

EXTREME STORMS IN THE MIDWESTERN US: CASE STUDIES

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ABSTRACT

This paper will examine how two agencies from the Midwestern US have dealt with an extreme storm from the winter of 2010-11. The agencies manage winter services for the City of Iowa City in Iowa, and McHenry County in Illinois. The blizzard in question struck a large part of the Northern US in February 2011.

The paper will present basic information about each community and about the resources available for winter services within that community. The meteorological data for the storm will be presented. Actions taken by the agencies in response to the storms will be discussed and the results from those actions will be considered. Finally, the lessons learned from fighting this particular storm will be shared.

One of the key issues in dealing with such severe storms is customer expectations. In the US there is in general an expectation of mobility in almost all kinds of weather. There is little acknowledgement of the fact that “sometimes Mother Nature wins” and the best response may simply be to stay home and not attempt to travel.

Related to the issue of customer expectations is determining when a storm is bad enough that the best response is for people to stay home. Social media provides some methods by which these concerns may be effectively communicated to the general public, but the issue of “how bad is bad enough” remains and must be addressed. The paper discusses this issue and has some suggestions for possible solutions to this dilemma.

1 INTRODUCTION

Severe storms can have profound negative impacts on the transportation system within an agency’s area of responsibility. However, the severity of a storm is not solely a function of the various meteorological factors that can be used to describe the storm. Other factors may combine to transform a storm that would otherwise be “normal” into a storm that is extreme. For example, storms that occur or have maximal impact during morning or evening rush hour times are inherently more difficult, operationally, to address than those that occur in the middle of the night when traffic levels are low. Likewise, a storm in which the forecast misses some key detail (for example, snow is forecast, but instead freezing rain occurs) may become much more extreme than a storm that is forecast correctly.

This paper will examine a storm that occurred in the Midwest of the United States. The storm was a blizzard that occurred in February 2011. The impact of that storm on two agencies (the City of Iowa City, Iowa, and McHenry County, Illinois) will be discussed, along with the various steps taken by the agencies to handle the storm, and the lessons learned by the agencies from the storm.

The paper will first present details about the two communities and the resources available to them. Next the storm will be described, with a particular emphasis on how it was experienced in the communities. The steps taken by the agencies in response to the storms will then be described. Finally “lessons learned” from the storms will be presented.

2 COMMUNITIES

McHenry County, Illinois is located about 40 miles (64 kilometers) northwest of the city of Chicago Illinois (see Figure 1). The population of the county is approximately 300,000 and it is relatively affluent. Many of the county residents are commuters who work in Chicago, so there is a perceived need for high levels of service on the roads which the County Department of Transportation must maintain. Those roads comprise 455 lane miles (728 lane kilometers) and they are treated at three levels of service, primarily as a function of the average daily traffic levels.

Depending on whether the storm is anticipated to last one shift or two shifts (or longer) McHenry County Department of Transportation (hereafter MCDOT) has either 19 routes serviced by 22 trucks (for a single shift operation) or 12 routes serviced by 12 trucks (for multiple shifts). This reflects the personnel availability for the County. In terms of strategies employed by MCDOT, they make extensive use of liquid brines in their winter service activities, often using a variety of blended brines. All trucks are equipped so as to be able to deliver pre-wet solid salt, and many (but not all) of the trucks can also deliver straight liquids. MCDOT has two Road Weather Information Systems (RWIS) of its own, and regularly uses data from the State of Illinois RWIS network. They have a meteorological services contract that allows them to contact their forecaster at any time, and also provides regular updates every 12 hours. A number of their trucks are equipped with GPS and AVL systems, including the ability to provide real time video images to the central office. They are also recognized to be one of the leaders in winter maintenance practice in the US.

The City of Iowa City, Iowa is located approximately 220 miles (352 kilometers) west of the city of Chicago, Illinois, just south of Interstate 80 (see Figure 1). The population of the city is about 68,000 and being the location of the University of Iowa (which includes a significant medical facility) it is relatively affluent also. Iowa City has responsibility for 256 lane miles in total (410 lane kilometers), broken down into three levels of priority. Level 1 (main thoroughfares and bus routes) comprises 26 lane miles (41 lane-km). Level 2 (heavily traveled streets and steeper grade streets) comprises 44 lane miles (70 lane-km). Level 3 (flat residential streets) comprises 186 lane miles (298 lane-km). No specific levels of service have been set for the three different priority levels, but by implication, in severe storms trucks will be pulled off level 3 and even level 2 routes to

maintain the level 1 routes. The city has 12 trucks (single rear axle) each with a front mounted plow and a spreader box in the back. The spreader box holds about 10,000 lbs (5,000 kg) of material when fully loaded.

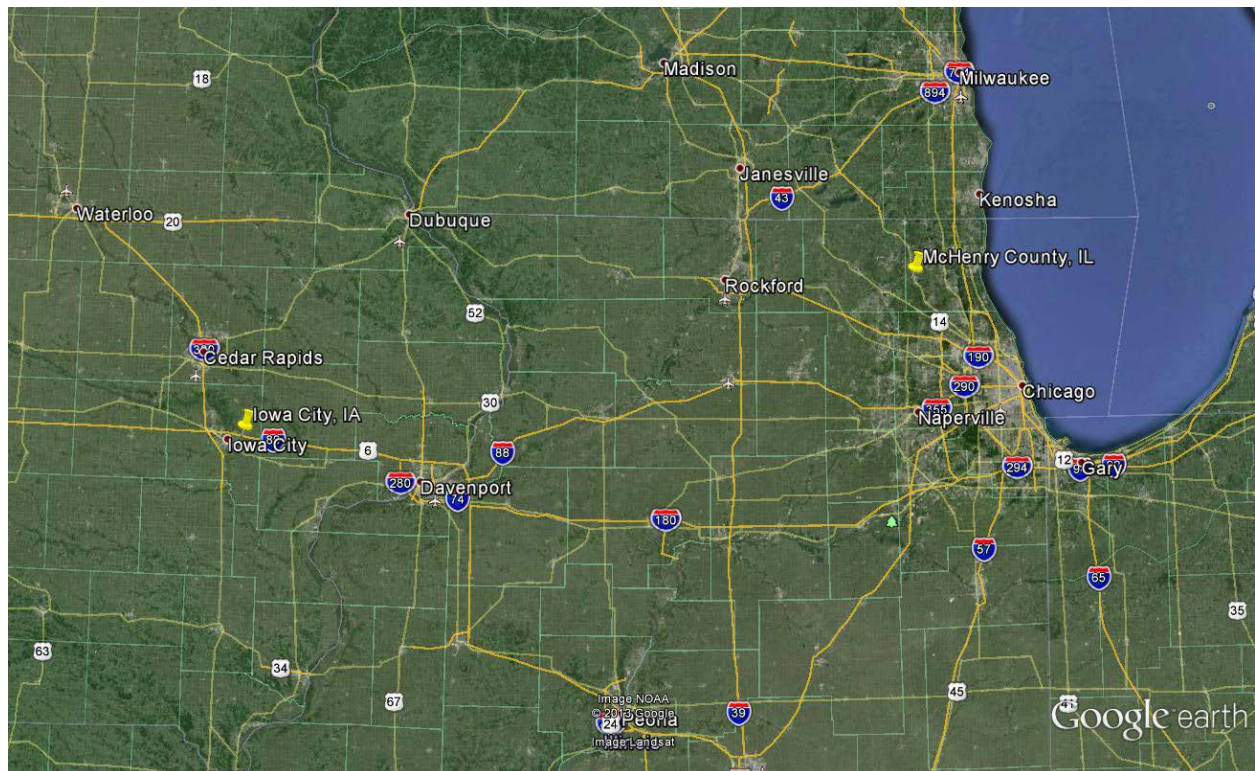


Figure 1: Approximate Locations of McHenry County and Iowa City

3 STORM DESCRIPTION

The blizzard in question caused heavy snow fall in the Midwest US on Tuesday February 1 and Wednesday February 2, 2011. Snowfall totals on the order of 18-24 inches (45 to 60 cm) were typical throughout Illinois, Iowa, Missouri and elsewhere in the central US, as can be seen in [1]. During the height of the storm, wind speeds in excess of 60 mph (100 kph) were observed in places, and drifting was significant. There had been snow the day before (between 1.5 and 3 inches - 3.75 and 7.5 cm) so pre-treatment of roads with liquids was not possible in most locations. The storm was blamed for at least 36 deaths, and impacted at least 16 states in the US. Estimated costs due to the storm are in the region of \$1.8 billion [2].

4 STORM RESPONSES

4.1 City of Iowa City

The response of the city of Iowa City to the blizzard is best understood in the context of their regular winter service operations. Table 1 shows their salt usage and annual costs (including salt costs, but also equipment costs, and labor costs) for the five winter

seasons from the 2007-08 season through the 2011-12 season. Also included are those costs for the period of the blizzard.

Winter Season	Inches of Snow	Tons of Salt Used	Total Cost in Dollars
2011-12	14.50	1,700	\$286,000
2010-11	34.75	4,000	\$596,000
2009-10	30.30	3,700	\$564,000
2008-09	30.55	2,900	\$695,000
2007-08	59.90	3,400	\$608,000
Five Year Average	34.00	3,140	\$549,800
Blizzard	16.5	175	\$133,000
Percentage of 5 yr Ave.	48.5%	5.5%	24.2%

Table 1: Iowa City Usage Statistics for Winter Service

Standard procedure for the City of Iowa City is to clear their priority 1 roads first and then to proceed to priority 2 and 3 roads. In a typical storm, they will spend about half their plowing time during the storm on the priority 1 roads, maybe one third of the storm time on the priority 2 roads, and try and make at least one pass during the storm on priority 3 roads. After the storm, clean up proceeds in one priority category until those roads are clear, then proceeds to the next lowest category. During the blizzard, all the in-storm plowing was focused solely on the priority one roads, and these were not close to being clear at the end of the storm (which was no surprise, given that snow rates during the storm were at times as high as 3 inches per hour, and the high winds caused significant drifting even in the relatively sheltered urban environment of Iowa City).

The condition of the roads in Iowa City at the end of February 2 (the day the blizzard ended) were that the first priority roads were for the most part passable, and some priority 2 roads could be driven with extreme care (because of significant snow depth). Priority 3 roads (primarily residential) were for the most part not passable, with significant snow depth caused both by direct snowfall and by drifting. This meant a second phase of operations was required, which continued for about one week, specifically snow hauling. Most of the snow on the priority 3 roads (and some of the priority 2 roads) had to be removed by end loaders, placed in trucks, and then taken to dump sites. This is of course an extremely time intensive process. Additional units had to be leased for the duration of this process (which lasted through February 9, about one week) comprising of 6 additional end loaders (the City normally has four available for operations). The cost of the rental units (including operators) was about 16% of the total storm budget.

It is of note for the City of Iowa City that whilst the snow fall in the blizzard was about half their annual average snowfall, the cost of dealing with the storm was only about 25% of their average annual budget, and their use of salt was only about 5% of their annual average salt usage. This indicates that they were relatively efficient in dealing with this serious storm, and furthermore, they appropriately cut back on their salt usage (especially during the storm) primarily because applying salt during the storm, given the very high rates of snowfall and drifting, would have been an obvious waste.

4.2 McHenry County

For McHenry County, the blizzard was a little more severe than for Iowa City, for two reasons. First, they got more snow than Iowa City (about 22.5 inches - 57 cm - as compared with 16.5 inches - 42 cm). Second, being a rural county, they saw much more drifting. They experienced sustained winds above 60 mph (100 kph) with gusting up to 70 mph (115 kph) during the blizzard - approximately the level of wind speeds that would be seen in a tropical storm, for comparative purposes.

The forecast began to indicate that the storm could be severe during the week of January 24, 2011, but the first solid forecast of a blizzard was on Friday January 28, when forecasts indicated that the Midwest could receive a "significant winter event." On the morning of Sunday January 30, forecasts were predicting that a major snow event, possibly at historic levels, would occur in the Midwest and that McHenry County would be in the path of this event and thus should expect significant snowfall and blizzard like conditions.

At that time, two distinct events were being forecast - a small storm starting on the afternoon of January 31, and ending early morning on February 1, with snowfall in the range of 2 to 4 inches (5 to 10 cm), followed by the blizzard, starting in the afternoon of February 1, and ending about Noon on February 2. Because of this forecast, the County opted to go into a split shift mode on the morning of Monday January 31. This reduces the number of snow plows they can put into the field to 13 (when a full shift is employed they can use 22 trucks, but only for 16 continuous hours - then mandatory rests must be taken). By 2 p.m. on January 30 all crews had been informed of the split shift decision and plow routes had been assigned using the split shift roster.

The first split shift began at 7 a.m. on January 31. For the most part, this shift (which ended at 3:30 p.m. that day) handled final preparatory work, such as checking plow readiness. Some light snow was reported as falling from Noon onward, but this might have been drifting rather than new accumulation and no action was required at that time. The second shift began at 3:30 p.m. on January 31 and at that time light snow was falling. Trucks were dispatched to plow and apply pre-wet salt as needed. By 6:00 p.m. that first snow shower had tailed off. Light snow started again at about 9:00 p.m. at which time, winds were northeasterly in the range of 13 to 23 mph (21 to 37 kph), with air temperatures of 21 F (-6 C) and road temperatures of 23 F (-5 C). The dispatch log at that time notes:

The roads are still in decent shape, considering the light snow and the winds. The ditches on Alden road are already filling in, and we could see right now that we will have major issues in keeping certain spots on certain roads even one lane open at the height of the storm tomorrow night. I already see on Alden road just north of Nelson, that east side ditch will be a big issue, especially with traffic heading north coming around the curve past Nelson. These are the spots that can really cause an accident with traffic moving and coming to a "wall" of snow around the curve.

By 11:30 p.m. on January 31, 3 inches (7.5 cm) of snow had fallen, pavement and air temperatures were unchanged from earlier, and wind speeds had risen slightly. These weather conditions held until the start of the third shift (at 3:30 a.m. on February 1). Shortly thereafter, due to a slight shift in the wind to the North East, some lake effect snow was observed, adding about one inch to the total that had fallen so far. In the morning of February 1, the latest forecast indicated the major storm would begin at sometime between 2 and 4 p.m. in McHenry County. This forecast indicated that the lake effect snow would not stop prior to the main event, that wind speeds would be at least 50 mph (80 kph) between 9 p.m. and 9 a.m. and that snowfall between 8 p.m. and 6 a.m. would be between 1 and 3 inches per hour (2.5 to 7.5 cm per hour), with rates as high as 4 inches per hour (10 cm per hour) being possible. Total snowfall during the blizzard would be in the range of 18 to 24 inches (45 to 60 cm).

At 1:30 p.m. it was decided to keep the current shift on until 6:30 p.m. to help with the rush hour, since heavy snow would likely have begun by then. By 3:30 p.m. all the fourth shift workers (the now rested second shift workers) had arrived at the shop. Most of these went out immediately to assist with the plows currently out. The weather had not deteriorated as expected at this point, and in fact, the major snow would not start until about 8 p.m., when whiteout conditions became widespread throughout the County. At 6:35 p.m., wind speeds had climbed into the 25 to 35 mph (40 to 56 kph) range, and were increasing steadily, which caused heavy drifting in places. A number of vehicles lost control and went into ditches or got stuck on the road itself, and by 7 p.m. five of the main roads in the County were at least temporarily closed due to such accidents.

Between 8 p.m. and midnight, the whiteout conditions continued, which resulted in many trucks simply not being able to operate for safety reasons (operators had been reminded at 8 p.m. not to drive in whiteout conditions). From 8 p.m. until about 7 a.m. on February 2, the County operations became focused on safety and rescue rather than on plowing the roads. Wind speeds were above 50 mph (80 kph) with gusts over 60 mph throughout this period, and in the early morning hours wind speeds were sustained at 60 mph (100 kph) with gusts up to 70 mph (115 kph). During this period, multiple road users had to be rescued, some of whom were on the road for what can only be considered frivolous reasons (a car of teenagers was rescued, for example, - they were "on their way to a party"). Conditions were so bad that a number of County vehicles became stuck during the night. At 2 a.m., for example, there were seven County vehicles stranded on the roads, with two of them close to running out of fuel. Since (see above) at least 36 deaths were blamed on the storm Nationwide, stranded vehicles were a very clear safety problem.

At 6:30 p.m. on February 1, most of the shift that had begun at 3:30 a.m. that morning were stood down. Normally, these workers would have returned to their homes, but clearly in such a severe storm that would have meant they could not get back to the shop for their next shift. Instead, they were accommodated at a nearby hotel, but even this proved somewhat problematic. The road between the hotel and the maintenance facility was drifted shut overnight, and had to be plowed open, around abandoned vehicles. There was barely enough room for the plow truck to plow past those vehicles,

and on several occasions the plow got stuck but eventually the shift workers were able to get to the facility.

In reviewing the situation that morning (February 2) as the blizzard was winding down, it was apparent that one lane (at least) had been kept open on County roads in the Eastern half of the County, and in the Southwestern quadrant. However, almost all roads in the West and Northwest of the County were blocked by a combination of snow (both drifted and fallen) and abandoned vehicles.

It should also be noted that the winds did not die down at daybreak and were still very strong at 9 a.m. (“so strong that you could barely stand upright”). The parking lot at the maintenance facility was heavily drifted (see Figure 2) and access to the garage facilities was severely hampered by the drifting (see Figure 3).



Figure 2: Parking Lot at the McHenry County Maintenance Facility on the morning of February 2, 2011

The snow finally came to an end at about 11:15 a.m. At that time, the County only had one snow plow remaining stranded, and was beginning clean up operations, which were made very difficult by the vehicles abandoned on the road. At one point, more than 125 private vehicles needed towing, and the tow trucks were not able to tow during the night

hours (several of them became stranded as well). However, by 4 p.m. all roads in the County except those in the Northwest quadrant had been opened and by 6:30 p.m. all the roads were fully open to two way traffic, and County plows were assisting the State Department of Transportation in opening State Route 23.

In total during the storm approximately 980 tons of solid salt was used, together with 9,980 gallons (38,000 litres) of liquid. The liquid in question was the standard brine mixture used by McHenry County which comprises 85% salt brine (a 23.3% by weight solution of sodium chloride in water) 10% of Calcium Chloride brine (a 30% solution) and 5% of a proprietary carbohydrate product (primarily byproducts from the processing of sugar beets, colloquially known as beet juice) called Geomelt. The quantities of materials used were similar to those used in a much lighter winter event, such as a 2 inch snowstorm. This reflects the fact that in the height of the storm no chemicals were used - at that time trucks were just plowing snow. This is very similar to what Iowa City experienced.



Figure 3: Drifting at Facility Access Point in McHenry County

5 LESSONS LEARNED

Clearly this storm was a particularly severe storm, perhaps more so for McHenry County, because it is primarily rural, than for the urban Iowa City situation, but nonetheless, the storm was very severe in both settings. For the most part, the general public recognized the severity of the storm and sensibly did not attempt to travel in it. While 125 stranded vehicles (in McHenry County) seems a high number, that should be compared with their population of more than 300,000 people - it is a small percentage and likely there will always be someone who feels that a blizzard is an excuse for a party and thus an appropriate time to try and drive on a snow covered road in whiteout conditions.

While both agencies experienced road closures during the storm, both were extremely successful at managing the storm. As indicated above, the roads in McHenry County were clear before the State Highway system was close to being clear. And while clean up in Iowa City took nearly a week on some of the lowest priority roads, the main roads were open soon after the end of the storm. This success is owed primarily to a willingness to accept what might seem like poor levels of service for a period of time, so that acceptable levels of service could be achieved sooner for the whole road network. In Iowa City, the decision was made to focus on the priority 1 roads, which meant that the lower priority roads became completely impassable during the storm and for some time after the end of the storm. However, had the City attempted to keep any of the lower priority roads open, they would likely have “lost” the priority 1 roads too, and created a much worse situation. By “pulling back” their resources and focusing them on a small but critical part of the system, they were able to systematically open the whole system after the storm much more quickly.

In McHenry County, safety dictated that plowing should cease at certain times on certain roads because of whiteout conditions. But careful preparation such as providing local accommodation for plow operators allowed a maximum use of the available resources so that as soon as the snow began to slacken, stuck trucks could be rescued, and plowing could rapidly resume. Even with this level of planning, McHenry County acknowledged that they spent a lot of time “rescuing” trucks and getting personnel to the facility - however, that trucks needed rescuing was in part due to the rescue work that the trucks were assisting with in the first place. A police car is unlikely to be able to reach a stranded vehicle if a plow truck cannot, so in many cases, the plow truck became stuck assisting the police with rescue efforts.

Without intending to imply that either Iowa City or McHenry County are looking forward to another blizzard like the one experienced in February 2011, both agencies feel they have learned a great deal from the storm, and have gained significant confidence in their abilities to handle even the most difficult of winter weather as a result.

6 CONCLUSIONS

An extremely severe blizzard hit the Midwestern United States on February 1-2 2011, and caused a great deal of disruption to the transportation system throughout the

Midwestern region. This paper discusses how two agencies (the City of Iowa City and McHenry County) responded to the storm and how they handled the unique circumstances it inflicted.

The primary lesson learned for both agencies is that focusing their resources on what they could manage, rather than attempting to do everything with what would have proven to be inadequate resources, allowed them to return their respective transportation systems to the desired level of service more effectively than would otherwise have been possible. Both agencies used much less ice control material than might have been expected during such a heavy event, primarily because once the heavy snow started they stopped using such materials and focused solely on plowing.

7 REFERENCES

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