ANNUAL WINTER MAINTENANCE REPORT

2008-2009

Meeting Challenges with Best Practices

Wisconsin Department of Transportation
Division of Transportation System Development
Bureau of Highway Operations
Winter Operations Unit

November 2009

Acknowledgments

Many people at Wisconsin DOT contributed to the development of this report, including:

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We wish to thank these individuals for their contributions to and assistance with this report.

In addition, we extend our thanks to Monty Mills of Washington State DOT for the use of his map of nationwide salt costs (see page 58).

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1 Introduction

To our partners

Wisconsin endured a second severe winter in 2008-2009, on the heels of the record-setting 2007-2008 season. The counties again faced challenges in dealing with rising salt costs and a continued nationwide salt shortage that led to two Wisconsin counties not receiving any salt directly from vendors.

Again this year we commend the county maintenance crews for their dedicated response to a harsh winter, and we recognize the role of WisDOT regional staff in coordinating these efforts. We especially applaud and encourage the counties' use of anti-icing and prewetting—internationally recognized best practices that help make the most efficient use of limited resources and materials. To capture these efforts, this report features:

- Five sections that correspond to the key components of winter and the counties' response, including Introduction, Winter Weather, Snow and Ice Control, Performance, and Looking Ahead.

- Two key tables that summarize important data at a glance: **Winter by the Numbers** (page 8) highlights statewide facts and figures, and has been expanded this year to include more data as well as information about the previous winter. **Winter in Wisconsin** (page 15) compiles key data for all 72 counties. These tables should be a first point of reference throughout the year whenever you need a winter statistic.

- Three maps that compare key data for this winter with the previous five years. These maps visually put each county's experience with **winter severity** (page 29), **salt use** (page 57) and **total costs** (page 97) in the context of what's normal for that county.

- Two new graphs that put Wisconsin's experience with **salt costs** in the context of what other states pay (pages 40 and 41), and a map of salt cost data for all snowy states compiled by Washington State DOT (page 58).

- **Best Practices** sidebars throughout the report that highlight efficient practices.

Because this report has a wide and diverse audience, the text includes some explanations of winter maintenance technologies and best practices, such as anti-icing, prewetting, and use of Road Weather Information Systems. The State Highway Maintenance Manual is the first resource for more information on any of these items, and there are other resources available on WisDOT's extranet site. Links to these resources are provided throughout this report. For more information, contact your regional WisDOT representative or Mike Sproul, WisDOT's state winter operations engineer, at michael.sproul@dot.wi.gov.

Sincerely,

David Vieth, Director
Bureau of Highway Operations

Table 1.1. Statewide Summary: This Winter by the Numbers

		Previous winter	2008-2009
Infrastructure	Lane miles	33,297 miles	**33,531 miles**
	Patrol sections	768	**762**
	Average patrol section length	43.36 lane miles	**45.54 lane miles**
Weather	Average statewide Winter Severity Index	37.2	**36.2**
	Number of storms, statewide average and range across counties	Average: 38 Range: 25 to 61	**Average: 36** **Range: 25 to 71**
	Snowfall, statewide average and range across counties	Average: 104.9 inches Range: 56 to 217 inches	**Average: 90.2 inches** **Range: 58 to 215 inches**
Materials[1]	Salt used	644,485 tons 19.4 tons per lane mile	**569,985 tons** **17.0 tons per lane mile**
	Average cost of salt	$41.69 per ton	**$47.19 per ton**
	Prewetting liquid used	1,293,655 gal.	**1,321,290 gal.**
	Anti-icing agents used	331,179 gal.	**500,673 gal.**
	Sand used	80,133 cubic yd.	**44,179 cubic yd.**
Costs, Equipment and Performance	Total winter costs[2]	$86,287,363	**$79,313,896**
	Total winter costs per lane mile	$2,591	**$2,365**
	Average crew reaction time from start of storm	2.66 hours	**2.57 hours**
	Time to bare/wet pavement (measured from end of storm)	3.27 hours	**2.54 hours**
	Road Weather Information System (RWIS) stations	59	**58**
	Counties with salt spreaders equipped with on-board prewetting unit	52 of 72 (72%)	**55 of 72 (76%)**
	Counties with salt spreaders equipped with ground-speed controller unit	67 of 72 (93%)	**67 of 72 (93%)**
	Underbody plows	565	**572**
	Counties with underbody plows	55 of 72 (76%)	**55 of 72 (76%)**
	Counties equipped to use anti-icing agents	65 of 72 (90%)	**65 of 72 (90%)**
	Counties that used anti-icing agents during the winter season	52 of 72 (72%)	**54 of 72 (75%)**
Labor and Services	Regular county winter labor hours[3]	178,682 hrs.	**148,655 hrs.**
	Overtime county winter labor hours	199,835 hrs.	**176,636 hrs.**
	Public service announcements aired	6,786 total 6,109 radio; 677 TV	**5,948 total** **5,340 radio; 608 TV**
	Cost of public service announcements	$35,000 ($301,463 market value)	**$36,500** **($288,895 market value)**

1. All material usage quantities are from the county storm reports except for salt. Salt quantities are from WisDOT's Salt Inventory Reporting System.
2. Costs refer to final costs billed to WisDOT for all winter activities, including activities such as installing snow fences and thawing culverts.
3. Labor hours come from county storm reports, and reflect salting, sanding, plowing and anti-icing efforts.

About This Report

Every year, WisDOT gathers a multitude of data on winter weather and the state's response to it. Tracking and analyzing this data helps us become more efficient by identifying good performance as well as areas that need improvement. In this way we use our limited resources to achieve the greatest benefit.

Through this report, WisDOT's Bureau of Highway Operations shares data with the department's regional maintenance staff and with our partners in the county highway departments. This allows regional and county staff to compare resource use with that of their peers across the state.

Report Structure and Data Sources

Following this section, this report is divided into four main sections:

Section 2: Weather
Section 3: Snow and Ice Control
Section 4: Performance
Section 5: Looking Ahead

Each section has several subsections; refer to the Table of Contents for more detail. To improve readability, this year's report includes more statewide summary tables within the text, while county-by-county data appears at the end of each section.

Within many of the county-by-county tables in this report, the counties are grouped by region, in acknowledgement of the role that WisDOT's regional staff plays in coordinating winter maintenance in their counties. In some tables, counties are divided by Winter Service Group (Groups A, B, C and D), which reflect the difference in the level of service provided on roads in these counties and facilitate comparisons within these groups. See Tables 1.3 and 1.4 on page 11 for more information on Winter Service Groups.

In most tables, raw numbers (such as total salt used) are presented along with data that has been adjusted for differences between counties (such as salt used per lane mile per Winter Severity Index point). This allows more accurate comparisons between counties in different parts of the state.

This report presents data from several sources:

- The weekly winter storm reports completed by the county highway departments, which detail the counties' estimates of the weather they faced and the materials, equipment and labor they used in responding to it. (See Section 4 for more information about storm reports.)
- Final cost and materials data as billed to WisDOT.
- Data on weather, crashes, travel and other topics from other bureaus within WisDOT and other agencies.

The final billed amounts are considered the most accurate source of cost and materials data, and are presented wherever possible. The source of the data in each table is indicated in the table's heading.

When interpreting the data in this report, readers should remember that many factors affect a county's response to winter, including the local Winter Severity Index, local traffic generators, the mix of highway types and classifications in a county, the type of equipment being used, and the length of patrol sections. Some tables in this report give data that is adjusted for one or more of these factors (for example, salt use per lane mile per severity index point), while others provide raw data.

Working with County Highway Departments

WisDOT's Bureau of Highway Operations, in partnership with the five WisDOT regional offices, is responsible for the maintenance of the state trunk highway system. The state trunk highway system includes 33,531 lane miles of highway and 4,483 bridges.

WisDOT contracts with the state's 72 county highway departments to plow and provide ice control on all state- and U.S.-owned highways in Wisconsin, including the Interstate system. This partnership was set up more than 90 years ago, and to our knowledge, it is unique in the nation.

This relationship benefits both WisDOT and the county highway departments. WisDOT receives the services of a skilled, experienced work force at fair labor rates, and the counties are able to purchase more pieces and types of equipment than they could otherwise afford. This equipment is then available for use on both county and state roads, an arrangement that allows WisDOT and the counties to avoid duplicating equipment purchases and having crews or equipment sitting idle.

Staff at WisDOT's five regional offices work closely with the county highway departments. Regional managers administer the contracts with the counties, and work with the counties to plan maintenance activities and set priorities. Regional staff oversee county highway departments' maintenance expenditures, and are responsible for ensuring that the counties use resources efficiently and adhere to state guidelines for materials use. Regional staff also serve as a resource for the counties on state and federal rules and regulations, and can provide training assistance.

Figure 1.1. WisDOT Regional Divisions

Snow Removal Strategy

In order to gain the most benefit from limited resources, counties provide different levels of service on highways according to the amount of daily traffic they receive. High-volume roads typically receive 24-hour coverage, while

Table 1.2. Highway Categories for Winter Maintenance

Category	Definition	Lane miles	% of total
1	Major urban freeways and most highways with six lanes and greater	2,876	9%
2	High volume four-lane highways (Average Daily Traffic ≥ 25,000) and some four-lane highways (ADT < 25,000), and some 6-lane highways.	3,207	10%
3	All other four-lane highways (ADT < 25,000)	8,432	25%
4	Most high volume two-lane highways (ADT ≥ 5,000) and some 2-lanes (ADT <5000)	4,897	15%
5	All other two-lane highways	14,119	42%
Total		**33,531**	

Note: Percentage totals exceed 100% due to rounding.

lower-volume roads receive 18-hour coverage. On lower-volume four-lane highways, the passing lanes may receive less attention than the driving lanes and ramps.

Table 1.2 shows how WisDOT categorizes the state's highways for winter maintenance. For more detail on the categories and which category each highway is assigned to, see the 2009 map on page 115 in the Appendix.

To facilitate comparisons between counties that provide similar levels of service, WisDOT divides the 72 counties into four Winter Service Groups—A, B, C and D, with A being the most urban and D the most rural. Table 1.3 explains the divisions between the groups. In many tables throughout this report, the counties are arranged according to these groups. Group A contains the fewest counties, while Group D has the most.

Table 1.3. County Winter Service Groups

Winter Service Group	Definition	Number of Counties	% of Counties
A	Counties where all or most of the highways receive 24-hour coverage	12	17%
B	Counties with 18-hour and 24-hour coverage. More than 50% of highways receive 24-hour coverage.	17	24%
C	Counties with 18-hour and 24-hour coverage. Less than 50% of highways receive 24-hour coverage.	21	29%
D	Counties where no highways receive 24-hour coverage.	22	31%

Note: Percentage totals exceed 100% due to rounding.

Table 1.4 shows which service group each county is assigned to.

Table 1.4. Winter Service Group Assignments

Winter Service Group	County Name
A	Brown, Dane, Eau Claire, Kenosha, La Crosse, Marathon, Milwaukee, Ozaukee, Portage, Racine, Waukesha, Winnebago
B	Chippewa, Columbia, Dodge, Dunn, Jefferson, Manitowoc, Marquette, Oneida, Outagamie, Rock, Sauk, Shawano, Sheboygan, St. Croix, Walworth, Washington, Waushara
C	Calumet, Clark, Crawford, Door, Douglas, Fond du Lac, Grant, Iowa, Jackson, Juneau, Kewaunee, Lafayette, Lincoln, Monroe, Oconto, Trempealeau, Vernon, Vilas, Washburn, Waupaca, Wood
D	Adams, Ashland, Barron, Bayfield, Buffalo, Burnett, Florence, Forest, Green, Green Lake, Iron, Langlade, Marinette, Menominee, Pepin, Pierce, Polk, Price, Richland, Rusk, Sawyer, Taylor

In addition, each county highway department divides its highways into winter patrol sections. One snowplow truck is generally assigned to each patrol section. This winter, there were 762 patrol sections on state-maintained highways, with an average of 45.54 lane miles per patrol section. Patrol section length is another factor that can affect performance; see Section 4 for a complete discussion of patrol sections.

This Winter in Wisconsin

Table 1.5 on pages 15-19 summarizes key data from this winter for all 72 counties, including total salt use and cost data. This table facilitates comparisons in these core areas across regions and counties, and serves as a quick reference for commonly used data. The table uses a similar format to the Storm Report Summary (Table A-1 on page 116 of the Appendix), but the cost data in Table 1.5 are actual billed costs as submitted to WisDOT by the counties, rather than estimates from the storm reports.

County-by-County
Quick Reference Winter Summary Table
for Section 1: Introduction

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Table 1.5. Winter in Wisconsin, 2008-2009													
	County	Winter service group	Lane miles	Severity Index	Snowfall (inches)	Total salt used (tons)	Salt used (tons) per lane mile	Salt used per lane mile per Severity Index	Total salt costs	Total salt costs per lane mile	Total winter costs	Total winter costs per lane mile	Total winter costs per lane mile per Severity Index
North Central Region													
	Adams	D	192.48	32.34	87.0	2,944	15.30	0.47	$165,600	$860	$444,349	$2,309	$71.38
	Florence	D	141.07	42.49	112.9	3,074	21.79	0.51	$158,219	$1,122	$347,295	$2,462	$57.94
	Forest	D	312.38	42.03	101.9	5,783	18.51	0.44	$297,593	$953	$808,601	$2,589	$61.59
	Green Lake	D	151.30	35.17	98.6	1,131	7.48	0.21	$51,291	$339	$234,269	$1,548	$44.03
	Iron	D	250.91	56.02	215.2	5,250	20.92	0.37	$273,315	$1,089	$803,413	$3,202	$57.16
	Langlade	D	292.69	46.01	85.1	3,372	11.52	0.25	$157,304	$537	$584,840	$1,998	$43.43
	Lincoln	C	418.33	49.09	77.0	4,403	10.53	0.21	$216,496	$518	$834,311	$1,994	$40.63
	Marathon	A	878.99	44.75	81.7	10,338	11.76	0.26	$490,021	$557	$1,620,066	$1,843	$41.19
	Marquette	B	243.91	29.30	89.9	3,894	15.96	0.54	$190,339	$780	$481,375	$1,974	$67.36
	Menominee	D	90.26	34.15	96.6	559	6.19	0.18	$22,248	$246	$115,481	$1,279	$37.46
	Oneida	B	396.79	50.44	89.8	7,750	19.53	0.39	$396,335	$999	$1,120,198	$2,823	$55.97
	Portage	A	504.28	40.95	89.0	6,980	13.84	0.34	$327,851	$650	$1,103,749	$2,189	$53.45
	Price	D	320.57	58.69	73.9	5,101	15.91	0.27	$280,912	$876	$743,735	$2,320	$39.53
	Shawano	B	516.24	40.27	106.5	7,120	13.79	0.34	$283,162	$549	$1,073,436	$2,079	$51.63
	Vilas	C	305.24	58.58	134.3	7,212	23.63	0.40	$387,573	$1,270	$955,817	$3,131	$53.45
	Waupaca	C	546.58	38.57	109.3	8,245	15.08	0.39	$351,897	$644	$1,143,687	$2,092	$54.25
	Waushara	B	345.71	32.88	95.6	3,276	9.48	0.29	$157,641	$456	$543,515	$1,572	$47.82
	Wood	C	362.92	42.90	86.7	4,825	13.29	0.31	$252,541	$696	$728,377	$2,007	$46.78
Region total			**6,270.65**			**91,257**			**$4,460,336**		**$13,686,514**		
Region average			**348.37**	**43.04**	**101.7**	**5,070**	**14.55**	**0.34**	**$247,796**	**$711**	**$760,362**	**$2,183**	**$50.72**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data are taken from WisDOT's Salt Inventory Reporting System.													

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Northeast Region													
	Brown	A	711.75	33.94	102.4	14,520	20.40	0.60	$482,500	$678	$1,873,396	$2,632	$77.55
	Calumet	C	201.31	40.01	91.7	2,385	11.85	0.30	$90,129	$448	$469,457	$2,332	$58.29
	Door	C	268.55	34.84	86.2	2,705	10.07	0.29	$107,740	$401	$787,290	$2,932	$84.15
	Fond du Lac	C	594.34	35.99	82.9	9,110	15.33	0.43	$397,652	$669	$1,437,770	$2,419	$67.22
	Kewaunee	C	110.41	34.06	125.3	1,265	11.46	0.34	$52,131	$472	$276,465	$2,504	$73.52
	Manitowoc	B	414.69	31.57	96.3	8,260	19.92	0.63	$320,488	$773	$1,275,336	$3,075	$97.42
	Marinette	D	388.36	45.67	112.9	5,315	13.69	0.30	$226,472	$583	$694,680	$1,789	$39.17
	Oconto	C	437.71	36.49	106.7	5,770	13.18	0.36	$226,876	$518	$770,328	$1,760	$48.23
	Outagamie	B	520.01	33.51	90.1	10,215	19.64	0.59	$387,046	$744	$1,430,401	$2,751	$82.09
	Sheboygan	B	520.30	30.04	98.9	9,450	18.16	0.60	$407,768	$784	$1,320,377	$2,538	$84.48
	Winnebago	A	567.36	31.42	79.1	11,560	20.38	0.65	$474,538	$836	$1,623,115	$2,861	$91.05
Region total			**4,734.79**			**80,555**			**$3,173,339**		**$11,958,615**		
Region average			**430.44**	**35.23**	**97.5**	**7,323**	**17.01**	**0.48**	**$288,485**	**$670**	**$1,087,147**	**$2,526**	**$71.69**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data are taken from WisDOT's Salt Inventory Reporting System.													

Table 1.5. Winter in Wisconsin, 2008-2009													
	County	Winter service group	Lane miles	Severity Index	Snowfall (inches)	Total salt used (tons)	Salt used (tons) per lane mile	Salt used per lane mile per Severity Index	Total salt costs	Total salt costs per lane mile	Total winter costs	Total winter costs per lane mile	Total winter costs per lane mile per Severity Index
Northwest Region													
	Ashland	D	247.57	53.23	180.9	2,891	11.68	0.22	$245,417	$991	$648,396	$2,619	$49.20
	Barron	D	423.09	37.70	69.7	2,774	6.56	0.17	$238,509	$564	$854,332	$2,019	$53.56
	Bayfield	D	316.90	55.03	158.9	5,705	18.00	0.33	$465,072	$1,468	$962,489	$3,037	$55.19
	Buffalo	D	315.77	36.50	60.7	2,024	6.41	0.18	$93,914	$297	$354,404	$1,122	$30.75
	Burnett	D	233.64	30.71	75.1	2,672	11.44	0.37	$221,188	$947	$513,129	$2,196	$71.52
	Chippewa	B	667.85	33.14	72.4	8,099	12.13	0.37	$539,555	$808	$1,302,731	$1,951	$58.86
	Clark	C	402.28	32.53	93.3	4,899	12.18	0.37	$305,012	$758	$709,710	$1,764	$54.23
	Douglas	C	439.23	44.49	154.7	6,224	14.17	0.32	$266,449	$607	$986,525	$2,246	$50.48
	Dunn	B	516.55	27.27	67.1	6,463	12.51	0.46	$362,251	$701	$1,032,272	$1,998	$73.28
	Eau Claire	A	559.86	26.87	57.9	6,580	11.75	0.44	$370,125	$661	$1,093,286	$1,953	$72.68
	Jackson	C	504.10	32.53	106.0	7,305	14.49	0.45	$378,107	$750	$928,556	$1,842	$56.62
	Pepin	D	111.05	25.76	61.2	879	7.92	0.31	$42,588	$383	$175,111	$1,577	$61.21
	Pierce	D	366.08	37.87	67.4	3,947	10.78	0.28	$212,230	$580	$697,955	$1,907	$50.34
	Polk	D	385.05	42.23	73.6	4,222	10.96	0.26	$228,072	$592	$718,667	$1,866	$44.20
	Rusk	D	213.47	31.39	73.6	1,806	8.46	0.27	$97,452	$457	$297,464	$1,393	$44.39
	St. Croix	B	616.98	39.06	66.0	7,638	12.38	0.32	$417,035	$676	$1,288,894	$2,089	$53.48
	Sawyer	D	367.44	34.18	78.2	3,272	8.90	0.26	$161,081	$438	$498,972	$1,358	$39.73
	Taylor	D	233.25	40.63	70.8	3,015	12.93	0.32	$177,312	$760	$400,563	$1,717	$42.27
	Trempealeau	C	432.31	29.48	76.9	5,993	13.86	0.47	$287,724	$666	$729,904	$1,688	$57.27
	Washburn	C	372.14	32.61	96.7	5,026	13.51	0.41	$224,260	$603	$623,908	$1,677	$51.41
Region total			**7,724.61**			**91,434**			**$5,333,352**		**$14,817,268**		
Region average			**386.23**	**36.16**	**88.1**	**4,572**	**11.55**	**0.32**	**$266,668**	**$690**	**$740,863**	**$1,918**	**$53.05**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data are taken from WisDOT's Salt Inventory Reporting System.													

Table 1.5. Winter in Wisconsin, 2008-2009													
	County	Winter service group	Lane miles	Severity Index	Snowfall (inches)	Total salt used (tons)	Salt used (tons) per lane mile	Salt used per lane mile per Severity Index	Total salt costs	Total salt costs per lane mile	Total winter costs	Total winter costs per lane mile	Total winter costs per lane mile per Severity Index
Southeast Region													
	Kenosha	A	554.27	32.35	96.7	9,436	17.02	0.53	$355,265	$641	$1,533,854	$2,767	$85.54
	Milwaukee	A	1795.62	32.15	78.8	47,166	26.27	0.82	$1,789,006	$996	$6,071,074	$3,381	$105.16
	Ozaukee	A	304.03	30.08	77.3	7,304	24.02	0.80	$272,074	$895	$883,171	$2,905	$96.57
	Racine	A	676.84	38.16	97.6	12,772	18.87	0.49	$545,492	$806	$2,249,473	$3,323	$87.09
	Walworth	B	691.89	31.51	88.4	15,896	22.97	0.73	$615,652	$890	$1,841,829	$2,662	$84.48
	Washington	B	580.03	30.64	85.4	11,635	20.06	0.65	$519,503	$896	$1,518,476	$2,618	$85.44
	Waukesha	A	1062.39	26.26	89.8	33,271	31.32	1.19	$1,344,814	$1,266	$3,135,266	$2,951	$112.38
Region total			**5,665.07**			**137,480**			**$5,441,807**		**$17,233,143**		
Region average			**809.30**	**31.59**	**87.7**	**19,640**	**24.27**	**0.77**	**$777,401**	**$961**	**$2,461,878**	**$3,042**	**$96.29**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data are taken from WisDOT's Salt Inventory Reporting System.													

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Southwest Region													
	Columbia	B	745.80	30.30	93.2	24,965	33.47	1.10	$1,311,911	$1,759	$2,862,543	$3,838	$126.67
	Crawford	C	385.21	35.64	63.4	4,089	10.61	0.30	$204,654	$531	$717,782	$1,863	$52.28
	Dane	A	1674.08	28.46	68.7	43,643	26.07	0.92	$2,022,853	$1,208	$4,735,884	$2,829	$99.40
	Dodge	B	606.62	31.75	80.5	15,141	24.96	0.79	$665,598	$1,097	$1,591,370	$2,623	$82.62
	Grant	C	624.14	33.92	68.6	7,369	11.81	0.35	$368,892	$591	$996,327	$1,596	$47.06
	Green	D	311.45	31.25	72.9	2,638	8.47	0.27	$137,097	$440	$495,198	$1,590	$50.88
	Iowa	C	451.03	28.82	74.6	5,087	11.28	0.39	$274,240	$608	$935,005	$2,073	$71.93
	Jefferson	B	458.21	26.52	70.0	10,373	22.64	0.85	$420,210	$917	$1,099,187	$2,399	$90.46
	Juneau	C	498.13	31.64	85.4	7,779	15.62	0.49	$436,480	$876	$1,006,426	$2,020	$63.86
	La Crosse	A	480.28	36.54	76.9	6,592	13.73	0.38	$311,274	$648	$1,064,125	$2,216	$60.64
	Lafayette	C	293.88	26.94	66.1	2,622	8.92	0.33	$137,262	$467	$499,331	$1,699	$63.07
	Monroe	C	644.23	36.59	77.4	9,083	14.10	0.39	$448,064	$696	$1,071,213	$1,663	$45.44
	Richland	D	328.72	26.96	75.3	2,945	8.96	0.33	$160,237	$487	$420,982	$1,281	$47.50
	Rock	B	592.56	31.84	85.1	9,982	16.85	0.53	$458,972	$775	$1,871,490	$3,158	$99.19
	Sauk	B	591.55	28.71	83.5	13,814	23.35	0.81	$824,281	$1,393	$1,565,829	$2,647	$92.20
	Vernon	C	450.00	33.21	76.5	3,137	6.97	0.21	$155,940	$347	$685,664	$1,524	$45.88
Region total			**9,135.89**			**169,259**			**$8,337,967**		**$21,618,356**		
Region average			**570.99**	**31.19**	**76.1**	**10,579**	**18.53**	**0.59**	**$521,123**	**$913**	**$1,351,147**	**$2,366**	**$75.86**
Statewide total			**33,531.01**			**569,985**			**$26,746,802**		**$79,313,896**		
Statewide average			**465.71**	**36.2**	**90.2**	**7,916**	**17.00**	**0.47**	**$371,483**	**$798**	**$1,101,582**	**$2,365**	**$65.33**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data are taken from WisDOT's Salt Inventory Reporting System.													

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2 Winter Weather

In this section...

Every winter is different—the number and type of storms, the range of temperatures, the amount of snow. These factors and more combine to create varying challenges for the county highway departments each year.

After the record-breaking winter of 2007-2008, WisDOT and the counties braced for the worst as the following winter began. And in December it appeared that Wisconsin was going to get it, as frequent storms hit nearly every part of the state. But by the middle of January, the storms had abated, and by winter's end the state had recorded an average snowfall of 90 inches—lower than last year's average of 105 inches, but still 73 percent higher than the 30-year normal of 52 inches. On average, temperatures were below normal statewide this winter.

This section describes the weather Wisconsin experienced during the 2008-2009 winter, and the tools and methodologies WisDOT uses to analyze individual storms and the winter as a whole. The Winter Severity Index is one such tool—WisDOT uses it to facilitate comparisons from one winter to the next, and from county to county within the same season.

Winter Weather, 2008-2009

	Statewide average	Range across counties
Total snowfall[1]	90.2 inches	58 – 215 inches
Winter Severity Index	36.2	25.8 – 58.7
Winter storms	36	25 – 71
Frost events	2	0 – 14
Freezing rain events	5	0 – 16

1. All data in this table is from Winter Storm Reports, 2008-2009.

Tracking the Winter

Each week during winter, representatives from the 72 county highway departments complete winter storm reports. These reports give WisDOT the tools to manage statewide materials use and maintenance expenses as the winter progresses. *See page 72 for more information.*

Winter Weather Challenges

Each year, county highway departments face unique combinations of temperatures and storms, and draw on their experience in deciding what combination of snow and ice control strategies to employ. The number of storms has a more significant impact on resources expended than snowfall totals, since staff and equipment may be mobilized even if only 0.1 inches of snow or freezing rain falls. Weekend and evening storms are also more costly than weekday storms because of overtime pay.

Storms with low temperatures can be difficult for crews because deicing agents become less effective at lower temperatures. Storms with high winds also are a challenge, because snow blows back onto the roadway quickly after the plows pass.

Counties in the northern half of the state tend to face colder temperatures and heavier snowfall than those in the southern half. Wisconsin's average annual snowfall ranges from about 40 inches in the south to as much as 160 inches along the shores of Lake Superior. The statewide average annual snowfall is 52.4 inches (30-year normal as recorded by the Wisconsin State Climatology Office).

On average, about 35 to 40 winter weather events hit Wisconsin each winter. While only a couple of large freezing rain events normally strike the state each winter, the state experiences numerous freezing drizzle and freezing fog events that cause roads to ice over.

This Winter's Weather

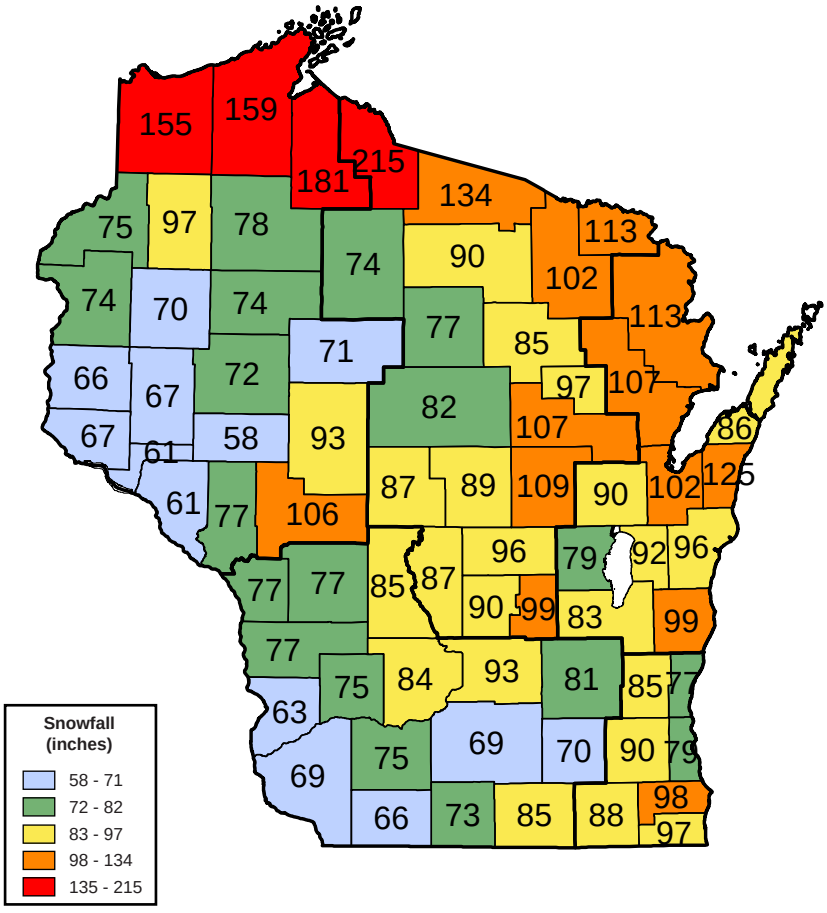
The winter of 2008-2009 can be divided into two distinct narratives. December and the first half of January brought what seemed like a continuation of the previous winter's record snowy conditions. But beginning in mid-January, the weather turned fairly benign.

December 2008 was characterized by frequent winter storms that struck virtually every part of the state. More than 30 inches of snow fell over the entire state, with the exception of extreme western and southwestern Wisconsin. Temperatures averaged at least 6 degrees below normal across the state. The harsh start to the winter brought fears of salt shortages across the entire Midwest.

The storms continued through the middle of January, then slowed down fairly abruptly as record cold Arctic air plunged into the state. This pushed the storm track farther to the south and caused the snow to ease. The last half of January was relatively dry, but the snow picked up again in February. There were only a couple of major storms, but that was enough to leave the state with average to slightly above average snowfall for the month.

March brought warming and little snowfall across most of the state, easing salt short-

Figure 2.1. Statewide Snowfall, 2008-2009
From Winter Storm Reports



Note: If you are looking at a black-and-white version of this map, you may download a color version of this report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm.

age concerns. There were occasional snowfalls, but the heaviest events stayed well north and west of the state.

During the 2008-2009 winter season, county highway departments responded to:

- A statewide average of 36 winter storm events per county, with a high of 71 in Vilas County and a low of 25 in Lafayette County.
- A statewide average of 3 frost events.
- A statewide average of 5 freezing rain events.

Figure 2.1 shows the total snowfall received in Wisconsin this winter based on storm reports data. Snowfall varied quite a bit across the state; the highest snowfall recorded was in Iron County, at 215 inches; the lowest was in Eau Claire County, at 58 inches. This range was similar to last year's range of 56 to 217 inches. Statewide, this winter's total snowfall ranged from near average in the northwest to above average in the southeast. On average, temperatures were below normal statewide this winter.

Winter Severity Index

WisDOT's Winter Severity Index is a management tool that allows the department to maximize winter maintenance efficiency by evaluating the materials, labor and equipment used based on the severity of the winter in a given county or region.

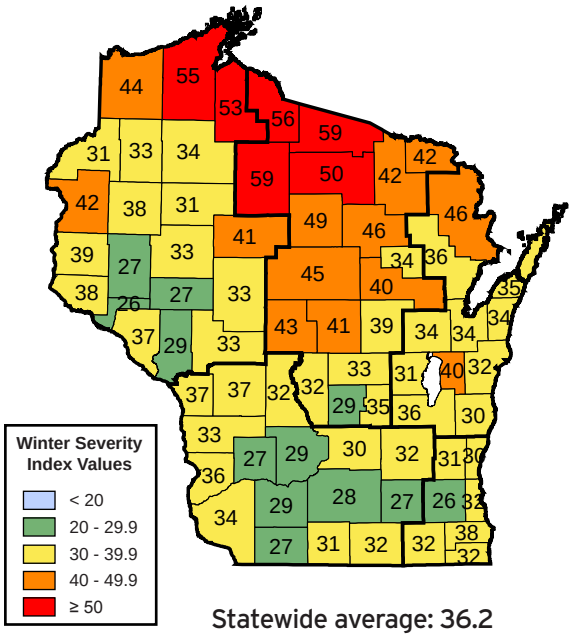
Developed in 1995, the severity index is calculated using a formula that includes:

- Number of snow events
- Number of freezing rain events
- Total snow amount
- Total storm duration
- Total number of incidents

Since all of these factors can affect materials use, the severity index gives the department a simple way to quantify severity that incorporates multiple factors into a single number. WisDOT uses the severity index in two ways:

1. Season-to-season comparisons. This lets the department compare apples to apples when evaluating materials use and costs over several seasons, and identify trends in winter weather that can be useful in planning materials purchases. In the case of cost trends, adjusting cost data for severity index ranking can help WisDOT separate cost increases due to more severe winters from those due to increased labor costs, equipment costs, lane miles and other factors.

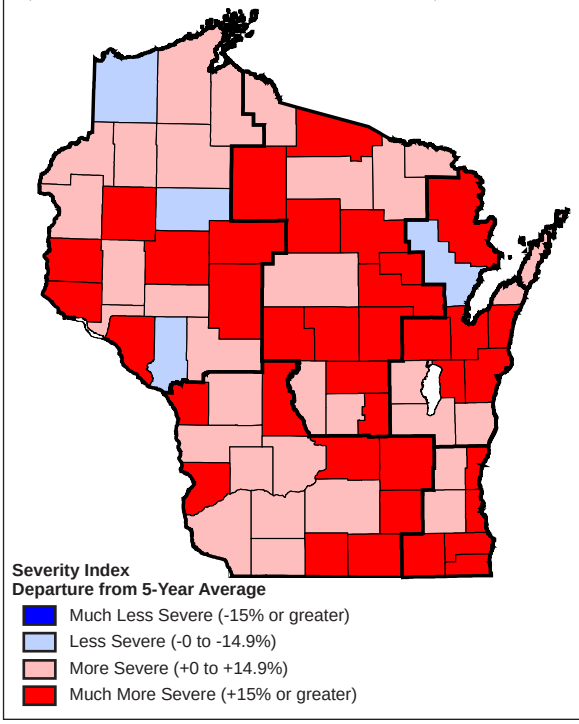
Figure 2.2. Winter Severity Index, 2008-2009



Statewide average: 36.2

Note: If you are looking at a black-and-white version of the maps on this page, you may download a color version of this report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm.

Figure 2.3. 2008-2009 Winter Severity Index vs. 5-Year Average (2003-2004 to 2007-2008)



2. Regional comparisons. Since snowfall, number of storms, and other factors vary widely across the state, the severity index also helps WisDOT compare resources use from one region or county to another within a single winter. This allows WisDOT to assess whether materials are being used consistently, whether counties have enough staff, and other factors that affect each region's response to winter.

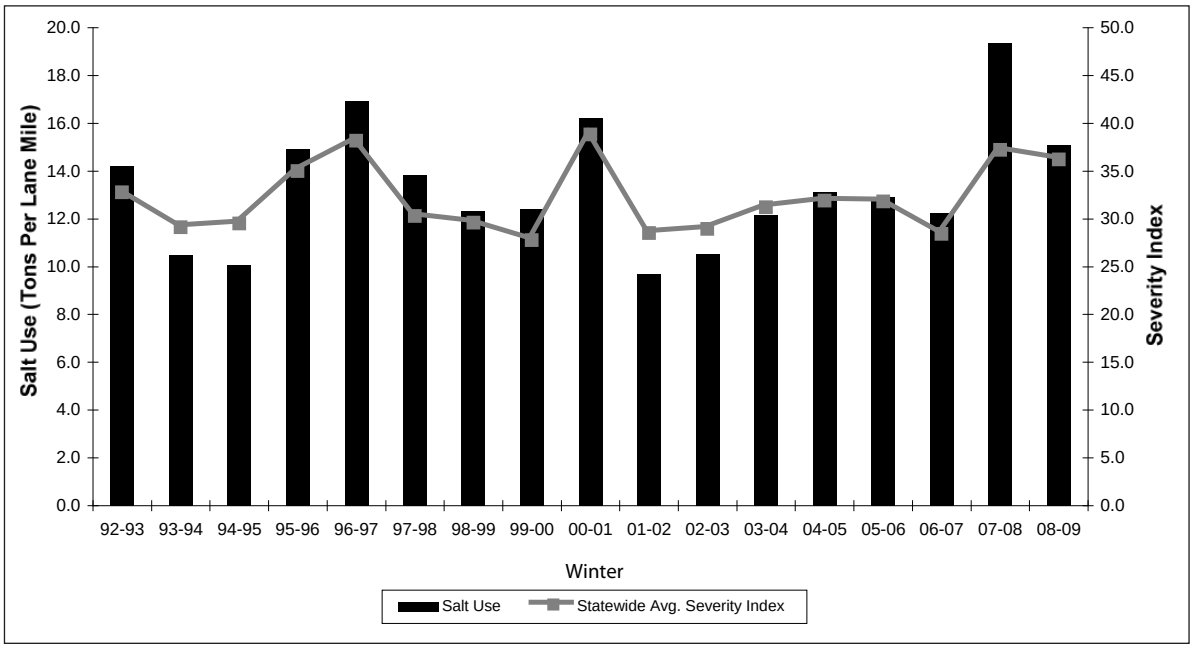
Data from weekly storm reports are used to calculate the Winter Severity Index for each county according to a weighted formula. The index expresses winter severity on a scale from 0 to 100. This winter:

- The statewide average Winter Severity Index was 36.2, which is 15 percent higher than the average of the previous 10 winters (31.4)
- Price and Vilas Counties had the highest severity index at 59
- Pepin and Waukesha Counties had the lowest severity index at 26

The high of 59 is higher than what is usually recorded as the state's highest severity index in the northern "snow belt" part of the state, and the low of 26 is higher than the state's typical lowest severity index as well. With few exceptions across the state, this winter was more severe than normal. Figure 2.2 on the previous page shows how severity index varied by county this winter, while Figure 2.3 shows how this winter's severity index for each county compares to the average of the previous five years in that county. For more detail on how each county's severity index compares with the five-year average, see Figure 2.5 on page 29.

Figure 2.4 plots the average statewide salt use per lane mile versus the average statewide Winter Severity Index. As expected, salt use tends to increase as the severity index increases. This year's total salt use was about average relative to the severity index. Last year's salt use was higher than average relative to the severity index, which may have been partly due to timing of storms (multiple storms in quick succession) as well as extended bouts of lower temperatures.

Figure 2.4. Salt Use per Lane Mile and Average Severity Index
From Salt Inventory Reporting System, 1992-2009



Since the Winter Severity Index is an important tool for comparing cost and materials data from year to year, this report includes several charts that compare trends in winter measures over time with changes in severity index. These include Figure 2.4 on the previous page, as well as Figure 3.2 (salt used per lane mile; page 39), Figure 4.2 (winter costs; page 77), and Figure 4.6 (winter crashes; page 82).

Because of concerns about consistency across all counties in reporting incidents, beginning with the 2005-2006 winter WisDOT adjusted the formula for computing the severity index to remove cleanup and bridge deck snow removal as components in the calculation. The effect of this change is slight, but readers should be aware of it when comparing severity index data from the last four winters against earlier data. The severity index for some counties may appear slightly lower using the new formula.

More information on the severity index is available by request from WisDOT:

- A report describing the process that was used to develop the severity index, including data on the five-year-average severity index for each county (March 1998).
- A table showing Winter Severity Index values for each county for the previous 10 winter seasons.

On page 30, Table 2.1 gives details about the types of storms and other incidents (such as frost, ice, and drifting or blowing snow) that each county experienced this winter, as reported by the counties in their winter storm reports.

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County-by-County Figure and Table for Section 2: Winter Weather

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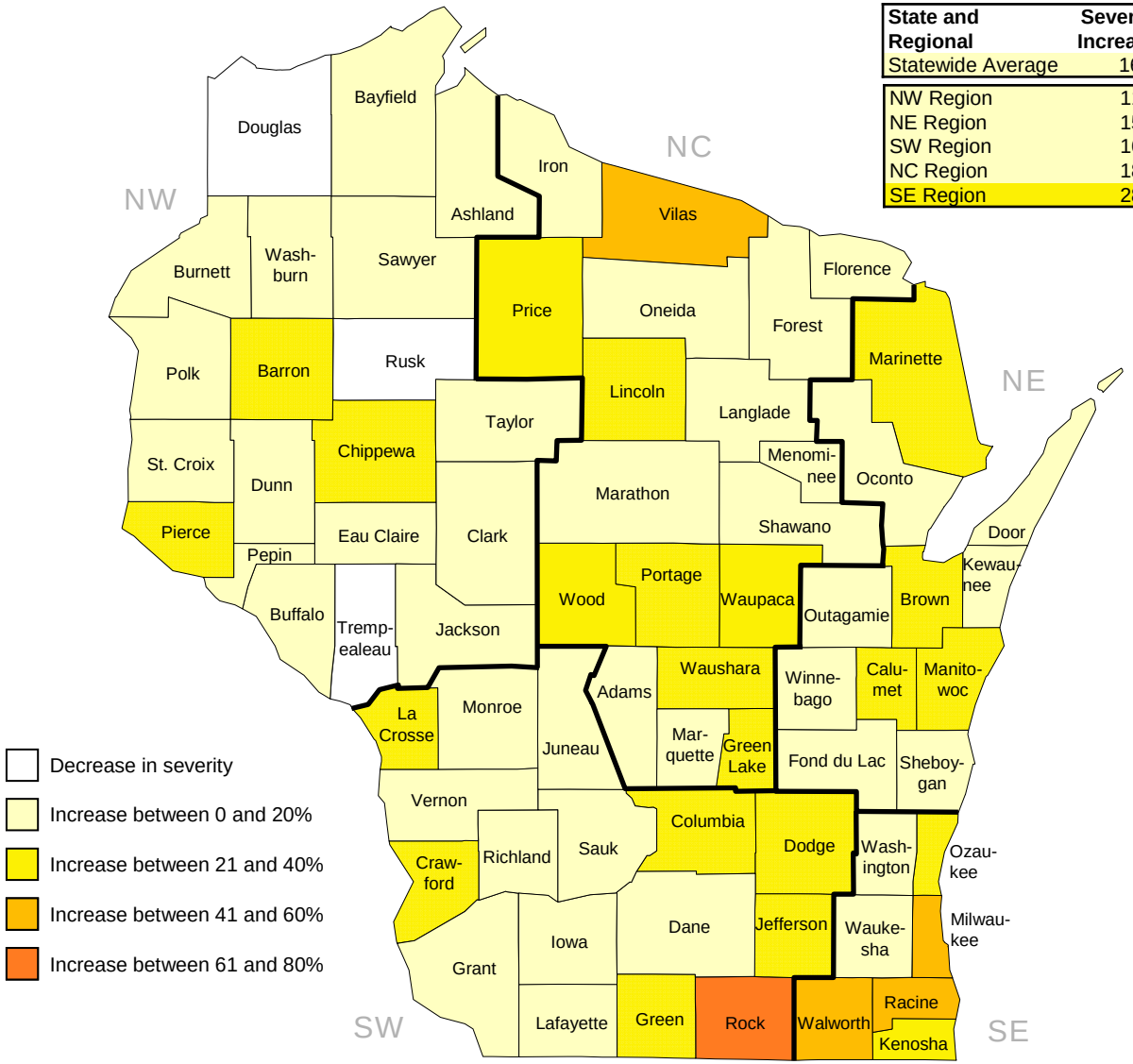
Figure 2.5. 2008-2009 Winter Severity Index vs. 5-Year Average

County	Severity Increase
Trempealeau	-4%
Rusk	-2%
Douglas	-2%
Oconto	0%
Sauk	0%
Burnett	0%
Forest	0%
Washburn	1%
Washington	1%
Marquette	1%
Iowa	1%
Iron	2%
Adams	2%
Richland	3%
Winnebago	3%
Dane	4%
Lafayette	5%
Fond du Lac	6%
Door	7%
Marathon	7%
Ashland	8%
Vernon	8%
Monroe	8%
Grant	8%
Sawyer	8%
Florence	8%
Dunn	9%
Oneida	10%
Bayfield	10%
Eau Claire	10%
Pepin	11%
Waukesha	11%
Sheboygan	11%
Jackson	12%
Polk	13%
Clark	15%

County	Severity Increase
Langlade	17%
Outagamie	17%
Menominee	18%
Shawano	18%
Juneau	18%
Taylor	19%
Buffalo	20%
Kewanee	20%
St. Croix	20%
Ozaukee	22%
Brown	23%
Dodge	23%
Crawford	23%
Pierce	23%
Columbia	23%
Manitowoc	24%
Lincoln	24%
Portage	24%
Marinette	25%
Waushara	25%
Barron	25%
La Crosse	27%
Green	27%
Calumet	28%
Green Lake	29%
Jefferson	30%
Chippewa	30%
Price	32%
Wood	34%
Kenosha	35%
Waupaca	37%
Milwaukee	41%
Walworth	47%
Vilas	50%
Racine	51%
Rock	65%



State and Regional	Severity Increase
Statewide Average	16%
NW Region	11%
NE Region	15%
SW Region	16%
NC Region	18%
SE Region	28%

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2008-2009

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NC	ADAMS	87.0	192.48	2944	15.30	33	14	18	8	8	18	7	6	0	2	0	15	5
	FLORENCE	112.9	141.07	3074	21.79	47	13	39	6	0	24	5	1	0	11	2	14	10
	FOREST	101.9	312.38	5783	18.51	46	18	29	5	8	24	16	12	0	5	3	12	2
	GREEN LAKE	98.6	151.30	1131	7.48	30	15	14	3	3	27	22	22	1	2	0	15	4
	IRON	215.2	250.91	5250	20.92	61	10	48	5	3	12	3	0	0	4	0	8	0
	LANGLADE	85.1	292.69	3372	11.52	47	18	24	16	8	22	9	10	1	16	0	9	8
	LINCOLN	77.0	418.33	4403	10.53	50	17	33	12	4	26	1	7	6	4	6	19	7
	MARATHON	81.7	878.99	10338	11.76	45	25	18	7	4	51	7	11	3	30	4	32	21
	MARQUETTE	89.9	243.91	3894	15.96	30	10	19	2	4	15	4	3	1	5	2	4	1
	MENOMINEE	96.6	90.26	559	6.19	37	13	19	5	7	31	6	1	5	18	2	23	0
	ONEIDA	89.8	396.79	7750	19.53	53	21	25	7	1	17	3	1	1	9	0	3	15
	PORTAGE	89.0	504.28	6980	13.84	46	13	27	8	2	23	8	0	7	14	0	7	0
	PRICE	73.9	320.57	5101	15.91	57	26	42	14	12	28	13	0	4	21	2	12	8
	SHAWANO	106.5	516.24	7120	13.79	41	16	25	5	2	30	13	20	0	11	11	22	2
	VILAS	134.3	305.24	7212	23.63	71	52	14	8	1	9	6	6	0	4	0	0	0
	WAUPACA	109.3	546.58	8245	15.08	40	17	17	5	3	27	10	5	3	5	0	12	2
	WAUSHARA	95.6	345.71	3276	9.48	30	13	13	6	3	16	7	8	4	7	0	5	2
	WOOD	86.7	362.92	4825	13.29	39	22	20	13	8	26	10	7	2	11	5	16	8
Region Average		101.7	348.37	5070	14.70	45	19	25	8	5	24	8	7	2	10	2	13	5

Final totals as of Monday, July 13, 2009

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2008-2009

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NE	BROWN	102.4	711.75	14520	20.40	33	9	21	3	1	15	8	3	2	4	3	4	0
	CALUMET	91.7	201.31	2385	11.85	31	6	28	1	3	42	32	8	1	16	1	17	13
	DOOR	86.2	268.55	2705	10.07	31	18	17	0	6	36	21	20	14	16	0	13	15
	FOND DU LAC	82.9	594.34	9110	15.33	31	12	22	6	3	35	13	4	1	10	1	25	7
	KEWAUNEE	125.3	110.41	1265	11.46	31	14	15	2	0	33	1	15	2	0	0	16	0
	MANITOWOC	96.3	414.69	8260	19.92	29	13	15	1	7	19	17	17	1	15	9	17	9
	MARINETTE	112.9	388.36	5315	13.69	43	21	19	5	2	40	16	5	1	27	7	22	2
	OCONTO	106.7	437.71	5770	13.18	41	18	19	5	2	36	7	7	0	3	3	34	2
	OUTAGAMIE	90.1	520.01	10215	19.64	33	18	17	2	3	19	12	14	3	7	0	6	5
	SHEBOYGAN	98.9	520.30	9450	18.16	27	12	18	1	4	23	13	3	1	5	5	13	6
	WINNEBAGO	79.1	567.36	11560	20.38	34	13	21	2	4	27	4	8	2	1	2	21	2
Region Average		97.5	430.44	7323	15.82	33	14	19	3	3	30	13	9	3	9	3	17	6

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2008-2009

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NW	ASHLAND	180.9	247.57	2891	11.68	54	23	28	5	11	22	2	3	2	10	1	16	2
	BARRON	69.7	423.09	2774	6.56	37	17	15	9	10	41	7	8	8	10	9	32	4
	BAYFIELD	158.9	316.90	5705	18.00	56	24	32	2	11	21	15	13	12	10	7	14	5
	BUFFALO	60.7	315.77	2024	6.41	36	12	21	7	6	22	15	1	3	9	2	9	4
	BURNETT	75.1	233.64	2672	11.44	28	16	11	2	11	27	14	18	0	22	4	21	0
	CHIPPEWA	72.4	667.85	8099	12.13	39	13	24	2	5	22	14	5	0	10	2	8	0
	CLARK	93.3	402.28	4899	12.18	37	19	19	5	5	12	7	1	0	2	0	7	6
	DOUGLAS	154.7	439.23	6224	14.17	50	31	23	4	0	24	12	4	1	18	10	10	6
	DUNN	67.1	516.55	6463	12.51	31	11	18	1	2	11	1	3	0	3	1	5	0
	EAU CLAIRE	57.9	559.86	6580	11.75	33	20	10	5	8	7	2	3	0	3	1	5	0
	JACKSON	106.0	504.10	7305	14.49	38	18	15	0	6	22	5	6	4	3	0	17	0
	PEPIN	61.2	111.05	879	7.92	32	12	20	2	3	15	6	6	0	12	4	2	2
	PIERCE	67.4	366.08	3947	10.78	38	11	24	9	5	22	14	6	6	13	4	9	4
	POLK	73.6	385.05	4222	10.96	33	14	16	4	3	40	28	9	1	25	0	2	0
	RUSK	73.6	213.47	1806	8.46	34	13	16	6	9	26	9	8	1	14	6	18	0
	SAINT CROIX	66.0	616.98	7638	12.38	42	36	3	6	8	24	11	5	6	16	6	10	0
	SAWYER	78.2	367.44	3272	8.90	35	17	17	4	19	22	9	9	2	12	10	20	0
	TAYLOR	70.8	233.25	3015	12.93	36	16	20	10	5	43	16	8	1	27	10	16	15
	TREMPEALEAU	76.9	432.31	5993	13.86	30	7	24	2	4	25	12	4	0	14	6	13	1
	WASHBURN	96.7	372.14	5026	13.51	35	15	18	5	0	17	4	5	0	4	2	10	12
Region Average		88.0	386.23	4572	11.55	38	17	19	5	7	23	10	6	2	12	4	12	3

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2008-2009

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
SE	KENOSHA	96.7	554.27	9436	17.02	30	16	14	2	12	19	9	7	2	4	1	15	15
	MILWAUKEE	78.8	,795.62	47166	26.27	30	17	11	5	5	7	0	1	3	1	2	0	6
	OZAUKEE	77.3	304.03	7304	24.02	31	11	17	2	3	33	6	6	0	6	5	23	2
	RACINE	97.6	676.84	12772	18.87	31	10	23	4	4	27	20	11	1	14	2	13	6
	WALWORTH	88.4	691.89	15896	22.97	32	10	17	4	2	14	6	4	0	6	2	1	2
	WASHINGTON	85.4	580.03	11635	20.06	33	13	18	4	4	9	4	1	0	2	2	8	8
	WAUKESHA	89.8	,062.39	33271	31.32	26	13	13	4	7	4	2	1	0	1	0	2	13
Region Average		87.7	809.30	19640	22.93	30	13	16	4	5	16	7	4	1	5	2	9	7

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2008-2009

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting Snow	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
SW	COLUMBIA	93.2	745.80	24965	33.47	31	15	17	2	5	21	13	8	0	2	0	14	4
	CRAWFORD	63.4	385.21	4089	10.61	28	6	18	7	4	37	21	15	3	10	0	19	7
	DANE	68.7	,674.08	43643	26.07	29	9	16	3	1	2	0	1	6	0	0	0	5
	DODGE	80.5	606.62	15141	24.96	33	19	11	5	2	16	11	1	0	4	0	6	8
	GRANT	68.6	624.14	7369	11.81	30	13	12	4	9	37	16	11	2	12	1	18	7
	GREEN	72.9	311.45	2638	8.47	31	9	21	3	3	37	7	10	2	6	0	31	5
	IOWA	74.6	451.03	5087	11.28	30	15	15	1	2	20	6	12	2	4	1	12	0
	JEFFERSON	70.0	458.21	10373	22.64	28	11	13	3	8	18	11	8	0	6	0	8	0
	JUNEAU	85.4	498.13	7779	15.62	32	21	8	6	5	14	7	2	2	1	0	11	10
	LA CROSSE	76.9	480.28	6592	13.73	31	9	22	4	6	39	13	14	14	16	3	22	14
	LAFAYETTE	66.1	293.88	2622	8.92	25	13	11	1	1	17	7	2	1	5	1	1	1
	MONROE	77.4	644.23	9083	14.10	37	15	20	5	10	25	15	6	5	9	4	13	10
	RICHLAND	75.3	328.72	2945	8.96	27	14	11	3	2	25	6	2	3	22	6	18	2
	ROCK	85.1	592.56	9982	16.85	30	10	15	6	6	12	5	4	0	4	0	8	1
	SAUK	83.5	591.55	13814	23.35	33	17	16	3	4	17	5	2	0	9	0	11	23
	VERNON	76.5	450.00	3137	6.97	35	21	10	5	2	15	6	3	9	8	0	4	7
Region Average		76.1	570.99	10579	16.11	31	14	15	4	4	22	9	6	3	7	1	12	7

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2008-2009

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting Snow	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
Statewide Averages		--	466	7916	15.11	36.4	15.8	19.2	4.7	4.9	23.3	9.6	6.7	2.3	9.3	2.5	12.8	5.2

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3 Snow and Ice Control

In this section...

Wisconsin county highway departments use an array of strategies to combat winter storms. Materials, equipment and labor are three key pieces of the puzzle; county patrol superintendents use their considerable skills and experience to combine these pieces in the most efficient way possible for each storm.

This section describes the counties' response to the 2008-2009 winter season, including materials use, best practices in equipment and technology, and training efforts. Many counties have added prewetting and anti-icing to their arsenal of best practices—strategies that help them use materials efficiently, save money and minimize environmental impacts.

Statewide Materials Use

	2008-2009
Total salt used[1]	569,985 tons
Total salt used per lane mile	17.0 tons
Total cost of salt used[2]	$26,746,802
Average cost per ton of salt	$47.19
Total prewetting agents used[3]	1,321,290 gal.
Counties prewetting salt	66 of 72 (92%)
Total abrasives used	44,179 cubic yards
Counties prewetting abrasives	6 of 65 using sand (9%)
Total anti-icing agents used	500,673 gal.
Counties equipped to use anti-icing	65 of 72 (90%)

1. Salt use data is final data from WisDOT's Salt Inventory Reporting System.
2. Cost data is actual salt costs as billed to WisDOT by the counties.
3. Prewetting, abrasives and anti-icing data are estimates from Winter Storm Reports.

There's More on the Web!

Looking for more information about winter maintenance in Wisconsin? WisDOT's extranet site features detailed reports on products, equipment, best practices and more.

See https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm.

3A. Materials

After decades of use, salt and sand remain the primary materials used in winter maintenance. The advent of prewetting technology has improved the efficiency of materials use, and proactive anti-icing applications have reduced the amount of salt needed to keep roads clear.

Salt

Salt is a critical part of a highway crew's response to winter storms. When salt combines with ice or snow, it creates a brine solution with a lower freezing point than water. This solution then acts to break the bond between the ice or packed snow and the pavement, which allows the snow to be removed more easily through plowing.

Because of cost and environmental concerns, maintenance crews strive to use the smallest amount of salt necessary to provide an appropriate level of service for each roadway. Using anti-icing agents can help reduce overall materials use; see pages 44 to 46 for details on statewide anti-icing use.

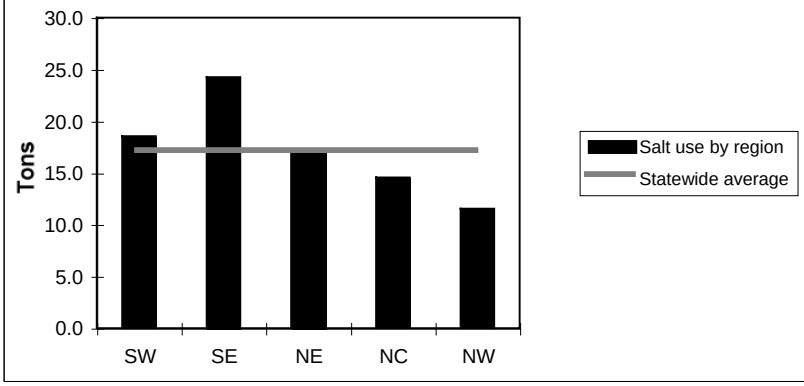
Historically, counties have used more salt during more severe winters; see Figure 2.4 on page 24 for a detailed comparison. This winter was the third-most severe of the last 10 winters, and this winter's statewide Winter Severity Index of 36.2 was 15 percent higher than the previous 10-year average of 31.4.

Though this winter's statewide average severity index was only 3 percent lower than the previous winter, salt use was 12 percent lower, at 569,985 tons. Salt use in 2007-2008 set a state record at 644,485 tons, beating out the previous record of 521,056 tons set in 2000-2001; this winter's salt use was the second highest on record. See Table 1.5 on page 15 for county-by-county salt use data for this winter.

Several factors contributed to this year's salt use total. First, the more urban areas of southern Wisconsin experienced unusually severe weather again this winter. These counties tend to have more lane miles that require 24-hour coverage, so severe weather there has a significant impact on statewide salt use. And like last winter, timing of storms was a factor, with multiple back-to-back events often leading to packed snow that required more salt to remove. Below-normal temperatures across the state again this winter posed challenges as well, since salt works less efficiently in colder temperatures.

Figure 3.1. Salt Used per Lane Mile

From Salt Inventory Reporting System, 2008-2009

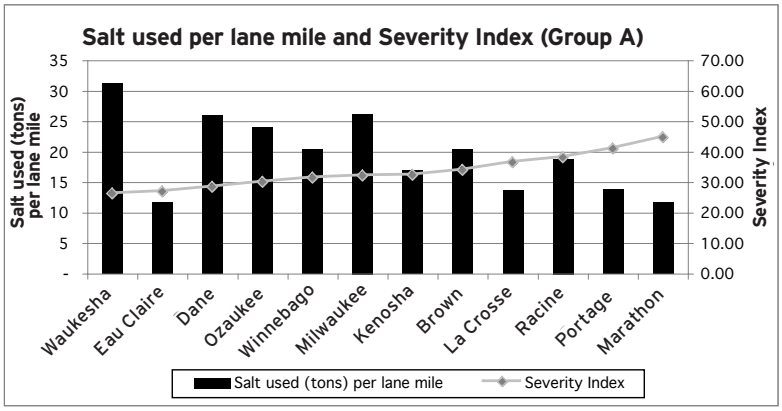


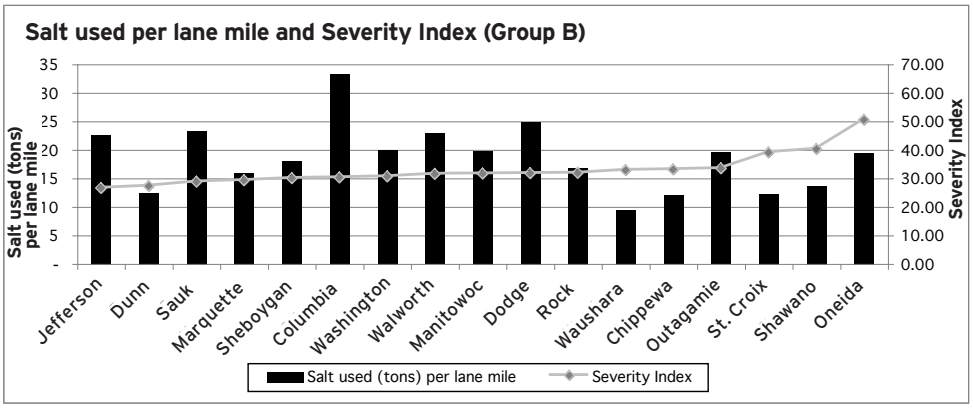
Despite this winter's relative severity, Wisconsin counties applied a statewide average of 17.0 tons of salt per lane mile on state highways, a decrease of 12 percent compared with the 2007-2008 winter but still 22 percent higher than the average of the five previous winters. (See Figure 3.6 on page 57 for a county-by-county comparison.) This year, that rate was higher than the nearby states of Minnesota (7.6 tons per lane mile), Iowa (8.8 tons per lane mile), Illinois (11.4 tons per lane mile), and Indiana (11.9 tons per lane mile), and slightly lower than Michigan (19.2 tons per lane mile). Several factors may contribute to other states' lower rates of salt used per lane mile, including salt shortages that prevented several states from obtaining the quantity of salt that they would normally use. In addition, some states provide a lower level of service that prescribes less salt and more sand use. And winter severity varied from state to state. Data on total salt use (not adjusted for lane miles) for most states is available on page 58 in a map of salt use and costs produced by Washington State DOT.

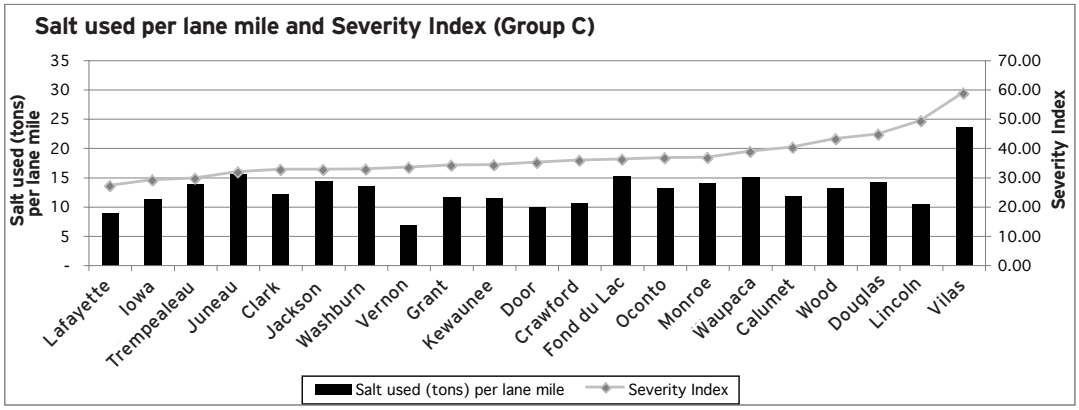
Figure 3.1 shows the regional levels of salt use per lane mile. Counties in the Southeast Region used an average of 24.3 tons of salt per lane mile, which reflects the greater number of highways in these counties receiving 24-hour service.

Figure 3.2. Salt Used per Lane Mile and Severity Index

From Salt Inventory Reporting System, 2008-2009







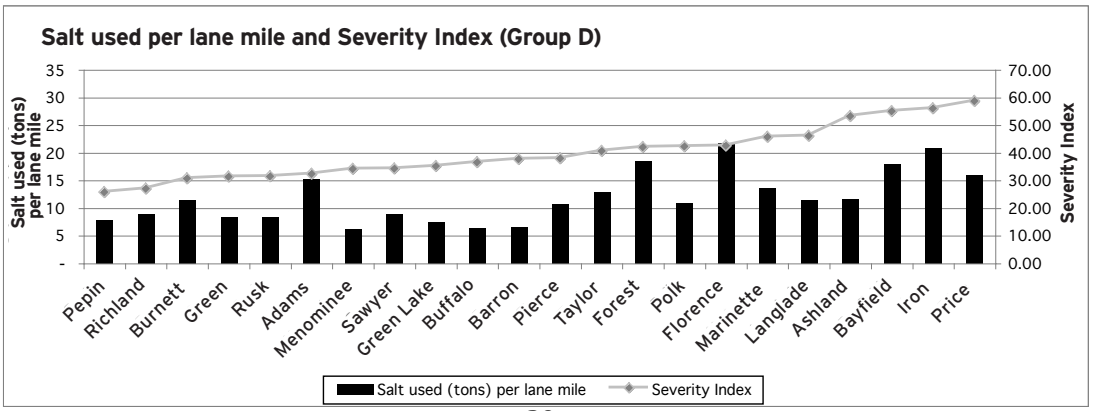


Figure 3.2 on page 39 shows salt use per lane mile in each county, overlaid with severity index to allow a further "apples to apples" comparison of salt use in each county. The counties in Winter Service Groups A and B have more urban highways and tend to use more salt per lane mile for a given level of severity.

For more detail on salt use in previous years, see Table A-9, "History of Salt Use on State Trunk Highways," on page 162 of the Appendix.

Cost of Salt

Salt prices continue to rise, which WisDOT's salt vendors attribute to multiyear supply and demand issues. This winter, WisDOT spent $26,746,802 on salt statewide, purchasing salt at an average of $47.19 per ton.

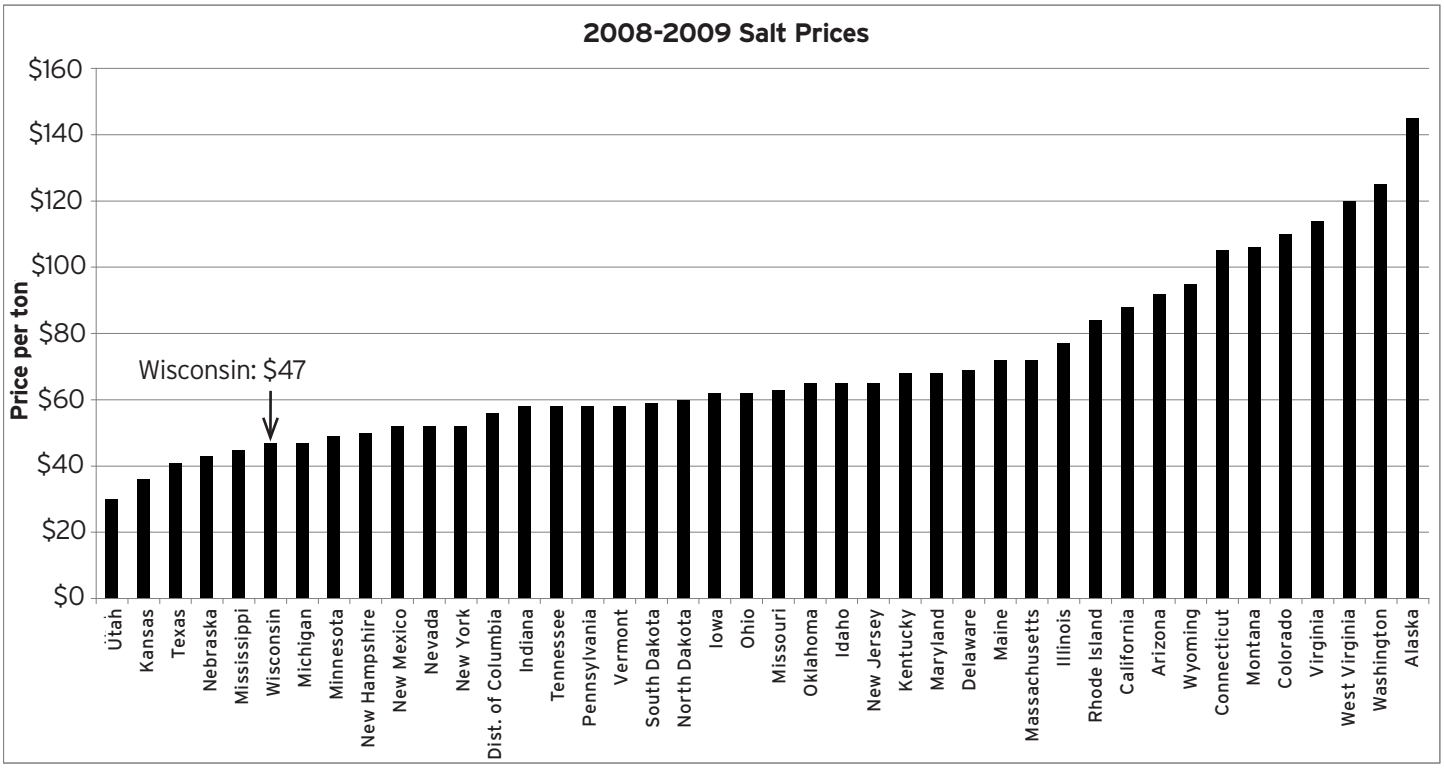
Higher fuel prices have contributed to higher salt transportation costs in recent years: The average of $47.19 per ton is an increase of 13 percent compared with prices paid under last winter's original salt contract, and an increase of 34 percent compared with the average price of $35.22 three winters ago.

Despite this marked increase, WisDOT pays less per ton for salt than most other snowy states across the country, according to data compiled by Washington State DOT: Only five states pay less on average per ton, one state (Michigan) pays about the same, and 35 states pay more. (See Figure 3.3.) WSDOT created a map of per-ton salt costs and average salt use across the country, which we have reproduced on page 58. Per-ton costs for straight rock salt range from $30 in Utah (New Mexico pays from $28 to $75 per ton) to $125 in Washington state (Montana pays from $72 to $139 per ton). Figure 3.4 shows that Wisconsin has historically paid less for salt than other states.

The department speculates that its contracting method may account for some of these cost savings. Wisconsin's contracts include a 100/115 provision, which means that the department guarantees that it will purchase 100 percent of the contracted amount of salt, and the salt vendor must keep an extra 15 percent on reserve. Some other states' contracts include an 80/120 provision that requires the salt vendor to keep 120 percent of the contracted salt amount on reserve, and commits the state to purchasing only 80 percent of the contracted amount. This 40 per-

Figure 3.3. Salt Prices Across the United States

Source: Washington State DOT data



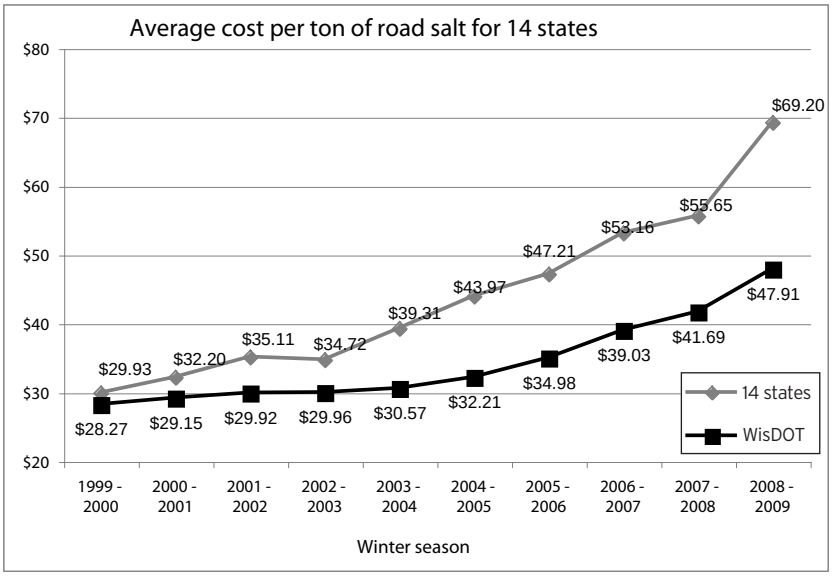
Note: Three states supplied a range of prices rather than an average. For these states, the midpoint of the range was used in this graph.

cent spread could translate to higher costs for states under an 80/120 contract.

Because the department secured enough salt through this winter's contract renewal, WisDOT did not need to purchase salt through supplemental contracts this winter. (In 2007-2008, supplemental salt purchases made up 25 percent of total salt tons purchased, and 37 percent of WisDOT's total salt expenditures. Last winter WisDOT spent an average of $76 per ton for 130,300 tons of additional salt purchased under supplemental contracts totaling about $9.9 million. In some counties, WisDOT paid up to $101 per ton for supplemental salt.)

Figure 3.4. Salt Prices Over Time

Source: Data from 14 states, 1999-2009



Source: Historical data supplied by Illinois, Indiana, Iowa, Maine, Massachusetts, Michigan, Minnesota, Missouri, North Dakota, New York, Ohio, Virginia, Washington and Wisconsin and compiled by Iowa DOT.

The department saw a decline compared with last winter in another expense related to salt shortages: trucking costs. In 2007-2008, counties spent $1.1 million trucking salt from depots and from county to county, while this winter they spent $650,000. This winter two counties were unable to secure supplier bids because of the nationwide salt shortage, which meant salt had to be trucked into these counties from surrounding areas.

For more on costs, see Section 4 on page 76.

A Note About Materials Data

This winter marks the second year that all salt data in this report comes from WisDOT's Salt Inventory Reporting System (SIRS). In previous years, some tables used preliminary salt use data collected in the weekly winter storm reports. Sand use data continues to come from the storm reports, as does some detailed anti-icing and prewetting data. These materials use estimates are included in this report because they provide a level of detail and of correlation with storm events that is not available from SIRS or from final financial data. The source of each table's data is indicated below the table title.

Abrasives

County highway departments sometimes use sand and other abrasives to improve vehicles' traction on icy or snowy roads when temperatures are too low for salt to be effective. Abrasives are somewhat effective in low-speed trouble spots and intersections. Abrasives should be prewetted with a liquid agent for better adherence to the roadway.

A total of 44,179 cubic yards of sand was used by 65 counties on state highways this winter, a decrease of 45 percent compared with last year's record-setting 80,133 cubic yards, but still 165 percent higher than the average of the five previous winters. Unlike last year, when record sand use was due in large part to the salt shortages in the southern counties, this year's higher-

Table 3.1. Statewide Sand Use

From storm reports data, 1997-2009

Year	Sand used (cubic yards)
2008-2009	44,179[1]
2007-2008	80,133[1]
2006-2007	13,636
2005-2006	15,997
2004-2005	15,843
2003-2004	17,959
2002-2003	19,864
2001-2002	18,154
2000-2001	67,108[1]
1999-2000	17,677
1998-1999	35,709
1997-1998	15,254

1. Higher than normal sand use on the state system during the winters of 2007-2008 and 2000-2001 was caused by greater use of salt/sand mixes due to the low supply of salt toward the end of the winter. In 2008-2009, the higher total reflects counties' use of leftover sand from the previous winter.

than-usual total was due to the salt-sand mixes in storage left over from last year that some Wisconsin counties had to use up.

With the last two winters as the exception, use of abrasives has been declining in recent years (see Table 3.1), which is a positive trend and a goal for the department—the disadvantages of abrasives use include potential environmental impacts such as clogged storm drains, siltation of streams and lakes, and air pollution. Abrasives are also very expensive when sweeping and cleanup costs are considered. This year, counties in the southwest corner of the state, which tend to have more hilly terrain and lower-volume roads, used 49 percent of the statewide total, or 21,597 cubic yards. The Northwest Region contributed 28 percent of the total, the North Central Region used 18 percent, the Northeast Region used 3 percent, and the Southeast Region used 1 percent. Last year, the Southwest Region used 76 percent of the statewide total.

The Bureau of Highway Operations commissioned a synthesis report, "Limitations of the Use of Abrasives in Winter Maintenance Operations" (see page 59), to substantiate WisDOT's guidance to Wisconsin counties on reducing sand use. The report cites factors recommending against the use of sand that have been supported by research, and offers the following general conclusions:

- Sand exhibits limited effectiveness at higher vehicle speeds, especially when it has not been prewetted. Mixing sand with salt to keep it from freezing also limits sand's effectiveness.
- Sand remains in the environment after its application, resulting in negative impacts on land, water and health.
- Sand used in a salt-abrasive mixture does not contribute to accident reductions.
- Salt is more cost-effective than sand in winter maintenance operations.

Table 3.1 on page 41 compares this winter's statewide sand use with previous years'. Refer to Table A-8 on page 156 of the Appendix for county-by-county sand use data for this winter.

BEST PRACTICES: Prewetting

WisDOT encourages counties to prewet both salt and sand before applying it to the roadway. Agencies across the country and worldwide consider prewetting a best practice, and some require that all material be prewetted before it is placed. Studies have shown that prewetting significantly improves the amount of material that stays on the road.

Dane County is taking prewetting to the next level as it tests a salt slurry generator from Monroe Equipment that first grinds salt into fine particles and then mixes it with liquid deicer to create a slurry. This mixture is then dispensed onto the roadway by a spinner disc. The slurry reportedly begins melting ice faster than standard prewetted salt, and more material stays on the road. This allows operators to reduce the amount of material used—saving time and money and reducing environmental impacts.

For more information on prewetting, see Chapter 35 of the State Highway Maintenance Manual.

A salt slurry generator mounted on a salt truck

The billed cost of sand varies greatly across the state, depending on the local availability of the sand and transportation costs. In 2002-2003, the last year for which data is available, most counties paid about $10.00 to $16.00 per cubic yard, with a statewide range of $3.50 to $34.00 per cubic yard.

For more information on using and storing abrasives, see Chapter 35 of the State Highway Maintenance Manual. A Wisconsin Transportation Bulletin on salt and sand use is also available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/best-practices/pdf/iie6.pdf.

Prewetting

Prewetting salt and sand with liquid deicing agents before or during their application to the pavement has several advantages. When used with salt, prewetting reduces loss of salt from bouncing and traffic action, which reduces the amount of material needed. Prewetting also improves salt penetration into ice and snow pack, and begins dissolving the salt, which allows it to work more quickly. When used with abrasives, prewetting helps keep the sand on the pavement and may allow crews to use higher truck spreading speeds.

WisDOT encourages all county highway departments to prewet their salt and sand, and to explore stocking more than one deicing agent so that different agents can be used as conditions warrant. For example, salt brine can be reasonably used at temperatures down to about 15°F, whereas agents such as magnesium chloride and calcium chloride are effective at lower temperatures, to about 0°F. See Table 3.2 for details on statewide prewetting agent use.

At about 14 cents per gallon for material and production costs, salt brine is a relatively inexpensive choice for prewetting (see Table 3.5 on page 46). Salt brine use has increased significantly since counties first tested it a decade ago; 48 counties used salt brine for prewetting this winter (see Table A-6 on page 148 of the Appendix for details). Counties used a record amount of salt brine for prewetting this winter—1,020,102 gallons—despite a 12 percent decrease in the amount of salt used statewide compared with last winter. Overall use of prewetting liquids increased 2 percent compared with last year's total, and salt brine use increased 6 percent.

In addition to salt brine, some counties used calcium chloride, magnesium chloride, or agricultural-based products for prewetting this year. See Table A-7 on page 150 for details.

Although once the only option for prewetting, calcium chloride is a more corrosive chemical than other prewetting liquids, and can damage equipment and be more difficult for operators to handle. WisDOT encourages counties to explore other options for prewetting, such as salt brine. This winter, only 7 counties used exclusively calcium chloride products for prewetting salt.

Several counties have also tested pretreated salt, in which a liquid prewetting agent is spray-applied to the salt supply before the salt is placed in storage. See https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm for details.

While prewetting salt is a common practice in Wisconsin—66 of 72 counties (92 percent) prewetted their salt this winter—prewetting abrasives is far

Table 3.2. Statewide Prewetting Agent Use for Salt

Chemical	Gallons used	Counties using
Salt brine	1,020,102	48
Calcium chloride-based products		
Calcium chloride – solid	144 tons	5
Calcium chloride – liquid	129,498	19
Calcium chloride with rust inhibitor	39,618	5
Magnesium chloride-based products		
Magnesium chloride	11,784	6
Freeze Guard	2,670	1
Agricultural-based products		
Ice Ban-M50	8,315	1
Ice Ban-M80	5,299	2
Ice Ban-MC90	2,805	2
Ice Ban-MC95	75,450	13
GeoMelt	25,749	3
Total	**1,321,290 gallons of liquid; 144 tons solid CaCl**	**66**

less common. Of the 65 counties that used sand this winter, only 6 counties prewetted it (see Table A-8 on page 156 for details). WisDOT strongly encourages counties to prewet their sand, since keeping sand on the pavement can reduce the amount of material used, which saves money and reduces environmental impacts.

Anti-icing

Anti-icing is a proactive snow and ice control strategy that involves applying a small amount of liquid deicing agent to pavements and bridge decks before a storm to prevent snow and ice from bonding with the surface. It is often used prior to light snowfall or freezing drizzle, and is also effective at preventing frost from forming on bridge decks and pavements.

Anti-icing can reduce salt use, reduce materials costs, and improve safety. The benefits of anti-icing include:

- Less chemicals are required to prevent ice bonding than to remove ice after it has bonded to the pavement.
- Clean-up after a storm may be easier with less ice bonded to pavement.
- Application can be made during regular working hours, reducing some overtime costs.
- Anti-icing applications may last for several days, particularly in preventing frost on bridge decks.
- Better pavement conditions (improved friction) can be achieved, reducing the number of crashes.

This winter, counties used a record 500,673 gallons of anti-icing liquid (see Table A-4 on page 140 for details). Currently, 65 of 72 counties (90 percent) are equipped to perform anti-icing operations, and this winter 54 counties made at least one anti-icing application. (Counties may choose not to anti-ice if weather conditions do not warrant it.) On the whole, anti-icing use has steadily increased in Wisconsin since the technology became part of winter operations in the state in 1999. Use of anti-icing materials was up around 50 percent over last year, even though back-to-back storms limited anti-operations this year. Salt brine, the most commonly used anti-icing agent, has limited effectiveness at temperatures below 15ºF. Some counties are mixing agents such as magnesium chloride with salt brine to lower the working temperature of the salt brine.

Accurate weather forecast information is critical to the success of anti-icing—if a forecasted storm does not arrive, resources may be wasted; if a storm hits sooner than expected, the opportunity for anti-icing may be lost. Through

BEST PRACTICES: Anti-icing

Anti-icing is a best practice not only nationwide, but across the globe. Agencies are finding that this technique, once reserved for bridge decks and trouble spots, yields excellent results on highways as well. More agencies are turning to anti-icing to help them use labor and materials efficiently, especially as salt prices continue to rise.

This winter, Wisconsin counties used 500,673 gallons of anti-icing liquid—the most on record and an increase of 51 percent over last winter's total. Yet at 0.5 percent of total winter expenditures, anti-icing continues to represent a small fraction of winter costs.

For more information on anti-icing, see WisDOT's Winter Information Web page at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/index.shtm (click "Best Practices," then "Anti-icing").

Table 3.3. Cost of Anti-icing vs. Deicing

Winter Service Group	Average cost of anti-icing treatment for possible frost				Average cost of deicing treatment for frost event				Counties reporting anti-icing costs
	2005-2006	2006-2007	2007-2008	**2008-2009**	2005-2006	2006-2007	2007-2008	**2008-2009**	**2008-2009**
A	$800	$2,765	$1,437	**$892**	$5,348	$3,919	$2,804	**$5,220**	3
B	$1,028	$838	$760	**$818**	$3,329	$3,517	$5,817	**$3,151**	1
C	$791	$820	$725	**$961**	$1,934	$1,485	$3,157	**$1,669**	6
D	$803	$610	$566	**$629**	$1,254	$1,842	$2,081	**$1,377**	8

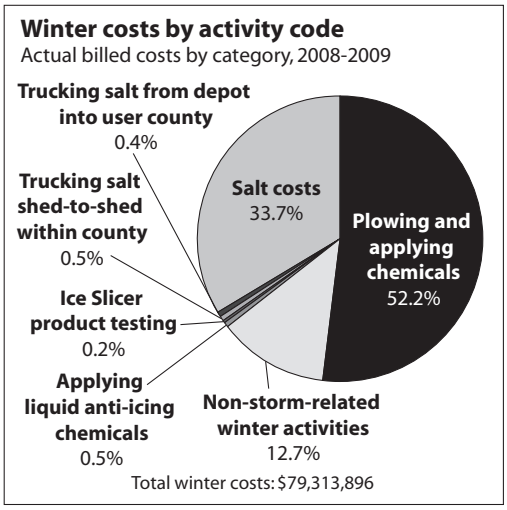
Wisconsin's Road Weather Information System, counties have access to detailed weather information, including the Meridian weather forecast system, and 58 weather and pavement sensors across the state. See page 46 for more information on RWIS.

Anti-icing Costs

In Wisconsin, proactive anti-icing applications for possible frost events are about three times less costly than reactive deicing operations for actual frost events. Table 3.3 compares the two strategies based on storm reports data. Costs vary from year to year in part because of variations in the number of counties reporting this data and the number of events represented.

At $370,357, anti-icing costs made up only 0.5 percent of total winter maintenance costs this winter (see Figure 3.5). This percentage has remained fairly steady over the years—always less than 1 percent of total statewide winter costs. Investing in anti-icing is a cost-effective way to reduce overall materials use.

Figure 3.5. Anti-icing as a Percentage of Winter Costs



Note: Total cost data differs slightly from cost data elsewhere in this report due to rounding.

Anti-icing Agents

As with prewetting, the use of salt brine for anti-icing operations has increased significantly since its introduction a decade ago, including an 85 percent increase between the 2004-2005 and 2006-2007 winter seasons. This winter, 45 of 72 counties (63 percent) used a total of 467,943 gallons of salt brine for anti-icing. This is a 53 percent increase compared with last winter, with the highest increase coming in the Southeast Region, which performed less anti-icing than usual in 2007-2008. See Table A-6 on page 148 of the Appendix for county-by-county data on salt brine use.

WisDOT encourages counties to explore stocking more than one agent for prewetting and anti-icing, so that a choice of agents is available for use according to pavement temperature and weather conditions. Table 3.4 shows the agents used for anti-icing in Wisconsin this winter; see Table A-4 on page 140 of the Appendix for county-by-county anti-icing data.

Table 3.4. Statewide Anti-icing Agent Use

Chemical	Gallons used	Counties using
Salt brine	467,943	45
Calcium chloride – liquid	2,690	4
Calcium chloride with rust inhibitor	400	1
Magnesium chloride	1,580	5
Freeze Guard	275	1
Ice Ban-M80	3,590	1
Ice Ban-MC95	17,345	7
GeoMelt	6,850	1
Total	**500,673**	

Table 3.5. Cost of Prewetting and Anti-icing Agents

Chemical	Average (per gallon)	Range (per gallon)
Salt brine	$0.14	$0.05 - $0.40 (47 counties)
Calcium chloride	$0.75	$0.45 - $1.22 (11 counties)
Calcium chloride with rust inhibitor	$0.76	$0.76 (1 county)
Magnesium chloride	$0.99	$0.64 - $1.29 (7 counties)
Ice Ban MC-95	$1.16	$0.75 - $1.32 (11 counties)
Ice Ban M-50	$1.51	$1.51 (1 county)
GeoMelt	$2.14	$1.90 - $2.26 (3 counties)

Cost of Deicing Agents

The cost of agents used for prewetting and anti-icing varies. Salt brine can be produced relatively cheaply (about $0.14 per gallon) at the county yard using salt brine production units purchased by WisDOT. Many counties have their own salt brine production units; others purchase salt brine from neighboring counties. Other agents tend to be more expensive, but may be useful at lower temperatures.

The average billed cost of selected agents this winter is detailed in Table 3.5. The unit cost of all products varies among counties based on the amount of material ordered and transportation costs.

3B. Equipment and Technology

As winter maintenance technology and practices evolve, the counties are continually expanding their arsenal of snow and ice control strategies. Some of the counties' snowplows are equipped with underbody plows, which can be used in place of the front plow for removing lighter snowfalls of up to 4 inches. A portion of the counties' salt spreaders are equipped with ground speed controllers, and some have on-board prewetting units. In recent years, Road Weather Information Systems have become an increasingly important part of counties' efforts.

Road Weather Information Systems

WisDOT has had a Road Weather Information System in place since 1986, and continues to expand and enhance the information available through this system. Designed to provide maintenance crews with the most accurate information about current and future weather conditions, WisDOT's RWIS system includes:

- 58 weather and pavement condition sensors along state highways.
- Detailed weather forecasts from Meridian forecast service.
- A winter storm warning service for county highway departments.
- Over 500 mobile infrared pavement temperature sensors on patrol trucks around the state.

WisDOT contracts with an RWIS consultant to manage its RWIS program. This on-site consultant serves as WisDOT's staff meteorologist and RWIS program manager, and provides ongoing technical and administrative support for the state's RWIS systems.

A roadside weather sensor.

Major activities in WisDOT's RWIS program this year included:

- Coordinating with Meridian on forecast services.
- Performing an annual weather forecast verification study, and monitoring comments from counties using the service.
- Providing RWIS training for regional operations staff and county highway departments.
- Overseeing maintenance and repair of the department's RWIS equipment.

In addition, the RWIS program manager works to coordinate WisDOT's RWIS activities within Wisconsin and with other state and national agencies, including:

- Coordinating activities with the National Weather Service.
- Participating in the Aurora research program (see page 50), and in multistate RWIS user group projects.
- Participating in national RWIS initiatives, including MDSS and Clarus (see page 51).
- Serving on WisDOT's 511 System Planning Committee.
- Providing RWIS presentations to WisDOT groups and agencies outside WisDOT.

Other ongoing services provided by the RWIS program manager include:

- Managing contracts for weather forecast and winter storm warning services, and for system maintenance.
- Coordinating use of Winter Severity Index data as an accurate tool to measure the relative severity of winter seasons.
- Establishing a plan for replacement of aging infrastructure, such as roadside towers and television monitors at rest areas.
- Ongoing assessment of new RWIS technology.
- Maintenance of traveler weather information systems at rest areas and the Kenosha weigh station.
- Supporting counties' use of vehicle-mounted infrared pavement temperature sensors.
- RWIS program management (budgeting, billing, planning, etc.).

BEST PRACTICES: Ground speed controllers

Ground speed controllers have been shown to reduce salt use by controlling the amount of salt spread according to the speed of the truck. These controllers can also provide accurate data on salt use.

In addition to reducing costs, controlling salt application can help limit the amount of chlorides that get into the environment, minimizing the degradation of plant species and water quality near roadways.

WisDOT has set a deadline of November 1, 2010, for all trucks on state winter maintenance patrol sections to be equipped with ground speed controllers. See Guideline 36.25 in the Winter Maintenance Manual for more information. WisDOT is working with the Machinery Management Committee to redefine reimbursement rates for spreaders without ground speed control.

Weather Forecast Service Use and Satisfaction

The weekly winter storm reports ask the counties to report whether they used the Meridian forecast service, and ask them to rate the quality of the forecast if they did use it. The Meridian forecast was used in 84 percent of winter storm events this year, a slight drop from the previous winter. Regionally, the usage rate varied from a high of 94 percent in the Northeast Region to a low of 77 percent in the Southwest Region. The Northeast Region rated the service the highest (2.55 on a scale of 1 to 3), while the Southeast Region rated it lowest at 2.19. The statewide average was 2.31, on par with last year's 2.37. For more details on the evaluation of the Meridian forecast service, see a summary report on page 123 of the Appendix, or view the full report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm. For more detail on the use of the service, see Table A-2 on page 128 of the Appendix.

For more information on RWIS activities in Wisconsin, see the program's annual report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm.

Equipment Calibration

Ensuring correct calibration of winter operations equipment—including salt spreaders, anti-icing applicators, and prewetting application equipment—is a key step in providing precise, consistent materials application, which reduces waste and saves money. Winter vehicles should be calibrated prior to the start of the season and whenever equipment is repaired. WisDOT regional staff are tasked with working with the counties to ensure proper calibration.

Product and Equipment Testing

Winter maintenance is a continuously evolving field—new technology and innovations are developed each year. In previous years, WisDOT managed test and evaluation projects of the most promising new equipment by the counties, these test results are available on the WisDOT extranet.

WisDOT encourages county highway departments to consider new technologies when purchasing equipment. Testing new products—both equipment and materials—can lead to improved processes and more efficient operations. BHO staff are available to assist counties in structuring a testing and evaluation program for any products they wish to test.

Recent product and equipment evaluation projects have included:

Alternative anti-icing and deicing materials

- Pretreated salt, where a liquid prewetting agent is spray-applied to the salt supply before the salt is placed in storage, exhibited good results in county tests.
- Counties reported that prewetting salt with a mixture of salt brine and GeoMelt has been effective as an anti-icing agent.

Winter maintenance technology and equipment

- Counties tested bridge deck anti-icing technologies that automate treatment during storm events and winter concept vehicles that included the latest in winter maintenance equipment and technology.
- Rubber-coated snowplow blades, end loader bucket scales and a variety of salt spreaders are among the winter maintenance equipment options evaluated.
- Past test projects that have become operational include mobile pavement temperature sensors and salt brine production units.

More information on many test projects is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm (scroll to the "Winter maintenance research reports" heading).

County Highway Department Innovations

The staffs of county highway departments continually encounter challenges as they perform winter maintenance work, and when they can't find a product that solves their problem, they devise their own solutions. A sampling of recent innovative solutions developed or purchased by Wisconsin's county highway departments is available from WisDOT on request. One county submitted an innovative solution for the 2008-2009 winter:

Polk County: Salt brine derived from cheese production

This winter, Polk County tested an innovative new source of salt brine: liquid from a nearby cheese-making factory. This use of material that would otherwise be discarded represented a win-win situation for the county, which had not been using salt brine for prewetting, and for F&A Dairy of Dresser, Wis., which supplied the brine.

The dairy filtered the liquid before hauling to remove whey solids, and Polk County obtained a conditional use permit from the Wisconsin Department of Natural Resources to use the brine on highways. Polk County tested the salt brine in several locations against control sections where salt and sand were not prewetted.

The county also tested the salt brine mixed with magnesium chloride, but found that this caused whey solids in the brine to clump and clog the equipment.

Polk County's testing showed that the salt brine was effective in reducing materials use by 30 to 40 percent, and that it reduced melting time and helped the salt adhere to the roadway. The salt brine cost 8 to 9 cents per gallon if Polk County transported the brine themselves. The roadways showed no sign of salt brine residue in the spring following the testing.

CTH D 2-12-09 400lbs per lane mile with 30% salt sand with Salt Brine

CTH E 2-12-09 600lbs per lane mile with 30% salt sand with out Salt Brine

The full report of Polk County's testing is available from WisDOT on request. For more information, contact Emil "Moe" Norby, Technical Support Manager, Polk County Highway Department, (715) 485-8732.

Winter Maintenance Research

In an effort to stay informed of the latest methods, equipment and materials, WisDOT joins other state DOTs in funding research projects of common interest. These pooled fund projects allow WisDOT to leverage its research dollars to support projects at a higher funding level that are important to all research partners. WisDOT participates in these three pooled fund projects:

• **Clear Roads.** Wisconsin is the lead state in this pooled fund project, which focuses on rigorous testing of winter maintenance materials, equipment and methods for use by highway maintenance crews. Launched in 2004, Clear Roads now has 17 member states and has initiated 10 research projects.

CLEAR ROADS
research for winter highway maintenance

Clear Roads research addresses topics that may be of interest to Wisconsin counties and WisDOT regional staff. See the Clear Roads Web site (http://www.clearroads.org) for:

• A final report and two-page research brief on a project that evaluated the **calibration accuracy of manual and ground-speed-control spreaders.** The report provides guidelines to help snowplow operators establish

and maintain accurate calibration of ground speed controllers. The project also included the development of a Calibration Guide for use in the field. See http://www.clearroads.org/research-projects/05-02calibration.html.

• Updates on projects that are nearing completion, such as:

  • **Development of Standardized Test Procedures for Evaluating Deicing Chemicals**
  Expected results: Standard tests that will help simplify the deicer evaluation process for state DOTs.

  • **Determining Effectiveness of Deicing Materials and Procedures**
  Expected results: A portable test method for determining the effectiveness of deicers that could be used by any interested state in a variety of locations under a variety of winter conditions.

  • **Development of Standardized Test Procedures for Carbide Insert Snowplow Blade Wear**
  Expected results: Testing procedures that could be used by an independent testing laboratory to determine life expectancy of any carbide insert snowplow blade.

  • **Development of Interface Specifications for Mobile Data Platforms on DOT Vehicles**
  Expected results: Communication and data format specifications that would support a "plug and play" approach to integrating sensors and other devices with mobile data platforms used by state DOTs.

• **Transportation Synthesis Reports** that compile research and best practices on topics including:

  • Limitations of abrasives
  • Post-storm meetings
  • Recording material use
  • Training winter operations supervisors
  • Material spreader use

These reports are available for download at http://www.clearroads.org/synthesis-reports.html.

• An **e-newsletter** of winter maintenance news items, publications and research in progress. Read the newsletter online at http://www.clearroads.org/winter-maintenance-news.html.

Clear Roads also initiated a **national multimedia winter safety campaign** designed to educate drivers about the importance of driving safely in winter conditions. The Clear Roads Web site houses sample campaign materials, photos and videos with the "Ice and Snow... Take It Slow" slogan developed for the campaign. WisDOT used the campaign this winter, both on its Web site and as part of its public service announcements.

• **Aurora.** Aurora is an international pooled fund partnership of public agencies that work together to perform joint research on road weather information systems (RWIS). Its membership includes 12 state DOTs and two international agencies. WisDOT became a member of Aurora in 1997. The department did not fund participation in this project in FY 2009, but WisDOT will resume membership in FY 2010.

The Aurora program performs research in many RWIS-related areas, some of which have applications in Wisconsin. This year WisDOT continued as the project champion for a study of the new Vaisala Spectro pavement sensor, which identifies and distinguishes between water, snow, ice, slush and frost on roadway surfaces. The sensor helps maintenance crews identify current driving conditions, and provides pavement information to initiate automatic deicer spraying equipment. This study,

performed by the Ontario Ministry of Transport and the University of North Dakota under WisDOT's guidance, has been completed and final reports are available.

See http://www.aurora-program.org/ for more information about this pooled fund project.

• **SICOP.** The Snow and Ice Pooled Fund Cooperative Program sponsors testing of new winter maintenance technologies that are developed in the U.S. and internationally. SICOP was developed by AASHTO and is overseen by AASHTO's Winter Maintenance Technical Service Program. WisDOT has been involved in several SICOP programs, including:

- Developing and implementing a computer-based training program on anti-icing practices and RWIS systems for snowplow drivers, managers and operators.
- Participating in a survey about the use of automatic vehicle location systems and GPS technology in winter maintenance.
- Participating in a survey about the use of Fixed Anti-icing Spray System Technology (FAST).
- Contributing to the Snow and Ice Listserv, a community of hundreds of winter maintenance professionals. The listserv provides a forum for discussing a wide range of winter maintenance issues.
- Assisting in planning for the 2009 National Winter Maintenance Peer Exchange, which was hosted by WisDOT in August 2009.

See http://www.sicop.net/ for more information about this pooled fund project.

In addition, WisDOT participates in the following partnership initiatives:

• **Maintenance Decision Support System.** The objective of this FHWA project is to produce a prototype tool for decision support to winter road maintenance managers. The concept is to use small-scale computer model weather forecasts combined with rules of practice for winter maintenance to generate treatment recommendations throughout storm events.

WisDOT joined the MDSS pooled fund project in September 2009, and the department has committed to implementing MDSS statewide in FY 2011. In FY 2010, WisDOT will take advantage of Dane County's countywide implementation of AVL/GPS by adding the MDSS component to the system and evaluating its performance. MDSS will also be paired with AVL/GPS along the Interstate corridor between the Illinois state line in Rock County and Hudson, Wis., and from Madison to Milwaukee. WisDOT will also introduce MDSS statewide in FY 2010 via the Meridian forecasting service.

See http://www.rap.ucar.edu/projects/rdwx_mdss/ for more information.

• **Clarus.** A joint effort of FHWA and the National Weather Service, this initiative aims to consolidate all road weather data into a national database. A WisDOT representative attended the annual project meeting in Charlotte, N.C., in September 2009. WisDOT continues to participate through its membership in the North/West Passage pooled fund, one of three teams that submitted a concept of operations detailing how the Clarus output would be used. Clarus has reached the regional demonstration phase, with teams of contractors and states being chosen to implement the previously developed concepts of operations. Due to limitations placed on the proposing teams by FHWA, WisDOT is not participating in the demonstrations, but staff are closely monitoring the demonstration project related to spring weight restrictions.

See http://www.clarusinitiative.org/ for more information.

National Winter Maintenance Peer Exchange

WisDOT hosted the second National Winter Maintenance Peer Exchange August 24 to 26, 2009, in Madison. Dedicated to information sharing and research coordination among winter maintenance professionals, the conference was organized collaboratively by groups including Clear Roads, Aurora, SICOP, FHWA and the Pacific Northwest Snowfighters and was attended by staff from more than 35 agencies and organizations. Attendees at the first peer exchange, held in 2007, identified 70 winter maintenance research needs statements, and this year's peer exchange built on these and developed an additional 27 problem statements. These research needs are being considered for inclusion in upcoming work programs of national research groups.

Peer exchange attendees ranked the 27 research needs statements according to the highest-priority areas. The top 10 topics were:

1. Develop Level of Service–based application guidelines for anti-icing and deicing, and develop salt prewetting guidelines for specific surface conditions.
2. Develop a searchable knowledge site such as a wiki that indexes training material, reports, computer-based training content, etc.
3. Develop best management practices for reducing corrosion on maintenance equipment (electrical and mechanical).
4. Initiate a comprehensive comparative study on blade types, inserts and fasteners, with recommendations based on pavement types.
5. Determine the true costs of snow and ice control operations.
6. Develop a guide for an outreach program for benefits of a proactive snow and ice control program using anti-icing and prewetting.
7. Develop mobile weather data collection guidelines.
8. Enhance computer-based training for anti-icing/Road Weather Information Systems to make the training more network- or Web-friendly for ease of distribution and tracking.
9. Study MDSS implementation costs; determine up-front costs vs. long-term benefits.
10. Develop best management practices for salt shed construction, siting and leachate management.

3C. Labor

Over 1,500 employees of Wisconsin's county highway departments are licensed to operate a snowplow, and over 700 of them are permanently assigned to the state highway system. Because a snowstorm can hit at any time of day, snowplow operators frequently put in overtime, and may plow for extended periods during heavy snowfall.

Labor costs vary from county to county according to each area's union contracts, which also define when overtime hours can be charged. This winter, counties spent $22.7 million on labor, for an average of $676 per lane mile. Per-lane-mile labor expenditures decreased 9 percent compared with last year's record-setting winter. An average of 29 percent of counties' winter maintenance costs were spent on labor, with a high of 38 percent in the Southeast Region, where hourly labor rates tend to be higher. Labor hours were down 17 percent for regular hours and 12 percent for overtime hours compared with last winter, a significant reduction in light of this winter's relatively small decline in overall severity index. See Table 4.10 on page 92 for county-by-county labor expenditures, and see Table 3.6 on page 64 for county-by-county estimated labor hours and costs from the winter storm reports.

Winter Operations Training

Before each winter season, BHO provides and supports a variety of training efforts for WisDOT regional staff and county highway departments. Recent efforts have included:

- **AASHTO Computer-Based Training.** AASHTO offers seven computer-based training courses that can be completed by winter maintenance staff at their own pace as schedules permit. Course topics include anti-icing/RWIS, mitigating environmental impacts, equipment maintenance, plowing techniques, deicing, mitigating blowing snow, and winter maintenance management. Counties are encouraged to have their operators complete the appropriate training courses, including courses for supervisors. For more information, see http://www.transportation.org/sites/sicop/docs/CBT_Handout.pdf.

- **RWIS Training.** WisDOT's RWIS program manager provides training for both WisDOT regional operations staff and county highway departments. A summary of these training activities can be found in the RWIS Annual Report, available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm.

- **Regional Operations/County Fall Training Sessions.** These sessions are held in all regions in preparation for the upcoming winter season, at some locations in conjunction with Snowfighters' Roadeos. WisDOT provided support and participated in some of these training sessions.

- **Snowfighters' Roadeos.** These events are held by some counties annually, with some roadeos held jointly by two or three counties. WisDOT prepared a Roadeo Manual in August 1997 to assist counties in organizing these roadeos (see https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/best-practices/pdf/vib1.pdf). In addition, organizations such as the Wisconsin chapter of the American Public Works Association and the Wisconsin County Highways Association periodically host statewide Snowfighters' Roadeos.

Past training efforts have included:

- **Winter Operations Workshops.** Facilitated by BHO staff, these interactive one-day workshops for WisDOT regional staff and county highway department patrol superintendents covered winter maintenance topics such as use of RWIS and weather forecast programs, anti-icing, living snow fences, and winter maintenance guidelines. The workshops were first held in October 2004 and held again at five locations in October 2005.

- **Division of State Patrol Winter Maintenance Training Sessions.** Presented by BHO, this training was last held in November 2007 with the new DSP trooper recruit class. As a follow-up to these sessions, local meetings of WisDOT regional operations staff, county highway departments and WisDOT regional state patrol staffs were held prior to the winter season.

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County-by-County Tables and Figures for Section 3: Snow and Ice Control

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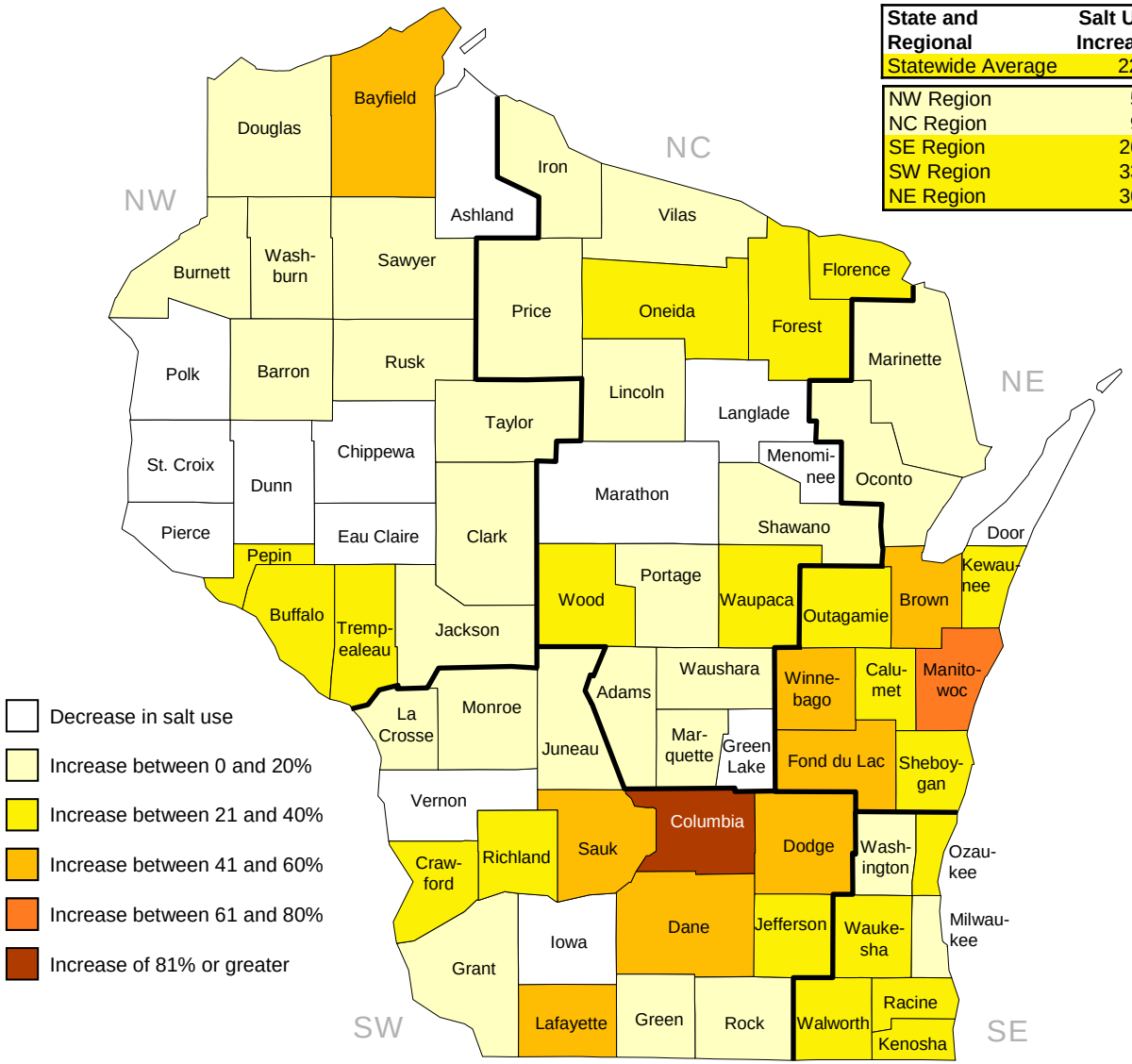
Figure 3.6. 2008-2009 Salt Use per Lane Mile vs. 5-Year Average

County	Salt Use Increase
Menominee	-67%
Vernon	-27%
Langlade	-25%
Chippewa	-8%
Polk	-8%
Pierce	-7%
Eau Claire	-7%
Dunn	-6%
Marathon	-5%
Door	-5%
Green Lake	-4%
Iowa	-4%
Ashland	-2%
St. Croix	-1%
Rusk	2%
Taylor	2%
Adams	3%
Grant	3%
Portage	5%
Marinette	5%
Iron	6%
Green	6%
Lincoln	6%
Sawyer	8%
Waushara	8%
Jackson	8%
Clark	9%
Burnett	10%
Juneau	10%
Barron	12%
Rock	12%
Price	12%
Marquette	14%
Washburn	15%
Vilas	15%
Douglas	15%

County	Salt Use Increase
Shawano	15%
Washington	17%
La Crosse	17%
Milwaukee	18%
Oconto	19%
Monroe	20%
Oneida	21%
Pepin	21%
Buffalo	21%
Forest	21%
Jefferson	22%
Wood	23%
Kewaunee	25%
Trempealeau	25%
Waukesha	26%
Walworth	26%
Crawford	27%
Florence	29%
Calumet	30%
Outagamie	33%
Sheboygan	35%
Waupaca	36%
Racine	37%
Ozaukee	37%
Kenosha	37%
Richland	40%
Brown	42%
Dodge	43%
Dane	44%
Sauk	44%
Lafayette	47%
Fond du Lac	50%
Bayfield	50%
Winnebago	51%
Manitowoc	67%
Columbia	84%



State and Regional	Salt Use Increase
Statewide Average	22%
NW Region	5%
NC Region	9%
SE Region	26%
SW Region	33%
NE Region	36%

- Decrease in salt use
- Increase between 0 and 20%
- Increase between 21 and 40%
- Increase between 41 and 60%
- Increase between 61 and 80%
- Increase of 81% or greater

2008-2009 D.O.T SALT PRICE COMPARISON & AVERAGE USAGE

PRODUCTION FACILITIES

SOLAR SALT:
Produced by using the "solar power" of wind and sunlight to evaporate in large open ponds.

EVAPORATED SALT:
Made by boiling saturated brine, under a partial vacuum with steam heat.

MINED SALT:
Mined from below ground.

*Inhibited salts contain a corrosion inhibitor which increases the cost of the product.

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Transportation Synthesis Report
RESEARCH & LIBRARY SERVICES
research@dot.state.wi.us

Limitations of the Use of Abrasives in Winter Maintenance Operations

Prepared for
Bureau of Highway Operations

Prepared by
CTC & Associates LLC
WisDOT Research & Library Unit
December 30, 2008

Transportation Synthesis Reports are brief summaries of currently available information on topics of interest to WisDOT staff throughout the department. Online and print sources for TSRs include NCHRP and other TRB programs, AASHTO, the research and practices of other transportation agencies, and related academic and industry research. Internet hyperlinks in TSRs are active at the time of publication, but changes on the host server can make them obsolete. To request a TSR, e-mail research@dot.state.wi.us or call (608) 261-8198.

Request for Report

In the interest of developing more effective winter maintenance operating procedures, WisDOT's Bureau of Highway Operations is interested in knowing more about the limitations of the use of sand in winter maintenance operations. As the lead state for the Clear Roads winter maintenance pooled fund, WisDOT will share the results of this research with the Clear Roads member states.

Summary

While sand, the most common abrasive used in winter maintenance, cannot melt snow and ice, it does play a role in many winter maintenance programs. According to NCHRP Report 526, *Snow and Ice Control: Guidelines for Materials and Methods*, "the primary function of abrasives is to provide temporary traction (friction) improvement on snow/ice surfaces." Many agencies use sand to maintain safety at hills, curves, intersections and low-volume roads, and on packed snow or ice that is too thick for chemicals to penetrate. We summarize **WisDOT's Current Practice** in the use of abrasives in winter maintenance below.

Sand's use over time has declined due to a variety of **Limiting Factors**, including its **Effectiveness**, **Environmental Impacts**, **Safety Implications** and **Cost**. See below for findings from reports and studies that address the limitations of the use of sand in winter maintenance operations. We conclude with **Recommended Best Practices** for the use of abrasives in winter maintenance programs compiled from two 2001 documents.

WisDOT's Current Practice

Chapter 35 of the State Highway Maintenance Manual provides recommendations for the use of abrasives in winter operations. Sand and other locally available abrasive materials can be used when high winds or storm conditions preclude the use of salt, or when pavement temperatures are too low (10°F or less) for deicing agents to work effectively. When conditions warrant, abrasives may be applied to predetermined low-speed areas such as certain grades, curves, intersections, structures and isolated areas where hazards exist. Abrasives should not be used where vehicle speeds exceed 45 mph. Prewetting of abrasives with a deicing agent is recommended to improve adherence to the roadway. Contact the WisDOT Library at library@dot.state.wi.us for a copy of WisDOT's State Highway Maintenance Manual.

Limiting Factors

Effectiveness

Sand has exhibited limited effectiveness at higher vehicle speeds, especially when it has not been prewetted. Mixing sand with salt to keep it from freezing also limits sand's effectiveness.

- Studies suggest that at highway speeds sand is swept off the road after relatively few vehicle passes (eight to 12) and that friction gains from sanding (when the sand remains on the road) are minimal (Nixon 2001b, page 1).

- Snow- and ice-covered roadways that have been treated with abrasives provide friction values that are far less than "bare" or "wet" pavement (NCHRP, page 25).

- During storm periods when anti-icing operations are successful, abrasive applications provide no consistent or apparent benefit in hard-braking friction, traction or pavement condition (FHWA 1998, page 208 of the PDF).

- Mixing sand with 50 to 100 pounds of salt per cubic yard is necessary to prevent freezing and keep it workable (Wisconsin Transportation Center, page 4).

- A mix of abrasives and chemical will usually be no more effective as an anti-icing treatment during snowstorms than the same amount of chemical placed alone (FHWA 1996b; click on *2.5 Abrasives Use*).

- A 1973 study (Keyser, pages 4-6 of the Word file) indicates that the melting of snow and ice will be delayed by using a mixture of salt and sand.

- In a blend, sand and salt often work against each other. The salt in the mix may blow away as vehicles travel the roadway. If the sand remains on snow, tires can push the sand down into the slush, making it ineffective for improving traction. Also, salt melts less ice when mixed with sand (Wisconsin Transportation Center, page 4).

- Use of salt/abrasives mixes at moderately or much higher application rates than straight chemical does not lead to corresponding improvements in hard-braking friction or pavement conditions. Comparisons of test and control operations using identical salt/abrasives mixes show that more frequent applications at similar rates also do not lead to corresponding improvements in friction or pavement conditions and even indicate that the more frequent applications can lead to slightly worse conditions (FHWA 1998, Section 7.4.1 on page 208 of the PDF).

Environmental Impacts

Studies have shown that sand remains in the environment after its application, resulting in negative impacts on land, water and health.

- An Oregon DOT study in the early 1990s found that 50 to 90 percent of sand applied to pavements remains in the environment after cleanup (FHWA 1996c).

- Up to 70 percent of sand entering Lake Tahoe was shown to be from snow and ice control. Sand was being carried by snowmelt into culverts that drained into the lake (FHWA 1996a).

- Sand creates debris deposits on roadways, mixing with oil, grease and other automotive byproducts. Sand remaining on roadways clogs storm water catch basins and fills streambeds, clouding the water, hurting aquatic animals and leading to an increase in microorganisms. If collected at the end of winter maintenance, sand may have to be disposed of as a hazardous waste. Sand is also ground into a fine dust by traffic, which can trigger respiratory problems like asthma (EPA).

- The use of abrasives can contribute to increased levels of ambient PM_{10}, the very small airborne particulate matter that is inhaled into the lungs and can cause respiratory problems. Researchers found that the use of abrasives increased the rate of road dust re-entrainment. Street sweeping, a practice intended to minimize air quality impacts of roadway abrasives, was found to actually increase the observed emission rate (Gertler, page 5984).

- Uncovered sand piles mixed with salt are susceptible to leaching. One study indicated that 10 inches of precipitation leached out 50 percent of the salt (Walker, page 2).

Safety Implications
Some research has concluded that sand used in a salt-abrasive mixture does not contribute to accident reductions.

- Accident rate reductions on two-lane highways were less with salt-abrasive mixtures than with salt only. Accident rates dropped dramatically after achievement of bare pavement with salt only but more slowly with salt-abrasive mixes. Accident reductions for freeways were much less and took much longer to occur when salt-abrasive mixtures were used, as compared with the use of salt only (Kuemmel and Bari, page 9 of the PDF).

Cost
Research indicates that salt is more cost-effective than sand in winter maintenance operations.

- Abrasives must be used in large quantities and applied frequently, making abrasives more expensive than salt in terms of material and manpower (Salt Institute 2004, page 8).

- When mixed with enough ice control chemical, abrasives will support anti-icing and deicing strategies; however, this is very inefficient and costly, as the abrasives for the most part are "going along for the ride" while the chemical portion of the mix is doing the work (NCHRP, page 14).

- A loaded salt truck, spreading at the rate of 500 pounds per two-lane mile for general storm conditions, can treat a 22.5-mile stretch of roadway, traveling a total of 45 miles. A sand truck requires seven loads, must travel a distance of 187 miles to treat the same section of road, and requires four times more fuel (Salt Institute 1995, page 3).

- Benefit-cost calculations showed that the application of salt-abrasive mixtures did not recover winter maintenance costs on two-lane highways during the 12-hour analysis period. Benefit-cost calculations showed that freeway operations recovered costs in six hours, substantially longer than the 35 minutes with salt only (Kuemmel and Bari, page 11 of the PDF).

- Cost analyses indicate that, where cleanup is performed, the most significant reduction in operational costs will result from the elimination of the use of abrasives as an anti-icing treatment (FHWA 1998, page 208 of the PDF).

- The cost for distributing abrasives on roads is several times higher than those for distribution of salt. Tests carried out on selected road sections in Zurich and Chur, Switzerland, indicate that in a normal winter, the costs for distributing abrasives over a 1-kilometer section are approximately six times higher than those for distributing salt. In a severe winter this factor rose to as high as 10 (Schlup and Ruess, page 49).

- Windshield damage from airborne particulates is 365 percent higher in areas using sand and abrasives instead of salt (Salt Institute 2004, page 9).

Recommended Best Practices

Two 2001 reports published by Wilfrid Nixon provide recommendations for the use of abrasives based on road type. The first report offers general recommendations for the use of dry abrasives (see pages 20-22 of the PDF). The second report expands on those recommendations to consider three different abrasive types: dry abrasives, abrasives prewetted with liquid deicers at the spreader or tailgate, and abrasives applied using a hot method (see pages 44-45). Examples of hot methods include heating abrasives to high temperatures (approximately 180°C) just before application and mixing the abrasives with hot water (about 90°C) as they are placed on the road. Nixon considers the hot application methods experimental, though promising. Nixon's guidelines for abrasive use include:

Rural Roads. Rural roads can see high-speed traffic. For this reason, if electing to apply dry abrasives, limit application to hills and curves on low-speed, low-volume roads. Application of prewetted abrasives on paved roads allows the abrasives to stay on the roadway longer than if the abrasives had been applied dry. Prewetted abrasives can also melt the snowpack and provide for extended increase in road surface friction.

Rural Intersections. Given the low speeds associated with rural intersections, abrasives could be applied dry. However, if the intersection is not gravel, prewetting the abrasive will allow the treatment to remain in place longer.

High-Speed Urban Roads. No benefit is expected when applying dry abrasives to these roads where posted speed limits exceed 30 mph. Application of prewetted abrasives may be appropriate for this road type; hot abrasives may also be considered.

Low-Speed Urban Roads. Limit dry abrasive application to the parts of the road where braking, accelerating or maneuvering is done, and only use this approach when the snowpack is expected to persist. Application of prewetted abrasives will allow the material to remain on the road surface longer. Again, hot application methods may be appropriate.

Urban Intersections. Dry abrasives can be used where the intersection is likely to be snow- or ice-covered for a longer-than-normal period of time. Prewetted abrasives will remain in place longer; hot application methods might also be considered.

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Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group A)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
MARATHON	NC	878.99	44.75	11.76	$413	3998	3649	7647	47.7%	8.70	0.19
PORTAGE	NC	504.28	40.95	13.84	$553	2573	3081	5654	54.5%	11.21	0.27
EAU CLAIRE	NW	559.86	26.87	11.75	$363	2056	2302	4358	52.8%	7.78	0.29
LA CROSSE	SW	480.28	36.54	13.73	$515	2996	2191	5187	42.2%	10.80	0.30
RACINE	SE	676.84	38.16	18.87	$836	3213	5505	8718	63.1%	12.88	0.34
MILWAUKEE	SE	1795.62	32.15	26.27	$764	8007	11673	19680	59.3%	10.96	0.34
OZAUKEE	SE	304.03	30.08	24.02	$536	2022	1214	3236	37.5%	10.64	0.35
BROWN	NE	711.75	33.94	20.40	$666	3416	5145	8561	60.1%	12.03	0.35
WINNEBAGO	NE	567.36	31.42	20.38	$559	1997	4655	6652	70.0%	11.72	0.37
DANE	SW	1674.08	28.46	26.07	$650	5222	14542	19764	73.6%	11.81	0.41
WAUKESHA	SE	1062.39	26.26	31.32	$667	4122	8963	13085	68.5%	12.32	0.47
KENOSHA	SE	554.27	32.35	17.02	$1,108	4012	5373	9385	57.3%	16.93	0.52
Group A Avg		814.15	33.49	19.62	$636	3636	5691	9327	57.2%	11.48	0.35

Final totals as of Tuesday, July 14, 2009

Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group B)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
WAUSHARA	NC	345.71	32.88	9.48	$318	1061	1314	2374	55.3%	6.87	0.21
SAINT CROIX	NW	616.98	39.06	12.38	$421	2075	3043	5117	59.5%	8.29	0.21
CHIPPEWA	NW	667.85	33.14	12.13	$363	2230	3121	5351	58.3%	8.01	0.24
ONEIDA	NC	396.79	50.44	19.53	$570	3183	1851	5034	36.8%	12.69	0.25
MARQUETTE	NC	243.91	29.30	15.96	$345	811	1136	1946	58.4%	7.98	0.27
SHAWANO	NC	516.24	40.27	13.79	$453	3240	2471	5711	43.3%	11.06	0.27
DUNN	NW	516.55	27.27	12.51	$406	1705	2338	4043	57.8%	7.83	0.29
WASHINGTON	SE	580.03	30.64	20.06	$448	1713	3397	5110	66.5%	8.81	0.29
DODGE	SW	606.62	31.75	24.96	$399	2245	3336	5580	59.8%	9.20	0.29
WALWORTH	SE	691.89	31.51	22.97	$566	2197	4460	6657	67.0%	9.62	0.31
MANITOWOC	NE	414.69	31.57	19.92	$491	2094	1977	4071	48.6%	9.82	0.31
SHEBOYGAN	NE	520.30	30.04	18.16	$538	2308	2883	5191	55.5%	9.98	0.33
SAUK	SW	591.55	28.71	23.35	$405	2742	2921	5663	51.6%	9.57	0.33
COLUMBIA	SW	745.80	30.30	33.47	$548	2956	4731	7687	61.5%	10.31	0.34
JEFFERSON	SW	458.21	26.52	22.64	$492	1590	2613	4203	62.2%	9.17	0.35
ROCK	SW	592.56	31.84	16.85	$603	2571	4207	6778	62.1%	11.44	0.36
OUTAGAMIE	NE	520.01	33.51	19.64	$539	4155	2497	6652	37.5%	12.79	0.38
Group B Avg		530.92	32.87	18.69	$465	2287	2841	5127	55.4%	9.61	0.30

Final totals as of Tuesday, July 14, 2009

Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group C)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
VERNON	SW	450.00	33.21	6.97	$225	1478	1296	2774	46.7%	6.16	0.19
CRAWFORD	SW	385.21	35.64	10.61	$297	1333	1279	2611	49.0%	6.78	0.19
VILAS	NC	305.24	58.58	23.63	$521	2077	1374	3451	39.8%	11.30	0.19
CLARK	NW	402.28	32.53	12.18	$301	1305	1308	2613	50.1%	6.50	0.20
DOUGLAS	NW	439.23	44.49	14.17	$432	2057	1849	3906	47.3%	8.89	0.20
WOOD	NC	362.92	42.90	13.29	$413	1495	1686	3181	53.0%	8.77	0.20
LINCOLN	NC	418.33	49.09	10.53	$432	2856	1552	4408	35.2%	10.54	0.21
GRANT	SW	624.14	33.92	11.81	$306	2230	2399	4628	51.8%	7.42	0.22
MONROE	SW	644.23	36.59	14.10	$364	2659	2571	5230	49.2%	8.12	0.22
JUNEAU	SW	498.13	31.64	15.62	$329	1619	1987	3606	55.1%	7.24	0.23
WASHBURN	NW	372.14	32.61	13.51	$324	1491	1324	2815	47.0%	7.57	0.23
TREMPEALEAU	NW	432.31	29.48	13.86	$294	1731	1257	2988	42.1%	6.91	0.23
WAUPACA	NC	546.58	38.57	15.08	$434	2121	2876	4997	57.6%	9.14	0.24
OCONTO	NE	437.71	36.49	13.18	$419	1925	1957	3882	50.4%	8.87	0.24
LAFAYETTE	SW	293.88	26.94	8.92	$292	746	1244	1990	62.5%	6.77	0.25
JACKSON	NW	504.10	32.53	14.49	$351	2610	1687	4297	39.3%	8.52	0.26
KEWAUNEE	NE	110.41	34.06	11.46	$413	512	485	997	48.7%	9.03	0.27
CALUMET	NE	201.31	40.01	11.85	$592	1140	1346	2486	54.2%	12.35	0.31
DOOR	NE	268.55	34.84	10.07	$610	1029	2002	3030	66.1%	11.28	0.32

Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group C)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
IOWA	SW	451.03	28.82	11.28	$447	1816	2789	4605	60.6%	10.21	0.35
FOND DU LAC	NE	594.34	35.99	15.33	$630	3309	4481	7790	57.5%	13.11	0.36
Group C Avg		416.29	36.62	12.95	$401	1787	1845	3633	50.6%	8.83	0.24

Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group D)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
PRICE	NC	320.57	58.69	15.91	$434	1504	1630	3134	52.0%	9.77	0.17
TAYLOR	NW	233.25	40.63	12.93	$273	1141	467	1608	29.1%	6.89	0.17
MARINETTE	NE	388.36	45.67	13.69	$384	1639	1389	3028	45.9%	7.80	0.17
ASHLAND	NW	247.57	53.23	11.68	$420	1205	1196	2401	49.8%	9.70	0.18
FLORENCE	NC	141.07	42.49	21.79	$321	719	389	1108	35.1%	7.85	0.18
POLK	NW	385.05	42.23	10.96	$378	1443	1567	3010	52.1%	7.82	0.19
BAYFIELD	NW	316.90	55.03	18.00	$421	2255	987	3242	30.4%	10.23	0.19
PIERCE	NW	366.08	37.87	10.78	$336	1388	1198	2585	46.3%	7.06	0.19
RUSK	NW	213.47	31.39	8.46	$254	733	536	1269	42.2%	5.94	0.19
LANGLADE	NC	292.69	46.01	11.52	$388	1468	1140	2608	43.7%	8.91	0.19
MENOMINEE	NC	90.26	34.15	6.19	$224	418	182	599	30.3%	6.64	0.19
GREEN LAKE	NC	151.30	35.17	7.48	$291	620	428	1048	40.8%	6.93	0.20
BUFFALO	NW	315.77	36.50	6.41	$294	1224	1055	2279	46.3%	7.22	0.20
SAWYER	NW	367.44	34.18	8.90	$297	1790	928	2717	34.1%	7.40	0.22
IRON	NC	250.91	56.02	20.92	$545	2080	1008	3088	32.6%	12.31	0.22
RICHLAND	SW	328.72	26.96	8.96	$270	1004	978	1982	49.3%	6.03	0.22
FOREST	NC	312.38	42.03	18.51	$378	1959	1098	3056	35.9%	9.78	0.23
ADAMS	NC	192.48	32.34	15.30	$362	723	749	1472	50.9%	7.64	0.24
BURNETT	NW	233.64	30.71	11.44	$316	1019	692	1711	40.4%	7.32	0.24

Table 3.6. Labor Hours/Lane Miles/Severity Index Ranking (Group D)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Salt per Lane Mi	Labor Cost per Lane Mi	Reg Hrs	OT Hrs	Total Hours	% OT	Total Hrs per Lane Mi	Total Hrs per Lane Mi/SI
BARRON	NW	423.09	37.70	6.56	$426	2394	1617	4011	40.3%	9.48	0.25
PEPIN	NW	111.05	25.76	7.92	$301	378	366	744	49.2%	6.70	0.26
GREEN	SW	311.45	31.25	8.47	$387	1516	1704	3220	52.9%	10.34	0.33
Group D Avg		272.43	39.82	11.94	$350	1301	968	2269	42.3%	8.17	0.21

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4 Performance

In this section...

Since weather can vary drastically from year to year, planning and budgeting for winter highway maintenance can be challenging. Throughout the winter, WisDOT staff and county highway departments evaluate progress in several areas, including materials use, money spent, and response time. When the season is complete, WisDOT can gather all the data and analyze this winter's performance across all regions and compared to previous winters.

This section begins with a description of the winter maintenance portion of Compass, WisDOT's operations performance measurement program, which measures trends in areas like response time and winter costs per lane mile. This section also discusses costs, using charts to visually compare spending in different categories from region to region and from year to year, and presents winter crash rates and customer satisfaction data.

Performance and Costs

	2008-2009 Statewide
Total lane miles	33,531
Total patrol sections	762
Average lane miles per patrol section	46
Average time to bare/wet pavement[1]	2.54 hours
Average crew reaction time from start of storm	2.57 hours
Total winter costs[2]	$79,313,896
Total winter costs per lane mile	$2,365
Total winter crashes[3]	10,837
Total winter crashes per 100 million VMT	40

1. Time to bare/wet pavement and crew reaction time data are from storm reports.
2. Cost data are actual costs as billed to WisDOT by the counties.
3. Crash data are from WisDOT's Bureau of Transportation Safety.

An Economical Choice

Proactive anti-icing operations are about three times less costly than treating frost once it has formed. Anti-icing costs made up only 0.5 percent of total winter maintenance costs this year. *See page 45 for more information on anti-icing costs.*

4A. Winter Maintenance Management

History of Snow and Ice Control in Wisconsin

The counties' plowing and salting strategies have evolved considerably over the past several decades. For many years beginning in the 1950s, WisDOT maintained a "bare pavement" policy for state highways, striving to ensure that the roadways were kept essentially clear of ice and snow during winter. Snowplows operated continuously during storms and simultaneously applied deicing salts. In the 1970s, however, economic and environmental concerns compelled the department to modify this policy. The national energy crisis and the high cost of employee overtime strained the maintenance budget, and WisDOT made the decision to reduce winter maintenance coverage on less traveled state highways. To address the risk of environmental damage by chloride chemicals, the policy was modified further to include provisions calling for the prudent use of chemicals, and limiting each application of salt to 300 pounds per lane mile.

In 2002, a detailed salt application table was added to the maintenance manual's winter guidelines. The table provides variable salt application rates for initial and repeated applications, depending on the type of precipitation, pavement temperature, wind speeds, and other weather variables. Anti-icing application rates were also established; county highway departments were instructed to perform anti-icing applications prior to predicted frost, black ice, or snow events in order to minimize the amount of salt used during the event.

Storm Reports

One way that WisDOT has worked to increase efficiency in recent years is through the Winter Storm Reports. Every week during the winter, the county highway departments complete online storm report forms. These storm reports let county and WisDOT staff track the season's weather and the counties' response to it throughout the season, which allows the counties to adjust their resource use midseason if necessary. The storm reports track data such as types of storm events, salt use, anti-icing applications, labor hours, and cost estimates. Uses for this data include:

WisDOT Central Office

- Create weekly reports and maps that track salt use and costs. These can help identify inconsistencies in service levels provided by neighboring counties.
- Calculate the severity index; use this to justify additional funding if conditions are more severe than normal

WisDOT Regional Offices

- Justify additional funding if conditions are more severe than normal
- Manage salt inventory
- Post-storm analysis of county's response
- Training tool for new staff

Counties

- Post-storm analysis of crew's response
- Compare their response (materials use, anti-icing, labor hours, etc.) to that of neighboring counties
- Justify funding to county boards

See https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/storms/howtouse.shtm for more detail on how to use the storm report data.

WisDOT relies on the county highway departments to make the storm reports a reliable tool by entering data accurately each week. Historically, the cost and salt use data in the storm reports has been relatively accurate when compared with final costs billed to WisDOT and end-of-season salt inventory figures.

Winter Patrol Sections

Many factors influence a county's response to winter storms, including the timing of snow events, the mix of highway types and classifications in a county, and the type of equipment being used. Another important factor is the length of each county's patrol sections.

Each county highway department divides the state highways it is responsible for plowing into patrol sections. In general, one snowplow operator is assigned to each patrol section. This winter, the state highway system was divided into 762 winter patrol sections, an average of 10.6 per county. The length of patrol sections varies, with counties that are more urban (Group A) tending to have shorter patrol sections than more rural counties (Group D). Local traffic patterns, highway geometrics, number of traffic lanes, intersections, interchanges, and other factors affect the length of patrol sections in each county.

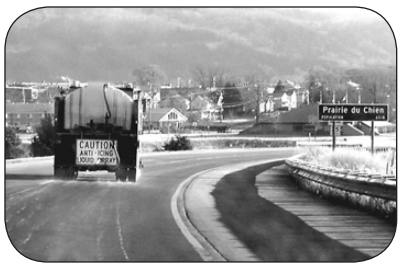
In responding to a storm, operators in longer patrol sections may use more salt in an effort to melt any snow that accumulates between plowings. In addition, drivers may notice that some roads appear to be cleared faster than others, since the longer a patrol section, the longer it takes a snowplow operator to clear all the roads in his section. Three counties have undertaken snowplow route optimization studies in the past to make their patrol section lengths as efficient as possible; see https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm for details.

Table 4.1 shows the average patrol section length for the counties in each Winter Service Group. For county-by-county patrol section data, see Table 4.8 on page 87.

Table 4.1. Average Patrol Section Lengths by Winter Service Group

Winter service group	Average patrol section length (lane miles)	Range of average patrol section lengths by county (lane miles)
A	40.1	29 – 51
B	44.2	35 – 62
C	45.3	34 – 57
D	48.6	37 – 61
Statewide average	44.0	29 – 62

BEST PRACTICES: Proactive approach



In general, a faster reaction time leads to faster clear pavement. WisDOT encourages county highway departments to have crews on the roads as soon as possible after a storm begins, within the guidelines for each county's service group and each highway's expected level of service.

Responding at the beginning of a storm reduces the amount of traffic that has packed down the snow before the plows and salt spreaders go to work. Since packed snow tends to require more effort to remove, minimizing the thickness of packed snow allows the counties to conserve resources and operate more efficiently.

For more information, contact Mike Sproul at michael.sproul@dot.wi.gov or (608) 266-8680.

4B. Response Time

WisDOT tracks two types of response time data—the time it takes a maintenance crew to get on the road after the start of a storm, and the time it takes the pavement to return to a bare/wet condition after the end of a storm. The first measure can impact the second. In general, a quicker response means the crews are dealing with less packed snow. However, WisDOT guidelines dictate that lower-volume highways receive 18-hour winter maintenance coverage rather than 24-hour coverage, so slower average reaction times are expected on these roads.

Maintenance Crew Reaction Time

Being proactive in getting on the road—even before the start of a storm—can result in bare/wet pavement being achieved faster and with less effort. Knowing this, county highway departments are becoming more proactive in their response to winter storms. Plows and salt spreader trucks are often on the road before a storm starts or shortly afterward.

Using data from the weekly winter storm reports, Table 4.2 shows the average reaction time to storm events in each Winter Service Group. The counties have become more proactive in responding to winter storm events over the last six winter seasons, responding an average of 13 percent faster this winter than in 2001-2002. As expected, average reaction times for Group A counties, which provide the highest level of service (24-hour coverage), were less than those counties that provide 18-hour coverage.

In recent years, the statewide average reaction time was lowest in 2004-2005 and 2005-2006, and has increased somewhat during the last three winters. This year's average reaction time was 2.57 hours.

Table 4.2. Maintenance Crew Reaction Time

From winter storm reports, 2001-2009

	Average reaction time (hours)								Percent change
Winter Service Group	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2008-2009 vs. 2001-2002
A	1.89	1.44	1.45	1.25	1.55	1.70	1.50	1.40	-26%
B	2.17	1.92	2.01	1.97	1.59	1.80	1.73	1.91	-12%
C	3.36	2.92	2.89	2.42	2.79	2.82	2.86	2.82	-16%
D	4.34	3.56	4.37	3.23	3.60	3.81	3.83	4.16	-4%
Statewide average (unweighted)	**2.94**	**2.46**	**2.68**	**2.22**	**2.38**	**2.53**	**2.48**	**2.57**	**-13%**

Time to Bare/Wet Pavement

As explained in Section 1, county highway departments provide different levels of effort during and after a storm according to each highway's category rating, as determined by average daily traffic. It would be expected that an urban freeway (Category 1) would receive more materials, labor and equipment—and would show a quicker recovery to bare/wet pavement—than a rural two-lane highway (Category 5). For more information on these categories, see page 10.

Table 4.3. Average Time to Bare/Wet Pavement

Highway Category	Average Time to Bare/Wet Pavement (hours after end of storm)					
	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
1	1.07	1.86	-1.21	-2.50	2.20	1.35
2	1.31	1.91	0.20	-0.55	0.76	1.01
3	1.52	2.08	1.77	1.57	3.14	2.40
4	2.45	1.95	2.47	2.70	4.01	3.06
5	3.63	2.03	3.40	2.73	4.84	3.74
Statewide average	**2.63**	**2.07**	**1.92**	**1.46**	**3.27**	**2.54**

Note: "Average Time to Bare/Wet Pavement" is defined as the time from the end of the storm to the time that the pavement was reported to be bare or wet. A negative "hours after end of storm" number or an extremely low number is caused by a number of storm events when the pavement was reported to be bare/wet before the reported end of the storm or the pavement was bare/wet at the same time as the end of the storm.

"Time to bare/wet pavement" is measured from the reported end time of a storm. Table 4.3 shows that the trend for average time to bare/wet pavement is as expected: More heavily traveled highways show a shorter average time to bare/wet pavement. From storm to storm, however, most variability is due to weather effects (type, duration and severity of storms throughout the winter season), according to analysis performed through the Compass program.

The average time to bare/wet pavement decreased over the first four winters that this measure was tracked, but this winter and last multiple factors combined to make it more challenging for crews to clear roads quickly, which increased the statewide average. This winter's statewide average was 2.54 hours, an improvement over last winter's 3.27 hours. The counties faced similar challenges this winter as last, including back-to-back storms that each contributed significant amounts of snow. These back-to-back storms created manpower issues, as counties had to temporarily suspend their plowing efforts to allow plow operators to rest. Vehicle traffic during these rest periods tended to pack snow and make it more difficult and time-consuming to remove.

And as with last winter, this winter's below-normal temperatures decreased the effectiveness of salt, which increased the time required to return pavement to bare/wet conditions.

4C. Compass

Developed in 2001, Compass is WisDOT's quality assurance and asset management program for highway operations. Annual Compass reports provide information on winter maintenance activities as well as other aspects of highway operations.

Measures for winter operations were established in 2003, and data from the winter of 2003-2004 was used to establish baseline measures for future winter seasons. The measures that were chosen included:

- time to bare/wet pavement
- winter weather crashes per vehicle miles traveled
- cost per lane mile per Winter Severity Index point

Table 4.4 on page 76 gives the statewide average values for these measures for the last six winters. More detail on these measures is provided later in this section.

Table 4.4. Statewide Compass Measures for Winter

	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Time to bare/wet pavement (after end of storm)	2 hours, 38 minutes	2 hours, 4 minutes	1 hour, 55 minutes	1 hour, 28 minutes	3 hours, 16 minutes	2 hours, 32 minutes
Cost per lane mile	$1,279	$1,374	$1,400	$1,549	$2,591	$2,365
Winter Severity Index	31.2	31.9	31.8	28.4	37.2	36.2
Cost per lane mile per Winter Severity Index point	$40.99	$43.07	$44.03	$54.54	$69.65	$65.33
Winter weather crashes	26 per 100 million vehicle miles traveled	25 per 100 million vehicle miles traveled	24 per 100 million vehicle miles traveled	23 per 100 million vehicle miles traveled	43 per 100 million vehicle miles traveled	40 per 100 million vehicle miles traveled

WisDOT plans to gather several years of baseline data before establishing targets for these measures. Until then, the data can be used to make a year-to-year comparison in these areas. Other winter measures that are being investigated for possible future use include:

1. Percent of winter operations equipment that is calibrated before winter begins
2. Average traffic speed recovery after a storm event (progress reports are available from WisDOT)

Annual Compass reports are available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/compass/reports/index.shtm.

4D. Costs

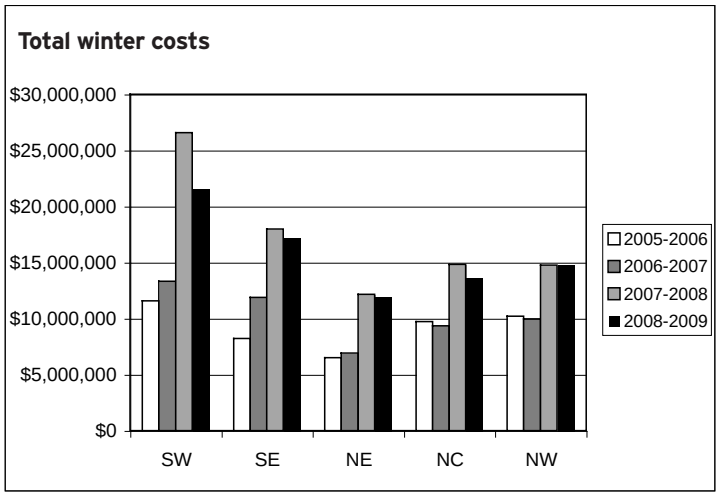
The total billed cost of statewide winter operations this winter was $79.3 million, making it the second most costly winter on record. While this figure represents an 8 percent decrease from last year's record-setting total costs, this winter's statewide costs were 48 percent higher than the average of costs in the previous five years. Comparing costs to a more typical Wisconsin winter—using a four-year average that excludes the record-breaking 2007-2008 winter—this winter's total statewide costs are 75 percent higher. Compared with a typical winter, the Southwest, Southeast and Northeast regions registered the steepest increases at 97 percent, 94 percent and 88 percent, respectively—nearly *double* the cost of an average winter. Costs in the Northwest Region were 50 percent higher than a typical winter, and costs in the North Central Region were 46 percent higher.

This winter's severe weather was the biggest reason for the continuing high cost of winter operations. While the counties experienced moderate decreases in labor and equipment costs, increased salt costs kept overall costs high.

Higher fuel prices have raised salt transportation costs in recent years: The average of $47.19 per ton paid this winter is an increase of 13 percent over last winter and an increase of 34 percent compared with the average of $35.22 three winters ago.

As Figure 4.1 shows, most regions experienced a decrease in costs compared with last winter, with the Northwest Region seeing an increase of less than 1 percent and the Southwest Region experiencing the most significant drop in costs. This year's slightly less severe winter contributed to this decrease in costs.

Figure 4.1. Change in Costs Since 2005-2006



The average Winter Severity Index declined in three regions, with the Southwest and Southeast regions seeing an 11 percent drop compared with last winter, while the North Central and Northwest regions saw small increases. But the winter was still more severe than normal, with all regions continuing to register an increase over the five-year average.

Figure 4.8 on page 97 shows county-by-county cost increases compared with the average of the previous five winters. Five counties saw increases of more than 85 percent, and an additional six counties saw increases of between 61 and 80 percent. Unlike last winter, when all counties with the highest increases were in the Southwest Region, the counties that registered the highest increases this winter are scattered throughout the state. Every county recorded an increase, with Menominee County reporting the lowest increase at 1 percent.

In individual expenditure categories for the 2008-2009 winter, statewide:

- **Salt expenditures** were $26.7 million. This was a slight increase compared with the previous winter, and a 69 percent increase over the 2006-2007 winter, with the Southwest and Northeast regions seeing the steepest increases at 86 percent and 80 percent, respectively.

- **Equipment expenditures** were $25 milion, a decrease of 15 percent compared with the previous winter and a 46 percent increase over the 2006-2007 winter, with the Northeast Region experiencing an 80 percent increase compared with two winters ago.

- **Labor expenditures** were $22.7 million, a decrease of 9 percent over the previous winter, with the Southwest Region seeing the greatest decrease at 20 percent.

- **Expenditures for materials other than salt** were $2.9 million, a decrease of 8 percent compared with the previous winter. Expenditures at the region level ranged from a 103 percent increase over the 2007-2008 winter in the Southeast Region to a 37 percent decrease in the Southwest Region. Statewide expenditures in this category were 135 percent higher than in the winter of 2006-2007.

Figure 4.5 on page 81 shows each region's expenditures per lane mile in each category.

This winter's statewide average cost per lane mile of $2,365 was lower than last year's average of $2,591, but still higher than the two previous years' averages of $1,549 and $1,400 per lane mile, and significantly higher than the $1,100 to $1,200 per lane mile that was common in the late 1990s and early 2000s. Figure 4.2 shows the trends in winter costs per lane mile and severity index over the last 12 win-

Figure 4.2. Winter Costs per Lane Mile

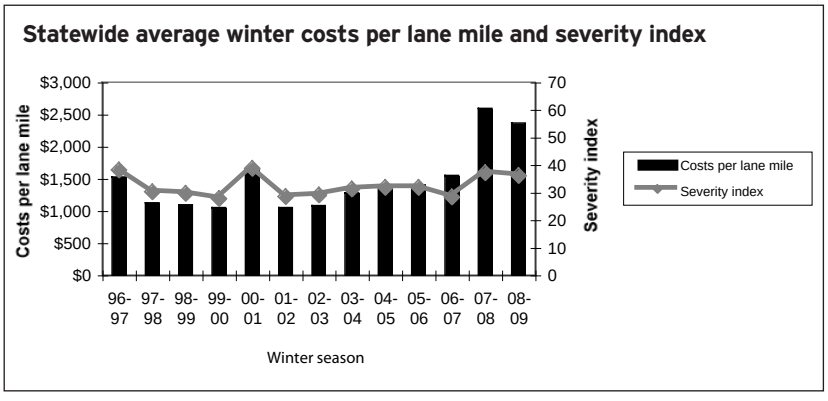


Table 4.5. Total Winter Costs Relative to Winter Severity

Region	Average Winter Severity Index	Actual cost per lane mile	Relative cost per severity index point
SW	31.19	$2,366	$75.86
SE	31.59	$3,042	$96.30
NE	35.23	$2,526	$71.70
NC	43.04	$2,183	$50.72
NW	36.16	$1,918	$53.04
Statewide	**36.19**	**$2,365**	**$65.35**

ters. On the whole, winter costs per lane mile tend to increase as statewide average severity increases, and this winter's higher relative costs were affected by higher salt costs than the state experienced in earlier years.

Table 4.5 on page 77 lists the total cost per lane mile for winter maintenance in each region, along with the region's Winter Severity Index. The level of service provided in each county affects total costs, as do the factors listed below. For these reasons, the Southeast Region historically experiences significantly higher costs relative to winter severity than the other regions.

Components of Winter Costs

Major components of winter costs include labor, equipment, salt, other materials such as sand and chemicals, and administrative costs. A region's expenditures in each area are affected by the severity of its winter and the portion of its highways receiving 24-hour coverage. In addition:

- **Labor costs** are based on rates set in each county's union contracts. Hourly rates tend to be higher in more urban counties. Timing of storms can increase labor costs if more overtime hours are required.

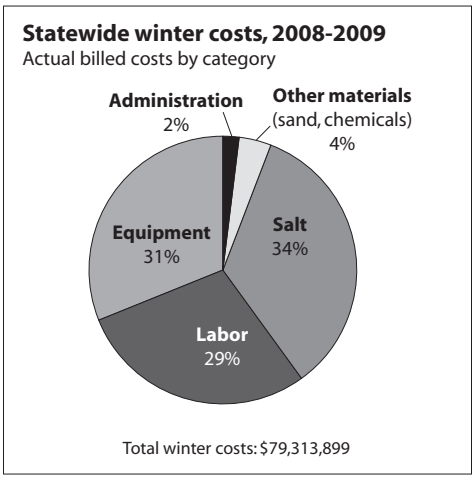
- **Equipment costs** are determined by the state Machinery Management Committee, which assigns an hourly rate to each piece of equipment that includes depreciation from the purchase price, maintenance costs, and fuel costs. Rising fuel costs have contributed to increased equipment costs, as have some counties' purchase of larger, more expensive vehicles. These larger vehicles are often more useful for year-round maintenance tasks and are also more efficient in the winter, as they can accommodate larger plows and carry more salt.

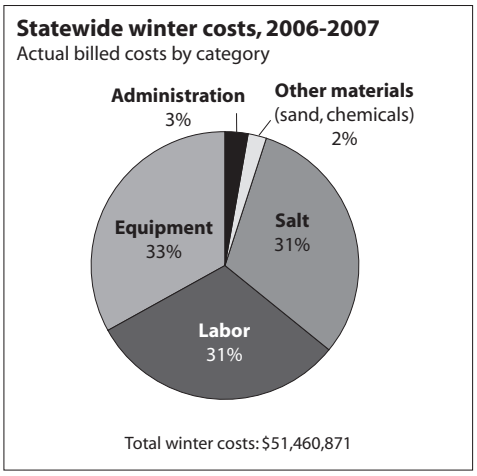
- **Salt costs** are affected by salt prices per ton, which vary because of transportation costs. For example, salt entering the state at the Port of Milwaukee doesn't have to travel as far to reach counties in the Southeast region as it does to reach counties in the center of the state.

- **Costs for materials** other than salt, such as sand, are also affected by transportation costs. In addition, some counties use more expensive deicing agents that are more effective at lower temperatures (see Table 3.5 on page 46 for details on deicing agent costs).

- **Administrative costs** are calculated at 4.5 percent of each county's combined labor, equipment and materials costs, and cover the overhead costs for office activities.

Figure 4.3. Statewide Winter Costs by Category





A comparison of total costs from year to year shows that the breakdown of costs among these five categories stays very similar from year to year, even when winter severity varies significantly. To illustrate this, Figure 4.3 shows the breakdown of costs for this winter compared with the winter of 2006-2007, when the statewide severity index of 28.4 was much more moderate.

However, the breakdown of expenditures by category varies among regions because of the factors described above. For example, the Southeast Region spends more on labor because hourly labor rates tend to be higher in those counties, while equipment expenditures make up a smaller percentage of that region's total expenditures. Figure 4.4 on page 79 shows the distribution of costs by category for each region.

Figure 4.4. Regional Winter Costs by Category

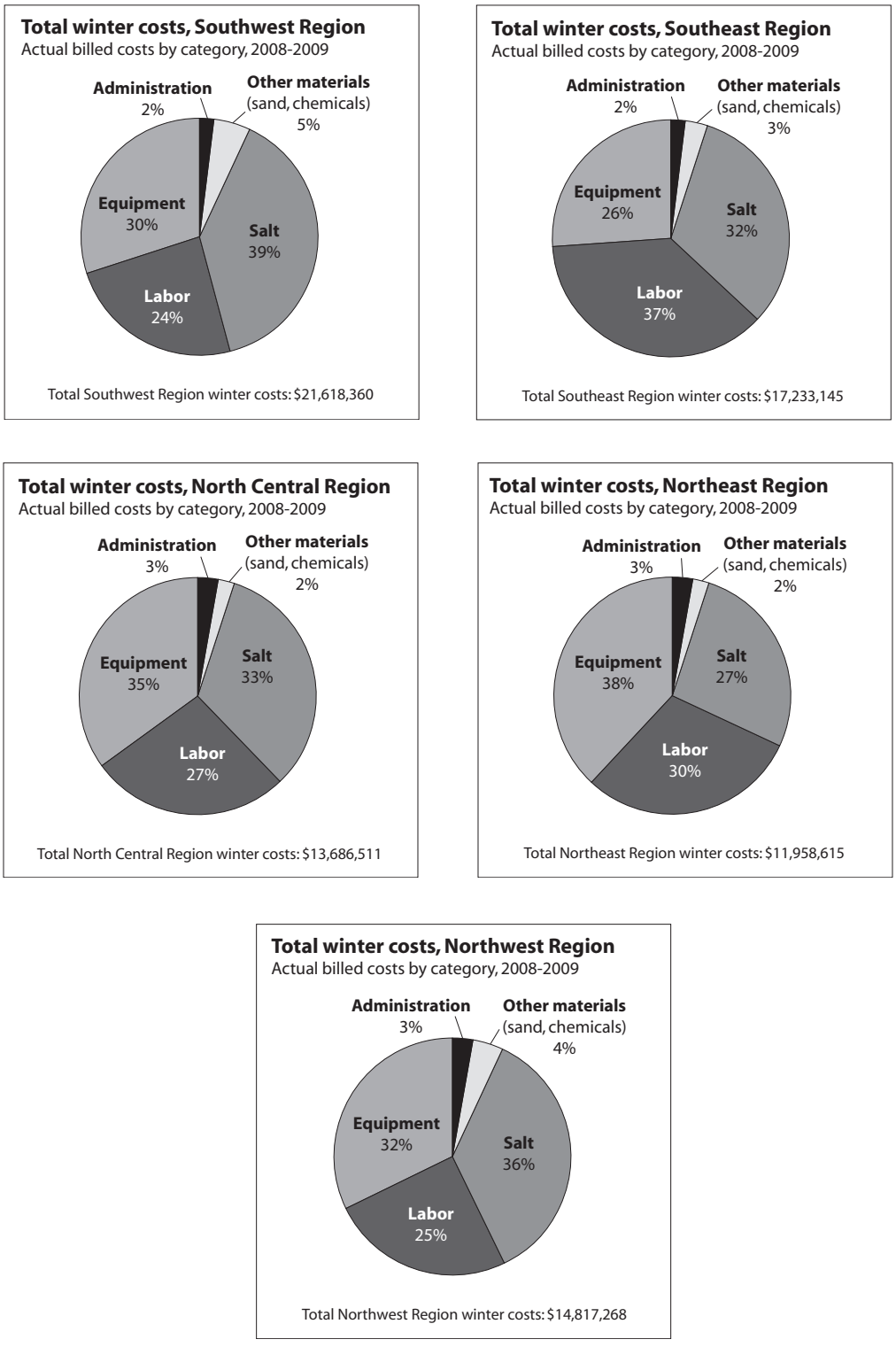
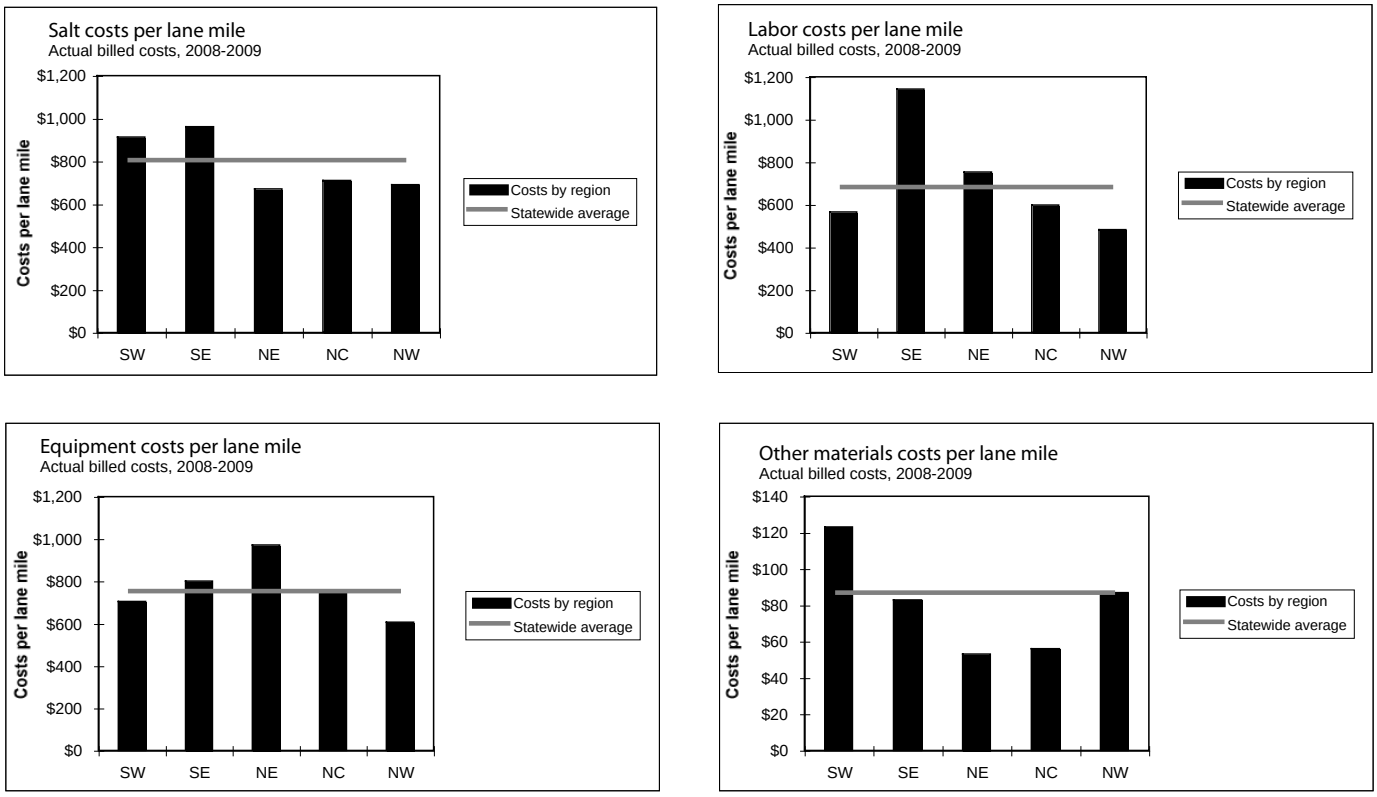


Table 4.6. Winter Costs as Billed to WisDOT by Counties

From WisDOT accounting system, 2008-2009

	Labor Costs	Equipment Costs	Cost of Other Materials (Sand, Chemicals)	Administration Costs	Cost of Salt Used	Total Costs for Winter	5-Year Avg. Cost for Winter ('04-'08 Avg.)	% Costs over 5-Year Average
Region 1 / Southwest	$5,160,965	$6,441,076	$1,123,438	$554,916	$8,337,965	$21,618,360	$14,086,400	153%
Region 2 / Southeast	$6,469,131	$4,537,262	$471,669	$313,277	$5,441,806	$17,233,145	$10,688,200	161%
Region 3 / Northeast	$3,563,530	$4,603,233	$252,649	$365,863	$3,173,340	$11,958,615	$7,508,500	159%
Region 4 / Northcentral	$3,747,650	$4,742,251	$351,224	$385,048	$4,460,338	$13,686,511	$10,443,800	131%
Region 5 / Northwest	$3,730,243	$4,690,563	$669,204	$393,905	$5,333,353	$14,817,268	$10,850,300	137%
Region Totals	**$22,671,519**	**$25,014,385**	**$2,868,184**	**$2,013,009**	**$26,746,802**	**$79,313,899**	**$53,577,200**	**148%**

Figure 4.5. Costs per Lane Mile by Category



Statewide winter cost data is presented in Table 4.6 on page 80. County-by-county cost data is available in Table 4.10 on page 92.

A Note About Cost Data

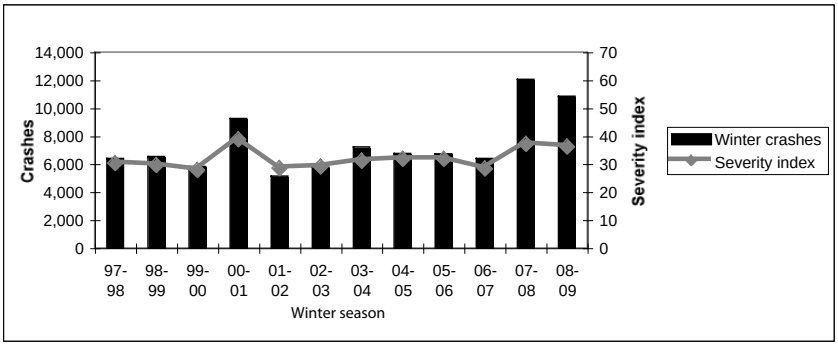
The tables at the end of this section were generated with data from two sources—final costs as billed to WisDOT, and preliminary costs from the winter storm reports. The tables created from preliminary storm reports data (such as Table 4.11 on page 98, Cost per Lane Mile per Severity Index Ranking) are included in this report because they provide county-by-county breakdowns of cost data not available elsewhere. Many of the tables in the Appendix also include cost data from the storm reports. The source of each table's data is indicated below the table title.

Final cost data includes expenses for all winter activities, including putting up snow fence, transporting salt, filling salt sheds, thawing out frozen culverts, calibrating salt spreaders, producing and storing salt brine, and anti-icing applications, as well as plowing and salting. Cost data from storm reports, however, include only plowing, sanding, salting and anti-icing expenses.

4E. Travel and Crashes

From black ice to freezing rain to white-out snowstorms, winter weather creates challenging conditions for even the most careful drivers. Many factors influence winter crash rates, most of which cannot be controlled by winter maintenance crews. However, by keeping roads as clear as possible within their expected level of service (18- or 24-hour coverage), maintenance crews have an opportunity to help prevent some winter crashes.

Figure 4.6. Winter Crashes and Winter Severity Index



Source: WisDOT Bureau of Transportation Safety

In the winter of 2008-2009, there were 10,837 reported winter weather crashes (those that occurred on pavements covered with snow, slush or ice). The crash rate (number of crashes per 100 million vehicle miles traveled) decreased slightly this winter to a statewide average of 40, down from last winter's crash rate of 43. Last winter, 12,060 winter crashes were reported.

Crash rates tend to increase in more severe winters, and this winter's rate was similar to both last winter's crash rate and the crash rate of 42 in the 2000-2001 winter (though total crashes in 2000-2001 were lower, at 9,238). Figure 4.6 shows the trends in total crashes statewide over the last 12 years overlaid with the Winter Severity Index.

It's important to note that crash rates provide only a portion of the picture of overall winter safety. Crash rates include only "reportable" crashes, which exclude those that cause property damage under $1,000 that aren't required by law to be reported to police. Also, crashes in urban areas are more likely to occur at lower speeds and cause fewer deaths, while crashes on high-speed rural roads are more likely than low-speed crashes to be fatal.

Crashes and Vehicle Miles Traveled

More urban areas such as the Southeast Region often have fewer winter weather crashes per 100 million vehicle miles traveled. This is partly due to the fact that a single crash in a county with low VMT has a bigger impact on the overall crash rate. In addition, urban regions have more highways with 24-hour coverage, which means that these roadways are more likely to be in passable condition. This year, some regions saw a decline in crash rates compared with last year's unusually high rate, while others experienced increases. The Southwest Region saw the steepest decline in crash rate, with this year's crash rate at 42 crashes per 100 million VMT reflecting a 26 percent decrease over last year's crash rate. The North Central and Northeast regions had increases in crash rates of 12 percent and 9 percent, respectively. The Northwest and Southeast regions showed the lowest crash rate, with both reporting 35 crashes per 100 million VMT (see Table 4.7). Table 4.12 on page 105 gives the estimated number of vehicle miles traveled in each county this winter (November 2008 to April 2009), and the number of crashes that occurred in each county.

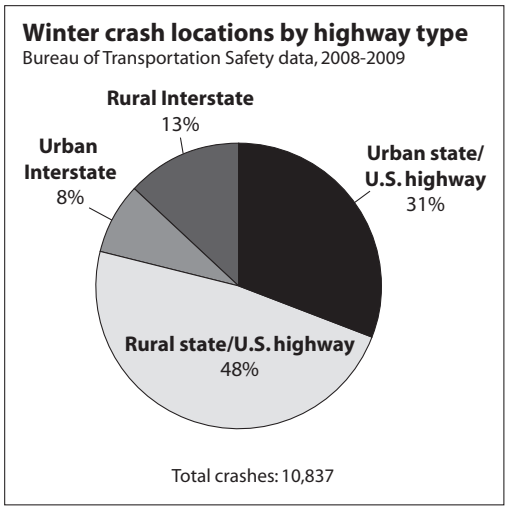
Table 4.7. Crashes and Vehicle Miles Traveled by Region

Region	Average Winter Severity Index	VMT (100 million)	Crashes	Crashes per 100 million VMT (2007-2008)	Crashes per 100 million VMT (2008-2009)
NC	43.04	32.49	1,485	41	**46**
NE	35.23	48.43	2,267	43	**47**
NW	36.16	37.99	1,347	35	**35**
SE	31.59	83.09	2,896	37	**35**
SW	31.19	66.88	2,842	57	**42**
Statewide	**36.19**	**268.88**	**10,837**	**43**	**40**

Source: WisDOT Bureau of Transportation Safety

WisDOT tracks crashes according to the type of road where they occurred (urban or rural, and Interstate or other state or U.S. highway), and whether the road was divided or nondivided. Figure 4.7 shows that most winter crashes occur on rural state or U.S. highways, largely because there are more lane miles in this category than in the others. Table 4.13 on page 108 shows the breakdown of crashes in each county according to highway type.

Figure 4.7. Winter Crash Locations



How VMT Is Calculated

WisDOT's Traffic Forecasting Section uses a number of factors to estimate Vehicle Miles of Travel for the state's roads. Annual average daily traffic counts are taken in about one-third of Wisconsin's counties every year, and estimates are made for the counties not counted. In addition, forecasters factor in gallons of gas sold, fuel tax collected, and average vehicle miles per gallon.

Total winter VMT for all counties is shown in Table 4.12 on page 105. This winter, total VMT ranged from a low of 22.4 million in Menominee County to a high of 3.3 billion in Milwaukee County. VMT estimates at the county level tend to be less reliable than at the statewide level, because current traffic counts are not available for all counties, and more variability exists in the data at finer levels of resolution.

4F. Customer Satisfaction

Over the last several years, WisDOT has gauged customer satisfaction with winter road conditions primarily through two types of surveys—a biannual survey of state troopers and a periodic survey of state residents.

State Troopers Winter Road Condition Survey

In April of 1999, 2001, 2003 and 2005, WisDOT surveyed State Patrol troopers on their opinions of the winter road conditions during the previous winter season. In general, the majority (70 to 75 percent) of the troopers that responded to the survey were satisfied with the winter maintenance activities performed by county highway departments on the state trunk highway system. A summary of the survey results was provided to the WisDOT regional highway operations staff, and copies of the summaries are available from BHO. WisDOT discontinued the surveys after 2005 because the comments received were very similar each year.

Highway Operations Customer Satisfaction Survey

WisDOT has periodically surveyed Wisconsin residents on their opinions of highway maintenance and traffic operations on the state highway system. Highlights of the most recent survey included:

- Over 90 percent of respondents rated state and county efforts to provide "good winter driving conditions" as excellent or good.
- 58 percent of respondents reported having seen or heard a WisDOT media spot or poster about winter driving conditions. Of those who had, 74 percent said that it made them more conscious and cautious while driving.
- When respondents were asked to allocate funds among nine different service areas, the highest allocations were for snow and ice removal. This indicates the importance of winter operations to users of the state highway system.

Copies of the complete survey are available from WisDOT.

WisDOT also conducted a survey in February 2004 that included questions about winter operations. Respondents gave the category "pavement clear of snow and ice" an average satisfaction rating of 7.47 on a scale of 0 to 10, where 10 indicated the greatest satisfaction.

Although a comprehensive survey on highway maintenance has not been conducted recently, the results of the earlier surveys remain relevant today because the level of service provided this winter is consistent or greater than the level of service provided at the time of the earlier surveys. Some highways have been upgraded from 18- to 24-hour coverage over the last several years, and money spent on winter maintenance per lane mile has been fairly consistent over the years with fluctuations in the severity index.

County-by-County Tables and Figure for Section 4: Performance

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Table 4.8. Winter Maintenance Sections

NC Region

County	Lane Miles	Winter Patrol Sections 2009 Survey	Lane Miles per Patrol Section	Winter Service Group
Adams	192.48	5	38.50	D
Florence	141.07	3	47.02	D
Forest	312.38	6	52.06	D
Green Lake	151.30	3	50.43	D
Iron	250.91	6	41.82	D
Langlade	292.69	6	48.78	D
Lincoln	418.33	10	41.83	C
Marathon	878.99	19	46.26	A
Marquette	243.91	5	48.78	B
Menominee	90.26	2	45.13	D
Oneida	396.79	10	39.68	B
Portage	504.28	13	38.79	A
Price	320.57	6	53.43	D
Shawano	516.24	14	36.87	B
Vilas	305.24	6	50.87	C
Waupaca	546.58	12	45.55	C
Waushara	345.71	7	49.39	B
Wood	362.92	15	24.19	C
Region Average			**44.41**	

NW Region

County	Lane Miles	Winter Patrol Sections 2009 Survey	Lane Miles per Patrol Section	Winter Service Group
Ashland	247.57	5	49.51	D
Barron	423.09	10	42.31	D
Bayfield	316.90	6	52.82	D
Buffalo	315.77	7	45.11	D
Burnett	233.64	5	46.73	D
Chippewa	667.85	16	41.74	B
Clark	402.28	10	40.23	C
Douglas	439.23	9	48.80	C
Dunn	516.55	11	46.96	B
Eau Claire	559.86	13	43.07	A
Jackson	504.10	9	56.01	C
Pepin	111.05	3	37.02	D
Pierce	366.08	7	52.30	D
Polk	385.05	7	55.01	D
Rusk	213.47	5	42.69	D
Saint Croix	616.98	10	61.70	B
Sawyer	367.44	6	61.24	D
Taylor	233.25	4	58.31	D
Trempeleau	432.31	11	39.30	C
Washburn	372.14	7	53.16	C
Region Average			**48.70**	

NE Region

County	Lane Miles	Winter Patrol Sections 2009 Survey	Lane Miles per Patrol Section	Winter Service Group
Brown	711.75	18	39.54	A
Calumet	201.31	6	33.55	C
Door	268.55	6	44.76	C
Fond du Lac	594.34	16	37.15	C
Kewaunee	110.41	3	36.80	C
Manitowoc	414.69	11	37.70	B
Marinette	388.36	8	48.55	D
Oconto	437.71	9	48.63	C
Outagamie	520.01	15	34.67	B
Sheboygan	520.30	11	47.30	B
Winnebago	567.36	15	37.82	A
Region Average			**40.59**	

SW Region

County	Lane Miles	Winter Patrol Sections 2009 Survey	Lane Miles per Patrol Section	Winter Service Group
Columbia	745.80	15	49.72	B
Crawford	385.21	7	55.03	C
Dane	1674.08	35	47.83	A
Dodge	606.62	17	35.68	B
Grant	624.14	11	56.74	C
Green	311.45	7	44.49	D
Iowa	451.03	10	45.10	C
Jefferson	458.21	13	35.25	B
Juneau	498.13	10	49.81	C
LaCrosse	480.28	13	36.94	A
Lafayette	293.88	6	48.98	C
Monroe	644.23	13	49.56	C
Richland	328.72	6	54.79	D
Rock	592.56	13	45.58	B
Sauk	591.55	12	49.30	B
Vernon	450.00	10	45.00	C
Region Average			**46.86**	

SE Region

County	Lane Miles	Winter Patrol Sections 2009 Survey	Lane Miles per Patrol Section	Winter Service Group
Kenosha	554.27	19	29.17	A
Milwaukee	1795.60	35	51.30	A
Ozaukee	304.03	9	33.78	A
Racine	676.84	17	39.81	A
Walworth	691.89	14	49.42	B
Washington	580.03	14	41.43	B
Waukesha	1062.40	29	36.63	A
Region Average			**40.22**	

	Lane Miles	Winter Patrol Sections 2009 Survey	Lane Miles per Patrol Section
Statewide Totals	33,531.00	762.0	44.00
Statewide Averages	465.71	10.6	44.00
Group A Averages	814.14	19.58	40.08
Group B Averages	530.92	12.24	44.19
Group C Averages	416.29	9.33	45.29
Group D Averages	272.43	5.59	48.55

Table 4.9. Storm Start vs. Crew Out by Precipitation Type, Group A

From Winter Storm Reports, 2008-2009

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several precipitations types but when calculating the average time difference for a particular precipitation type this is not taken into account.

County	Region	Precipitation Type (Average Time in Hours)					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
MARATHON	NC	1.99	2.14	2.13	2.77	2.18	44.75	33.03
PORTAGE	NC	2.06	2.10	1.69	1.22	2.10	40.95	45.81
LA CROSSE	SW	2.57	2.68	2.51	2.68	2.59	36.54	48.21
EAU CLAIRE	NW	1.23	1.18	1.09	1.16	1.17	26.87	55.50
BROWN	NE	1.27	0.86	2.67	-5.31	1.79	33.94	59.40
RACINE	SE	0.84	0.73	0.67	0.69	0.66	38.16	61.40
WINNEBAGO	NE	1.59	1.52	1.76	1.35	1.63	31.42	64.75
OZAUKEE	SE	0.55	0.52	0.31	0.40	0.58	30.08	68.84
MILWAUKEE	SE	0.00	0.00	0.00	0.00	0.00	32.15	71.43
KENOSHA	SE	1.00	1.03	1.70	1.21	1.03	32.35	84.48
DANE	SW	0.34	0.47	-0.06	0.41	0.33	28.46	87.63
WAUKESHA	SE	2.72	2.72	3.65	3.51	2.72	26.26	101.34
Group A Averages		1.35	1.33	1.51	0.84	1.40	33.49	65.15

Table 4.9. Storm Start vs. Crew Out by Precipitation Type, Group B

From Winter Storm Reports, 2008-2009

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several precipitations types but when calculating the average time difference for a particular precipitation type this is not taken into account.

County	Region	Precipitation Type					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
		(Average Time in Hours)						
WAUSHARA	NC	2.32	2.19	1.93	1.48	2.20	32.88	35.14
SHAWANO	NC	3.52	3.70	2.91	3.49	3.70	40.27	40.57
SAINT CROIX	NW	1.16	1.20	1.38	2.58	1.59	39.06	40.79
ONEIDA	NC	6.19	6.46	4.57	14.20	6.20	50.44	43.14
CHIPPEWA	NW	1.89	1.80	2.91	2.68	1.88	33.14	50.85
MARQUETTE	NC	2.99	3.11	2.76	2.15	3.00	29.30	52.22
DUNN	NW	1.31	1.08	1.83	1.20	1.49	27.27	56.24
OUTAGAMIE	NE	1.62	1.62	1.94	1.74	1.62	33.51	56.56
MANITOWOC	NE	2.66	2.62	2.50	2.50	2.69	31.57	58.68
WASHINGTON	SE	0.86	0.92	0.73	0.70	0.86	30.64	58.93
ROCK	SW	1.48	2.27	1.39	1.94	1.48	31.84	62.79
SHEBOYGAN	NE	1.29	1.31	1.34	1.77	1.34	30.04	63.03
DODGE	SW	2.76	2.74	3.87	3.65	2.68	31.75	63.62
WALWORTH	SE	0.62	0.61	0.79	0.32	0.60	31.51	68.63
JEFFERSON	SW	-0.20	-0.20	-0.29	-0.29	-0.18	26.52	72.43
SAUK	SW	0.87	0.88	0.79	0.76	0.88	28.71	82.22
COLUMBIA	SW	0.48	0.43	0.37	0.42	0.44	30.30	100.05
Group B Averages		1.87	1.93	1.87	2.43	1.91	32.87	59.17

Table 4.9. Storm Start vs. Crew Out by Precipitation Type, Group C

From Winter Storm Reports, 2008-2009

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several precipitations types but when calculating the average time difference for a particular precipitation type this is not taken into account.

County	Region	Precipitation Type					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
		(Average Time in Hours)						
VERNON	SW	3.27	3.35	3.23	2.24	3.34	33.21	26.95
LINCOLN	NC	5.34	5.59	4.99	4.80	5.62	49.09	30.74
CRAWFORD	SW	3.09	3.46	2.83	2.81	3.24	35.64	33.74
DOUGLAS	NW	2.33	2.31	1.71	2.27	2.27	44.49	34.41
WOOD	NC	2.30	2.33	1.98	0.23	2.30	42.90	37.62
GRANT	SW	2.62	2.37	1.77	2.09	2.42	33.92	39.26
OCONTO	NE	3.36	3.34	2.66	1.99	3.34	36.49	39.39
MONROE	SW	2.20	2.26	1.91	1.84	2.19	36.59	41.14
KEWAUNEE	NE	3.91	3.87	3.83	3.90	3.90	34.06	41.24
VILAS	NC	4.98	3.84	4.25	3.40	4.33	58.58	41.90
LAFAYETTE	SW	2.81	2.72	2.12	2.11	2.68	26.94	41.90
WAUPACA	NC	2.84	2.68	2.75	1.93	2.72	38.57	42.10
WASHBURN	NW	4.30	4.34	4.03	4.31	4.31	32.61	42.21
CALUMET	NE	3.62	4.58	3.83	4.98	5.10	40.01	44.01
CLARK	NW	4.53	4.55	3.62	4.63	4.54	32.53	44.58
TREMPEALEAU	NW	0.56	0.50	0.30	0.29	0.32	29.48	45.00
JACKSON	NW	0.30	0.32	0.32	-0.12	0.32	32.53	47.96
DOOR	NE	2.49	2.49	2.15	3.14	2.50	34.84	48.40
JUNEAU	SW	0.97	0.90	0.83	0.75	0.86	31.64	50.99
IOWA	SW	1.90	1.90	1.41	1.37	1.90	28.82	55.72
FOND DU LAC	NE	0.79	0.55	0.83	0.77	1.01	35.99	55.77
Group C Averages		2.79	2.77	2.45	2.37	2.82	36.62	42.14

Table 4.9. Storm Start vs. Crew Out by Precipitation Type, Group D

From Winter Storm Reports, 2008-2009

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several precipitations types but when calculating the average time difference for a particular precipitation type this is not taken into account.

County	Region	Precipitation Type					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
		(Average Time in Hours)						
MENOMINEE	NC	5.32	5.14	4.90	5.12	5.35	34.15	25.15
BUFFALO	NW	2.84	2.82	2.68	2.47	2.98	36.50	26.18
GREEN LAKE	NC	7.62	7.39	5.43	4.45	7.48	35.17	28.99
MARINETTE	NE	5.88	5.88	5.65	8.56	5.89	45.67	30.55
LANGLADE	NC	4.43	4.60	3.79	3.52	4.41	46.01	30.67
PRICE	NC	3.92	4.19	3.27	3.17	3.94	58.69	31.75
SAWYER	NW	4.25	4.24	4.20	4.27	4.24	34.18	32.57
RUSK	NW	3.30	3.11	3.18	2.93	3.24	31.39	33.24
POLK	NW	2.90	3.07	3.58	3.77	2.94	42.23	33.34
PIERCE	NW	4.49	4.66	4.18	4.01	4.62	37.87	33.79
TAYLOR	NW	2.95	2.90	2.57	1.90	2.99	40.63	35.03
ASHLAND	NW	3.62	3.64	3.33	3.22	3.64	53.23	37.07
BARRON	NW	1.65	1.78	1.92	1.93	1.72	37.70	40.03
RICHLAND	SW	4.16	4.18	3.78	3.08	4.20	26.96	40.57
PEPIN	NW	4.24	4.24	4.40	5.29	4.45	25.76	41.13
IRON	NC	5.09	5.56	3.32	2.98	4.76	56.02	41.38
GREEN	SW	3.20	3.36	3.33	3.04	3.47	31.25	44.12
FOREST	NC	3.23	3.37	3.19	3.00	3.39	42.03	44.20
FLORENCE	NC	5.29	5.30	4.16	6.02	6.02	42.49	44.94
BAYFIELD	NW	3.11	3.16	3.06	2.96	3.15	55.03	45.48
ADAMS	NC	5.09	5.05	4.32	4.03	5.06	32.34	53.03
BURNETT	NW	3.69	3.61	2.99	3.28	3.48	30.71	54.77
Group D Averages		4.10	4.15	3.69	3.77	4.16	39.82	37.64

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2009

Final billed costs from the WisDOT accounting system

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Materials Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2009 Winter Costs	2009 LOS Lane Miles	Winter Costs per Lane Mile
REGION 1 / SOUTHWEST												
Columbia	$556,955	$747	$782,114	$1,049	$147,679	$198	$63,885	$1,311,911	24,965	$2,862,544	745.80	$3,838
Crawford	$221,826	$576	$244,431	$635	$25,363	$66	$21,508	$204,654	4,089	$717,782	385.21	$1,863
Dane	$1,236,711	$739	$1,098,663	$656	$263,779	$158	$113,878	$2,022,853	43,643	$4,735,884	1,674.08	$2,829
Dodge	$326,377	$538	$547,508	$903	$13,170	$22	$38,717	$665,598	15,141	$1,591,370	606.62	$2,623
Grant	$226,708	$363	$326,556	$523	$47,947	$77	$26,225	$368,892	7,369	$996,328	624.14	$1,596
Green	$139,291	$447	$191,595	$615	$12,282	$39	$14,935	$137,097	2,638	$495,200	311.45	$1,590
Iowa	$252,448	$560	$357,735	$793	$22,872	$51	$27,711	$274,240	5,087	$935,006	451.03	$2,073
Jefferson	$279,366	$610	$352,991	$770	$18,461	$40	$28,158	$420,210	10,373	$1,099,186	458.21	$2,399
Juneau	$238,894	$480	$264,413	$531	$42,668	$86	$23,972	$436,480	7,779	$1,006,427	498.13	$2,020
La Crosse	$270,905	$564	$409,627	$853	$40,713	$85	$31,605	$311,274	6,592	$1,064,124	480.28	$2,216
Lafayette	$109,652	$373	$161,369	$549	$75,871	$258	$15,177	$137,262	2,622	$499,331	293.88	$1,699
Monroe	$242,211	$376	$329,685	$512	$25,228	$39	$26,025	$448,064	9,083	$1,071,213	644.23	$1,663
Richland	$105,059	$320	$134,340	$409	$10,436	$32	$10,910	$160,237	2,945	$420,982	328.72	$1,281
Rock	$460,567	$777	$588,211	$993	$304,904	$515	$58,836	$458,972	9,982	$1,871,490	592.56	$3,158
Sauk	$289,788	$490	$408,403	$690	$12,271	$21	$31,087	$824,281	13,814	$1,565,830	591.55	$2,647
Vernon	$204,207	$454	$243,435	$541	$59,794	$133	$22,287	$155,940	3,137	$685,663	450.00	$1,524
SW TOTAL	**$5,160,965**	**$565**	**$6,441,076**	**$705**	**$1,123,438**	**$123**	**$554,916**	**$8,337,965**	**169,259**	**$21,618,360**	**9,135.89**	**$2,366**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2009

Final billed costs from the WisDOT accounting system

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Materials Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2009 Winter Costs	2009 LOS Lane Miles	Winter Costs per Lane Mile
REGION 2 / SOUTHEAST												
Kenosha	$609,329	$1,099	$493,622	$891	$26,275	$47	$49,363	$355,265	9,436	$1,533,854	554.27	$2,767
Milwaukee	$3,166,430	$1,763	$1,062,521	$592	$53,116	$30	$1	$1,789,006	47,166	$6,071,074	1,795.62	$3,381
Ozaukee	$282,604	$930	$296,103	$974	$6,801	$22	$25,590	$272,074	7,304	$883,172	304.03	$2,905
Racine	$707,156	$1,045	$678,127	$1,002	$247,825	$366	$70,873	$545,492	12,772	$2,249,473	676.84	$3,323
Walworth	$544,920	$788	$612,424	$885	$17,386	$25	$51,447	$615,652	15,896	$1,841,829	691.89	$2,662
Washington	$439,469	$758	$506,102	$873	$11,401	$20	$42,001	$519,503	11,635	$1,518,476	580.03	$2,618
Waukesha	$719,223	$677	$888,363	$836	$108,865	$102	$74,002	$1,344,814	33,271	$3,135,267	1,062.39	$2,951
SE TOTAL	**$6,469,131**	**$1,142**	**$4,537,262**	**$801**	**$471,669**	**$83**	**$313,277**	**$5,441,806**	**137,480**	**$17,233,145**	**5,665.07**	**$3,042**
REGION 3 / NORTHEAST												
Brown	$525,762	$739	$781,145	$1,097	$26,201	$37	$57,787	$482,500	14,520	$1,873,395	711.75	$2,632
Calumet	$140,070	$696	$221,484	$1,100	$1,894	$9	$15,880	$90,129	2,385	$469,457	201.31	$2,332
Door	$262,369	$977	$349,765	$1,302	$38,989	$145	$28,427	$107,740	2,705	$787,290	268.55	$2,932
Fond du Lac	$428,812	$721	$534,897	$900	$32,748	$55	$43,662	$397,652	9,110	$1,437,771	594.34	$2,419
Kewaunee	$72,841	$660	$131,173	$1,188	$10,945	$99	$9,375	$52,131	1,265	$276,465	110.41	$2,504
Manitowoc	$440,210	$1,062	$439,727	$1,060	$34,966	$84	$39,945	$320,488	8,260	$1,275,336	414.69	$3,075
Marinette	$212,055	$546	$224,959	$579	$11,675	$30	$19,518	$226,472	5,315	$694,679	388.36	$1,789
Oconto	$206,843	$473	$313,397	$716	$449	$1	$22,763	$226,876	5,770	$770,328	437.71	$1,760
Outagamie	$442,323	$851	$564,033	$1,085	($6,339)	($12)	$43,337	$387,046	10,215	$1,430,400	520.01	$2,751
Sheboygan	$390,639	$751	$475,723	$914	$8,960	$17	$37,288	$407,768	9,450	$1,320,378	520.30	$2,538
Winnebago	$441,606	$778	$566,930	$999	$92,161	$162	$47,881	$474,538	11,560	$1,623,116	567.36	$2,861
NE TOTAL	**$3,563,530**	**$753**	**$4,603,233**	**$972**	**$252,649**	**$53**	**$365,863**	**$3,173,340**	**80,555**	**$11,958,615**	**4,734.79**	**$2,526**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2009

Final billed costs from the WisDOT accounting system

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Materials Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2009 Winter Costs	2009 LOS Lane Miles	Winter Costs per Lane Mile
REGION 4 / NORTHCENTRAL												
Adams	$115,242	$599	$125,343	$651	$26,569	$138	$11,596	$165,600	2,944	$444,350	192.48	$2,309
Florence	$59,034	$418	$111,775	$792	$10,454	$74	$7,812	$158,219	3,074	$347,294	141.07	$2,462
Forest	$178,260	$571	$279,326	$894	$32,409	$104	$21,013	$297,593	5,783	$808,601	312.38	$2,589
Green Lake	$87,725	$580	$81,340	$538	$6,244	$41	$7,669	$51,291	1,131	$234,269	151.30	$1,548
Iron	$212,243	$846	$282,075	$1,124	$13,588	$54	$22,192	$273,315	5,250	$803,413	250.91	$3,202
Langlade	$176,451	$603	$226,793	$775	$6,494	$22	$17,798	$157,304	3,372	$584,840	292.69	$1,998
Lincoln	$262,775	$628	$312,961	$748	$16,277	$39	$25,803	$216,496	4,403	$834,312	418.33	$1,994
Marathon	$443,713	$505	$591,715	$673	$47,501	$54	$47,117	$490,021	10,338	$1,620,067	878.99	$1,843
Marquette	$125,531	$515	$146,294	$600	$7,032	$29	$12,179	$190,339	3,894	$481,375	243.91	$1,974
Menominee	$23,305	$258	$51,940	$575	$14,069	$156	$3,919	$22,248	559	$115,481	90.26	$1,279
Oneida	$295,458	$745	$380,745	$960	$17,427	$44	$30,231	$396,335	7,750	$1,120,196	396.79	$2,823
Portage	$357,703	$709	$373,491	$741	$12,173	$24	$32,531	$327,851	6,980	$1,103,749	504.28	$2,189
Price	$188,521	$588	$242,098	$755	$13,054	$41	$19,150	$280,912	5,101	$743,735	320.57	$2,320
Shawano	$313,444	$607	$402,008	$779	$41,821	$81	$32,999	$283,162	7,120	$1,073,434	516.24	$2,079
Vilas	$217,172	$711	$304,033	$996	$23,254	$76	$23,784	$387,573	7,212	$955,816	305.24	$3,131
Waupaca	$309,446	$566	$406,507	$744	$42,743	$78	$33,093	$351,897	8,245	$1,143,686	546.58	$2,092
Waushara	$170,176	$492	$185,120	$535	$14,405	$42	$16,173	$157,641	3,276	$543,515	345.71	$1,572
Wood	$211,451	$583	$238,687	$658	$5,710	$16	$19,989	$252,541	4,825	$728,378	362.92	$2,007
NC TOTAL	**$3,747,650**	**$598**	**$4,742,251**	**$756**	**$351,224**	**$56**	**$385,048**	**$4,460,338**	**91,257**	**$13,686,511**	**6,270.65**	**$2,183**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2009

Final billed costs from the WisDOT accounting system

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Materials Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2009 Winter Costs	2009 LOS Lane Miles	Winter Costs per Lane Mile
REGION 5 / NORTHWEST												
Ashland	$146,995	$594	$205,591	$830	$33,528	$135	$16,865	$245,417	2,891	$648,396	247.57	$2,619
Barron	$255,267	$603	$290,261	$686	$44,848	$106	$25,447	$238,509	2,774	$854,332	423.09	$2,019
Bayfield	$209,551	$661	$252,794	$798	$14,342	$45	$20,731	$465,072	5,705	$962,490	316.90	$3,037
Buffalo	$108,460	$343	$136,867	$433	$4,308	$14	$10,854	$93,914	2,024	$354,403	315.77	$1,122
Burnett	$103,858	$445	$148,834	$637	$27,132	$116	$12,116	$221,188	2,672	$513,128	233.64	$2,196
Chippewa	$328,552	$492	$343,958	$515	$58,788	$88	$31,878	$539,555	8,099	$1,302,731	667.85	$1,951
Clark	$171,342	$426	$209,605	$521	$6,918	$17	$16,833	$305,012	4,899	$709,710	402.28	$1,764
Douglas	$242,631	$552	$377,842	$860	$70,179	$160	$29,424	$266,449	6,224	$986,525	439.23	$2,246
Dunn	$316,376	$612	$294,764	$571	$31,010	$60	$27,869	$362,251	6,463	$1,032,270	516.55	$1,998
Eau Claire	$302,720	$541	$352,974	$630	$37,244	$67	$30,224	$370,125	6,580	$1,093,287	559.86	$1,953
Jackson	$204,207	$405	$307,967	$611	$15,154	$30	$23,120	$378,107	7,305	$928,555	504.10	$1,842
Pepin	$61,556	$554	$53,979	$486	$11,438	$103	$5,549	$42,588	879	$175,110	111.05	$1,577
Pierce	$192,046	$525	$232,712	$636	$40,822	$112	$20,146	$212,230	3,947	$697,956	366.08	$1,907
Polk	$163,201	$424	$247,384	$642	$59,637	$155	$20,374	$228,072	4,222	$718,668	385.05	$1,866
Rusk	$61,357	$287	$117,406	$550	$13,146	$62	$8,104	$97,452	1,806	$297,465	213.47	$1,393
Sawyer	$134,877	$367	$170,139	$463	$18,729	$51	$14,147	$161,081	3,272	$498,973	367.44	$1,358
St. Croix	$333,368	$540	$385,394	$625	$116,728	$189	$36,368	$417,035	7,638	$1,288,893	616.98	$2,089
Taylor	$87,432	$375	$116,989	$502	$9,663	$41	$9,168	$177,312	3,015	$400,564	233.25	$1,717
Trempealeau	$168,441	$390	$224,718	$520	$31,026	$72	$17,996	$287,724	5,993	$729,905	432.31	$1,688
Washburn	$138,006	$371	$220,385	$592	$24,564	$66	$16,692	$224,260	5,026	$623,907	372.14	$1,677
NW TOTAL	**$3,730,243**	**$483**	**$4,690,563**	**$607**	**$669,204**	**$87**	**$393,905**	**$5,333,353**	**91,434**	**$14,817,268**	**7,724.61**	**$1,918**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2009

Final billed costs from the WisDOT accounting system

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Materials Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2009 Winter Costs	2009 LOS Lane Miles	Winter Costs per Lane Mile
STATEWIDE SUMMARY												
SW Region	$5,160,965	$565	$6,441,076	$705	$1,123,438	$123	$554,916	$8,337,965	169,259	$21,618,360	9,135.89	$2,366
SE Region	$6,469,131	$1,142	$4,537,262	$801	$471,669	$83	$313,277	$5,441,806	137,480	$17,233,145	5,665.07	$3,042
NE Region	$3,563,530	$753	$4,603,233	$972	$252,649	$53	$365,863	$3,173,340	80,555	$11,958,615	4,734.79	$2,526
NC Region	$3,747,650	$598	$4,742,251	$756	$351,224	$56	$385,048	$4,460,338	91,257	$13,686,511	6,270.65	$2,183
NW Region	$3,730,243	$483	$4,690,563	$607	$669,204	$87	$393,905	$5,333,353	91,434	$14,817,268	7,724.61	$1,918
Statewide Totals	$22,671,519	$676	$25,014,385	$746	$2,868,184	$86	$2,013,009	$26,746,802	569,985	$79,313,899	33,531.01	$2,365

prepared by: Cathy Meinholz/Bureau of Highway Operations

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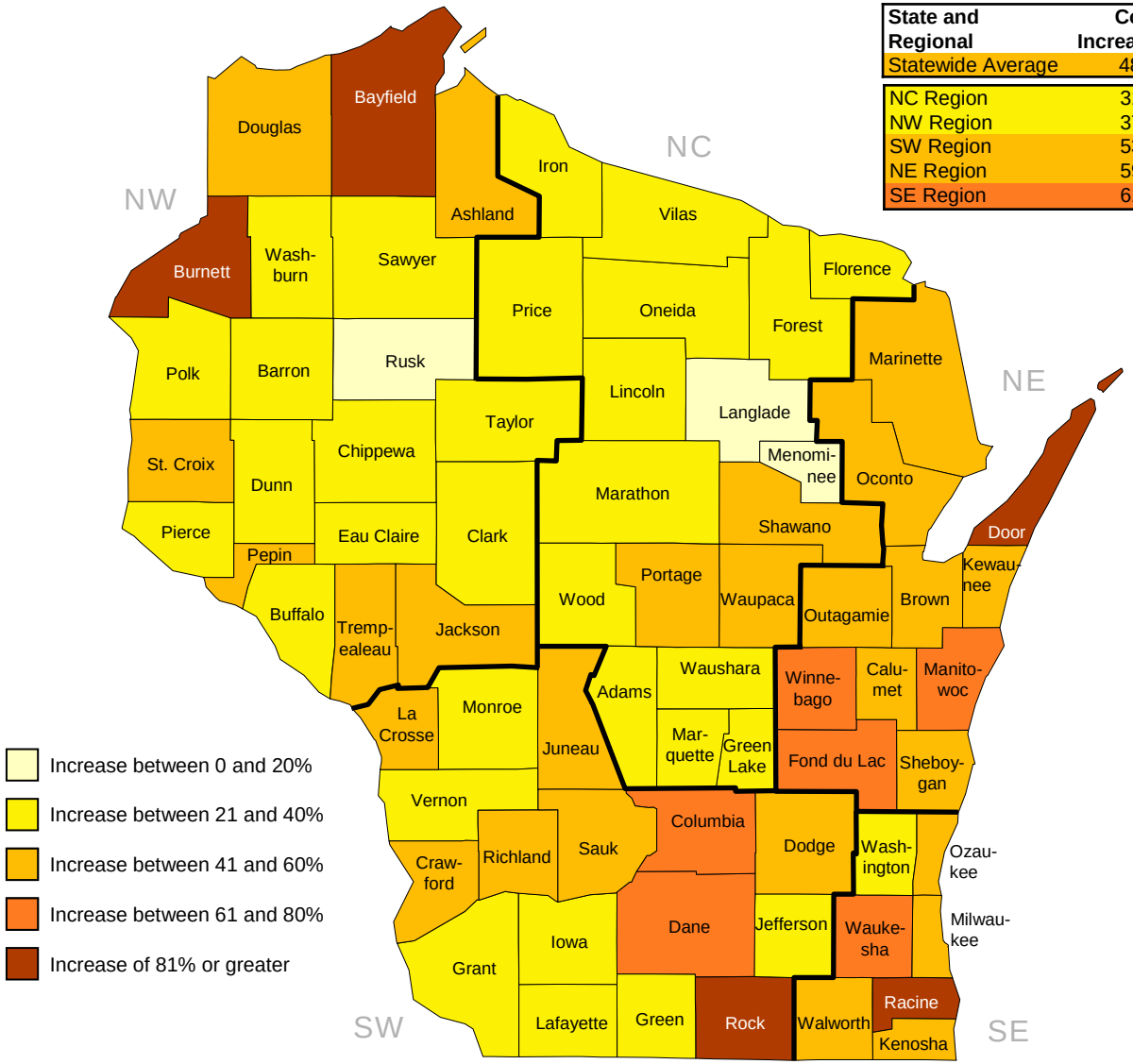
August 12, 2009

Figure 4.8. 2008-2009 Winter Costs vs. 5-Year Average

County	Cost Increase
Menominee	1%
Langlade	2%
Rusk	9%
Marathon	21%
Green	21%
Clark	21%
Iron	22%
Taylor	23%
Vernon	23%
Chippewa	24%
Lincoln	25%
Dunn	26%
Washburn	26%
Polk	28%
Eau Claire	28%
Florence	29%
Marquette	30%
Barron	30%
Forest	31%
Grant	31%
Wood	31%
Adams	33%
Sawyer	33%
Pierce	34%
Jefferson	35%
Vilas	35%
Waushara	36%
Monroe	36%
Price	36%
Oneida	37%
Buffalo	37%
Iowa	37%
Green Lake	37%
Lafayette	38%
Washington	38%
Ozaukee	41%

County	Cost Increase
Portage	42%
Douglas	42%
St. Croix	42%
Jackson	43%
Trempealeau	44%
La Crosse	44%
Shawano	45%
Waupaca	47%
Calumet	48%
Oconto	48%
Outagamie	49%
Richland	49%
Brown	50%
Dodge	50%
Pepin	51%
Marinette	52%
Crawford	52%
Walworth	53%
Kewanee	53%
Juneau	53%
Ashland	54%
Kenosha	58%
Sheboygan	59%
Milwaukee	59%
Sauk	59%
Dane	61%
Fond du Lac	66%
Winnebago	67%
Waukesha	70%
Manitowoc	73%
Columbia	78%
Burnett	86%
Bayfield	88%
Door	88%
Rock	91%
Racine	99%



State and Regional	Cost Increase
Statewide Average	48%
NC Region	31%
NW Region	37%
SW Region	53%
NE Region	59%
SE Region	61%

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group A)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
MARATHON	NC	878.99	44.75	81.7	10338	11.76	0.26	$1,299,000	$1,478	33.03
PORTAGE	NC	504.28	40.95	89.0	6980	13.84	0.34	$946,000	$1,876	45.81
LA CROSSE	SW	480.28	36.54	76.9	6592	13.73	0.38	$846,000	$1,761	48.21
EAU CLAIRE	NW	559.86	26.87	57.9	6580	11.75	0.44	$835,000	$1,491	55.50
BROWN	NE	711.75	33.94	102.4	14520	20.40	0.60	$1,435,000	$2,016	59.40
RACINE	SE	676.84	38.16	97.6	12772	18.87	0.49	$1,586,000	$2,343	61.40
WINNEBAGO	NE	567.36	31.42	79.1	11560	20.38	0.65	$1,154,000	$2,034	64.75
OZAUKEE	SE	304.03	30.08	77.3	7304	24.02	0.80	$629,000	$2,070	68.84
MILWAUKEE	SE	1,795.62	32.15	78.8	47166	26.27	0.82	$4,123,000	$2,296	71.43
KENOSHA	SE	554.27	32.35	96.7	9436	17.02	0.53	$1,515,000	$2,733	84.48
DANE	SW	1,674.08	28.46	68.7	43643	26.07	0.92	$4,176,000	$2,494	87.63
WAUKESHA	SE	1,062.39	26.26	89.8	33271	31.32	1.19	$2,827,000	$2,661	101.34
Group A Averages		814.15	33.49	83.0	17514	19.62	0.62	$1,780,917	$2,105	65.15

Table 4.11 Cost per Lane Mile per Severity Index Ranking (Group B)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
WAUSHARA	NC	345.71	32.88	95.6	3276	9.48	0.29	$399,000	$1,155	35.14
MARQUETTE	NC	243.91	29.30	89.9	3894	15.96	0.54	$373,000	$1,530	52.22
DUNN	NW	516.55	27.27	67.1	6463	12.51	0.46	$792,000	$1,534	56.24
SAINT CROIX	NW	616.98	39.06	66.0	7638	12.38	0.32	$983,000	$1,594	40.79
SHAWANO	NC	516.24	40.27	106.5	7120	13.79	0.34	$843,000	$1,634	40.57
CHIPPEWA	NW	667.85	33.14	72.4	8099	12.13	0.37	1,126,000	$1,685	50.85
WASHINGTON	SE	580.03	30.64	85.4	11635	20.06	0.65	1,047,000	$1,805	58.93
MANITOWOC	NE	414.69	31.57	96.3	8260	19.92	0.63	$768,000	$1,853	58.68
SHEBOYGAN	NE	520.30	30.04	98.9	9450	18.16	0.60	$985,000	$1,893	63.03
OUTAGAMIE	NE	520.01	33.51	90.1	10215	19.64	0.59	$986,000	$1,895	56.56
JEFFERSON	SW	458.21	26.52	70.0	10373	22.64	0.85	$880,000	$1,921	72.43
ROCK	SW	592.56	31.84	85.1	9982	16.85	0.53	1,185,000	$1,999	62.79
DODGE	SW	606.62	31.75	80.5	15141	24.96	0.79	1,225,000	$2,020	63.62
WALWORTH	SE	691.89	31.51	88.4	15896	22.97	0.73	1,496,000	$2,163	68.63
ONEIDA	NC	396.79	50.44	89.8	7750	19.53	0.39	$863,000	$2,176	43.14
SAUK	SW	591.55	28.71	83.5	13814	23.35	0.81	1,396,000	$2,360	82.22
COLUMBIA	SW	745.80	30.30	93.2	24965	33.47	1.10	2,261,000	$3,032	100.05

Table 4.11 Cost per Lane Mile per Severity Index Ranking (Group B)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
Group B Averages		530.92	32.87	85.8	10234	18.69	0.59	1,035,765	$1,897	59.17

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group C)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
VERNON	SW	450.00	33.21	76.5	3137	6.97	0.21	$403,000	$895	26.95
LAFAYETTE	SW	293.88	26.94	66.1	2622	8.92	0.33	$332,000	$1,129	41.90
CRAWFORD	SW	385.21	35.64	63.4	4089	10.61	0.30	$463,000	$1,202	33.74
TREMPEALEAU	NW	432.31	29.48	76.9	5993	13.86	0.47	$574,000	$1,327	45.00
GRANT	SW	624.14	33.92	68.6	7369	11.81	0.35	$831,000	$1,332	39.26
WASHBURN	NW	372.14	32.61	96.7	5026	13.51	0.41	$512,000	$1,376	42.21
KEWAUNEE	NE	110.41	34.06	125.3	1265	11.46	0.34	$155,000	$1,405	41.24
OCONTO	NE	437.71	36.49	106.7	5770	13.18	0.36	$629,000	$1,437	39.39
CLARK	NW	402.28	32.53	93.3	4899	12.18	0.37	$583,000	$1,450	44.58
MONROE	SW	644.23	36.59	77.4	9083	14.10	0.39	$970,000	$1,505	41.14
LINCOLN	NC	418.33	49.09	77.0	4403	10.53	0.21	$631,000	$1,509	30.74
DOUGLAS	NW	439.23	44.49	154.7	6224	14.17	0.32	$672,000	$1,531	34.41
JACKSON	NW	504.10	32.53	106.0	7305	14.49	0.45	$782,000	$1,552	47.70
IOWA	SW	451.03	28.82	74.6	5087	11.28	0.39	$724,000	$1,606	55.72
JUNEAU	SW	498.13	31.64	85.4	7779	15.62	0.49	$804,000	$1,614	50.99
WOOD	NC	362.92	42.90	86.7	4825	13.29	0.31	$586,000	$1,614	37.62
WAUPACA	NC	546.58	38.57	109.3	8245	15.08	0.39	$888,000	$1,624	42.10
DOOR	NE	268.55	34.84	86.2	2705	10.07	0.29	$453,000	$1,686	48.40

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group C)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
CALUMET	NE	201.31	40.01	91.7	2385	11.85	0.30	$354,000	$1,761	44.01
FOND DU LAC	NE	594.34	35.99	82.9	9110	15.33	0.43	1,193,000	$2,007	55.77
VILAS	NC	305.24	58.58	134.3	7212	23.63	0.40	$749,000	$2,454	41.90
Group C Averages		416.29	36.62	92.4	5454	12.95	0.36	$632,762	$1,525	42.13

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group D)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
MENOMINEE	NC	90.26	34.15	96.6	559	6.19	0.18	$78,000	$859	25.15
BUFFALO	NW	315.77	36.50	60.7	2024	6.41	0.18	$302,000	$955	26.18
GREEN LAKE	NC	151.30	35.17	98.6	1131	7.48	0.21	$154,000	$1,020	28.99
RUSK	NW	213.47	31.39	73.6	1806	8.46	0.27	$223,000	$1,043	33.24
PEPIN	NW	111.05	25.76	61.2	879	7.92	0.31	$118,000	$1,060	41.13
RICHLAND	SW	328.72	26.96	75.3	2945	8.96	0.33	$360,000	$1,094	40.57
SAWYER	NW	367.44	34.18	78.2	3272	8.90	0.26	$409,000	$1,113	32.57
PIERCE	NW	366.08	37.87	67.4	3947	10.78	0.28	$468,000	$1,279	33.79
GREEN	SW	311.45	31.25	72.9	2638	8.47	0.27	$429,000	$1,379	44.12
MARINETTE	NE	388.36	45.67	112.9	5315	13.69	0.30	$542,000	$1,395	30.55
POLK	NW	385.05	42.23	73.6	4222	10.96	0.26	$542,000	$1,408	33.34
LANGLADE	NC	292.69	46.01	85.1	3372	11.52	0.25	$413,000	$1,411	30.67
TAYLOR	NW	233.25	40.63	70.8	3015	12.93	0.32	$332,000	$1,423	35.03
BARRON	NW	423.09	37.70	69.7	2774	6.56	0.17	$638,000	$1,509	40.03
BURNETT	NW	233.64	30.71	75.1	2672	11.44	0.37	$393,000	$1,682	54.77
ADAMS	NC	192.48	32.34	87.0	2944	15.30	0.47	$330,000	$1,715	53.03
FOREST	NC	312.38	42.03	101.9	5783	18.51	0.44	$580,000	$1,858	44.20
PRICE	NC	320.57	58.69	73.9	5101	15.91	0.27	$597,000	$1,863	31.75

Table 4.11. Cost per Lane Mile per Severity Index Ranking (Group D)

From Winter Storm Reports, 2008-2009

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
FLORENCE	NC	141.07	42.49	112.9	3074	21.79	0.51	$269,000	$1,910	44.94
ASHLAND	NW	247.57	53.23	180.9	2891	11.68	0.22	$489,000	$1,973	37.07
IRON	NC	250.91	56.02	215.2	5250	20.92	0.37	$582,000	$2,318	41.38
BAYFIELD	NW	316.90	55.03	158.9	5705	18.00	0.33	$793,000	$2,503	45.48
Group D Averages		272.43	39.82	95.5	3242	11.94	0.30	$410,955	$1,490	37.64

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

Bureau of Transportation Safety data, November 2008 - April 2009

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
North Central Region			
ADAMS	103,600,000	37	36
FLORENCE	27,300,000	10	37
FOREST	52,800,000	16	30
GREEN LAKE	86,100,000	30	35
IRON	50,700,000	21	41
LANGLADE	101,500,000	37	36
LINCOLN	188,400,000	77	41
MARATHON	724,400,000	423	58
MARQUETTE	115,600,000	32	28
MENOMINEE	22,400,000	5	22
ONEIDA	199,600,000	70	35
PORTAGE	368,400,000	159	43
PRICE	82,000,000	28	34
SHAWANO	262,400,000	120	46
VILAS	146,100,000	49	34
WAUPACA	267,600,000	166	62
WAUSHARA	160,900,000	59	37
WOOD	289,000,000	146	51
Total	**3,248,800,000**	**1,485**	**46**
Northeast Region			
BROWN	1,076,600,000	470	44
CALUMET	173,400,000	85	49
DOOR	164,600,000	33	20
FOND DU LAC	529,600,000	253	48
KEWAUNEE	84,100,000	35	42
MANITOWOC	377,900,000	174	46
MARINETTE	217,800,000	107	49
OCONTO	229,300,000	87	38
OUTAGAMIE	726,800,000	329	45
SHEBOYGAN	476,500,000	197	41
WINNEBAGO	786,700,000	497	63
Total	**4,843,300,000**	**2,267**	**47**

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

Bureau of Transportation Safety data, November 2008 - April 2009

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
Northwest Region			
ASHLAND	80,400,000	24	30
BARRON	237,300,000	58	24
BAYFIELD	94,300,000	20	21
BUFFALO	77,000,000	32	42
BURNETT	74,200,000	17	23
CHIPPEWA	371,700,000	91	24
CLARK	184,400,000	84	46
DOUGLAS	220,200,000	101	46
DUNN	299,000,000	123	41
EAU CLAIRE	498,400,000	189	38
JACKSON	252,300,000	112	44
PEPIN	32,500,000	7	22
PIERCE	138,100,000	72	52
POLK	185,500,000	47	25
RUSK	71,900,000	22	31
ST.CROIX	514,800,000	176	34
SAWYER	93,800,000	27	29
TAYLOR	83,500,000	20	24
TREMPEALEAU	170,300,000	79	46
WASHBURN	119,000,000	46	39
Total	**3,798,600,000**	**1,347**	**35**
Southeast Region			
KENOSHA	709,600,000	350	49
MILWAUKEE	3,261,600,000	1110	34
OZAUKEE	491,600,000	141	29
RACINE	778,600,000	308	40
WALWORTH	538,000,000	184	34
WASHINGTON	611,000,000	319	52
WAUKESHA	1,918,300,000	484	25
Total	**8,308,700,000**	**2,896**	**35**

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

Bureau of Transportation Safety data, November 2008 - April 2009

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
Southwest Region			
COLUMBIA	442,800,000	184	42
CRAWFORD	98,500,000	38	39
DANE	2,225,300,000	660	30
DODGE	427,000,000	211	49
GRANT	239,000,000	115	48
GREEN	142,800,000	58	41
IOWA	164,300,000	70	43
JEFFERSON	434,000,000	170	39
JUNEAU	287,200,000	124	43
LA CROSSE	469,200,000	329	70
LAFAYETTE	94,400,000	32	34
MONROE	340,000,000	181	53
RICHLAND	88,800,000	56	63
ROCK	743,100,000	379	51
SAUK	359,200,000	180	50
VERNON	132,800,000	55	41
Total	**6,688,400,000**	**2,842**	**42**
Statewide Totals	**26,887,800,000**	**10,837**	**40**

Table 4.13. Motor Vehicle Crashes on Roads with Snow/Ice/Slush
Bureau of Transportation Safety data, Nov. 1, 2008 - April 30, 2009 - State, U.S. and Interstate highways only

NC Region

		Urban	Rural	Urban	Rural	Urban State Highway			Rural State Highway		
County	Total	STH	STH	IH	IH	Non-div	Divided	Unkn	Non-div	Divided	Unkn
ADAMS	37	0	37	0	0	0	0	0	37	0	0
FLORENCE	10	0	10	0	0	0	0	0	9	0	1
FOREST	16	0	16	0	0	0	0	0	16	0	0
GREEN LAKE	30	8	22	0	0	8	0	0	21	1	0
IRON	21	0	21	0	0	0	0	0	21	0	0
LANGLADE	37	7	30	0	0	7	0	0	29	1	0
LINCOLN	77	10	67	0	0	9	0	1	24	43	0
MARATHON	423	133	237	11	42	58	75	0	76	161	0
MARQUETTE	32	0	8	0	24	0	0	0	8	0	0
MENOMINEE	5	0	5	0	0	0	0	0	5	0	0
ONEIDA	70	5	65	0	0	1	4	0	58	6	1
PORTAGE	159	51	65	6	37	21	30	0	25	40	0
PRICE	28	0	28	0	0	0	0	0	28	0	0
SHAWANO	120	9	111	0	0	7	1	1	36	75	0
VILAS	49	0	49	0	0	0	0	0	47	2	0
WAUPACA	166	11	155	0	0	6	5	0	79	76	0
WAUSHARA	59	0	46	0	13	0	0	0	39	6	1
WOOD	146	94	52	0	0	27	67	0	38	14	0
Total	1,485	328	1,024	17	116	144	182	2	596	425	3

NE Region

		Urban	Rural	Urban	Rural	Urban State Highway			Rural State Highway		
County	Total	STH	STH	IH	IH	Non-div	Divided	Unkn	Non-div	Divided	Unkn
BROWN	470	313	75	47	35	86	227	0	27	48	0
CALUMET	85	16	69	0	0	1	15	0	61	8	0
DOOR	33	7	26	0	0	1	6	0	19	7	0
FOND DU LAC	253	65	188	0	0	41	23	1	75	113	0
KEWAUNEE	35	0	35	0	0	0	0	0	35	0	0
MANITOWOC	174	65	52	3	54	27	38	0	48	4	0
MARINETTE	107	14	93	0	0	13	1	0	79	14	0
OCONTO	87	0	87	0	0	0	0	0	34	53	0
OUTAGAMIE	329	142	187	0	0	60	82	0	83	104	0
SHEBOYGAN	197	47	88	1	61	29	18	0	45	43	0
WINNEBAGO	497	125	372	0	0	73	52	0	96	276	0
Total	2,267	794	1,272	51	150	331	462	1	602	670	0

Table 4.13. Motor Vehicle Crashes on Roads with Snow/Ice/Slush
Bureau of Transportation Safety data, Nov. 1, 2008 - April 30, 2009 - State, U.S. and Interstate highways only

NW Region

		Urban	Rural	Urban	Rural	Urban State Highway			Rural State Highway		
County	Total	STH	STH	IH	IH	Non-div	Divided	Unkn	Non-div	Divided	Unkn
ASHLAND	24	8	16	0	0	7	1	0	16	0	0
BARRON	58	4	54	0	0	2	2	0	26	27	1
BAYFIELD	20	0	20	0	0	0	0	0	20	0	0
BUFFALO	32	0	32	0	0	0	0	0	30	2	0
BURNETT	17	0	17	0	0	0	0	0	16	1	0
CHIPPEWA	91	12	79	0	0	6	6	0	27	52	0
CLARK	84	0	84	0	0	0	0	0	36	47	1
DOUGLAS	101	53	32	16	0	27	26	0	15	17	0
DUNN	123	15	44	18	46	11	4	0	40	4	0
EAU CLAIRE	189	87	55	2	45	4	83	0	32	23	0
JACKSON	112	0	30	0	82	0	0	0	25	4	1
PEPIN	7	0	7	0	0	0	0	0	7	0	0
PIERCE	72	13	59	0	0	13	0	0	58	1	0
POLK	47	0	47	0	0	0	0	0	44	3	0
RUSK	22	0	22	0	0	0	0	0	22	0	0
SAINT CROIX	176	17	97	17	45	12	5	0	56	41	0
SAWYER	27	0	27	0	0	0	0	0	27	0	0
TAYLOR	20	0	20	0	0	0	0	0	20	0	0
TREMPEALEAU	79	0	72	0	7	0	0	0	66	6	0
WASHBURN	46	0	46	0	0	0	0	0	18	28	0
Total	1,347	209	860	53	225	82	127	0	601	256	3

SE Region

		Urban	Rural	Urban	Rural	Urban State Highway			Rural State Highway		
County	Total	STH	STH	IH	IH	Non-div	Divided	Unkn	Non-div	Divided	Unkn
KENOSHA	350	97	155	6	92	48	49	0	46	109	0
MILWAUKEE	1,110	616	0	494	0	120	496	0	0	0	0
OZAUKEE	141	32	32	18	59	19	13	0	15	17	0
RACINE	308	188	44	5	71	97	91	0	33	11	0
WALWORTH	184	27	108	2	47	15	11	1	78	30	0
WASHINGTON	319	146	173	0	0	51	94	1	65	108	0
WAUKESHA	484	202	89	100	93	55	146	1	49	40	0
Total	2,896	1,308	601	625	362	405	900	3	286	315	0

Table 4.13. Motor Vehicle Crashes on Roads with Snow/Ice/Slush
Bureau of Transportation Safety data, Nov. 1, 2008 - April 30, 2009 - State, U.S. and Interstate highways only

SW Region

		Urban	Rural	Urban	Rural	Urban State Highway			Rural State Highway		
County	Total	STH	STH	IH	IH	Non-div	Divided	Unkn	Non-div	Divided	Unkn
COLUMBIA	184	13	94	1	76	11	2	0	82	12	0
CRAWFORD	38	6	32	0	0	6	0	0	31	1	0
DANE	660	292	231	34	103	52	239	1	116	115	0
DODGE	211	27	184	0	0	18	9	0	95	89	0
GRANT	115	13	102	0	0	11	2	0	69	33	0
GREEN	58	7	51	0	0	0	7	0	48	3	0
IOWA	70	0	70	0	0	0	0	0	31	39	0
JEFFERSON	170	40	78	0	52	35	4	1	67	11	0
JUNEAU	124	0	44	0	80	0	0	0	43	1	0
LA CROSSE	329	167	75	51	36	64	103	0	41	34	0
LAFAYETTE	32	0	32	0	0	0	0	0	26	6	0
MONROE	181	27	49	7	98	13	14	0	49	0	0
RICHLAND	56	0	56	0	0	0	0	0	49	7	0
ROCK	379	88	144	62	85	37	51	0	117	27	0
SAUK	180	26	103	0	51	21	5	0	79	24	0
VERNON	55	0	55	0	0	0	0	0	54	1	0
Total	2,842	706	1,400	155	581	268	436	2	997	403	0
TOTALS	**10,837**	**3,345**	**5,157**	**901**	**1,434**						

STH = State highways or non-Interstate U.S. highways
IH = Interstate highways Non-div = Non-divided
Rural = An unincorporated area or an incorporated area with a population under 5,000
Urban = An incorporated area with a population of 5,000 or more.

*2009 figures are preliminary at this time.
**Does not include deer or other animal crashes

5 Looking Ahead

The winter of 2008-2009 wasn't as snowy as the winter of 2007-2008, but it was still one of the three most severe winters in the last 10 years. Increasing salt costs continue to be an issue, with higher salt use in several counties this winter than ever before. Use of anti-icing liquid increased this year, which can help counties use less salt.

In 2009-2010, WisDOT's focus will remain on maintaining the current winter level of service. With ever-increasing costs, this will mean that there will be reductions in many areas not related to winter. Most of the effort next winter will be to conduct winter operations more efficiently and cost-effectively. This effort will include the implementation of new technologies and the continued emphasis on best practices.

Areas of focus for the 2009-2010 winter:

1. WisDOT will invest in two Tow Plows. These plows will be evaluated in Marquette and Eau Claire counties.
2. WisDOT will invest in three portable Scale-Tec calibration scales. The scales will be evaluated in Marquette, Eau Claire and Dane counties.
3. WisDOT will piggyback on Dane County's recent decision to implement AVL/GPS (Automatic Vehicle Location/Global Positioning System) equipment countywide by adding and evaluating the MDSS (Maintenance Decision Support System) component.
4. The MDSS component will also be introduced statewide via the Meridian forecasting service.
5. MDSS will be paired with AVL/GPS along the Interstate corridor that extends from the Illinois line in southern Rock County to Hudson, and from Madison to Milwaukee.
6. Dane County will evaluate a new salt slurry spreader from Monroe Equipment.
7. Standing corn will be purchased from some farmers around the state and will be evaluated as living snow fence.
8. Region staff will work with counties to assure that material application guidelines are adhered to.
9. WisDOT staff will be taking a more active role with the counties in preparation for and reacting to winter events.
10. Regions will continue to be more diligent in conducting post-storm analyses.
11. Continued emphasis will be placed on the accuracy of storm reports that are submitted by the counties.
12. WisDOT will emphasize the need for counties to keep equipment calibrated.
13. WisDOT will work with the counties to identify and use alternate deicing agents when the pavement temperatures are very low and salt is less effective.
14. WisDOT will encourage counties in the Southwest and Southeast regions to incorporate underbody plows into their fleets.
15. WisDOT will continue to stress the advantages of using best practices such as prewetting salt and anti-icing.

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Appendix

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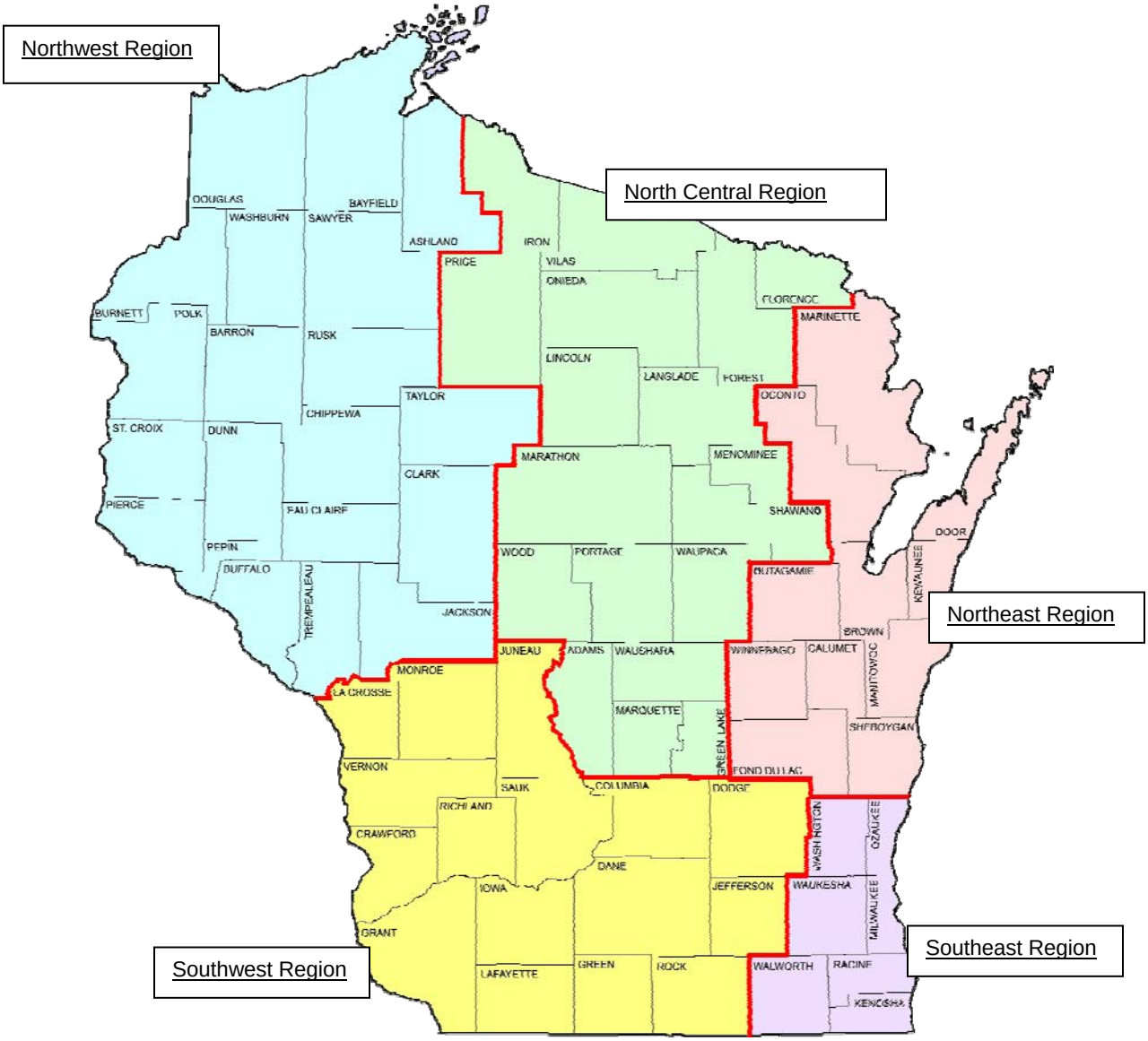
Wisconsin Department of Transportation
New regional organization
Effective May 29, 2005 (updated July 18, 2005)



Snow plowing and ice control categories during a storm

Category

1 **Major urban freeways and most highways with six lanes and greater**
All lanes and ramps will be maintained to the highest level practical.

2 **High volume four-lane highways (ADT* >= 25,000) and some four-lane highways (ADT < 25,000) and some six-lane highways**
All lanes and ramps will be maintained equally with emphasis on plowing and sensible salting.

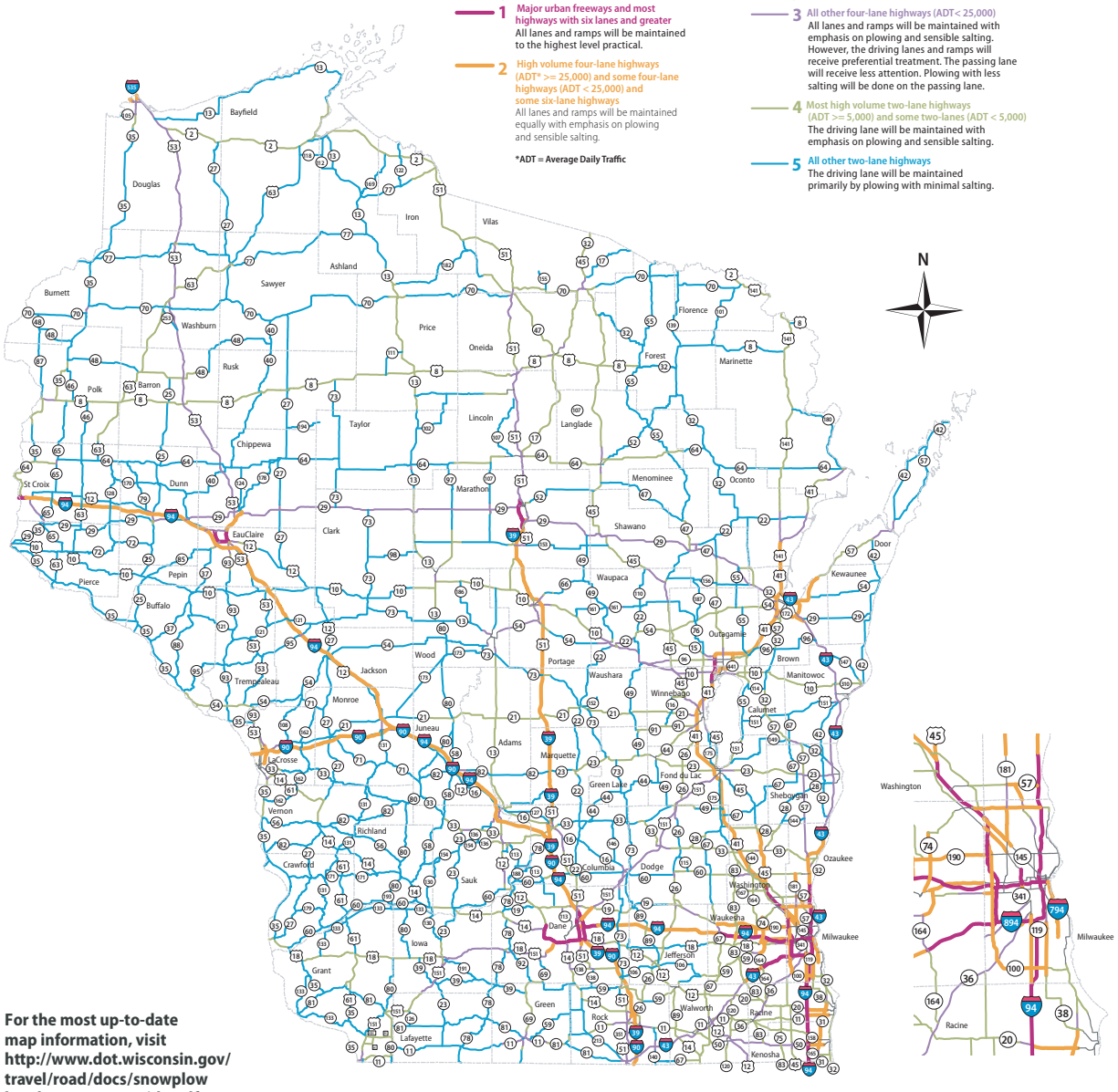
*ADT = Average Daily Traffic

Category

3 **All other four-lane highways (ADT< 25,000)**
All lanes and ramps will be maintained with emphasis on plowing and sensible salting. However, the driving lanes and ramps will receive preferential treatment. The passing lane will receive less attention. Plowing with less salting will be done on the passing lane.

4 **Most high volume two-lane highways (ADT >= 5,000) and some two-lanes (ADT < 5,000)**
The driving lane will be maintained with emphasis on plowing and sensible salting.

5 **All other two-lane highways**
The driving lane will be maintained primarily by plowing with minimal salting.



For the most up-to-date map information, visit http://www.dot.wisconsin.gov/travel/road/docs/snowplowbrochure2009mapside.pdf

10/13/2008

Table A-1. Storm Report Summary

From Winter Storm Reports, 2008-2009

Notes: 1) Costs shown in table are estimated and do not include the 4.25% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of June '07 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Region NC County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season			Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile				Estimated Total Cost to Date
				Anti-Icing	Storms	Incident									Mat'l	Equip	Labor	Total	
ADAMS	192.48	32.34	87.0	5	33	18	11	4,756	2,944	1,812	15.3	160.0	723.0	748.5	$860	$493	$362	$1,715	$330,156
FLORENCE	141.07	42.49	112.9	10	47	24	8	3,750	3,074	676	21.8	187.5	718.5	389.0	$1,122	$467	$321	$1,910	$269,382
FOREST	312.38	42.03	101.9	2	46	24	16	9,653	5,783	3,870	18.5	121.0	1958.5	1097.5	$953	$528	$378	$1,858	$580,361
GREEN LAKE	151.3	35.17	98.6	4	30	27	7	2,488	1,131	1,357	7.5	4.0	620.0	428.0	$339	$390	$291	$1,020	$154,279
IRON	250.91	56.02	215.2	0	61	12	8	10,085	5,250	4,835	20.9	470.0	2080.0	1008.0	$1,089	$684	$545	$2,318	$581,697
LANGLADE	292.69	46.01	85.1	8	47	22	16	7,725	3,372	4,353	11.5	6.4	1467.5	1140.0	$537	$486	$388	$1,411	$413,068
LINCOLN	418.33	49.09	77.0	7	50	26	18	6,880	4,403	2,477	10.5	946.0	2855.5	1552.0	$518	$560	$432	$1,509	$631,285
MARATHON	878.99	44.75	81.7	21	45	51	10	16,437	10,338	6,099	11.8	913.0	3997.5	3649.0	$557	$507	$413	$1,478	$1,299,232
MARQUETTE	243.91	29.30	89.9	1	30	15	5	5,931	3,894	2,037	16.0	0.0	810.5	1135.5	$780	$405	$345	$1,530	$373,259
MENOMINEE	90.26	34.15	96.6	0	37	31	6	2,040	559	1,481	6.2	366.0	417.8	181.5	$246	$388	$224	$859	$77,532
ONEIDA	396.79	50.44	89.8	15	53	17	9	11,056	7,750	3,306	19.5	776.0	3183.0	1850.8	$999	$607	$570	$2,176	$863,364
PORTAGE	504.28	40.95	89.0	0	46	23	11	10,370	6,980	3,390	13.8	802.0	2573.0	3081.0	$650	$673	$553	$1,876	$946,093
PRICE	320.57	58.69	73.9	8	57	28	20	7,452	5,101	2,351	15.9	514.0	1503.5	1630.0	$876	$553	$434	$1,863	$597,334
SHAWANO	516.24	40.27	106.5	2	41	30	8	9,715	7,120	2,595	13.8	726.2	3240.0	2470.8	$549	$632	$453	$1,634	$843,320
VILAS	305.24	58.58	134.3	0	71	9	31	10,292	7,212	3,080	23.6	1413.0	2076.5	1374.0	$1,270	$664	$521	$2,454	$749,181
WAUPACA	546.58	38.57	109.3	2	40	27	7	9,390	8,245	1,145	15.1	114.0	2120.8	2876.3	$644	$546	$434	$1,624	$887,575
WAUSHARA	345.71	32.88	95.6	2	30	16	11	5,020	3,276	1,744	9.5	128.5	1060.5	1313.5	$456	$381	$318	$1,155	$399,356
WOOD	362.92	42.90	86.7	8	39	26	19	8,080	4,825	3,255	13.3	508.0	1495.3	1685.8	$696	$505	$413	$1,614	$585,737
Region Total		--	--	--	--	--	--	141,120	91,257	49,863	--	8156	--	--	--	--	--	--	$10,582,210
Region Average		43.04	101.7	5.3	44.6	23.7	12.3	7,840	5,070	2,770	14.7	453	1827.8	1533.9	$730	$526	$411	$1,667	$587,901

Table A-1. Storm Report Summary

From Winter Storm Reports, 2008-2009

Notes: 1) Costs shown in table are estimated and do not include the 4.25% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of June '07 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Region NE County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season			Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile				Estimated Total Cost to Date
				Anti-Icing	Storms	Inci-dent									Mat'l	Equip	Labor	Total	
BROWN	711.75	33.94	102.4	0	33	15	5	16,460	14,520	1,940	20.4	116.0	3415.5	5145.0	$678	$672	$666	$2,016	$1,435,013
CALUMET	201.31	40.01	91.7	13	31	42	4	3,250	2,385	865	11.8	10.0	1139.5	1346.5	$448	$721	$592	$1,761	$354,471
DOOR	268.55	34.84	86.2	15	31	36	2	2,890	2,705	185	10.1	365.0	1028.5	2001.8	$401	$675	$610	$1,686	$452,840
FOND DU LAC	594.34	35.99	82.9	7	31	35	10	10,060	9,110	950	15.3	174.0	3309.0	4481.0	$669	$708	$630	$2,007	$1,192,857
KEWAUNEE	110.41	34.06	125.3	0	31	33	2	1,980	1,265	715	11.5	612.0	512.0	485.4	$472	$520	$413	$1,405	$155,092
MANITOWOC	414.69	31.57	96.3	9	29	19	6	8,970	8,260	710	19.9	0.0	2094.0	1977.0	$773	$589	$491	$1,853	$768,323
MARINETTE	388.36	45.67	112.9	2	43	40	9	6,880	5,315	1,565	13.7	113.0	1638.5	1389.0	$583	$428	$384	$1,395	$541,898
OCONTO	437.71	36.49	106.7	2	41	36	7	7,740	5,770	1,970	13.2	5.0	1925.3	1956.5	$518	$500	$419	$1,437	$629,157
OUTAGAMIE	520.01	33.51	90.1	5	33	19	6	13,230	10,215	3,015	19.6	0.0	4154.8	2496.8	$744	$612	$539	$1,895	$985,567
SHEBOYGAN	520.3	30.04	98.9	6	27	23	3	11,610	9,450	2,160	18.2	6.0	2308.0	2883.3	$784	$571	$538	$1,893	$985,026
WINNEBAGO	567.36	31.42	79.1	2	34	27	7	12,490	11,560	930	20.4	3.0	1997.1	4654.5	$836	$639	$559	$2,034	$1,154,213
Region Total		--	--	--	--	--	--	95,560	80,555	15,005	--	1404	--	--	--	--	--	--	$8,654,456
Region Average		35.23	97.5	5.5	33.1	29.5	5.5	8,687	7,323	1,364	15.8	128	2138.4	2619.7	$628	$603	$531	$1,762	$786,769

Table A-1. Storm Report Summary

From Winter Storm Reports, 2008-2009

Notes: 1) Costs shown in table are estimated and do not include the 4.25% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of June '07 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Region / NW County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season: Anti-Icing	Storms	Incident	Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile: Mat'l	Equip	Labor	Total	Estimated Total Cost to Date
ASHLAND	247.57	53.23	180.9	2	54	22	16	8,029	2,891	5,138	11.7	246.0	1205.3	1196.0	$991	$562	$420	$1,973	$488,541
BARRON	423.09	37.70	69.7	4	37	41	13	4,087	2,774	1,313	6.6	1343.0	2394.0	1617.3	$564	$520	$426	$1,509	$638,396
BAYFIELD	316.9	55.03	158.9	5	56	21	15	7,526	5,705	1,821	18.0	120.0	2255.0	987.0	$1,468	$614	$421	$2,503	$793,098
BUFFALO	315.77	36.50	60.7	4	36	22	10	3,923	2,024	1,899	6.4	146.0	1224.0	1055.0	$297	$364	$294	$955	$301,713
BURNETT	233.64	30.71	75.1	0	28	27	10	3,823	2,672	1,151	11.4	635.0	1019.0	691.5	$947	$420	$316	$1,682	$393,066
CHIPPEWA	667.85	33.14	72.4	0	39	22	5	14,220	8,099	6,121	12.1	1912.0	2229.5	3121.0	$808	$514	$363	$1,685	$1,125,601
CLARK	402.28	32.53	93.3	6	37	12	9	7,299	4,899	2,400	12.2	30.0	1305.0	1308.0	$758	$391	$301	$1,450	$583,262
DOUGLAS	439.23	44.49	154.7	6	50	24	11	8,414	6,224	2,190	14.2	176.0	2057.0	1848.5	$607	$492	$432	$1,531	$672,460
DUNN	516.55	27.27	67.1	0	31	11	3	12,677	6,463	6,214	12.5	938.0	1705.0	2338.0	$701	$426	$406	$1,534	$792,138
EAU CLAIRE	559.86	26.87	57.9	0	33	7	9	12,780	6,580	6,200	11.8	382.0	2056.0	2302.0	$661	$467	$363	$1,491	$834,814
JACKSON	504.1	32.53	106.0	0	38	22	18	11,135	7,305	3,830	14.5	275.0	2610.0	1687.0	$750	$450	$351	$1,552	$782,125
PEPIN	111.05	25.76	61.2	2	32	15	3	1,434	879	555	7.9	347.0	377.5	366.0	$383	$376	$301	$1,060	$117,690
PIERCE	366.08	37.87	67.4	4	38	22	13	6,913	3,947	2,966	10.8	1282.0	1387.5	1197.5	$580	$363	$336	$1,279	$468,398
POLK	385.05	42.23	73.6	0	33	40	10	7,670	4,222	3,448	11.0	1562.4	1443.0	1567.3	$592	$438	$378	$1,408	$542,130
RUSK	213.47	31.39	73.6	0	34	26	14	3,454	1,806	1,648	8.5	317.7	733.0	535.5	$457	$333	$254	$1,043	$222,709
SAINT CROIX	616.98	39.06	66.0	0	42	24	10	10,725	7,638	3,087	12.4	967.0	2074.5	3042.6	$676	$496	$421	$1,594	$983,175
SAWYER	367.44	34.18	78.2	0	35	22	17	5,220	3,272	1,948	8.9	108.0	1789.9	927.5	$438	$377	$297	$1,113	$408,983
TAYLOR	233.25	40.63	70.8	15	36	43	17	4,988	3,015	1,973	12.9	247.0	1140.5	467.3	$760	$390	$273	$1,423	$331,947
TREMPEALEAU	432.31	29.48	76.9	1	30	25	6	7,379	5,993	1,386	13.9	412.0	1731.0	1257.0	$666	$368	$294	$1,327	$573,513
WASHBURN	372.14	32.61	96.7	12	35	17	7	5,830	5,026	804	13.5	1038.0	1491.0	1324.3	$603	$449	$324	$1,376	$512,175
Region Total		--	--	--	--	--	--	147,526	91,434	56,092	--	12484	--	--	--	--	--	--	$11,565,934
Region Average	36.16	88.0	3.1	37.7	23.3	10.8	7,376	4,572	2,805	11.6	624	1611.4	1441.8	$685	$441	$349	$1,474	$578,297	

Table A-1. Storm Report Summary

From Winter Storm Reports, 2008-2009

Notes: 1) Costs shown in table are estimated and do not include the 4.25% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of June '07 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Region SE / County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season			Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile				Estimated Total Cost to Date
				Anti-Icing	Storms	Incident									Mat'l	Equip	Labor	Total	
KENOSHA	554.27	32.35	96.7	15	30	19	8	14,389	9,436	4,953	17.0	0.0	4011.8	5372.8	$641	$984	$1,108	$2,733	$1,514,998
MILWAUKEE	1795.6	32.15	78.8	6	30	7	6	60,627	47,166	13,461	26.3	0.0	8007.0	11673.0	$996	$536	$764	$2,296	$4,123,247
OZAUKEE	304.03	30.08	77.3	2	31	33	2	11,151	7,304	3,847	24.0	0.0	2021.5	1214.0	$895	$639	$536	$2,070	$629,460
RACINE	676.84	38.16	97.6	6	31	27	6	15,704	12,772	2,932	18.9	54.0	3213.0	5505.3	$786	$721	$836	$2,343	$1,585,703
WALWORTH	691.89	31.51	88.4	2	32	14	9	20,479	15,896	4,583	23.0	426.0	2197.3	4459.5	$890	$707	$566	$2,163	$1,496,221
WASHINGTON	580.03	30.64	85.4	8	33	9	7	16,376	11,635	4,741	20.1	58.0	1713.0	3396.8	$896	$461	$448	$1,805	$1,047,218
WAUKESHA	1062.4	26.26	89.8	13	26	4	8	40,571	33,271	7,300	31.3	0.0	4122.0	8963.0	$1,266	$729	$667	$2,661	$2,827,414
Region Total		--	--	--	--	--	--	179,297	137,480	41,817	--	538	--	--	--	--	--	--	$13,224,261
Region Average		31.59	87.7	7.4	30.4	16.1	6.6	25,614	19,640	5,974	22.9	77	3612.2	5797.8	$910	$682	$704	$2,296	$1,889,180

Table A-1. Storm Report Summary

From Winter Storm Reports, 2008-2009

Notes: 1) Costs shown in table are estimated and do not include the 4.25% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of June '07 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Region SW County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season			Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile				Estimated Total Cost to Date
				Anti-Icing	Storms	Incident									Mat'l	Equip	Labor	Total	
COLUMBIA	745.8	30.30	93.2	4	31	21	5	29,245	24,965	4,280	33.5	3713.0	2956.3	4731.0	$1,866	$618	$548	$3,032	$2,261,124
CRAWFORD	385.21	35.64	63.4	7	28	37	12	5,748	4,089	1,659	10.6	2062.0	1332.5	1278.5	$531	$374	$297	$1,202	$463,197
DANE	1674.1	28.46	68.7	5	29	2	5	49,588	43,643	5,945	26.1	239.0	5221.5	14542.2	$1,208	$636	$650	$2,494	$4,175,554
DODGE	606.62	31.75	80.5	8	33	16	7	16,310	15,141	1,169	25.0	1.0	2244.5	3335.5	$1,097	$523	$399	$2,020	$1,225,223
GRANT	624.14	33.92	68.6	7	30	37	8	11,563	7,369	4,194	11.8	2142.4	2229.5	2398.5	$591	$435	$306	$1,332	$831,086
GREEN	311.45	31.25	72.9	5	31	37	7	4,295	2,638	1,657	8.5	592.5	1515.5	1704.0	$440	$551	$387	$1,379	$429,406
IOWA	451.03	28.82	74.6	0	30	20	4	5,940	5,087	853	11.3	263.0	1816.0	2789.0	$608	$551	$447	$1,606	$724,253
JEFFERSON	458.21	26.52	70.0	0	28	18	8	14,866	10,373	4,493	22.6	295.0	1589.5	2613.0	$917	$512	$492	$1,921	$880,151
JUNEAU	498.13	31.64	85.4	10	32	14	10	11,238	7,779	3,459	15.6	989.0	1619.0	1986.5	$876	$408	$329	$1,614	$803,762
LA CROSSE	480.28	36.54	76.9	14	31	39	8	10,946	6,592	4,354	13.7	1793.0	2996.0	2191.0	$648	$598	$515	$1,761	$845,929
LAFAYETTE	293.88	26.94	66.1	1	25	17	7	4,090	2,622	1,468	8.9	2786.0	745.9	1244.2	$467	$370	$292	$1,129	$331,739
MONROE	644.23	36.59	77.4	10	37	25	12	12,282	9,083	3,199	14.1	1284.0	2658.8	2571.3	$696	$446	$364	$1,505	$969,736
RICHLAND	328.72	26.96	75.3	2	27	25	5	6,195	2,945	3,250	9.0	616.0	1003.8	977.8	$487	$336	$270	$1,094	$359,534
ROCK	592.56	31.84	85.1	1	30	12	10	15,472	9,982	5,490	16.8	1165.0	2570.5	4207.3	$775	$622	$603	$1,999	$1,184,704
SAUK	591.55	28.71	83.5	23	33	17	8	16,168	13,814	2,354	23.4	488.0	2741.5	2921.0	$1,393	$562	$405	$2,360	$1,396,329
VERNON	450	33.21	76.5	7	35	15	9	7,409	3,137	4,272	7.0	3168.0	1477.5	1296.3	$347	$324	$225	$895	$402,822
Region Total		--	--	--	--	--	--	221,355	169,259	52,096	--	21597	--	--	--	--	--	--	$17,284,552
Region Average		31.19	76.1	6.5	30.6	22.0	7.8	13,835	10,579	3,256	16.1	1350	2169.9	3174.2	$809	$492	$408	$1,709	$1,080,284

Table A-1. Storm Report Summary

From Winter Storm Reports, 2008-2009

Notes: 1) Costs shown in table are estimated and do not include the 4.25% Administrative Costs; 2) Material Costs includes Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on $60 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds as of June '07 (modified as required) plus early seasonal fill plus seasonal fill plus vendor reserve available.

Statewide Total	--	--	--	--	--	--	784,858	569,985	214,873	--	44178.5	--	--	--	--	--	--	$61,311,413
Statewide Average	36.19	90.2	5.2	36.4	23.3	9.3	10,901	7,916	2,984	15.1	613.6	2064.6	2453.3	$737	$522	$440	$1,698	$851,547

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WEATHER MANAGEMENT SOLUTIONS, LLC

EVALUATION OF WEATHER FORECAST SERVICES

Michael J. Adams

2009

Executive Summary

Introduction

In order to assess the quality of weather and pavement temperature forecasts provided to the Wisconsin Department of Transportation (WisDOT) and the county highway departments who provide winter maintenance on the state trunk highway system, the WisDOT Road Weather Information System (RWIS) Program Manager performed a verification study on these forecasts. The primary aim of this study is to uncover any potential problems in forecast accuracy. The ultimate goal of this project is to use the findings of this study to improve the quality of weather and pavement temperature forecast information provided by Meridian Environmental Technology, Inc. (Meridian), or any other provider of forecast information.

In addition, Meridian conducted two surveys of the county highway departments (the users of the forecast information) during the winter. The aim of these surveys is twofold. They enable Meridian and WisDOT to gauge customer satisfaction. They also promote interaction between Meridian and the users of the service they provide.

For all information presented in this report, results for the winter seasons of 1998-99 through 2004-05 are for forecasts provided by Surface Systems, Inc., while results after that are for forecasts provided by Meridian.

Verification Procedures

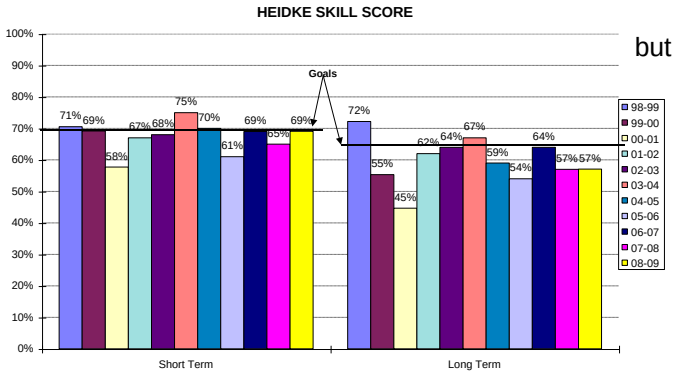
Forecasts for eight locations were examined: Madison, Milwaukee, Green Bay, Wausau, La Crosse, Eau Claire, and Rhinelander, and Rice Lake. The time period covered by the verification study was December 1, 2008 through March 31, 2009. Four specific criteria were examined: snow, freezing precipitation, wind speed, and pavement temperature.

For the first two criteria, the verification methodology was based on a paper presented by John Thornes at the 1998 Standing International Road Weather Commission (SIRWEC) conference. It is based on common meteorological forecast verification techniques. The basis of the method is to choose two time periods (in our case 0 to 6 hours and 6 to 24 hours after forecast issuance) during the forecasts and see if the particular criterion was forecast to occur and whether it actually occurred during the periods being examined. In other words, was snow forecast to occur and did it occur? Two-by-two contingency tables are then constructed. A number of statistics were calculated, each of which provides a different piece of intelligence. Goal scores for each statistic have also been established. For pavement temperature and wind speed, the forecast values 3 and 9 hours after forecast issuance times were compared to the actual values and error statistics were computed. In addition, the timing error for the start and stop of precipitation and the lead time provided by the winter storm warning service were also examined. Some minor adjustments to the methodology used in previous verification studies were required due to the different format of the Meridian forecasts.

Results of this and previous studies are made available to Meridian or whoever the current forecast provider is. It is expected that Meridian will use the results of these studies to continue to improve upon their weather support to WisDOT and the county highway departments.

Verification Results

- **Precipitation forecasts.** Accuracy was slightly better than the previous winter, the results still failed to meet established goals. On an encouraging note, performance was best in December, which was, by far, the harshest month of the winter.



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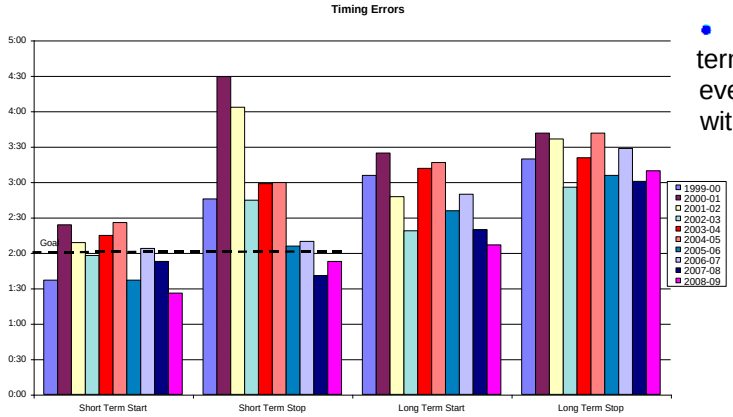
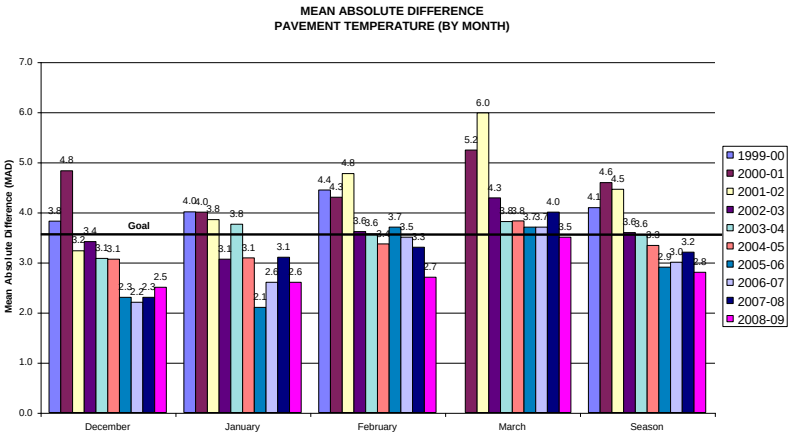
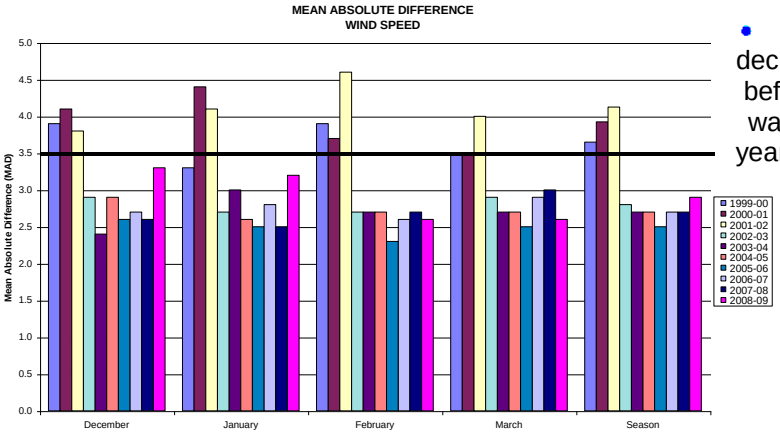


- **Timing error.** Timing errors for both short term and long term start of snow were the best ever recorded in these studies. This means that within six hours of the actual start time, Meridian's forecasts were accurate to within an hour.

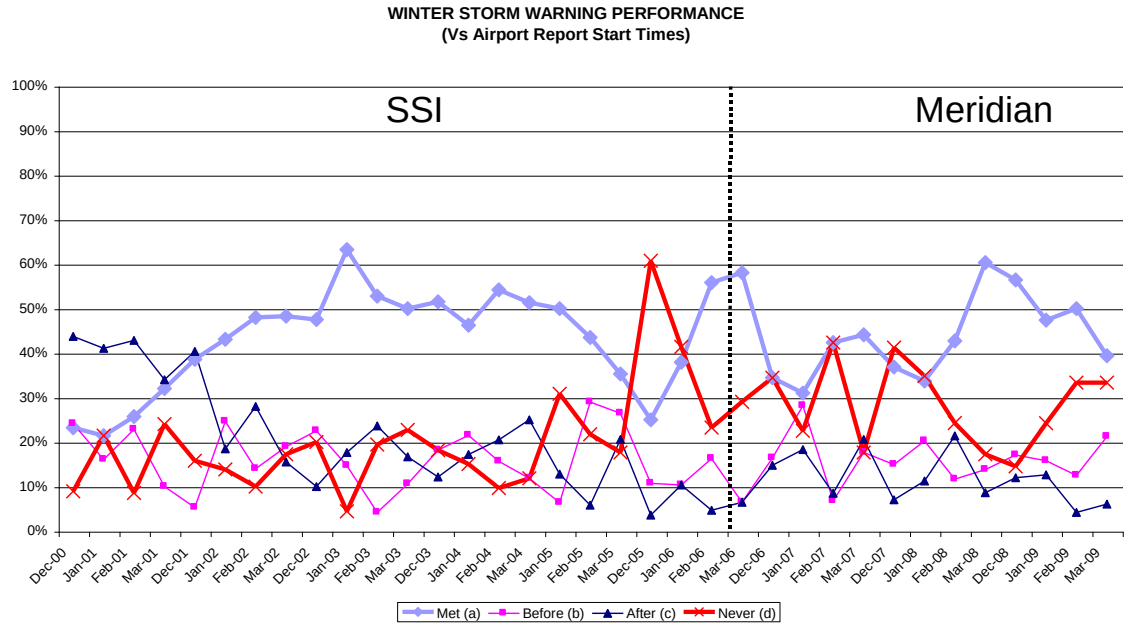
- **Pavement temperature.** Performance continued to be excellent, and even improved compared to the previous winter. The problem noted the past two years with regard to afternoon pavement temperature forecast accuracy in the northern locations was not as evident this year. This implies that Meridian's cloud cover forecasts improved.





- **Winds.** Wind forecast accuracy declined sharply in December and January before rebounding. But overall, accuracy was the lowest it has been in the four years since Meridian began forecasting for WisDOT. Performance is still exceeding the goals, but the trend is worrisome.

- **Winter storm warnings.** Performance was slightly better than previous seasons, but again failed to meet expectations. For the winter, 51 percent of events were preceded by a warning issued more than two hours in advance, as required by WisDOT's contract with Meridian. About 23 percent of events were preceded by no warning at all, though many of these were likely inconsequential.



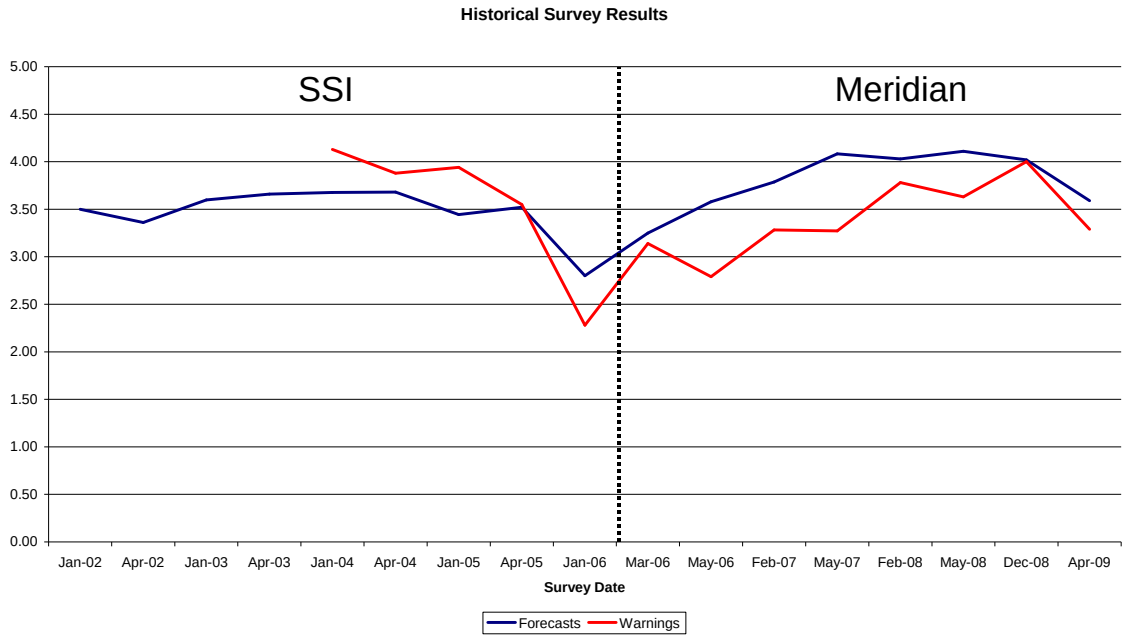
Legend:

Met: warning issued more than 2 hours before event onset
Before: warning issued before event onset
After: warning issued after event onset
Never: no warning ever issued for event

Survey Results

Surveys taken during January and May 2009, brought mixed results. The January forecast rating of 4.02 was consistent with the previous three surveys. However, this number fell to 3.59 in the May survey. While this drop is significant, the reasons for it are unclear. Perhaps the weather caused more missed forecasts (many small, light events). Or perhaps the group sampled simply had a lower opinion than previous groups. This result will be monitored closely next winter in order to determine if a trend is

developing. As usual, users gave lower ratings to the storm warning service, though the trends are similar.



Recommendations

Meridian will prepare a plan of action to address winter storm warning performance, including the high number of false alarms and the low percentage of warnings that met the required two-hour lead time, no later than August 15, 2009 and implement solutions no later than October 15, 2009:

The WisDOT RWIS Program Manager (PM) will monitor the accuracy of wind speed forecasts and customer satisfaction surveys to determine if negative trends are developing in these areas. If such trends are found, the PM will coordinate with Meridian on appropriate actions.

Table A-2. Weather Forecasting Service Usage

From Winter Storm Reports, 2008-2009

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
SW	JEFFERSON	3	0	0	3	25	11%	10,373	70.0	26.5	0.85	28	18	3	0
	VERNON	8	30	1	39	3	93%	3,137	76.5	33.2	0.21	35	15	5	7
	CRAWFORD	1	22	8	31	4	89%	4,089	63.4	35.6	0.30	28	37	7	7
	DANE	12	9	13	34	0	100%	43,643	68.7	28.5	0.92	29	2	3	5
	DODGE	26	1	3	30	11	73%	15,141	80.5	31.7	0.79	33	16	5	8
	GRANT	13	11	6	30	7	81%	7,369	68.6	33.9	0.35	30	37	4	7
	IOWA	7	14	8	29	1	97%	5,087	74.6	28.8	0.39	30	20	1	0
	COLUMBIA	23	3	5	31	4	89%	24,965	93.2	30.3	1.10	31	21	2	4
	JUNEAU	7	19	0	26	16	62%	7,779	85.4	31.6	0.49	32	14	6	10
	LA CROSSE	5	16	0	21	24	47%	6,592	76.9	36.5	0.38	31	39	4	14
	LAFAYETTE	16	9	0	25	1	96%	2,622	66.1	26.9	0.33	25	17	1	1
	MONROE	9	17	12	38	9	81%	9,083	77.4	36.6	0.39	37	25	5	10
	RICHLAND	12	15	0	27	2	93%	2,945	75.3	27.0	0.33	27	25	3	2
	ROCK	26	0	2	28	3	90%	9,982	85.1	31.8	0.53	30	12	6	1
	SAUK	10	21	3	34	22	61%	13,814	83.5	28.7	0.81	33	17	3	23
	GREEN	26	2	5	33	3	92%	2,638	72.9	31.3	0.27	31	37	3	5
Region Average		12.8	11.8	4.1	28.7	8.4	78.3%	10,578.7	76.1	31.2	0.53	30.6	22.0	3.8	6.5

Table A-2. Weather Forecasting Service Usage

From Winter Storm Reports, 2008-2009

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
SE	OZAUKEE	7	13	11	31	2	94%	7,304	77.3	30.1	0.80	31	33	2	2
	KENOSHA	2	23	2	27	18	60%	9,436	96.7	32.4	0.53	30	19	2	15
	MILWAUKEE	12	12	6	30	6	83%	47,166	78.8	32.1	0.82	30	7	5	6
	RACINE	28	0	1	29	8	78%	12,772	97.6	38.2	0.49	31	27	4	6
	WALWORTH	9	7	16	32	2	94%	15,896	88.4	31.5	0.73	32	14	4	2
	WAUKESHA	9	25	1	35	4	90%	33,271	89.8	26.3	1.19	26	4	4	13
	WASHINGTON	16	18	4	38	3	93%	11,635	85.4	30.6	0.65	33	9	4	8
Region Average		11.9	14.0	5.9	31.7	6.1	84.6%	19,640.0	87.7	31.6	0.74	30.4	16.1	3.6	7.4

Table A-2. Weather Forecasting Service Usage

From Winter Storm Reports, 2008-2009

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
NW	EAU CLAIRE	32	0	1	33	0	100%	6,580	57.9	26.9	0.44	33	7	5	0
	ASHLAND	22	23	11	56	0	100%	2,891	180.9	53.2	0.22	54	22	5	2
	BARRON	13	22	4	39	2	95%	2,774	69.7	37.7	0.17	37	41	9	4
	BAYFIELD	50	5	0	55	6	90%	5,705	158.9	55.0	0.33	56	21	2	5
	BUFFALO	6	22	5	33	7	83%	2,024	60.7	36.5	0.18	36	22	7	4
	BURNETT	15	8	5	28	0	100%	2,672	75.1	30.7	0.37	28	27	2	0
	CLARK	41	0	0	41	2	95%	4,899	93.3	32.5	0.37	37	12	5	6
	DOUGLAS	4	29	9	42	14	75%	6,224	154.7	44.5	0.32	50	24	4	6
	DUNN	1	1	0	2	29	6%	6,463	67.1	27.3	0.46	31	11	1	0
	SAWYER	8	15	12	35	0	100%	3,272	78.2	34.2	0.26	35	22	4	0
	JACKSON	2	33	2	37	1	97%	7,305	106.0	32.5	0.45	38	22	0	0
	WASHBURN	5	12	1	18	29	38%	5,026	96.7	32.6	0.41	35	17	5	12
	TAYLOR	39	8	3	50	1	98%	3,015	70.8	40.6	0.32	36	43	10	15
	SAINT CROIX	2	2	38	42	0	100%	7,638	66.0	39.1	0.32	42	24	6	0
	CHIPPEWA	18	12	7	37	2	95%	8,099	72.4	33.1	0.37	39	22	2	0
	RUSK	7	4	3	14	20	41%	1,806	73.6	31.4	0.27	34	26	6	0
	POLK	4	27	1	32	1	97%	4,222	73.6	42.2	0.26	33	40	4	0
	PIERCE	10	25	4	39	3	93%	3,947	67.4	37.9	0.28	38	22	9	4
	PEPIN	13	19	1	33	1	97%	879	61.2	25.8	0.31	32	15	2	2
	TREMPEALEAU	14	9	0	23	8	74%	5,993	76.9	29.5	0.47	30	25	2	1
Region Average		15.3	13.8	5.4	34.5	6.3	83.8%	4,571.7	88.0	36.2	0.33	37.7	23.3	4.5	3.1

Table A-2. Weather Forecasting Service Usage

From Winter Storm Reports, 2008-2009

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
NE	DOOR	33	6	1	40	6	87%	2,705	86.2	34.8	0.29	31	36	0	15
	MANITOWOC	37	0	1	38	0	100%	8,260	96.3	31.6	0.63	29	19	1	9
	CALUMET	18	12	2	32	12	73%	2,385	91.7	40.0	0.30	31	42	1	13
	FOND DU LAC	26	9	3	38	0	100%	9,110	82.9	36.0	0.43	31	35	6	7
	KEWAUNEE	0	28	3	31	0	100%	1,265	125.3	34.1	0.34	31	33	2	0
	OCONTO	41	1	0	42	1	98%	5,770	106.7	36.5	0.36	41	36	5	2
	OUTAGAMIE	13	17	6	36	2	95%	10,215	90.1	33.5	0.59	33	19	2	5
	SHEBOYGAN	24	3	3	30	3	91%	9,450	98.9	30.0	0.60	27	23	1	6
	WINNEBAGO	5	26	4	35	1	97%	11,560	79.1	31.4	0.65	34	27	2	2
	MARINETTE	16	25	3	44	2	96%	5,315	112.9	45.7	0.30	43	40	5	2
	BROWN	33	0	0	33	0	100%	14,520	102.4	33.9	0.60	33	15	3	0
Region Average		22.4	11.5	2.4	36.3	2.5	94.2%	7,323.2	97.5	35.2	0.46	33.1	29.5	2.5	5.5

Table A-2. Weather Forecasting Service Usage

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NC	PRICE	40	22	3	65	0	100%	5,101	73.9	58.7	0.27	57	28	14	8
	FLORENCE	0	36	2	38	19	67%	3,074	112.9	42.5	0.51	47	24	6	10
	FOREST	18	25	4	47	1	98%	5,783	101.9	42.0	0.44	46	24	5	2
	GREEN LAKE	2	14	16	32	2	94%	1,131	98.6	35.2	0.21	30	27	3	4
	IRON	1	47	13	61	0	100%	5,250	215.2	56.0	0.37	61	12	5	0
	LANGLADE	13	24	10	47	8	85%	3,372	85.1	46.0	0.25	47	22	16	8
	LINCOLN	26	25	3	54	3	95%	4,403	77.0	49.1	0.21	50	26	12	7
	MARATHON	8	6	2	16	50	24%	10,338	81.7	44.7	0.26	45	51	7	21
	MARQUETTE	1	27	3	31	0	100%	3,894	89.9	29.3	0.54	30	15	2	1
	MENOMINEE	22	12	3	37	0	100%	559	96.6	34.2	0.18	37	31	5	0
	PORTAGE	43	2	1	46	0	100%	6,980	89.0	41.0	0.34	46	23	8	0
	SHAWANO	3	0	0	3	40	7%	7,120	106.5	40.3	0.34	41	30	5	2
	VILAS	33	35	3	71	0	100%	7,212	134.3	58.6	0.40	71	9	8	0
	WAUPACA	2	37	0	39	3	93%	8,245	109.3	38.6	0.39	40	27	5	2
	WAUSHARA	10	18	4	32	0	100%	3,276	95.6	32.9	0.29	30	16	6	2
	WOOD	36	10	1	47	0	100%	4,825	86.7	42.9	0.31	39	26	13	8
	ADAMS	10	27	0	37	1	97%	2,944	87.0	32.3	0.47	33	18	8	5
	ONEIDA	6	18	29	53	15	78%	7,750	89.8	50.4	0.39	53	17	7	15
Region Average		15.2	21.4	5.4	42.0	7.9	85.5%	5,069.8	101.7	43.0	0.34	44.6	23.7	7.5	5.3

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From Winter Storm Reports, 2008-2009

Region	County	Good	Fair	Poor	Times Used	Times Not Used	% of Events Used	Salt Used (tons)	Snow Amount (inches)	Severity Index	Salt per LM per Severity Index	No. of Storms Events	No. of Incidents Reported	No.of Freezing Rains	No. of Anti-Ice Appl.
Statewide Average		15.5	14.9	4.7	35.1	6.6	84.6%	7,916.5	90.2	36.2	0.44	36.4	23.3	4.7	5.2

Table A-3. Anti-icing Details

From Winter Storm Reports, 2007-2008

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
NC	ADAMS	5	2	2	1	1	0	0	0	1,020	661	1,681
	FLORENCE	10	1	7	3	0	0	0	0	3,210	2,000	5,210
	FOREST	2	0	0	1	0	0	1	0	1,440	1,243	2,683
	GREEN LAKE	4	2	0	0	0	1	2	0	1,230	889	2,119
	LANGLADE	8	1	1	5	1	1	1	0	2,310	1,626	3,936
	LINCOLN	7	2	3	2	0	3	0	0	1,770	1,324	3,094
	MARATHON	21	1	1	0	0	1	21	0	12,750	8,590	21,340
	MARQUETTE	1	0	1	0	0	0	0	0	840	536	1,376
	ONEIDA	15	0	0	0	0	0	15	0	5,670	3,584	9,254
	PRICE	8	7	1	4	2	0	0	0	2,280	1,543	3,823
	SHAWANO	2	0	0	0	0	0	2	0	990	690	1,680
	WAUPACA	2	0	0	0	0	1	1	0	960	884	1,844
	WAUSHARA	2	1	1	0	0	0	0	0	840	834	1,674
	WOOD	8	6	0	6	2	0	0	0	1,320	931	2,251
Region Total		95	23	17	22	6	7	43	0	36,630	25,335	61,965
Region Average		7	--	--	--	--	--	--	0	2,616	1,810	4,426

Table A-3. Anti-icing Details

From Winter Storm Reports, 2007-2008

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
NE	CALUMET	13	0	1	0	0	0	12	0	3,390	2,263	5,653
	DOOR	15	2	2	0	1	10	6	0	6,900	4,674	11,574
	FOND DU LAC	7	2	4	2	1	0	0	0	6,000	4,291	10,291
	MANITOWOC	9	0	0	0	0	0	9	0	3,780	2,536	6,316
	MARINETTE	2	1	1	0	0	0	0	0	240	240	480
	OCONTO	2	0	0	0	0	0	2	0	180	641	821
	OUTAGAMIE	5	3	0	1	1	0	2	0	3,780	2,343	6,123
	SHEBOYGAN	6	0	3	0	0	1	2	0	2,880	2,026	4,906
	WINNEBAGO	2	0	0	0	0	0	2	0	870	1,694	2,564
Region Total		61	8	11	3	3	11	35	0	28,020	20,707	48,727
Region Average		7	--	--	--	--	--	--	0	3,113	2,301	5,414

Table A-3. Anti-icing Details

From Winter Storm Reports, 2007-2008

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
NW	ASHLAND	2	0	0	0	0	2	0	0	660	381	1,041
	BARRON	4	0	0	0	0	3	1	0	1,680	1,083	2,763
	BAYFIELD	5	0	0	0	0	5	0	0	2,400	1,430	3,830
	BUFFALO	4	0	0	0	0	1	3	0	1,440	1,059	2,499
	CLARK	6	3	0	2	1	0	2	0	2,880	1,780	4,660
	DOUGLAS	6	1	2	2	0	1	3	0	2,520	1,768	4,288
	PEPIN	2	0	0	0	0	0	2	0	360	216	576
	PIERCE	4	1	1	2	1	1	1	0	1,500	1,663	3,163
	TAYLOR	15	2	1	6	2	0	9	0	3,300	1,865	5,165
	TREMPEALEAU	1	0	0	0	0	0	1	0	180	140	320
	WASHBURN	12	0	0	0	0	0	12	0	4,620	2,672	7,292
Region Total		61	7	4	12	4	13	34	0	21,540	14,057	35,597
Region Average		6	--	--	--	--	--	--	0	1,958	1,278	3,236

Table A-3. Anti-icing Details

From Winter Storm Reports, 2007-2008

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
SE	KENOSHA	15	1	0	0	0	0	14	0	2,730	2,392	5,122
	MILWAUKEE	6	0	0	0	0	0	6	0	12,120	11,507	23,627
	OZAUKEE	2	0	0	0	0	0	2	0	1,260	891	2,151
	RACINE	6	0	0	0	0	0	6	0	3,480	3,106	6,586
	WALWORTH	2	0	0	0	0	0	2	0	960	705	1,665
	WASHINGTON	8	1	0	0	0	0	8	0	1,980	5,520	7,500
	WAUKESHA	13	0	0	0	0	0	13	0	47,910	3,023	50,933
Region Total		52	2	0	0	0	0	51	0	70,440	27,144	97,584
Region Average		7	--	--	--	--	--	--	0	10,063	3,878	13,941

Table A-3. Anti-icing Details

From Winter Storm Reports, 2007-2008

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
SW	COLUMBIA	4	0	0	0	0	0	4	0	1,920	1,302	3,222
	CRAWFORD	7	0	0	3	0	0	4	0	2,700	1,726	4,426
	DANE	5	0	0	0	0	5	0	0	3,000	2,496	5,496
	DODGE	8	0	0	0	0	0	8	0	3,840	2,138	5,978
	GRANT	7	0	0	0	0	0	7	0	2,940	1,604	4,544
	GREEN	5	0	1	0	0	2	4	0	630	311	941
	JUNEAU	10	0	0	0	0	0	8	0	3,420	3,531	6,951
	LA CROSSE	14	2	0	2	0	5	7	0	5,760	3,840	9,600
	LAFAYETTE	1	0	0	0	0	0	1	0	300	164	464
	MONROE	10	0	0	0	0	4	8	0	10,410	7,174	17,584
	RICHLAND	2	0	0	0	0	0	2	0	1,620	1,185	2,805
	ROCK	1	0	0	1	0	0	0	0	240	161	401
	SAUK	23	1	0	0	0	0	22	0	9,300	5,214	14,514
	VERNON	7	0	0	0	0	7	7	0	3,840	2,275	6,115
Region Total		104	3	1	6	0	23	82	0	49,920	33,121	83,041
Region Average		7	--	--	--	--	--	--	0	3,566	2,366	5,932

Table A-3. Anti-icing Details

From Winter Storm Reports, 2007-2008

Region	County	Anti-Icing applic.	What weather prediction caused you to anti-ice? Or did you do anti-icing on a routine schedule?						Estimated Costs			
			Wet Snow	Dry Snow	Frz Rain	Sleet	Frost	Routine	$ Mat'l	$ Equip	$ Labor	$ Total
Statewide Total		373	43	33	43	13	54	245	0	206,550	120,365	326,915

Table A-4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2008-2009

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M50 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo-Melt (gal)	Ice Stop (gal)
NC	ADAMS	0	6,900	0	0	0	0	0	0	0	0	0	0	0	0
	FLORENCE	0	26,300	0	0	0	0	0	0	9,100	0	0	0	0	0
	FOREST	120	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN LAKE	0	8,100	0	0	0	0	0	0	0	0	0	0	0	0
	IRON	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LANGLADE	0	5,500	0	0	0	0	0	0	0	0	0	0	0	0
	LINCOLN	0	9,700	0	0	0	0	0	0	0	0	0	0	0	0
	MARATHON	0	31,900	0	0	0	0	0	0	0	0	0	0	0	0
	MARQUETTE	0	9,000	0	0	0	0	0	0	0	0	0	0	0	0
	MENOMINEE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ONEIDA	0	3,700	0	0	0	0	0	0	0	0	0	0	0	0
	PORTAGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PRICE	0	2,795	0	0	0	0	0	0	0	0	0	0	0	0
	SHAWANO	0	850	0	0	0	0	0	0	0	0	0	0	0	0
	VILAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WAUPACA	0	1,080	0	0	0	0	0	0	0	0	0	0	0	0
	WAUSHARA	0	600	0	0	0	0	0	0	0	0	0	0	0	0
	WOOD	0	7,600	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		120	114,025	0	0	0	0	0	0	9,100	0	0	0	0	0

Table A-4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2008-2009

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M50 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo-Melt (gal)	Ice Stop (gal)
NE	BROWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CALUMET	0	5,050	0	0	0	0	0	0	0	0	0	0	0	0
	DOOR	2,475	26,400	0	0	0	0	0	0	0	0	0	0	0	0
	FOND DU LAC	0	0	0	0	0	0	0	0	1,015	0	0	0	0	0
	KEWAUNEE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MANITOWOC	0	8,250	0	0	0	0	0	0	0	0	0	0	0	0
	MARINETTE	0	550	0	0	0	0	0	0	0	0	0	0	0	0
	OCONTO	0	70	0	0	0	0	0	0	0	0	0	0	0	0
	OUTAGAMIE	0	14,700	0	0	0	0	0	0	0	0	0	0	0	0
	SHEBOYGAN	0	3,400	0	0	0	0	0	0	0	0	0	0	0	0
	WINNEBAGO	0	5,200	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		2,475	63,620	0	0	0	0	0	0	1,015	0	0	0	0	0

Table A-4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2008-2009

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M50 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo-Melt (gal)	Ice Stop (gal)
NW	ASHLAND	0	0	0	0	0	0	0	0	230	0	0	0	0	0
	BARRON	0	0	0	0	0	0	0	0	700	0	0	0	0	0
	BAYFIELD	0	0	0	0	0	0	0	0	1,425	0	0	0	0	0
	BUFFALO	0	3,170	0	0	0	0	0	0	0	0	0	0	0	0
	BURNETT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CHIPPEWA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CLARK	0	1,800	0	0	0	0	0	0	0	0	0	0	0	0
	DOUGLAS	0	0	0	0	0	0	0	0	2,875	0	0	0	0	0
	DUNN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EAU CLAIRE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JACKSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PEPIN	0	300	200	0	0	0	0	0	0	0	0	0	0	0
	PIERCE	0	2,480	0	0	0	0	0	0	0	0	0	0	0	0
	POLK	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RUSK	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SAINT CROIX	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SAWYER	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TAYLOR	0	3,945	0	0	0	0	0	0	0	0	0	0	0	0
	TREMPEALEAU	0	100	100	0	0	0	0	0	0	0	0	0	0	0
	WASHBURN	0	0	0	0	3,590	0	0	0	0	0	0	0	0	0
Region Total		0	11,795	300	0	3,590	0	0	0	5,230	0	0	0	0	0

Table A-4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2008-2009

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M50 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo-Melt (gal)	Ice Stop (gal)
SE	KENOSHA	15	0	0	0	0	275	0	0	0	0	0	0	0	0
	MILWAUKEE	0	31,125	0	0	0	0	0	0	0	0	0	0	0	0
	OZAUKEE	0	950	0	0	0	0	0	0	0	0	0	0	0	0
	RACINE	0	860	370	0	0	0	0	0	0	0	0	0	0	0
	WALWORTH	0	1,550	0	0	0	0	0	0	0	0	0	0	0	0
	WASHINGTON	0	2,850	0	0	0	0	0	0	0	0	0	0	0	0
	WAUKESHA	80	72,030	0	0	0	0	400	0	0	0	0	0	0	0
Region Total		95	109,365	370	0	0	275	400	0	0	0	0	0	0	0

Table A-4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2008-2009

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M50 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo-Melt (gal)	Ice Stop (gal)
SW	COLUMBIA	0	7,900	0	0	0	0	0	0	0	0	0	0	0	0
	CRAWFORD	0	14,100	0	0	0	0	0	0	0	0	0	0	0	0
	DANE	0	10,050	0	0	0	0	0	0	0	0	0	0	0	0
	DODGE	0	0	0	0	0	0	0	0	2,000	0	0	0	0	0
	GRANT	0	175	875	0	0	0	0	0	0	0	0	0	0	0
	GREEN	0	200	0	0	0	0	0	0	0	0	0	0	0	0
	IOWA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JEFFERSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JUNEAU	0	6,650	0	0	0	0	0	0	0	0	0	0	0	0
	LA CROSSE	0	40,588	0	0	0	0	0	0	0	0	0	0	0	0
	LAFAYETTE	0	0	35	0	0	0	0	0	0	0	0	0	0	0
	MONROE	0	66,990	0	0	0	0	0	0	0	0	0	0	6,850	0
	RICHLAND	0	2,300	0	0	0	0	0	0	0	0	0	0	0	0
	ROCK	0	750	0	0	0	0	0	0	0	0	0	0	0	0
	SAUK	0	8,530	0	0	0	0	0	0	0	0	0	0	0	0
	VERNON	0	10,905	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		0	169,138	910	0	0	0	0	0	2,000	0	0	0	6,850	0

Table A-4. Annual Anti-icing Agent Usage

From Winter Storm Reports, 2008-2009

Region	County	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB_M50 (gal)	IB_M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo-Melt (gal)	Ice Stop (gal)
Grand Total		2,690	467,943	1,580	0	3,590	275	400	0	17,345	0	0	0	6,850	0

Table A-5. Actual Anti-icing Costs

Final billed costs from the WisDOT accounting system, October 2008 - April 2009
County charges to Activity Code #73 (Applying Liquid Anti-icing Agents)

REGION	GROUP	COUNTY	TOTAL
SOUTHWEST	B	COLUMBIA	$8,082
	C	CRAWFORD	$4,192
	A	DANE	$12,399
	B	DODGE	$6,742
	C	GRANT	$3,342
	D	GREEN	$0
	C	IOWA	$0
	B	JEFFERSON	$4,947
	C	JUNEAU	$1,833
	A	LACROSSE	$21,077
	C	LAFAYETTE	$961
	C	MONROE	$17,158
	D	RICHLAND	$3,188
	B	ROCK	$2,306
	B	SAUK	$12,357
	C	VERNON	$8,046
		TOTAL	**$106,630**
SOUTHEAST	A	KENOSHA	$5,206
	A	MILWAUKEE	$28,314
	A	OZAUKEE	$2,448
	A	RACINE	$4,966
	B	WALWORTH	$2,442
	B	WASHINGTON	$5,391
	A	WAUKESHA	$14,993
		TOTAL	**$63,760**
NORTHEAST	A	BROWN	$3,919
	C	CALUMET	$3,211
	C	DOOR	$12,110
	C	FOND DU LAC	$25,419
	C	KEWAUNEE	$0
	B	MANITOWOC	$10,621
	D	MARINETTE	$2,085
	C	OCONTO	$1,635
	B	OUTAGAMIE	$0
	B	SHEBOYGAN	$2,695
	A	WINNEBAGO	$3,226
		TOTAL	**$64,921**

Table A-5. Actual Anti-icing Costs

Final billed costs from the WisDOT accounting system, October 2008 - April 2009
County charges to Activity Code #73 (Applying Liquid Anti-icing Agents)

REGION	GROUP	COUNTY	TOTAL
NORTH CENTRAL	D	ADAMS	$1,803
	D	FLORENCE	$4,830
	D	FOREST	$134
	D	GREEN LAKE	$1,519
	D	IRON	$0
	D	LANGLADE	$2,316
	C	LINCOLN	$3,004
	A	MARATHON	$23,150
	B	MARQUETTE	$1,989
	D	MENOMINEE	$0
	B	ONEIDA	$6,500
	A	PORTAGE	$0
	D	PRICE	$3,920
	B	SHAWANO	$1,971
	C	VILAS	$0
	C	WAUPACA	$2,278
	B	WAUSHARA	$6,980
	C	WOOD	$0
		TOTAL	**$60,394**
NORTHWEST	D	ASHLAND	$796
	D	BARRON	$1,204
	D	BAYFIELD	$4,514
	D	BUFFALO	$1,969
	D	BURNETT	$0
	B	CHIPPEWA	$0
	C	CLARK	$2,529
	C	DOUGLAS	$38,046
	B	DUNN	$0
	A	EAU CLAIRE	$635
	C	JACKSON	$1,210
	D	PEPIN	$253
	D	PIERCE	$3,549
	D	POLK	$0
	D	RUSK	$0
	D	SAWYER	$0
	B	ST. CROIX	$0
	D	TAYLOR	$0
	C	TREMPEALEAU	$11,728
	C	WASHBURN	$8,219
		TOTAL	**$74,652**
		STATE TOTAL	**$370,357**
		55/72 COUNTIES (76%)	

Table A-6. Salt Brine Use

From Winter Storm Reports, 2008-2009

REGION	GROUP	COUNTY	PREWETTING (GALLONS)	ANTI-ICING (GALLONS)	TOTAL (GALLONS)
SOUTHWEST	B	COLUMBIA	15,735	7,900	23,635
	C	CRAWFORD	15,715	14,100	29,815
	A	DANE	139,810	10,050	149,860
	B	DODGE	399	0	399
	C	GRANT	0	175	175
	D	GREEN	3,176	200	3,376
	C	IOWA	0	0	0
	B	JEFFERSON	0	0	0
	C	JUNEAU	0	6,650	6,650
	A	LA CROSSE	9,474	40,588	50,062
	C	LAFAYETTE	0	0	0
	C	MONROE	1,665	66,990	68,655
	D	RICHLAND	1,200	2,300	3,500
	B	ROCK	17,301	750	18,051
	B	SAUK	0	8,530	8,530
	C	VERNON	3,360	10,905	14,265
		TOTAL	**207,835**	**169,138**	**376,973**
SOUTHEAST	A	KENOSHA	0	0	0
	A	MILWAUKEE	0	31,125	31,125
	A	OZAUKEE	5,522	950	6,472
	A	RACINE	18,860	860	19,720
	B	WALWORTH	7,988	1,550	9,538
	B	WASHINGTON	49,920	2,850	52,770
	A	WAUKESHA	51,613	72,030	123,643
		TOTAL	**133,903**	**109,365**	**243,268**
NORTHEAST	A	BROWN	22,399	0	22,399
	C	CALUMET	7,065	5,050	12,115
	C	DOOR	8,327	26,400	34,727
	C	FOND DU LAC	126	0	0
	C	KEWAUNEE	3,400	0	3,400
	B	MANITOWOC	46,530	8,250	54,780
	D	MARINETTE	11,826	550	12,376
	C	OCONTO	15,864	70	15,934
	B	OUTAGAMIE	60,499	14,700	75,199
	B	SHEBOYGAN	39,493	3,400	42,893
	A	WINNEBAGO	194,343	5,200	199,543
		TOTAL	**409,872**	**63,620**	**473,492**

Table A-6. Salt Brine Use

From Winter Storm Reports, 2008-2009

REGION	GROUP	COUNTY	PREWETTING (GALLONS)	ANTI-ICING (GALLONS)	TOTAL (GALLONS)
NORTH CENTRAL	D	ADAMS	0	6,900	6,900
	D	FLORENCE	16,073	26,300	42,373
	D	FOREST	0	0	0
	D	GREEN LAKE	4,710	8,100	12,810
	D	IRON	14,178	0	14,178
	D	LANGLADE	19,804	5,500	25,304
	C	LINCOLN	48,019	9,700	57,719
	A	MARATHON	20,421	31,900	52,321
	B	MARQUETTE	0	9,000	9,000
	D	MENOMINEE	1,200	0	1,200
	B	ONEIDA	28,744	3,700	32,444
	A	PORTAGE	25,927	0	25,927
	D	PRICE	8,830	2,795	11,625
	B	SHAWANO	12,288	850	13,138
	C	VILAS	20,275	0	20,275
	C	WAUPACA	1,365	1,080	2,445
	B	WAUSHARA	0	600	600
	C	WOOD	1,960	7,600	9,560
		TOTAL	**223,794**	**114,025**	**337,819**
NORTHWEST	D	ASHLAND	0	0	0
	D	BARRON	0	0	0
	D	BAYFIELD	240	0	0
	D	BUFFALO	4,626	3,170	7,796
	D	BURNETT	0	0	0
	B	CHIPPEWA	0	0	0
	C	CLARK	4,720	1,800	6,520
	C	DOUGLAS	0	0	0
	B	DUNN	0	0	0
	A	EAU CLAIRE	0	0	0
	C	JACKSON	0	0	0
	D	PEPIN	0	300	300
	D	PIERCE	5,900	2,480	8,380
	D	POLK	1,330	0	0
	D	RUSK	0	0	0
	D	SAWYER	0	0	0
	B	ST. CROIX	0	0	0
	D	TAYLOR	31,280	3,945	35,225
	C	TREMPEALEAU	1,040	100	1,140
	C	WASHBURN	3,917	0	0
		TOTAL	**53,053**	**11,795**	**64,848**
		STATE TOTAL	**1,028,457**	**467,943**	**1,496,400**
		# OF COUNTIES	48	45	52
PREVIOUS USE		2007-2008	965,797	305,409	1,271,206
		2006-2007	530,733	456,875	987,608
		2005-2006	570,203	394,991	965,194
		2004-2005	398,661	246,813	695,474
		2003-2004	285,710	241,780	527,490
		2002-2003	174,413	228,524	402,937
		2001-2002	144,505	194,349	338,854
		2000-2001	111,816	48,149	159,965
		1999-2000	45,023	?	?
		1998-1999	44,211	?	?

Table A-7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2008-2009

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
NC	ADAMS	2,944	0	2,435	0	0	0	0	0	0	0	0	0	0	0	0	0
	FLORENCE	3,074	0	0	16,073	0	0	0	0	0	0	400	0	0	0	0	0
	FOREST	5,783	0	6,725	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN LAKE	1,131	0	1,635	4,710	0	0	0	0	0	0	0	0	0	0	0	0
	IRON	5,250	0	0	14,178	0	0	0	0	0	0	0	0	0	0	0	0
	LANGLADE	3,372	0	0	19,804	0	0	0	0	0	0	0	0	0	0	0	0
	LINCOLN	4,403	0	0	48,019	0	0	0	0	0	0	0	0	0	0	0	0
	MARATHON	10,338	0	0	20,421	835	0	0	0	0	0	0	0	0	0	0	0
	MARQUETTE	3,894	0	0	0	0	0	0	0	0	0	9,800	0	0	0	0	0
	MENOMINEE	559	0	0	1,200	0	0	0	0	0	0	0	0	0	0	0	0
	ONEIDA	7,750	0	251	28,744	0	0	0	0	0	0	0	0	0	0	0	0
	PORTAGE	6,980	1	0	23,017	0	0	0	0	0	0	0	0	0	0	0	0
	PRICE	5,101	0	0	8,830	0	0	0	0	0	0	0	0	0	0	0	0
	SHAWANO	7,120	0	40	12,288	0	0	0	0	0	0	0	0	0	0	0	0
	VILAS	7,212	0	0	19,210	0	0	0	0	0	0	0	0	0	0	0	0
	WAUPACA	8,245	0	0	1,365	0	0	0	0	0	0	0	0	0	0	0	0
	WAUSHARA	3,276	0	4,929	0	0	0	0	0	184	0	0	0	0	0	0	0
	WOOD	4,825	1	0	1,960	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		91,257	2	16,015	219,819	835	0	0	0	184	0	10,200	0	0	0	0	0

Table A-7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2008-2009

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
NE	BROWN	14,520	0	0	22,399	0	0	0	0	0	0	0	0	0	0	0	0
	CALUMET	2,385	0	0	7,065	0	0	0	0	0	0	0	0	0	0	0	0
	DOOR	2,705	0	52	8,327	0	0	0	0	0	0	0	0	0	0	0	0
	FOND DU LAC	9,110	15	240	126	1,105	0	0	0	0	0	13,754	0	0	0	0	0
	KEWAUNEE	1,265	0	0	3,400	0	0	0	0	0	0	0	0	0	0	0	0
	MANITOWOC	8,260	0	0	46,530	0	0	0	0	0	0	0	0	0	0	0	0
	MARINETTE	5,315	0	295	11,826	0	0	0	0	0	0	0	0	0	0	0	0
	OCONTO	5,770	0	0	15,864	0	0	0	0	0	0	0	0	0	0	0	0
	OUTAGAMIE	10,215	0	0	60,499	0	0	0	0	0	0	0	0	0	0	0	0
	SHEBOYGAN	9,450	0	0	39,493	0	0	0	0	0	0	0	0	0	0	0	0
	WINNEBAGO	11,560	0	0	194,343	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		80,555	15	587	409,872	1,105	0	0	0	0	0	13,754	0	0	0	0	0

Table A-7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2008-2009

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
NW	ASHLAND	2,891	0	0	0	0	0	0	0	0	0	12,557	0	0	0	0	0
	BARRON	2,774	0	0	0	0	0	0	0	0	0	695	0	0	0	0	0
	BAYFIELD	5,705	0	0	240	0	0	0	0	0	0	0	0	0	0	0	0
	BUFFALO	2,024	0	0	4,626	0	0	0	0	0	0	0	0	0	0	0	0
	BURNETT	2,672	0	0	0	0	0	0	0	0	0	7,630	0	0	0	0	0
	CHIPPEWA	8,099	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CLARK	4,899	0	0	4,720	0	0	0	0	840	0	0	0	0	0	0	0
	DOUGLAS	6,224	0	0	0	0	0	0	0	0	0	15,454	0	0	0	0	0
	DUNN	6,463	0	4,747	0	0	0	0	0	0	0	0	0	0	0	0	0
	EAU CLAIRE	6,580	0	13,790	0	0	0	0	0	1,485	0	0	0	0	0	0	0
	JACKSON	7,305	0	0	0	3,500	0	300	0	0	300	950	0	0	0	0	0
	PEPIN	879	0	2,490	0	140	0	0	0	1,190	0	0	0	0	0	0	0
	PIERCE	3,947	0	700	5,900	0	0	0	0	0	0	0	0	0	0	0	0
	POLK	4,222	0	0	1,330	0	0	0	0	0	0	10,115	0	0	0	0	0
	RUSK	1,806	0	0	0	0	0	0	0	0	0	1,350	0	0	0	0	0
	SAINT CROIX	7,638	0	42,197	0	0	0	0	0	0	0	0	0	0	0	0	0
	SAWYER	3,272	0	0	0	0	0	0	0	0	0	1,615	0	0	0	0	0
	TAYLOR	3,015	0	0	31,280	0	0	0	0	0	0	0	0	0	0	270	0
	TREMPEALEAU	5,993	0	0	1,040	6,040	0	0	0	0	0	0	0	0	0	0	0
	WASHBURN	5,026	0	0	3,917	0	0	4,999	0	0	0	0	0	0	0	0	0
Region Total		91,434	0	63,924	53,053	9,680	0	5,299	0	3,515	300	50,366	0	0	0	270	0

Table A-7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2008-2009

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
SE	KENOSHA	9,436	0	0	0	20	0	0	2,670	0	0	100	0	0	0	0	0
	MILWAUKEE	47,166	40	30,240	0	0	0	0	0	0	0	0	0	0	0	0	0
	OZAUKEE	7,304	0	7,083	5,522	0	0	0	0	0	0	0	0	0	0	0	0
	RACINE	12,772	0	8,969	18,860	144	0	0	0	0	0	0	0	0	0	0	0
	WALWORTH	15,896	0	76	7,988	0	0	0	0	0	0	0	0	0	0	0	0
	WASHINGTON	11,635	87	0	49,920	0	0	0	0	0	0	0	0	0	0	0	0
	WAUKESHA	33,271	0	2,604	51,613	0	0	0	0	35,919	0	0	0	0	0	0	0
Region Total		137,480	127	48,972	133,903	164	0	0	2,670	35,919	0	100	0	0	0	0	0

Table A-7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2008-2009

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
SW	COLUMBIA	24,965	0	0	15,685	0	0	0	0	0	0	0	0	0	0	0	0
	CRAWFORD	4,089	0	0	11,385	0	0	0	0	0	0	0	0	0	0	0	0
	DANE	43,643	0	0	139,810	0	0	0	0	0	0	0	0	0	0	0	0
	DODGE	15,141	0	0	399	0	0	0	0	0	0	0	0	0	0	0	0
	GRANT	7,369	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN	2,638	0	0	3,176	0	0	0	0	0	0	0	0	0	0	0	0
	IOWA	5,087	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JEFFERSON	10,373	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JUNEAU	7,779	0	0	0	0	8,315	0	0	0	0	0	0	0	0	0	0
	LA CROSSE	6,592	0	0	9,474	0	0	0	0	0	0	0	0	0	0	24,389	0
	LAFAYETTE	2,622	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MONROE	9,083	0	0	1,665	0	0	0	0	0	0	0	0	0	0	1,090	0
	RICHLAND	2,945	0	0	1,200	0	0	0	0	0	0	0	0	0	0	0	0
	ROCK	9,982	0	0	17,301	0	0	0	0	0	0	0	0	0	0	0	0
	SAUK	13,814	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	VERNON	3,137	0	0	3,360	0	0	0	0	0	2,505	1,030	0	0	0	0	0
Region Total		169,259	0	0	203,455	0	8,315	0	0	0	2,505	1,030	0	0	0	25,479	0

Table A-7. Annual Prewetting Agent Usage for Salt

From Winter Storm Reports, 2008-2009

Region	County	Salt (ton)	CaCl2 (ton)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
Statewide Total		569,985	144	129,498	1,020,102	11,784	8,315	5,299	2,670	39,618	2,805	75,450	0	0	0	25,749	0

Table A-8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2008-2009

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
NC	ADAMS	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FLORENCE	188	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FOREST	121	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN LAKE	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	IRON	470	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LANGLADE	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LINCOLN	946	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MARATHON	913	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MARQUETTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MENOMINEE	366	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ONEIDA	776	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PORTAGE	802	0	2,910	0	0	0	0	0	0	0	0	0	0	0	0
	PRICE	514	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHAWANO	726	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	VILAS	1,413	0	1,065	0	0	0	0	0	0	0	0	0	0	0	0
	WAUPACA	114	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WAUSHARA	129	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WOOD	508	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		8,156	0	3,975	0	0	0	0	0	0	0	0	0	0	0	0

Table A-8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2008-2009

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
NE	BROWN	116	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CALUMET	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DOOR	365	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FOND DU LAC	174	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	KEWAUNEE	612	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MANITOWOC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MARINETTE	113	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OCONTO	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OUTAGAMIE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHEBOYGAN	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINNEBAGO	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		1,404	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2008-2009

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
NW	ASHLAND	246	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BARRON	1,343	0	0	0	0	0	0	0	0	678	0	0	0	0	0
	BAYFIELD	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BUFFALO	146	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BURNETT	635	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CHIPPEWA	1,912	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CLARK	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DOUGLAS	176	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DUNN	938	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EAU CLAIRE	382	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JACKSON	275	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PEPIN	347	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PIERCE	1,282	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	POLK	1,562	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RUSK	318	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SAINT CROIX	967	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SAWYER	108	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TAYLOR	247	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TREMPEALEAU	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WASHBURN	1,038	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		12,484	0	0	0	0	0	0	0	0	678	0	0	0	0	0

Table A-8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2008-2009

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
SE	KENOSHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MILWAUKEE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OZAUKEE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RACINE	54	36	0	0	0	0	0	0	0	0	0	0	0	0	0
	WALWORTH	426	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WASHINGTON	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WAUKESHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Region Total		538	36	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2008-2009

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
SW	COLUMBIA	3,713	0	50	0	0	0	0	0	0	0	0	0	0	0	0
	CRAWFORD	2,062	0	4,330	0	0	0	0	0	0	0	0	0	0	0	0
	DANE	239	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DODGE	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GRANT	2,142	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN	593	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	IOWA	263	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JEFFERSON	295	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JUNEAU	989	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LA CROSSE	1,793	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LAFAYETTE	2,786	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MONROE	1,284	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RICHLAND	616	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROCK	1,165	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SAUK	488	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	VERNON	3,168	0	0	0	0	0	0	0	0	215	0	0	0	0	0
Region Total		21,597	0	4,380	0	0	0	0	0	0	215	0	0	0	0	0

Table A-8. Annual Abrasives and Prewetting Agent Usage for Abrasives

From Winter Storm Reports, 2008-2009

Region	County	Sand (CY)	CaCl2 (gal)	NaCl Brine (gal)	MgCl2 (gal)	IB-M50 (gal)	IB-M80 (gal)	Freeze Guard (gal)	CaCl2 DOW (gal)	MC90 (gal)	MC95 (gal)	Caliber M1000 (gal)	Caliber M2000 (gal)	Clear Lane (gal)	Geo Melt (gal)	Ice Stop (gal)
Statewide Total		44,179	36	8,355	0	0	0	0	0	0	893	0	0	0	0	0

Table A-9. History of Salt Use on State Trunk Highways

From Salt Inventory Reporting System

Winter	Tons of Salt	Lane Miles	Tons/Lane Mile	Million Vehicle Miles Traveled STH System (Winter)
1959/60	93,673	19,521	4.8	8,828
1960/61	54,805	19,948	2.7	9,254
1961/62	109,412	19,966	5.5	9,558
1962/63	77,719	19,756	3.9	9,782
1963/64	82,033	19,717	4.2	10,064
1964/65	149,329	19,911	7.5	10,566
1965/66	111,634	19,505	5.7	11,122
1966/67	181,230	20,137	8.0	11,933
1967/68	137,729	22,395	6.2	12,140
1968/69	193,004	22,675	8.5	12,870
1969/70	199,353	22,831	8.7	13,853
1970/71	273,010	23,120	11.8	15,133
1971/72	223,249	25,543	8.7	14,325
1972/73	256,571	25,673	10.0	15,301
1973/74	218,189	N/A	N/A	16,198
1974/75	237,916	N/A	N/A	15,807
1975/76	257,154	N/A	N/A	16,198
1976/77	188,011	N/A	N/A	18,556
1977/78	210,054	N/A	N/A	19,621
1978/79	235,193	N/A	N/A	21,053
1979/80	220,180	N/A	N/A	20,403
1980/81	151,021	N/A	N/A	19,360
1981/82	192,740	N/A	N/A	20,210
1982/83	234,529	27,407	8.6	20,056
1983/84	224,368	27,416	8.2	20,873
1984/85	217,136	27,598	7.9	21,214
1985/86	304,296	27,632	11.0	22,110
1986/87	196,035	27,613	7.1	23,176
1987/88	224,573	27,743	8.1	24,346
1988/89	230,403	27,872	8.3	24,550
1989/90	297,004	28,024	10.6	25,370
1990/91	364,174	28,006	13.0	26,247
1991/92	337,079*	28,104	12.0*	27,391
1992/93	416,594*	28,182	14.8*	28,252
1993/94	314,489*	28,221	11.1*	28,859
1994/95	295,479*	28,312	10.4*	29,210
1995/96	440,488*	28,374	15.5	30,077
1996/97	509,147*	28,545	17.8*	31,122
1997/98	413,824*	29,619	14.0*	32,083
1998/99	371,602	30,119	12.4	33,236
1999/00	346,963*	30,340	11.4*	33,825
2000/01	521,056	30,553	17.1	34,657
2001/02	308,954	30,909	10.0	34,076
2002/03	328,922	30,975	10.6	35,088
2003/04	390,664	31,429	12.4	35,662
2004/05	407,924	31,810	12.8	36,013
2005/06	410,570	33,022	12.4	35,642
2006/07	405,793	33,221	12.2	27,911
2007/08	644,484	33,297	19.4	27,931
2008/09	569,985	33,531	17.0	26,888

* Quantities adjusted