that are particularly slippery
- Traffic flow and accident information
II.D. Decision Making for Snow and Ice Control Operations

As MUNICIPALITY acquires more information resources, it will be moving toward routine information-based decision making for determining appropriate snow and ice control treatments. That process involves the following:

- Gathering all available relevant information about recent past, present and near-term future conditions.
- Selecting a treatment option that best addresses those conditions.
- Systematically gathering and evaluating data on treatment effectiveness, actual road conditions, and actual weather conditions from operators and other sources.

II.D.1 Elements of Snow and Ice Control Decision Making

II.D.1.a Status of Assets

Assets for snow and ice control operations include personnel, equipment, information systems and materials inventories. Deficiencies in any of these areas will impact treatment decisions. Loss of truck availability due to mechanical failures or accidents will have an impact on response time and general snow removal operations. Every effort will be made to cover the route(s) by redistribution of resources.

II.D.1.b Weather Information

II.D.1.b.1 Weather Forecasts

There are a variety of weather forecast products available to MUNICIPALITY’s maintenance forces. Decision-makers should be simultaneously evaluating short-term, mid-term, and long-term forecasts. Information on precipitation should include onset, cessation, type and intensity. Other relevant factors include air temperature, dew point, wind speed, wind direction, and cloud cover.

II.D.1.b.2 Current Weather Data and Observations

Current weather data and observations may be obtained from maintenance patrols, operators, police agencies, and media outlets.

II.D.1.b.3 Other Weather Information

Other weather data sources include radar and satellite imagery (Internet and local TV), NOAA radio, The Weather Channel, computer acquired current condition data from upstream storm locations, local TV and radio, etc.

II.D.1.c Highway and Pavement Information
II.D.1.c.1 Pavement Temperature

Pavement temperature is one of the most important factors when deciding on a snow and ice control treatment. Data on recent past, current and predicted pavement temperature is very useful. This data may be obtained from in-pavement systems, truck mounted and hand-held sensors, surrogate locations (other systems, facility parking areas, etc.). Predictions and estimates can be made based on forecast knowledge of air temperature, ground temperature, cloud cover, precipitation, wind, and time of day.

II.D.1.c.2 Accumulations of Snow and Ice on the Pavement

Knowledge of the character and depth of any snow or ice accumulation on the pavement surface prior to treatment is important in the treatment decision process. Relative slipperiness and whether or not the snow or ice is bonded to the pavement is even more important.

II.D.1.c.3 Traffic Characteristics

Traffic data are important to the decision-maker. Relevant characteristics include volume, speed, timing of peak flow, status of any closures and any reduction in available lanes.

II.D.1.c.4 Status of Critical Locations

Traffic flow and pavement condition information for “critical” locations are important in prioritizing snow and ice control operations. “Critical” areas include hills, intersections, bridges, cold locations (low, shaded and elevated) locations having mist or fog generation tendencies, traffic generators, high snow and ice accident locations, school bus routes and access to the municipal center, fire station and ambulance service.

II.D.1.D Assessments of Effectiveness and Efficiency

Systematic after-action assessments of effectiveness and efficiency are important in the decision-making process as they provide a knowledge base for future decisions. Results achieved in response to treatment can be obtained from the reports of operators and crew leaders. Other factors to evaluate include cycle times achieved, materials used, equipment performance, and cooperative procedures.
II.E Snow Control

II.E.1 General

For the purpose of this manual snow and ice control operations are separated into two categories – snow control and ice control. Snow control is the mechanical removal of accumulations of “loose” snow from the paved and stabilized portions of the system. This is accomplished primarily with truck-mounted plows. In certain circumstances like cleanup and drift removal, front-end loaders snow blowers, and motor graders are sometimes used. It may also involve the use of passive measures like snow fence and plantings.

Ice control is all treatment operations directed toward preventing snow or ice from bonding to the pavement and the chemical and or mechanical removal of bonded snow or ice from the pavement. It also includes providing temporary friction improvement by spreading abrasives and abrasives/chemical mixtures and using no-treatment when appropriate.

Snow control is one of the most difficult and important tasks assigned to MUNICIPALITY maintenance personnel. Having uniform snow control methods is important for the safety of our customers and our maintenance personnel.

There are some definitions relating to snow control that will help clarify subsequent sections of this manual:

- snow plowing: the relatively rapid displacement of snow from paved surfaces with vehicle-mounted plows and wing plows.
- snow removal: physically relocating areas of accumulated snow. This is usually a slow operation that may be accomplished with plows, loaders or snow blowers.
- berm or windrow: an accumulation of snow cast by plow or other equipment.
- tandem plowing: snow plows working together to clear wider areas.

There are some general guidelines for keeping snowplowing operations reasonably uniform on MUNICIPALITY system:

- To the extent possible, traffic should not have to pass through a berm of plowed snow.
All plowing shall be done with trucks moving in the direction of traffic, except in an emergency situations where the work area is closed to traffic or, backing in the direction of traffic is required to spread material on very slippery surfaces where normal directional travel will not provide sufficient traction for the truck to move and as necessary in the cul du sacs.

To the extent possible, plow snow beyond the point where it could melt and run back across the highway. Snow may be cast toward the center of the cul de sacs even though it may be higher than the outside.

Plowed snow shall not be cast into traffic.

Cast snow downwind to the extent possible.

In the cul de sacs, cast snow away from the driveways to the extent possible. This is less demanding on the property owners and facilitates more efficient general route plowing.

Within the normal sequences of operations, any time there is enough snow on the road to plow, it should be plowed.

In events where snow is likely to change to freezing rain before ending, consideration should be given to leaving enough unplowed snow on the road to absorb the freezing rain. Plow and treat the road again after the event has ended.

At the end of the storm, push snow back as much as possible to make room for the next snow storm.

Occasionally snowfall intensity is so severe that operator visibility is reduced to a few feet. With supervisor approval, operators may drive their trucks to a safe haven that is stable and well off the highway, shut their lights off and wait until visibility improves before continuing.

When low visibility is anticipated, extra caution in operations should be exercised. Vehicles and other obstacles may be anywhere. Supervisors should be prepared to suspend operations and recommend road closure if conditions warrant, or recommend temporary road closure so that plowing can be completed.

II.E.2 Safety Restoration and Cleanup Operations (Snow Removal)

After the entire MUNICIPALITY maintained highway system is in satisfactory condition, safety restoration and cleanup operations shall begin and continue until complete or operations are directed to higher priority snow and ice control or emergency work. This work will generally be performed on a “regular time” basis. Coordination of this work with
interfacing agencies and other MUNICIPALITY units is recommended. Cleanup operations that may impact traffic flow or larger numbers of customers should be performed in lower volume time periods if possible and utilize traffic protection where appropriate. The following is a listing in priority order of the areas where snow should be removed:

- Locations that could melt and run onto traveled areas, For example: banked curves and sloped bridge decks.
- Snow stored on bridge decks. (Do not throw snow over the side of the bridges – transport it beyond the back wall and off the shoulder.)
- Areas having reduced sight distances for customers and plow operators, such as sharp curves and intersections.
- Buried or obscured regulatory and warning signs, delineators, and accumulated snow around work zone delineation.
- Any area where accumulated snow is causing traffic to use other-than-intended pavement areas.
- Any narrow raised features between the outside edges of pavement that may be storing snow.
- Commercial, business and residential areas where street parking is required to maintain mobility

II.E.3 Drainage Restoration

After safety restoration and cleanup operations are complete, drainage facilities should be inspected and cleared as necessary

II.F Ice Control

Ice control is all treatment operations directed toward preventing snow and ice from bonding to the pavement and the chemical and/or mechanical removal of bonded snow or ice from the pavement. It also includes providing temporary friction improvement by spreading abrasives (sand) and abrasives/chemical mixtures, and using delayed or no-treatment options when appropriate.
II.F.1 Ice Control Strategies

There are four basic ice control strategies used by MUNICIPALITY – anti-icing, de-icing, temporary friction improvement, and delay of or no treatment. When conditions are favorable for success and resources permit, anti-icing shall be the strategy of choice.

II.F.1.a Anti-icing

Anti-icing is a modern strategy that takes an information-based systematic approach to preventing snow/ice pavement bond. This results in higher levels of service for longer periods of time. The key to effective anti-icing is to get an appropriate quantity of ice control chemical on the pavement surface before or very soon after precipitation or ice formation begins. This strategy is not appropriate for unpaved roads.

II.F.1.b De-Icing

De-icing is a traditional strategy for dealing with snow or ice that has already bonded to the pavement surface. It is used when anti-icing treatments have failed, as they occasionally will, or as a series of treatments at the end or after a storm. De-icing is most effectively accomplished by spreading a coarse-graded solid or pre-wet solid ice control chemical on the surface of the bonded snow or ice during favorable road, weather and traffic conditions. The coarse particles will melt through the snow and ice and break the bond as created chemical solution flows across the pavement surface. This strategy is not suitable for unpaved roads.

II.F.1.c Temporary Friction Improvement (Sand and Sand/Salt Mixes)

Temporary friction improvement is an immediate short-term improvement in surface friction that is achieved by spreading abrasives (sand) or abrasives/chemical mixtures on the snow or ice surface. There will be times when this is an appropriate strategy – usually in very cold conditions. A major disadvantage of this strategy is that its effectiveness degrades very quickly with traffic. If sufficient ice control chemical is spread with abrasives, it can be part of anti-icing and de-icing strategies. However, the effectiveness of ice control chemicals are significantly reduced by the sand.

II.F.1.d Delayed or Non-Treatment

Delaying or not applying ice control materials is a tactic that may be used in support of the anti-icing strategy. Conditions where this tactic should be considered include light precipitation events, where pavement temperature is likely to remain above freezing, and dry snow and blowing snow events where pavement surface temperature is below about 10° F and there is no residual ice control chemical on the pavement.

II.F.2 Terms Relating to Precipitation, Road Conditions, Ice Control Chemicals, and Operational Procedures
II.F.2.a  Precipitation Terms:

Light Rain       small liquid droplets falling at a rate such that individual drops are easily detectable splashing from a wet surface. Include drizzle in this category

Moderate Rain    liquid drops falling are not clearly identifiable and spray from the falling drops is observable just above pavement or other hard surfaces

Heavy Rain       rain seemingly falls in sheets; individual drops are not identifiable; heavy spray from falling rain can be observed several inches over hard surfaces

Freezing Rain    when rain freezes upon impact and forms a glaze on the pavement or other exposed surfaces

Sleet (Ice Pellets) precipitation of transparent or translucent pellets of ice, that are round or irregular in shape

Light Sleet      scattered pellets that do not completely cover an exposed surface regardless of duration. Visibility is not affected.

Moderate Sleet   slow accumulation on ground Visibility is reduced by ice pellets to less than 7 miles.

Heavy Sleet      rapid accumulation on ground Visibility is reduced by ice pellets to less than 3 miles.

Light Snow       snow alone is falling and the visibility is greater than ½ mile.

Moderate Snow    snow alone is falling and the visibility is greater than ¼ mile but less than or equal to ½ mile.

Heavy Snow       snow alone is falling and the visibility is less than or equal to ¼ mile.

Blowing Snow     when fallen snow is raised by the wind to a height of 6 feet or more and is transported across a road

None             no precipitation or blowing snow
## II.F.2.b Road Condition Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>no wetting on the pavement surface</td>
</tr>
<tr>
<td>Damp</td>
<td>light coating of moisture on the pavement resulting in slight darkening of surface, but with no visible water drops</td>
</tr>
<tr>
<td>Wet</td>
<td>road surface saturated with water from rain or melt-water, whether or not resulting in puddles or run-off</td>
</tr>
<tr>
<td>Slush</td>
<td>accumulation of snow on the pavement that is saturated with water. It will not support any weight when stepped or driven on but will “squish” until the base support is reached</td>
</tr>
<tr>
<td>Loose Snow</td>
<td>unconsolidated snow that can be blown by the wind into drifts or off of a surface, or blown by traffic into non-traffic areas or off of a surface.</td>
</tr>
<tr>
<td>Packed Snow</td>
<td>snow-pack or pack that results from compaction of wet snow by traffic or by alternate surface melting and re-freezing of the water</td>
</tr>
<tr>
<td>Frost</td>
<td>also called hoarfrost. Ice crystals in the form of white scales, needles, feathers, or fans deposited on pavement and other surfaces cooled by radiation or by other processes</td>
</tr>
<tr>
<td>Thin Ice</td>
<td>a very thin coating of clear, bubble-free, homogeneous ice which forms on a pavement; sometimes called black ice</td>
</tr>
<tr>
<td>Thick Ice</td>
<td>a coating of ice thicker than black ice or frost that is formed from freezing rain, or from freezing of ponded water or poorly drained melt-water. It may be clear or milky in appearance, and generally is smooth though it sometimes may be somewhat rough.</td>
</tr>
</tbody>
</table>

## II.F.2.C Ice Control Chemical Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>the physical state of the chemical – usually solid or liquid</td>
</tr>
<tr>
<td>Gradation</td>
<td>a characterization the distribution of particle sizes for solid chemicals and abrasives – i.e., fine, coarse, percent passing various sieve sizes, etc.</td>
</tr>
<tr>
<td>Concentration</td>
<td>the percent (by weight) of the ice control chemical in the liquid or solid product</td>
</tr>
</tbody>
</table>
**Solution**
a liquid containing chemicals and water

**Eutectic Temperature**
the lowest temperature a concentrated (near saturated) solution begins to freeze or the lowest temperature it will melt ice

**Eutectic Concentration**
the solution concentration that produces the eutectic temperature

**Dilution**
reducing solution concentration by adding water

**Endothermic**
becomes colder when going into solution

**Exothermic**
becomes warmer when going into solution

**Hygroscopic**
having the ability to draw water vapor from the air

### II.F.2.d Operational Procedure Terms

- **Pre-treating**: applying an ice control chemical (liquid or solid) to the road before a snow or ice event begins
- **Pre-wetting**: adding liquid ice control chemical or water to solid ice control chemicals or abrasives prior to distribution on the road
- **Application Rate**: the amount (weight or volume) of ice control chemical applied per mile or ln-mi of highway. In the case of pre-wetting liquids, it is the number of gallons of liquid applied to a ton of solid ice control chemical, or abrasives.

### II.F.3 Ice Control Chemicals

**MUNICIPALITY** uses salt (sodium chloride or rock salt) as the primary ice control chemical. Other chemical will be evaluated if they show promise for improving efficiency, effectiveness and environmental friendliness.

The important properties of ice control chemicals include the lowest (eutectic) temperature it will melt ice, how much ice will be melted at various temperatures and the relationship between solution concentration and freezing point. The lowest (eutectic) ice melting temperatures appear in Table 2 and Figure 1. How much ice melted per unit of common chloride chemicals, at various temperatures, appears in Table 3.

The temperatures above are pavement surface temperatures. Other chemicals have similar relationships where their effectiveness decreases with decreasing pavement temperature. The importance of pavement temperature in ice control operations should be obvious.
The relationship (phase diagram) between solution concentration and freezing point is found in Figure I for sodium chloride, magnesium chloride, and calcium chloride. The low point on each diagram is the lowest temperature at which the chemical will melt ice (eutectic temperature). Any value falling below any point on the curves will be frozen. This includes solution concentrations greater that those producing the eutectic or lowest melting temperature on the diagrams.

The hygroscopic properties of the common solid ice control chemicals are:

- Sodium Chloride - slight
- Magnesium Chloride - moderate
- Calcium Chloride - high
Table 2. Ice Control Chemical Comparison

<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>TEMPERATURE, F</th>
<th>CORROSION POTENTIAL</th>
<th>CONCRETE DAMAGE POTENTIAL</th>
<th>HANDLING CONCERNS</th>
<th>ENVIRONMENTAL CONCERNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formula Name</td>
<td>Form</td>
<td>Effective to * Eutectic</td>
<td>Vehicles</td>
<td>Structure</td>
<td></td>
</tr>
<tr>
<td>NaCl (Road Salt)</td>
<td>Solid</td>
<td>15</td>
<td>Yes</td>
<td>Yes</td>
<td>Some **</td>
</tr>
<tr>
<td>NaCl (Road Salt)</td>
<td>Liquid</td>
<td>23</td>
<td>Yes</td>
<td>Yes</td>
<td>Some **</td>
</tr>
<tr>
<td>MgCl₂ (Magnesium Chloride)</td>
<td>Solid</td>
<td>0</td>
<td>Low</td>
<td>Possible</td>
<td>Very Little</td>
</tr>
<tr>
<td>MgCl₂ (Magnesium Chloride)</td>
<td>Liquid</td>
<td>10</td>
<td>Low</td>
<td>Possible</td>
<td>Very Little</td>
</tr>
<tr>
<td>CaCl₂ (Calcium Chloride)</td>
<td>Solid</td>
<td>-20</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes **</td>
</tr>
<tr>
<td>CaCl₂ (Calcium Chloride)</td>
<td>Liquid</td>
<td>0</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes **</td>
</tr>
<tr>
<td>Organic Chemicals</td>
<td>Liquid</td>
<td>0</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

* Pavement Surface Temperature
** If concrete is non-air entrained or has utilized poor materials or procedures
Figure 1. Phase Diagram for Ice Control Chemicals. Values plotted are not precise and are shown for illustrative purposes. These values have been estimated from the phase diagram shown in the FHWA *Manual of Practice for an Effective Anti-icing Program*. 
Table 3. MELTING ABILITY AND TEMPERATURE FOR CHLORIDE CHEMICALS

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Units of Ice Melted Per Unit of Chloride Chemical</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Sodium</th>
</tr>
</thead>
<tbody>
<tr>
<td>°F</td>
<td>°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>-1.1</td>
<td>31.1</td>
<td>47.8</td>
<td>46.3</td>
</tr>
<tr>
<td>25</td>
<td>-3.9</td>
<td>10.4</td>
<td>15.4</td>
<td>14.4</td>
</tr>
<tr>
<td>20</td>
<td>-6.7</td>
<td>6.8</td>
<td>10.0</td>
<td>8.6</td>
</tr>
<tr>
<td>15</td>
<td>-9.4</td>
<td>5.5</td>
<td>7.9</td>
<td>6.3</td>
</tr>
<tr>
<td>10</td>
<td>-12.2</td>
<td>4.8</td>
<td>6.8</td>
<td>4.9</td>
</tr>
<tr>
<td>5</td>
<td>-15.0</td>
<td>4.4</td>
<td>6.1</td>
<td>4.1</td>
</tr>
<tr>
<td>0</td>
<td>-17.8</td>
<td>4.0</td>
<td>5.5</td>
<td>3.7</td>
</tr>
<tr>
<td>-6</td>
<td>-21.1</td>
<td>3.7</td>
<td>5.0</td>
<td>3.2</td>
</tr>
</tbody>
</table>

This means that solid calcium chloride and solid magnesium chloride should be protected with airtight coverings during storage.

The temperature increase or decrease when water is added to common solid ice control chemicals is:

- Sodium Chloride - slight decrease (endothermic)
- Magnesium Chloride - slight increase (exothermic)
- Calcium Chloride - large increase (exothermic)

Caution must be exercised when adding water to solid calcium chloride.

II.F.4 Pre-Wetting Ice Control Materials

Pre-wetting is the addition of a liquid to a solid ice control chemical or abrasives prior to distribution on the highway. The liquid application rate typically ranges from 8 to 12 gallons of liquid per ton of solid ice control chemical, depending on the efficiency of the pre-wetting technique and the gradation of the solid chemical. The benefits of this procedure include:

- Improving the retention of the materials on the road or ice surface.
- Accelerating the melting action of the solid ice control chemical
- Allowing the solid ice control to work better on lower pavement temperatures

Improved effectiveness should yield an overall reduction in solid ice control chemical use.
Any liquid as long as it is mostly water and will not freeze during operations is suitable for pre-wetting.  **MUNICIPALITY** is currently using pre-wetting with liquid calcium chloride.

The use of pre-wetting is most effective in storms having pavement surface temperatures above about 12°F, and when necessary to spread material on packed, icy or dry pavement.  Using pre-wet solid ice control chemicals on pavements having sufficient available moisture (loose snow, slush, water) and warmer temperatures (above 23°F) will not significantly improve the effectiveness of the solid ice control chemical.

II.F.5  **Factors that Impact the Choice of Ice Control Treatments and the Application Rates of Snow and Ice Control Materials**

II.F.5.a  **Pavement Surface Temperature**

Pavement temperature is one of the most important factors that impacts treatment decisions.  A number of factors influence this temperature and understanding them will aid in making treatment decisions.

**SOLAR RADIATION OR SUNSHINE**
Solar radiation can warm surface temperatures significantly above air temperature.  The darker the surface, the more pronounced this effect will be.  It is not uncommon to have surface temperatures 30 to 40 Fahrenheit degrees above the air temperature early in the afternoon.  As the angle of the sun above the horizon increases, solar warming increases.  The lowest sun angles occur at the winter solstice and at sunrise and sunset of each day.

**CLEAR NIGHT SKY RADIATION**
In the same way the sun warms surfaces through radiation, clear night skies, with little or no wind, cool surfaces.  This can result in pavement surface temperature being colder than the adjacent air temperature.  This condition often allows black ice or frost to form on the pavement surface.  This cooling is also related to the subsurface temperatures and the time of the year.

**GEO-THERMAL EFFECTS**
Subsurface temperature influences pavement surface temperature primarily through thermal conduction.  In the fall, the earth is still warm and short-term air temperature drops below freezing, absent radiation effects, will probably not cause the pavement surface to fall below freezing.  During the spring end of the season, pavement surface temperatures will remain cold although the air temperature is warmer (absent radiation effects).  Bridge decks may freeze quicker than adjacent road surfaces in the fall due to the lack of thermal conduction provided by the earth.  However, in the spring, bridge decks can warm more quickly than surrounding surfaces for the same reason.
AIR TEMPERATURE AND WIND
Absent radiation and geo-thermal effects, the pavement surface temperature will always be moving toward the adjacent air temperature. The rate of temperature change is usually slower than changes caused by radiation or geo-thermal effects. However, with increasing wind speed, the rate of pavement temperature change due to air temperature will increase.

TRAFFIC
Traffic can slightly increase pavement surface temperature as a result of tire-road friction and the radiant effects of engine and exhaust systems.

II.F.5.b Dilution of Ice Control Chemical

There are several factors that influence how quickly an ice control chemical reaches “critical dilution” or the freezing point.

WATER OR SNOW AND ICE ON THE PAVEMENT AT THE TIME OF TREATMENT
This is largely due to the effectiveness of the plowing operation or accumulation on the road if there is no plowing prior to the chemical treatment. The more water or snow/ice on the pavement at the time of treatment, the more quickly it will dilute the ice control chemical.

ICE CONTROL CHEMICAL FORM
Liquid ice control chemicals are quite dilute (23% - 32%) to begin with. With dilution, they will reach the freezing point more quickly than solid chemicals that are nearly 100% chemical.

ICE CONTROL CHEMICAL TYPE AND GRADATION
Some solid chemicals go into solution more quickly than others. Their potential for critical dilution is greater. Finer graded solid chemicals also go into solution more quickly. Different chemicals also have different ice melting rate characteristics.

ICE OR WATER CONTENT OF THE EVENT
The ice content of snow and ice events varies dramatically. Light, fluffy dry snow has an ice or water content in the range of 5%. Wetter heavier snow may be as high as 80% ice or water. Rain, freezing rain, and sleet all have nearly 100% water or ice. Higher ice content events will dilute ice control chemicals more rapidly.

EVENT INTENSITY
The more intense the precipitation rate, the quicker it will dilute an ice control chemical.
CYCLE TIME OF CHEMICAL TREATMENTS
The greater the time between treatment cycles, the greater the opportunity for dilution. However, cycle times should be long enough to allow the chemicals to work.

CLEARING ABILITY OF PLOWS
The more snow and ice mechanical equipment removes, the less dilution will occur in the following chemical treatment.

ICE-PAVEMENT BOND AT THE TIME OF TREATMENT
This may be the single most important factor effecting chemical dilution. If there is ice-pavement bond, more ice control chemical will usually be required in order to be effective. The thickness of the bonded ice is also important. Very thin ice will require little or no additional ice control chemical while thick ice and snow pack will require significantly more. The following are indications that there is ice-pavement bond:

- A spray of water will be produce by moving vehicle tires.
- On loose snow or slush-covered roads, the track created by moving tires will appear bare.
- There will be many bare spots on freshly plowed pavement.
- Scraping the snow or ice on a pavement with a plow (or shovel) will easily expose the pavement surface.
- The plow will make a louder noise if there is no bond

TRAFFIC
Traffic can have positive and negative effects on ice control efforts. Mechanical agitation helps break up snow and ice that have been weakened by the ice control chemicals, aids in allowing chemicals to go into solution quicker and keeps some potentially frozen brine solutions from actually solidifying. Traffic can also remove ice control chemicals from surface and consolidated snow to form pack. Vehicle generated wind and natural wind can displace solid chemicals and cause tire spray to leave the pavement environment.

II.F.5.c Ice-Pavement Bond at the Time of Treatment
If there is ice-pavement bond at the time of treatment, more ice control chemical will be required to penetrate the ice, break the bond and remain above critical dilution until the next treatment. Very thin ice would be an exception to this.

II.F.6 Deciding on an Ice Control Treatment
Every time a snow or ice treatment is being designed, as much of the following information as possible should be on hand or estimated:

- The level of service prescribed by MUNICIPALITY policy;
- Present pavement temperature;
- Trend of the pavement temperature;
• Snow and ice conditions on the pavement
• Traffic volume and timing
• Precipitation type and intensity

Once some determination of the items above and other operational considerations has been made, a decision on treatment can be made. It is likely that every treatment will be different as the critical factors are always changing.

Table 4 (Recommended Salt Application Rates) summarizes the most recent available guidance for ice control using salt. Here the factors that relate to pavement surface temperature and ice-pavement bond are displayed in a fairly simple matrix. The ice-pavement bond characteristic determination can be made by operators or supervisors in the field using the guidance in II.F.5.b.

Table 4 – Recommended Salt Application Rates

<table>
<thead>
<tr>
<th>Pavement Temperature (°)</th>
<th>Ice Pavement Bond</th>
<th>Application Rate, lb/Im</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Solid &amp; Pre Wet Solid products</td>
</tr>
<tr>
<td>Over 32</td>
<td>No</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>250</td>
</tr>
<tr>
<td>30 to 32</td>
<td>No</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>325</td>
</tr>
<tr>
<td>25 to 30</td>
<td>No</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>400</td>
</tr>
<tr>
<td>20 to 25</td>
<td>No</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>475</td>
</tr>
<tr>
<td>15 to 20</td>
<td>No</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>500</td>
</tr>
<tr>
<td>Below 15</td>
<td>No</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>600</td>
</tr>
</tbody>
</table>

**MUNICIPALITY** uses the following sand/salt mixtures as ice control treatments:

<table>
<thead>
<tr>
<th>WEATHER AND ROAD CONDITIONS</th>
<th>SAND/SALT RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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II.F.7 Application Techniques for Solid Ice Control Chemicals

After the ice control treatment for prevailing conditions has been decided, the final step is to get the designed treatment in the right location at the right time. There are a number of techniques for spreading solid chemicals that can optimize treatment effectiveness:

TRAVEL LANES
Try to place solid ice control chemicals in a fairly narrow band near the high edge of each lane on two land highways. On multi-lane highways, a more general distribution may be used in spreading on more than one lane.

BRIDGES AND OTHER ELEVATED STRUCTURES NOT RESTING ON EARTH
In the fall and at other times when there is a rapid, severe, decrease in air temperature, elevated structures are likely to be colder than adjacent pavement on earth. The application rate made be increased by up to 20 percent on these structures so chemical solution freezing will not occur or will occur at about the same time as the surrounding pavement. Toward spring, when air temperatures are warming, structure temperatures are likely to be warmer than the surrounding pavement. Higher application rates are not necessary in this situation.

STRONG CROSS WINDS AND BLOWING AND DRIFTING SNOW
When spreading in strong cross winds, try to keep the spreader upwind of the intended spread location. If the wind is too strong, and the pavement temperature is low, spreading may not be appropriate.

BANKED OR ELEVATED CURVES
Try to keep the spread pattern on the high side of elevated curves. As the chemical works, chemical brine will migrate over the remainder of the pavement.

PARKING AREAS AND WALKWAYS
Spreading ice control chemicals as evenly as possible over the entire paved area is recommended for parking areas and walkways. These areas present an opportunity for pre-event anti-icing with solid chemicals as traffic will not displace them very readily from the surface.

THE WORST CASE SCENERIOS
The worst cases usually occur when the chemical treatment is quickly overwhelmed (diluted) by excessive amounts of water or ice. Blizzard conditions (intense snowfall, wind, very cold temperatures) quickly dilute ice control chemicals and render them virtually useless. If the pavement temperature going into and coming out of a blizzard is expected to be low, then plowing only is probably the best strategy. After the blizzard if it is still very cold, use abrasives as necessary until warmer temperatures will allow chemical de-icing to work. If the pavement temperature throughout and after the blizzard is likely to be fairly warm, a treatment with an ice control chemical before or early in the
storm followed by plowing only throughout the storm, will make de-icing at the end of the storm much quicker.

Rapidly accumulating freezing rain is a major maintenance concern. The best strategy here is to apply solid ice control chemicals, at a high rate, in very narrow bands in the high side wheel path of each lane. Usually, this will provide a location in each lane that will have enough friction to allow vehicles to stop and steer.

GETTING THE APPLICATION RATE RIGHT
Application rates for ice control chemicals are usually specified in pounds per lane mile. Spreaders are usually calibrated to deliver pounds per mile (the discharge rate). It is important to understand that relationship in order to be sure the proper application rate is being used. The application rate is the number of pounds dispensed per mile (the discharge rate), divided by the number of lanes being treated.

11.F.8 Materials Spreading Equipment

Materials spreading equipment is most efficient and effective when associated with plow trucks. Independent plowing and spreading operations require almost impossible coordination. By spreading chemicals on freshly plowed surfaces, the chemicals will dilute less and last longer. Most chemicals need time to work. Uncoordinated plowing that removes chemicals from the surface too soon is wasteful.

There are a variety of solid material spreader types used by MUNICIPALITY. These include V-Box (slide-in or frame mount), and under- tailgate.

II.F.8.a Calibration

Whatever materials distribution system is used, it must be calibrated. This will assure that the proper amount of material is being applied. Over-application is wasteful and under-application will not achieve the desired results. Solid material spreaders are usually calibrated by capturing and weighing material dispensed at various speeds, control settings and gate openings. A back-up or manual calibration for automatic control systems should be developed for each spreader. A calibration procedure for solid chemicals appears in Appendix __.
Calibration procedures for liquid spreaders are similar except that the liquid is captured in a container and the time of discharge is recorded. This will yield a rate of discharge (volume or weight) that can be related to vehicle speed and area of coverage for calculating application rate.

Prewetting systems also require calibration. Here, the prewetting liquid is captured and related to the amount of solid ice control chemical dispensed in the same time period. Adjustment is primarily a function of changing nozzle size.
For smaller and hand operated solid material spreaders, a band of material can be run across a plastic tarp. The area of that band on the tarp is measured and the amount of material on the tarp is weighed. The weight of material on the tarp divided by the area of material on the tarp is the application rate for these spreader conditions.

II.F.8.b Spread Pattern Control

Most commercial materials spreaders have the capability of adjusting the spread pattern they deliver. The most common device for spreading solid materials is a vaned spinner plate. The distance material is cast is controlled by the speed of the spinner plate. The faster the spinner plate rotates the farther it will cast material.

The direction of cast from spinner plate is controlled by the direction of rotation of the spinner and the location of the point where the material drops onto the spinner plate. Material dropped on one side of the spinner plate is generally discharged on the opposite side. Deflectors or skirts that divert the cast material downward provide additional control. Once deflectors are controlling the spread, the effect of spinner speed is diminished.

The proper spread pattern adjustments should be determined on the floor of the chemical storage facility. By pushing the discharged material into a windrow that runs parallel to the back of the spreader, a good indication of spread pattern can be obtained. Spread patterns determined by this method should be field verified by observing the distribution under actual operating conditions and making adjustments as necessary. The spread pattern for liquid distribution systems is usually accomplished by adjusting the direction and spacing of the nozzles. Observing the pattern is the best method to determine if it provides the desired distribution.

II.F.8.c Spreading Speed

The potential for solid ice control chemicals to bounce and scatter increases with increasing truck speed. Spreading speed should be as slow as possible, consistent with maintaining a safe speed in traffic.

II.G Post-Storm Activities

II.G.1 Post-Storm Evaluations

Post-storm evaluations should be conducted at the crew level. The following should be discussed and significant findings/results should be committed to record:

- Personnel issues
- Materials and materials management issues
- Equipment issues
- Safety issues
- Weather and information system accuracy