Snow and Ice Control

A Best Practices Review

Executive Summary

In some years, keeping roads clear of ice and snow in Minnesota is a six-month long effort. It involves multiple decisions made by hundreds of individual agencies around the state. And because the roads can be very different — some carry tens of thousands of vehicles a day while others carry a couple of hundred, some are paved while others are gravel — how local governments maintain them during the winter can vary as well.

This is a review of local governments' snow and ice control practices in Minnesota. It highlights some of the practices that counties, cities, and townships have found to be effective or efficient. We hope that the information may be useful to local governments that are interested in how others similar to them control snow and ice on the roads.

DIFFERENT ROADS REQUIRE DIFFERENT SNOW AND ICE CONTROL

Counties, cities, townships, and the state are involved in controlling snow and ice on roads. Each level of government has roads under its jurisdiction and has discretion over how to maintain them in the winter months. The state does not govern how local jurisdictions maintain roads.

Counties, cities, and townships have road systems quite different from one another, requiring different snow and ice control services. Generally speaking, cities spend more time and resources on plowing because their plow operators have to drive at slower speeds to contend with driveways, cul-de-sacs, intersections, alleys, and traffic. In contrast, operators plowing long stretches of uninterrupted county or township roads usually cover miles more quickly. Cities' costs per lane mile tend to be higher as a result. (See the following figure.) Cities typically have more operators per lane mile and spend more snowplow personnel hours on snow and ice control per lane mile than counties or townships.

Many cities plow cul-de-sacs, deadends, alleys, and sidewalks while counties and townships usually have fewer or none of these features in their road systems. Many cities also have areas such as business districts where they must not only plow snow but also load and remove it. In contrast, fewer counties and townships load and haul snow. Further, cities have fewer miles of gravel roads than counties or townships. Compared with paved roads, gravel roads generally require lower levels of winter maintenance. These differences among the types of road systems and their required levels of service lead to higher costs for cities than counties or towns.

This review highlights snow and ice control practices that some Minnesota counties, cities, and townships have found effective or efficient.

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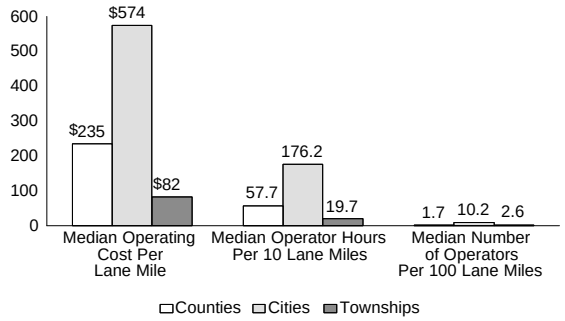
Costs, Hours, and Number of Operators for Snow and Ice Control



Source: Office of the Legislative Auditor snow and ice control survey.

What is a best practices review?

This report identifies some of the best techniques for snow and ice control in Minnesota. It is based on a statewide study of the current practices of counties, cities, and townships, as well as the latest research findings of scientists and road maintenance engineers.

The purpose of this report is to catalog effective methods of snow and ice control, demonstrate the conditions under which they may be successful, and encourage their adoption wherever appropriate throughout the state. Unlike a regular audit or evaluation, this report does not focus on deficiencies, but highlights successful practices.

We hope that Minnesota's local governments will actively use this report to examine their own practices and consider a range of ideas for ensuring safe and passable winter roads.

This best practices review is part of a program created by the Minnesota Legislature in 1994 to identify best practices in local government service delivery.

EFFECTIVE SNOW AND ICE CONTROL

What makes for effective snow and ice control? Although many factors are involved, timing is critical. Once ice and snow bond to roads, the time and effort required to plow or clear them dramatically increases. In addition, traffic traveling over the road compacts the snow, making plowing even more difficult. Consequently, the sooner an agency initiates action, the more likely it will succeed. To make a timely response to snow and ice, agencies have to prepare in advance with trained staff, fully functioning and well-maintained equipment, adequate supplies of sand, salt, or other materials, and methods for communicating with the traveling public.

We have identified 12 actions for effective snow and ice control. The actions represent items that agencies typically consider in planning their system of snow and ice control. They affect an agency's ability to respond to snow and ice on the roads in a timely and effective manner. Some of the 12 actions deal with how agencies organize, administer, and manage their snow and ice control. Others deal with the agencies' day-to-day operations.

Many local governments already take, or have considered, these actions in their snow and ice control programs. They use a variety of practices and styles to implement the actions, some of which we list in this review. The practices included here are those that local governments have found help them save time, reduce labor, cut costs, increase their level of service, or otherwise improve their ability to get the job done.

Not every practice listed, however, can apply to every local jurisdiction. Areas with high levels of vehicle-miles traveled, for instance, will likely require different practices than areas with low traffic levels. Jurisdictions will have to come to their own decisions on what practices make sense for them given the characteristics of their road systems.

We first discuss the five actions dealing with administering and managing effective snow and ice control. Then we discuss seven actions which can help with day-to-day operations.

ADMINISTRATION AND MANAGEMENT

We identified five actions relating to administration and management which contribute to effective and efficient snow and ice control operations. These are: adopt written snow policies; encourage cooperative or coordinated snowplowing services or fa-

Actions for Effective Snow and Ice Control

ADMINISTRATION AND MANAGEMENT

- Adopt written snow policies
- Encourage cooperative snowplowing services and facilities
- Contract for services, when appropriate
- Measure performance and maintain records
- Plan for equipment replacement

OPERATIONS

- Foster a quality work force
- Prepare plans for routing, scheduling, and obtaining weather forecasts
- Select, store, and apply materials appropriately
- Communicate with the public
- Apply appropriate snowplowing techniques
- Use passive snow control measures
- Employ equipment improvements and preventive maintenance

cilities; contract for service when appropriate; measure performance; and plan for equipment replacement. We briefly discuss each of them and some of the practices local governments are using that illustrate the value of these actions.

Adopt Written Snow Policies

Writing and adopting policies to guide snow and ice control programs can protect the jurisdiction, help employees, and instruct the public. A written snow policy might address the timing of plowing or sanding, priorities in routes and procedures, general guidelines for the use of materials, and flexibility to change procedures in response to weather and road conditions. We surveyed 520 local governments in Minnesota and found that slightly more than one-half of counties and cities, and a smaller share of townships, have written policies that guide their snow and ice control.

If adopted by a jurisdiction's legislative body, policies that balance the competing needs of road safety, employee safety, and fiscal constraints, can offer some protection to communities against liability for accidents. An agency can also use written policies to familiarize employees with the jurisdiction's standards and expectations. Finally, written policies can help educate residents about what to expect from the jurisdiction's program of snow and ice control.

Owatonna's snow removal policy explains the typical circumstances under which the street department will commence plowing, sanding, and hauling snow. Owatonna plows all streets after two inches have fallen; plowing begins at midnight unless snow is still falling. The policy also states that plowing will be done at the discretion of the lead street personnel when fewer than two inches of snow falls. The policy sets priorities among its snow and ice control activities, specifying that the street department will plow and sand all arterial streets first. Sanding priorities are also listed. The policy states that the department hauls snow out of the downtown area the night after plowing is completed; it also lists the order of priority for clean-up activities.

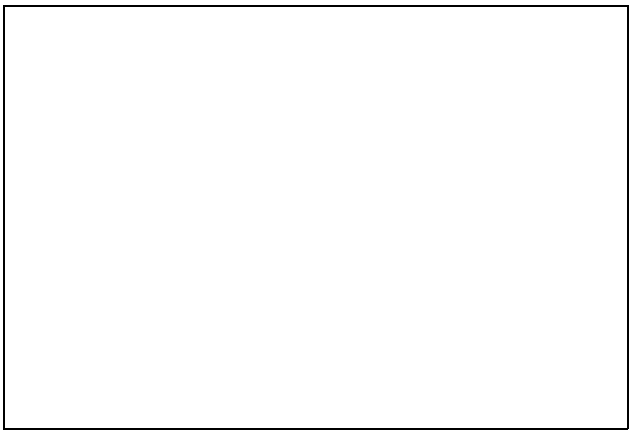
Agencies may want to state in their policies that they reserve the flexibility to change their procedures depending upon the type of snow, wind, and times of day the snow falls. For flexibility in adapting to variable weather and road conditions, an agency may want to specify details on specific techniques and practices in a document other than the policy adopted by the governing body. To make the policy workable, agencies can involve operators in developing the policy, as well as in reviewing and updating it as needs dictate.

Encourage Cooperative Services and Facilities

Local governments that coordinate services or share resources may be able to curtail expenditures, avoid duplication of services, eliminate unnecessary purchases of equipment and facilities, and use employees more

The townships of ***Hawk Creek, Ericson, Wang, Sacred Heart, and Crooks*** in Renville County share the costs of a road maintenance association. Controlled by a board of the participating township supervisors, the association hires two employees who provide snow and ice control services as well as summer maintenance on township roads. The participating townships pay an hourly rate for snowplowing plus a charge per mile of road each year for the depreciation of the association's three motor graders, plows, and wings.

effectively. Salt storage sheds or refueling stations are examples of facilities that jurisdictions could share. For smaller communities, jointly providing snow and ice control may be more cost effective than providing the service individually. According to our survey, many local jurisdictions already share snowplowing equipment, duties, or personnel.



Waseca County uses one of the bins in a state-owned salt storage facility.

Contract for Service, or Parts of Service, When Appropriate

When a service requires special types of vehicles, additional equipment, or additional staff, a jurisdiction can consider contracts with other local governments or private providers. In these situations, contracting for some or all snow and ice control services may be more cost effective than having an agency provide the service itself. About 74 percent of the townships responding to our survey contract with other local governments or private contractors for all of their snow and ice control. No counties and less than 10 percent of cities contract for all of their snowplowing routes.

White Bear Lake contracts with private companies to plow the city's 78 cul-de-sacs, as well as its alleys and parking lots. White Bear Lake does not have the equipment it needs to plow cul-de-sacs efficiently, and the city believes it is more cost effective to contract for this service than to provide the service with its own employees and equipment. White Bear Lake's public works department plows city streets while contractors plow cul-de-sacs, allowing them to usually finish all plowing on the day following a snowfall.

Measure Performance and Maintain Records

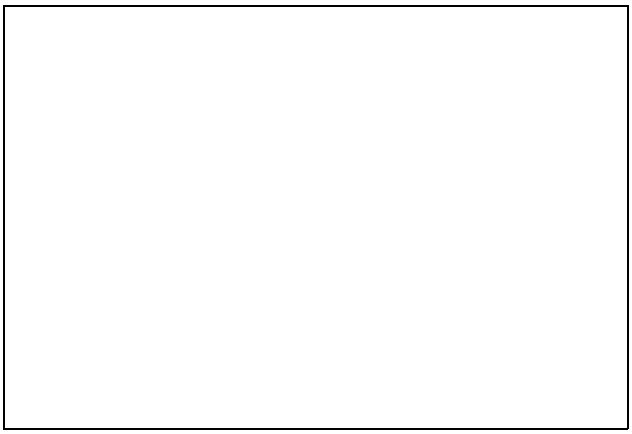
Local jurisdictions may be able to improve their snow and ice control services by measuring the effectiveness of services they provide. Measuring performance, or the results of services, provides several benefits. The results can demonstrate value to taxpayers. Knowing the results of the service allows an agency to tell whether it has accomplished its intended objectives, and, if necessary, adjust its procedures or practices. Concentrating on results also helps agencies to be more responsive to the needs of their customers, and may help agencies to communicate more effectively with taxpayers. To measure meaningful results, local governments may have to improve the records that they keep.

The street department in ***Woodbury*** sets objectives for its performance in snow and ice control. To see how closely it meets the objectives, the department collects information to assess equipment and labor costs per plowing or sanding event as well as timeliness. The department uses the data to justify requests for funds and make changes in procedures when necessary.

Plan for Equipment Replacement

Local governments can use equipment replacement funds to help them prepare for replacing equipment that wears out or becomes obsolete. This usually involves systematically determining how long equipment can be expected to last, and setting aside funds each year to replace the equipment at the end of its useful life. Equipment replacement funds prepare local governments to finance capital purchases without the need for a large influx of dollars in any single year. According to our survey, most counties and cities, and a smaller share of townships, already use equipment replacement plans.

Hoyt Lakes purchases all equipment through its capital-equipment improvement program. By accumulating money in a fund for capital purchases over several years, the city avoids the need for large increases in property taxes in a given year. The capital improvement program also helps city officials set clear priorities each year for major expenditures.



Capital equipment is an essential part of snow and ice control.

OPERATIONS

In the area of day-to-day operations, we identified seven actions for effective snow and ice control. These are: foster a quality work force; prepare plans for routing, scheduling, and obtaining weather forecasts; select, store, and apply materials appropriately; communicate with the public; apply appropriate snowplowing techniques; use passive snow control measures; and employ equipment improvements and preventive maintenance. We briefly discuss each of them and some of the practices local governments are using that illustrate the value of these actions.

Foster a Quality Work Force

Good employees are key to any operation's success, and they are crucial to successful snow and ice control. Building and retaining a quality work force comes from a long-term, ongoing commitment to an agency's staff. The day-to-day operations in an agency, including effective recruitment of employees, training, treating employees fairly, recognizing employees for a job well done, and taking care of disciplinary problems, contribute to a quality work force.

Snowplow operators new to the job in ***Polk County*** receive 16 hours of required safety training and experienced operators receive 8 hours of refresher training every year. Operators receive training on all department equipment, giving them the skills to knowledgeably and safely use any piece of equipment. Prior to the snow season, operators drive their equipment on "dry runs" of their snowplow routes to become familiar with the route, identify hazardous areas, and note turn-around areas.

One of these elements, regular training for employees, is particularly important for ongoing improvements in snow and ice control. About 84 percent of counties responding to our survey indicated that they either provide operator training themselves or require operators to attend other training. Sixty-nine percent of cities and 31 percent of townships with their own operators provide or require training.

Prepare Plans for Routing, Scheduling, and Obtaining Weather Forecasts

For effective snow and ice control, local government agencies prepare for winter operations with advance planning. Part of the planning includes designating the routes along which snowplows will travel. Effective routing establishes priorities among routes, minimizes "deadhead" trips (e.g., those trips with the sole purpose of returning to refill sand or other materials), and ensures that service is provided as expediently as possible. Over 90 percent of counties and cities with their own operators establish priority routes, according to our survey. Of the 32 townships that indicated they provide their own service, 56 percent set priority routes.

Mankato schedules on-call teams of operators who deice slippery intersections and other dangerous road sections. The operators respond quickly to treat the problem roads at night, on weekends, or whenever winter weather creates hazardous driving conditions outside of normal working hours. Each team has three operators who serve the on-call duty for a week at a time and who deice three assigned zones in the city.

Effective scheduling ensures that operators are on the job when needed — in time to make roads accessible, or to prevent precipitation from bonding to the surface of the road in the first place. Scheduling plowing or sanding prior to heavy traffic levels or rush hours helps prevent snow compaction. Assigning the same operator to the same route and to the same equipment for each storm increases operator efficiency. Most local governments already do this, according to our survey: All counties, 94 per-

cent of cities with their own operators, and 78 percent of townships with their own service have their operators use the same vehicle with each snowfall.

For snowplowing agencies, accurate weather reports are very important but not consistently easy to obtain. Knowing current and predicted weather conditions helps an agency decide what type of response is needed and when to call out operators. For example, agencies need reliable weather information to practice anti-icing, which requires spreading materials just as a snowstorm begins. Most counties (93 percent), cities with their own operators (91 percent), and townships providing their own service (59 percent) rely on television or radio weather reports, including the National Weather Service reports via telephone, for weather information. Some agencies supplement this information with privately-provided weather forecasts specific to their geographic areas.

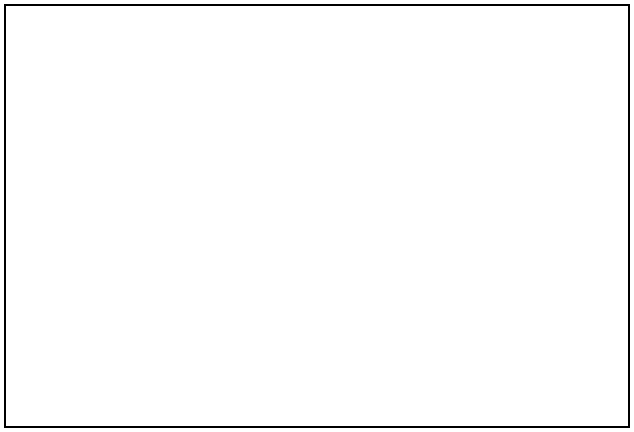
Select, Store, and Apply Materials Appropriately

The benefits of abrasives, salt, and chemicals for controlling snow and ice vary under differing conditions. The volume of traffic, type of weather (including temperature, wind, and form of precipitation), and type and location of the road all affect the timing and quantity of spreading salt, sand, or chemicals. Most local governments spread a mix of sand and salt, although some alter the ratio of salt to sand according to weather and ice conditions.

Anoka County produces its own salt brine to prewet salt before spreading salt on roads. Fourteen of the county's snowplow trucks have 100-gallon tanks mounted on the tailgates. From inside the cab, operators control the salt brine flow from the tanks onto the salt and spread the salt onto the road surface. Prewet salt keeps more salt on the road and activates melting sooner than dry salt.

Recycling sand can be an effective way to lower the costs of purchasing and disposing of sand. Although recycling sand shows promise, the environmental impacts and costs and benefits of recycling require additional monitoring due to the relative newness of the practice.

Another relatively new practice is prewetting road salt before applying it to the paved road. Prewetted salt accelerates the melting of snow and ice. Prewetted salt quickly penetrates the snow or ice layers and breaks the bond between the snow/ice and the pavement. Prewetting also reduces salt loss that occurs when dry salt bounces off of the road. Although the practice is growing in acceptance, more research is needed to determine the circumstances under which prewetting is most effective. Currently, about 11 percent of counties responding to our survey routinely prewet their salt. Approximately 8 percent of cities with their own operators prewet salt. Only one township reported prewetting.



An electric pump moves salt brine from a tailgate tank onto the salt and sand mix.

Proper storage facilities are necessary to keep road salt workable and free flowing as well as to protect the environment from excessive concentrations of salt. According to our survey, about 73 percent of counties own or share an enclosed or semi-enclosed salt storage facility. Of the cities providing their own service, 39 percent own an enclosed or semi-enclosed salt storage facility. No towns reported having enclosed facilities.

Communicate With the Public

Snowplowing is a very visible service and it affects everyone who travels during winter months. Communication between local governments and citizens is important for the safety of the traveling public and for effective plowing and ice control. Cities

and townships have to let their residents know about parking regulations so that trucks can plow unimpeded by "snowbirds." Agencies also need to remind the public about appropriate actions during snow emergencies and ways to avoid accidents with snowplows, such as not crowding the plow.

Bloomington uses a variety of means to communicate snowplowing information to its residents. The public works department has mailed a snow and ice control brochure to all residents, describing parking regulations and other pertinent information. When a snow emergency is pending, residents can find out when the plows start by phoning the department at any hour of the day to receive the information via voice mail. The city also uses interactive cable television to inform people about plowing activities.

Apply Appropriate Snowplowing Techniques

Equipment that is effective for plowing main streets may not be as effective in other areas, such as cul-de-sacs. Effective plowing and sanding procedures can also vary depending upon traffic levels, type of road, and weather conditions.

Albert Lea's street department uses a four-way, articulated plow on a front-end loader to plow cul-de-sacs and alleys. The four-way plow angles to the right and left, converts to a v-plow for large loads of snow, and also inverts, controlled by the operator from inside the cab. Operators plowing narrow alleys can pull the blade into a tight "v" shape and then simply widen the "v" to plow the full width of a wider alley.

Use Passive Snow Control Measures

The design of a roadway can improve snow and ice control. Particularly in open areas, raising the road surface above the surrounding snow cover is one way to control blowing snow and deter drifting.

When ***Kittson County*** upgrades or rebuilds its roads, it elevates the surface of the road approximately five to six feet above the surrounding area. The heightened elevation is somewhat higher than usual to expose road surfaces to the wind and prevent the buildup of snow. With less snow drifting over the roads, the county reduces the time it spends plowing and scraping roads. Each year the county elevates segments of roads as part of its ongoing road improvement program.

Properly designed, tall snow fences and living shelter belts of trees and shrubs can also effectively control drifts. Keeping blown snow off the roads improves driver safety and reduces the need for snowplowing.

Employ Equipment Improvements and Preventive Maintenance

Minnesota's harsh winters and heavy snows mean that local governments need the proper equipment if they are to effectively control snow and ice. Not all local governments need or can afford state-of-the-art equipment, but they do need information about equipment improvements if they are to make informed decisions on purchasing and using equipment.

Chisholm uses polyurethane blades instead of steel or carbide blades on its snowplow trucks. Operators find that the polyurethane blades float over road obstructions, and ride smoothly on road surfaces, thus saving wear and tear on equipment. The blade is less likely to cause damage to curbs and can last longer than steel or carbide blades. Although not practical for high-speed plowing or for cutting hard-packed snow and ice, the polyurethane blades work well in other applications on low-traffic and low-speed roads.

With preventive maintenance programs, agencies systematically schedule regular maintenance for all their equipment. Preventive maintenance helps to ensure that equipment is available when needed most and protects agencies' capital investments. Of the counties responding to our survey, 96 percent said they have a routine maintenance program. Ninety-eight percent of cities and 72 percent of townships with their own snow control service have a routine maintenance program.

CONCLUSIONS

Effective snow and ice control practices and equipment continue to evolve. We observed local governments' road agencies trying new ways of doing things, experimenting with equipment designs to better meet their needs, and working to improve their services. Agencies expressed interest in how others similar to them are working, as well as in the latest developments in snow and ice control research and equipment. We learned about ongoing

research by the Minnesota Department of Transportation and others pertaining to winter road maintenance and about the professional networks that help disseminate that information. Yet, many questions remain about what are the best winter maintenance strategies, and under what circumstances they are best applied. In our view:

- **Local jurisdictions would benefit from additional winter maintenance research that focuses on experiences at the local government level.**

We found that local government practitioners were interested in objective information that will allow them to make decisions about the cost effectiveness of winter maintenance practices and equipment in their own jurisdictions. With any given practice they want to know for local applications: how is it done, when is it effective, how much does it cost, what are its drawbacks, and what road or weather conditions make the practice most effective.

No single practice works effectively in every jurisdiction. Differences in road types and conditions, traffic levels and speeds, and community expectations dispel the notion that there is only one right way of controlling snow and ice. At the same time, we realize that local governments need objective information about winter maintenance practices if they are to make informed decisions for themselves.

- **Service providers want ongoing exchanges of snow and ice control information among themselves.**

Some opportunities for sharing transportation information already exist. Organizations such as the Technology Transfer (T^2) Program at the University of Minnesota's Center for Transportation Studies and the Minnesota Local Road Research Board currently help local governments with research results, training, and other information. Several professional organizations in the public works field also serve their members by fostering the exchange of information.

Yet, not all jurisdictions have as much current, comprehensive information on effective snow and ice control practices as they would like. As technology continues to change and improve and as additional field applications of innovations are tested, local governments will need ongoing sources of comprehensive research and ways to share that information.