ANNUAL WINTER MAINTENANCE REPORT

2005-2006

Using Resources Efficiently

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Acknowledgments

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Table of Contents

List of Tables

List of Figures

1 Introduction

To our partners

I am pleased to introduce the 2005-2006 Annual Winter Maintenance Report. You'll notice we have a redesigned format for the report this year, which we hope will improve both its readability and its usability as a reference tool. Our goals for the redesign were to restructure the report into five sections that group related data, to facilitate comparisons across regions and statewide, and to use charts and tables effectively to highlight key data.

In reorganizing the report, we talked with maintenance professionals across the state, both in WisDOT's regional offices and in county highway departments, and incorporated their feedback on what parts of the report they used most and what improvements would make it a better reference tool.

This year's report includes more charts to allow easier visual comparisons across regions and from year to year. In addition, two new tables summarize important data at a glance: the **Winter by the Numbers table** (page 8) highlights statewide facts and figures, while the **Winter in Wisconsin table** (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.

This year's report centers around a theme of efficiency. As winter maintenance practices and technologies evolve, maintenance crews are able to do more in less time and with less materials. Efficient practices are highlighted throughout this report in "Best practices" sidebars, and on the front page of each section.

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 Thomas Martinelli, WisDOT's state winter operations engineer, at thomas.martinelli@dot.state.wi.us.

Sincerely,

David Vieth, Director
Bureau of Highway Operations

Table 1.1. Statewide Summary: This Winter by the Numbers

From multiple sources, 2005-2006

Infrastructure	Lane miles	33,022 miles
	Patrol sections	733
	Average patrol section length	45.05 miles
Materials[1]	Salt used	410,570 tons 12.4 tons per lane mile
	Average cost of salt	$35.22 per ton
	Prewetting liquid used	803,131 gal.
	Anti-icing agents used	435,277 gal.
	Sand used	15,997 cubic yd.
Costs, Equipment and Performance	Total winter costs[2]	$46,244,946
	Total winter costs per lane mile	$1,400
	Average crew reaction time from start of storm	2.38 hours
	Time to bare/wet pavement	1.92 hours
	Road Weather Information System (RWIS) stations	58
	Salt spreaders equipped with on-board prewetting unit[3]	639 of 2,647 (24%)
	Counties with salt spreaders equipped with on-board prewetting unit	59 of 72 (82%)
	Salt spreaders equipped with ground-speed controller unit	1,316 of 2,647 (50%)
	Counties with salt spreaders equipped with ground-speed controller unit	69 of 72 (96%)
	Underbody plows	508
	Counties with underbody plows	51 of 72 (71%)
	Counties equipped to use anti-icing agents	65 of 72 (90%)
	Counties that used anti-icing agents during 2005-06 winter season	49 of 72 (68%)
Labor and Services	Regular county winter labor hours[4]	110,354 hrs.
	Overtime county winter labor hours	112,522 hrs.
	Public service announcements aired	6,989 total 6,353 radio; 636 TV
	Cost of public service announcements	$31,500

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. County equipment may be used on either state or county roads.

4. 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 their materials, equipment and labor use 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.

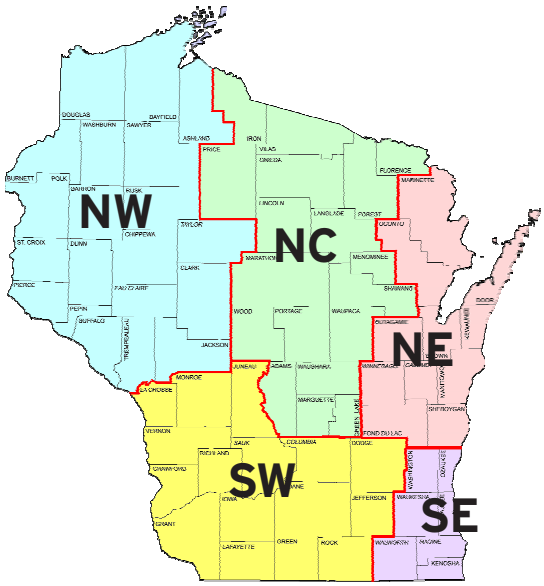
When interpreting the data in this report, readers should remember that many factors affect a county's response to winter, including the local winter severity index, local traffic generators, the mix of highway types and classifications in a county, the type of equipment being used, and the length of 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 33,022 lane miles of highway and 4,999 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 85 years ago, and to our knowledge, it is unique in the nation.

Figure 1.1. WisDOT Regional Divisions



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.

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	2,806	8%
2	High volume four-lane highways (Average Daily Traffic ≥ 25,000) and some four-lane highways (ADT < 25,000), and some 6-lane highways.	2,978	9%
3	All other four-lane highways (ADT < 25,000)	8,210	25%
4	Most high volume two-lane highways (ADT ≥ 5,000) and some 2-lanes (ADT <5000)	4,905	15%
5	All other two-lane highways	14,123	43%
Total		**33,022**	

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 2005 map on page 107 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 being 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 733 patrol sections on state-maintained highways, with an average of 45 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 is a new table that 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. This new table uses a similar format to the Storm Report Summary (Table A-1 on page 108 of the Appendix), but the salt and cost data in Table 1.5 are final numbers taken from the Salt Inventory Reporting System and from 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

Table 1.5. Winter in Wisconsin, 2005-2006											
County	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	192.09	33.10	56.90	2,798	14.57	0.44	$116,900	$609	$318,484	$1,658	$50.09
Florence	141.07	49.18	121.10	2,562	18.16	0.37	$98,637	$699	$282,300	$2,001	$40.69
Forest	312.38	51.03	132.50	4,663	14.93	0.29	$176,308	$564	$670,285	$2,146	$42.05
Green Lake	149.06	30.15	53.30	870	5.84	0.19	$29,806	$200	$145,475	$976	$32.37
Iron	246.87	60.04	209.30	4,533	18.36	0.31	$184,946	$749	$659,807	$2,673	$44.52
Langlade	292.69	47.97	85.90	4,382	14.97	0.31	$153,414	$524	$556,354	$1,901	$39.63
Lincoln	389.97	45.73	86.30	4,103	10.52	0.23	$155,340	$398	$629,486	$1,614	$35.30
Marathon	859.87	43.30	56.50	11,216	13.04	0.30	$420,166	$489	$1,255,068	$1,460	$33.71
Marquette	244.80	33.94	53.70	2,624	10.72	0.32	$92,155	$376	$324,256	$1,325	$39.03
Menominee	90.26	31.90	59.20	1,379	15.28	0.48	$43,604	$483	$98,812	$1,095	$34.32
Oneida	389.71	48.72	85.70	5,430	13.93	0.29	$211,010	$541	$763,205	$1,958	$40.20
Portage	485.96	32.51	57.10	5,029	10.35	0.32	$170,279	$350	$632,490	$1,302	$40.03
Price	320.57	45.86	71.10	4,557	14.22	0.31	$192,032	$599	$551,048	$1,719	$37.48
Shawano	508.94	35.68	54.90	5,042	9.91	0.28	$161,579	$317	$659,227	$1,295	$36.30
Vilas	305.18	43.31	109.20	6,150	20.15	0.47	$259,776	$851	$714,362	$2,341	$54.05
Waupaca	535.10	29.10	37.10	4,403	8.23	0.28	$146,075	$273	$646,999	$1,209	$41.55
Waushara	344.05	28.77	41.30	2,673	7.77	0.27	$96,496	$280	$334,595	$973	$33.80
Wood	362.92	32.51	50.70	2,889	7.96	0.24	$113,278	$312	$498,970	$1,375	$42.29
Region total	**6,171.49**			**75,303**			**$2,821,801**		**$9,741,223**		
Region average	**342.86**	**40.16**	**78.99**	**4183.50**	**12.20**	**0.30**	**$156,767**	**$457**	**$541,179**	**$1,578**	**$39.31**
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	677.81	30.36	50.10	10,010	14.77	0.49	$271,872	$401	$1,100,693	$1,624	$53.49
Calumet	202.80	29.57	41.90	1,893	9.33	0.32	$56,237	$277	$280,931	$1,385	$46.85
Door	231.83	36.03	38.60	2,205	9.51	0.26	$68,399	$295	$343,416	$1,481	$41.11
Fond du Lac	587.02	38.76	49.90	6,176	10.52	0.27	$197,508	$336	$768,159	$1,309	$33.76
Kewaunee	111.29	26.78	41.90	730	6.56	0.24	$23,551	$212	$124,365	$1,117	$41.73
Manitowoc	415.45	25.52	50.10	3,893	9.37	0.37	$121,929	$293	$571,353	$1,375	$53.89
Marinette	313.81	38.56	87.70	3,905	12.44	0.32	$126,873	$404	$397,924	$1,268	$32.88
Oconto	411.99	38.77	75.70	4,725	11.47	0.30	$143,974	$349	$496,869	$1,206	$31.11
Outagamie	504.94	31.74	51.30	6,934	13.73	0.43	$216,277	$428	$831,100	$1,646	$51.86
Sheboygan	516.49	28.11	42.40	7,084	13.72	0.49	$235,897	$457	$742,156	$1,437	$51.12
Winnebago	553.42	33.06	51.40	7,511	13.57	0.41	$237,755	$430	$835,358	$1,509	$45.66
Region total	**4,526.85**			**55,066**			**$1,700,272**		**$6,492,324**		
Region average	**411.53**	**32.48**	**52.82**	**5006.00**	**12.16**	**0.37**	**$154,570**	**$376**	**$590,211**	**$1,434**	**$44.16**
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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Northwest Region											
Ashland	247.57	50.92	154.60	3,716	15.01	0.29	$135,523	$547	$453,455	$1,832	$35.97
Barron	421.98	26.95	84.40	3,062	7.26	0.27	$131,176	$311	$655,322	$1,553	$57.62
Bayfield	316.90	53.04	143.30	4,770	15.05	0.28	$181,256	$572	$543,949	$1,716	$32.36
Buffalo	302.86	33.81	45.80	1,593	5.26	0.16	$55,086	$182	$228,768	$755	$22.34
Burnett	253.46	27.78	57.30	3,401	13.42	0.48	$146,177	$577	$303,757	$1,198	$43.14
Chippewa	649.87	24.46	59.90	7,545	11.61	0.47	$312,194	$480	$917,579	$1,412	$57.72
Clark	401.56	27.34	68.30	3,776	9.40	0.34	$166,384	$414	$507,174	$1,263	$46.20
Douglas	436.65	46.80	166.80	6,088	13.94	0.30	$203,105	$465	$706,086	$1,617	$34.55
Dunn	518.95	25.72	58.20	5,999	11.56	0.45	$236,901	$457	$715,552	$1,379	$53.61
Eau Claire	548.70	21.96	44.80	4,491	8.18	0.37	$173,783	$317	$663,415	$1,209	$55.06
Jackson	499.14	29.80	80.20	6,603	13.23	0.44	$239,821	$480	$596,215	$1,194	$40.08
Pepin	106.24	19.84	49.00	698	6.57	0.33	$12,786	$120	$92,615	$872	$43.94
Pierce	361.23	31.58	56.20	4,838	13.39	0.42	$199,906	$553	$558,713	$1,547	$48.98
Polk	385.06	35.79	69.70	4,640	12.05	0.34	$174,696	$454	$510,941	$1,327	$37.07
Rusk	238.39	30.00	80.70	2,266	9.51	0.32	$92,000	$386	$269,359	$1,130	$37.66
St. Croix	614.24	33.05	70.20	6,399	10.42	0.32	$256,856	$418	$849,308	$1,383	$41.84
Sawyer	367.44	30.95	88.80	3,079	8.38	0.27	$117,210	$319	$377,578	$1,028	$33.20
Taylor	234.08	34.31	51.80	2,582	11.03	0.32	$117,274	$501	$323,457	$1,382	$40.27
Trempealeau	415.92	35.06	49.30	4,270	10.27	0.29	$150,902	$363	$427,242	$1,027	$29.30
Washburn	368.98	32.94	106.90	5,098	13.82	0.42	$185,159	$502	$501,651	$1,360	$41.27
Region total	**7,689.22**			**84,914**			**$3,288,195**		**$10,202,136**		
Region average	**384.46**	**32.61**	**79.31**	**4245.70**	**10.97**	**0.34**	**$164,410**	**$428**	**$510,107**	**$1,327**	**$40.69**
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, 2005-2006												
	County	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	550.15	16.99	42.20	4,897	8.90	0.52	$147,449	$268	$631,879	$1,149	$67.60
	Milwaukee	1,777.00	17.03	37.60	29,792	16.77	0.98	$874,003	$492	$3,226,385	$1,816	$106.61
	Ozaukee	304.03	21.18	43.60	4,855	15.97	0.75	$136,377	$449	$533,284	$1,754	$82.82
	Racine	593.65	20.68	47.40	5,385	9.07	0.44	$149,434	$252	$622,785	$1,049	$50.73
	Walworth	689.25	17.90	43.80	10,397	15.08	0.84	$335,929	$487	$951,830	$1,381	$77.15
	Washington	585.03	27.89	56.60	9,257	15.82	0.57	$292,799	$500	$907,716	$1,552	$55.63
	Waukesha	1,027.07	20.60	39.60	19,084	18.58	0.90	$636,261	$619	$1,350,098	$1,315	$63.81
Region total		**5,526.18**			**83,667**			**$2,572,252**		**$8,223,977**		
Region average		**789.45**	**20.32**	**44.40**	**11952.43**	**15.14**	**0.74**	**$367,465**	**$465**	**$1,174,854**	**$1,488**	**$73.22**
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, 2005-2006

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Southwest Region											
Columbia	775.73	21.54	49.60	12,912	16.64	0.77	$593,952	$766	$1,461,122	$1,884	$87.44
Crawford	377.95	26.49	48.10	2,824	7.47	0.28	$103,980	$275	$423,153	$1,120	$42.27
Dane	1,668.14	27.92	47.70	26,314	15.77	0.56	$878,884	$527	$2,379,815	$1,427	$51.10
Dodge	606.62	25.98	47.40	10,179	16.78	0.65	$353,415	$583	$925,787	$1,526	$58.74
Grant	614.85	27.37	53.10	5,268	8.57	0.31	$180,956	$294	$557,978	$908	$33.16
Green	311.45	21.68	42.10	2,716	8.72	0.40	$114,564	$368	$328,933	$1,056	$48.71
Iowa	450.33	28.61	41.20	4,474	9.93	0.35	$159,902	$355	$535,832	$1,190	$41.59
Jefferson	446.57	19.01	44.10	6,989	15.65	0.82	$249,228	$558	$646,474	$1,448	$76.15
Juneau	498.09	28.77	54.00	5,038	10.11	0.35	$198,145	$398	$527,742	$1,060	$36.83
La Crosse	460.76	31.57	64.90	4,465	9.69	0.31	$127,745	$277	$571,250	$1,240	$39.27
Lafayette	292.70	21.32	52.70	1,507	5.15	0.24	$45,918	$157	$254,200	$868	$40.73
Monroe	643.21	41.21	66.90	7,606	11.83	0.29	$276,250	$429	$766,272	$1,191	$28.91
Richland	329.08	24.42	47.00	1,198	3.64	0.15	$39,833	$121	$203,977	$620	$25.38
Rock	592.51	12.54	43.00	7,316	12.35	0.98	$274,381	$463	$793,311	$1,339	$106.77
Sauk	591.05	25.02	49.20	7,666	12.97	0.52	$293,193	$496	$718,664	$1,216	$48.60
Vernon	448.75	31.46	66.70	5,148	11.47	0.36	$188,056	$419	$490,776	$1,094	$34.76
Region total	**9,107.79**			**111,620**			**$4,078,402**		**$11,585,286**		
Region average	**569.24**	**25.93**	**51.11**	**6976.25**	**12.26**	**0.47**	**$254,900**	**$448**	**$724,080**	**$1,272**	**$49.05**
Statewide total	**33,021.53**			**410,570**			**$14,460,922**		**$46,244,946**		
Statewide average	**458.63**	**31.8**	**65.52**	**5702.36**	**12.43**	**0.39**	**$200,846**	**$438**	**$642,291**	**$1,400**	**$44.04**

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.

2 Winter Weather

In this section...

How much is it going to snow? That's the million-dollar question when it comes to budgeting for winter maintenance. Not only does snowfall vary from year to year, but the types of storms, range of temperatures, and timing of storms combine to create different challenges for the county highway departments each year.

This winter, snowfall was about 80 percent of normal statewide, with very few areas experiencing above-average snowfall by winter's end. However, winter hit Wisconsin early this year, with many counties experiencing lower temperatures and greater snowfall than average in December. This winter also brought a greater-than-average number of freezing rain events.

This section describes the weather Wisconsin experienced during the 2005-2006 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, 2005-2006

	Statewide average	Range across counties
Total snowfall[1]	65.5 inches	37 – 209 inches
Winter Severity Index	31.8	12.5 – 60.0
Winter storms	33	16 – 58
Frost events	2	0 – 11
Freezing rain events	7	0 – 17

1. All data in this table is from Winter Storm Reports, 2005-2006.

Using Resources Efficiently

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 64 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 0.10 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 the lower temperatures. Storms with high winds also are a challenge, because the 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.

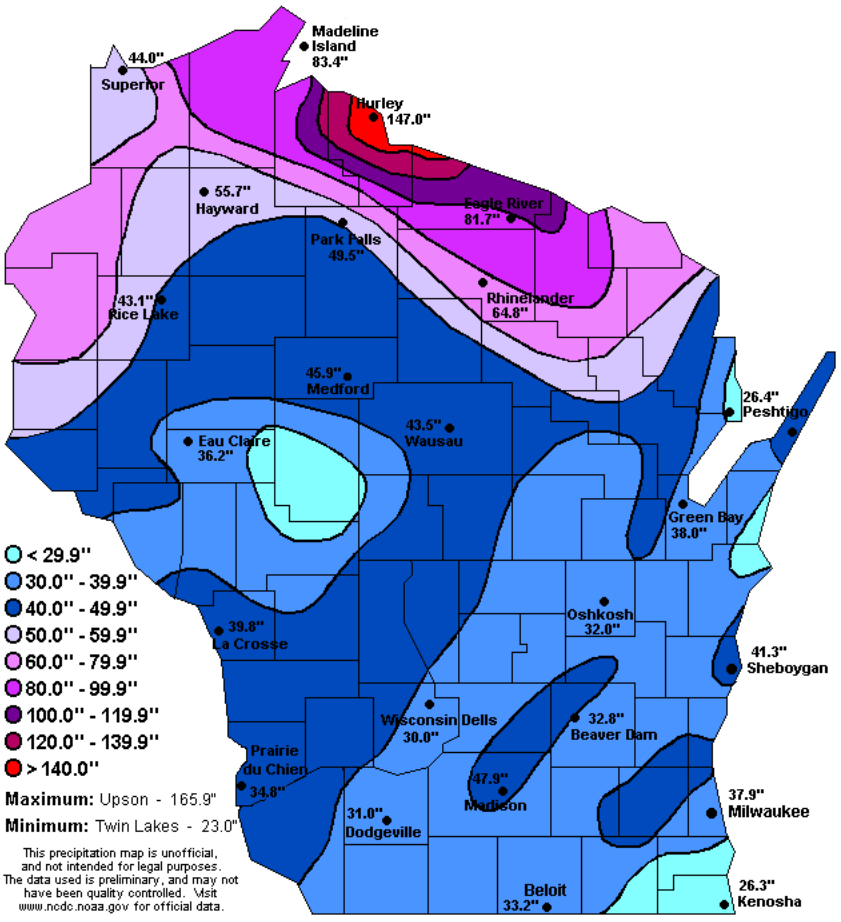
This Winter's Weather

Winter weather hit Wisconsin early and hard this year, but then became milder, with a below-average total snowfall. The first three weeks of December 2005 were unusually cold and snowy across most of Wisconsin. December temperatures were below average and snowfall was much above average across most of the state. After that, the winter was generally mild across the state.

Temperatures from January through March were above average and snowfall was below average, although the occasional strong storm system did affect the state. Most notable was a blizzard that struck parts of northwest Wisconsin in mid-March, dropping as much as 2 feet of snow in some areas. In Barron County, this storm caused the highway department to remove its snowplow trucks from the highways until conditions improved, effectively closing US 53 in Barron County.

For the winter as a whole, snowfall was about 80 percent of normal, with very few areas experiencing above-average snowfall. The west central part of the state saw the largest snowfall deficit. Also of note was a greater-than-average number of freezing rain events.

Figure 2.1. Statewide Snowfall, 2005-2006



Note: Snowfall totals are based on data provided by approximately 200 National Weather Service weather observers. Some smoothing was used to avoid a doughnut-hole/checkerboard pattern. 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.

During the 2005-2006 winter season, county highway departments responded to:

- a statewide average of 33 winter storm events per county, with a high of 58 in Iron County and a low of 16 in Rock County
- a statewide average of 2 frost events
- a statewide average of 7 freezing rain events

Figure 2.1 shows the total snowfall received across the state this winter. Snowfall varied quite a bit across the state; the highest snowfall recorded was in Upson, in Iron County, at 165.9 inches; the lowest was in Mazomanie, in Dane County, at 23.0 inches. Statewide, this winter's total snowfall was about 20% less than normal.

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 from a formula that includes:

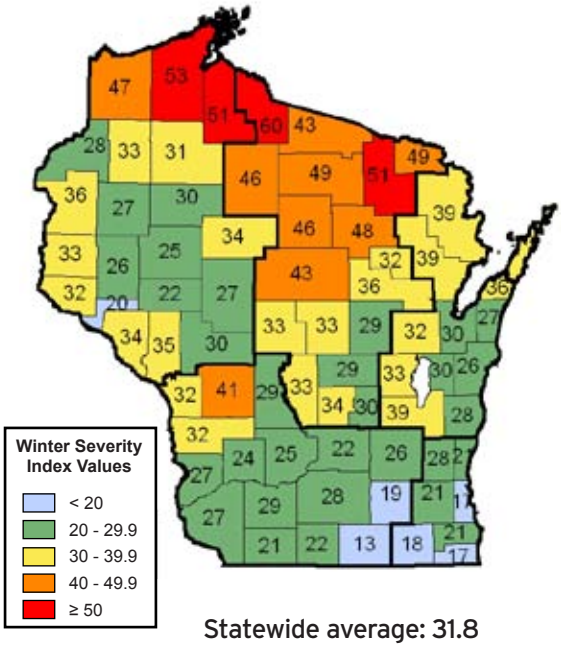
- Number of snow events
- Number of freezing rain events
- Total snow amount
- Total storm duration
- Total number of incidents

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.

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

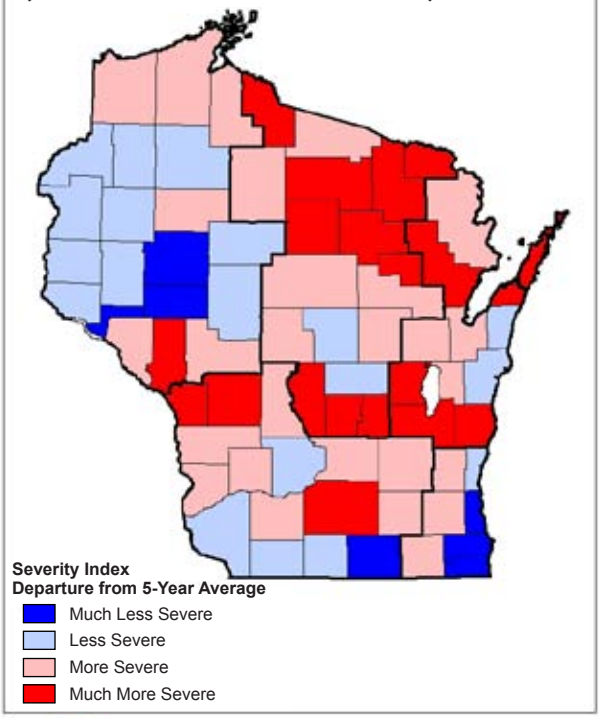
Figure 2.2. Winter Severity Index, 2005-2006



Statewide average: 31.8

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. 2005-2006 Winter Severity Index vs. 5-Year Average (2000-2001 to 2004-2005)



are being used consistently, whether counties have enough staff, and other factors that affect each region's response to winter.

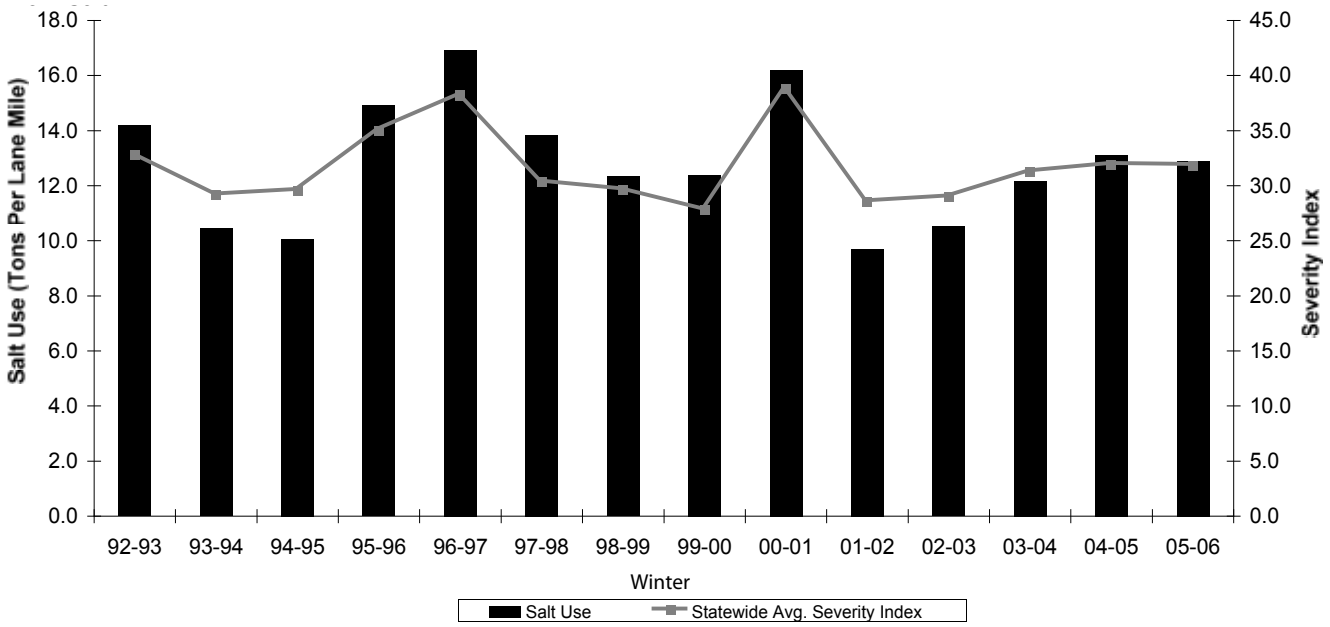
Data from weekly storm reports are used to calculate the winter severity index for each county according to a weighted formula. The index expresses winter severity on a scale from 0 to 100. This winter:

- The statewide average winter severity index was 31.8, which is the same as the average of the previous 10 winters.
- Iron County had the highest severity index at 60.0
- Rock County had the lowest severity index at 12.5

The high of 60.0 is within the normal range for the state's highest severity index in the northern "snow belt" part of the state, but the low of 12.5 falls below the normal range for the lowest severity index in the southern part of the state. In general, it was an average winter for Wisconsin. 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.

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.

Figure 2.4. Salt Use per Lane Mile and Average Severity Index
From Salt Inventory Reporting System, 1992-2006



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, or provide adjusted versions of these measures that account for differences in severity index. These include Figure 2.4 above, as well as Figure 3.2 (salt used per lane mile; page 37), Figure 4.4 (winter costs; page 71), and Figure 4.5 (winter crashes; page 73).

Because of concerns about consistency across all counties in reporting incidents, this 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 this winter's severity index data to previous years'. 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 the next pages, 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. The salt use figures in this table are also estimates from the storm reports.

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

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2005-2006

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	
NC	ADAMS	56.9	192.09	3284	17.10	35	19	12	13	3	3	1	0	0	2	0	0	6
	FLORENCE	121.1	141.07	2540	18.01	51	15	31	10	2	25	15	11	0	5	0	12	2
	FOREST	132.5	312.38	5232	16.75	53	26	17	10	9	12	9	5	0	4	1	6	0
	GREEN LAKE	53.3	149.06	1409	9.45	33	27	6	7	6	14	6	6	1	4	0	6	5
	IRON	209.3	246.87	4792	19.41	58	23	24	13	0	26	8	5	1	6	5	17	0
	LANGLADE	85.9	292.69	5561	19.00	46	25	4	17	5	14	11	9	0	12	0	5	0
	LINCOLN	86.3	389.97	4915	12.60	44	23	18	13	16	14	8	7	3	3	1	4	2
	MARATHON	56.5	859.87	13362	15.54	39	18	13	11	9	32	11	11	3	12	1	12	9
	MARQUETTE	53.7	244.80	3330	13.60	34	12	11	12	7	3	2	2	1	0	0	2	1
	MENOMINEE	59.2	90.26	1379	15.28	37	20	10	11	5	23	3	2	0	7	1	20	0
	ONEIDA	85.7	389.71	5804	14.89	43	18	19	12	16	17	3	3	4	11	0	10	0
	PORTAGE	57.1	485.96	6278	12.92	41	16	17	7	2	13	6	0	1	8	0	6	1
	PRICE	71.1	320.57	5635	17.58	45	22	22	9	9	10	8	0	0	7	0	5	5
	SHAWANO	54.9	508.94	5042	9.91	33	17	7	11	2	26	8	14	4	14	9	18	1
	VILAS	109.2	305.18	6799	22.28	52	16	32	8	0	12	0	1	1	3	0	7	4
	WAUPACA	37.1	535.10	5933	11.09	33	17	7	10	3	21	0	5	2	3	1	14	1
	WAUSHARA	41.3	344.05	3818	11.10	31	19	5	12	4	3	2	1	0	1	0	0	0
	WOOD	50.7	362.92	4061	11.19	33	17	13	8	3	12	5	9	2	3	0	1	7
Region Average		79.0	342.86	4954	14.87	41	19	15	11	6	16	6	5	1	6	1	8	2

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2005-2006

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	
NE	BROWN	50.1	677.81	8872	13.09	29	11	13	9	0	5	3	2	2	0	0	0	2
	CALUMET	41.9	202.80	1929	9.51	27	6	18	4	1	38	15	0	1	15	1	21	13
	DOOR	38.6	231.83	2391	10.31	30	15	11	13	8	31	17	16	7	9	4	15	8
	FOND DU LAC	49.9	587.02	6120	10.43	37	15	13	14	2	27	11	3	2	4	2	13	8
	KEWAUNEE	41.9	111.29	719	6.46	29	14	8	6	1	13	6	6	1	0	0	2	0
	MANITOWOC	50.1	415.45	4450	10.71	26	18	4	4	3	17	6	5	2	8	0	11	13
	MARINETTE	87.7	313.81	3734	11.90	35	16	22	6	8	28	12	8	0	13	11	16	5
	OCONTO	75.7	411.99	4420	10.73	36	17	10	11	9	23	14	14	3	2	3	11	3
	OUTAGAMIE	51.3	504.94	7385	14.63	34	26	4	12	4	8	5	5	2	2	0	2	4
	SHEBOYGAN	42.4	516.49	6784	13.13	24	13	15	9	7	19	7	2	9	9	1	4	18
	WINNEBAGO	51.4	553.42	7001	12.65	38	16	22	5	2	20	3	5	2	3	2	10	1
Region Average		52.8	411.53	4891	11.23	31	15	13	8	4	21	9	6	3	6	2	10	7

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2005-2006

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	
NW	ASHLAND	154.6	247.57	3673	14.84	45	16	24	7	7	19	8	3	1	2	0	10	1
	BARRON	84.4	421.98	3057	7.24	26	18	6	4	5	14	5	4	1	4	8	3	0
	BAYFIELD	143.3	316.90	4781	15.09	49	20	26	4	5	31	17	13	11	13	1	14	5
	BUFFALO	45.8	302.86	1593	5.26	33	18	9	12	2	11	5	4	1	4	2	2	10
	BURNETT	57.3	253.46	2520	9.94	27	15	7	6	5	6	1	2	0	1	0	6	0
	CHIPPEWA	59.9	649.87	8084	12.44	25	16	8	4	7	9	1	2	0	9	4	1	0
	CLARK	68.3	401.56	5282	13.15	31	19	9	6	3	4	1	3	0	1	0	1	7
	DOUGLAS	166.8	436.65	6228	14.26	49	30	14	5	0	25	14	3	1	8	6	7	0
	DUNN	58.2	518.95	8274	15.94	28	11	15	2	0	8	0	1	0	7	0	1	0
	EAU CLAIRE	44.8	548.70	5786	10.54	23	20	2	5	7	4	2	2	1	2	1	2	1
	JACKSON	80.2	499.14	6252	12.53	33	20	7	5	1	7	2	1	1	0	0	6	7
	PEPIN	49.0	106.24	698	6.57	24	8	18	0	7	10	0	0	0	9	1	1	1
	PIERCE	56.2	361.23	4403	12.19	36	22	14	8	11	11	4	2	1	8	1	7	0
	POLK	69.7	385.06	5256	13.65	36	22	11	8	2	23	4	9	3	9	4	13	0
	RUSK	80.7	238.39	1661	6.97	34	24	8	2	7	21	6	7	1	17	6	12	0
	SAINT CROIX	70.2	614.24	7896	12.85	40	33	3	7	2	9	1	0	2	0	2	5	0
	SAWYER	88.8	367.44	3160	8.60	35	22	9	4	6	11	3	3	1	6	0	6	0
	TAYLOR	51.8	234.08	2933	12.53	26	18	8	11	10	25	13	19	3	23	3	7	6
	TREMPEALEAU	49.3	415.92	4156	9.99	37	17	13	13	0	7	2	2	3	0	1	3	8
	WASHBURN	106.9	368.98	5073	13.75	35	22	8	4	4	12	2	3	0	1	1	8	16
Region Average		79.3	384.46	4538	11.42	34	20	11	6	5	13	5	4	2	6	2	6	3

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2005-2006

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	
SE	KENOSHA	42.2	550.15	3987	7.25	20	12	9	0	4	13	5	4	2	1	0	9	4
	MILWAUKEE	37.6	,777.00	31620	17.79	19	21	0	1	3	3	1	2	1	0	0	0	9
	OZAUKEE	43.6	304.03	4855	15.97	24	20	7	3	0	14	3	0	3	4	2	7	10
	RACINE	47.4	593.65	5316	8.96	24	14	9	1	0	14	5	3	4	0	0	6	24
	WALWORTH	43.8	689.25	10426	15.13	23	16	5	0	2	15	5	1	4	4	2	9	2
	WASHINGTON	56.6	585.03	9257	15.82	29	14	8	8	2	5	3	0	2	1	0	2	3
	WAUKESHA	39.6	,027.07	20097	19.57	23	12	11	4	4	5	2	0	2	1	0	2	1
Region Average		44.4	789.45	12223	14.35	23	16	7	2	2	10	3	1	3	2	1	5	8

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2005-2006

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	49.6	775.73	11079	14.28	23	14	4	6	0	3	2	1	0	0	0	2	2
	CRAWFORD	48.1	377.95	2778	7.35	29	8	17	6	0	9	4	2	6	1	0	0	17
	DANE	47.7	,668.14	27673	16.59	27	18	7	6	4	22	3	2	10	11	12	4	1
	DODGE	47.4	606.62	9666	15.93	32	25	4	6	0	10	3	1	1	2	0	5	10
	GRANT	53.1	614.85	5632	9.16	22	9	10	5	2	26	10	1	5	4	0	8	2
	GREEN	42.1	311.45	2413	7.75	22	10	11	2	4	23	7	0	4	4	1	17	0
	IOWA	41.2	450.33	4174	9.27	32	13	13	6	0	11	0	3	5	2	0	3	0
	JEFFERSON	44.1	446.57	6761	15.14	22	14	5	3	3	7	4	3	1	0	0	3	0
	JUNEAU	54.0	498.09	5733	11.51	34	24	6	8	3	5	1	0	1	0	1	2	0
	LA CROSSE	64.9	460.76	3728	8.09	30	20	8	5	8	23	7	7	5	10	2	10	7
	LAFAYETTE	52.7	292.70	1486	5.08	19	9	7	2	2	10	4	0	3	3	0	0	0
	MONROE	66.9	643.21	6168	9.59	42	24	9	15	6	16	8	11	1	2	4	8	9
	RICHLAND	47.0	329.08	1711	5.20	28	18	6	5	1	17	4	5	1	11	4	12	7
	ROCK	43.0	592.51	7316	12.35	16	10	7	0	1	0	0	0	0	0	0	0	0
	SAUK	49.2	591.05	7992	13.52	28	20	6	5	2	14	3	0	0	5	0	9	16
	VERNON	66.7	448.75	3110	6.93	33	16	10	9	2	10	4	2	6	6	1	3	7
Region Average		51.1	569.24	6714	10.48	27	16	8	6	2	13	4	2	3	4	2	5	5

Table 2.1. Storms and Incidents

From Winter Storm Reports, 2005-2006

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		--	459	5927	12.33	32.8	17.6	11.2	7.1	4.0	14.6	5.3	4.0	2.1	5.1	1.6	6.8	4.3

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 2005-2006 winter season, including materials use, best practices in equipment and technology, and training efforts. Choosing the right strategy at the right time is the hallmark of efficient winter maintenance practices. Newer tools like Road Weather Information Systems can give patrol superintendents more precise information to make the best decisions for their roads, which helps the counties conserve resources.

Statewide Materials Use

	2005-2006
Total salt used[1]	410,570 tons
Total salt used per lane mile	12.4 tons
Total cost of salt used[2]	$14,460,922
Average cost per ton of salt	$35.22
Total prewetting agents used[3]	803,131 gal.
Counties prewetting salt	65 of 72 (90%)
Total abrasives used	15,997 cubic yards
Counties prewetting abrasives	6 of 72 (8%)
Total anti-icing agents used	435,277 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.

Using Resources Efficiently

Most Wisconsin county highway departments spray liquid anti-icing chemicals on roadways prior to winter storm events. These proactive anti-icing operations are about three times less costly than treating frost once it has formed. *See page 41 for more information.*

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 chemicals can help reduce overall materials use; see page 41 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's statewide winter severity index of 31.8 was the same as the previous 10-year average, while total salt use (410,600 tons) was slightly higher than the range over the past four years (309,000 to 408,000 tons). See Table 3.6 on page 57 for county-by-county salt use data for this winter.

Since last winter, 1,211 lane miles have been added to the state highway system, a larger-than-usual increase of 3.8% (bringing the statewide total to 33,022 lane miles). This increase was primarily due to a detailed reevaluation of the lane miles that are entered into WisDOT's Level of Service model, and may account for part of the increase in total salt use. Salt use per lane mile stayed relatively similar to previous years at a statewide average of 12.4 tons per lane mile. This rate is higher than the neighboring states of Minnesota (9.1 tons per lane mile), Illinois (7.6 tons per lane mile), and Iowa (7.8 tons per lane mile), but lower than Michigan (19.9 tons per lane mile). Minnesota's weather patterns are the most similar to Wisconsin's.

Figure 3.1. Salt Used per Lane Mile
From Salt Inventory Reporting System, 2005-2006

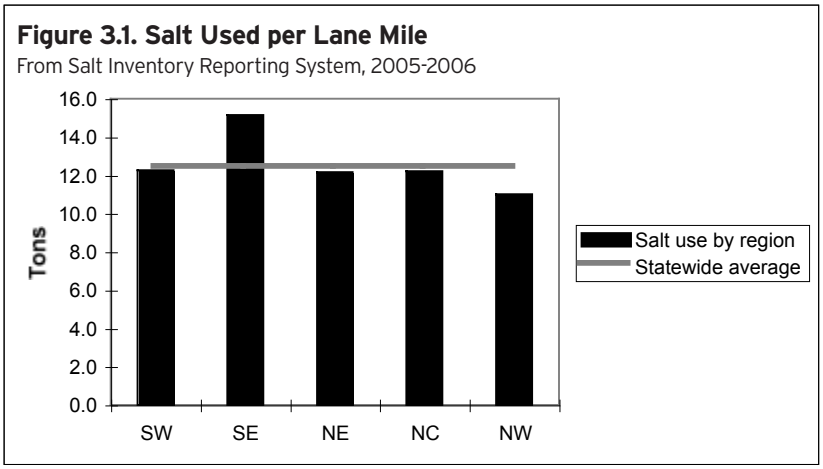


Figure 3.1 shows the regional levels of salt use per lane mile. Counties in the Southeast Region used an average of 15.1 tons of salt per lane mile, which reflects the greater number of highways in these counties receiving 24-hour service.

Figure 3.2 shows salt use per lane mile in each county, adjusted for 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 display the greatest amount of variation. In Group A, the counties at the high end of the scale are among the most urban, while in Group B the counties at the high end experienced some of the least severe winter weather in the state.

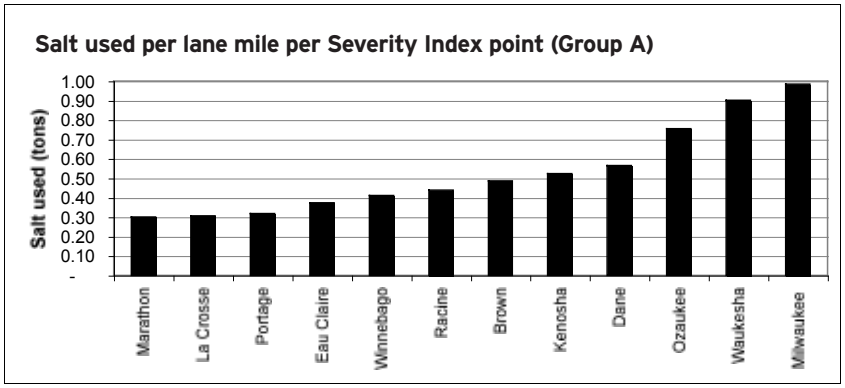
For more detail on salt use in previous years, see Table A-9, "History of Salt Use on State Trunk Highways," on page 153 of the Appendix.

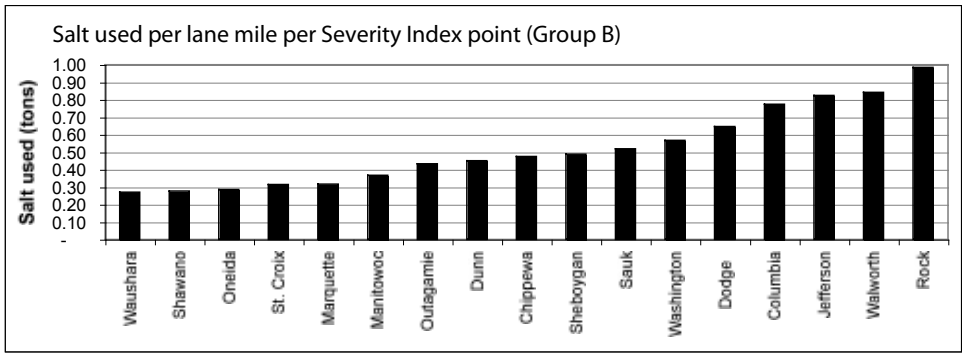
Cost of Salt

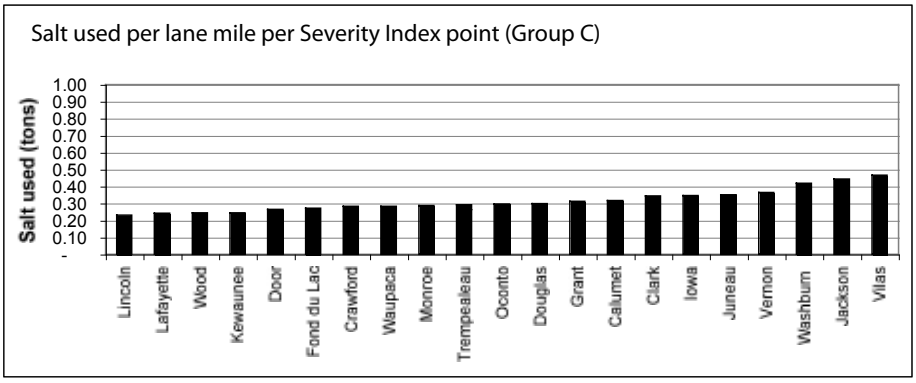
The price of a ton of salt varies across the state according to material availability and transportation costs, and in the past it has varied according to when in the season the salt was delivered. (For the 2005-2006 winter, WisDOT received one combined bid for all salt supplied during the season.) This winter, the counties spent a combined $14,460,922 on salt, for an average of $35.22 per ton.

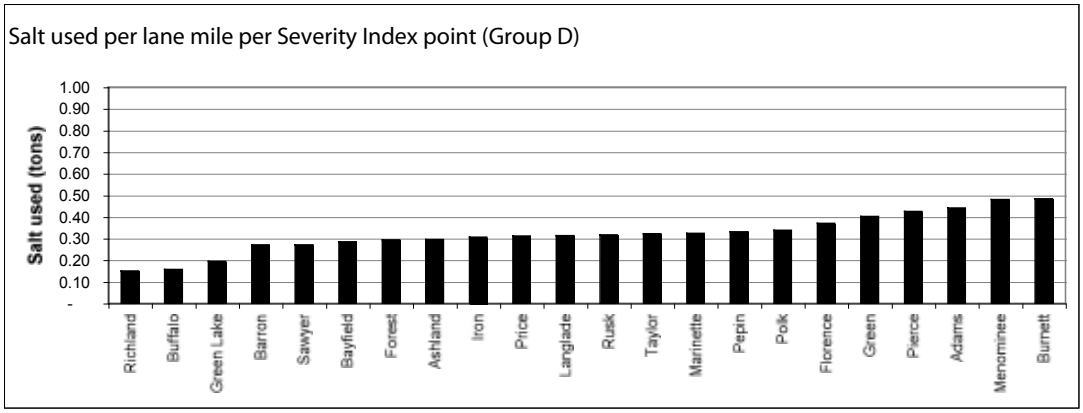
Figure 3.2. Salt Used per Lane Mile per Severity Index

From Salt Inventory Reporting System, 2005-2006









A Note About Materials Data

The salt tables in this section were generated with data from WisDOT's Salt Inventory Reporting System (SIRS). Elsewhere in this report and in the Appendix, preliminary salt use data from the winter storm reports appears in tables generated from the storm reports database (for example, Table 3.7 on page 58, Labor Hours per Lane Mile, and Table 4.11 on page 89, Cost per Lane Mile). Sand use data also comes 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 may use sand and other abrasives to improve vehicles' traction on icy or snowy roads when temperatures are too low for salt to be effective. They may also be used when high winds or other storm conditions preclude the use of salt. Abrasives can be prewetted with a liquid agent for better adherence to the roadway.

A total of 15,997 cubic yards of sand was used by 48 counties this winter. Counties in the Southwest Region, which tend to have more hilly terrain and lower-volume roads, used 60% of the statewide total, or 9,582 cubic yards. Counties in the Southeast Region did not use any sand.

Table 3.1 compares this winter's sand use with previous years'. Refer to Table A-8 on page 147 of the Appendix for county-by-county sand use data for this winter.

Table 3.1. Statewide Sand Use
From Storm reports data, 1997-2006

Year	Sand used (cubic yards)
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 during 2000-2001 was caused by greater use of 50/50 salt/sand mixes due to the low supply of salt toward the end of the winter.

Cost of Sand

The billed cost of sand varies greatly throughout the state, from a low cost of $3.50 per cubic yard in Racine and Kenosha County to a high cost of $34.00 per cubic yard in Green County, depending on the local availability of the sand and transportation costs. The average billed cost of sand purchased by most counties is in the range of $10.00 to $16.00 per cubic yard. (All material costs are 2002-2003 data.)

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 chemicals 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 chemical so that different chemicals can be used as conditions warrant. For example, salt brine is effective to about 15°F, whereas chemicals such as magnesium chloride and calcium chloride are effective at lower temperatures, to about 0°F.

At about 5 cents per gallon for material and production costs, salt brine is a relatively inexpensive choice for prewetting (see Table 3.5 on page 42). Salt brine use has increased significantly since counties first tested it a

decade ago; 38 counties used salt brine for prewetting this winter (see Table A-6 on page 138 of the Appendix for details), a 43% increase in total gallons used compared with the previous winter. In addition to salt brine, some counties used calcium chloride, magnesium chloride, or agricultural-based products for prewetting this year.

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 10 counties used exclusively calcium chloride products for prewetting salt.

While prewetting salt is a common practice in Wisconsin—65 of 72 counties (90%) prewetted their salt this winter—prewetting abrasives is far less common. Only 6 counties used prewetted abrasives this winter. 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.

Table 3.2. Statewide Prewetting Agent Use for Salt

Chemical	Gallons used	Counties using
Salt brine	570,203	38
Calcium chloride-based products		
Calcium chloride – solid	52 tons	3
Calcium chloride – liquid	102,720	16
Calcium chloride with rust inhibitor	50	1
Magnesium chloride-based products		
Magnesium chloride	51,452	13
Freeze Guard	13,771	2
Agricultural-based products		
Ice Ban-M50	192	1
Ice Ban-M80	9,071	3
Ice Ban-MC90	990	3
Ice Ban-MC95	48,936	11
GeoMelt	5,746	4
Total	**803,131**	

BEST PRACTICES: Prewetting

WisDOT encourages counties to prewet both salt and sand when appropriate before applying it to the roadway. Studies have shown that prewetting significantly improves the amount of material that stays on the road. The department's recommendations for prewetting include:

- Stocking more than one chemical for prewetting and anti-icing provides flexibility in responding to events at different temperatures.
- 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 chemicals for prewetting, such as salt brine.
- Prewetting sand helps keep the sand on the pavement, and may allow crews to use higher truck spreading speeds.

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

Photo: Wisconsin Transportation Information Center

On-board prewetting using saddle tanks

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 page 45 for details.

Anti-icing

Anti-icing is a proactive snow and ice control strategy that involves applying a small amount of liquid chemical 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.

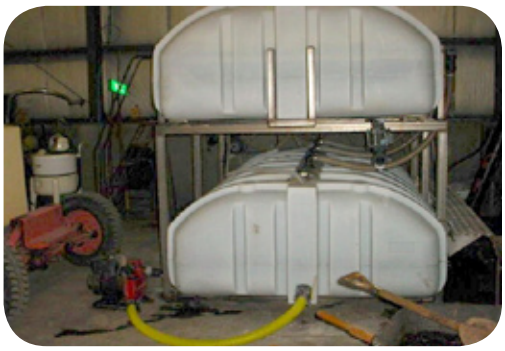
Anti-icing use has been steadily increasing in Wisconsin since the technology became part of winter operations in the state in 1999. Currently, 65 of 72 counties (90%) are equipped to perform anti-icing operations, and this winter 49 counties made at least one anti-icing application. (Counties may choose not to use anti-icing if weather conditions do not warrant it.)

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: Salt brine

At about 5 cents per gallon including material costs, salt brine is a relatively inexpensive choice for anti-icing (see Table 3.5 on page 42). Salt brine use has increased significantly since counties first tested it a decade ago; 36 counties used salt brine for anti-icing this winter, and 38 used it for prewetting (42 counties used salt brine for at least one purpose).

Statewide, the counties used a total of 965,194 gallons of salt brine for prewetting and anti-icing this winter. This is a significant increase compared with the previous winter—in just one year, total gallons of salt brine used increased 43% for prewetting and 60% for anti-icing (see Table A-6 on page 138 of the Appendix for details).



A salt brine production unit

Salt brine is most effective at temperatures of 15 F or above, so it isn't the most efficient choice for all temperatures. But it can be a cost-effective chemical for many conditions. Salt brine is typically produced at the county yard using salt brine production units such as the one shown above. Currently, 29 counties have a total of 39 salt brine production units. In addition, 10 counties purchase salt brine from neighboring counties.

For more information on applying salt brine, see https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/best-practices/pdf/iik4.pdf.

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 42 for more information on RWIS.

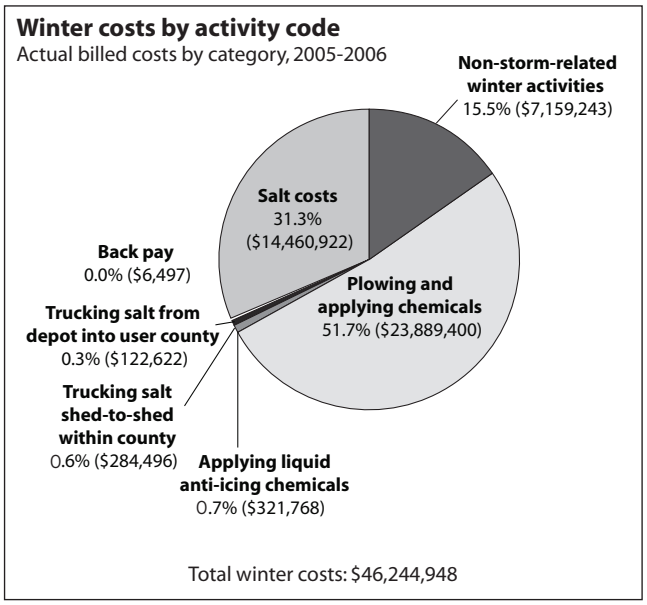
An emerging use of anti-icing technology is to install fixed liquid spray systems on bridge decks. Wisconsin has tested three of these systems, and two are still in use in Kenosha and Racine Counties. In addition, two counties have installed anti-icing overlays on bridge decks or approaches. See page 46 for details on these projects.

Anti-icing Costs

In Wisconsin, proactive anti-icing applications for possible frost events are about three times less costly than reactive de-icing operations for actual frost events. Table 3.3 compares the two strategies based on storm reports data.

Anti-icing costs made up only 0.7% of total winter maintenance costs this winter (see Figure 3.1). This percentage has remained fairly steady over the years—always less than 1% of total statewide winter costs. Investing in anti-icing is a cost-effective way to reduce overall materials use.

Figure 3.1. Anti-icing as a Percentage of Winter Costs



Note: Total cost data is slightly greater than cost data elsewhere in this report due to rounding.

Table 3.3. Cost of Anti-icing vs. De-icing

Winter Service Group	Average cost of anti-icing treatment for possible frost		Average cost of de-icing treatment for frost event		Number of counties
	2004-2005	2005-2006	2004-2005	2005-2006	
A	$1,046	$800	$3,746	$5,348	12
B	$647	$1,028	$2,161	$3,329	17
C	$758	$791	$1,969	$1,934	21
D	$587	$803	$1,604	$1,254	22

Anti-icing Chemicals

As with prewetting, the use of salt brine for anti-icing operations has increased significantly since its introduction a decade ago. This winter, 36 of 72 counties (50%) used a total of 394,991 gallons of salt brine for anti-icing. See Table A-6 on page 138 of the Appendix for county-by-county data on salt brine use.

WisDOT encourages counties to explore stocking more than one chemical for prewetting and anti-icing, so that a

Table 3.4. Statewide Anti-icing Agent Use

Chemical	Gallons used	Counties using
Salt brine	394,991	36
Calcium chloride – liquid	4,600	1
Calcium chloride with rust inhibitor	80	1
Magnesium chloride	17,318	9
Freeze Guard	2,275	4
Ice Ban-MC95	6,155	6
GeoMelt	9,858	3
Total	**435,272**	

choice of chemicals is available for use according to pavement temperature and weather conditions. Table 3.4 on the previous page shows the chemicals used for anti-icing in Wisconsin this winter; see Table A-4 on page 130 of the Appendix for county-by-county anti-icing data.

Cost of Chemicals

The cost of chemicals used for prewetting and anti-icing varies. Salt brine can be produced relatively cheaply (about $0.05 per gallon) at the county yard using salt brine production units purchased by WisDOT. Currently, 29 counties have a total of 39 salt brine production units. In addition, 10 counties purchase salt brine from neighboring counties. Other chemicals tend to be more expensive, but may be useful at lower temperatures.

Based on a 2002-2003 survey, the average billed cost of selected chemicals 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.

Table 3.5. Cost of Prewetting and Anti-icing Agents

Chemical	Average (per gallon)	Range (per gallon)
Salt brine	$0.05	$0.05 - $0.15 (39 counties)
Calcium chloride	$0.38	$0.31 - 0.62
Calcium chloride with rust inhibitor	$0.83	$0.72 - $0.94 (2 counties)
Magnesium chloride	$0.64	$0.60 - 0.68
Freeze Guard	$0.66	$0.60 - 0.81
Ice Ban M-50	$0.84	$0.82-$0.85 (2 counties)
Ice Ban M-80	$0.88	$0.71-$1.05 (2 counties)
GeoMelt	$1.05	$0.98-$1.05 (4 counties)

3B. Equipment and Technology

Wisconsin county highway departments have over 700 snowplow trucks available for use on the state-maintained highway system. Over 500 of these trucks are equipped with underbody plows, which can be used in place of the front plow for removing lighter snowfalls of up to 4 inches.

About 50% of the counties' salt spreaders are equipped with a ground speed controller, and about 24% have an on-board prewetting unit. As winter maintenance technology and practices evolve, the counties are continually expanding their arsenal of snow and ice control strategies. In recent years, Road Weather Information Systems (RWIS) 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 the change to a new vendor (Meridian) for 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 as part of WisDOT's Winter Operations Workshops.
- 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 52), and in multistate RWIS user group projects.
- Participating in national RWIS initiatives, including MDSS and Clarus (see page 53).
- 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.).

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 81% of the winter storm events. Regionally, the usage rate varied from a high of 88% in the Northeast Region to a low of 75% in the Southwest Region. Ratings of the service followed a similar pattern. The Northeast Region rated the service the highest (2.37 on a scale of 1 to 3), while the Southwest Region rated it lowest at 2.07. The statewide average was 2.23. For more details on the evaluation of the Meridian forecast service, see https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/weather_forecast_services_evaluation2005-06.pdf. For more detail on the use of the service, see Table A-2 on page 118 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/pdf/rwis-06-annualreport.pdf.

Equipment Calibration

Ensuring and reporting correct calibration of winter operations equipment—including salt spreaders, anti-icing applicators, and prewetting application equipment—is a key step in providing consistent materials application. WisDOT has tracked the counties' equipment calibration efforts since the 2003-2004 winter. This winter, 90% of winter vehicles were calibrated prior to the start of the season in the counties reporting their calibration activities. This is a 5% improvement over the 2003-2004 winter and a decrease of 3% over last year.

The counties in the former District 4 have made the greatest improvement over time; this year, 85% of their vehicles were correctly calibrated, compared with just 36% in 2003-2004. Once several years of data have been collected, WisDOT may consider making equipment calibration a performance measure in the Compass program. For more information on equipment calibration, see the report on page 154 of the Appendix.

Product and Equipment Testing

Winter maintenance is a continuously evolving field—new technology and innovations are developed each year. WisDOT manages test and evaluation projects of the most promising new equipment by the counties and makes these test results 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; contact Tom Martinelli at thomas.martinelli@dot.state.wi.us or (608) 266-3745 for more information.

The following pages summarize the outcomes of recent product and equipment evaluation projects. More information on many of these 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).

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.

ALTERNATIVE ANTI-ICING/DEICING MATERIALS

Recent projects

1. Pretreated salt. Several counties have tested a "pretreated" salt supply during the last few winters. With pretreated salt, a liquid prewetting agent is spray-applied to the salt supply before the salt is placed in storage. No additional prewetting of the salt is performed when the salt is applied to the roadway. Reports on these projects are available from WisDOT.

- In December 2001, Marquette County tested liquid Caliber-2000 (30% magnesium chloride/70% agricultural by-product) applied at 8 gallons per ton of salt on a rural two-lane road. The operator was able to lower the salt application rate by 100 pounds per lane mile compared to the normal rate and still provide an acceptable level of service. Additional testing was done during 2002-2003.

- During the 2000-2001 winter, La Crosse County pretreated a salt supply with liquid Ice Ban M-50 (50% magnesium chloride/50% agricultural by-product). Results were favorable, but the pretreated salt was not used the following winter due to a lack of separate storage for it. Prior to the 2002-2003 winter season, La Crosse County equipped all of its state patrol section trucks with onboard prewetting equipment, eliminating the need for pretreated salt.

- Fond du Lac County used a supply of Cargill "Clear-Lane" pretreated salt during the 2002-2003 winter. Operators reported that the pretreated salt stayed on the road better than salt that was prewetted onboard. At pavement temperatures above 25° F, the pretreated salt cleared the pavement faster, with longer-lasting results, than prewetted salt. The product did not work as well at pavement temperatures less than 25° F.

- Dane County used a supply of salt pretreated with Ossian "Activar" surfactant liquid at one salt storage facility during the 2002-2003 winter. A small quantity of the product (0.6 gallons per ton) was applied to a salt supply at the supplier's facility and shipped to one of the Dane County garages for use on a four-lane expressway patrol section. Dane County was able to lower the normal dry salt application rate by 100 pounds per lane mile when using this product. Pretreated salt material stayed on the pavement better than dry salt material and provided a faster salt brine reaction time.

- Oneida County evaluated Cargill "Clear Lane" pretreated salt during the winter of 2005-2006. Operators did not experience a noticeable difference in the results obtained with pretreated salt compared with standard salt. Oneida County plans to continue evaluating the salt next winter. See the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/cargillclearlaneenhancedsalt-progressreport1.pdf.

2. Prewetting of road salt with a salt brine/GeoMelt mixture. Buffalo, Crawford, La Crosse, and Trempealeau Counties used a mixture of salt brine and GeoMelt (80% salt brine/20% GeoMelt) as an anti-icing and prewetting agent during the 2002-2003 and 2003-2004 winters. The mixture was applied for anti-icing at pavement temperatures down to 3° F. It was not slippery after application and appeared to resist wearing off. La Crosse County also applied the mixture on a section of snow-packed road in a La Crosse County Park, and reported that the road was 80% free of snow pack one hour after application. A report is available from WisDOT; contact Tom Martinelli at thomas.martinelli@dot.state.wi.us or (608) 266-3745.

Past test projects that have become operational

1. Anti-icing liquids. Now commonly used, anti-icing applications were first tested in Wisconsin in 1997-1998. Four surveys on the counties' experience with anti-icing are available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/reports.shtm, and reports on the original field testing and evaluation of anti-icing liquids between 1997 and 1999 are available from WisDOT.

2. Prewetting of road salt. Prewetting techniques have continued to evolve beyond the traditional strategy of applying liquid calcium chloride to salt just before it is applied to the road. Salt brine, magnesium chloride, and Ice-Ban products are among the chemicals counties have tested and continue to use. An August 2000 survey on the counties' experience with prewetting is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/prewettingsurvey1999-2000.pdf, and a report on field testing of prewetting with magnesium chloride and Ice-Ban products is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/prewetmgcl2-iceban97-98.pdf.

Past projects that did not result in a change to operational procedures

1. Alternative salt gradations. Between 1996 and 1998, Brown and Columbia Counties tested finer gradations of salt used with lower application rates for anti-icing. Although the finer gradation of prewetted salt produced a quicker salt brine reaction, the reaction was not as long-lasting as coarse-graded salt applied at standard rates. See the final report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/finegradedsalt1998.pdf.

WINTER MAINTENANCE EQUIPMENT

Recent projects

1. Automated vehicle tracking system. This system provides the exact location of patrol trucks and can function as an e-mail communication link and a data collection tool for the patrol truck. It was first field-tested in Douglas County during the 1997-1998 winter and in Columbia and Polk Counties between 1998 and 2001. Waukesha County began testing the technology on five of their patrol trucks in 2002, but subsequently removed the units due to technical issues. Automated vehicle tracking has also being used in the winter concept vehicle project. A report is available from WisDOT.

2. Bridge deck anti-icing system. This technology dispenses anti-icing liquid automatically on bridge decks. Two systems are currently operational: One in Kenosha County (installed in 2000) and one in Racine County (installed in 2001), both on bridges over the Des Plaines River. WisDOT also participated in an FHWA study of these two systems. A third system in Walworth County is no longer functional. See the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/freeze-freesystem.pdf.

3. Bridge deck anti-icing overlay. This epoxy-aggregate mixture provides a reservoir for storing magnesium chloride, which is released onto the bridge surface as needed during frost or icing events. One overlay was installed on a bridge in Forest County in July 2003, and a second overlay was placed in Douglas County on an on-grade bridge approach ramp in 2005. Before the overlays were installed, winter crashes had occurred at both locations, and the guardrail needed repairs each year at the Forest County site. No crashes have been reported at either location since the overlays were installed. Evaluation is continuing; the most recent progress report is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/2006smartlaneprogressreport3.pdf.

Past test projects that have become operational

1. Mobile infrared pavement temperature sensors. These sensors have been installed on patrol superintendents' vehicles and some winter patrol trucks in all counties in the past decade. Approximately 500 of these sensors are now in use throughout the state. In general, field experience with these units has been good, and WisDOT recommends that counties continue to purchase them. See the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/infraredpavetempsensors.pdf.

2. Salt brine production units. The use of salt brine production units by county highway departments has increased continuously since the first units became operational in 1995. Currently, 29 counties have a total of 39 units. Thirty-four of the units are made by Varitech Industries, three units are made by Sprayer Specialties, and two units were fabricated in county shops. In addition, 10 counties without their own units purchase salt brine made by adjacent

counties. WisDOT developed salt brine production guidelines in November 2000; the guidelines are available by request.

Past projects that did not result in a change to operational procedures

1. "Salt Miser" salt application rate controllers. These controllers automatically vary the salt application rate according to pavement temperature and vehicle speed, and were installed on patrol trucks in seven counties in 1997 and 1998. Due to numerous installation and interfacing issues, field-testing of these units has been very limited. No counties have used the units during the past six winter seasons.

Other Winter Maintenance Equipment

Recent projects

1. Winter concept vehicle. Several counties tested next-generation "concept vehicles" that included the latest winter maintenance equipment and technology available. Between 1999 and 2002, these vehicles were field-tested in Columbia, Manitowoc, Florence, Portage, Trempealeau, Taylor, Barron and Kenosha Counties.

Final field evaluation and testing of the GPS/AVL and data management portion of this project were completed during the 2005-2006 winter. The final report for the data management portion of the project was completed in June 2006 and is available from WisDOT. Highlights of the report included:

- A GIS-based decision support system for winter highway maintenance vehicles was developed, tested, documented and installed at county highway garages and the WisDOT central office.
- The software computes performance measures, and produces reports and decision management tools based on the performance measures.
- The software requires accurate files of roadway centerlines and patrol sections.
- Detailed user documentation, including tutorials, was developed and training for software users was conducted.
- Options for the maintenance of the roadway files, and the software package are provided in the report. Options addressing the maintenance of software source code are also described in the report.

The final report for the concept vehicle project is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/conceptvehicleiiifinalreport1102.pdf. The final report for the data management study is available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/year5report4.pdf.

2. Black Cat Joma 6000 rubber-coated snowplow blades. These blades were used by 17 counties during the 2003-2004 winter. Users of the blade reported better scraping results, and said the blades conformed to the pavement surface and were longer-lasting than standard carbide insert blades. They also reported that less vibration and noise carried into the cab. The normal life expectancy of these blades appears to be three to four times longer than carbide insert blades. See the reports at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/blackcat.pdf and https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/blackcat-joma6000-progressreport-aug2001.pdf.

3. Swenson Precision Placement System salt spreaders. Two PPS salt spreaders were field-tested by Waushara County. These spreaders use the "zero-velocity" concept to keep more salt on the road surface. See the report at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/swensonppswaushara-co-progressreport.pdf.

4. Monroe Truck Equipment Accu-Place Spreader System units. These spreaders also use the "zero velocity" concept to keep a greater percentage of discharged salt on the pavement. The units are being used by Outagamie and Winnebago County, and a unit was also installed on the winter concept vehicle in Columbia County. A fact sheet is available from WisDOT.

5. Dual-chute V-box salt spreader. Jackson County shop-fabricated this spreader and is field-testing it on Interstate 94. The county has also purchased a manufactured version of the same dual-chute concept, and is comparing the performance of these units to Tyler zero-velocity spreaders. A fact sheet is available from WisDOT.

6. Marine-grade wiring. Winter patrol trucks in Marquette and Milwaukee Counties are being equipped with marine-grade wiring in order to minimize corrosion of the wiring and connectors. A fact sheet is available from WisDOT.

7. End loader bucket scales. A total of 44 end loader bucket scales were used by 14 counties for a salt weighing/inventory control pilot program between 2003 and 2005. Each county completed surveys on the technology. Progress reports, including summaries of survey results, are available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/bucketscaleprogressreportnov2004.pdf and https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/bucketscaleprogressreport2_june2005.pdf.

Past test projects that have become operational

1. Underbody plows. The use of underbody plows by county highway departments has been increasing since a report on these blades was issued by WisDOT in 1997 (see https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/underbody%20-blades.pdf). Fifty-one counties now use underbody plows.

Past projects that did not result in a change to operational procedures

1. Cryogenically treated snowplow blades. Treated through a freezing process, these blades were tested in Barron County over concrete pavement during the 1999-2000 winter. The cryogenically treated blades did not last as long as the standard carbide insert blades. A report is available from WisDOT.

2. Damage due to raised pavement markers. Damage to plow blades, plows and truck frames from the plowing of raised pavement markers was documented in 17 counties during the 1999-2000 and 2000-2001 winters. In general, minimal damage was documented, especially on roads containing raised pavement markers installed in 1999. A report is available from WisDOT.

SNOWPLOW ROUTE OPTIMIZATION

Past project

St. Croix, Manitowoc and Dane Counties performed route optimization studies of their winter maintenance patrol sections and salt storage facilities between 1997 and 2001. Route optimization is a computer-based program planning tool used to establish the most efficient winter patrol section routes and garage locations. See the final report for St. Croix at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/st-croix.pdf, and for Manitowoc at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/reports/pdf/snow-plow-facilities.pdf. A report on the Dane County project is available from WisDOT.

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. Below are a few of the innovative solutions developed or purchased by Wisconsin's county highway departments. To submit an innovation for consideration for inclusion in next year's report, contact Tom Martinelli at thomas.martinelli@dot.state.wi.us.

County: **Barron**

Innovation: **Retractaflap**

The Retractaflap automatically retracts a truck's mud flaps when the truck is shifted into reverse. The flaps can also be individually raised with a control box mounted in the cab. Either configuration allows the driver to stay in the cab rather than getting out to raise the flaps manually. During winter, this device could be used when backing up to salt sheds for loading salt, backing up in driveways, or while turning around.

The Retractaflap was invented by Gene Anderson of Barron County, who has worked for Barron County Highway Department for 40 years. The Retractaflap is now sold commercially by Red Horse Truck Body & Hoist in Menominee.

Contact: Red Horse Truck Body & Hoist, Inc. (formerly Menominee Truck)
E5484 CTH "BB"
Menominee, WI 54751
Phone: (715) 235-8282, (866) 355-8282
www.redhorsetruck.com

Jerry Pich
Barron County Highway Department
250 North 7th Street
Barron, WI 54812
(715) 637-6778, jerry.pich@co.barron.wi.us

County: **Dane**

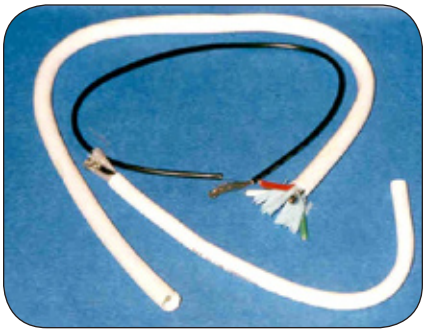
Innovation: **Automated salt brine production**

The Dane County Highway Department installed an automated salt brine production system in December 2005. The system is capable of producing 5,000 gallons of 23.3% salt brine per hour. The system automatically monitors and controls salt brine consistency during the production cycle. Sediment collected in the bottom of the production tank can be flushed out of the system. The "Accubrine" salt brine maker is marketed by Cargill Salt (http://www.cargilldeicing.com).

Contact: Greggar Petersen
Dane County Highway Department
2302 Fish Hatchery Road
Madison, WI 53713-2495
(608) 266-9081, petersen.greg@co.dane.wi.us

Counties: **Milwaukee and Marquette**

Innovation: **Marine-grade wiring**



Electrical wiring and connections installed on winter maintenance vehicles can short out due to corrosion at the connections or breakage of the wires' coating caused by the combination of salt, moisture, and cold temperatures. To minimize these wiring problems, Milwaukee and Marquette Counties now replace the standard wiring in their winter maintenance trucks with marine-grade wiring. This switch to marine-grade wiring has helped minimize truck downtime due to wiring corrosion or breakage.

Contacts:

Bill Tietjen
Milwaukee County Department of Public Works
10320 Watertown Plank Road
Wauwatosa, WI 53226
(414) 257-6596

Lee Sauer
Marquette County Highway Department
328 Underwood Avenue, P.O. Box 398
Montello, WI 53949-0398
(608) 297-9127
lsauer@co.marquette.wi.us

County: **Shawano**

Innovation: **Salt sensor**

Patrolman Mike Bohm invented a tailgate switch that senses salt at the tailgate. When there is not salt at the tailgate, a light in the cab will inform the driver that the auger may be empty and he needs to raise the box.

Contact:

Mike Bohm or Randy Zastrow
Shawano County Highway Department
3035 East Richmond Street
Shawano, WI 51466
(715) 526-9182
hwyrandy@co.shawano.wi.us

Counties: **Milwaukee and Wood**

Innovation: **Anti-icing spray bar attachments**

Anti-icing spray bar applicators have been used by county highway departments for a number of years. Milwaukee and Wood County have added sections of rubber hose to their spray bars in order to distribute the anti-icing agent closer to the pavement surface. This minimizes the loss of material due to cross winds or turbulence behind the applicator.

Contact: Greg Heisel or Bill Tietjen
Milwaukee County Department of Public Works
10190 Watertown Plank Road
Wauwatosa, WI 53226
(414) 257-6501

Randy Kaddatz or Doug Passineau
Wood County Highway Department
555 17th Avenue North
Wisconsin Rapids, WI 54495
(715) 421-8875

County: **Wood**

Innovation: **2,800-gallon anti-icing trailer**

The Wood County Highway Department began its anti-icing program by treating bridge decks using a 250-gallon tow-behind unit mounted on a flatbed trailer. Once crews became familiar with the anti-icing technique, the department expanded its anti-icing program to some patrol sections in the Wisconsin Rapids area. In order to economically treat these patrol sections with salt brine, the county purchased a tow-behind trailer with a 2,800-gallon tank and spray bar system from Monroe Truck and Equipment. This large tank capacity saves the county time and money by allowing the driver to apply salt brine to a large area before returning to the shop to refill the tank.

Contact: Doug Passineau
Wood County Highway Department
555 17th Avenue North
Wisconsin Rapids, WI 54495
(715) 421-8875
dpassineau@co.wood.wi.us

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 nine member states and completed its first research project this summer, a synthesis of methods for eliminating icing and fogging on snowplow windshields, windows and mirrors. A project on the calibration accuracy of manual and ground-speed-control spreaders will be complete in 2007.

Clear Roads also publishes an e-newsletter of winter maintenance news items, publications, and research in progress. Read the newsletter online at http://www.clearroads.org/resources.htm.

See www.clearroads.org for more information about this pooled fund project.

• **Aurora.** Aurora is an international partnership of public agencies who work together to perform joint research on road weather information systems (RWIS). Its membership includes 13 state DOTs and three international agencies. WisDOT rejoined Aurora in FY 2006.

The Aurora program performs research in many RWIS-related areas, some of which have applications in Wisconsin. WisDOT is 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 de-icer spraying equipment. The Aurora study is being performed by the Ontario Ministry of Transport and the University of North Dakota.

WisDOT is also a member of several other Aurora project teams, including a project to develop a standardized winter severity index.

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 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.

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 the storm events.

This project is a multi-year effort, and WisDOT continues to monitor its progress. The major obstacle to full MDSS implementation in Wisconsin is in providing of feedback to the system. The MDSS can easily generate initial predictions, but requires input as to what maintenance actions actually occurred. If a system can be put into place where this can be easily accomplished, then it will become much easier to implement the entire MDSS. For now, for Wisconsin the greatest value of the project continues to be in hoped-for increases in forecast accuracy. WisDOT will explore the possibility of conducting a pilot test of the MDSS concept in FY 2007.

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

• **Clarus.** A joint effort between FHWA and the National Weather Service, this initiative aims to consolidate all road weather data into a national database. A WisDOT representative attended a project meeting in Salt Lake City in November 2005. This project is a huge undertaking with a very aggressive schedule that will require some state effort. It is anticipated that WisDOT will be part of a team that submits a bid to be part of one of the Clarus regional demonstration projects in FY 2007. The Northwest Passage group and Aurora (WisDOT is a member of both groups) are planning to submit proposals. Since Wisconsin is already providing RWIS data and the statewide traffic operations center is now active, the state is well positioned to provide road weather information to Clarus, and then use the outputs that result.

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

• **Midwest Snow and Ice Group.** This group of nine Midwest states comes together to discuss winter maintenance issues including materials, equipment and new technologies. Members emphasize learning from each other's experiences and sharing specifications and test results. The group has an annual face-to-face meeting and periodic teleconferences during the year.

A subcommittee of the Midwest Snow and Ice Group was formed to develop specifications and laboratory performance testing procedures for liquid and solid anti-icing and deicing materials used in the Midwest. Interim specifications for liquid materials were developed in 2002, and the subcommittee continues to meet on general winter operations issues.

See http://rebar.ecn.purdue.edu/snownice/index.htm for more information.

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 $14.4 million on labor, for an average of $437 per lane mile. An average of 31% of counties' winter maintenance costs were spent on labor, with a high of 41% in the Southeast Region, where hourly labor rates tend to be higher. See Table 3.7 on page 58 for a county-by-county breakdown of 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:

- **Winter Operations Workshops.** Facilitated by BHO staff, these interactive one-day workshops for WisDOT regional staff and county highway department patrol superintendents cover winter maintenance topics such as use of RWIS and weather forecast programs, anti-icing, living snow fences, and winter maintenance guidelines. First held in October 2004 and held again at five locations in October 2005, the workshops will be offered on an 18-month schedule in coming years.

- **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/pdf/rwis-06-annualreport.pdf.

- **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 were held by some counties in the fall of 2005, 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).

  Some counties participated in a statewide Snowfighters' Roadeo in September 2005 at Lambeau Field in Green Bay, which was hosted by the Wisconsin chapter of the American Public Works Association. A number of counties have also sent representatives to the Wisconsin County Highways Association Snowfighters' Roadeos held each June (most recently in Lake Delton, Wis.).

Past training efforts have included:

- **Division of State Patrol Winter Maintenance Training Sessions.** Presented by BHO, this training was last held in November 2002 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.

- **Law Enforcement Fact Sheets.** Developed in 1999 and distributed to all State Patrol troopers, these fact sheets address all aspects of winter operations. The original fact sheets were updated in 2002 to correspond with updates to the state Maintenance Manual. The fact sheets are available at https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/winter/fact-sheets/winterfacts.shtm.

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

Table 3.6. Actual Salt Used per Lane Mile

From Salt Inventory Reporting System, 2005-2006

NC Region

County	Lane Miles	Tons Used	Tons per Lane Mile	Winter Service Group
Adams	192.09	2798	14.6	D
Florence	141.07	2562	18.2	D
Forest	312.38	4663	14.9	D
Green Lake	149.06	870	5.8	D
Iron	246.87	4533	18.4	D
Langlade	292.69	4382	15.0	D
Lincoln	389.97	4103	10.5	C
Marathon	859.87	11216	13.0	A
Marquette	244.80	2624	10.7	B
Menominee	90.26	1379	15.3	D
Oneida	389.71	5430	13.9	B
Portage	485.96	5029	10.3	A
Price	320.57	4557	14.2	D
Shawano	508.94	5042	9.9	B
Vilas	305.18	6150	20.2	C
Waupaca	535.10	4403	8.2	C
Waushara	344.05	2673	7.8	B
Wood	362.92	2889	8.0	C
Region Total	6171.49	75303		
Region Average	342.86	4184	12.7	

NW Region

County	Lane Miles	Tons Used	Tons per Lane Mile	Winter Service Group
Ashland	247.57	3716	15.0	D
Barron	421.98	3062	7.3	D
Bayfield	316.90	4770	15.1	D
Buffalo	302.86	1593	5.3	D
Burnett	253.46	3401	13.4	D
Chippewa	649.87	7545	11.6	B
Clark	401.56	3776	9.4	C
Douglas	436.65	6088	13.9	C
Dunn	518.95	5999	11.6	B
Eau Claire	548.70	4491	8.2	A
Jackson	499.14	6603	13.2	C
Pepin	106.24	698	6.6	D
Pierce	361.23	4838	13.4	D
Polk	385.06	4640	12.1	D
Rusk	238.39	2266	9.5	D
Saint Croix	614.24	6399	10.4	B
Sawyer	367.44	3079	8.4	D
Taylor	234.08	2582	11.0	D
Trempealeau	415.92	4270	10.3	C
Washburn	368.98	5098	13.8	C
Region Total	7689.22	84914		
Region Average	384.46	4246	11.0	

NE Region

County	Lane Miles	Tons Used	Tons per Lane Mile	Winter Service Group
Brown	677.81	10010	14.8	A
Calumet	202.80	1893	9.3	C
Door	231.83	2205	9.5	C
Fond du Lac	587.02	6176	10.5	C
Kewaunee	111.29	730	6.6	C
Manitowoc	415.45	3893	9.4	B
Marinette	313.81	3905	12.4	D
Oconto	411.99	4725	11.5	C
Outagamie	504.94	6934	13.7	B
Sheboygan	516.49	7084	13.7	B
Winnebago	553.42	7511	13.6	A
Region Total	4526.85	55066		
Region Average	411.53	5006	11.4	

SW Region

County	Lane Miles	Tons Used	Tons per Lane Mile	Winter Service Group
Columbia	775.73	12912	16.6	B
Crawford	377.95	2824	7.5	C
Dane	1668.10	26314	15.8	A
Dodge	606.62	10179	16.8	B
Grant	614.85	5268	8.6	C
Green	311.45	2716	8.7	D
Iowa	450.33	4474	9.9	C
Jefferson	446.57	6989	15.7	B
Juneau	498.09	5038	10.1	C
LaCrosse	460.76	4465	9.7	A
Lafayette	292.70	1507	5.1	C
Monroe	643.21	7606	11.8	C
Richland	329.08	1198	3.6	D
Rock	592.51	7316	12.3	B
Sauk	591.05	7666	13.0	B
Vernon	448.75	5148	11.5	C
Region Total	9107.75	111620		
Region Average	569.23	6976	11.0	

SE Region

County	Lane Miles	Tons Used	Tons per Lane Mile	Winter Service Group
Kenosha	550.15	4897	8.9	A
Milwaukee	1777.00	29792	16.8	A
Ozaukee	304.03	4855	16.0	A
Racine	593.65	5385	9.1	A
Walworth	689.25	10397	15.1	B
Washington	585.03	9257	15.8	B
Waukesha	1027.10	19084	18.6	A
Region Total	5526.21	83667		
Region Average	789.46	11952	14.3	

	Lane Miles	Tons Used	Tons per Lane Mile
Statewide Totals	33,021.52	410570.3	12.4
Statewide Averages	458.63	5702.4	12.4
Group A Averages	792.21	11087.41	12.9
Group B Averages	529.07	6961.14	12.8
Group C Averages	408.87	4332.10	10.4
Group D Averages	269.75	3100.37	11.7

Table 3.7. Labor Hours/Lane Miles/Severity Index Ranking (Group A)

From Winter Storm Reports, 2005-2006

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	859.87	43.30	15.54	$337	3607	3330	6937	48.0%	8.07	0.19
WINNEBAGO	NE	553.42	33.06	12.65	$296	1559	2472	4031	61.3%	7.28	0.22
LA CROSSE	SW	460.76	31.57	8.09	$295	1734	1588	3321	47.8%	7.21	0.23
RACINE	SE	593.65	20.68	8.96	$290	1173	1906	3079	61.9%	5.19	0.25
PORTAGE	NC	485.96	32.51	12.92	$319	1899	2074	3973	52.2%	8.18	0.25
BROWN	NE	677.81	30.36	13.09	$368	2163	3025	5187	58.3%	7.65	0.25
DANE	SW	1668.14	27.92	16.59	$338	5485	6974	12459	56.0%	7.47	0.27
OZAUKEE	SE	304.03	21.18	15.97	$271	1179	641	1820	35.2%	5.98	0.28
EAU CLAIRE	NW	548.70	21.96	10.54	$246	1600	1815	3415	53.1%	6.22	0.28
WAUKESHA	SE	1027.07	20.60	19.57	$303	1870	4399	6269	70.2%	6.10	0.30
KENOSHA	SE	550.15	16.99	7.25	$319	1539	1649	3187	51.7%	5.79	0.34
MILWAUKEE	SE	1777.00	17.03	17.79	$373	5480	6452	11932	54.1%	6.71	0.39
Group A Avg		792.21	26.43	13.25	$313	2441	3027	5467	54.2%	6.82	0.27

Table 3.7. Labor Hours/Lane Miles/Severity Index Ranking (Group B)

From Winter Storm Reports, 2005-2006

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	344.05	28.77	11.10	$196	700	950	1650	57.6%	4.80	0.17
MARQUETTE	NC	244.80	33.94	13.60	$249	663	902	1565	57.6%	6.39	0.19
SHEBOYGAN	NE	516.49	28.11	13.13	$237	1366	1418	2784	50.9%	5.39	0.19
SHAWANO	NC	508.94	35.68	9.91	$325	2367	1418	3785	37.5%	7.44	0.21
SAINT CROIX	NW	614.24	33.05	12.85	$266	1789	2453	4242	57.8%	6.91	0.21
MANITOWOC	NE	415.45	25.52	10.71	$234	1026	1229	2255	54.5%	5.43	0.21
WASHINGTON	SE	585.03	27.89	15.82	$269	1198	2363	3561	66.4%	6.09	0.22
SAUK	SW	591.05	25.02	13.52	$214	1719	1696	3415	49.7%	5.78	0.23
ONEIDA	NC	389.71	48.72	14.89	$486	2923	1513	4436	34.1%	11.38	0.23
DODGE	SW	606.62	25.98	15.93	$296	1837	2012	3849	52.3%	6.34	0.24
COLUMBIA	SW	775.73	21.54	14.28	$244	1942	2276	4218	54.0%	5.44	0.25
OUTAGAMIE	NE	504.94	31.74	14.63	$287	2856	1259	4115	30.6%	8.15	0.26
DUNN	NW	518.95	25.72	15.94	$335	1787	2005	3792	52.9%	7.31	0.28
JEFFERSON	SW	446.57	19.01	15.14	$265	1070	1476	2545	58.0%	5.70	0.30
CHIPPEWA	NW	649.87	24.46	12.44	$302	1942	2897	4839	59.9%	7.45	0.30
WALWORTH	SE	689.25	17.90	15.13	$308	1535	2574	4109	62.6%	5.96	0.33
ROCK	SW	592.51	12.54	12.35	$227	1003	1810	2813	64.3%	4.75	0.38
Group B Avg		529.07	27.39	13.61	$279	1631	1779	3410	53.0%	6.51	0.25

Final totals as of Thursday, October 19, 2006

Table 3.7. Labor Hours/Lane Miles/Severity Index Ranking (Group C)

From Winter Storm Reports, 2005-2006

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
MONROE	SW	643.21	41.21	9.59	$257	1989	2114	4103	51.5%	6.38	0.15
TREMPEALEAU	NW	415.92	35.06	9.99	$218	1411	925	2336	39.6%	5.62	0.16
OCONTO	NE	411.99	38.77	10.73	$273	1465	1183	2648	44.7%	6.43	0.17
JUNEAU	SW	498.09	28.77	11.51	$182	1001	1394	2394	58.2%	4.81	0.17
VERNON	SW	448.75	31.46	6.93	$197	1329	1068	2396	44.6%	5.34	0.17
DOUGLAS	NW	436.65	46.80	14.26	$391	1636	1992	3628	54.9%	8.31	0.18
GRANT	SW	614.85	27.37	9.16	$182	1507	1486	2993	49.6%	4.87	0.18
DOOR	NE	231.83	36.03	10.31	$311	583	1011	1594	63.4%	6.87	0.19
KEWAUNEE	NE	111.29	26.78	6.46	$199	365	219	584	37.4%	5.24	0.20
FOND DU LAC	NE	587.02	38.76	10.43	$300	2242	2237	4479	49.9%	7.63	0.20
JACKSON	NW	499.14	29.80	12.53	$229	1699	1344	3042	44.2%	6.09	0.20
LAFAYETTE	SW	292.70	21.32	5.08	$160	558	726	1283	56.6%	4.38	0.21
WAUPACA	NC	535.10	29.10	11.09	$249	1521	1697	3218	52.7%	6.01	0.21
CRAWFORD	SW	377.95	26.49	7.35	$208	1077	1013	2090	48.5%	5.53	0.21
IOWA	SW	450.33	28.61	9.27	$236	1156	1595	2751	58.0%	6.11	0.21
LINCOLN	NC	389.97	45.73	12.60	$358	2394	1422	3816	37.3%	9.78	0.21
WOOD	NC	362.92	32.51	11.19	$305	1390	1135	2525	45.0%	6.96	0.21
VILAS	NC	305.18	43.31	22.28	$389	1851	1017	2868	35.4%	9.40	0.22
CLARK	NW	401.56	27.34	13.15	$250	1198	1209	2407	50.2%	5.99	0.22

Final totals as of Tuesday, November 21, 2006

Table 3.7. Labor Hours/Lane Miles/Severity Index Ranking (Group C)

From Winter Storm Reports, 2005-2006

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
WASHBURN	NW	368.98	32.94	13.75	$301	1520	1219	2739	44.5%	7.42	0.23
CALUMET	NE	202.80	29.57	9.51	$345	786	852	1638	52.0%	8.08	0.27
Group C Avg		408.87	33.22	10.82	$264	1365	1279	2644	48.5%	6.54	0.20

Table 3.7. Labor Hours/Lane Miles/Severity Index Ranking (Group D)

From Winter Storm Reports, 2005-2006

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
ADAMS	NC	192.09	33.10	17.10	$235	478	560	1038	53.9%	5.40	0.16
FLORENCE	NC	141.07	49.18	18.01	$338	524	622	1146	54.3%	8.12	0.17
BUFFALO	NW	302.86	33.81	5.26	$198	982	721	1703	42.3%	5.62	0.17
GREEN LAKE	NC	149.06	30.15	9.45	$187	464	302	766	39.4%	5.14	0.17
MENOMINEE	NC	90.26	31.90	15.28	$162	315	176	491	35.8%	5.44	0.17
BAYFIELD	NW	316.90	53.04	15.09	$321	1953	930	2883	32.3%	9.10	0.17
BURNETT	NW	253.46	27.78	9.94	$180	707	514	1221	42.1%	4.82	0.17
TAYLOR	NW	234.08	34.31	12.53	$231	938	514	1452	35.4%	6.20	0.18
ASHLAND	NW	247.57	50.92	14.84	$347	1123	1168	2291	51.0%	9.25	0.18
PRICE	NC	320.57	45.86	17.58	$423	1276	1425	2701	52.8%	8.42	0.18
PIERCE	NW	361.23	31.58	12.19	$239	1170	970	2140	45.3%	5.92	0.19
POLK	NW	385.06	35.79	13.65	$299	1430	1242	2671	46.5%	6.94	0.19
RUSK	NW	238.39	30.00	6.97	$218	829	560	1389	40.3%	5.82	0.19
MARINETTE	NE	313.81	38.56	11.90	$314	1150	1219	2369	51.4%	7.55	0.20
RICHLAND	SW	329.08	24.42	5.20	$190	868	717	1584	45.2%	4.81	0.20
SAWYER	NW	367.44	30.95	8.60	$238	1390	933	2323	40.2%	6.32	0.20
LANGLADE	NC	292.69	47.97	19.00	$393	1607	1279	2885	44.3%	9.86	0.21
IRON	NC	246.87	60.04	19.41	$576	2272	1019	3291	31.0%	13.33	0.22
FOREST	NC	312.38	51.03	16.75	$442	2426	1299	3725	34.9%	11.92	0.23

Final totals as of Tuesday, November 21, 2006

Table 3.7. Labor Hours/Lane Miles/Severity Index Ranking (Group D)

From Winter Storm Reports, 2005-2006

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
PEPIN	NW	106.24	19.84	6.57	$207	287	283	569	49.7%	5.36	0.27
BARRON	NW	421.98	26.95	7.24	$282	1536	1599	3135	51.0%	7.43	0.28
GREEN	SW	311.45	21.68	7.75	$240	951	1045	1996	52.4%	6.41	0.30
Group D Avg		269.75	36.77	12.29	$285	1121	868	1989	44.2%	7.24	0.20

4 Performance

In this section...

So, how did we do? Throughout the winter, WisDOT central office and regional staff, along with 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. While still in its early stages, this program allows the department to identify trends from year to year 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

	2005-2006 Statewide
Total lane miles	33,022
Total patrol sections	733
Average lane miles per patrol section	45
Average time to bare/wet pavement[1]	1.92 hours
Average crew reaction time from start of storm	2.38 hours
Total winter costs[2]	$46,244,946
Total winter costs per lane mile	$1,400
Total winter crashes[3]	6,724
Total winter crashes per 100 million VMT	24

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.

Using Resources Efficiently

County highway departments are becoming more proactive in getting crews on the road quickly, sometimes even before a storm starts. This winter, crews responded an average of 19% more quickly than they did in 2001-2002. *See page 66 for more information.*

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. See Table A-10 on page 157 of the Appendix for a comparison of estimated costs drawn from the storm reports with final billed costs.

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 733 winter patrol sections, an average of 10.2 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 page 48 for more 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 79.

Table 4.1. Average Patrol Section Lengths by Winter Service Group

Winter service group	Average patrol section length (miles)	Range of patrol section lengths (miles)
A	43.4	29 – 61
B	44.6	34 – 61
C	45.7	21 – 61
D	49.4	38 – 61
Statewide average	45.1	21 – 61

4B. 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 4.2 on page 66 gives the statewide average values for these measures for the last three winters. More detail on these measures is provided later in this section.

Table 4.2. Statewide Compass Measures for Winter

	FY 2004	FY 2005	FY 2006
Time to bare/wet pavement (after end of storm)	2 hours 38 minutes	2 hours 4 minutes	1 hour 55 minutes
Cost per lane mile	$1,279	$1,374	$1,400
Winter Severity Index	31.2	31.9	31.8
Cost per lane mile per Winter Severity Index point	$40.99	$43.07	$44.03
Winter weather crashes	26 per 100 million vehicle miles traveled	25 per 100 million vehicle miles traveled	24 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 (see page 154 of the Appendix for a brief report on winter equipment calibration)
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. Instructions for obtaining an extranet login are provided at the site.

4C. 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, which may require more materials, labor and time to remove.

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

Table 4.3. Maintenance Crew Reaction Time

From Winter Storm Reports, 2001-2006

	Average reaction time (hours)					Percent change
Winter Service Group	**2001-2002**	**2002-2003**	**2003-2004**	**2004-2005**	**2005-2006**	**2005-2006 vs. 2001-2002**
A	1.89	1.44	1.45	1.25	1.55	-18%
B	2.17	1.92	2.01	1.97	1.59	-27%
C	3.36	2.92	2.89	2.42	2.79	-17%
D	4.34	3.56	4.37	3.23	3.60	-17%
Statewide average (unweighted)	**2.94**	**2.46**	**2.68**	**2.22**	**2.38**	-19%

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 4.3 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 five winter seasons, responding an average of 19% 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.

Table 4.4. 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
1	1.07	1.86	-1.21
2	1.31	1.91	0.20
3	1.52	2.08	1.77
4	2.45	1.95	2.47
5	3.63	2.03	3.40
Statewide average	2.63	2.07	1.92

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

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.

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.

Anti-icing is another component of a proactive approach to winter maintenance. As shown in Table 3.3 on page 41, the cost of a preventive anti-icing treatment for a forecasted frost event is three times less than the cost of de-icing once the frost has occurred.

For more information, contact Tom Martinelli at thomas.martinelli@dot.state.wi.us or (608) 266-3745.

"Time to bare/wet pavement" is measured from the reported end time of a storm. Table 4.4 on the previous page 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 has decreased each winter that this measure has been tracked, and this winter the statewide average was under 2 hours. WisDOT is still in the process of gathering baseline data for this winter measure.

4D. Costs

The total actual billed cost of statewide winter operations this year was $46.2 million. This figure is higher than WisDOT's projected budget for this winter, but is influenced by a larger-than-usual annual increase in lane miles from 31,811 to 33,022 (a 3.8% increase), and by higher labor rates.

Factoring in the increase in lane miles, however, costs were still higher than in recent years. This winter's statewide average cost per lane mile of $1,400 was similar to last year's figure, but higher than the average of the past several years, which is around $1,100 to $1,200 (see Figure 4.4 on page 71).

WisDOT uses an average of the previous five years' costs to develop a budget for the coming winter, and a budget for each county based on its characteristics according to WisDOT's Level of Service model. Counties are expected to stay within their budgets unless the winter is unusually severe.

Major components of winter costs include labor, equipment, salt, other materials such as sand and chemicals, and administrative costs:

- **Labor costs** are determined by each county's union contracts, and hourly rates tend to be higher in more urban counties.

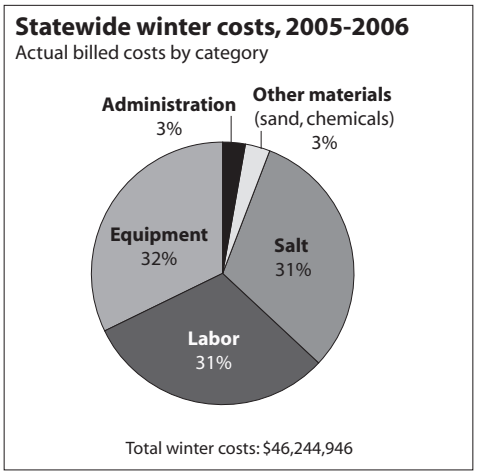
- **Equipment costs** are determined by the state Machinery Management Committee, which assigns an hourly rate to each piece of equipment that includes depreciation from the purchase price, maintenance costs, and fuel costs. Although fuel costs have risen dramatically in the last year, they are still a relatively small portion of the cost of operating each piece of equipment, so equipment costs have not risen sharply.

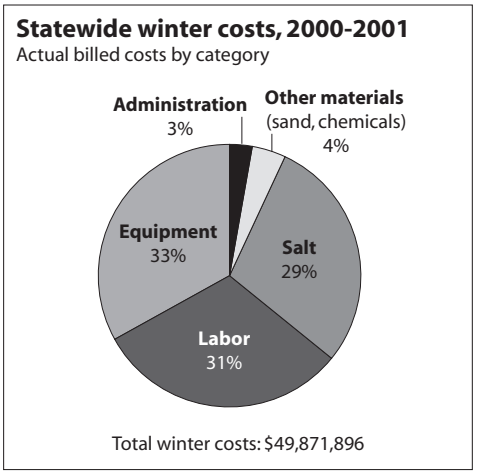
- **Salt costs** vary across the state, in part because of transportation costs. For example, salt entering the state at the Port of Milwaukee doesn't have to travel as far to reach counties in the Southeast region as it does to reach counties in the center of the state.

- **Costs for materials** other than salt, such as sand, are also affected by transportation costs. In addition, some counties choose to use more expensive chemicals than others.

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

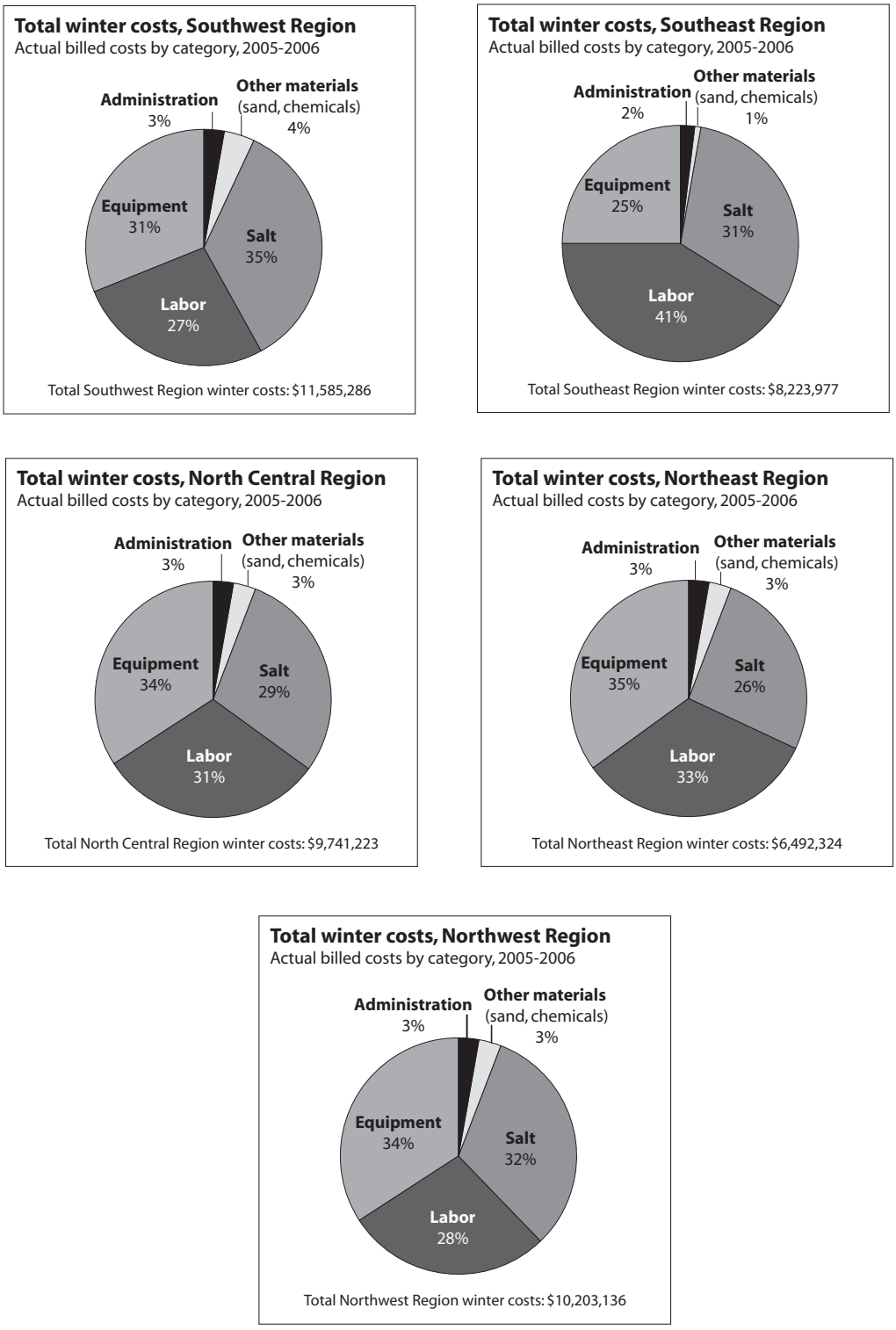
Figure 4.1. Statewide Winter Costs by Category





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 4.1 shows the breakdown of costs for this winter and for the 2000-2001 winter, when the statewide severity index was 22% higher (38.8 compared with this year's 31.8).

Figure 4.2. Regional Winter Costs by Category



However, the percentage of total costs spent on each category varies among regions because of the factors described above. For example, the Southeast Region spends more on labor costs because hourly labor rates tend to be higher in those counties, while equipment costs make up a smaller percentage of that region's total costs. Figure 4.2 on the previous page shows the distribution of costs by category for each region.

Adjusting the costs to account for the differences in lane miles between the regions, some of the same differences between regions are visible, and new ones emerge as well. For example, Figure 4.3 shows that the Northeast Region has markedly lower salt costs per lane mile than the other regions, which is likely primarily due to low salt transportation costs. The Southeast Region has significantly lower costs for materials other than salt, which reflects those counties' below-average use of sand. (Administrative costs are calculated as a flat 4.5% of each county's combined costs, so a graph of these costs would not be meaningful.)

Figure 4.3. Costs per Lane Mile by Category

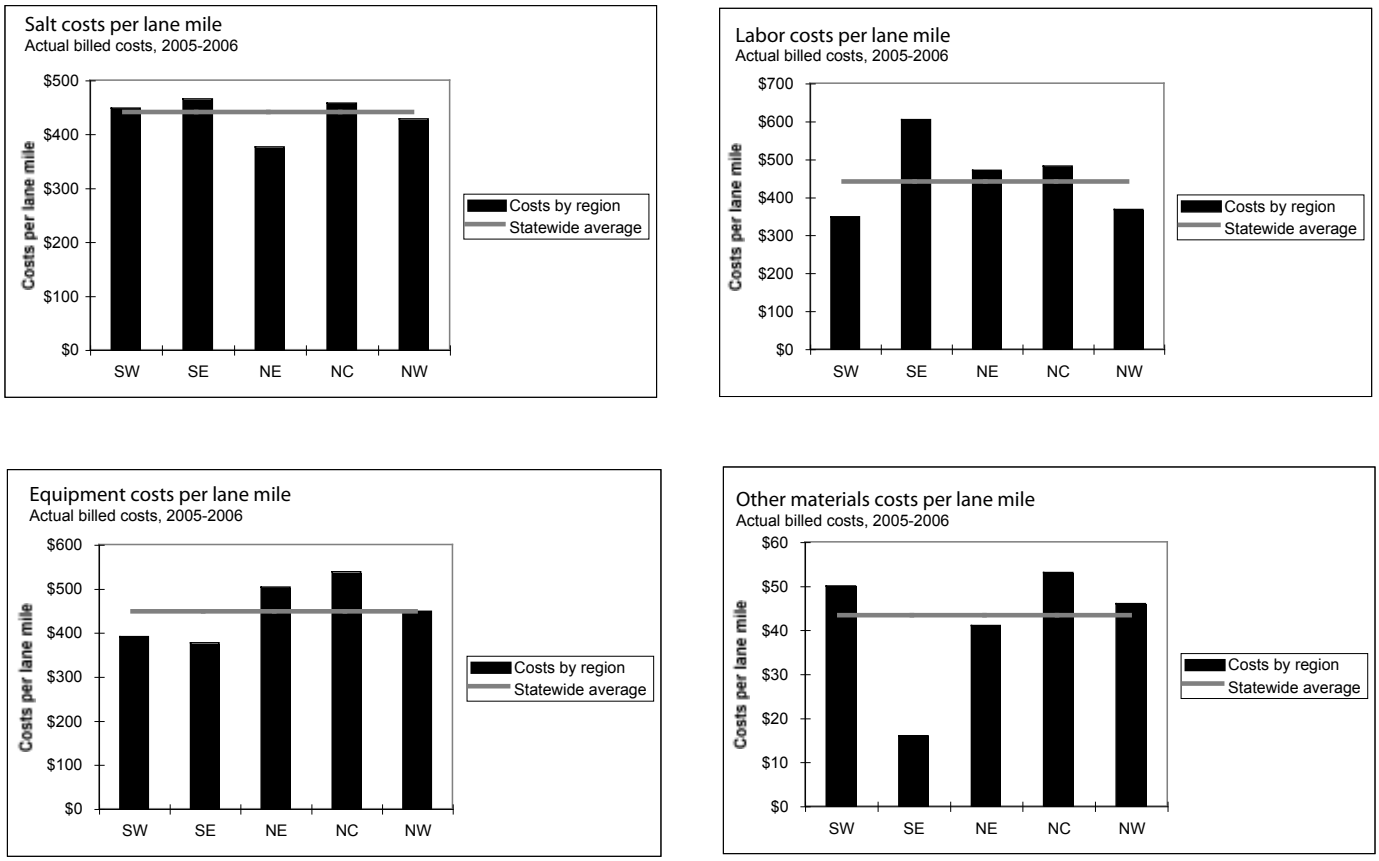


Table 4.5 lists the total cost per lane mile for winter maintenance in each region, along with the region's winter severity index. The level of service provided in each county affects total costs, as do the factors listed on page 68. For these reasons, the Southeast Region historically experiences significantly higher costs relative to winter severity than the other regions.

This winter, the statewide average cost per lane mile was $1,400, with an average severity index of 31.8. Total costs in Table 4.5 include material, labor, equipment and administrative costs.

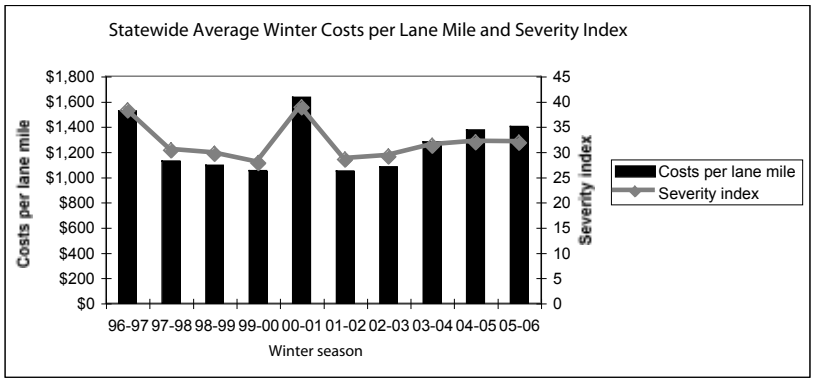
Statewide winter cost data is presented in Table 4.6 on page 72. County-by-county cost data is available in Table 4.10 on page 84.

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
SE	20.32	$1,488	$73.23
SW	25.93	$1,272	$49.06
NE	32.48	$1,434	$44.15
NW	32.60	$1,327	$40.71
NC	40.16	$1,578	$39.29
Statewide	**31.80**	**$1,400**	**$44.03**

As would be expected, winter costs per lane mile tend to increase with more severe winters. Figure 4.4 shows the trends in total winter costs and severity index over the last 10 winters.

Figure 4.4. Winter Costs per Lane Mile



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 89, Cost per Lane Mile per Winter Severity Index) 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.

Table 4.6. Winter Costs as Billed to WisDOT by Counties

From WisDOT accounting system, 2005-2006

	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 ('01-'05 Avg.)	% Costs over 5-Year Average
Region 1 / Southwest	$3,170,321	$3,564,302	$450,905	$321,356	$4,078,402	$11,585,286	$9,250,400	125%
Region 2 / Southeast	$3,338,390	$2,085,068	$86,917	$141,350	$2,572,252	$8,223,977	$7,500,900	110%
Region 3 / Northeast	$2,126,285	$2,275,350	$185,829	$204,588	$1,700,272	$6,492,324	$5,687,600	114%
Region 4 / North Central	$2,974,201	$3,320,908	$328,738	$295,575	$2,821,801	$9,741,223	$8,251,500	118%
Region 5 / Northwest	$2,820,642	$3,447,479	$351,922	$293,898	$3,288,195	$10,202,136	$9,284,100	110%
Region Totals	$14,429,839	$14,693,107	$1,404,311	$1,256,767	$14,460,922	$46,244,946	$39,974,500	116%

prepared by: Cathy Meinholz/Bureau of Highway Operations

August 15, 2006

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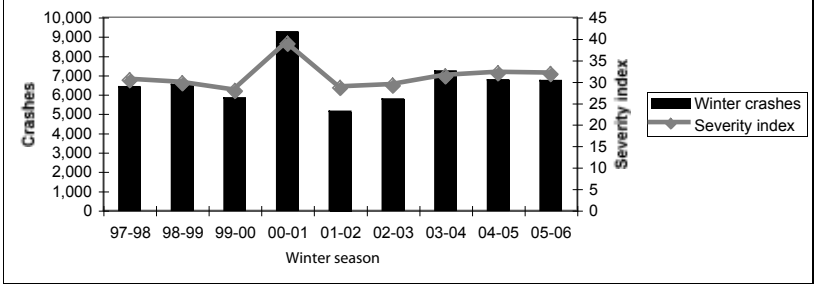
4E. Travel and Crashes

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 4.5. Statewide Winter Crashes and Severity Index



Source: WisDOT Bureau of Transportation Safety

This year, there were 6,724 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) declined slightly this year to a statewide average of 24.

Crash rates tend to increase in more severe winters. Figure 4.5 shows the trends in total crashes statewide over the last nine years overlaid with the winter severity index.

Crashes and Vehicle Miles Traveled

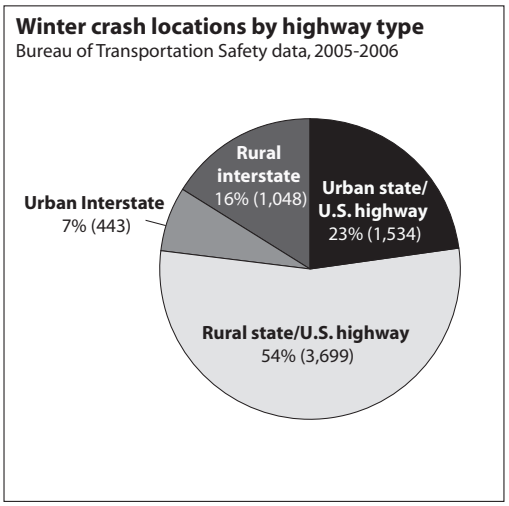
Table 4.7 shows that more urban regions such as the Southeast Region tend to have fewer winter weather crashes per 100 million vehicle miles traveled. This is partly due to the fact that a single crash in a county with low VMT has a bigger impact on the overall crash rate. In addition, urban regions have more highways with 24-hour coverage, which means that these roadways are more likely to be in passable condition. Table 4.12 on page 96 gives the estimated number of vehicle miles traveled in each county this winter (November 2005 to April 2006), and the number of crashes that occurred in each county.

Table 4.7. Crashes and Vehicle Miles Traveled by Region

Region	VMT (100 million)	Crashes	Crashes per 100 million VMT	Average Winter Severity Index
NC	34.40	1,072	31	40.16
NE	50.45	1,226	24	32.48
NW	39.18	1,102	28	32.60
SE	84.61	1,408	17	20.32
SW	71.39	1,916	27	25.93
Statewide	**280.02**	**6,724**	**24**	**31.80**

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 4.6 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 99 shows the breakdown of crashes in each county according to highway type.

Figure 4.6. 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 96. This winter, total VMT ranged from a low of 22.6 million in Menominee County to a high of 3.4 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

In 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 (70-75%) 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.

Highway Operations Customer Satisfaction Survey

In the spring of 1999, WisDOT surveyed Wisconsin residents on their opinions of highway maintenance and traffic operations on the state highway system. This survey replicated similar studies conducted during 1996 and 1997. Highlights of the 1999 survey included:

- Over 90% of respondents rated state and county efforts to provide "good winter driving conditions " as excellent or good.
- 58% of respondents reported having seen or heard a WisDOT media spot or poster about winter driving conditions. Of those who had, 74% 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 for Section 4: Performance

Table 4.8. Winter Maintenance Sections

NC Region

County	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section	Winter Service Group
Adams	192.09	5	38.42	D
Florence	141.07	3	47.02	D
Forest	312.38	6	52.06	D
Green Lake	149.06	3	49.69	D
Iron	246.87	6	41.15	D
Langlade	292.69	6	48.78	D
Lincoln	389.97	8	48.75	C
Marathon	859.87	18	47.77	A
Marquette	244.80	5	48.96	B
Menominee	90.26	2	45.13	D
Oneida	389.71	10	38.97	B
Portage	485.96	13	37.38	A
Price	320.57	6	53.43	D
Shawano	508.94	14	36.35	B
Vilas	305.18	5	61.04	C
Waupaca	535.10	12	44.59	C
Waushara	344.05	8	43.01	B
Wood	362.92	17	21.35	C
Region Average			**44.66**	

NW Region

County	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section	Winter Service Group
Ashland	247.57	5	49.51	D
Barron	421.98	11	38.36	D
Bayfield	316.90	6	52.82	D
Buffalo	302.86	7	43.27	D
Burnett	253.46	5	50.69	D
Chippewa	649.87	16	40.62	B
Clark	401.56	11	36.51	C
Douglas	436.65	9	48.52	C
Dunn	518.95	11	47.18	B
Eau Claire	548.70	9	60.97	A
Jackson	499.14	9	55.46	C
Pepin	106.24	2	53.12	D
Pierce	361.23	7	51.60	D
Polk	385.06	7	55.01	D
Rusk	238.39	4	59.60	D
Saint Croix	614.24	10	61.42	B
Sawyer	367.44	6	61.24	D
Taylor	234.08	4	58.52	D
Trempeleau	415.92	10	41.59	C
Washburn	368.98	7	52.71	C
Region Average			**50.94**	

NE Region

County	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section	Winter Service Group
Brown	677.81	17	39.87	A
Calumet	202.80	6	33.80	C
Door	231.83	6	38.64	C
Fond du Lac	587.02	14	41.93	C
Kewaunee	111.29	3	37.10	C
Manitowoc	415.45	12	34.62	B
Marinette	313.81	7	44.83	D
Oconto	411.99	9	45.78	C
Outagamie	504.94	15	33.66	B
Sheboygan	516.49	11	46.95	B
Winnebago	553.42	13	42.57	A
Region Average			**39.98**	

SW Region

County	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section	Winter Service Group
Columbia	775.73	15	51.72	B
Crawford	377.95	7	53.99	C
Dane	1668.10	35	47.66	A
Dodge	606.62	12	50.55	B
Grant	614.85	11	55.90	C
Green	311.45	7	44.49	D
Iowa	450.33	9	50.04	C
Jefferson	446.57	13	34.35	B
Juneau	498.09	10	49.81	C
LaCrosse	460.76	13	35.44	A
Lafayette	292.70	6	48.78	C
Monroe	643.21	13	49.48	C
Richland	329.08	7	47.01	D
Rock	592.51	13	45.58	B
Sauk	591.05	12	49.25	B
Vernon	448.75	10	44.88	C
Region Average			**47.43**	

SE Region

County	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section	Winter Service Group
Kenosha	550.15	19	28.96	A
Milwaukee	1777.00	35	50.77	A
Ozaukee	304.03	8	38.00	A
Racine	593.65	16	37.10	A
Walworth	689.25	13	53.02	B
Washington	585.03	14	41.79	B
Waukesha	1027.10	19	54.06	A

	Lane Miles	Winter Patrol Sections 2006 Survey	Lane Miles per Patrol Section
Statewide Totals	33,021.52	733.0	45.05
Statewide Averages	458.63	10.2	45.05
Group A Averages	792.21	17.92	43.38
Group B Averages	529.07	12.00	44.59
Group C Averages	408.87	9.14	45.74
Group D Averages	269.75	5.55	49.35

Final totals as of 10/19/2006

Table 4.9. Storm Start vs. Crew Out (Group A)

From Winter Storm Reports, 2005-2006

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculations because an individual storm may have several precipitation 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)						
LA CROSSE	SW	2.54	2.47	2.65	2.65	2.42	31.57	$30.39
MARATHON	NC	1.13	1.03	0.94	0.99	1.11	43.30	$31.79
WINNEBAGO	NE	2.45	2.50	2.19	2.57	2.64	33.06	$33.72
BROWN	NE	5.49	5.96	5.34	5.52	5.52	30.36	$37.86
PORTAGE	NC	1.68	1.68	1.45	1.57	1.63	32.51	$38.66
RACINE	SE	1.10	1.06	0.76	1.00	1.00	20.68	$41.17
EAU CLAIRE	NW	1.74	1.39	1.33	1.33	1.33	21.96	$46.81
DANE	SW	0.27	0.18	0.17	0.28	0.12	27.92	$46.98
KENOSHA	SE	0.54	0.54	1.00	0.67	0.55	16.99	$50.24
OZAUKEE	SE	0.96	0.86	0.42	0.77	0.77	21.18	$51.31
WAUKESHA	SE	1.47	1.48	2.16	1.84	1.57	20.60	$63.85
MILWAUKEE	SE	0.00	0.00	0.00	0.00	0.00	17.03	$84.21
Group A Averages		1.61	1.60	1.53	1.60	1.55	26.43	$46.42

Table 4.9. Storm Start vs. Crew Out (Group B)

From Winter Storm Reports, 2005-2006

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculations because an individual storm may have several precipitation 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	2.08	2.05	2.12	2.31	2.21	28.77	$29.26
SHEBOYGAN	NE	1.60	1.48	1.68	1.22	1.64	28.11	$29.97
SHAWANO	NC	3.08	2.59	2.35	2.08	2.59	35.68	$30.05
SAINT CROIX	NW	1.52	1.27	1.19	1.02	1.26	33.05	$30.28
MANITOWOC	NE	2.64	2.89	2.81	2.18	2.83	25.52	$31.22
MARQUETTE	NC	3.32	3.50	3.77	3.19	3.88	33.94	$33.01
ONEIDA	NC	2.96	3.38	3.10	3.19	3.11	48.72	$33.80
OUTAGAMIE	NE	1.40	1.84	1.63	1.91	1.46	31.74	$35.08
WASHINGTON	SE	1.35	1.52	1.57	1.22	1.52	27.89	$38.64
DUNN	NW	1.09	1.08	0.99	1.11	1.11	25.72	$41.79
SAUK	SW	1.42	1.42	1.45	0.18	1.29	25.02	$47.16
DODGE	SW	1.04	1.00	1.23	1.16	1.16	25.98	$47.22
CHIPPEWA	NW	0.80	0.88	1.07	1.85	1.13	24.46	$50.24
JEFFERSON	SW	-0.50	-0.33	-0.16	-1.16	-0.06	19.01	$51.21
COLUMBIA	SW	3.28	0.51	0.14	0.77	0.77	21.54	$54.35
ROCK	SW	1.17	1.13	1.33	1.33	1.19	12.54	$58.29
WALWORTH	SE	0.01	0.01	0.01	0.01	0.01	17.90	$63.07
Group B Averages		1.66	1.54	1.55	1.39	1.59	27.39	$41.45

Table 4.9. Storm Start vs. Crew Out (Group C)

From Winter Storm Reports, 2005-2006

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculations because an individual storm may have several precipitation 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)						
LAFAYETTE	SW	2.78	2.65	3.08	1.83	2.68	21.32	$19.68
MONROE	SW	2.09	1.72	1.61	1.35	1.72	41.21	$20.29
FOND DU LAC	NE	1.29	1.81	1.95	1.65	1.63	38.76	$22.26
LINCOLN	NC	3.69	3.59	3.81	3.63	3.58	45.73	$22.89
VERNON	SW	2.74	2.73	2.71	2.26	2.71	31.46	$25.78
TREMPEALEAU	NW	0.00	0.00	0.00	0.00	0.00	35.06	$25.99
CRAWFORD	SW	3.40	3.07	3.27	3.48	3.48	26.49	$27.52
GRANT	SW	5.10	6.12	4.62	3.42	5.40	27.37	$27.67
KEWAUNEE	NE	7.44	5.88	5.22	7.66	5.95	26.78	$28.11
DOUGLAS	NW	2.02	1.93	1.87	1.92	1.92	46.80	$28.14
OCONTO	NE	2.73	2.66	2.67	2.23	2.65	38.77	$28.53
IOWA	SW	2.62	2.91	3.40	2.82	2.82	28.61	$30.15
DOOR	NE	2.64	2.70	2.69	3.21	2.70	36.03	$31.13
JUNEAU	SW	1.81	2.15	2.27	1.76	2.11	28.77	$31.39
WASHBURN	NW	6.70	5.99	5.66	6.37	5.69	32.94	$31.45
CALUMET	NE	3.11	2.89	3.37	1.57	3.02	29.57	$32.38
JACKSON	NW	2.21	2.00	1.90	2.42	1.88	29.80	$32.53
VILAS	NC	3.76	4.17	3.40	3.66	3.66	43.31	$34.04
WOOD	NC	2.49	2.51	2.46	2.58	2.48	32.51	$36.63
WAUPACA	NC	2.43	2.31	2.13	2.71	2.33	29.10	$37.92
CLARK	NW	0.52	0.38	0.36	1.35	0.16	27.34	$42.59
Group C Averages		2.93	2.87	2.78	2.76	2.79	33.22	$29.38

Table 4.9. Storm Start vs. Crew Out (Group D)

From Winter Storm Reports, 2005-2006

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculations because an individual storm may have several precipitation 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)						
BUFFALO	NW	3.83	3.36	3.31	3.29	3.33	33.81	$21.24
ASHLAND	NW	4.02	4.23	3.77	4.03	4.06	50.92	$21.76
FLORENCE	NC	2.92	2.95	2.93	3.76	3.07	49.18	$22.35
GREEN LAKE	NC	4.30	3.64	3.75	3.54	3.95	30.15	$23.14
BAYFIELD	NW	4.45	4.39	3.78	3.75	4.51	53.04	$23.66
RICHLAND	SW	3.95	3.67	3.95	1.94	3.73	24.42	$25.12
SAWYER	NW	5.69	5.22	4.88	4.82	5.23	30.95	$25.54
PIERCE	NW	4.01	3.89	4.04	3.61	4.03	31.58	$25.77
FOREST	NC	3.03	2.85	2.84	2.65	2.85	51.03	$25.96
LANGLADE	NC	5.12	3.57	3.49	4.11	3.51	47.97	$26.06
RUSK	NW	6.63	6.50	5.36	5.01	5.74	30.00	$26.14
PRICE	NC	3.94	3.90	3.86	3.94	3.92	45.86	$26.97
MARINETTE	NE	2.33	2.46	2.36	2.74	2.35	38.56	$28.15
BURNETT	NW	8.00	6.34	6.91	5.57	6.24	27.78	$28.75
POLK	NW	3.04	2.98	3.19	2.03	3.07	35.79	$30.29
IRON	NC	2.28	2.60	2.26	2.38	2.38	60.04	$32.31
MENOMINEE	NC	3.85	3.61	3.47	2.89	3.55	31.90	$34.77
TAYLOR	NW	1.48	1.32	1.21	1.36	1.21	34.31	$35.02
BARRON	NW	4.08	3.18	3.08	5.86	3.01	26.95	$36.08
GREEN	SW	2.23	2.20	3.25	2.82	2.23	21.68	$36.10
ADAMS	NC	3.74	3.42	2.80	2.45	3.41	33.10	$36.28
PEPIN	NW	2.93	3.56	2.00	2.74	3.92	19.84	$38.55
Group D Averages		3.90	3.63	3.48	3.42	3.60	36.77	$28.64

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2006

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Material Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2006 Winter Costs	2006 LOS Lane Miles	Winter Costs per Lane Mile
REGION 1 / SOUTHWEST												
Columbia	$333,515	$430	$400,479	$516	$96,175	$124	$37,001	$593,952	12,912	$1,461,122	775.73	$1,884
Crawford	$148,150	$392	$144,863	$383	$12,450	$33	$13,710	$103,980	2,824	$423,153	377.95	$1,120
Dane	$666,456	$400	$688,162	$413	$81,680	$49	$64,633	$878,884	26,314	$2,379,815	1,668.14	$1,427
Dodge	$240,790	$397	$293,940	$485	$13,055	$22	$24,587	$353,415	10,179	$925,787	606.62	$1,526
Grant	$150,630	$245	$185,596	$302	$24,734	$40	$16,062	$180,956	5,268	$557,978	614.85	$908
Green	$98,590	$317	$103,579	$333	$2,984	$10	$9,216	$114,564	2,716	$328,933	311.45	$1,056
Iowa	$165,374	$367	$175,269	$389	$19,099	$42	$16,188	$159,902	4,474	$535,832	450.33	$1,190
Jefferson	$167,403	$375	$192,939	$432	$20,673	$46	$16,231	$249,228	6,989	$646,474	446.57	$1,448
Juneau	$160,861	$323	$141,007	$283	$13,541	$27	$14,188	$198,145	5,038	$527,742	498.09	$1,060
La Crosse	$174,875	$380	$216,555	$470	$33,055	$72	$19,020	$127,745	4,465	$571,250	460.76	$1,240
Lafayette	$81,046	$277	$97,681	$334	$20,612	$70	$8,943	$45,918	1,507	$254,200	292.70	$868
Monroe	$193,123	$300	$267,149	$415	$8,689	$14	$21,061	$276,250	7,606	$766,272	643.21	$1,191
Richland	$70,208	$213	$77,053	$234	$9,815	$30	$7,068	$39,833	1,198	$203,977	329.08	$620
Rock	$201,401	$340	$228,990	$386	$66,339	$112	$22,200	$274,381	7,316	$793,311	592.51	$1,339
Sauk	$183,038	$310	$217,000	$367	$7,221	$12	$18,212	$293,193	7,666	$718,664	591.05	$1,216
Vernon	$134,861	$301	$134,040	$299	$20,783	$46	$13,036	$188,056	5,148	$490,776	448.75	$1,094
SW TOTAL	**$3,170,321**	**$348**	**$3,564,302**	**$391**	**$450,905**	**$50**	**$321,356**	**$4,078,402**	**111,620**	**$11,585,286**	**9,107.79**	**$1,272**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2006

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Material Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2006 Winter Costs	2006 LOS Lane Miles	Winter Costs per Lane Mile
REGION 2 / SOUTHEAST												
Kenosha	$279,422	$508	$178,048	$324	$6,139	$11	$20,821	$147,449	4,897	$631,879	550.15	$1,149
Milwaukee	$1,705,998	$960	$616,267	$347	$30,117	$17	$0	$874,003	29,792	$3,226,385	1,777.00	$1,816
Ozaukee	$193,594	$637	$180,129	$592	$6,112	$20	$17,072	$136,377	4,855	$533,284	304.03	$1,754
Racine	$243,533	$410	$206,534	$348	$2,923	$5	$20,361	$149,434	5,385	$622,785	593.65	$1,049
Walworth	$299,431	$434	$273,166	$396	$17,380	$25	$25,924	$335,929	10,397	$951,830	689.25	$1,381
Washington	$282,481	$483	$294,431	$503	$11,572	$20	$26,433	$292,799	9,257	$907,716	585.03	$1,552
Waukesha	$333,931	$325	$336,493	$328	$12,674	$12	$30,739	$636,261	19,084	$1,350,098	1,027.07	$1,315
SE TOTAL	**$3,338,390**	**$604**	**$2,085,068**	**$377**	**$86,917**	**$16**	**$141,350**	**$2,572,252**	**83,667**	**$8,223,977**	**5,526.18**	**$1,488**
REGION 3 / NORTHEAST												
Brown	$330,883	$488	$441,103	$651	$21,951	$32	$34,884	$271,872	10,010	$1,100,693	677.81	$1,624
Calumet	$100,689	$496	$111,870	$552	$2,496	$12	$9,639	$56,237	1,893	$280,931	202.80	$1,385
Door	$117,946	$509	$107,047	$462	$38,184	$165	$11,840	$68,399	2,205	$343,416	231.83	$1,481
Fond du Lac	$283,241	$483	$252,878	$431	$10,062	$17	$24,470	$197,508	6,176	$768,159	587.02	
Kewanee	$36,630	$329	$58,235	$523	$1,652	$15	$4,297	$23,551	730	$124,365	111.29	$1,117
Manitowoc	$234,281	$564	$164,231	$395	$31,661	$76	$19,251	$121,929	3,893	$571,353	415.45	$1,375
Marinette	$123,764	$394	$130,376	$415	$5,266	$17	$11,645	$126,873	3,905	$397,924	313.81	$1,268
Oconto	$140,188	$340	$168,675	$409	$28,836	$70	$15,196	$143,974	4,725	$496,869	411.99	$1,206
Outagamie	$272,568	$540	$309,085	$612	$6,936	$14	$26,234	$216,277	6,934	$831,100	504.94	$1,646
Sheboygan	$229,871	$445	$241,641	$468	$13,318	$26	$21,429	$235,897	7,084	$742,156	516.49	$1,437
Winnebago	$256,224	$463	$290,209	$524	$25,467	$46	$25,703	$237,755	7,511	$835,358	553.42	$1,509
NE TOTAL	**$2,126,285**	**$470**	**$2,275,350**	**$503**	**$185,829**	**$41**	**$204,588**	**$1,700,272**	**55,066**	**$6,492,324**	**4,526.85**	**$1,434**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2006

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Material Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2006 Winter Costs	2006 LOS Lane Miles	Winter Costs per Lane Mile
REGION 4 / NORTHCENTRAL												
Adams	$83,459	$434	$80,477	$419	$29,997	$156	$7,651	$116,900	2,798	$318,484	192.09	$1,658
Florence	$62,628	$444	$102,497	$727	$10,635	$75	$7,903	$98,637	2,562	$282,300	141.07	$2,001
Forest	$179,109	$573	$255,900	$819	$37,890	$121	$21,078	$176,308	4,663	$670,285	312.38	$2,146
Green Lake	$59,235	$397	$46,787	$314	$4,666	$31	$4,981	$29,806	870	$145,475	149.06	$976
Iron	$207,843	$842	$236,352	$957	$10,230	$41	$20,436	$184,946	4,533	$659,807	246.87	$2,673
Langlade	$166,858	$570	$204,908	$700	$13,945	$48	$17,229	$153,414	4,382	$556,354	292.69	$1,901
Lincoln	$189,094	$485	$240,228	$616	$24,420	$63	$20,404	$155,340	4,103	$629,486	389.97	$1,614
Marathon	$352,686	$410	$421,796	$491	$24,581	$29	$35,839	$420,166	11,216	$1,255,068	859.87	$1,460
Marquette	$102,393	$418	$96,636	$395	$23,161	$95	$9,911	$92,155	2,624	$324,256	244.80	$1,325
Menominee	$15,976	$177	$31,495	$349	$5,360	$59	$2,377	$43,604	1,379	$98,812	90.26	$1,095
Oneida	$248,313	$637	$270,765	$695	$9,350	$24	$23,767	$211,010	5,430	$763,205	389.71	$1,958
Portage	$222,856	$459	$204,229	$420	$15,493	$32	$19,633	$170,279	5,029	$632,490	485.96	$1,302
Price	$154,877	$483	$176,160	$550	$12,897	$40	$15,082	$192,032	4,557	$551,048	320.57	$1,719
Shawano	$208,137	$409	$231,021	$454	$37,091	$73	$21,399	$161,579	5,042	$659,227	508.94	$1,295
Vilas	$175,709	$576	$235,394	$771	$23,961	$79	$19,522	$259,776	6,150	$714,362	305.18	$2,341
Waupaca	$220,659	$412	$229,177	$428	$29,579	$55	$21,509	$146,075	4,403	$646,999	535.10	$1,209
Waushara	$112,462	$327	$103,931	$302	$11,459	$33	$10,247	$96,496	2,673	$334,595	344.05	$973
Wood	$211,907	$584	$153,155	$422	$4,023	$11	$16,607	$113,278	2,889	$498,970	362.92	$1,375
NC TOTAL	**$2,974,201**	**$482**	**$3,320,908**	**$538**	**$328,738**	**$53**	**$295,575**	**$2,821,801**	**75,303**	**$9,741,223**	**6,171.49**	**$1,578**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2006

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Material Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2006 Winter Costs	2006 LOS Lane Miles	Winter Costs per Lane Mile
REGION 5 / NORTHWEST												
Ashland	$118,278	$478	$167,846	$678	$18,117	$73	$13,691	$135,523	3,716	$453,455	247.57	$1,832
Barron	$210,234	$498	$282,240	$669	$9,153	$22	$22,519	$131,176	3,062	$655,322	421.98	$1,553
Bayfield	$149,787	$473	$192,214	$607	$5,182	$16	$15,510	$181,256	4,770	$543,949	316.90	$1,716
Buffalo	$70,233	$232	$87,318	$288	$8,977	$30	$7,154	$55,086	1,593	$228,768	302.86	$755
Burnett	$56,565	$223	$84,531	$334	$9,708	$38	$6,776	$146,177	3,401	$303,757	253.46	$1,198
Chippewa	$275,340	$424	$255,874	$394	$49,242	$76	$24,929	$312,194	7,545	$917,579	649.87	$1,412
Clark	$157,651	$393	$164,626	$410	$3,839	$10	$14,674	$166,384	3,776	$507,174	401.56	$1,263
Douglas	$179,823	$412	$261,490	$599	$40,256	$92	$21,412	$203,105	6,088	$706,086	436.65	$1,617
Dunn	$244,003	$470	$211,848	$408	$2,224	$4	$20,576	$236,901	5,999	$715,552	518.95	$1,379
Eau Claire	$196,406	$358	$221,285	$403	$51,660	$94	$20,281	$173,783	4,491	$663,415	548.70	$1,209
Jackson	$133,468	$267	$196,998	$395	$10,585	$21	$15,343	$239,821	6,603	$596,215	499.14	$1,194
Pepin	$40,509	$381	$32,054	$302	$3,851	$36	$3,415	$12,786	698	$92,615	106.24	$872
Pierce	$155,656	$431	$181,365	$502	$6,375	$18	$15,411	$199,906	4,838	$558,713	361.23	$1,547
Polk	$120,752	$314	$188,019	$488	$13,068	$34	$14,406	$174,696	4,640	$510,941	385.06	$1,327
Rusk	$58,836	$247	$100,675	$422	$10,530	$44	$7,318	$92,000	2,266	$269,359	238.39	$1,130
Sawyer	$101,682	$277	$132,048	$359	$15,426	$42	$11,212	$117,210	3,079	$377,578	367.44	$1,028
St. Croix	$238,686	$389	$273,310	$445	$55,217	$90	$25,239	$256,856	6,399	$849,308	614.24	$1,383
Taylor	$91,044	$389	$102,535	$438	$3,748	$16	$8,856	$117,274	2,582	$323,457	234.08	$1,382
Trempealeau	$114,221	$275	$141,712	$341	$8,562	$21	$11,845	$150,902	4,270	$427,242	415.92	$1,027
Washburn	$107,468	$291	$169,491	$459	$26,202	$71	$13,331	$185,159	5,098	$501,651	368.98	$1,360
NW TOTAL	**$2,820,642**	**$367**	**$3,447,479**	**$448**	**$351,922**	**$46**	**$293,898**	**$3,288,195**	**84,914**	**$10,202,136**	**7,689**	**$1,327**

Table 4.10. Winter Maintenance Costs per Lane Mile, Fiscal Year 2006

	Labor	Labor Costs per Lane Mile	Equipment	Equip. Costs per Lane Mile	Materials	Material Costs per Lane Mile	Admin.	Cost of Salt Used	Tons of Salt Used	Total FY 2006 Winter Costs	2006 LOS Lane Miles	Winter Costs per Lane Mile
STATEWIDE SUMMARY												
SW Region	**$3,170,321**	**$348**	**$3,564,302**	**$391**	**$450,905**	**$50**	**$321,356**	**$4,078,402**	**111,620**	**$11,585,286**	**9,107.79**	**$1,272**
SE Region	**$3,338,390**	**$604**	**$2,085,068**	**$377**	**$86,917**	**$16**	**$141,350**	**$2,572,252**	**83,667**	**$8,223,977**	**5,526.18**	**$1,488**
NE Region	**$2,126,285**	**$470**	**$2,275,350**	**$503**	**$185,829**	**$41**	**$204,588**	**$1,700,272**	**55,066**	**$6,492,324**	**4,526.85**	**$1,434**
NC Region	**$2,974,201**	**$482**	**$3,320,908**	**$538**	**$328,738**	**$53**	**$295,575**	**$2,821,801**	**75,303**	**$9,741,223**	**6,171.49**	**$1,578**
NW Region	**$2,820,642**	**$367**	**$3,447,479**	**$448**	**$351,922**	**$46**	**$293,898**	**$3,288,195**	**84,914**	**$10,202,136**	**7,689.22**	**$1,327**
Statewide Total	**$14,429,839**	**$437**	**$14,693,107**	**$445**	**$1,404,311**	**$43**	**$1,256,767**	**$14,460,922**	**410,570**	**$46,244,946**	**33,021.53**	**$1,400**

prepared by: Cathy Meinholz/Bureau of Highway Operations

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August 15, 2006

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

From Winter Storm Reports, 2005-2006

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
LA CROSSE	SW	460.76	31.57	64.9	3728	8.09	0.26	$442,000	$959	30.39
MARATHON	NC	859.87	43.30	56.5	13362	15.54	0.36	$1,184,000	$1,377	31.79
WINNEBAGO	NE	553.42	33.06	51.4	7001	12.65	0.38	$609,000	$1,115	33.72
BROWN	NE	677.81	30.36	50.1	8872	13.09	0.43	$778,000	$1,149	37.86
PORTAGE	NC	485.96	32.51	57.1	6278	12.92	0.40	$609,000	$1,257	38.66
RACINE	SE	593.65	20.68	47.4	5316	8.96	0.43	$505,000	$851	41.17
EAU CLAIRE	NW	548.70	21.96	44.8	5786	10.54	0.48	$564,000	$1,028	46.81
DANE	SW	1,668.14	27.92	47.7	27673	16.59	0.59	$2,188,000	$1,312	46.98
KENOSHA	SE	550.15	16.99	42.2	3987	7.25	0.43	$470,000	$854	50.24
OZAUKEE	SE	304.03	21.18	43.6	4855	15.97	0.75	$330,000	$1,087	51.31
WAUKESHA	SE	1,027.07	20.60	39.6	20097	19.57	0.95	$1,351,000	$1,315	63.85
MILWAUKEE	SE	1,777.00	17.03	37.6	31620	17.79	1.04	$2,536,000	$1,434	84.21
Group A Averages		792.21	26.43	48.6	11548	13.25	0.54	$963,833	$1,145	46.42

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

From Winter Storm Reports, 2005-2006

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	343.63	28.77	66.9	3202	9.32	0.32	$289,000	$842	29.26
SHEBOYGAN	NE	508.00	28.11	65.9	5215	10.27	0.37	$427,000	$842	29.97
SHAWANO	NC	493.00	35.68	65.7	4723	9.58	0.27	$528,000	$1,072	30.05
SAINT CROIX	NW	596.88	33.05	50.9	6834	11.45	0.35	$597,000	$1,001	30.28
MANITOWOC	NE	405.00	25.52	53.2	3373	8.33	0.33	$322,000	$797	31.22
MARQUETTE	NC	244.70	33.94	60.3	3530	14.43	0.43	$274,000	$1,120	33.01
ONEIDA	NC	372.48	48.72	98.5	6237	16.74	0.34	$613,000	$1,647	33.80
OUTAGAMIE	NE	515.00	31.74	58.0	7401	14.37	0.45	$571,000	$1,113	35.08
WASHINGTON	SE	602.08	27.89	70.6	9505	15.79	0.57	$640,000	$1,078	38.64
DUNN	NW	518.99	25.72	76.9	7078	13.64	0.53	$558,000	$1,075	41.79
SAUK	SW	520.48	25.02	49.5	8152	15.66	0.63	$614,000	$1,180	47.16
DODGE	SW	576.28	25.98	55.4	8817	15.30	0.59	$707,000	$1,227	47.22
CHIPPEWA	NW	643.66	24.46	55.9	7943	12.34	0.50	$791,000	$1,229	50.24
JEFFERSON	SW	437.75	19.01	45.7	6379	14.57	0.77	$426,000	$973	51.21
COLUMBIA	SW	716.94	21.54	41.2	10277	14.33	0.67	$839,000	$1,171	54.35
ROCK	SW	578.45	12.54	37.0	5110	8.83	0.70	$423,000	$731	58.29
WALWORTH	SE	655.53	17.90	42.9	10308	15.72	0.88	$739,000	$1,129	63.07

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

From Winter Storm Reports, 2005-2006

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		513.46	27.39	58.5	6711	12.98	0.51	$550,471	$1,072	41.45

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

From Winter Storm Reports, 2005-2006

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
LAFAYETTE	SW	378.70	21.32	40.8	1605	4.24	0.20	$159,000	$419	19.68
MONROE	SW	620.16	41.21	69.5	5817	9.38	0.23	$519,000	$836	20.29
FOND DU LAC	NE	595.45	38.76	55.7	5063	8.50	0.22	$514,000	$863	22.26
LINCOLN	NC	457.80	45.73	73.4	4675	10.21	0.22	$479,000	$1,047	22.89
VERNON	SW	431.20	31.46	64.4	4099	9.51	0.30	$350,000	$811	25.78
TREMPEALEAU	NW	409.11	35.06	64.4	5041	12.32	0.35	$373,000	$911	25.99
CRAWFORD	SW	372.78	26.49	48.9	2860	7.67	0.29	$272,000	$729	27.52
GRANT	SW	623.77	27.37	55.3	6903	11.07	0.40	$473,000	$758	27.67
KEWAUNEE	NE	110.00	26.78	82.8	615	5.59	0.21	$83,000	$753	28.11
DOUGLAS	NW	411.70	46.80	173.9	5011	12.17	0.26	$542,000	$1,317	28.14
OCONTO	NE	358.00	38.77	88.3	4430	12.37	0.32	$395,000	$1,106	28.53
IOWA	SW	439.99	28.61	45.5	4564	10.37	0.36	$380,000	$863	30.15
DOOR	NE	224.00	36.03	83.9	2422	10.81	0.30	$251,000	$1,121	31.13
JUNEAU	SW	498.09	28.77	61.4	6776	13.60	0.47	$450,000	$903	31.39
WASHBURN	NW	369.87	32.94	77.2	4064	10.99	0.33	$383,000	$1,036	31.45
CALUMET	NE	212.00	29.57	60.0	1806	8.52	0.29	$203,000	$957	32.38
JACKSON	NW	470.46	29.80	93.1	5969	12.69	0.43	$456,000	$970	32.53
VILAS	NC	311.00	43.31	114.4	5376	17.29	0.40	$459,000	$1,474	34.04

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

From Winter Storm Reports, 2005-2006

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
WOOD	NC	383.00	32.51	85.0	5338	13.94	0.43	$456,000	$1,191	36.63
WAUPACA	NC	514.38	29.10	72.2	6031	11.72	0.40	$568,000	$1,103	37.92
CLARK	NW	389.78	27.34	90.1	5036	12.92	0.47	$454,000	$1,164	42.59
Group C Averages		408.63	33.22	76.2	4452	10.76	0.33	$391,381	$968	29.38

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

From Winter Storm Reports, 2005-2006

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
BUFFALO	NW	304.64	33.81	54.1	1870	6.14	0.18	$219,000	$718	21.24
ASHLAND	NW	247.26	50.92	182.2	2779	11.24	0.22	$274,000	$1,108	21.76
FLORENCE	NC	151.40	49.18	70.9	2133	14.09	0.29	$166,000	$1,099	22.35
GREEN LAKE	NC	144.68	30.15	56.6	1062	7.34	0.24	$101,000	$698	23.14
BAYFIELD	NW	301.00	53.04	172.0	3700	12.29	0.23	$378,000	$1,255	23.66
RICHLAND	SW	335.13	24.42	54.2	1891	5.64	0.23	$206,000	$613	25.12
SAWYER	NW	364.56	30.95	74.8	2745	7.53	0.24	$288,000	$791	25.54
PIERCE	NW	361.23	31.58	59.1	4081	11.30	0.36	$294,000	$814	25.77
FOREST	NC	336.20	51.03	101.3	4660	13.86	0.27	$445,000	$1,325	25.96
LANGLADE	NC	318.60	47.97	87.0	4805	15.08	0.31	$398,000	$1,250	26.06
RUSK	NW	239.58	30.00	83.3	1604	6.70	0.22	$188,000	$784	26.14
PRICE	NC	314.00	45.86	69.7	4666	14.86	0.32	$388,000	$1,237	26.97
MARINETTE	NE	309.00	38.56	97.6	3773	12.21	0.32	$336,000	$1,086	28.15
BURNETT	NW	253.46	27.78	76.2	2247	8.87	0.32	$202,000	$799	28.75
POLK	NW	383.32	35.79	63.4	4401	11.48	0.32	$415,000	$1,084	30.29
IRON	NC	238.00	60.04	157.2	4791	20.13	0.34	$462,000	$1,940	32.31
MENOMINEE	NC	87.00	31.90	59.2	1579	18.15	0.57	$97,000	$1,109	34.77
TAYLOR	NW	233.06	34.31	65.2	3360	14.42	0.42	$280,000	$1,202	35.02

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

From Winter Storm Reports, 2005-2006

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
BARRON	NW	399.00	26.95	71.7	2663	6.67	0.25	$388,000	$972	36.08
GREEN	SW	304.28	21.68	45.2	1801	5.92	0.27	$238,000	$783	36.10
ADAMS	NC	190.70	33.10	71.9	3376	17.70	0.53	$229,000	$1,201	36.28
PEPIN	NW	106.24	19.84	64.1	823	7.75	0.39	$81,000	$765	38.55
Group D Averages		269.20	36.77	83.5	2946	11.33	0.31	$276,045	$1,029	28.64

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

November 2005 - March 2006

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
NC Region			
ADAMS	116,900,000	21	18
FLORENCE	30,700,000	16	52
FOREST	57,200,000	22	38
GREEN LAKE	95,500,000	20	21
IRON	53,300,000	9	17
LANGLADE	106,000,000	30	28
LINCOLN	212,500,000	106	50
MARATHON	736,700,000	250	34
MARQUETTE	131,200,000	22	17
MENOMINEE	22,600,000	3	13
ONEIDA	226,400,000	72	32
PORTAGE	380,000,000	121	32
PRICE	88,200,000	25	28
SHAWANO	274,400,000	84	31
VILAS	143,300,000	52	36
WAUPACA	275,100,000	85	31
WAUSHARA	173,000,000	42	24
WOOD	316,500,000	92	29
Total	**3,439,500,000**	**1,072**	**31**
NE Region			
BROWN	1,146,600,000	249	22
CALUMET	185,500,000	37	20
DOOR	173,000,000	30	17
FOND DU LAC	515,500,000	168	33
KEWAUNEE	87,600,000	8	9
MANITOWOC	405,400,000	100	25
MARINETTE	222,300,000	43	19
OCONTO	241,300,000	52	22
OUTAGAMIE	762,700,000	167	22
SHEBOYGAN	487,900,000	116	24
WINNEBAGO	816,700,000	256	31
Total	**5,044,500,000**	**1,226**	**24**

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

November 2005 - March 2006

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
NW Region			
ASHLAND	90,300,000	27	30
BARRON	270,000,000	58	21
BAYFIELD	102,700,000	30	29
BUFFALO	83,700,000	23	27
BURNETT	79,800,000	26	33
CHIPPEWA	392,600,000	64	16
CLARK	191,100,000	43	23
DOUGLAS	237,800,000	70	29
DUNN	290,200,000	104	36
EAU CLAIRE	472,000,000	119	25
JACKSON	258,600,000	115	44
PEPIN	35,100,000	8	23
PIERCE	145,000,000	67	46
POLK	201,000,000	40	20
RUSK	75,000,000	18	24
SAINT CROIX	508,800,000	169	33
SAWYER	93,500,000	15	16
TAYLOR	89,000,000	17	19
TREMPEALEAU	177,300,000	46	26
WASHBURN	124,400,000	43	35
Total	**3,917,900,000**	**1,102**	**28**
SE Region			
KENOSHA	710,200,000	144	20
MILWAUKEE	3,418,400,000	371	11
OZAUKEE	470,700,000	75	16
RACINE	762,900,000	167	22
WALWORTH	532,600,000	124	23
WASHINGTON	626,000,000	179	29
WAUKESHA	1,940,100,000	348	18
Total	**8,460,900,000**	**1,408**	**17**

Table 4.12. Crashes per 100 Million Vehicle Miles of Travel

November 2005 - March 2006

COUNTY	WINTER VMT	CRASHES	CRASHES/ 100,000,000 VMT
SW Region			
COLUMBIA	486,400,000	123	25
CRAWFORD	103,000,000	39	38
DANE	2,272,800,000	457	20
DODGE	447,700,000	101	23
GRANT	416,800,000	79	19
GREEN	149,100,000	50	34
IOWA	174,300,000	55	32
JEFFERSON	462,300,000	78	17
JUNEAU	297,900,000	140	47
LA CROSSE	473,100,000	171	36
LAFAYETTE	99,700,000	35	35
MONROE	350,800,000	171	49
RICHLAND	91,900,000	52	57
ROCK	794,500,000	197	25
SAUK	377,800,000	104	28
VERNON	141,000,000	64	45
Total	**7,139,100,000**	**1,916**	**27**
Statewide Totals	**28,001,900,000**	**6,724**	**24**

Table 4.13. Motor Vehicle Crashes* on Roads with Snow/Ice/Slush

Nov. 1, 2005 - April 30, 2006 — State, US and Interstate Highways Only**

NC Region

County	Total	Urban STH	Rural STH	Urban IH	Rural IH	Urban State Highway			Rural State Highway		
						Non-div	Divided	Unkn	Non-div	Divided	Unkn
ADAMS	21	0	21	0	0	0	0	0	21	0	0
FLORENCE	16	0	16	0	0	0	0	0	16	0	0
FOREST	22	0	22	0	0	0	0	0	22	0	0
GREEN LAKE	20	2	18	0	0	2	0	0	18	0	0
IRON	9	0	9	0	0	0	0	0	9	0	0
LANGLADE	30	6	24	0	0	4	1	1	24	0	0
LINCOLN	106	4	102	0	0	4	0	0	32	70	0
MARATHON	250	60	170	0	20	27	33	0	68	101	1
MARQUETTE	22	0	9	0	13	0	0	0	9	0	0
MENOMINEE	3	0	3	0	0	0	0	0	3	0	0
ONEIDA	72	8	64	0	0	2	6	0	57	6	1
PORTAGE	121	27	47	15	32	14	12	1	27	20	0
PRICE	25	0	25	0	0	0	0	0	25	0	0
SHAWANO	84	5	79	0	0	5	0	0	33	46	0
VILAS	52	0	52	0	0	0	0	0	50	2	0
WAUPACA	85	6	79	0	0	4	2	0	40	39	0
WAUSHARA	42	0	31	0	11	0	0	0	27	3	1
WOOD	92	54	38	0	0	17	37	0	34	4	0
Total	1,072	172	809	15	76	79	91	2	515	291	3

NE Region

County	Total	Urban STH	Rural STH	Urban IH	Rural IH	Urban State Highway			Rural State Highway		
						Non-div	Divided	Unkn	Non-div	Divided	Unkn
BROWN	249	179	38	21	11	42	136	1	11	27	0
CALUMET	37	5	32	0	0	0	5	0	30	2	0
DOOR	30	3	27	0	0	0	3	0	25	2	0
FOND DU LAC	168	32	136	0	0	17	15	0	69	67	0
KEWAUNEE	8	0	8	0	0	0	0	0	8	0	0
MANITOWOC	100	40	26	2	32	23	17	0	23	3	0
MARINETTE	43	2	41	0	0	1	1	0	37	4	0
OCONTO	52	0	52	0	0	0	0	0	28	24	0
OUTAGAMIE	167	62	105	0	0	31	31	0	55	48	2
SHEBOYGAN	116	28	62	0	26	20	8	0	37	25	0
WINNEBAGO	256	48	208	0	0	28	20	0	56	152	0
Total	1,226	399	735	23	69	162	236	1	379	354	2

Table 4.13. Motor Vehicle Crashes* on Roads with Snow/Ice/Slush

Nov. 1, 2005 - April 30, 2006 — State, US and Interstate Highways Only**

NW Region

County	Total	Urban STH	Rural STH	Urban IH	Rural IH	Urban State Highway Non-div	Urban State Highway Divided	Urban State Highway Unkn	Rural State Highway Non-div	Rural State Highway Divided	Rural State Highway Unkn
ASHLAND	27	8	19	0	0	7	1	0	19	0	0
BARRON	58	4	54	0	0	3	1	0	27	27	0
BAYFIELD	30	0	30	0	0	0	0	0	30	0	0
BUFFALO	23	0	23	0	0	0	0	0	21	2	0
BURNETT	26	0	26	0	0	0	0	0	24	2	0
CHIPPEWA	64	7	57	0	0	3	4	0	26	31	0
CLARK	43	0	43	0	0	0	0	0	33	10	0
DOUGLAS	70	25	40	5	0	7	18	0	14	26	0
DUNN	104	15	41	5	43	11	4	0	36	5	0
EAU CLAIRE	119	39	31	2	47	3	36	0	27	4	0
JACKSON	115	0	24	0	91	0	0	0	20	3	1
PEPIN	8	0	8	0	0	0	0	0	8	0	0
PIERCE	67	9	58	0	0	7	2	0	57	1	0
POLK	40	0	40	0	0	0	0	0	40	0	0
RUSK	18	0	18	0	0	0	0	0	18	0	0
SAINT CROIX	169	4	92	11	62	3	1	0	69	23	0
SAWYER	15	0	15	0	0	0	0	0	15	0	0
TAYLOR	17	0	17	0	0	0	0	0	17	0	0
TREMPEALEAU	46	0	43	0	3	0	0	0	43	0	0
WASHBURN	43	0	43	0	0	0	0	0	17	25	1
Total	1,102	111	722	23	246	44	67	0	561	159	2

SE Region

County	Total	Urban STH	Rural STH	Urban IH	Rural IH	Urban State Highway Non-div	Urban State Highway Divided	Urban State Highway Unkn	Rural State Highway Non-div	Rural State Highway Divided	Rural State Highway Unkn
KENOSHA	144	48	64	1	31	34	14	0	25	39	0
MILWAUKEE	371	178	0	193	0	38	140	0	0	0	0
OZAUKEE	75	20	14	20	21	14	6	0	8	6	0
RACINE	167	74	49	2	42	40	34	0	44	5	0
WALWORTH	124	13	81	3	27	9	4	0	52	29	0
WASHINGTON	179	52	127	0	0	21	31	0	53	74	0
WAUKESHA	348	138	90	72	48	33	104	1	57	33	0
Total	1,408	523	425	291	169	189	333	1	239	186	0

Table 4.13. Motor Vehicle Crashes* on Roads with Snow/Ice/Slush

Nov. 1, 2005 - April 30, 2006 — State, US and Interstate Highways Only**

SW Region

County	Total	Urban STH	Rural STH	Urban IH	Rural IH	Urban State Highway Non-div	Urban State Highway Divided	Urban State Highway Unkn	Rural State Highway Non-div	Rural State Highway Divided	Rural State Highway Unkn
COLUMBIA	123	6	58	7	52	2	3	1	51	7	0
CRAWFORD	39	9	30	0	0	9	0	0	29	1	0
DANE	457	147	178	30	102	18	128	1	92	86	0
DODGE	101	20	81	0	0	18	2	0	49	32	0
GRANT	79	0	79	0	0	0	0	0	58	21	0
GREEN	50	4	46	0	0	0	4	0	44	2	0
IOWA	55	0	55	0	0	0	0	0	27	27	1
JEFFERSON	78	15	41	0	22	12	3	0	37	4	0
JUNEAU	140	0	33	0	107	0	0	0	31	2	0
LA CROSSE	171	60	58	21	32	20	40	0	38	19	1
LAFAYETTE	35	0	35	0	0	0	0	0	26	9	0
MONROE	171	20	48	8	95	16	4	0	47	1	0
RICHLAND	52	0	52	0	0	0	0	0	44	8	0
ROCK	197	35	87	25	50	13	22	0	78	9	0
SAUK	104	13	63	0	28	10	2	1	53	10	0
VERNON	64	0	64	0	0	0	0	0	64	0	0
Total	1,916	329	1,008	91	488	118	208	3	768	238	2

STH = State highways or non-interstate US 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.

*Does not include deer or other animal crashes
**2006 figures are preliminary at this time.

5 Looking Ahead

As an ongoing effort to continue to provide a high level of winter maintenance service on the state highway system through the most efficient and economical means possible, WisDOT has established two sets of goals for the 2006-2007 winter season, one for WisDOT and one for the county highway departments.

WisDOT Goals:

1. Continue to improve the winter storm event electronic reporting system.
2. Explore modifying the Winter Severity Index for possible use in budgeting and planning.
3. Schedule annual RWIS and winter operations training efforts, including regional workshops.
4. Continue winter maintenance public relations efforts.
5. Continue development of an online winter operations "best practices" reference manual.
6. Continue to participate in regional and national winter maintenance projects such as Aurora, the RWIS multistate user group, the Midwest Snow and Ice Control workshop, the Clear Roads pooled fund project, and Clarus.
7. Continue to develop the Compass program's winter operations performance measures and measure targets.

County Highway Department Goals:

1. Continue use of salt brine, magnesium chloride, or agriculture-based products for prewetting and anti-icing applications.
2. Expand the use of anti-icing technology.
3. Expand the use of mobile infrared pavement temperature sensors on county patrol trucks.
4. Continue to test and evaluate anti-icing overlays installed in Forest and Douglas Counties.
5. Continue to test and evaluate alternative salt spreaders and snowplow blades.
6. Provide ground speed controllers for salt spreaders on all state winter patrol sections by November 1, 2010, in accordance with Chapter 36.25 of the state Maintenance Manual.

Upcoming Activities

WisDOT's ongoing training efforts include regional Weather Workshops in October 2006 and Winter Operations Workshops in April 2007.